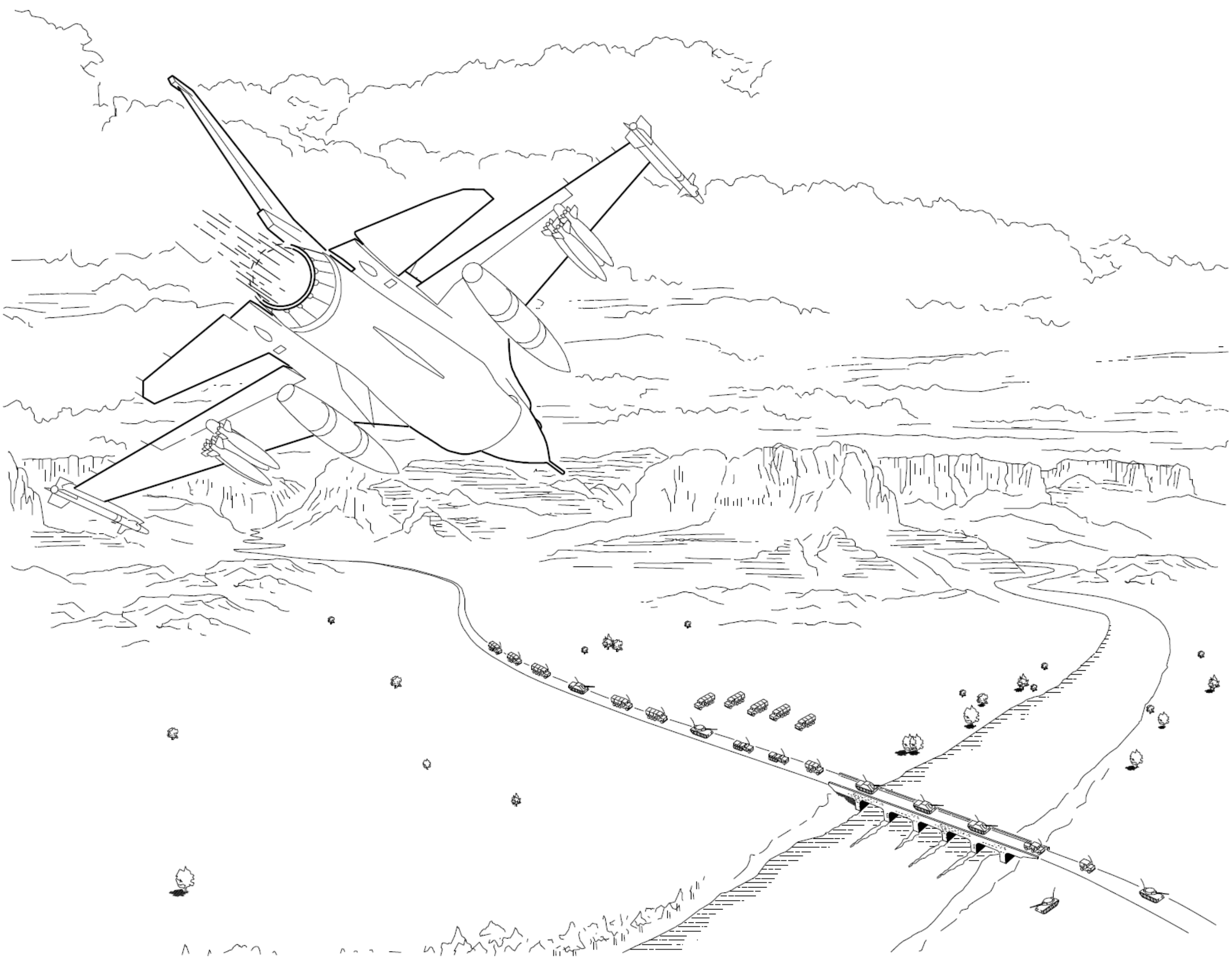
TO 1F-16CM/AM-34-1-1 BMS

AVIONICS AND NONNUCLEAR WEAPONS DELIVERY FLIGHT MANUAL

F-16C AND F-16D

BLOCKS 50, 52, 52+ and MLU



Ver.: BMS 4.37.4.1

Date: 01 July 2024

FOREWORD

PURPOSE AND SCOPE

This manual contains data describing relevant aircraft avionics, weapons systems, support equipment and munitions designated for employment by the aircraft and data necessary to execute air-to-air and air-to-ground missions employing nonnuclear munitions.

The following manuals supplement this manual to establish the complete Falcon BMS series:

- TO-BMS1F-16CM/AM-1 (Aircraft systems, Normal procedures, and abnormal procedures).
- BMS-Training Manual (Documentation to accompany Falcon BMS training missions).
- BMS-User Manual (Falcon BMS front end, anything specific to the BMS simulation).
- Checklists and Cockpit Diagrams (avionics, emergency, non-F-16 pit layouts).
- BMS-Comms Nav Book (The Navigation manual with supporting KTO AIP, Charts, etc.).
- BMS-Technical Manual (Key Files & Editor, Keystrokes, Callbacks, etc.).
- BMS-Naval-Ops (Naval Operations from aircraft carriers in BMS).

These documents are located in the *Docs* folder of your Falcon BMS install, along with other supporting documents.

All changes in this document coming with 4.37.0 are marked with a **black** line.
All changes in this document coming with 4.37.1 are marked with a **blue** line.
All changes in this document coming with 4.37.2 are marked with a **red** line.
All changes in this document coming with 4.37.3 are marked with a **green** line.
Please note that the TO-1F-16CMAM-34-1-1 received a major overhaul and heavy restructuring with version 4.37.3.
All changes in this document coming with 4.37.4 and 4.37.4.1 are marked with an **orange** line.

COPYRIGHT STATEMENTS

TABLE OF CONTENT

PART I - MISSION DESCRIPTION

1.1 GENERAL

The F-16 fighter jet is a tactical multi-role aircraft with a single engine capable of air-to-air and air-to-ground operations. For air-to-air operations, it can use air-to-air missiles and a 20mm gun for attack purposes. Similarly, for air-to-ground missions, the aircraft is equipped to launch a variety of guided and unguided weapons.

The F-16 has an integrated fire control avionic system that allows one-man operation for weapon delivery purposes. The pilot receives critical information through a head-up display (HUD), two multifunction displays (MFDs), and a data entry display (DED). The throttle and stick are equipped with switches and controls for quick-reaction fingertip handling of weapons, radar, and displays. The aircraft also has upfront controls and multifunction displays for air-to-air and air-to-ground attack mode control and weapon selection.

The aircraft is capable of employing electronic countermeasures (ASPIS) and has a video system that includes a cockpit TV sensor (CTVS) and an airborne video tape recorder (AVTR) to support mission-related requirements. Cruise energy management is another feature that provides HUD symbology and DED data during cruising conditions to indicate the best airspeed/altitude values for maximum range or maximum endurance.

PART II - AIRCRAFT WEAPON RELEASE SYSTEMS AND CONTROLS

2.1 GENERAL AND MISCELLANEOUS CONTROLS

The following section outlines the functionality and placement of controls and displays related to the weapon system. Its primary objective is to serve as a convenient reference guide for locating the system explained in this manual. Whenever relevant, this section includes a reference to the location where the system is described in comprehensive detail.

2.1.1 COCKPIT CONTROLS AND DISPLAYS

See TO 1F-16CMAM-1 BMS for a layout of the F-16 front cockpit.

2.1.1.1 PHILOSOPHY OF COCKPIT CONTROLS AND DISPLAYS

The F-16 avionic system incorporates master mode, cursor control and sensor-of-interest (SOI) features designed to integrate controls and displays and simplify display and sensor management. For this section, the cockpit controls and displays are categorized as follows:

- Key Avionic Console Switches.
- Upfront Controls.
- Video Displays.
- Hands-On Controls.

The cockpit layout is meticulously designed to provide the operator with maximum flexibility in selecting system modes, sensors, and weapons while simultaneously ensuring efficient movement within the cockpit and minimizing pilot workload.

The avionic system enables the pilot to configure preplanned setups for modes, sensors, and weapons, either automatically or manually, prior to takeoff. These preplanned configurations allow the pilot to make effective use of hands-on controls, Multifunction Displays, Upfront Controls, and the Head-Up Display/Helmet Mounted Cueing System, reducing the need to divert attention inside the cockpit and saving valuable time.

2.1.1.1.1 KEY AVIONIC CONSOLE SWITCHES

The positioning of console panels is carefully arranged to ensure convenience and functionality. Switches that can be set during ramp start and don't require frequent adjustments are placed on the right console, out of immediate view. On the other hand, consoles that directly impact mission completion, such as communications, navigation, and landing gear controls, are grouped together for easy access during flight and are typically located on the left console.

2.1.1.1.2 UPFRONT CONTROLS

The Upfront Controls (UFC) are comprised of three components: The Integrated Control Panel (ICP), the Data Entry Display (DED), and the Pilot Fault List Display (PFLD). This comprehensive system combines and streamlines the communication, navigation, and identification (CNI) functions. The UFC configuration divides the controls into two sections, with frequently used controls located on the ICP and less frequently used controls positioned on the side consoles. The ICP grants quick access to commonly used functions, including override and priority features, through a single push-button interface.

2.1.1.1.3 VIDEO DISPLAYS

The F-16 is equipped with essential mission information through the use of two Multifunction Displays (MFDs), a Head-Up Display (HUD), and a Helmet Mounted Cueing System (HMCS), enabling efficient heads-down and heads-up operations.

The MFDs serve as a central interface for operating and controlling various subsystems and sensors, while also providing video display for radar, weapons, targeting pod, and navigation pod.

The HUD allows the pilot to monitor both navigation and weapon delivery information without losing focus on the external environment.

For daytime operations, the HMCS is an electro-optical device that presents information directly in front of the pilot's right eye. It primarily serves as an extension of the HUD, displaying information outside the HUD field of view (FOV) and offering the pilot the ability to cue the aircraft's sensor suite and weapons. The HMCS also provides feedback on sensor and weapon data. Both the HMCS and HUD are considered as a single Sensor of Interest (SOI) and share the same Hands-On Control switchology.

2.1.1.1.4 HANDS-ON-CONTROLS

The hands-on controls encompass switches positioned on both the throttle grip and the side-stick controller. These controls are specifically designed for functions that demand immediate access, such as radio transmission, target designation, and weapon release. Additionally, they enable the pilot to carry out necessary actions during in-flight maneuvering, eliminating the need to remove their hands from the stick and throttle.

2.1.1.2 F-16 MODING AND SENSOR CONCEPTS

2.1.1.2.1 MASTER MODE SELECTION AND CONTROL

The F-16 allows a master mode to be rapidly selected with a single switch action; thus configuring the avionics suite and the cockpit controls and displays for a particular mission. The table below provides a list of the master modes and their respective switch locations and positions. All the master modes, except Emergency Jettison, can be pre-programmed to a desired set of conditions. Master mode configurations can be programmed into the Data Transfer Cartridge (DTC) in the UI during mission planning, or set up with Weapon Delivery Planner. The master modes are automatically configured when the DTC is loaded into the aircraft via the DTE MFD page. Upon exiting the current master mode, the last master mode table is updated with any changes that have been made. If necessary, the master modes may also be programmed manually using the master mode switches and the Multifunction Display Set (MFDS) menus.

MASTER MODE	SWITCH LOCATION	SWITCH POSITION
Dogfight	Throttle	DGFT (left/outward)
Missile Override	Throttle	MSL OVRD (right/inward)
Emergency Jettison	Landing Gear Panel	EMER STORES JETTISON button
Air-to-Air	ICP	A-A button
Air-to-Ground	ICP	A-G button
Selective Jettison	SMS MFD pages	OSB 11 (S-J)
Navigation		Default if no other Master Mode selected

Master Modes – Switch locations and positions

The Emergency Jettison master mode takes precedence over all other master modes. By pressing the Emergency Jettison button on the landing gear panel, all air-to-ground stores will be jettisoned while retaining air-to-air weapons and pods. Once the jettison process is complete, the system will revert to the previously selected master mode.

The Dogfight and Missile Override master modes have priority over any other selected master mode, except for Emergency Jettison. When Dogfight or Missile Override is chosen, the master mode will be configured with the options saved in the Data Transfer Cartridge (DTC) or manually set during ramp start. If the DTC is not programmed or used, the master mode will revert to the default configuration. Dogfight is selected by moving the Dogfight/Missile Override switch on the throttle grip to the outboard position, while Missile Override is selected by moving the switch to the inboard position.

When the Dogfight/Missile Override switch is in the center position, the Air-to-Air, Air-to-Ground, Navigation, or Selective Jettison master modes can be selected. Air-to-Air and Air-to-Ground master modes are activated by pressing the A-A button or the A-G button, respectively, on the Integrated Control Panel (ICP). The Selective Jettison master mode is accessed through any of the Stores Management Set (SMS) mode pages. It's worth noting that the Selective Jettison master mode can now be pre-programmed in the DTC in both 2D and 3D environments and is fully implemented.

To select the Navigation master mode, the current master mode needs to be deselected by placing the Dogfight/Missile Override switch in the center position. When the switch is moved back to the center from Dogfight or Missile Override positions, the avionic system will return to the previously selected master mode when the switch was in the center position.

In the absence of any programming through the Data Transfer Equipment (DTE) for the master modes, the avionics system will default to the previously used configuration or a predefined "canned" setup (refer to the table below). The option to reset to the canned setup is accessible through the MFDS format menu page. It is important to note that for the Air-to-Air and Air-to-Ground delivery master modes, the availability of the respective weapons in the inventory is necessary for access.

To streamline display management, the following ground rules are applied to sensor modes:

- The Air-to-Air, Dogfight (DGFT), and Missile Override (MSL OVRD) master modes exclusively permit air-to-air sensor modes.

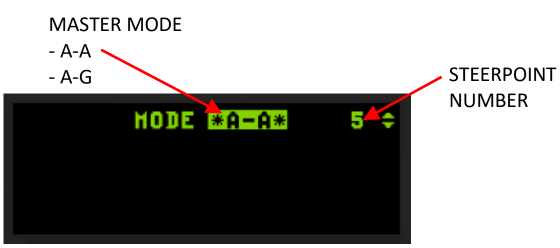
- Modes that necessitate both air-to-ground targeting capability and air-to-air situational awareness permit the use of both air-to-air and air-to-ground sensor modes.

MASTER MODE	DISPLAY FORMAT					
	LEFT MODE			RIGHT MODE		
	LEFT (PRIM)	MID (SEC)	RIGHT (SEC)	LEFT (PRIM)	MID (SEC)	RIGHT (SEC)
DOGFIGHT	FCR	BLANK	BLANK	SMS	BLANK	BLANK
MSL OVRD	FCR	BLANK	BLANK	SMS	BLANK	BLANK
A-A	FCR	BLANK	BLANK	SMS	BLANK	BLANK
A-G/A-G (HARM)	FCR	BLANK	BLANK	SMS	BLANK	BLANK
NAV	FCR	BLANK	BLANK	SMS	BLANK	BLANK
JETTISON	FCR	BLANK	BLANK	SMS	BLANK	BLANK

Master Modes – Display formats

In the event of a malfunction with either the Air-to-Ground (A-G) or Air-to-Air (A-A) master mode pushbuttons on the Integrated Control Panel (ICP), an alternate method for selecting A-A and A-G master modes is accessible using via the UFC LIST button. To access the MODE page, the LIST page needs to be selected by pressing the MODE option, identified as ICP key 8. The DED will then display a MODE mnemonic, indicated by asterisks (either A-A or A-G).

If the displayed MODE mnemonic matches the active master mode, it will be highlighted. The master mode mnemonic will toggle between A-A and A-G when any key (1-9) is pressed or when the data control switch is set to sequence (SEQ). To choose the desired master mode, the mode select button (M-SEL) on the ICP should be pressed.



Master Mode in the DED

2.1.1.2.2 SYSTEM POINT-OF-INTEREST (SPI)

The F-16 sensor management follows a single line-of-sight concept, where all sensors are synchronized to a shared focal point known as the System Point-of-Interest (SPI). However, there are exceptions to this concept in the NAV and A-A master modes.

In the A-A master mode, both the Fire Control Radar (FCR) and Targeting Pod (TGP) can track targets simultaneously. This allows for concurrent air-to-air tracking with both sensors.

In the NAV master mode, there is flexibility in sensor configuration. It is possible to have two air-to-air tracking sensors or one air-to-air tracking sensor combined with one air-to-ground tracking sensor. This grants the pilot the ability to monitor multiple air-to-air targets or a combination of air-to-air and air-to-ground targets while the NAV master mode is active.

In the Dogfight (DGFT), Gunnery modes, Missile Override (MSL OVRD), and Air-to-Air Missile modes where the AIM-120 is selected as the weapon, the Fire Control Radar (FCR) establishes the system line-of-sight, and the weapons are launched against targets tracked by the FCR.

In DGFT, MSL OVRD, and Air-to-Air Missile modes with a Short Range Missile (SRM) as the chosen weapon, either the FCR or the Targeting Pod (TGP) can define the system line-of-sight. SRMs are launched against targets tracked by the FCR, targets tracked by the TGP, or fired directly at the designated point (Bore).

The System Point-of-Interest (SPI) can take various forms, such as a steerpoint, an offset aimpoint, a visual initial point, a visual reference point, or the target itself. In Navigation (NAV) or Air-to-Ground (A-G) preplanned modes, the SPI is selected by choosing the sighting option at OSB 10 on the Multifunction Displays (MFDS) sensor page. In Air-to-Air (A-A) or A-G visual modes, the SPI corresponds to the target, which can be either the weapon impact point or the designated target. In these visual modes, there are no available sighting options.

Please see SPI MANAGEMENT for more details.

2.1.1.2.3 SENSOR-OF-INTEREST (SOI)

The Simplified Sensor of Interest (SOI) mechanism streamlines the management of multiple sensors by designating a single sensor format for hands-on control. The position of the SOI asterisk symbol indicates the chosen sensor format. On the Head-Up Display (HUD)/Helmet Mounted Cueing System (HMCS), the asterisk is located at the upper left of the HUD. On the Multifunction Displays (MFDs), the SOI symbol is represented by a line drawn around the edge of the MFD.

The selection of the SOI is based on either the sensor with the highest priority or the pilot's intended choice. Pilot intent can be influenced by various actions, including:

- Moving the Display Management Switch (DMS) upward, which transitions the SOI designation to the HUD if allowed.
- When the HUD is the SOI and the DMS is moved downward, the SOI designation shifts to the MFDs.
- If the DMS is moved downward and the SOI is on the MFDs, the SOI transitions to the other MFD if allowed.
- Depressing the SWAP OSB on an MFD causes the SOI symbol to follow the sensor display to the other MFD.

It is important to note that the SOI cannot be designated in the MARK OFLY submode or the snowplow (SP) ground radar mode within the pre-designate (PRE) state.

The designated SOI display on the MFD can only be in the FCR, TGP, WPN, HAD, and HSD formats. The HUD can only be the designated SOI in navigation and air-to-ground master modes. In the air-to-air master mode, the SOI display is limited to the FCR, HSD, and TGP formats. On the FCR, TGP, HSD, HAD, and WPN formats, the text "NOT SOI" appears whenever the format is not selected as the sensor of interest.

2.1.1.3 F-16 COCKPIT CONTROLS

The overview of relevant F-16 controls is presented from left aft, clockwise proceeding to right aft in the cockpit.
Also reference TO 1F-16CM/AM-1 BMS.

In terms of .key file related callbacks, please refer to the "BMS Cockpit Interaction Guide"
(/Docs/01 Input Devices/00 Cockpit Guide/) and all other related documentation in the *(/Docs/01 Input Devices)* folder.

2.1.1.4 IFF (IDENTIFICATION FRIEND OR FOE) CONTROL PANEL

Modern F-16 blocks have a fully implemented IFF system and the AUX COMM panel has been replaced with the IFF panel in some AIFF equipped aircraft. Backup TACAN controls have been moved to a MFD page and have been replaced by backup IFF controls. Note: some non AIFF aircraft still have the AUX COMM panel (see below).

The IFF MASTER knob controls power to the IFF transponder/interrogator unit. In OFF the system is unpowered. In STBY the system is powered but unable to answer IFF interrogations. In LOW the IFF is operating normally (can interrogate) but responds to interrogation at half effective distance (reduced interrogation range). NORM is the normal operation position; the IFF can interrogate and respond to interrogations. In EMER, the IFF can interrogate but responds to interrogations with a fixed emergency code: (Mode 1: 70; Mode 2: 7777 and Mode 3: 7700; Mode C and Mode 4 response is normal).

The M-4 CODE switch controls how the IFF responds to mode-4 interrogations. A/B is the normal operation position; the IFF uses the normal secret key that is either stored in A or B bank (set in UFC for normal operations and set with the Mode 4 reply switch in backup mode).

In ZERO, both code A and code B are erased from memory when the position is held for 2 seconds (keys are also erased automatically upon shutdown). In HOLD, power-off zeroing is temporarily disabled, and the Mode 4 codes are saved.

The CNI knob allows the pilot to toggle between the BACKUP system and the UFC (Up Front Controller). The heart of the F-16 cockpit is the UFC made of the ICP, the DED and the two MFDs. Those need the main generator running and are thus unavailable at ramp start, shut down or in the event of malfunction or battle damage. In that case the CNI switch needs to be placed in BACKUP which provides alternate operation of the UHF, IFF and other systems.

The IFF enable switch enables control of IFF modes in backup mode (CNI in Backup position). Normal IFF controls are set through the IFF UFC pages (more information in the UFC chapter). M1/M3 enables Mode 1 and Mode 3 responses with the relevant codes inputted in the backup IFF digits codes. M3/MS enables Mode 3 and Mode S responses (Mode S is not implemented in BMS yet).

The digit selectors of the IFF panel are relevant to Mode 1 and Mode 3 IFF codes. Do not confuse them with the old TACAN channel digit selectors on the AUX COMM panel.

The MODE 4 REPLY switch is a three-position switch that controls the Mode 4 reply in backup mode.

OFF: no response to mode4 interrogation.
A: reply to Mode 4 interrogations with code A,
B: reply to Mode 4 interrogations with code B.

The MODE4 MONITOR switch enables AUDIO feedback of the IFF system in AUDIO position. No audio feedback is provided in OUT position. Audio feedback is a tone which signals the inability of the system to answer a Mode 4 interrogation correctly.

Although not the case for block 50 & block 52 F-16, some other F-16 models may still have the AUX COMM panel installed. The main difference to the IFF panel documented above is the possibility to manage the backup TACAN controls rather than the backup IFF controls.

The lower right part of the panel allows the pilot to set a TACAN channel, band and mode when the CNI switch is in BACKUP. The TACAN channel is entered into the first three windows. The fourth window is used to set the X or Y band.

The T/R, A/A TR switch provides control of TACAN functions when the CNI switch is in BACKUP.

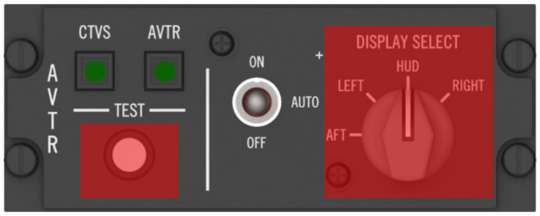
T/R is Transmit / Receive mode. The system receives signals which result in bearing and course deviation on the HSI and transmit distance interrogation to the station to get DME information.

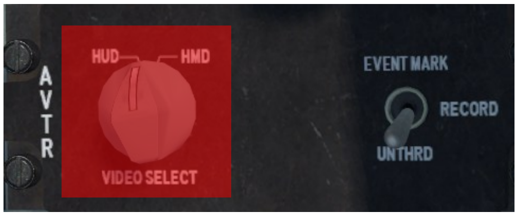
REC (Receive) is not implemented.

A/A TR is the Air to Air Transmit and Receive mode. The system interrogates and receives signals from aircraft having air to air capability, providing slant range (Nm) distance between aircraft operating 63 TACAN channels apart. (The KC-10 also provides bearing information).

For more information about the IFF system, please refer to the Identification Friend or Foe (IFF) chapter.

2.1.1.5 AIRBORNE VIDEO TAPE RECORDER (AVTR)/DIGITAL VIDEO RECORDER (DVR) CONTROL PANELS





This panel is designed to activate or deactivate the ACMI. In the current version of BMS, the switch is set to RECORD by default which turns on the ACMI automatically when entering 3d and cannot be deactivated.

2.1.1.6 AUDIO 1 CONTROL PANEL

The primary communication systems are controlled by the AUDIO 1 panel. The controls on this panel are active by default, regardless of the position of the CNI switch on the AUX COMM panel.

The COMM1 power knob is equipped with an ON/OFF switch and controls the volume for the COMM1 radio (UHF) when rotated past the OFF position. This can be adjusted using an analogue potentiometer through the advanced setup or with regular keystrokes. The knobs are animated and reflect their correct position.

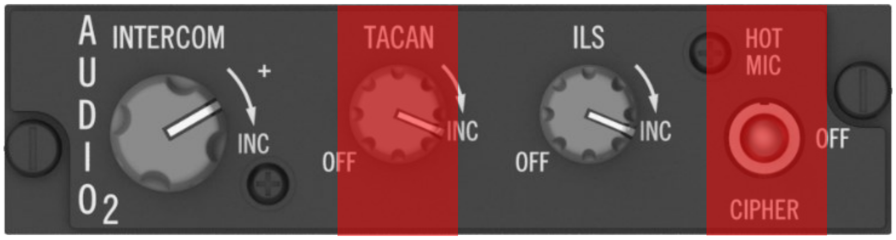
The COMM1 mode knob has three positions: OFF, SQL, and GD. In OFF mode, squelch is disabled (although not implemented in BMS). In SQL mode, the squelch mode is activated, reducing background noise during normal operations. In GD mode, the main receiver and transmitter are tuned to the guard UHF frequency (243.000). Note that the GD position is not functional when the CNI is in BACKUP, and guard must then be selected from the backup UHF panel. The push function is not implemented in BMS.

The COMM2 power and mode knobs have the same functions but for the second radio (VHF). The GD position tunes to VHF guard (121.5).
The secure voice and TF knobs are not implemented in BMS.

The MSL knob is used to set the sidewinder missile acquisition sound level. This can be set using an analogue potentiometer through the advanced setup or with regular keystrokes. The knob has no ON/OFF position, so its position should be checked during ramp and FENCE checks unless a potentiometer is used to interface with it. In that case, the volume is set at whatever position the pot was left during the last flight.

The THREAT knob is used to set the TWS (Threat Warning System) sound level. This can be set using an analogue potentiometer through the advanced setup or with regular keystrokes. The knob has no ON/OFF position, so its position should be checked during ramp and FENCE checks unless a potentiometer is used to interface with it. In that case, the volume is set at whatever z-position the pot was left during the last flight.

2.1.1.7 AUDIO 2 CONTROL PANEL



The primary function of the AUDIO 2 panel is to provide control over the infrequently used communication system. The intercom volume knob allows the user to adjust the volume of all sounds normally heard in the pilot's helmet and set the respective individual volumes to a desired 'mix' level. This knob enables the user to turn the volume up or down relative to the rest of the background sounds (those typically not heard in the pilot's headset).

The TACAN volume control is not implemented in BMS. Furthermore, the TACAN volume knob is always coded "on" and does not require switching out of the OFF position to function.

The ILS volume control allows the pilot to turn the ILS on and off and set the volume of the markers (outer and inner markers). The pilot needs to power the ILS to view the ILS symbology.

Lastly, the HOT MIC switch is not implemented.

2.1.1.8 UHF RADIO BACKUP CONTROL PANEL

The UHF radio is the only backup radio available in the F-16 cockpit. There is no backup mode for the VHF radio. To activate the UHF backup radio, the C&I switch on the IFF or AUX COMM panel must be set to the BACKUP position.

When the right mode knob is set to MNL (manual), any valid frequency can be selected using the frequency control knobs.

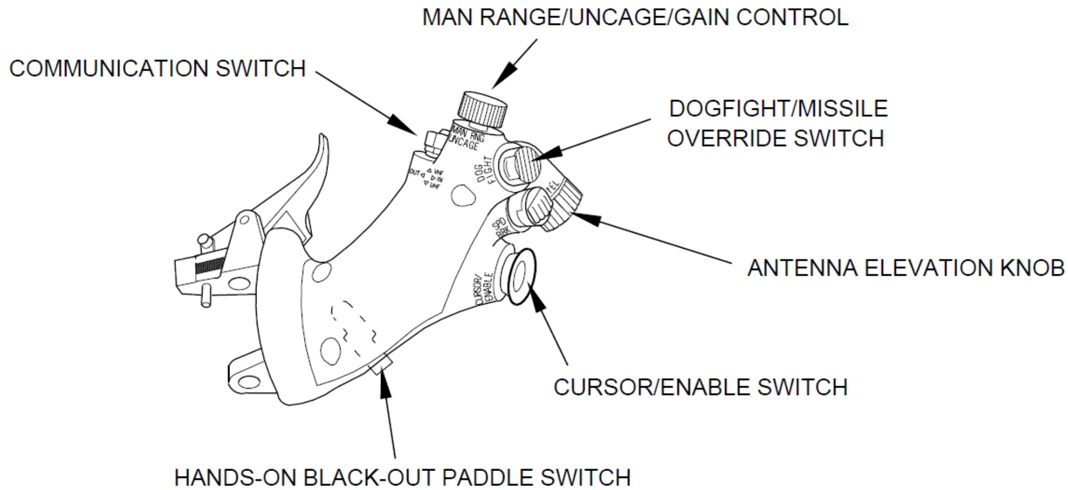
The left mode knob has 4 positions, but only 3 are used in BMS: OFF, MAIN, and BOTH. ADF is not supported. In OFF, the backup UHF is not powered. In MAIN, as long as the COMM1 power switch on the AUDIO1 panel is ON, the UHF radio operates on the selected preset channel displayed on the 2-digit display or in manual mode. In BOTH, the radio works as in MAIN but can also receive transmissions on the UHF GUARD frequency (receive only).

The right mode functions knob has three positions: MNL, PRESET, and GUARD. MNL prioritizes the manual frequency. In PRESET, the frequency is determined by the channel knob and indicated by the 2-digit display. In GUARD, the main receiver and transmitter are automatically tuned to the UHF guard frequency.

The channel knob selects one of the 19 available presets which are automatically set with the Falcon BMS.cfg config line: *set g_bInitBUPfromDTC 1*. By default, the panel selects channel 6, but this can be configured in the [your callsign].ini file COMMS section.

The tiny volume knob has been implemented to balance IVC volume against AI volume, although this is not its intended function. It is quite useful in Falcon where AI comms do not follow the same logic as IVC human comms on UHF & VHF. The knob also has analogue values.

2.1.1.9 THROTTLE



The throttle in the cockpit is equipped with various switches and controls that are responsible for different weapon delivery-related functions. These include the DOGFIGHT/Missile Override switch, the MAN RNG/UNCAGE control for manual range/uncage/gain, the ANT ELEV knob for adjusting the antenna elevation, the CURSOR/ENABLE switch, the HOBO switch for Hands-On Black-Out, and the communication switch.

More detailed information can be found in the HANDS-ON CONTROLS or RADAR section.

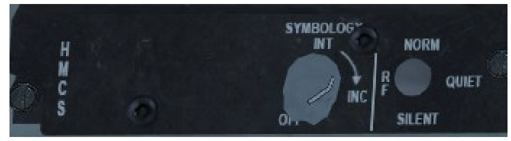
2.1.1.10 CHAFF/FLARE DISPENSE BUTTON

The CHAFF/FLARE dispense button is located on the left side panel near the throttle and provides manual initiation of chaff/flare dispense signals to the dispensers. For additional information, refer to Countermeasures Dispenser Set (ALE-47) chapter.

2.1.1.11 ALE-47 COUNTERMEASURES DISPENSER SET (CMDS) PANEL

The CMDS panel is located in the left forward console. For additional information, refer to Countermeasures Dispenser Set (ALE-47) chapter.

2.1.1.12 HELMET MOUNTED CUEING SYSTEM (HMCS) CONTROL PANEL



The Helmet Mounted Cueing System displays weapon, sensor and flight information to the pilot through the helmet visor providing off-boresight missile capability. It is an extension of the HUD and considered as one SOI (HUD & HMCS).

The panel consists of a single knob featuring and ON/OFF switch and a clockwise motion for increased brightness. The knob can be interfaced with an analogue device as well.

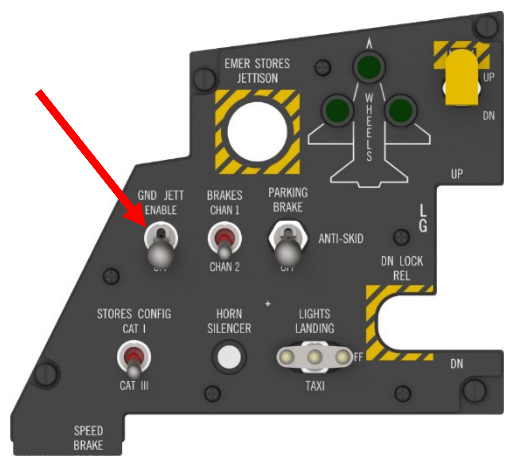
Refer to the HMCS chapter for more information.

2.1.1.13 ELECTRONIC COUNTERMEASURES (ECM) CONTROL PANEL

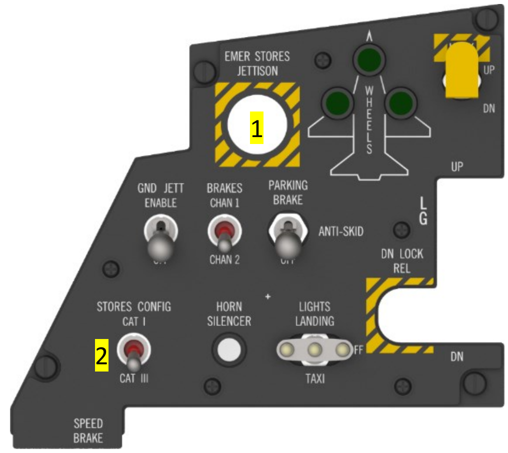
The ECM pod control panel is located on the left console.
For additional information on ECM control, refer to ELECTRONIC COUNTERMEASURES SYSTEM chapter.

2.1.1.14 GROUND JETTISON (GND JETT) SWITCH

When in the ENABLE position, all emergency and normal release functions can be performed on the ground as if airborne. The GND JETT switch, found on the landing gear control panel, is a lever-lock switch with two positions: OFF and ENABLE. When locked in the OFF position, emergency jettison is inhibited when weight is on the wheels, but stores can still be jettisoned with weight off the wheels. On the other hand, when in the ENABLE position, both conditions are bypassed, allowing all arming and release conditions on the ground that are not otherwise available. For more information, please refer to HANDS-ON CONTROLS chapter.



2.1.1.15 EMER STORES JETTISON BUTTON



Depressing the EMER STORES JETTISON button 1 for more than 1 second results in the jettisoning of all air-to-ground stores and external fuel tanks. Air-to-air weapons, HTS, TGP, and ECM pods will remain on board. During the depression of the emergency jettison button, the SMS Jettison page is displayed on the MFD.

2.1.1.16 STORES CONFIGURATION (STORES CONFIG) SWITCH

The two-position toggle switch STORES CONFIG CATI/CATIII 2, can be set to either CATI or CATIII. When the aircraft is loaded with category III stores, the switch should be set to CATIII. This setting enables the AOA limiter, which is discussed further in the FLCS chapter.

2.1.1.17 ADV MODE SWITCH

The ADV mode pushbutton 1 indicator is an integral part of the Terrain Following Radar (TFR) system, which is managed through the TFR MFD page. The indicator features a pushbutton that enables or disables AUTO TFR. The top portion of the indicator is marked as ACTIVE in green and illuminates when AUTO TFR is activated. The bottom part of the indicator is labelled STBY in yellow and signals that the TFR system is in STBY mode (either manual or blended mode). It's important to note that automatic TFR is only accessible when carrying the AN/AAQ-13 navigation pod (NVP).

2.1.1.18 MASTER ARM SWITCH

The left miscellaneous panel (MISC) features the MASTER ARM switch 2, which is a three-position switch that governs the weapon delivery system's arming. When set to OFF, all ordnance systems are secured, and release is prohibited except for emergency jettison. With the switch set to MASTER ARM or SIMULATE, the MMC can enter weapon delivery modes. The MASTER ARM position allows for the arming and release of stores as designated on the MFD, whereas the SIMULATE position prevents the release of stores, excluding emergency jettison.

2.1.1.19 ALT REL (ALTERNATE RELEASE) BUTTON

The ALT REL button 3 operates similarly to the pickle button found on the HOTAS SSC or stick.

2.1.1.20 LASER ARM SWITCH

The targeting pod designation/ranging lasers can be armed for firing using the LASER ARM switch 4. This switch is located on the left miscellaneous (MISC) panel. The operational details of the laser can be found in the relevant chapters on targeting pods.

2.1.1.21 RUN SILENT (RF) SWITCH

The RF switch 5 is a three-position toggle switch that regulates electromagnetic emissions from the aircraft as described below:

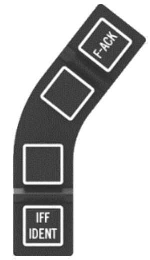
NORM is the standard position used for normal aircraft operation.

QUIET position reduces the level of EW emissions by switching the radar and IFF transponder to standby.

SILENT position shuts down all EW emissions from the aircraft, including RADAR, TFR, RALT, ECM, and IFF.

2.1.1.22 IFF IDENT BUTTON

At present, the IFF IDENT pushbutton remains non-functional despite the complete implementation of the IFF system in BMS.



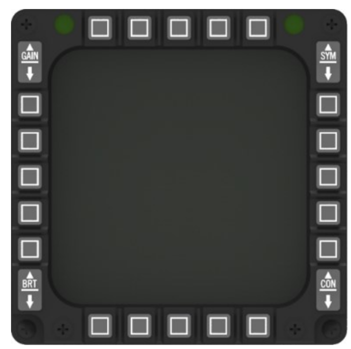
2.1.1.23 THREAT WARNING AUX PANEL/PRIME PANEL/AZIMUTH INDICATOR

For the THREAT WARNING AUX panel, THREAT WARNING PRIME panel, and azimuth indicator please refer to the RADAR WARNING RECEIVER (RWR) section.

2.1.1.24 MULTIFUNCTION DISPLAY SET (MFDS)

The Multifunction Display Set (MFDS) includes two display surfaces and their corresponding controls that can show video and/or text data.

Please refer to MULTIFUNCTION DISPLAY SET (MFDS) chapter for more details.



2.1.1.25 INTEGRATED CONTROL PANEL (ICP)

The upfront control panel (UFC) allows control of communication, navigation, and identification (CNI) equipment, input of information related to weapons delivery, and adjustment of HUD power and intensity. The UFC consists of knobs, switches, and buttons but has no electronic components. Further details can be found in the UPFRONT CONTROLS (UFC) section.

2.1.1.26 HEAD-UP DISPLAY (HUD)

The HUD unit 1 comprises the display surface and the integrated control panel (ICP). The symbology displayed on the HUD is dependent on the switch positions/modes selected on the HUD Control Panel and ICP.

The Head-Up Display (HUD) presents a range of flight information by utilizing a collimating system. To activate the HUD, the SYM wheel on the left of the ICP is used. This wheel has a switch at the start of its movement which switches the HUD on and off. Once activated, the wheel is used to adjust the brightness of the HUD.

The pilot can modify various settings on the HUD using the UFC or the HUD control panel located on the right console. For more details, please refer to the HEAD-UP DISPLAY (HUD) chapter.

2.1.1.27 DATA ENTRY DISPLAY (DED)

The Upfront Controls (UFC) 2 provide a display of data for Communication, Navigation, and Identification (CNI) and weapon-delivery related information, using the Dedicated Display (DE).

For more details, please refer to UPFRONT CONTROLS (UFC) section.

2.1.1.28 PILOT FAULT LIST DISPLAY (PFLD)

The Pilot Fault List Display (PFLD) shows information regarding flight control, engine, and avionics system faults.

2.1.1.29 IFF CAUTION LIGHT

The caution light panel houses the IFF caution light 1, which illuminates when the aircraft's IFF system is queried on mode 4 but cannot respond due to various reasons such as zeroized or uncoded mode 4 codes (A and B), disabled mode 4, or the RF switch being set to QUIET or SILENT.

2.1.1.30 SIDE-STICK CONTROLLER

The stick is equipped with hands-on switches that interact with various systems. For more detailed information, please refer to the HANDS-ON CONTROLS section.

2.1.1.31 SENSOR POWER CONTROL PANEL (SNSR PWR)

The SENSOR panel contains four toggle switches, with the two leftmost serving as power switches for the two chin intake pylons (LEFT HDPT and RIGHT HDPT). These pylons can carry pods such as SNIPER, LANTIRN, and HTS and require power to operate. If the switches are in the OFF position, the pods will not receive power and will not function. It is important to note that some pods require time to become operational after powering them up, so the pylons should be powered up early in the flight.

The FCR switch is a two-state switch that activates the Fire Control Radar (FCR). When powered on, the FCR enters a Power ON Built-In Test (PO BIT) mode that is visible on the MFD. The BIT takes approximately three minutes to complete, after which the radar is set to standby mode unless it was previously set to a specific mode. The PO BIT cannot be interrupted in the middle of the test, and the only way to stop it is to turn off the radar. Since the FCR is off when the aircraft is on the Ramp, the FCR PO BIT must be completed when starting the aircraft from a cold state for the FCR to function correctly.

The PO BIT, which lasts for three minutes, is performed whenever the radar power is switched to OFF for more than four seconds and then back on. A shorter manual BIT that lasts about 30 seconds can also be performed through the MFD TEST page (OSB #19 FCR) or by turning the FCR switch OFF for less than four seconds and then back on.

The RDR ALT switch is a three-position switch used to control the radar altimeter. With the switch in the OFF position, the radar altimeter is inactive. In STBY mode, the radar altimeter is in standby mode (used on the ground to avoid harming the crew chief). In RDR ALT mode, the radar altimeter is fully operational. The RALT BIT is implemented and visible from the MFD TEST page (OSB 7). When the radar altimeter is active, the radar altitude can be read in the HUD in the box preceded by the letter R.

The display of radar altitude in the HUD is subject to certain conditions that depend on the altitude. At low altitude, the RALT will be blanked beyond 30° pitch and approximately 90° bank. At high altitude, the RALT will be blanked above 10° pitch and approximately 75° bank. Note that the comma in the altitude display remains visible even when the altitude is blanked.

2.1.1.32 HUD CONTROL PANEL

The Head Up Display (HUD) panel provides the pilot with the ability to customize their display. The panel consists of two rows of four toggle switches, each with different functions:

The first row includes the VV/VAH - VAH - OFF switch which controls the vertical velocity scales found on the HUD. When in VV/VAH, there is a vertical velocity scale as well as a bank angle indicator (15°/30°/45°/60°) displayed on the Flight Path Marker (FPM). When in VAH, there is a roll indicator below the heading tape (unless the DED or PFL is being displayed in the HUD) with 10°/20°/30° and 45° cues. When set to OFF, no scales or bank/roll indication are displayed.

The second row consists of the ATT/FPM - FPM - OFF switch, which manages the pitch ladder and flight path markers (FPM). When in ATT/FPM, both the pitch ladder and flight path marker are displayed. When in FPM, only the flight path marker is displayed. When set to OFF, neither pitch ladder nor FPM is displayed.

The DED DATA - PFL - OFF switch, found in the first row, adds DED or PFL data to the bottom part of the HUD as display repeaters. When set to DED DATA, the DED is displayed in the HUD. When centred on PFL, the Pilot Fault List is displayed at the bottom of the HUD. When set to OFF, neither the DED nor the PFL is displayed on the HUD.

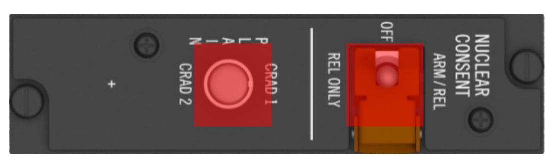
The DEPR RET switch, a three-position switch labelled STBY, PRI, and OFF, is used for standby bombing mode.

The CAS - TAS - GND SPD switch controls the display of the speed scale on the left of the HUD. When set to CAS, the speed tape shows the Calibrated Airspeed. When set to TAS, the speed tape shows the True Airspeed. When set to GND SPD, the HUD tape displays the speed over the ground. When in GND SPD mode, a caret is also displayed on the heading tape indicating that the system is now in wind-corrected ground track instead of showing the heading as magnetic track. It is important to note that whenever the landing gear is lowered, the HUD airspeed automatically reverts back to CAS, regardless of the switch position.

The ALT switch, a three-position switch labelled RADAR, BARO, and AUTO, is relevant to the altitude scale on the right of the HUD. When set to RADAR, the altitude tape indicates radar altitude. When set to BARO, the altitude tape shows barometric altitude. When set to AUTO, the altitude tape indicates barometric altitude above 1500 feet and switches to radar altitude below 1500 feet.

For further information, please refer to the Head-Up Display HUD chapter.

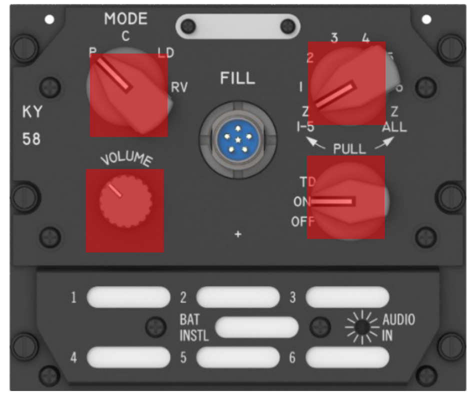
2.1.1.33 PLAIN CIPHER SWITCH + NUCLEAR CONSENT



The PLAIN Cipher Switch and NUCLEAR CONSENT switches are located on the right console. Those switches are not implemented in BMS yet.

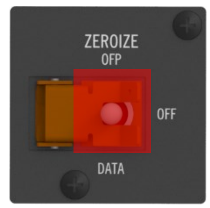
2.1.1.34 SECURE VOICE CONTROL PANEL (KY-58)

The secure voice control panel is located on the right console. The KY-58 is not implemented in BMS yet.



2.1.1.35 ZEROIZE OFP/DATA SWITCH

The Zeroize OFP/Data switch is not implemented in BMS yet.



2.1.1.36 AVIONICS POWER PANEL

The AVIONICS POWER panel consists of six locking toggle switches and two knobs used to power up avionic systems. The MMC switch enables power to the Modular Mission Computer, while the ST STA switch enables power to the Store Stations. The MFD switch powers up the Multi-Function Displays, the UFC switch enables power for the Up Front Controls, the DL switch enables power to the data link receiver and the MIDS LVT enables TACAN and Link 16 functions. The MAP switch is not functional.

In our block 50/52, the INS has been replaced by EGI (Embedded GPS/INS), which explains why the GPS switch on the old Avionic panel has been removed. The BMS implementation includes the following positions:

OFF, ALIGN NORM, NAV, and IN-FLT ALIGN. The ALIGN STOR HDG and ATT positions are not implemented, and the OFF position terminates all INS functions. To start a normal alignment, the knob should be placed in the ALIGN NORM position. After 90 seconds, when the EGI has heading information, the AUX yellow flag on the ADI disappears, and a steady RDY is displayed in the HUD and DED, indicating that a short ramp procedure can be performed. Full alignment takes approximately four minutes, as opposed to the old eight minutes with the INS. At this point, RDY flashes in the HUD and on the DED to indicate full alignment.

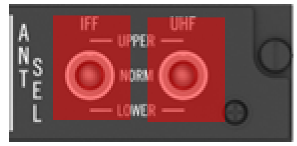
Once the EGI is ready, switch the EGI knob to NAV to allow the EGI system to provide navigation information to the navigation system. It is important to note that navigation cues will only be displayed when the EGI knob is set to NAV. During normal alignment, the navigation cues are not displayed (flight plan on HSD, etc.).

In case of EGI failure or problems, an IN-FLIGHT alignment can be performed. The EGI is then realigned according to GPS data provided by the GPS system. During in-flight alignment, a straight, level, and unaccelerated attitude should be maintained until the EGI reports a state at or above 8.1. Normally, the magnetic heading should be manually entered in the DED, but it is not required in the current BMS code. The MIDS LVT, or Multifunction Information Distribution System Low Volume Terminal, serves as a platform for Tactical Air Navigation (TACAN) and Link 16 data link operations.

2.1.1.37 ANT SEL PANEL

The ANT SEL switches are not implemented in BMS yet.

IFF and UHF works by default in all directions equally.



2.1.1.38 DATA TRANSFER EQUIPMENT (DTE)

The DTE facilitates automated data input and retrieval. It comprises a Data Transfer Unit (DTU)/Advanced Data Transfer Unit (ADTU), a Data Transfer Cartridge (DTC)/Advanced Data Transfer Cartridge (ADTC), or a Digital Terrain System/Data Transfer Cartridge (DTS/DTC).

2.1.2 AFT SEAT CONTROLS AND DISPLAYS

A dedicated aft seat cockpit and infrastructure/functionality for F-16D and F-16B models are currently not implemented in BMS.

2.1.3 WEAPON DELIVERY RELATED AVIONICS

The weapon system is organized into separate sections within an avionics network. Each avionics system has its own microprocessor and is programmed to handle specific tasks and process its own data. The software associated with certain subsystems is identified by Operational Flight Program identifications (OFP ID) and can be loaded and verified using the Viper Memory Load-Verifier (MLV) while the units are installed on the aircraft. The Modular Mission Computer (MMC) displays the OFP ID for selected subsystems on the DED (Data Entry Display) and also records OFP IDs through the DTE (Data Transfer Equipment). The table below presents various subsystems with their respective unique OFPs.

Modular Mission Computer (MMC)*	Embedded GPS/INS (EGI)*	Electronic Horizontal Situation Indicator (EHSI)*
Color Programmable Display Generator (CPDG)	Data Transfer Cartridge (DTC)*	Helmet Mounted Cuing System (HMCS)*
Common Data Entry Electronics Unit (CDEEU)	Digital Terrain System (DTS)*	Multiple air-to-air and air-to-ground munitions are controlled by specific OFPs
Fire Control Radar (FCR)	Recce Pod (RCCE)*	Counter-Measures Dispensing Set (CMDS)*
Multifunction Display System (MFDS)*	Advanced Identification Friend or Foe (AIFF)*	Radar Warning Receivers*
Upfront Control (UFC)*	Digital Flight Controls (DFLCS)*	HARM Targeting System (HTS)**
Intraflight Data Modem (IDM)*	Navigation Pod (NVP)*	
Crash Survivable Flight Data Recorder (CSFDR)*	Targeting Pod (TGP)*	
* The MMC maintains a four character OFP ID number for these subsystems.		
** The HTS OFP ID is shown on the HAD Threat Page.		

Avionics OFP and Subsystems with OFPs.

The avionics systems mentioned earlier, which are related to weapon delivery, perform essential functions such as stores identification, navigation, electronic defense, and weapon release. The integration of these functions is achieved by the Modular Mission Computer (MMC) utilizing digital data multiplex (MUX) buses, including A-MUX, B-MUX, C(L)-MUX, C(R)-MUX, DMUX, F-MUX, EW-MUX, and W-MUX. These MUX buses enable the seamless transmission of digital data between the avionics systems, facilitating effective coordination and operation.

The avionics system architecture is based on a dual-redundant setup, utilizing MIL-STD-1553B AMUX, B-MUX, C(L)-MUX, C(R)-MUX, D-MUX, EW-MUX, and F-MUX buses. Additionally, the dual-redundant Remote Interface Unit (RIU) protocol operates on the W-MUX bus, facilitating communication between the Modular Mission Computer (MMC), racks, and weapons loaded at the stations. The design is structured to ensure that sensor functions are processed within each sensor subsystem. Symbol generation and display processing are integrated into all avionics displays.

Each display, sensor, and subsystem is interconnected via the multiplex bus, enabling the exchange of data with other subsystems. The MMC integrates sensors, displays, and subsystems into various system modes. This results in several notable features:

- Simple, non time-critical interfaces.
- Efficient fault detection and isolation.
- Subsystems capable of operating autonomously, even in the presence of single-point faults or failures.
- Subsystem flexibility in implementing display functions.
- Simplified system development, management, and scalability.

These features enhance the overall performance, fault tolerance, and adaptability of the avionics system.

The communication link between various avionics subsystems within the weapon system and flight controls system is established through bus transmission lines and matrix assemblies. Each bus consists of dual redundancy, utilizing two transmission lines labeled as "A" and "B." Each transmission line is composed of a shielded, twisted wire pair enclosed in a protective jacket. Data transmission or reception on the MUX buses is controlled exclusively by the bus controller within the avionics subsystems. Matrix assemblies serve as connection points for the transmission lines, ensuring impedance matching and isolation between these units.

The Modular Mission Computer (MMC) serves as the primary bus controller for each multiplex bus, establishing interface and communication. In degraded mode operation, the Multi-Function Displays (MFDS) assume the role of bus controller to maintain continuous communication on the A-MUX and D-MUX for "get home" capability. The MMC has the ability to communicate with both 1553 and 1553B multiplex bus terminals on the A-MUX, B-MUX, C(L)-MUX, C(R)-MUX, D-MUX, and F-MUX. It acts as both the primary and backup controller for the W-MUX. The EW-MUX is primarily controlled by the ARWR (ALE-56 M). The MMC functions as the central computer, coordinating sensors, displays, and modes, while performing system-level processing, such as air-to-ground bombing solutions that require input from multiple sources.

At times, the MMC operates as a pass-through for data, for instance, relaying ATP (Automatic Targeting Pod) data to the Integrated Armament Modules (IAMs).

It's worth noting that the C-MUX is split into a left MUX (C(L)) and a right MUX (C(R)) to accommodate sufficient bandwidth for supporting smart weapons.

2.1.4 MODULAR MISSION COMPUTER (MMC)

The Modular Mission Computer (MMC) is a versatile computer resource designed to facilitate the addition and removal of functions, performance enhancements, and interfaces.

The MMC Power switch is utilized for applying or removing power to and from the MMC. It can also be used to reset the MMC by power cycling it. However, it's important to note that resetting the MMC will reset the time assigned to maintenance faults, causing them to be inaccurately related to the mission timeline. This is because the MMC initializes the time of occurrence to the time of reboot (time at MMC power-up).

The MMC comprises various modules, including one avionic display module, four aircraft input/output modules, three MIL-STD-1553/1553B multiplex bus modules, two weapons multiplex bus modules, two power supply modules, one HUD (Head-Up Display) low-voltage power supply module, two power conditioning modules, and one DC-to-DC converter module.

For the MMC 7000A, the AD70A, MB70A, and WM70A processor modules are utilized.

The MMC serves as the central control unit for the F-16 Avionics system and offers the following capabilities:

- Managing and controlling multiplex bus traffic on avionics multiplex buses.
- Generating and controlling symbology displayed on the HUD.
- Controlling the master mode, submode, and weapon delivery options of the avionics system.
- Conducting Built-In Tests (BITs) for avionics subsystems, collecting fault data, and reporting.
- Performing navigation calculations.
- Handling calculations and control for air-to-air missile delivery and gun operations.
- Managing calculations and control for air-to-ground weapon delivery and gun operations.
- Conducting stores identification.
- Activating and controlling stores.
- Managing stores release, launch, and jettison operations.
- Providing avionics interface (pass-through) for various aircraft inputs and outputs, such EW-systems, etc.

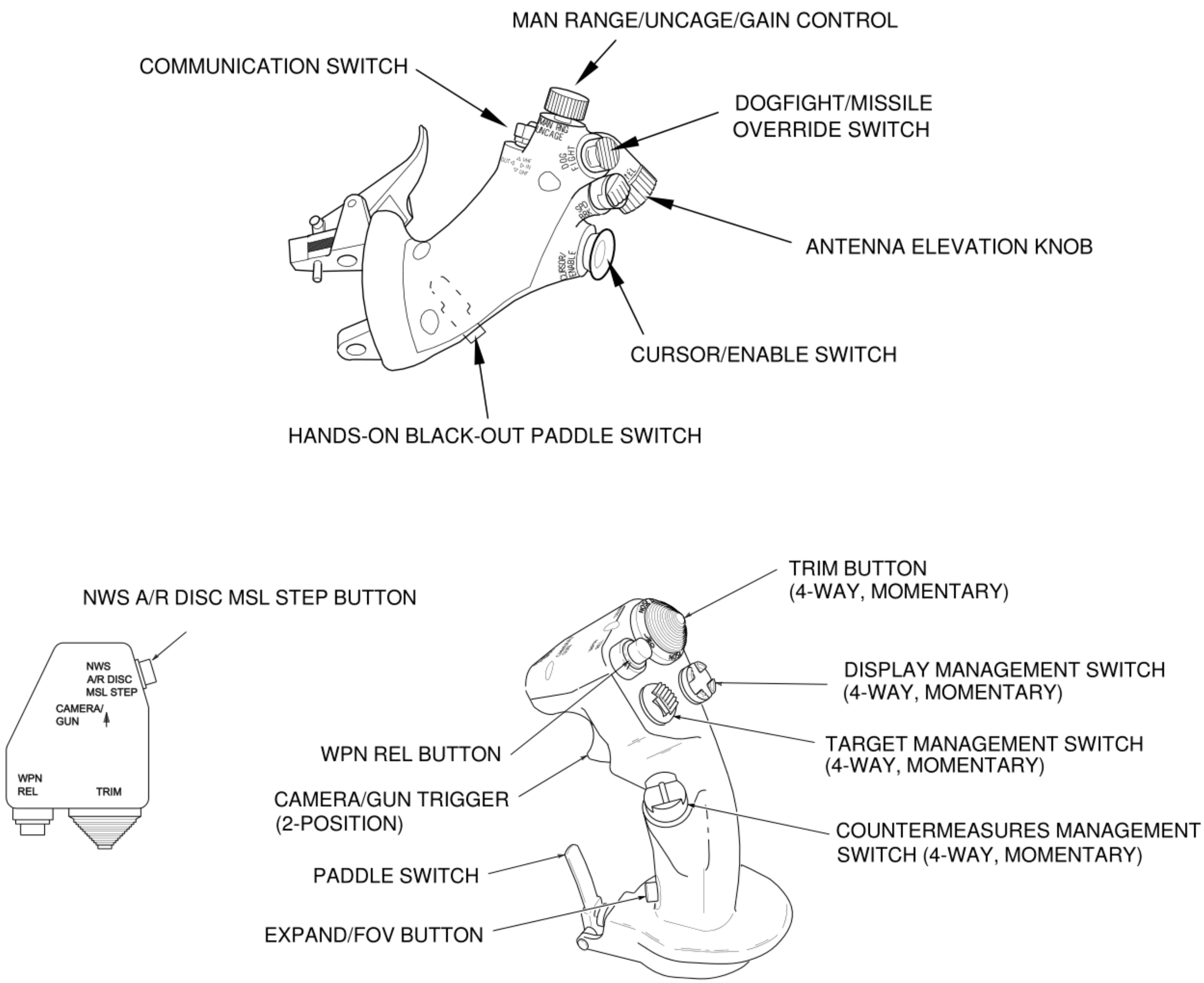
The MMC Operational Flight Program (OFP) includes the necessary processing to implement F-16 avionics system modes and functions while integrating system operations. The Fire control function analyses the state of the weapons system, considering switch positions, subsystem modes, and subsystem status, to ensure avionics system integration for navigation, air-to-air combat, and air-to-ground attack. The Stores Management function is responsible for managing, conditioning, monitoring, and controlling the stores carried on the F-16 aircraft. The Head-Up Display function controls HUD windows (on/off, position, and contents), scales (on/off and position), and symbology (on/off and position).

2.1.5 HANDS-ON CONTROLS

The hands-on controls consist of switches located on the throttle grip and the side-stick controller. Functions that require instantaneous access (e.g., radio transmit, target designate, weapon release) and functions that must be accomplished during manoeuvring flight, when the pilot cannot remove his hands from the stick and throttle, are controlled by the hands-on controls.

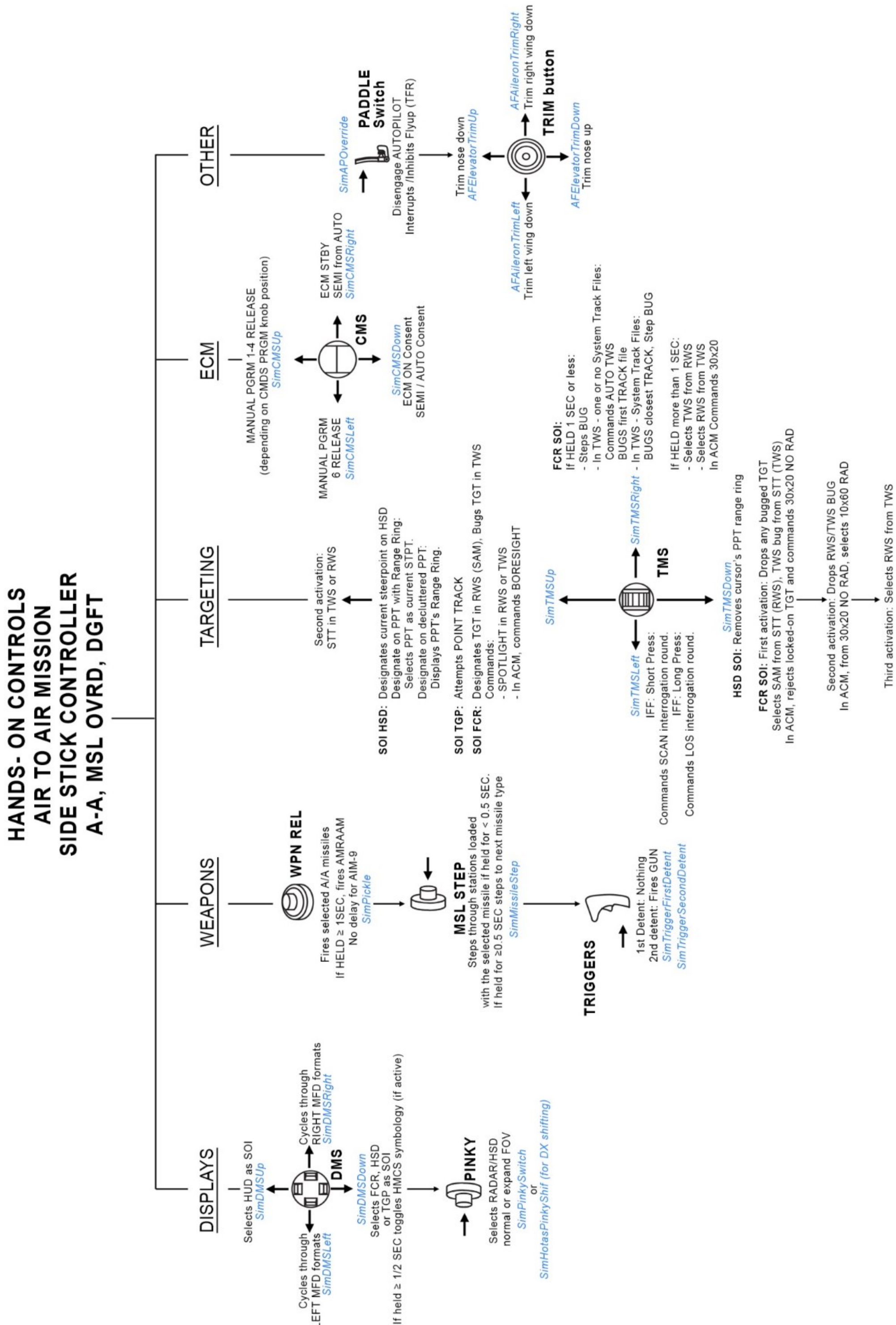
The following diagrams illustrate the typical F-16 HOTAS control grips and the various functions assigned to them. Except for the black-out switch (HOBO), all HOTAS functions are modelled in the game.

The sections which follow illustrate the functionality of the various controls in A-A and A-G modes and provide the names of the key file callback names that are typically mapped to each switch position on the stick and throttle grips. They should be referred back to as necessary.



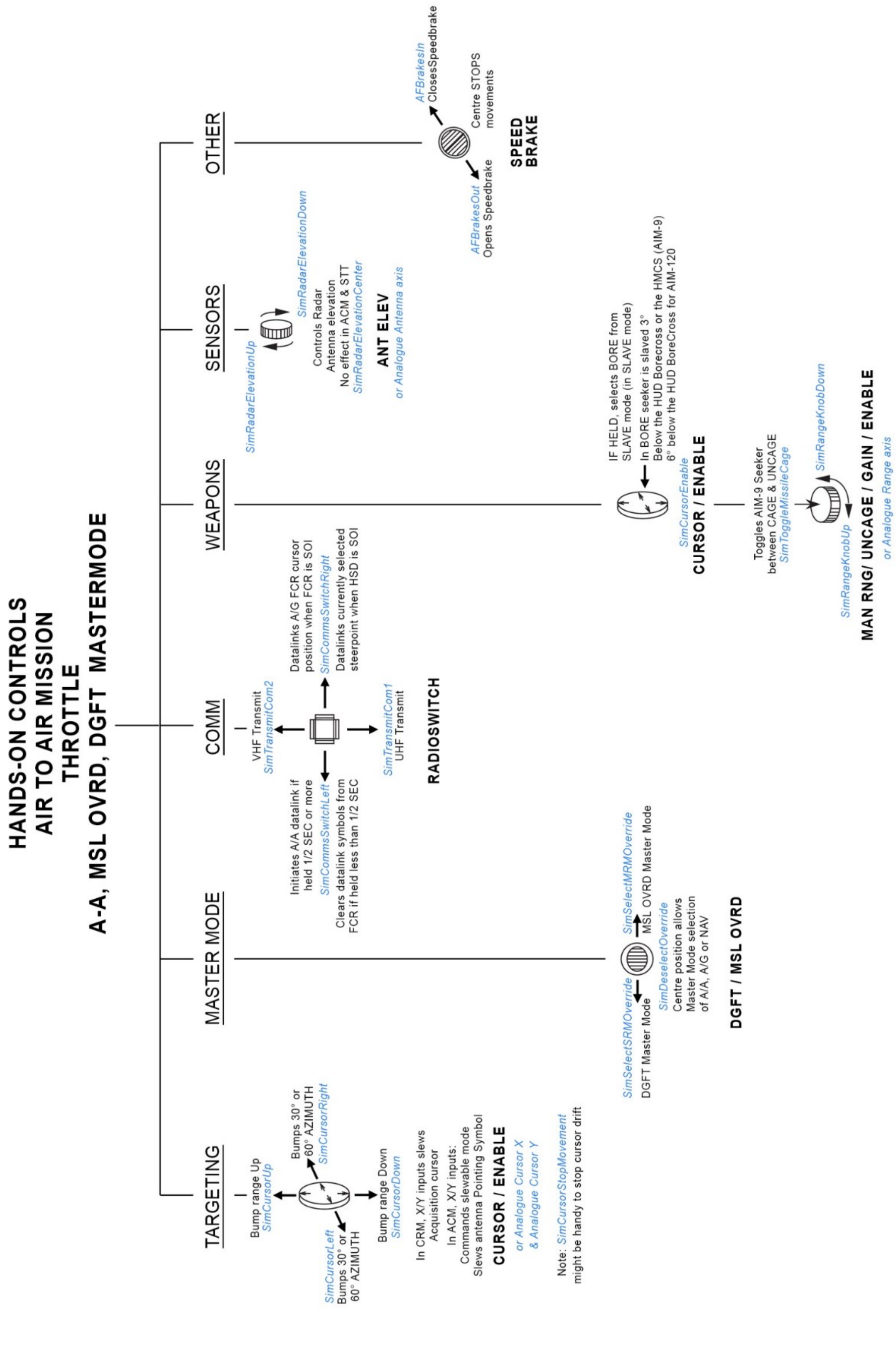
F-16 HOTAS Throttle (TQS) and Stick (SSC) Controls

2.1.5.1 AIR-TO-AIR MISSION – STICK



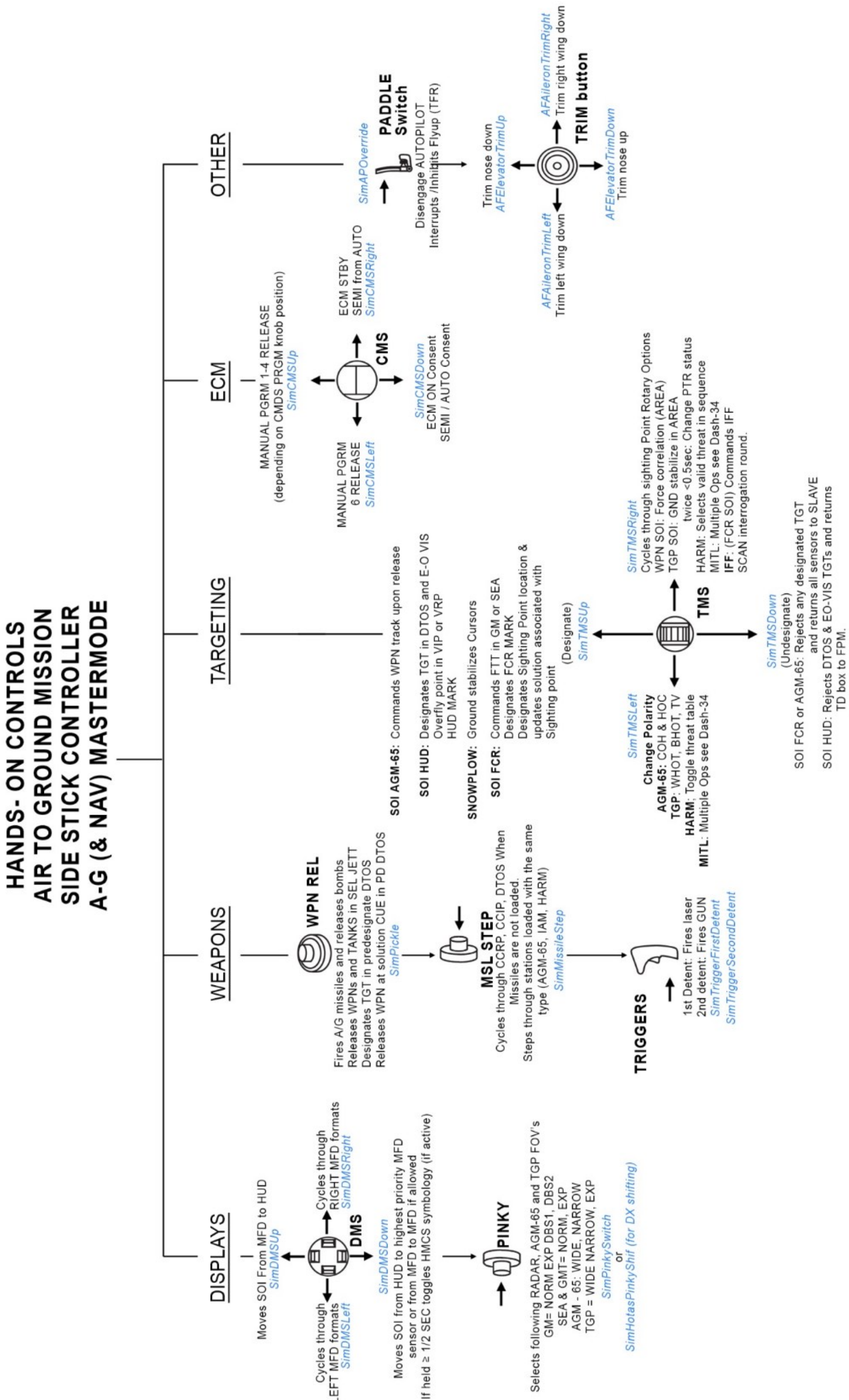
Hands on Control – Sidestick - Air-to-Air Mastermode

2.1.5.2 AIR-TO-AIR MISSION – THROTTLE



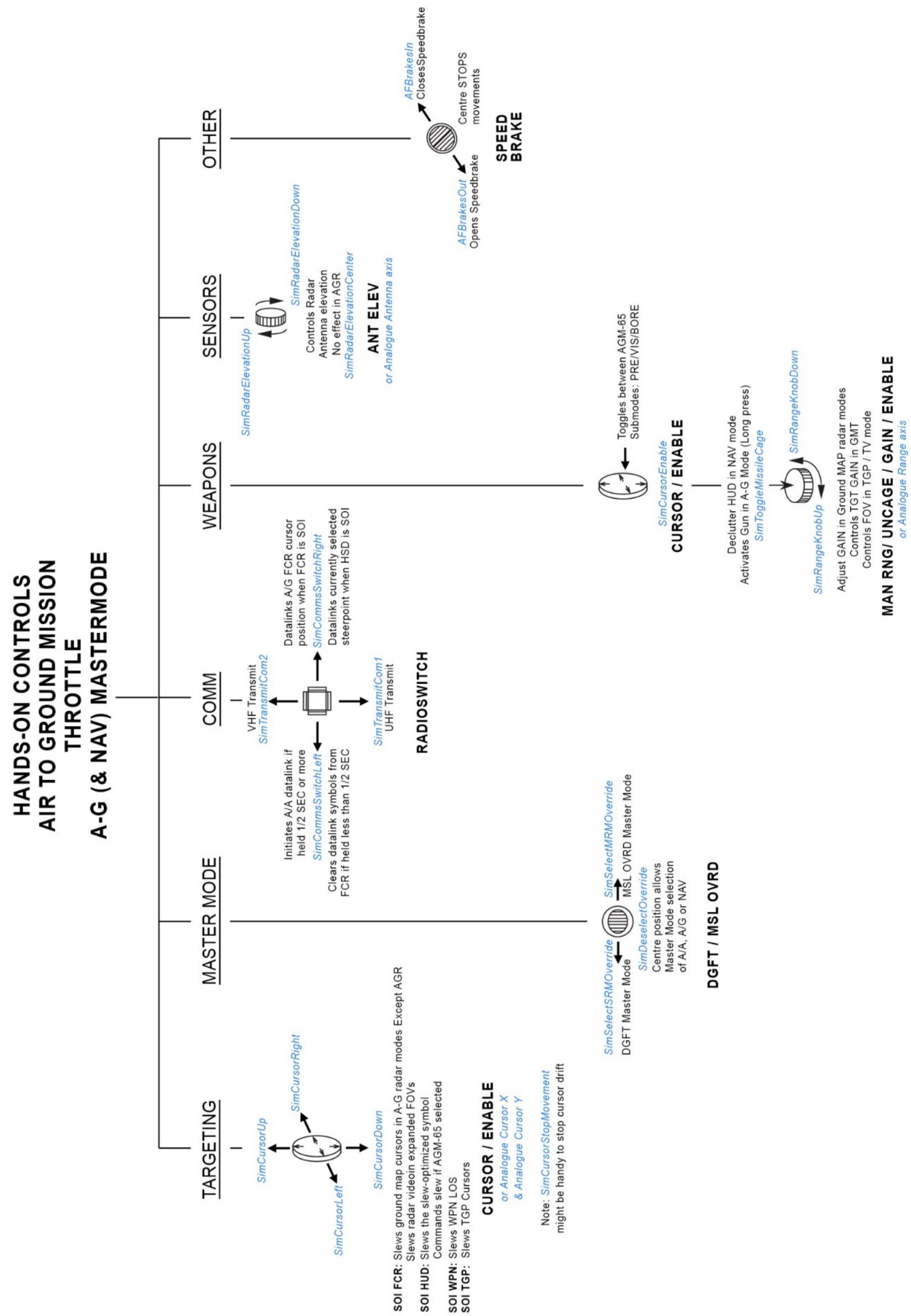
Hands on Control – Throttle - Air-to-Air Mastermode

2.1.5.3 AIR-TO-GROUND MISSION – STICK



Hands on Control – Sidestick - Air-to-Ground Mastermode

2.1.5.4 AIR-TO-GROUND MISSION – THROTTLE

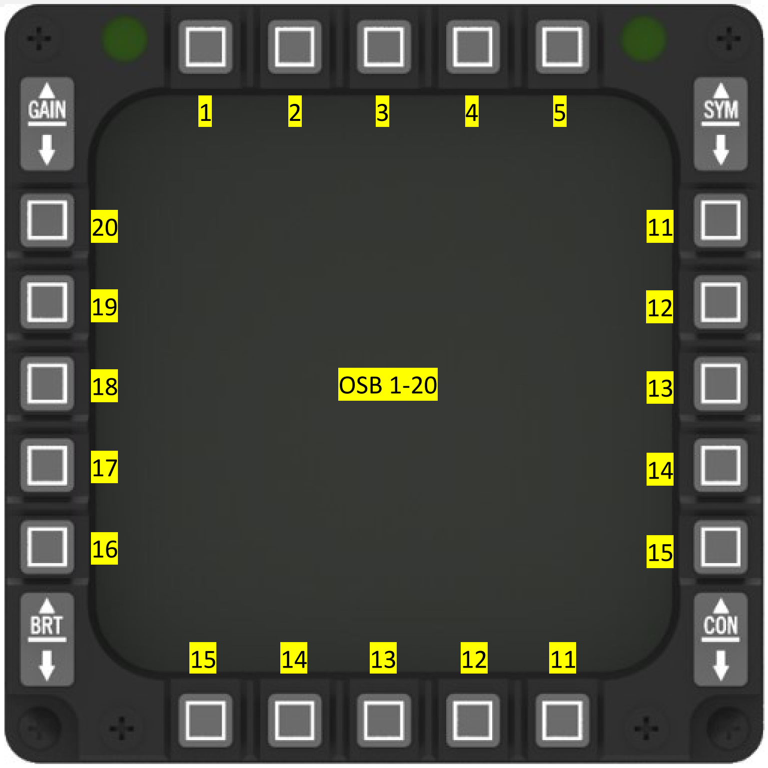


Hands on Control – Throttle - Air-to-Ground Mastermode

2.1.6 MULTIFUNCTION DISPLAY SET (MFDS)

The Color Multifunction Display System (MFDs) are units measuring 4 inches by 4 inches that facilitate weapon system management functions. To operate these units, option select buttons (OSBs) are utilized. These buttons are located on a bezel surrounding the display screen of each MFD and interact with the text displayed beside them to govern the displayed functions. The Color Multifunction Display (CMFD) and Common Color Multifunction Display (CCMFD) are both currently employed.

There are 4 rocker switches and 20 option select buttons (OSBs) surrounding each Multifunction Display (MFD). The four rocker switches are SYM (symbology), CON (contrast), BRT (brightness), and GAIN. The GAIN rocker switch controls additional features for specific ATP functions, FCR ground map, and air-to-air Moving Target Reject value. Each of these switches acts as an increase/decrease control. For instance, to intensify the MFD symbology, press the upper half of the SYM switch. To reduce symbology intensity, press the lower half.



Multifunction Display with OSB 1-20

If any of these rocker switches are held down, the selection (e.g., symbology intensity) will keep increasing or decreasing until either the switch is released or the maximum or minimum allowable value is reached. The rate of change for each switch takes roughly 5 seconds to transition from full off to full on.

The MFDS provides the ability to independently adjust the symbology brightness, contrast, and gain for each video format, along with a unified selection of symbology brightness and control for all text-only formats. The MFDS preserve the last chosen symbology, contrast, and brightness level for each format. This ensures that when a specific mode is reselected, the last chosen symbology intensity, brightness, and contrast level is remembered, eliminating the need for readjustment. For instance, a higher contrast can be picked for the radar format compared to the test format. The gain value for each sensor video is kept in that sensor, leading to similar operation for gain selections.

When exchanging MFD formats (OSB 15), the brightness and contrast settings are preserved for each format during the transition to the new display. Symbol intensity is stored per channel per format. The same applies for both displays. The MFDs utilize three distinct display types: text, video, and symbols.

The MFDs feature a reset function for symbology, brightness, and contrast. In cases where these controls have been incorrectly configured and it's not immediately clear which controls need adjustment; the RESET MENU format can be accessed on the display format page. By selecting SBC DFLT RESET on the RESET MENU page, the symbology, brightness, and contrast will be set to default values.

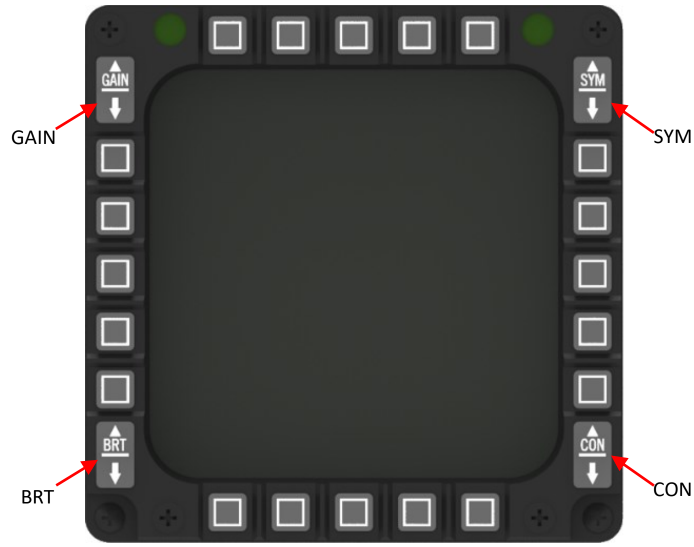
The 20 OSBs on the frame of each MFD function in tandem with the text displayed beside each button.

Typically, the OSBs situated at the bottom of the MFD are responsible for choosing display formats, whereas the ones at the top select sensor modes. The OSBs located at the sides of the MFD manage functions that are specific to the chosen format/mode. To confirm that an OSB has been successfully pressed (in Falcon BMS: key callback via input devise), the display area around the corresponding OSB briefly illuminates.

2.1.6.1 MULTIFUNCTION DISPLAY SET (MFDS) SWITCHES

The Multifunction Display (MFD) is equipped with 4 rocker switches and 20 OSBs surrounding its face. These switches have specific labels and functions. The four rocker switches are SYM (symbology) -> not implemented, CON (contrast) -> not implemented, BRT (brightness), and GAIN (additional features controlled via the GAIN switch for certain ATP functions, FCR ground map, and air-to-air Moving Target Reject value). Each of these switches operates as an increase/decrease control. For instance, to increase the brightness of MFD symbology, press the upper half of the BRT switch. To decrease the symbology brightness, press the lower half of the switch.

The rate of change for each switch is approximately 5 seconds from the fully off position to the fully on position.



Multifunction Display Switches

The MFDs allow independent adjustments of symbology brightness, contrast, and gain for each video format, as well as a single adjustment for symbology brightness and control across all text-only formats. The MFDs store the last settings of symbology, contrast, and brightness for each format, so when a particular mode is selected again, the previous settings are automatically applied, eliminating the need for readjustment. For example, a higher contrast setting may be chosen for the radar format compared to the text format. The gain value for each sensor video is stored within the respective sensor, ensuring consistent operation for gain selections.

When swapping between MFD formats (OSB 15), the brightness and contrast settings specific to each format are not retained during the transition to the new display.

The MFDs utilize three distinct display types: text, video, and symbols. The following table defines the MFD rocker switches that affect each of these display types:

Rocker Switches are:

- SYM (symbology): Controls symbology intensity *(Not implemented in BMS yet).*
- CON (contrast): Adjusts contrast levels *(Not implemented in BMS yet).*
- BRT (brightness): Regulates the brightness setting.
- GAIN: Enables additional features and controls for specific ATP functions, FCR ground map, and air-to-air Moving Target Reject value.

Things displayed on an MFD	**MFD Rocker Switches**		
	BRT	**CON**	**SYM**
TEXT	X	Not implemented	Not implemented
VIDEO	X	Not implemented	Not implemented
MFD Generated Symbols	X	Not implemented	Not implemented
Video Generated Symbols	X	Not implemented	Not implemented

MFD Rocker switch functions

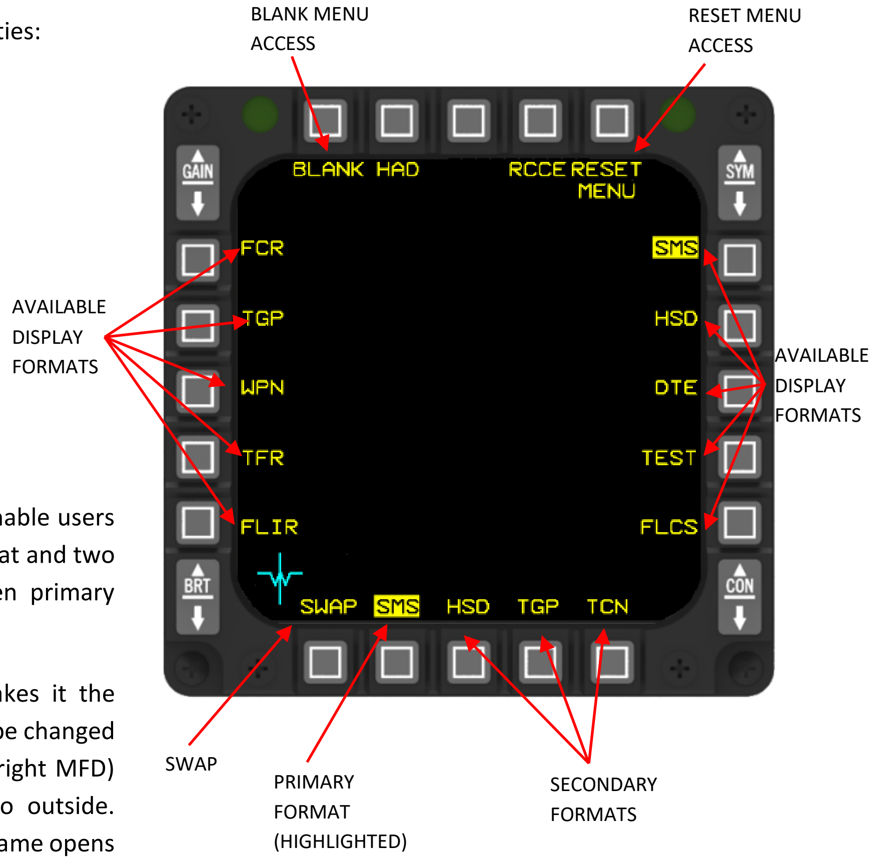
2.1.6.2 TYPICAL MFDS FUNCTIONS

The capabilities of the MFDS encompass the following abilities:

- Select display formats.
- Swap display formats.
- Declutter certain alphanumeric data.
- Select various options via either rotaries or menus.
- Increment/decrement certain data.
- Enter numerical data via a keyboard including recovering from mistakes and errors.

On the bottom row of the MFD, the trio of center OSBs enable users to choose the MFD format. The names of the primary format and two additional formats are consistently exhibited. The chosen primary format is emphasized.

Pressing the OSB next to a secondary format name makes it the primary format for that MFD. The primary format can also be changed by using the DMS left (for the left MFD) or right (for the right MFD) switch. The selection of formats is done from inside to outside. Pressing the OSB next to the primary (highlighted) format name opens the master menu of available formats. Pressing the OSB next to the desired format name on the menu page opens the selected format and replaces the previous primary format. Out of the six available formats (three on each MFD), no two can be the same unless they are blank formats or TEST formats during MFD BIT. If a format is selected from the master menu page that already exists as one of the five other formats, the blank format is used instead of the old format.



MFDS functions

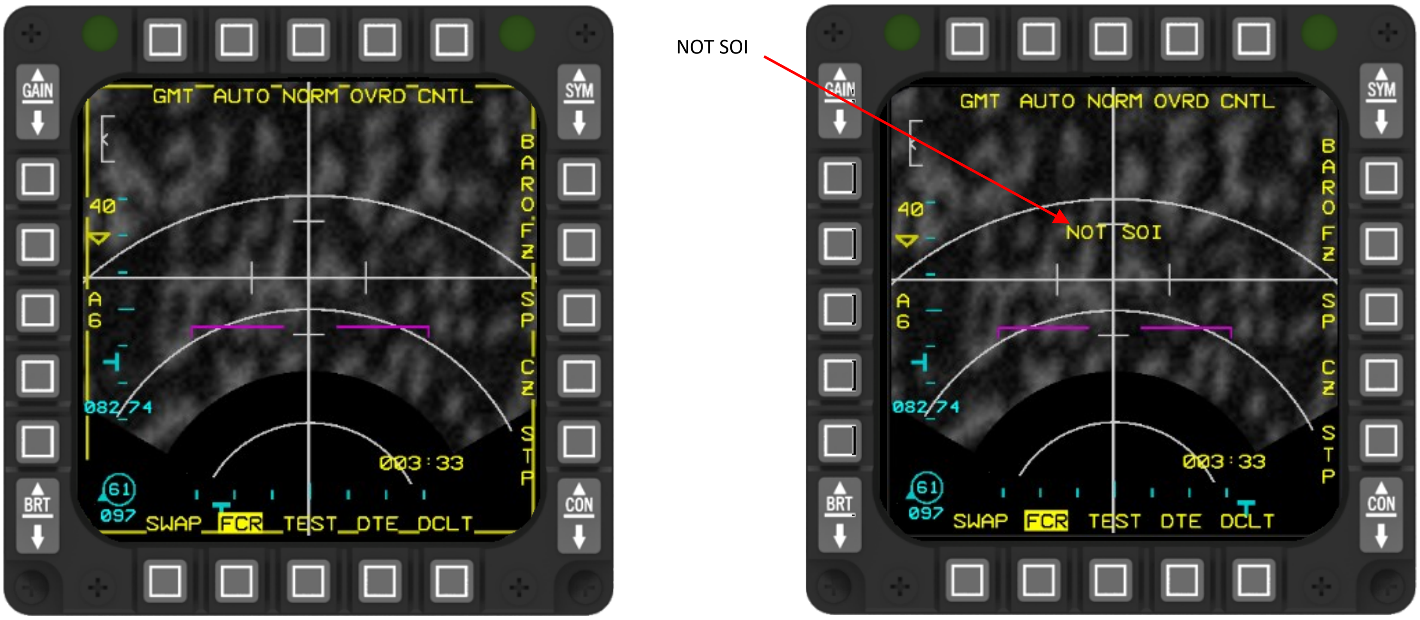
The formats for controlling and displaying video and/or text data on the MFD are:

FORMAT	MNEMONIC	TYPE OF DISPLAY
FLIR Navigation Pod	FLIR	Video and text
Digital Flight Control System	FLCS	Text
HARM Attack Display	HAD	Text
Horizontal Situation Display	HSD	Text
Test	TEST	Text
Data Transfer Equipment	DTE	Text
Stores Management System	SMS	Text
Weapon (AGM-65, AGM-88, etc.)	WPN	Video and text
Fire Control Radar	FCR	Video and text
Targeting Pod	TGP	Video and text
TACAN Format	TCN	Text
Navigation Pod Terrain Following Radar	TFR	Video and text
Blank	None	Text

MFD formats

2.1.6.3 Sensor of Interest (SOI)

At times, it may be necessary to focus on one MFD instead of the other. In order to inform the system about your area of focus, you will need to use the Sensor of Interest (SOI) mechanism. Consider the following scenario: the FCR is set as SOI on the left MFD, while the HSD is displayed on the right. Suppose you wish to delete a threat ring on the HSD, but moving your cursor causes the captain's bar to move on both the HSD and FCR. To inform the system that you wish to work specifically on the HSD, you need to make the HSD SOI. This can be done by simply moving the Display Management Switch (DMS) on your HOTAS downwards. The SOI will toggle from one MFD to the other, with a big square box drawn outside the OSB labels serving as a visual cue for MFD SOI. If an MFD is not SOI, the text "NOT SOI" will be displayed in the center, reminding the pilot that the display is not the Sensor of Interest.



MFDS – Sensor of Interest. Left SOI/Right NOT SOI.

In the above scenario, the FCR on the left MFD is designated as the SOI and displays a large square cue around the edge of the display. On the other hand, the FCR on the right MFD does not display the SOI cue and instead shows the "NOT SOI" cue in grey in the centre. Only one MFD can be designated as SOI at a time.

If the HUD is in a mode that allows for SOI, selecting DMS up will designate it as SOI, with an asterisk displayed in the top left corner of the HUD serving as the SOI cue. DMS down toggles the SOI from one MFD to the other.

When the ground cursor position (System Point of Interest or SPI) is slewed, the current steerpoint is effectively slewed by adding a system delta to all steerpoints. As a result, all NAV and weapon delivery steering and symbology, including the great circle steering cue (tadpole), will be referenced to the amended steerpoint(s). On aircraft with the Nav EGI upgrade, the CZ mnemonic will be highlighted if a system delta exists (i.e., SPI slew). To revert the system solution back to the original navigation solution after cursor slews have been made, pilots should use the following routine:

1- TMS down
2- Cursor Zero (OSB#9).
3- Wide Field of View (OSB#3).

This habit should be developed after each cursor slew phase and at each IP if cursor slews have been made.

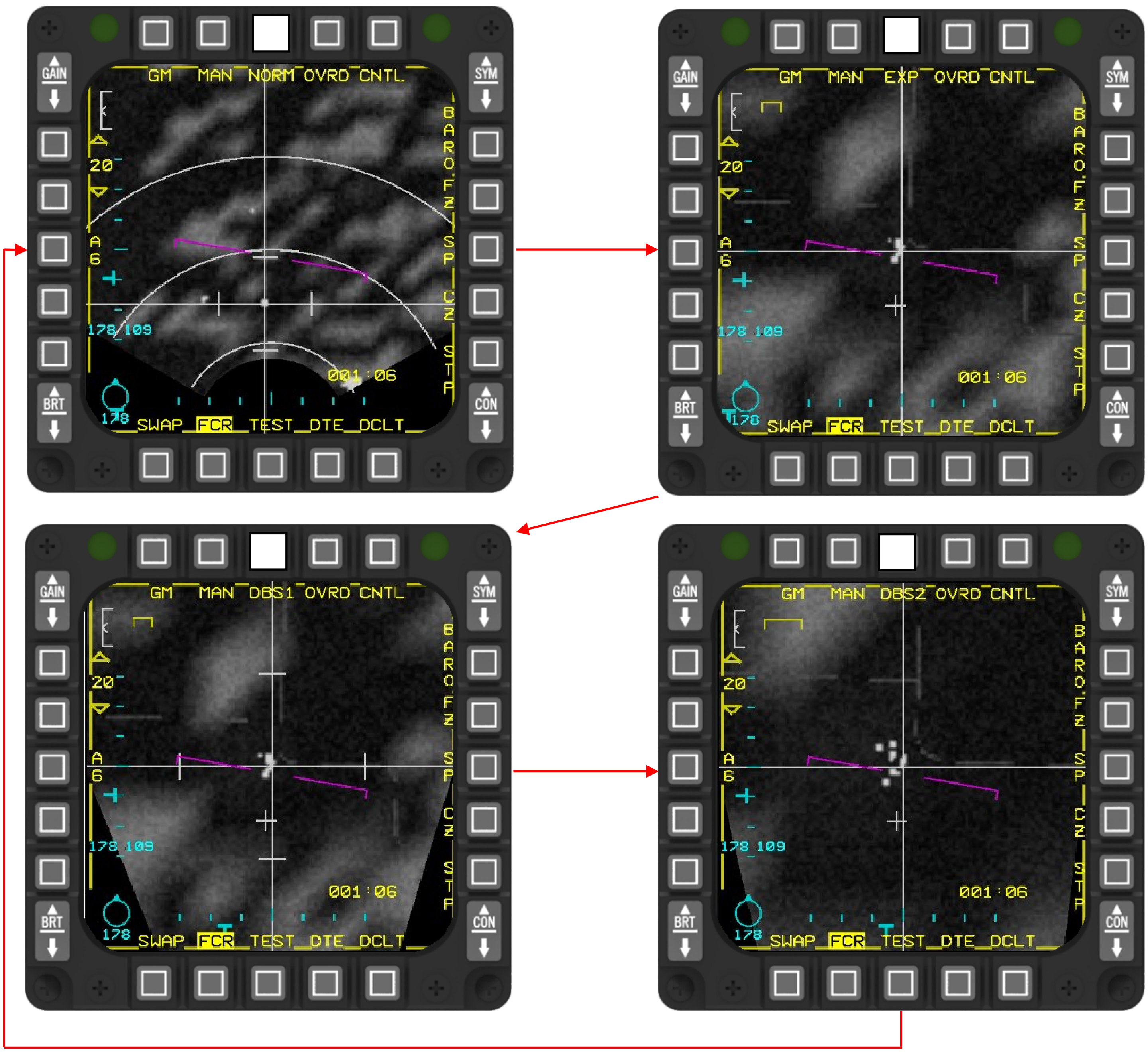
For more information, please refer to the chapter on SPI Management in the TO-BMS1F-16CM-34-1-1.

2.1.6.4 SELECT OPTIONS

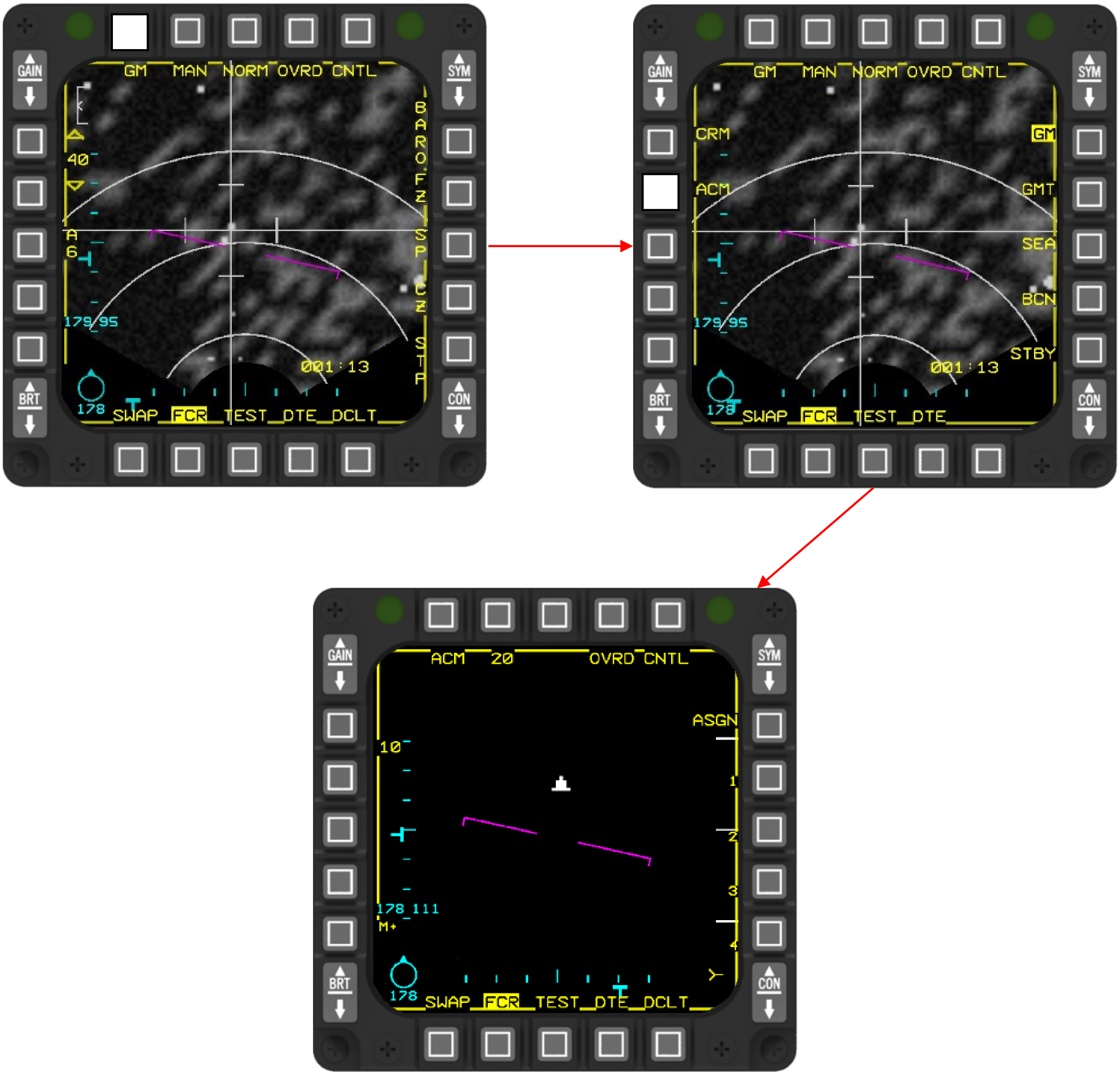
On most MFD formats, there are various items or options that can be selected. If there are only four or fewer options, they can be selected using a rotary control. However, if there are more than four options, they will be accessible through a menu.

The currently selected options that can be modified are displayed on the MFD screen next to an OSB (Option Select Button). To change a rotary control, simply press the OSB next to the displayed mnemonic. By repeatedly pressing the OSB, you can cycle through the available choices for that particular option.

When there are multiple choices for a specific option, they are presented in a menu format. Pressing the OSB adjacent to the currently selected choice will display the available choices, with the currently selected choice highlighted. To select a different option, press the OSB next to the desired choice, and the MFD will return to the normal format page.



MFDS – OPTIONS SELECT VIA ROTARY



MFDS – OPTIONS SELECT VIA MENU

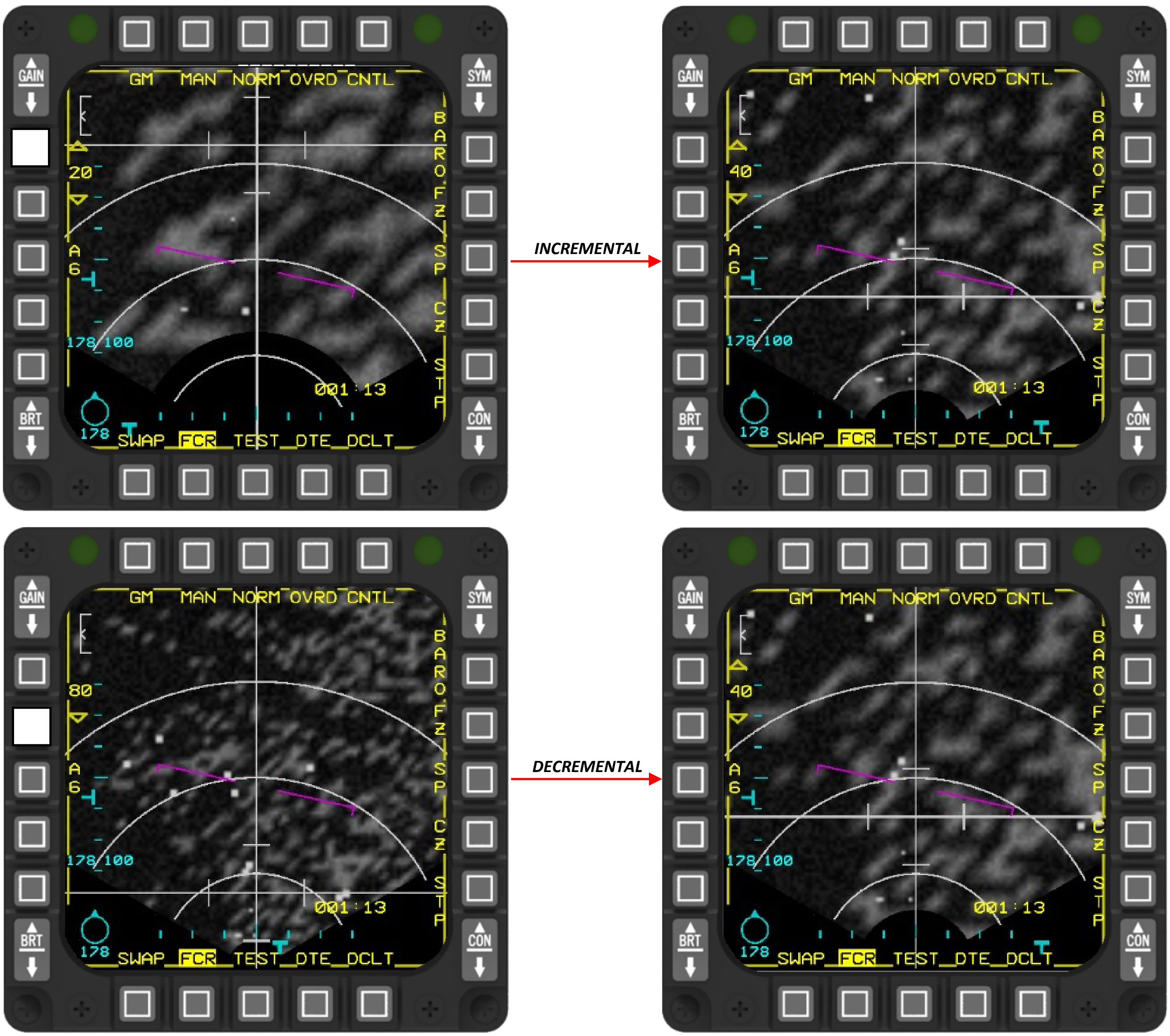
2.1.6.5 INCREMENT/DECREMENT

Some items on the MFD formats can be adjusted using an increment/decrement function. These items are indicated on the MFD by the presence of up and down pointing triangles or arrowheads. The upward pointing symbol is located next to one, while the downward pointing symbol is positioned next to the lower OSB.

Pressing the increment OSB will cause the selected item to increase to the next allowable value. For example, it can be used to change the radar range scale from 20 miles to 40 miles. Conversely, pressing the decrement OSB will decrease the item to the next allowable value.

Items indicated by triangles require a single press of the OSB to increment or decrement. Each press will cycle through the available selections. Once the maximum value is reached, further increment commands will have no effect.

Items indicated by arrowheads require a press and hold action for continuous increase or decrease. You can repeatedly press and release the OSB or hold it down to automatically increase or decrease the item. The automatic increase will continue until the OSB is released or the maximum value is reached. The decrement function follows a similar process.



MFDS – Incremental/Decremental

2.1.6.6 DATA ENTRY AND RECALL

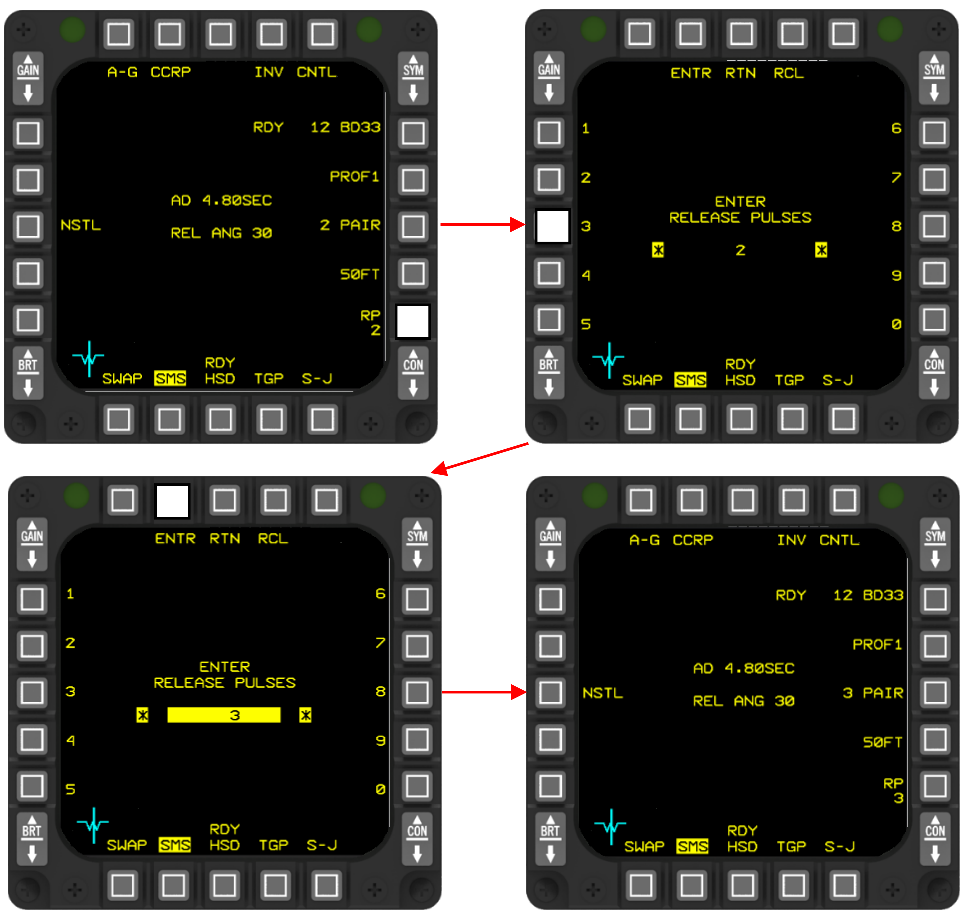
To input data on the MFDs (Multi-Function Displays), follow these steps:

1. Press the OSB (On-Screen Button) next to the data you want to change.
2. Use the OSBs to enter the numerical data.
3. Press the ENTR (Enter) OSB.

When the OSB next to the old data is pressed, the MFD displays a data entry page. This page includes numbers 1, 2, 3, ... 0 next to the side OSBs, format controls along the bottom OSBs, and a prompt in the center of the display. Below the prompt, there is a data entry field with the initial data (old number) enclosed by highlighted asterisks (similar to the upfront controls data entry display).

To enter new data, input the new number (the entire data entry field will highlight) and press the ENTR OSB located at the top edge of the MFD. If there are more data fields, pressing ENTR will move the asterisks to the next field. If you don't need to make an entry, press the RTN (Return) OSB to go back to the previous page. When the ENTR OSB is pressed on the last data field of a data entry page, the MFD will automatically return to the previous page.

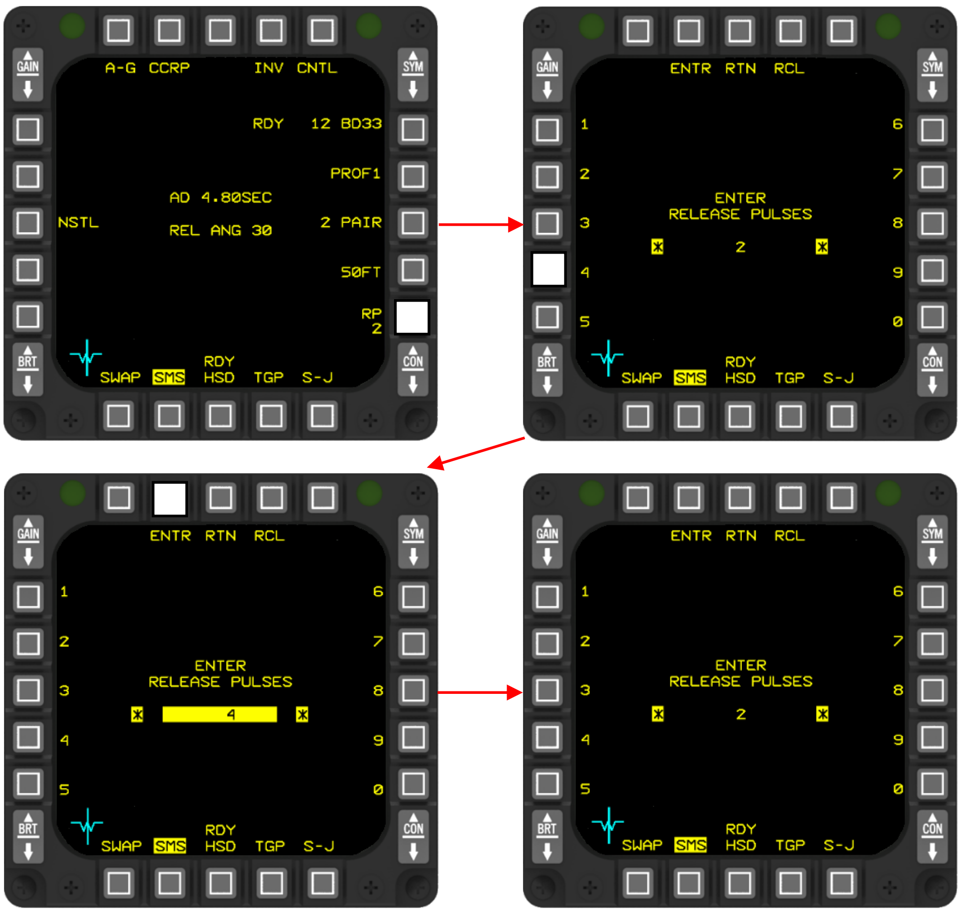
The new data is not accepted by the MFD until the OSB labelled ENTR is pressed. If ENTR is not pressed, the old data will be restored when another page is selected. Each data field has a limited number of digits that can be entered. If the field is already filled, any additional key presses will be ignored.



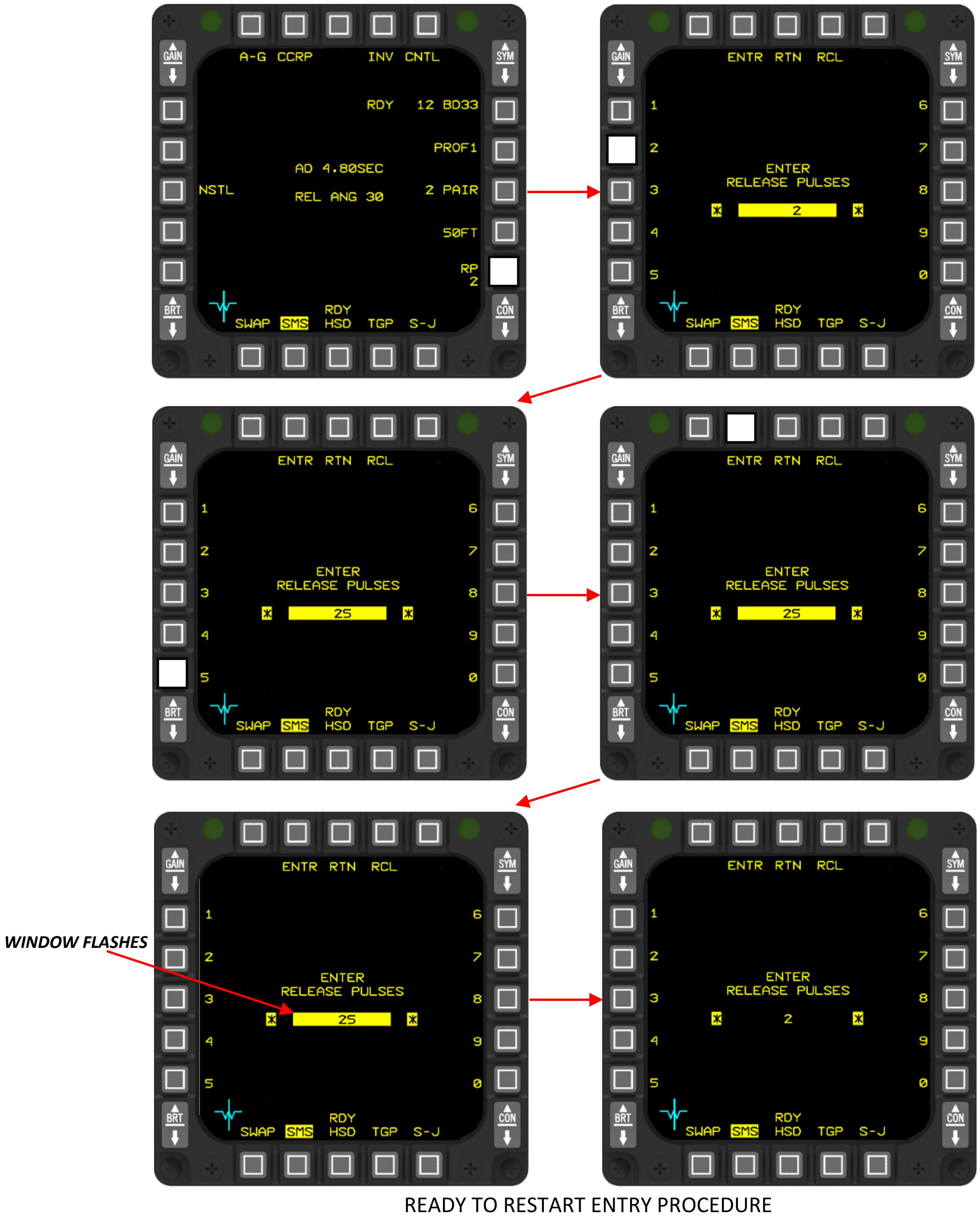
MFDS – Data entry

If an error occurs while entering data, you can recall the previous valid data using the recall (RCL) OSB. At any point before pressing ENTR, pressing the RCL OSB will retrieve the previous valid data and remove the data entry highlight. You can then re-enter the correct data. If a different MFD page is selected, the partially entered data will be rejected, the last valid data will be recalled, and the MFD will return to the normal format.

The MFDs perform error checks on certain data entered. If an error is detected, the system will prevent entry of the erroneous data, flash the highlight around the erroneous data (alternating between highlighting and de-highlighting), and freeze the display. To recall the last valid data, restart the entry process, and unfreeze the display, press the recall (RCL) OSB.



MFDS – Data entry, Mistake recovery using recall



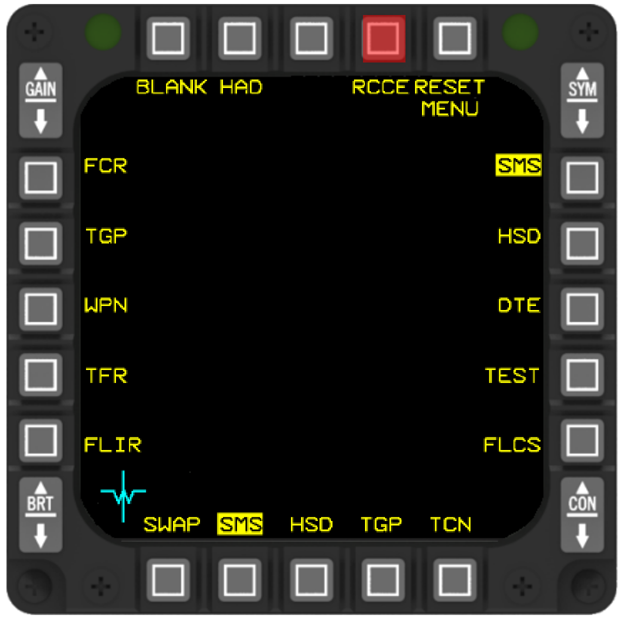
MFDS – Data entry error

2.1.6.7 Menu page

The Menu page is the link between all subpages. It is displayed when the DA (Direct Access) button is depressed while that particular page is already displayed (pressing FCR when FCR is already being displayed for instance).

You can thus access any subpages in any master mode from this page: Stores Management System (SMS), Horizontal Situation Display (HSD), Data Transfer Equipment (DTE), TEST page, FLCS page, Forward Looking Infrared (FLIR) page, Terrain Following Radar (TFR), Weapon (WPN) page, Targeting Pod (TGP) page; Fire Control Radar (FCR), BLANK page, HARM Attack Display (HAD) page, Reconnaissance (RCCE), Tacan (TCN) and RESET page.

In later chapters of this section, each subpage will be explained in further detail.



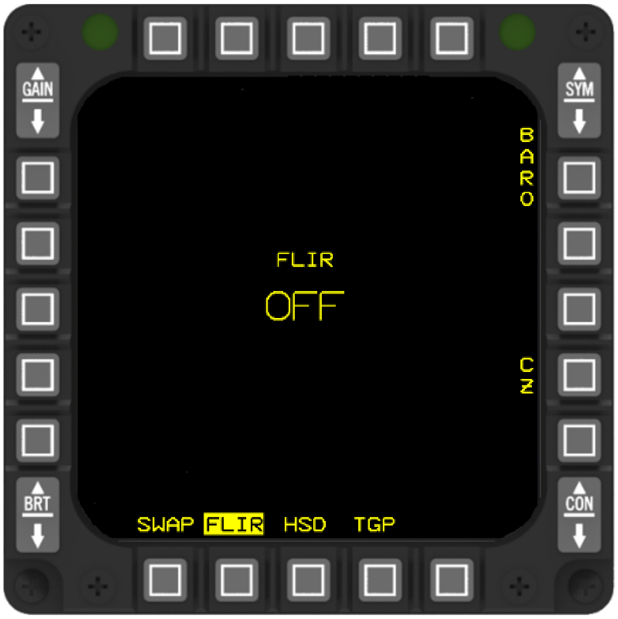
MFDS – Menu page

BLANK	Blank page
HAD	HARM Attack Display page
RCCE	Reconnaissance page (not implemented yet)
RESET MENU	Reset menu page
SMS	Stores Management System page
HSD	Horizontal Situation Display page
DTE	Data Transfer Equipment page
TEST	Test page
TCN	TACAN page
TGP	Targeting Pod page
FLIR	Forward Looking Infrared page
TFR	Terrain Following Radar page
WPN	Weapon page
FCR	Fire Control Radar page

MFDS – Menu pages

2.1.6.8 OFF FORMAT

If a format is not in use or not available, selecting it from the menu will display the OFF page on the MFD. The OFF page will remain on the MFD until the format is deselected (as seen on the right picture: FLIR OFF)



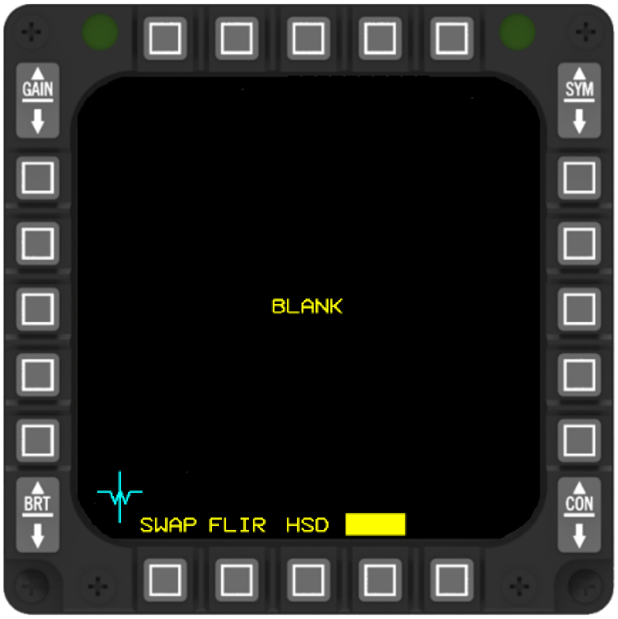
2.1.6.9 SWAP DISPLAYS

The MFDS include a feature that allows the exchange of displays between the two MFDs. By depressing the SWAP OSB on either MFD, the information displayed on the left MFD is swapped with that of the right MFD, including both video and text data.

2.1.6.10 BLANK FORMAT

Depressing the OSB next to a secondary format that is blank will not display any mnemonic. Selecting this position will show the blank format display and highlight the primary format label position.

Any blank formats will be skipped when using DMS left or right.

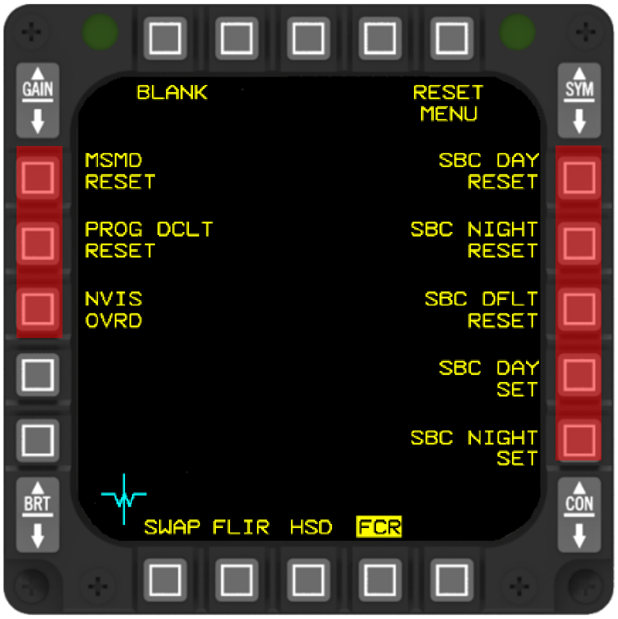


2.1.6.11 RCCE PAGE

The RCCE page cannot be accessed via OSB 4 of the MENU page and it currently serves no purpose in BMS as none of its functionality is implemented.

2.1.6.12 RESET MENU

Although the RESET menu can be accessed via OSB 5 of the MENU page, it currently serves no purpose in BMS as none of its functionality is currently implemented.



2.1.6.13 DTE PAGE

To access the DTE pages, press OSB 8 on the menu page. Those two pages utilized to load the Data Cartridge from the UI that was prepared during mission planning into the aircraft computer. Loading is typically done by pressing OSB 3 at ramp start, right after or just before switching the CNI to UFC. During loading, each displayed system (e.g., MPD, COMM) is highlighted in sequence, and the DTC changes should be visible in the DED, including presets for VHF and UHF, among others. Loading occurs in a counter-clockwise sequence from the LOAD button.

To manually load any color profile that has been set up using the Avionics Configurator and saved to your [callsign].ini file, use COLR. This can be used to change any aspect of the symbology to your preference, such as turning yellow MFDs back to white. This functionality is available in the real aircraft and is described in more detail in the Avionics Configurator chapter in the BMS Technical Manual.

The successful loading of Link 16 data is indicated by the de-highlighting of the Link 16 mnemonic, followed shortly by the appearance of the phrase "LINK 16 INIT CHECK" at the center bottom of the MFD. If two NDL files were transferred, an 'A' or 'B' designation will be displayed below the Link 16 mnemonic. However, if only one NDL was available on the DTC, this field will remain blank. To switch between the A and B files, depress the OSB adjacent to Link 16 for less than 0.5 seconds.

To change file A to file B for Link 16, press OSB 8 long. Please note that file B must contain information. If no information is available, option “A” and “B” is not visible for OSB 8. In addition, no files are visible before L16 is loaded from the DTC.

Refer to the table to the left for further information about the DTE submodes.

ON	Not functional
CLSD	Classified Coefficient Data
LOAD	Initiates loading each subsystem
CLSD	Classified Coefficient Data
FCR	Fire Control Radar
DLNK	Improved Data Modem Data
LINK 16	Link 16 Symbology (File A or B)
NCTR	Non-cooperative Target Recognition
MSMD	Master Mode Initialization
PROF	Weapons Delivery Profiles
INV	Stores Inventory
COMM	Communication
MPD	Mission Planning Data
COLR	Colour profile
GPS	Global Positioning System data

DTE submodes

2.1.6.14 TEST PAGES

The TEST page is a useful tool for pilots to monitor the Built-In Tests (BIT) of various subsystems during flight. BIT1, BIT2 and BIT3 (push OSB #1 to switch between BIT 1-3) give access to subsequent test pages and shows the maintenance fault list (MFL) encountered during the flight, which includes information such as the subsystem where the fault occurred, test number that failed, number of failures of that subsystem, and time since FCC power up when the first fault occurred.

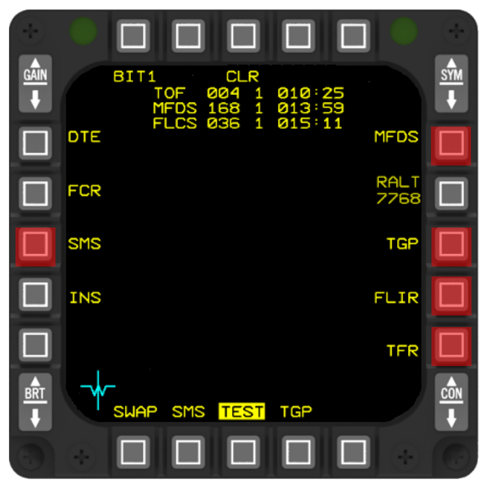
In addition to recording actual faults, two pseudo-faults are always recorded: take-off time (TOF) and landing time (LAND). TOF is recorded when the airspeed reaches 120 kts with the gear up, while LAND is recorded when the gear is down and airspeed is less than 80 kts.

To clear the fault list and launch a fault survey, pilots can simply press the CLR button. The MFL can hold a maximum of 17 faults, including the two pseudo-faults, and if more than 17 faults are present, the oldest fault will be replaced by the newest one. After the flight, pilots can review the full MFL from the flight in the DTC file, which is recorded in the dtc_last_flight_faults.txt file in the \User\Logs\ folder. However, it's important to note that this file is overwritten with each new flight.

During Ramp Start, it's normal for faults to be displayed on the TEST page, and these faults will clear as the systems come online. However, in the event of a real problem, it may be necessary to clear the MFL with OSB 3 to launch a fault survey. After clearing the MFL, if a system is still malfunctioning, the fault will display again on the MFL, allowing the pilot to take appropriate action to solve it. Overall, the TEST page provides pilots with valuable information to ensure safe and efficient flight operations.

BIT 1 - Page

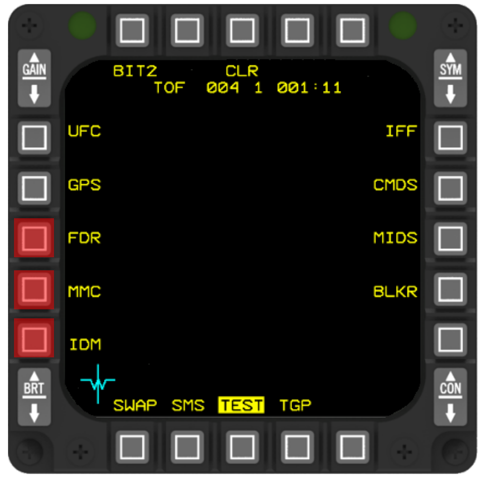
BIT 1-3	Switch between BIT 1-3 pages
CLR	Clear fault list (if fault persists, a new entry will created)
MFDS	Multifunction Display Set (N/I)
RALT	Radar Altimeter (available if RALT is activated)
TGP	Targeting Pod (N/I)
FLIR	Forward Looking Infrared (N/I)
TFR	Terrain Following Radar (N/I)
INS	Inertial Navigation System
SMS	Stores Management System (N/I)
FCR	Fire Control Radar
DTE	Data Transfer Equipment



BIT Page 1

BIT 2 - Page

BIT 1-3	Switch between BIT 1-3 pages
CLR	Clear fault list (if fault persists, a new entry will created)
IFF	Identification Friend or Foe
CMDS	Countermeasures Dispenser System
MIDS	Multifunctional Information Distribution System
BLKR	Blanker
IDM	Improved Data Modem (N/I)
MMC	Modular Mission Computer (N/I)
FDR	Standard Flight Data Recorder (N/I)
GPS	Global Positioning System
UFC	Upfront Controls



BIT Page 2

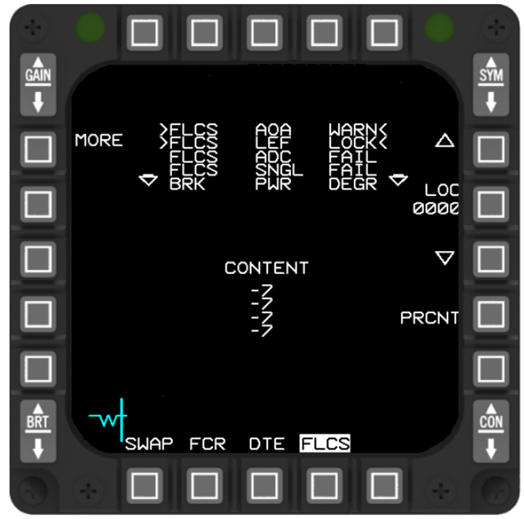
BIT 3 - Page

BIT 1-3	Switch between BIT 1-3 pages
CLR	Clear fault list (if fault persists, a new entry will created)
EHSIS	Electronic Horizontal Situation Indicator Slave
EHSIM	Electronic Horizontal Situation Indicator Master
HMCS	Helmet Mounting Cueing System (n/i)
RECCE	Reconnaissance (n/i)

BIT Page 3

For all information about the Maintenance Fault List (MFL) codes and explanation, please refer to chapter 7.1.2 of this document.

2.1.6.15 FLCS PAGE

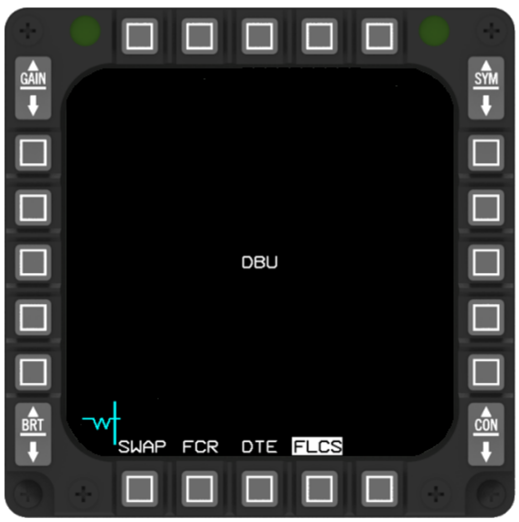


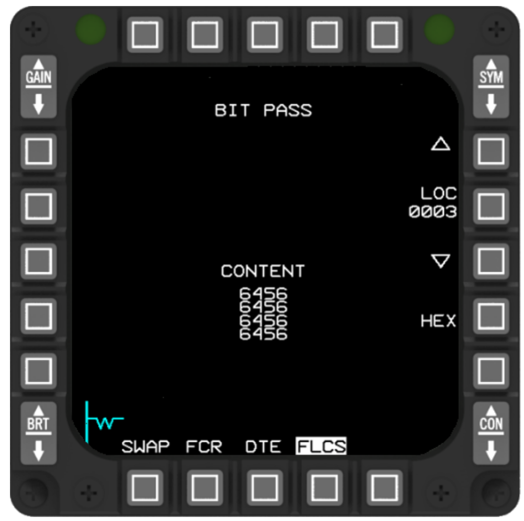
The FLCS MFD format serves as a backup display for FLCS faults and allows for the display and control of maintenance functions when the F-16 is on the ground. It can show up to five faults simultaneously.

Two downward-pointing arrows indicate the last fault displayed, and the "MORE" mnemonic is positioned next to OSB 20 to indicate the presence of additional faults.

By pressing OSB 20, the MFD display can be switched to show the additional faults.

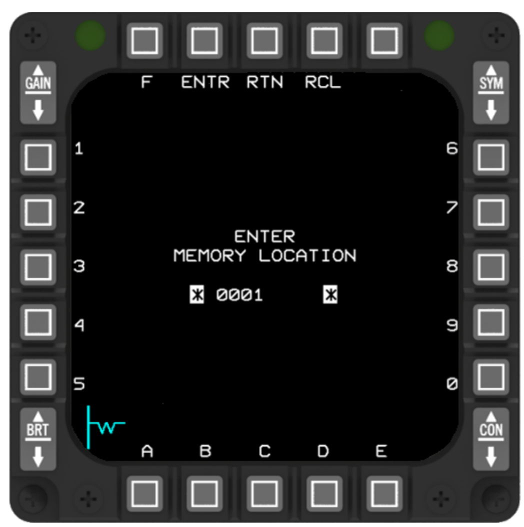
When the aircraft is on the ground, maintenance options are shown to access the four FLCSs. These options enable personnel to view data stored in the same memory location in each computer (OSB 7).





Pressing OSB 6 or 8 increments or decrements the selected memory location by one position. Alternatively, the desired location can be entered through the data entry page by pressing OSB 7. The content can be displayed as a percentage or in hexadecimal form.

Cycling the DBU switch while the WOW (Weight on Wheels) condition is active will reinitialize the FLCS and prevent FLCS MFL reporting for 20 seconds. The FLCS page displays "DBU" while the DBU process is running.



If the FLCS MFLs clear and do not reappear within 20 seconds, no maintenance action is required.

Memory Select (OSB 7)	This option brings up a data entry page with numeric labels ranging from 0 to 9.
Memory Select INC/DEC (OSB 6 & 8)	These options allow you to increment or decrement through the memory locations.
HEX/PRCNT (OSB 9)	Switches between Hexadecimal or Percent.
Extended fault list (OSB 20)	Shows an extended list if more than 5 faults appear

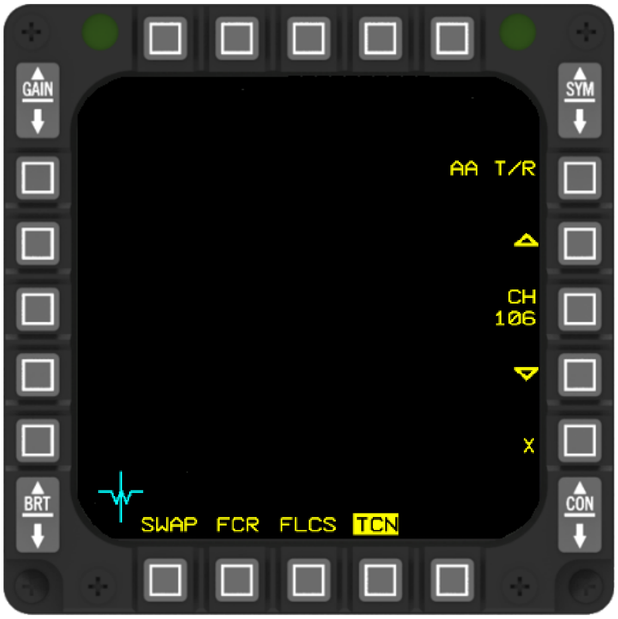
2.1.6.16 TCN PAGE

You can access the backup information for TACAN channel (1-126), TACAN band (X or Y), and TACAN communication mode (REC, T/R, or A/A TR) at all times using the MFDS TACAN page.

The displayed data on this page represents the actual values reported by the TACAN system.

Backup TACAN control is only available for a single failure (the UFC). Backup TACAN control is not available when the MFDS is the (backup) bus controller (MMC degraded operations) and the UFC has failed.

Channel Select (OSB 8)	This option brings up a data entry page with numeric labels ranging from 0 to 9.
Channel Select INC/DEC (OSB 7 & 9)	These options allow you to increment or decrement through the channels. The MFDS only accepts integer values between 1 and 126 for channel selection.
Band Select (OSB 10):	This is a two-position rotary control used to choose between the X or Y band.
TACAN Mode Select (OSB 6):	This three-position rotary control lets you select between REC, T/R, and A/A TR modes.



For more information about TACAN, refer to the TACAN chapter.

2.1.6.17 MFDS SYMBOLOGY

The Multifunction Display (MFD) presents a combination of symbology generated by the MFDS and symbology generated by sensors, which is then inserted into the sensor video sent to the MFDS. The extensive variety of symbology displayed on the MFD is described in detail in the individual system display descriptions within this book.

Each symbol generated by the MFDS is strategically positioned in relation to the Forward Looking Radar (FCR) video, and most symbols can be masked when they intersect with another symbol. These symbols are assigned prioritization levels with level 1 being the highest. Occlusion refers to the selective blanking of the background video behind an MFDS generated symbol, removing only a small area of the background video around the symbol. All MFD text and symbology exhibit occlusion.

Priority determines the display hierarchy when one MFD generated symbol intersects with another symbol of lower priority. The priority levels are based on the specific information required under particular circumstances.

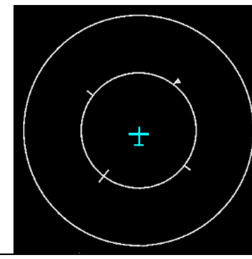
Masking involves the blanking of a lower priority symbol that intersects with a symbol of higher priority. Masking symbols have a rectangular zone around them that masks lower priority symbols within that area. However, some MFD symbols do not have masking zones and will merge with underlying symbols of lower priority.

Therefore, priority masking is defined as the blanking of lower priority symbology that lies beneath symbology of higher priority. The priority mask zone effectively erases any lower priority symbology it overlays, regardless of whether the lower priority symbol has its own masking zone. This means that symbols with different priority levels will merge only if the symbol with the higher priority level does not have the masking option set. Symbols with the same priority level will merge upon intersecting, regardless of whether the masking option is enabled.

During mission planning, it is possible to modify the colors of specific symbols (via BMS Avionics Configurator), which can then be uploaded into the avionic system by selecting the OSB next to "COLR" on page 2 of the MFDS DTE format. These chosen symbology colors will remain consistent even after power cycles of the MFDS.

The most essential MFD display symbology are summarized on the next page. Those symbols are part of the MFDS subpages FCR and/or HSD. For further information about those subpages, refer to the HSD and FCR chapter.

All other dedicated MFD subpage symbology is explained in each associated chapter.

AIRCRAFT REFERENCE	HORIZON LINE	DLZ TARGET RANGE CUE
AIRCRAFT REFERENCE	DYNAMIC LAUNCH ZONE	TWS EXPAND CUE
AIR-TO-AIR RANGE MARKS	ANTENNA ELEVATION TICS	INCREMENT/DECREMENT
ANTENNA AZIMUTH MARKER	ANTENNA AZIMUTH TICS	 HSD OWNSHIP/ RANGE RING
ELEVATION MARKER	ACQUISITION CURSORS	MARKPOINT RECEIVED
ATTACK STEERING CUE	BULLSEYE	MARKPOINT RECEIVED AND SELECTED
AIFF FRIEND	BULLSEYE LOS	MARKPOINT OWNSHIP
AIFF UNKNOWN	HSD STEERPOINT	MARKPOINT OWNSHIP AND SELECTED
	HSD ROUTE	
	HSD LINE 1-4	

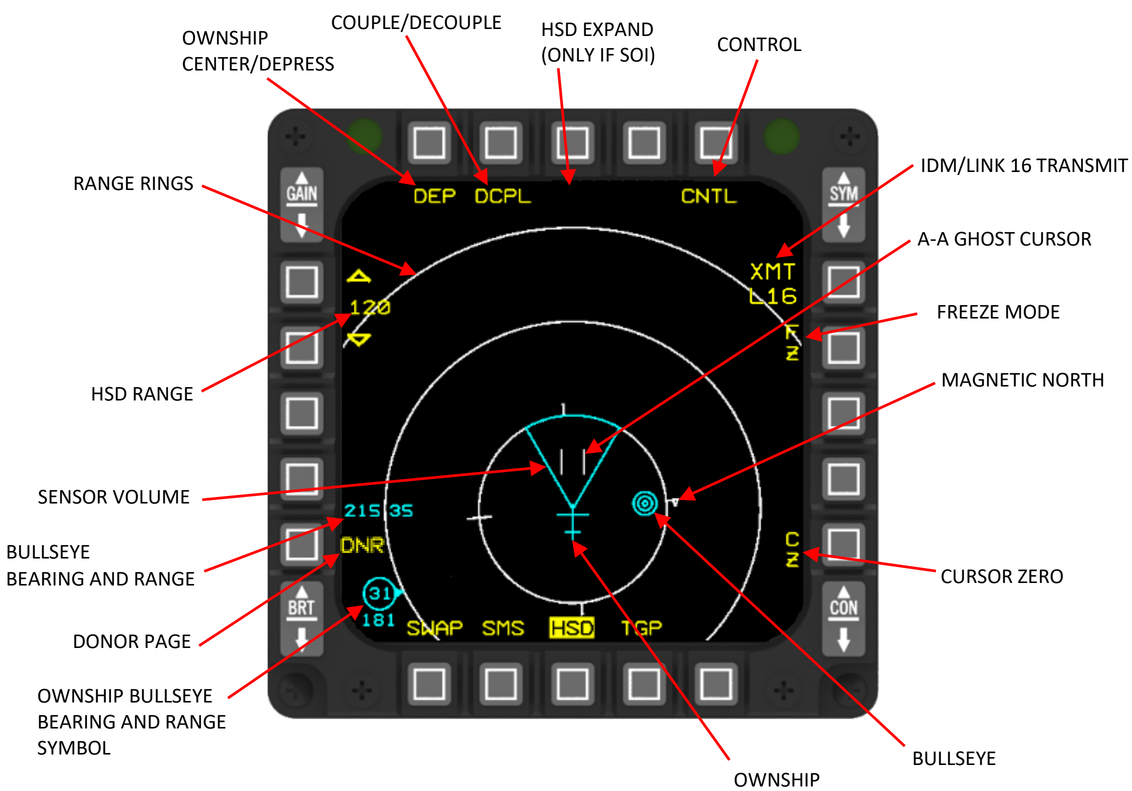
SEARCH TARGET (HIGH ASPECT)	SEARCH TARGET (LOW ASPECT)
SYSTEM TRACK FILE	EXTRAPOLATED TRACK FILE
BUGGED/PRIORITY TRACK FILE	ECM / JAMMING DETECTED
BUGGED TRACK FILE (BTF) WITH (INACTIVE) AMRAAM IN FLIGHT	TRACK FILE WITH (INACTIVE) AMRAAM IN FLIGHT
BTF WITH ACTIVE MPRF (HPRF IF NO \) AMRAAM IN FLIGHT	TF WITH ACTIVE MPRF (HPRF IF NO \) AMRAAM IN FLIGHT
BTF AT AMRAAM PREDICTED TIME OF IMPACT	TF AT AMRAAM PREDICTED TIME OF IMPACT
BTF WITH LOSE AMRAAM IN FLIGHT	TF WITH LOSE AMRAAM IN FLIGHT

MFDS symbology (HSD and FCR)

2.1.6.18 HSD PAGE

To access the Horizontal Situation Display (HSD) format, press OSB 7 on the master format menu page. The HSD format consists of several components, including the HSD Base page and the HSD control page. These pages offer a comprehensive and detailed overview of tactical data, providing a "God's eye view" of the situation. The HSD format is designed to enhance situational awareness across all mission phases.

The HSD base page presents various symbology to provide essential information. This includes the following: HSD range scale, range rings, navigation routes, current steerpoint, radar scan volume, air-to-air ghost cursor, air-to-ground ghost cursor, HSD cursor, HSD cursor bearing and range data, HSD display control functions, bullseye bearing and range data, ownship bearing and range symbol, ownship symbol, data link steerpoint, preplanned threats, mission planning lines, IDM symbols, Link 16 symbols, display controls, SPI data, Cursor Zero, HSD Scale Bar, North Pointing Arrow, and more. The subsequent paragraphs provide descriptions of the most commonly seen symbology on the HSD base page.



HSD page

2.1.6.18.1 HSD RANGE RINGS

On the HSD, the range rings serve to divide the HSD range scale into specific increments based on the selected format. When the depressed format is chosen, the range rings divide the HSD range scale into thirds. Conversely, when the centered format is selected, the range rings divide the HSD range scale by two. Let's consider an example: If the HSD range scale is set to 60 and the HSD display is depressed, each range ring represents 20 nautical miles (NM). On the other hand, if the HSD range scale is set to 80 and the HSD display is centered, each range ring represents 40 NM.

2.1.6.18.2 HSD RANGE SCALE

In the depressed (DEP) HSD format, you have the option to select from a range of distances including 8, 15, 30, 60, 120, and 240 nautical miles (NM). However, when you switch to the centered (CEN) HSD format, the selectable ranges change to 5, 10, 20, 40, 80, and 160 NM. It's important to note that the range scale does not wrap around once you reach the minimum or maximum range setting.

The INC/DEC range symbols can be found by pressing OSB 19 and OSB 20. Pressing D&R (Depress & Release) on OSB 19 will decrease the range scale by one setting, while D&R on OSB 20 will increase the range scale by one setting. If HSD freeze mode is activated and the HSD is not the current SOI, it is possible to select the HSD as the new SOI. In this scenario, the HSD cursors will initialize in the center of the display format.

The minimum range for the centered HSD display is set to 5 NM, whereas the minimum range for the depressed HSD display is set to 7.5 NM. When the current range is already at the minimum value of 5 NM in the centered HSD format, the decrement triangle (OSB 19) is no longer displayed. Similarly, in the depressed HSD format, the decrement triangle is removed when the current range reaches the minimum value of 7.5 NM.

2.1.6.18.2.1 CURSOR BUMPING

Another method, applicable to both the HSD and FCR, is known as cursor bumping. This involves moving the cursor towards the upper or lower edge of the display. As the cursor approaches these edges, the range will automatically adjust upwards or downwards accordingly. This technique is primarily used with the FCR, especially when it is the selected sensor of interest (SOI). However, it can also be applied to the HSD when it is the SOI.

If the HSD is in CPL mode, the first contact with either the top or bottom edge will switch it to DCPL mode. Subsequent interactions will then allow for range adjustments.

2.1.6.18.3 HSD CURSORS

When the HSD is selected as the Sensor of Interest (SOI), the HSD cursor is initially positioned at the location of the FCR (Fire Control Radar) ghost cursor, either in air-to-air (A-A) or air-to-ground (A-G) mode. In cases where no ghost cursor is available, the HSD cursor initializes at the ownship location. However, when the HSD is not the selected SOI, the HSD cursor is not displayed. Furthermore, if the HSD is the SOI and the bullseye mode is activated, the bearing and range data between the bullseye point and the HSD cursor (i.e., the bearing and range from the bullseye point to the HSD cursor) are presented on the MFDS HSD base page.

The HSD features A-A (air-to-air) and A-G (air-to-ground) ghost cursors that are specifically designed to offer quick situational awareness regarding the sensor aiming locations. These ghost cursors provide valuable information about where the sensors are directed. However, it's important to note that when the HSD is the Sensor of Interest (SOI), these ghost cursors are fixed and cannot be manually adjusted or moved.

2.1.6.18.4 HSD SENSOR VOLUME

On the HSD, the sensor volume is shown when the radar is actively searching in air-to-air (A-A) or air-to-ground (A-G) modes, provided that no track has been established yet.

2.1.6.18.5 HSD OWNSHIP INDICATION (DEP/CEN)

The ownship indication on the HSD is represented by a cyan-colored aircraft symbol. The HSD base page offers two format options known as centered and depressed.

- In the centered format, the ownship symbol is positioned at the center of the display format.
- In the depressed format, the ownship symbol is placed three-fourths down from the top of the display format.
- To switch between these configurations and remove the "Centered" (CEN) or "Depressed" (DEP) mnemonics displayed next to OSB (On-Screen Button) 1, simply depress OSB 1 alternately.

HSD – Depressed mode

HSD – Centered mode

2.1.6.18.6 HSD COUPLE/DECOUPLE (CPL/DCPL)

The HSD base page provides control over the coupling or decoupling of the HSD range scale to the radar range scale by depressing OSB 2 next to the CPL (Coupled) or DCPL (Decoupled) mnemonic. When the HSD is coupled to the radar, any changes made to the radar range scale automatically reflect in the HSD range scale, and modifying the HSD range scale directly on the HSD base page is not possible (OSB #19 and #20 are inhibited). However, when the HSD is decoupled, the HSD range scale can be adjusted independently on the HSD base page. Changes made to the radar range scale will not affect the HSD range scale in this mode.

When coupled in the centered format, the HSD range equals the FCR range, and when coupled in the depressed format, the HSD range equals 1.5 times the FCR range. However, with the SOI on the HSD, the pilot may temporarily suspend the CPL mode by using the HSD cursor to bump range the display. With this capability, the pilot may bump range without the display option changing to DCPL, and when the SOI is removed from the HSD, the HSD range reverts back to the corresponding HSD range for the current FCR CPL range.

Regardless of whether the HSD is coupled or decoupled, in a centered or depressed format, whenever the range of the HSD is adjusted, the cursor will remain at the same distance from the ownship symbol in the new range scale. If the range is decreased, the cursor will be reset to the ownship symbol in the new range scale format.

2.1.6.18.7 HSD EXPAND

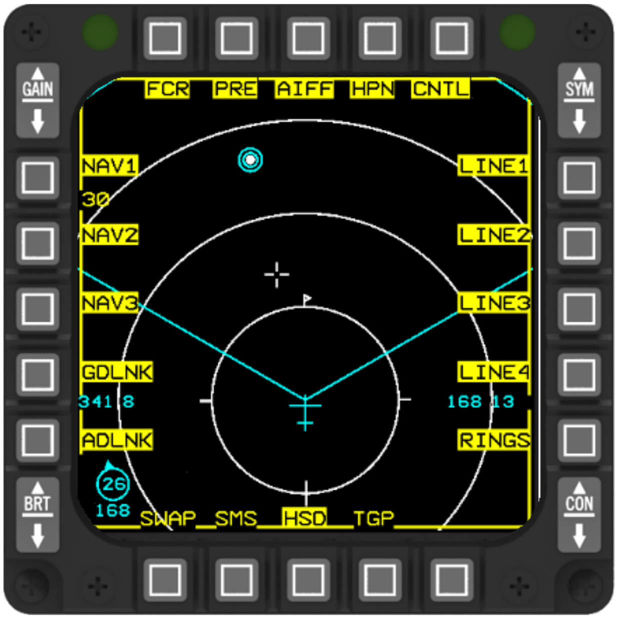
To activate the HSD expansion mode, which includes EXP1 (2:1 expansion) and EXP2 (4:1 expansion), when the HSD is the selected object of interest (SOI), you can depress OSB 3 or briefly press the EXPAND/FOV button (for less than 0.5 seconds). The rotary control cycles through the modes in the following order: NORM, EXP1, EXP2, and back to NORM.

When EXP1 or EXP2 is chosen, the symbology on the HSD is expanded around the cursor, and the display is centered on the cursor. The expanded area will fill the entire display, with the cursor positioned at the center. Importantly, the HSD remains dynamic during the expansion, meaning that the display continues to update without freezing. While in the expanded mode, the cursor movement is limited to the area within the expanded patch, but the patch itself cannot be moved.

During the activation of the expansion mode, the EXP1 or EXP2 label will flash at a rate of 5Hz. Additionally, certain labels and functions are decluttered while the expansion mode is active:

- HSD range scale and increment/decrement switches.
- Sensor volume.
- HSD A-A “ghost” cursor.
- HSD A-G “ghost” cursor.
- Range rings and Magnetic North pointer.
- Centered/Depressed Option.
- Coupled/Decoupled Option.
- HSD Freeze.

2.1.6.18.8 HSD CONTROL PAGE (CNTL)



The HSD has one control page and is access via the HSD page by depressing OSB 5. All of the symbols and graphics visible on the base page are also displayed on the control page. However, certain settings such as range, display format (CEN/DEP), coupled/decoupled mode, and freeze options cannot be modified on the control page. These settings remain the same as the values selected when entering the control page.

Whenever a specific item is modified on the HSD control page, the associated symbols and graphics appear or disappear accordingly. This feature allows the pilot to verify the correct configuration of the selected displays before exiting the control page.

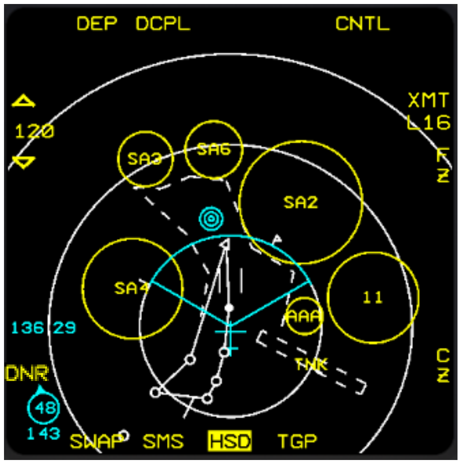
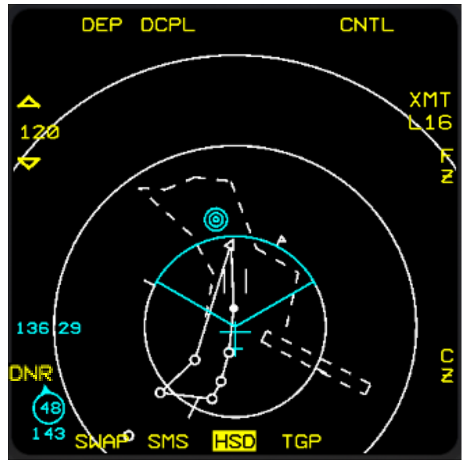
When the pilot adjusts the display parameters on the HSD control page in the aircraft, these settings are saved and will be restored when re-entering the corresponding master mode. Any items that are decluttered on the HSD control page are preserved based on the specific master mode.

Once selecting the CNTL page, the CNTL mnemonic is highlighted, indicating the activation of the control page. The available control page options vary depending on the active master mode. The pilot has the flexibility to configure the A-A (Air-to-Air) master mode differently from the A-G (Air-to-Ground) master mode.

When the associated display options are selected, their corresponding mnemonics are highlighted, providing visual feedback to the pilot.

The HSD control page provides five options: NAV, LINE, RINGS, ADLNK and GDLNK as well as declutter options for FCR, PRE and AIFF.

FCR	When OSB 1 is pressed, the FCR mnemonic is highlighted, and the radar search volume (displayed in cyan) and the white Ghost Cursor (representing the cursor position in A-A or A-G FCR mode) are shown.
PRE	The PRE (preplanned) feature on the HSD displays the locations of threats that were entered in the Data Transfer Cartridge (DTC) during mission planning. Each threat type is represented by a three-character code, which is displayed on the HSD at the corresponding preplanned threat location. Additionally, a range ring is shown around the threat symbol to indicate its lethal range. To hide these symbols, the PRE option on the HSD control page can be deselected. Yellow symbols and lethal range circles represent preplanned threat IDs, which are stored in steerpoints 56-70. These threat IDs cannot be modified within the cockpit and are cleared from memory when the Weight On Wheels (WOW) condition is met during power cycles. However, the preplanned threat location (latitude and longitude) and the range of the threat ring can be adjusted in the cockpit. If the Data Transfer Cartridge (DTC) load does not include preplanned threats, the PRE mnemonic will not appear on the HSD control page. When the aircraft enters the threat ring, the color of the threat range ring changes from yellow to the default color (red). It is important to note that the mechanization only considers the horizontal range and does not take into account the entered threat altitude.

	  HSD – Threat Ring Declutter
AIFF	In the air-to-air master mode, initiating an interrogation results in the display of IFF friendly symbols (green circles) and unknown symbols (yellow squares) on the HSD. To remove these symbols from the display, simply deselect the AIFF option on the HSD control page. For more information about AIFF HSD symbology, refer to the IFF chapter.
HPN	Harpoon (Not implemented yet)
LINE 1-4	The HSD provides the capability to draw four geographic lines: LINE1, LINE2, LINE3, and LINE4. These lines can be created in the BMS UI 2d map, allowing for the definition of a forward edge of battle area (FEBA), free-fire zones, and boundaries for restricted and operating areas. The lines are represented by dashed lines that connect the corresponding steerpoints. In case any part of a line extends beyond the visible area of the HSD, the visible portion of the line is displayed.
RINGS	When the option is enabled, the range rings and magnetic north pointer (ownship) are displayed. On the other hand, when the option is deselected, the range rings and magnetic north pointer are removed from the display.
ADLNK	If activated, the HSD provides Air to Air datalink information. For more information about A-A datalink symbology, refer to chapter 1.5.2.4
GDLNK	If activated, the HSD provides Air to Ground datalink information. For more information about A-G datalink symbology, refer to chapter 1.5.2.5
NAV 1-3	The HSD (Head-Up Display) can display up to three navigation routes using steerpoints 1-25. A solid line connects all the steerpoints within a route. Steerpoints that are not part of any route will not appear on the HSD, unless they are the system steerpoint. Each steerpoint can be designated as a steerpoint (circle), initial point (square), or target (triangle). The configuration of routes and steerpoint types can only be loaded via DTC (Data Transfer Cartridge) and cannot be modified from the cockpit. If a DTC load is not performed, the previously defined route configurations and steerpoint types will be retained.

2.1.6.18.9 HSD LINK 16/IDM TRANSMIT (XMT L16/XMT IDM)

OSB 6 regulates the transmission of the current SPI or steerpoint. With support for both IDM and L16 A-G SPI transmissions, toggling OSB 6 switches between IDM and L16 functionalities. By default, XMT IDM is selected.

For now, the XMTL16 option serves no different purpose then the XMT IDM option in BMS.

2.1.6.18.10 HSD FREEZE OF GROUND STABILIZED SYMBOLS (FZ)

When the HSD (Horizontal Situation Display) is selected as the SOI (Selected Option Item) and OSB 7 (On-Screen Button 7) on the HSD Base page is activated with valid navigation data, the HSD becomes unresponsive, freezing at the current HSD cursor position. Please note that if the navigation data is invalid, OSB 7 on the HSD Base page is disabled. Upon entering the frozen state, the HSD switches to a centered format display, with the ground-stabilized cursor position as the center of the display.

On the other hand, when the HSD is not the selected SOI and OSB 7 on the HSD Base page is triggered, the HSD freezes at the ownship position. Once again, upon entering the freeze state, the HSD adopts a centered format display, with the ground-stabilized ownship position serving as the center of the display.

During HSD freeze, the range rings and magnetic north pointer are shown unless they have been manually disabled through the HSD control page. If you don't see the range rings and magnetic pointer during HSD freeze, you can access the HSD control page and select "RINGS" (OSB 10) to enable their display.

Once you exit HSD Freeze, the range rings and magnetic north pointer will continue to be visible. If the HSD was in the depressed format before entering HSD freeze, the display mode switches to the centered format, which also adjusts the range scale. When you exit HSD freeze, the HSD reverts back to its previous state, which in this case is the depressed format.

In HSD freeze, the INC/DEC Range symbols can be found at OSB 19 and OSB 20. Pressing OSB 19 decreases the range scale by one setting, while OSB 20 increases it by one setting. The Bump Range feature is available but can only be used when the HSD cursors are displayed, which happens when the HSD is the selected SOI (Selected Option Item).

If a successful Range Scale Bump is performed in NORM Mode and the range scale is increased, the HSD cursor will be positioned at the same range and bearing from the ownship as in the previous range scale. However, if the range scale is decreased, the HSD cursor will be placed at the ownship position. In FREEZE Mode, a successful Range Scale Bump will position the HSD cursor at the center of the display.

When HSD freeze is activated and the HSD is not the selected SOI, it can still be chosen as the SOI. In this scenario, the HSD cursors will initialize in the center of the display format.

During HSD freeze, the data associated with steerpoints 1-89 remains static. However, the ownship symbol and the corresponding radar field-of-view continue to move across the frozen map. The aircraft symbol can either be flown off the frozen map or it may disappear if different range scales are selected in relation to the ground-stabilized center of the display format.

2.1.6.18.11 HSD CURSOR ZERO (CZ)

The CZ function is designed to remove any slews that have been applied to the system point-of-interest. To access this function, simply depress OSB 10 next to the CZ mnemonic. The CZ option is displayed on the HSD base page under the same conditions as it appears on the A-G FCR format (including A-G preplanned and manual, S-J, and E-J).

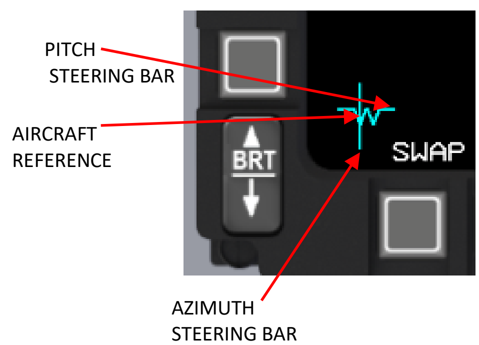
The CZ mnemonic is highlighted whenever there are existing system slews, such as in JDAM Relative Targeting. Pressing CZ (OSB 10) triggers a cursor zero command, clearing any system slews, and removes the highlighting from the CZ mnemonic. This feature ensures that unintentional cursor slews are not applied to the target location when no slewing of the target location was intended. Importantly, depressing this button does not rely on the sensor of interest (SOI) and can be used regardless of the current SOI.

2.1.6.18.12 HSD LINK 16 - DONOR PAGE (DNR)

OSB 16 displayed the DED donor page. Refer to the Link 16 MFD Donor chapter for further information.

2.1.6.18.13 HSD AIRCRAFT REFERENCE SYMBOL

The aircraft reference symbol is located in the lower left section of the display. The wings of the reference symbol align with the aircraft's wings to provide a visual reference. This symbol works together with the azimuth and pitch bars for steering purposes. However, if neither of the steering bars is present (indicating invalid steering), the reference symbol is not displayed.



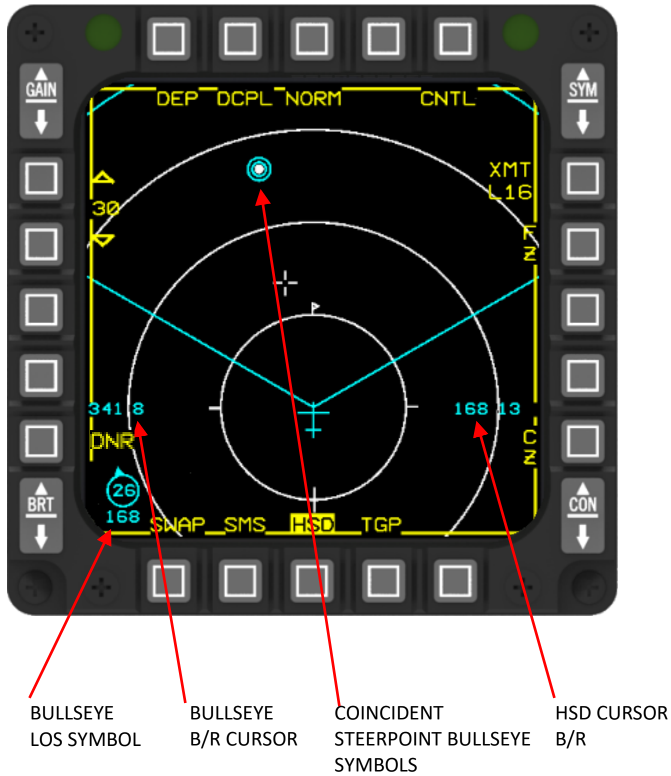
In air-to-ground modes, the aircraft symbol flashes to indicate weapon release, similar to the flashing of the FPM (Flight Path Marker) in the HUD (Head-Up Display). The flashing continues until the weapon release button is released. When the bullseye function is selected, the aircraft reference symbol is replaced with the bullseye bearing and range symbol, providing specific information about the bullseye location.

2.1.6.18.13.1 HSD STEERING BARS

The azimuth and pitch steering bars are aligned with the aircraft reference symbol to provide guidance during flight. To follow the steering instructions, adjust your flight path so that the reference symbol aligns with the steering bars, keeping them centered. The number of steering bars that appear (none, one, or both) depends on the selected mode. In general, the pitch bar is used for LADD (Low Altitude Dive Delivery) and CCRP-LOFT (Continuously Computed Release Point – Loft maneuver steering). On the other hand, the azimuth bar is utilized for navigation, air-to-air great circle steering, and air-to-ground attack steering.

2.1.6.18.14 HSD BULLSEYE BEARING AND RANGE DATA

The Bullseye Line-of-Sight (LOS) bearing and range symbol, along with its associated text data, is visible on the FCR (Fire Control Radar), HAD (HARM Attack Display), and HSD (Horizontal Situation Display) formats. The display of bullseye data takes precedence at higher display priority levels (levels 1 and 2) compared to IDM (Identification of Friend or Foe) data, which appears at levels 3 and 4. This prioritization ensures that the bullseye symbology is not obscured by IDM symbology, preventing any occlusion or overlap between the two sets of data.



2.1.6.18.14.1 HSD BULLSEYE LOS B/R SYMBOLOGY

The bullseye LOS bearing, and range circle provides information about the bearing and range from the current aircraft position to the bullseye location. The circle includes a directional tic that indicates the bearing to the bullseye, while the number displayed inside the circle represents the range.

Additionally, below the circle, there is a three-digit number that indicates the magnetic bearing from the bullseye to the current aircraft position. This number gives the relative direction from the bullseye to the aircraft.

The bullseye symbol appears on the display, indicating the computed ground range and relative bearing from the aircraft to the designated bullseye steerpoint. This occurs when the bullseye option is selected via the UFC (Up-Front Control-> STPT 25 in BMS by default).

2.1.6.18.14.2 HSD BULLSEYE B/R CURSOR TEXT

The displayed bullseye bearing and range text data provides information about the bearing and range from the bullseye position to the target of interest.

The bearing and range information is represented by a reduced-size numerical display consisting of five digits located above the bullseye symbol on the left side of the HSD and FCR. The first three digits indicate the bearing in degrees (ranging from 001 to 360), while the last two digits indicate the range.

When the bullseye is selected as the mode and the FCR (Fire Control Radar) has a designated bugged target, the displayed bearing and range information indicates the distance and direction from the bullseye to the bugged target. However, if the FCR does not have a bugged target, the readout on the display shows the range and bearing from the bullseye to the position of the ghost cursor.

When the bullseye has not been selected as the mode and the FCR (Fire Control Radar) has a designated bugged target, the displayed readout presents the range and bearing from the bugged target to the currently selected steerpoint. In the absence of a bugged target in the FCR, the readout provides the range and bearing from the current steerpoint to the position of the ghost cursor.

2.1.6.18.14.3 HSD CURSOR B/R TEXT

When the HSD (Horizontal Situation Display) is the selected sensor of interest (SOI) and the bullseye is chosen as the mode, the MFDS (Multi-Function Display System) HSD base page (between OSB 9/10) displays the bearing and range from the bullseye point to the HSD cursor. This provides information about the relative position of the HSD cursor in relation to the bullseye.

On the other hand, if the HSD is the SOI but the bullseye is not selected as the mode, the HSD cursor bearing and range are displayed based on the currently selected steerpoint. This means that the information presented on the HSD reflects the bearing and range from the selected steerpoint to the HSD cursor, rather than the bullseye.

A reduced-size, numerical display consisting of five digits is located above the CZ (Cursor Zero) text on the right side of the HSD (Horizontal Situation Display). This display provides information about the CZ and is comprised of the first three digits indicating the bearing in degrees (001-360), followed by the last two digits representing the range in nautical miles (0-99 NM).

2.1.6.18.15 HSD LINK 16 INFORMATION

Refer to the Link 16 Messages chapter.

2.1.6.19 FCR PAGE

Refer to the FCR MFD - MULTI FUNCTION DISPLAY chapter.

2.1.6.20 FCR DECLUTTER PAGES

Refer to the FCR DCLT (DECLUTTER) chapter.

2.1.6.21 SMS PAGE

Refer to the STORES MANAGEMENT SYSTEM (SMS) chapter.

2.1.6.22 HAD PAGE

Refer to the HARM Attack Display (HAD) chapter.

2.1.6.23 FLIR PAGE

Refer to the LANTIRN chapter.

2.1.6.24 TFR PAGE

Refer to the Terrain Following Radar (TFR) chapter.

2.1.6.25 TGP PAGE

Refer to the AN/AAQ-33 SNIPER XR Advanced Targeting Pod chapter.

2.1.6.26 IDM

Refer to the IDM chapter.

2.1.6.27 LINK 16

Refer to the Link 16 chapter.

2.1.7 HEAD-UP DISPLAY (HUD)

The HUD, or Head-Up Display, is comprised of several components, namely the head-up display unit, Pilot Display Unit (PDU), and the HUD control panel. The head-up display unit consists of a display surface and an integrated control panel. Both control panels are responsible for managing the symbology displayed on the HUD. The information shown on the HUD is dependent on the selected master mode and submode.

2.1.7.1 Head-Up Display Set

The Head-Up Display Set serves as an electronic and optical device used to generate and display information within the pilot's forward Field-Of-View (FOV). This device presents flight data using stroke-written symbols and video raster. These symbols convey essential information such as attack, navigation, weapon aiming, landing details, and aircraft performance data like altitude, airspeed, attitude, and heading. The symbols are created in response to command and data signals received from the MMC, as well as other avionics subsystems and sensors.

Moreover, the HUD is designed to function both in daylight and nighttime environments. It processes information, calculates Enhanced Envelope Gunsight (EEGS) algorithms, backup air-to-air missile algorithms, and target acquisition location information. Additionally, it projects written weapon delivery and flight information in symbolic form.

To further enhance its capabilities, the HUD incorporates an Advanced Color Cockpit Television Sensor (ACCTVS) video camera. This camera generates a recorded video signal that overlays symbology onto the outside world or the displayed sensor video. In case of active HUD failures, a standby reticle, independent of the HUD's primary symbology generation electronics, serves as a backup sighting system. It can also be used for air-to-ground weapon delivery.

Furthermore, the HUD includes a built-in test and self-test function, enabling the pilot or technician to monitor the system's performance.

2.1.7.2 Head-Up Display Components and Locations

The HUD system is composed of three-line replaceable units:

1. Pilot Display Unit (PDU).

2. PDU Mount.

3. HUD Control Panel.

2.1.7.2.1 Pilot Display Unit (PDU)

The pilot display unit (PDU) is positioned on the forward cockpit instrument panel and consists of various components. These include a chassis assembly, combiner glass, Cathode Ray Tube (CRT), integrated control panel (ICP), self-test circuitry, and associated optics. The purpose of these elements is to optically merge the external view of the aircraft with a CRT display generated internally, which contains crucial flight and combat information. It's worth noting that the combiner glass serves an additional safety function as it not only presents the CRT display but also acts as a blast deflector during the ejection sequence or in the event of an accidental canopy separation while in flight.

2.1.7.2.2 WAC and WAR Combiner Glass

There are two configurations for the HUD hardware in the aircraft. The first configuration is the Wide Angle Conventional (WAC) pattern (Block 50/52), and the second configuration is the Wide Angle Raster (WAR) pattern (Block 40/42).

HUD – Wide Angle Conventional (WAC)

HUD – Wide Angle Raster (WAR)

2.1.7.2.3 Display Unit Mount

The display unit mount is aligned with the aircraft's longitudinal axis and the firing line of the weapon system. As a result, the Pilot Display Unit can be replaced without the need for boresighting after it has been removed for maintenance. The mount is situated within the forward center console.

2.1.7.2.4 HUD Control Panel - General

The HUD Control Panel includes various controls for enabling or decluttering HUD scales, adjusting the Flight Path Marker (FPM) and attitude bars, displaying Data Entry Display/Pilot Fault List Display (DED/PFLD) data, adjusting symbology brightness, performing HUD built-in tests, and manually selecting the reticle.

For further information, please refer to the HUD Control Panel – Detail section.

2.1.7.3 HUD Controls (ICP)

The controls for adjusting symbology intensity, raster contrast, reticle depression, forward-looking infrared (FLIR) polarity, FLIR gain, and FLIR level on the HUD can be found on the integrated control panel.

For further details about the Integrated Control Panel (ICP) and Data Entry Display (DED), please refer to UPFRONT CONTROLS (UFC) chapter.

Symbology (SYM) Control

The symbology (SYM) control features an on-off switch with a variable potentiometer. When the control is set to the extreme downward position (OFF), power is cut off from the circuits responsible for generating and controlling the stroke symbology display. As the control is progressively rotated upward, the stroke symbology brightness on the combiner glass increases. Working together with the brightness switch on the HUD control panel and an analog voltage from the ambient light sensor, this control maintains the selected symbology brightness visible on the combiner glass.

Brightness (BRT) Control

The brightness (BRT) control is equipped with an on-off switch and a variable potentiometer. When the control is set to the extreme downward position (OFF), power is disconnected from the circuits controlling the raster video display. Gradually rotating the control upward enhances the raster video brightness on the combiner glass. This control, in conjunction with the brightness switch on the HUD control panel and an analog voltage from the ambient light sensor, preserves the chosen raster video brightness observed on the combiner glass.

Reticle Depression (RET DEPR) Control

Rotating the reticle depression (RET DEPR) control upward adjusts the depression of the selected HUD manual reticle (standby or primary) from 0 to 260 milliradians. The standby or primary reticle can be selected using the DEPR RET switch on the HUD control panel. The amount of standby or primary reticle depression is digitally displayed on the HUD.

Contrast (CONT) Control

Contrast (CONT) Control cannot be used and it currently serves no purpose in BMS as it is nonfunctional.

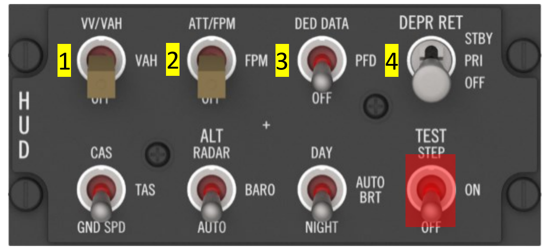
DRIFT C/O Switch

When set to NORM, the flight path marker (FPM) and steering bar accurately represent the aircraft's actual flight path, including wind effects.

The drift cutoff (DRIFT C/O) position prevents the FPM from drifting in azimuth, effectively centering the attitude display (ladder) between the side scales.

The lower momentary position is labelled WARN RESET and is used to reset the HUD WARN message.

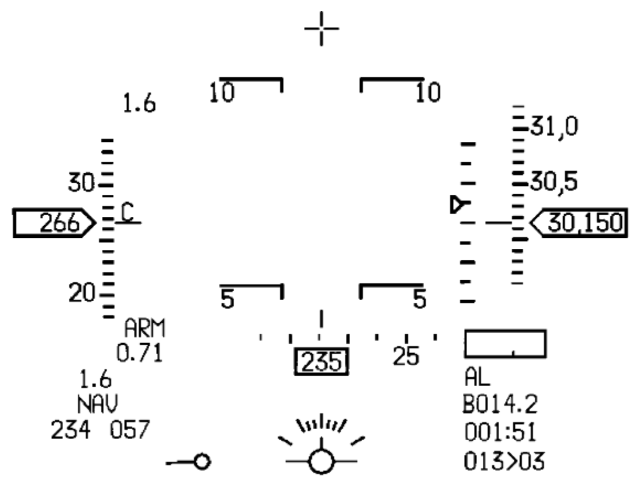
2.1.7.4 HUD Control Panel - Detail



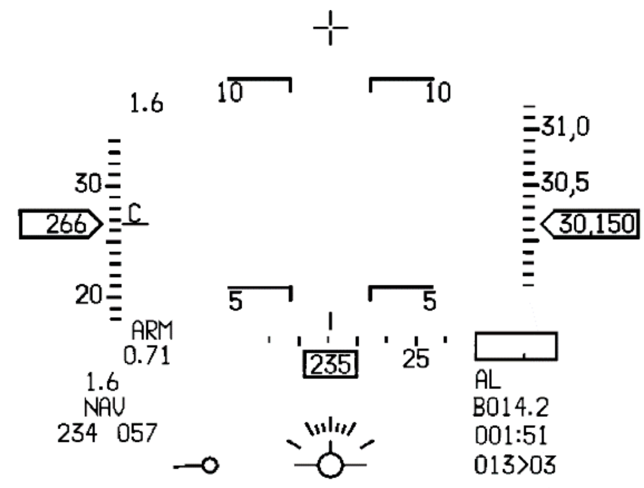
The control panel for the Head-Up Display (HUD) is positioned on the forward right console and is responsible for managing the displayed symbology.

Vertical velocity scale (VV/VAH) Switch 1

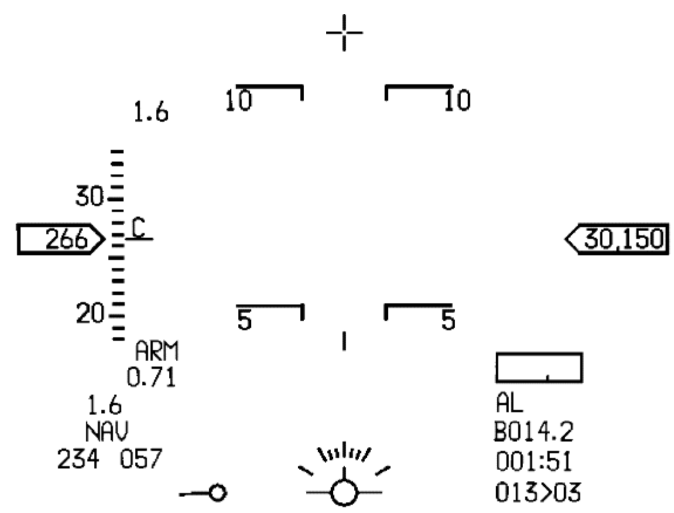
The scales switch is responsible for managing the visibility of various elements on the Head-Up Display (HUD), including the vertical velocity, airspeed, altitude, heading scales, and the bank angle indicator (BAI).



HUD – Control Panel – VV/VAH



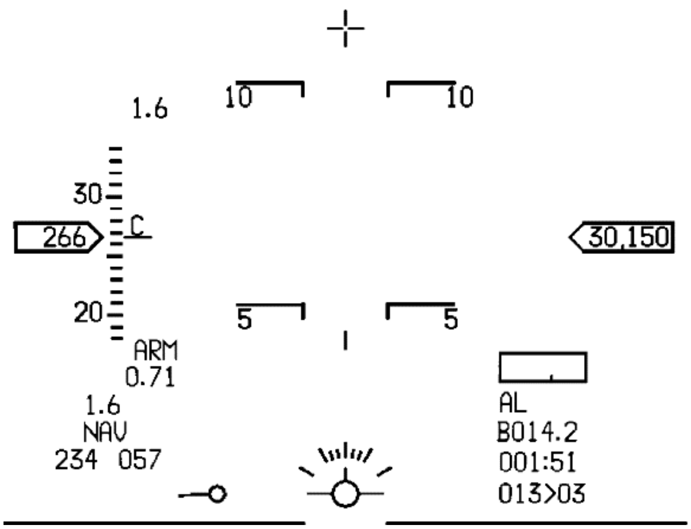
HUD – Control Panel – VAH



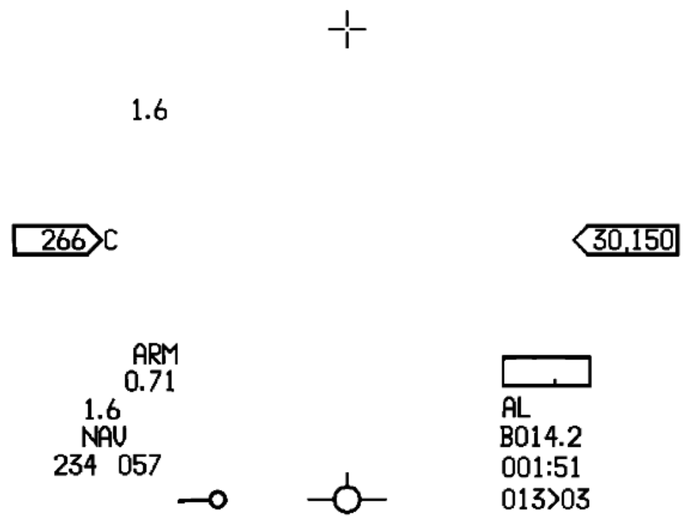
HUD – Control Panel – OFF

Flight Path Marker (FPM) Switch 2

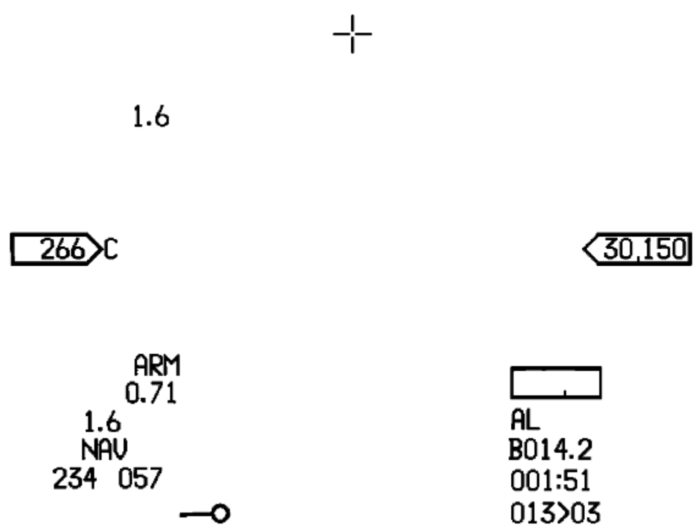
The FPM switch governs the visibility of various elements on the display, including the FPM, attitude bars, roll indicator, "FLYING W" steering cue, and BAI. When the FPM switch is in the FPM position, it clears the display of all elements except for the FPM and the BAI. In the OFF position, the FPM, attitude bars, roll indicator and BAI are all removed from view.



HUD – Flight Path Marker Switch – ATT/FPM



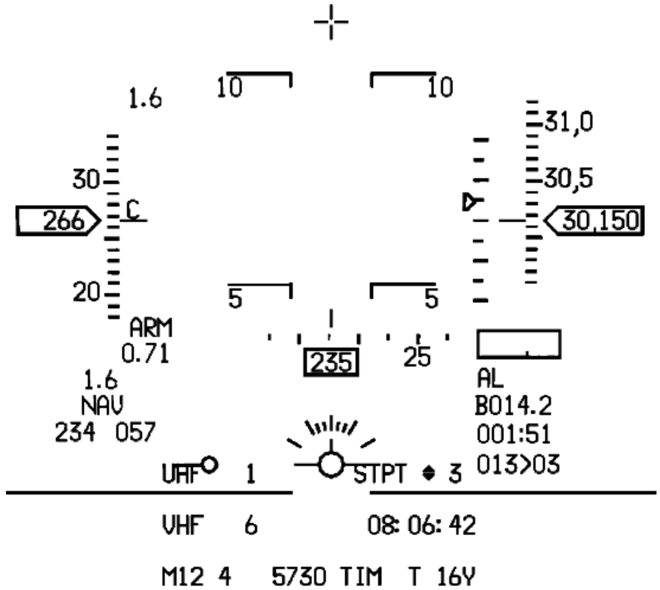
HUD – Flight Path Marker Switch – FPM



HUD – Flight Path Marker Switch – OFF

DED/PFLD DATA Switch 3

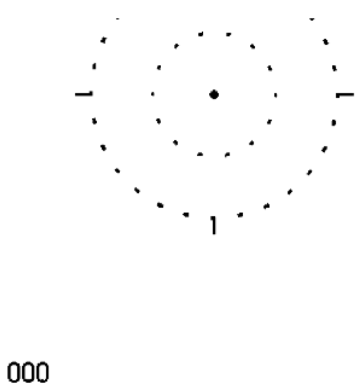
The function of the DED DATA switch is to manage the presentation of the five rows of DED or PFLD data in the respective HUD windows. When the DED DATA switch is set to DED DATA, the lower section of the HUD displays DED/PFLD data.



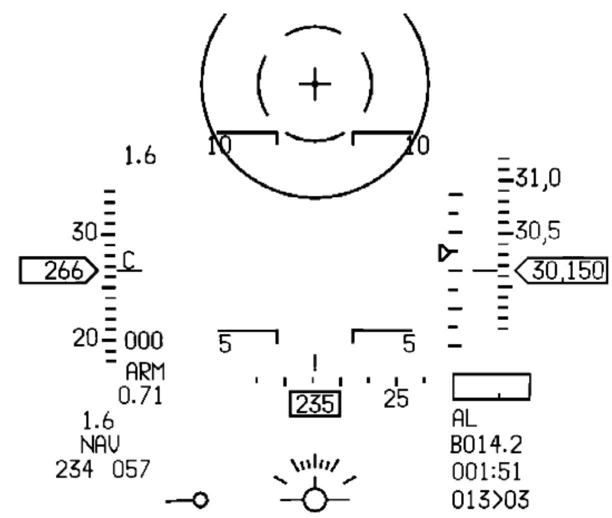
HUD – DED DATA

Depressible Reticle (DEPR RET) Switch 4

The DEPR RET switch is responsible for choosing between the primary and standby reticles. When set to the STBY position, the standby reticle is selected, and all other symbols are cleared from view. On the other hand, when set to the PRI position, the primary reticle is selected, without affecting other displayed symbology. By turning the switch to the OFF position, both reticles are removed from the display. To ensure visibility of the standby reticle, the BRT knob on the ICP (Integrated Control Panel) must be turned off.



HUD – Depressible Reticle - STBY



HUD – Depressible Reticle - PRI

Velocity Switch 5

The velocity switch allows for the selection of different velocity scales, including:

• CAS - This corresponds to the Calibrated Airspeed scale.

• TAS - This corresponds to the True Airspeed scale.

• GND SPD - This corresponds to the Groundspeed scale.

Please note the following:

• When the landing gear handle is in the down position, regardless of airspeed or the position of the velocity switch, CAS will be displayed on the HUD. In DGFT (Digital Flight Guidance System Test), CAS is automatically selected.

• When the switch is set to the GND SPD position, the magnetic ground track is displayed.

Altitude (ALT) Switch 6

The ALT switch is responsible for choosing between different altitude scales. The available options are as follows:

• RADAR - This selects the radar altitude scale, which represents the altitude Above Ground Level (AGL).

• BARO - This selects the barometric altitude scale, which represents the altitude Above Mean Sea Level (MSL). Additionally, it also chooses the central air data computer (CADC) as the data source for altitude information.

• AUTO - This mode enables automatic switching between the radar altitude scale (displayed in thermometer format) and the barometric altitude scale based on the appropriate conditions.

Brightness Control Switch 7

The brightness control switch allows for the selection of different modes:

• DAY - adjustable from off to maximum brightness.

• NIGHT - adjustable from off to half the maximum brightness.

• AUTO BRT - automatically adjusts the brightness to maintain a suitable contrast ratio between symbols and the background, based on the prevailing light conditions.

The HMCS (Helmet-Mounted Cueing System) Day/Night/Auto selection can be adjusted using the HUD (Head-Up Display) Day/Night/Auto switch located on the HUD Control Panel. When the pilot chooses the Night option on the HUD Control Panel, both the HMCS and the HUD will be configured to a night brightness setting.

Here are the specific brightness settings for each mode:

- In the Day setting, the HMCS brightness can be adjusted from being completely invisible to reaching its maximum intensity of 10,000 foot-Lamberts.
- In the Night setting, the brightness range is from being imperceptible to 1/20th of the maximum intensity, equivalent to 500 foot-Lamberts.
- When the AUTO switch is selected, the HMCS utilizes its own Automatic Brightness Control (ABC) sensor to attempt to maintain the pilot's chosen potentiometer setting, adapting to varying lighting conditions.

TEST Switch 8

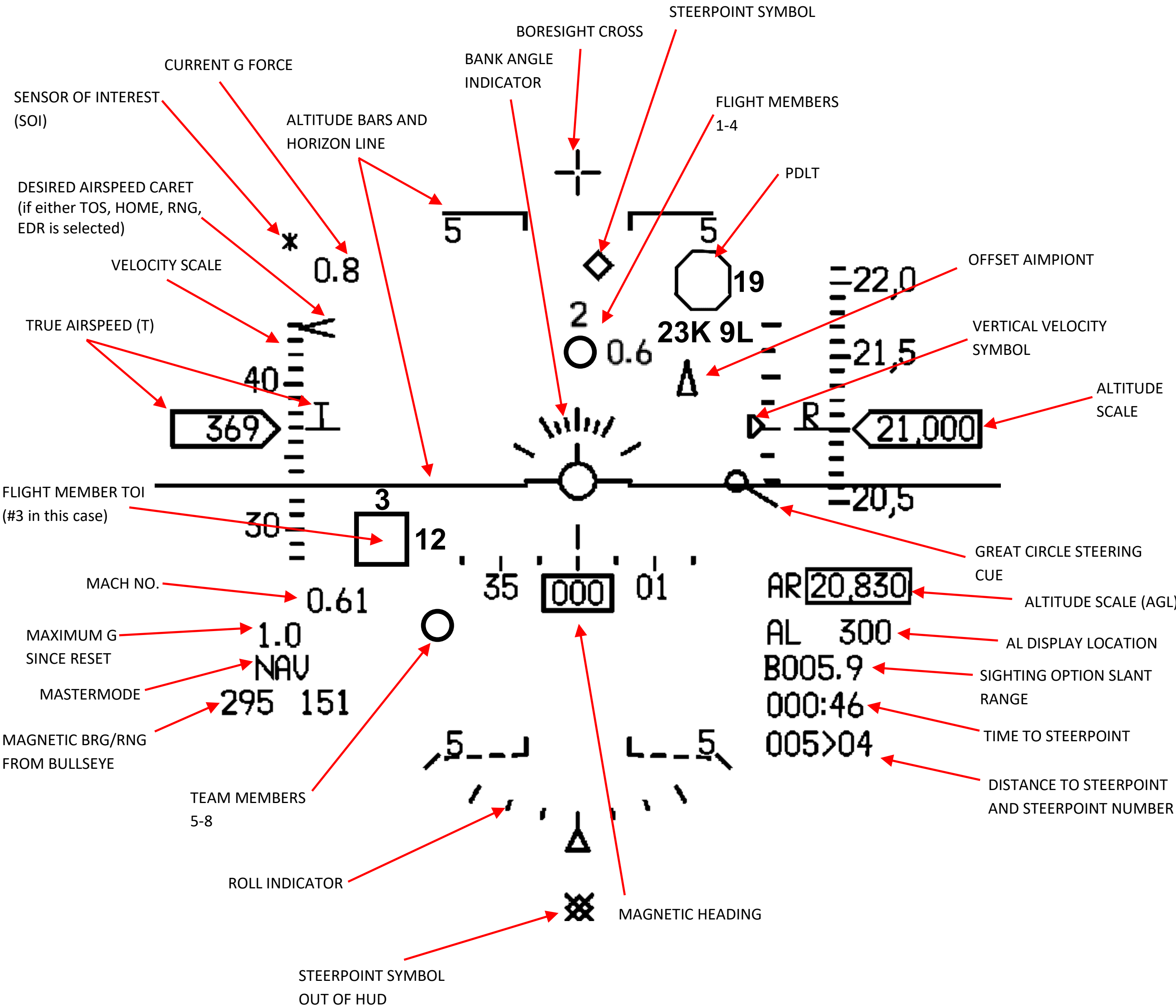
This switch is not implemented in BMS yet.

2.1.7.5 Common HUD Symbology

HUD symbology includes cues, scales, and text that are visible in all master modes. The positioning of HUD text is determined by the corresponding HUD window where it appears. The functionality of scales and cues is explained based on their purpose. The HUD cursor's rate of movement is optimized to track the symbol that is nearest in range within the field-of-view of the HUD.

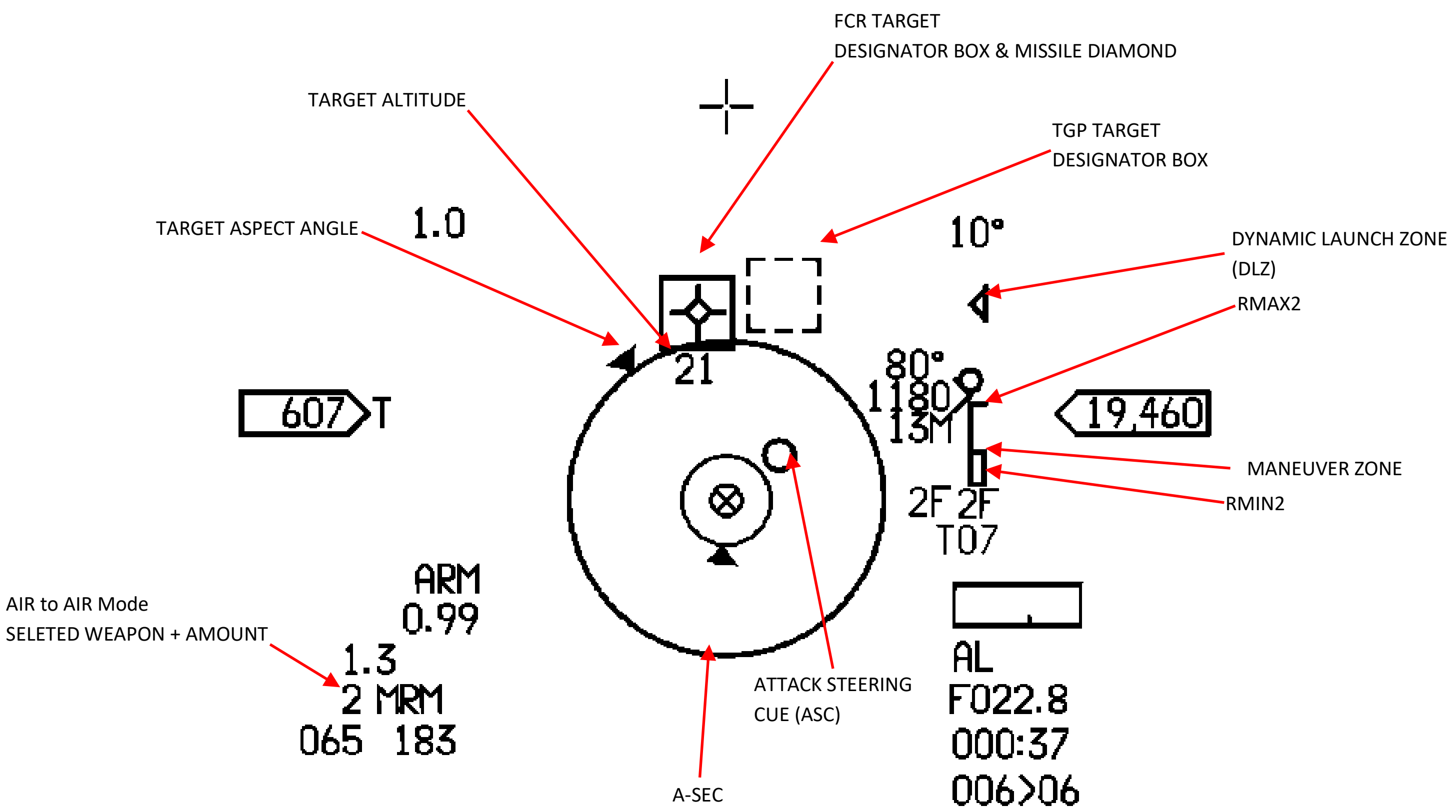
The symbols that benefit from this optimized movement are the target designator box, steerpoint diamond, offset aimpoint symbol, and pop-up point symbol. Please note that the descriptions provided here are meant to give a general overview. For more detailed explanations of the symbology, refer to chapter 2.1.7.6.

2.1.7.5.1 HUD NAVIGATION SYMBOLOGY (NAV)



HUD – Nav Master Mode Symbology

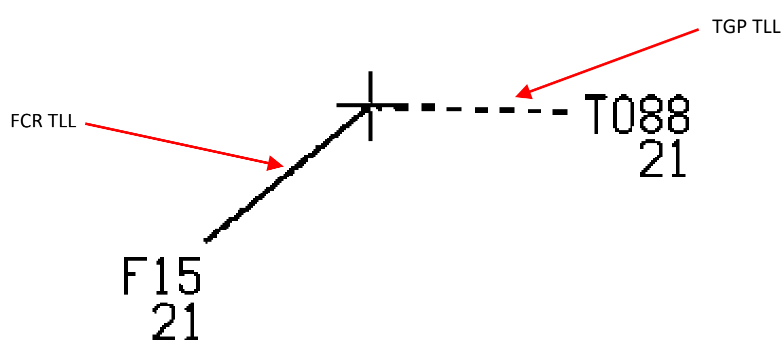
2.1.7.5.2 HUD AIR-TO-AIR SYMBOLOGY



HUD – Symbology – Air-to-Air

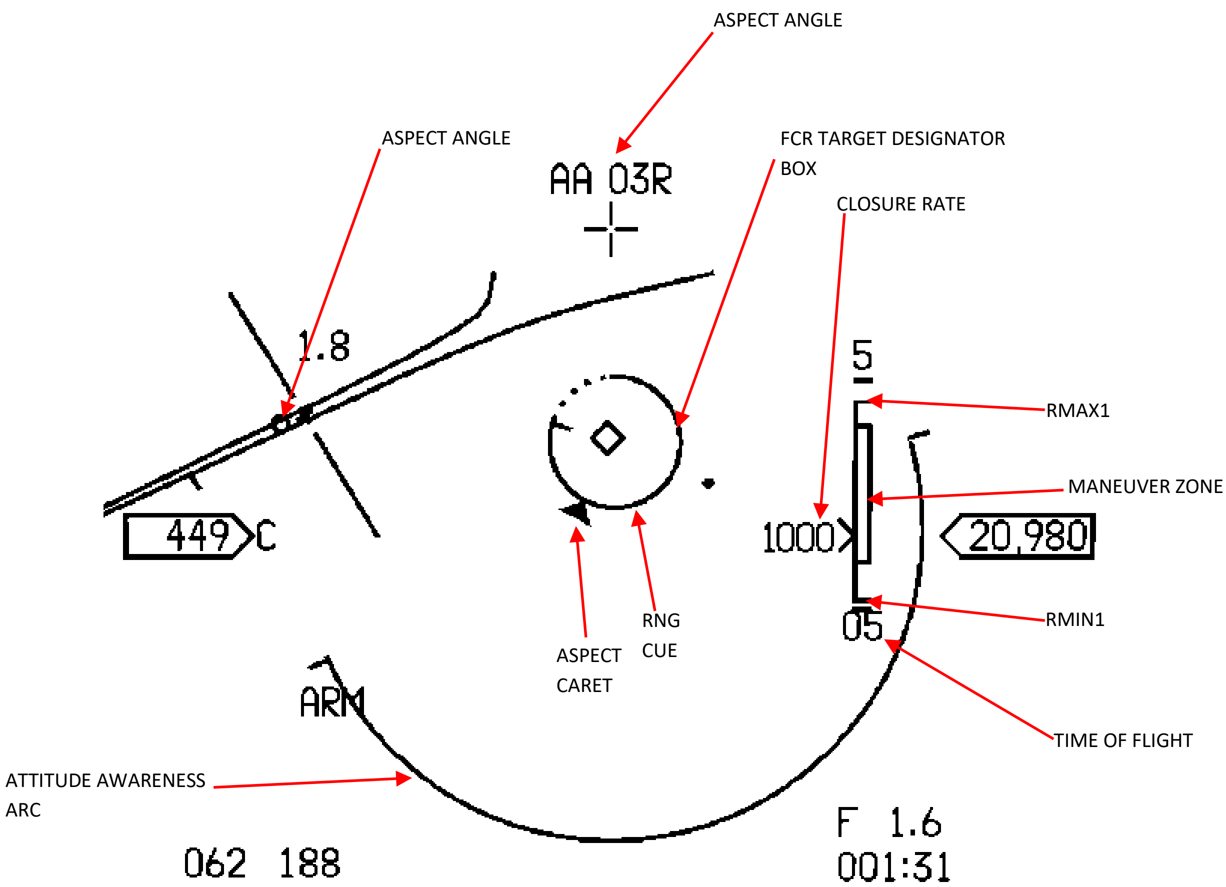
TARGET LOCATOR LINE (TLL)

When the TGP operates in air-to-air mode and engages in tracking, the target position in azimuth and elevation is represented by a 25 mR box outlined with dotted lines. If the targeting pod is utilized as the tracking sensor, the TGP TLL (Target Locator Line) and TLA (Target Locator Angle) can be displayed. The TGP target locator line is shown when air-to-air targets are outside the Heads-Up Display (HUD) Field of View (FOV). The 40 mR dotted line extends from the gun boresight cross, forming an angle or relative bearing (a combination of horizontal and vertical angles) to the target. In the window, the letter "T" is displayed to indicate the TGP, followed by a two-digit target angle. The target angle off the nose is updated in one-degree increments.



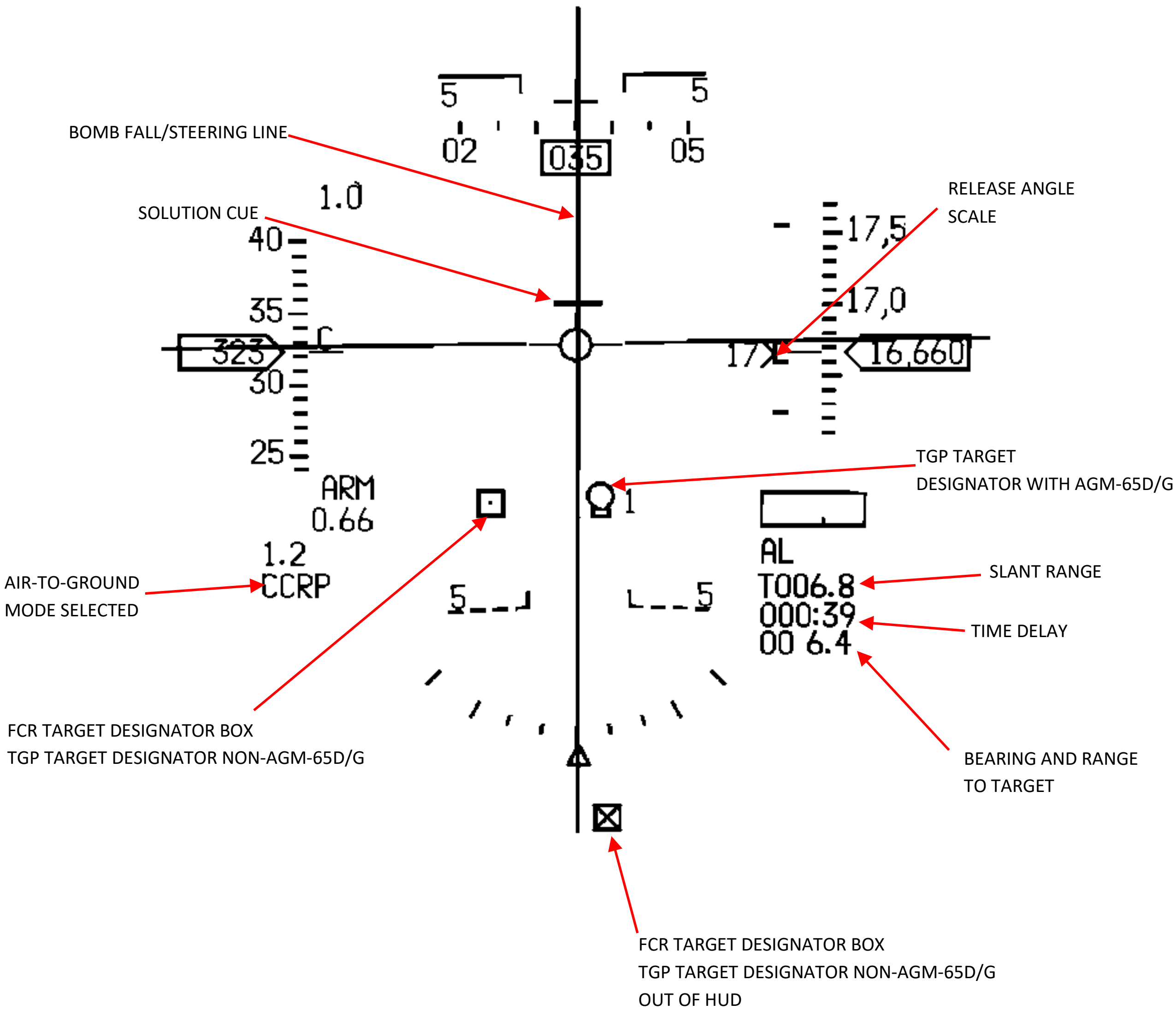
HUD – Target Locator Line

DOGFIGHT MODE



HUD – Dogfight mode symbology

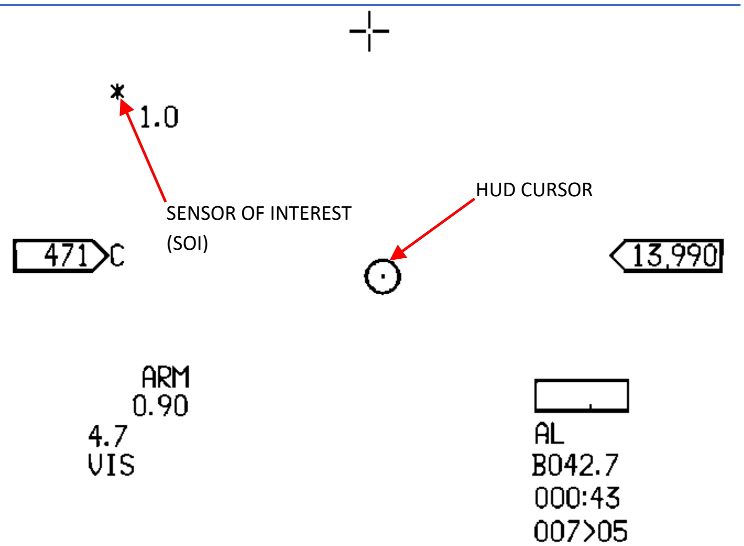
2.1.7.5.3 HUD AIR-TO-GROUND SYMBOLOGY



HUD – Symbology – Air-to-Ground (Example: CCRP submode)

2.1.7.5.4 HUD SENSOR OF INTEREST (SOI)

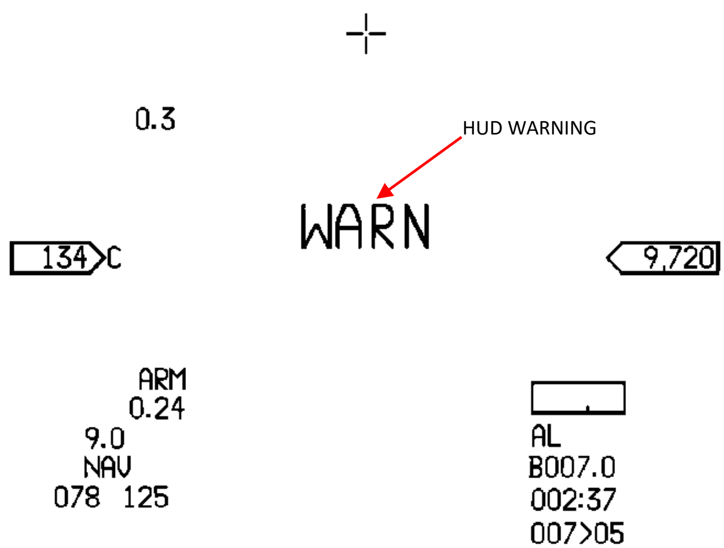
The Head-Up display can be selected as the Sensor of Interest (SOI) by using the DMS up command on the sidestick, similar to selecting the left or right Multi-Function Display (MFD) as SOI. When the HUD is designated as SOI, an asterisk appears in the top left corner of the HUD.



The HUD is utilized as SOI for two main purposes: creating HUD mark points and employing air-to-ground missiles in Visual (VIS) mode. When the HUD is selected as SOI, a movable cursor or target designator box is displayed on the HUD. The position of this cursor or designator box can be adjusted using the cursor switch on the throttle, and the designated target can be stabilized or designated for ground-based operations using the TMS up command on the sidestick.

2.1.7.5.5 HUD WARNING

In the event of a relevant malfunction, the Head-Up Display (HUD) may present a flashing WARN message at its center, accompanied by an audible "WARNING - WARNING" message from the Voice Management System (VMS). Unlike the flashing WARN message on the HUD, the MASTER CAUTION button does not reset it; instead, it can be reset using the momentary switch labeled ICP WARN RESET.



In addition to the primary WARN message, the HUD may also display other smaller warnings. For example, a flashing FUEL message may appear in the middle of the HUD, positioned below the main WARN message. Alternatively, a steady TRP FUEL indication could replace the NAV mode indication and be displayed on the left side of the HUD.

It is important to note that when the Terrain-Following Radar (TFR) is not in Standby mode, various TFR-specific warnings will be triggered and displayed in the HUD. For detailed information, please refer to the TFR system chapter.

2.1.7.6 HUD Cues and Scales

2.1.7.6.1 SENSOR OF INTEREST (SOI) SYMBOL

The symbol representing the HUD SOI (Sensor of Interest) is an asterisk located at the upper left corner above the airspeed scale on the HUD display (refer to Figure NAV Mastermode).

2.1.7.6.2 FLIGHT PATH MARKER

The flight path marker (FPM) is comprised of a 10 mR circle with 10 mR wings, which are stabilized by the aircraft, along with a 5 mR tail extending upwards from the circle (refer to Figure NAV Mastermode). The position of the FPM accurately represents the velocity vector of the aircraft. In air-to-ground weapon delivery or jettison modes, the FPM flashes to indicate consent for weapon release. The flashing persists until the WPN REL button is released. When the FPM is restricted within the HUD field of view, an X-symbol is overlaid on top of the FPM. If the FPM is not displayed and the ILS (Instrument Landing System) is selected, the W-steering cue is shown 11 mR below the boresight cross.

2.1.7.6.3 GREAT CIRCLE STEERING CUE

The great circle steering cue is composed of a 12 mR line that extends outward from a 6 mR circle. The position of the roll-stabilized steering cue on the HUD is determined by its azimuthal relationship to the flight path marker. By aligning the flight path marker with the steering cue, pilots can effectively steer the aircraft. The orientation of the steering cue line on the HUD provides information about the bearing to the steerpoint. When the steering cue line is at the 12 o'clock position relative to the horizon, it indicates a bearing of zero degrees to the steerpoint. Similarly, at the 3 o'clock position, the steering cue line indicates a bearing of 90 degrees to the right of the steerpoint.

2.1.7.6.4 STEERPOINT DIAMOND SYMBOL

During air-to-ground and navigation modes, the position of the steerpoint diamond is determined by adding the selected steerpoint with cursor adjustments. If both the air-to-ground target designator box (TD-box) and the diamond coincide, the diamond will be obscured. In air-to-ground preplanned submodes like CCRP and LADD when the weapon system status is not RDY, REL, or SIM, the steerpoint diamond aligns with the line of sight to the direct aimpoint. In preplanned submodes where the initial sighting point option is chosen and the selected steerpoint number matches the initial point number, along with a weapon system status other than RDY, REL, or SIM, the steerpoint diamond is positioned at the entered latitude, longitude, and elevation. If the reference point sighting option is selected and the weapon system status is RDY, REL, or SIM, the steerpoint diamond is placed at a specific range and bearing from the entered latitude, longitude, and elevation.

In air-to-ground visual submodes, the diamond signifies the steerpoint and its elevation is determined by the system altitude and the entered elevation of the selected steerpoint. It should be noted that this symbol is not available in the A-A (air-to-air), dogfight, or MSL (missile) override master modes.

2.1.7.6.5 OFFSET AIMPOINT TRIANGLE SYMBOL

Upon accessing the OA1 or OA2 sighting option through the MFD (Multi-Function Display) in the air-to-ground or navigation master mode, the HUD will display the offset aimpoint triangle symbol. This symbol represents the selected offset aimpoint and is positioned accordingly. It is composed of an isosceles triangle measuring 12 mR in height and 6 mR in width.

2.1.7.6.6 HUD BORESIGHT CROSS

The HUD boresight cross is represented by an incomplete plus symbol positioned at zero degrees in azimuth, symbolizing the fuselage reference line. This boresight cross is visible across all modes on the HUD display.

2.1.7.6.7 PRIMARY RETICLE

The depressible primary reticle is comprised of a 2 mR pipper surrounded by a dashed inner circle with a diameter of 50 mR, as well as a solid outer circle with a diameter of 100 mR. The primary reticle can be chosen by selecting it through the HUD Control Panel, and it can be lowered or depressed using the RET DEPR knob on the integrated control panel (ICP). The degree of depression is indicated in milliradians (mR) and can be observed at HUD window 30.

2.1.7.6.8 STANDBY RETICLE

The depressible standby reticle features a 2 mR pipper encompassed by a dotted inner circle with a diameter of 50 mR. Additionally, it has a dotted outer circle with a diameter of 100 mR. The outer circle is marked with four 6 mR tics positioned at the 3, 6, 9, and 12 o'clock positions. To select the standby reticle, it can be chosen via the HUD Control Panel. Lowering or depressing the standby reticle is achieved by adjusting the RET DEPR knob on the ICP. The degree of depression is indicated in milliradians (mR) and can be viewed at HUD window 30.

2.1.7.6.9 TARGET DESIGNATOR BOXES AND LOCATOR LINES

The HUD has the capability to display both the target data from the FCR (Fire Control Radar) and TGP (Targeting Pod) simultaneously.

2.1.7.6.10 FCR TARGET DESIGNATOR BOX AND LOCATOR LINE

In the A-A (air-to-air) master mode, the target location is depicted by square TD-boxes. The size of these boxes varies depending on the selected master mode. In air-to-air submodes, the Primary TD-box measures 25 mR on each side, indicating the target position in terms of azimuth and elevation relative to the aircraft. The Secondary TD-boxes, on the other hand, are 15 mR on each side.

The primary and secondary TD-boxes, along with the Target of Interest (TOI) symbol, provide information such as range, altitude, and digital aspect angle of the target. In the case of ACM (Air Combat Maneuvering) or RWR (Radar Warning Receiver), the TD-box and target locator line box are displayed with a dotted pattern.

2.1.7.6.11 TGP TARGET DESIGNATOR BOX AND LOCATOR LINE

In air-to-air mode, when the TGP (Targeting Pod) is actively tracking, a 25 mR box with dotted lines is used to represent the target position in terms of azimuth and elevation (refer to Figure A-A mastermode). If the targeting pod is being utilized as the tracking sensor, additional information such as TGP TLL (Target Locator Line) and TLA (Target Locator Angle) can be displayed.

The TGP target locator line is shown when air-to-air targets are positioned outside the field of view (FOV) of the HUD. It is represented by a 40 mR dotted line that extends from the gun boresight cross at an angle or relative bearing (a combination of horizontal and vertical angles) towards the target. In the HUD window, the letter "T" is displayed as the far-left character, denoting the TGP, followed by a two-digit target angle. The target angle off the nose is updated in increments of one degree.

2.1.7.6.12 AIR-TO-AIR MISSILE SYMBOLOGY

Refer to chapter 4.3 Air-To-Air Combat

2.1.7.6.13 AIR-TO-GROUND ATTACK SYMBOLOGY

Please refer to the Air-To-Ground Combat (4.2) section for a comprehensive list of features including Electro-Optical (EO) Reticle, Bomb Fall/Steering Line, Air-to-Ground Solution Cue, Extended A-G Solution Cue for IAMs, Maximum Toss Anticipation Cue, Horizontal and Vertical Steering Bars, CCIP Pipper and In Range Cue, Popup Point Cue, Missile Launch Envelope Scale, Inertially Aided Munitions Release Scale, AGM-88 Launch Scale, Low Warning/Pull-up Anticipation Cue, and more.

2.1.7.6.14 ROLL INDICATOR

The Head-Up Display (HUD) roll indicator exhibits markings positioned along a circular reference with a radius of 70 milliradians (mR). This circle is centered 50 mR below the middle of the overall field of view. Each marking is separated by 10 degrees, except for the outer markings, which are spaced at 45 degrees. These markings remain fixed with respect to the aircraft's orientation. The caret roll remains stable within the display's limitations. The display is constrained to a range of ±45 degrees, and as the aircraft rolls beyond this limit, the outer portion of the caret will disappear. The caret will align with a line passing through the center of the circular arc, perpendicular to the local level.

2.1.7.6.15 BANK ANGLE INDICATOR

The bank angle indicator (BAI) is a curved line composed of several markings arranged in an arc shape, spanning 120 degrees around the Flight Path Marker (FPM). The BAI scale includes three larger markings, each representing 3 milliradians (mR), indicating 0, 30, and 60 degrees of bank. Additionally, smaller 1 mR markings are present at 10 and 20 degrees. The BAI remains aligned with the horizon and is synchronized with the FPM. The tail of the FPM serves as a reference point against the BAI. Whenever the FPM is displayed and the vertical velocity scale is selected, the BAI is also shown.

2.1.7.6.16 AIR SPEED SCALE

The airspeed scale on the display represents velocity in tens of knots, with markings at 50 knot intervals. The airspeed value is determined by comparing the position of a stationary index mark with the moving scale. There are three available speed scales: calibrated airspeed (C), true airspeed (T), and groundspeed (G). The currently selected scale, denoted by the mnemonic (C, T, or G), is displayed above the fixed index mark. To the left of the scale, opposite the index mark, a digital representation of the aircraft's speed is shown. The digital value cannot be removed to reduce clutter. The desired speed scale can be chosen by using the velocity switch located on the HUD control panel.

2.1.7.6.17 ALTITUDE SCALES

The altitude display includes tape measure scales and a radar altitude scale presented in a thermometer format. By utilizing the altitude switch on the HUD Control Panel, one of three altitude scales can be shown on the HUD: barometric (B), radar (R), or Auto. A digital representation of the aircraft's altitude appears to the right of the tape measure scales, across from the fixed index mark. This digital value cannot be removed to declutter the display.

When the barometric altitude scale is selected, the radar altitude is also displayed digitally below the altitude scale, indicated by the "R" mnemonic. Some important characteristics of the altitude display are as follows:

- The last digit always shows zero.

- Below the radar altitude window, the manually set altitude low value is presented. The "AL" (altitude low) mnemonic is shown before the altitude low reading. It represents the pilot-selected activation point (altitude) for the Altitude Low Warning (ALOW) system. The ALOW system can be configured using the ALOW priority function (key 2) on the ICP.

2.1.7.6.18 BAROMETRIC ALTITUDE SCALE

The barometric altitude scale on the display indicates barometric altitude in increments of hundreds of feet, accompanied by a digital readout at 500-foot intervals. Each interval is marked by reference tics, representing 100 feet per tic. The first digit of the digital readout is followed by a comma, indicating thousands of feet. The aircraft's altitude is determined by comparing the position of a fixed index mark with the moving scale. Below the scale, a digital readout of the radar altimeter value is provided (indicated by the letter "R" within the window). If radar altitude unavailable, the digital radar altitude window will remain blank.

During the landing phase, the altitude scale undergoes expansion five times. In this mode, the reference tics represent 20 feet instead of 100 feet, and each interval indicates 100 feet instead of 500 feet. This expanded scale provides greater precision during critical landing maneuvers.

2.1.7.6.19 RADAR ALTITUDE SCALE

The radar altitude scale on the display presents radar altitude using the identical scale as the barometric altitude scale. The following specific conditions apply:

- An "R" symbol is positioned above the index line to indicate when the radar altimeter is driving the altitude scale. If radar altitude information is not available, the barometric altitude scale replaces the radar altitude scale.

- When the radar altitude is descending and falls below 1500 feet, commas and leading zeros are removed from the display. Additionally, the digits on the scale are presented in feet rather than hundreds of feet. This adjustment allows for a more concise representation of the lower altitude values during decent.

2.1.7.6.20 AUTOMATIC RADAR ALTITUDE SCALE

When the barometric altitude scale is active, the absence of the letter "R" next to the box indicates that it is a barometric reading.

The automatic radar altitude scale appears on the display when the automatic radar altitude mode is selected using the AUTO position of the altitude switch on the HUD Control Panel. This scale is shown when the actual radar altitude is below 1200 feet during descent or below 1500 feet during ascent. The automatic scale consists of a set of fixed tic marks indicating altitudes ranging from 0 to 1500 feet. Below the scale, there is a digital readout displaying the radar altitude in feet (rounded to the nearest 10 feet) and marked with the letters "AR". In case the radar altitude information is unavailable, the digital readout for radar altitude is blanked, the window flashes, and the barometric altitude scale is displayed instead of the automatic radar altitude scale. The radar altitude is represented using a moving thermometer scale against the fixed altitude display.

Furthermore, the scale includes an altitude low window that presents the manually set minimum altitude (referred to as the Radar Altitude Setting Window). The AL mnemonic is displayed before the altitude low reading, and a T-bar is positioned on the scale at the altitude low value. The AL mnemonic flashes when the actual radar altitude falls below the altitude low setting, providing a visual warning to the pilot.

2.1.7.6.21 VERTICAL VELOCITY SCALE

Adjacent to the altitude scale, the display features the vertical velocity scale. This scale consists of a moving scale aligned with a fixed index mark. The index mark remains in proximity to the vertical velocity scale even when the thermometer altitude scale is active. The shared index mark serves as a reference point denoting zero vertical velocity. Reference tics are positioned at intervals of 500 feet per minute, aiding in the interpretation of the aircraft's vertical rate of ascent or descent.

2.1.7.6.22 ATTITUDE BARS, HORIZON LINE AND GHOST HORIZON LINE

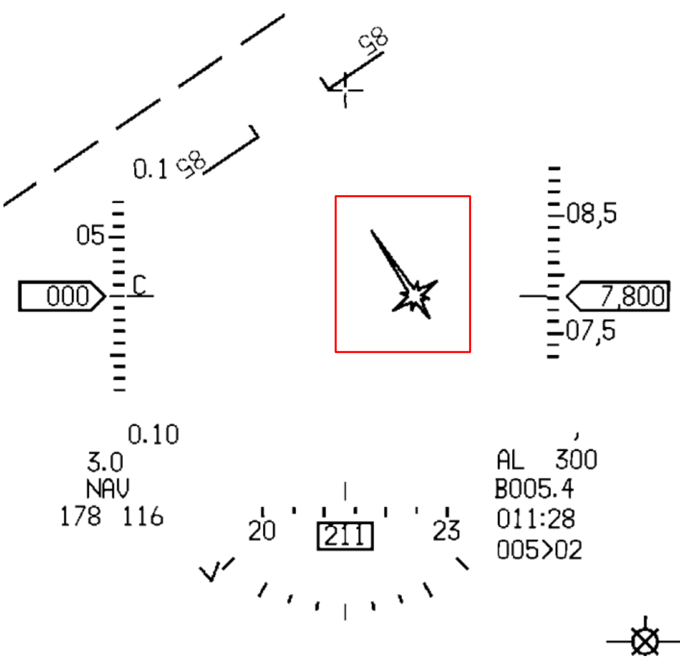
The HUD incorporates an asymmetric pitch scale that includes various symbols such as attitude bars, a horizon line (extended/ghost), and zenith and nadir symbols.

The attitude bars are composed of solid 25 milliradian (mR) lines positioned above the horizon line, while below the horizon line, they transition into dashed lines. The attitude bars, along with one or two digits, are spaced at 5-degree intervals, ranging from ±5 degrees to ±85 degrees, maintaining a 1 to 1 ratio. A minimum of three pitch lines are constantly visible on the HUD. Above the horizon, the attitude bars are solid with inward-pointing elbows, while below the horizon, they are dashed with elbows pointing towards the horizon line. The negative pitch bars curve to form a funnel shape, indicating the direction back to the horizon. However, the negative 2.5-degree pitch line does not bend and only appears during the landing mode. At ±90 degrees pitch, the zenith and nadir symbols are displayed, with their arms pointing towards the horizon. The horizon line is wider than the attitude bars and is solid when the true horizon is within the HUD field of view (FOV), known as the extended horizon line (EHL). When the true horizon is outside the HUD FOV, the horizon line appears dashed, referred to as the ghost horizon line (GHL). The EHL and GHL provide a larger and more noticeable constant reference to the horizon. Despite being longer than the HUD horizon line, they do not obstruct the airspeed, altitude, or heading scales' digital readout boxes, nor any of the missile launch envelope (MLE) data associated with air-to-air (A-A) or air-to-ground (A-G) operations.

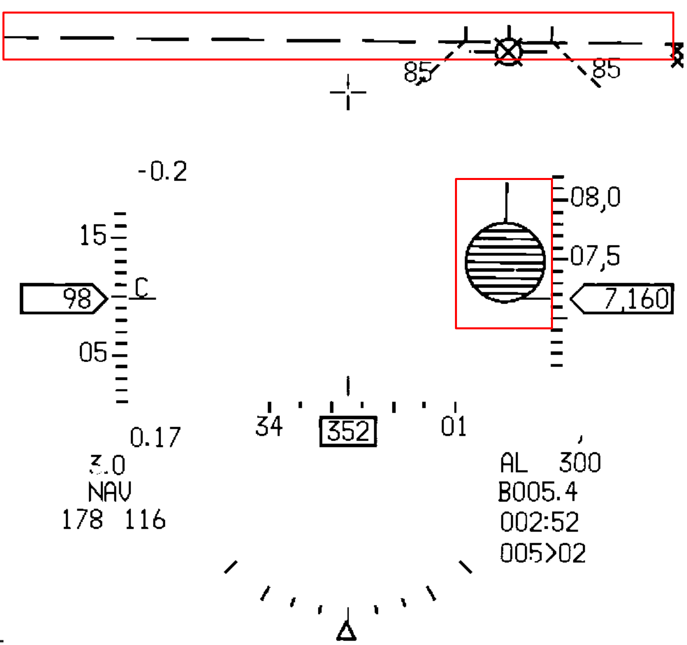
Both the attitude bars and horizon lines on the HUD feature gaps in their center sections to accommodate the display of the Flight Path Marker (FPM). Due to their roll stabilization, the attitude bars and horizon line remain parallel to the actual horizon. By observing the position of the FPM in relation to the attitude bars and horizon line, pilots can determine the aircraft's attitude and roll angle.

The ghost horizon line comes into play when the regular horizon line exits the HUD's total field of view (HTFOV). Positioned on the outer edge of an imaginary circle centered in the HUD's field of view, the ghost horizon line has a radius of 8 degrees. As the aircraft banks, the ghost horizon line rotates around the center of the circle. For instance, at a 90-degree bank, the ghost horizon line will be on the side of the circle. When the actual horizon returns within the HTFOV, the ghost horizon line is no longer displayed.

The Zenith symbol appears when the pitch reaches +90 degrees, and it is represented by an elongated star with its longest arms pointing towards the horizon line. Conversely, the Nadir symbol is displayed at the pitch corresponding to -90 degrees. It consists of a 31.4 milliradian (mR) circle with a 15.7 mR line extending from the circle and pointing towards the horizon. To distinguish it from other similar symbols, the Nadir features twelve lines inside the circle that run parallel to the horizon line.



HUD – Zenith



HUD – Nadar + Ghost Horizontal Line

2.1.7.6.23 ATTITUDE AWARENESS ARC (AAA)

In Dogfight mode, the Attitude Awareness Arc is displayed between the airspeed and altitude references on the Head-Up Display (HUD). The symbol of the arc has a radius of 99.5 mR, measured from the center of the HUD TFOV (Total Field of View).

When the wings are level, there are two tic marks on each side of the arc. These tic marks extend 5.2 mR outward from the center of the arc, aligned directly towards the airspeed and altitude scale. It's important to note that these tic marks are always oriented radially outward from the center of the HUD.

The length of the arc is smallest, measuring 10.35 mR, when the pitch is at +87 degrees. At a pitch of -87 degrees, the arc has closed and approximates a circle with a 10.35 mR gap. This represents the maximum size the arc can reach.

When the conditions for landing are met while in Dogfight mode, the Attitude Awareness Arc is blanked or not displayed. For more detailed information, please refer to the DOGFIGHT (DGFT) MODE documentation.

2.1.7.6.24 SYMBOLOGY OCCLUSION AND DISTORTION CORRECTION

To prevent superimposition of symbols, the following prioritization is implemented:

• The boresight cross and limit X-symbols are always visible and not occluded while operating in the EEGS submode. However, they can be occluded by the CCIP reticle, in-range cue, air-to-ground TD box, and OAP symbols. Additionally, the boresight cross can be occluded by the AIM-9 and AIM-120 missile diamonds.

• All symbology is occluded within the air-to-air or air-to-ground TD box.

When the CCIP reticle (with or without the in-range cue), the OAP symbol, and the air-to-ground TD box are simultaneously displayed, occlusion is prioritized in the following order:

1. The 12 milliradian (mR) CCIP reticle, whether displayed with or without the 16 mR in-range cue.

2. The air-to-ground TD box.

3. The OAP symbol.

2.1.7.6.25 LANDING DECLUTTER

In NAV and landing modes, when the uncage switch on the aircraft is pressed and then released, several symbols on the Head-Up Display (HUD) are affected. The HUD heading scale is shifted to the UP position, and the following symbols are no longer displayed on the HUD:

- Roll indicator
- ILS (Instrument Landing System) bars
- Flight director symbol
- DED (Data Entry Display) data (if it was previously present)

However, the HUD symbols will reappear under the following conditions:

- Exiting the NAV mode
- Exiting the landing mode (Landing Gear Up)
- The avionic system detecting weight-on-wheels indication
- Subsequent depression of the Cage/Uncage switch

2.1.7.6.26 LINK 16 FLIGHT MEMBER SYMBOLOGY | TOI | PDLT

Please refer to the Link 16 Flight Member Symbology chapter in this document.

2.1.8 COMBINED ALTITUDE RADAR ALTIMETER (CARA)

The Radar Altimeter (RALT) system is an advanced technology radar altimeter that operates on the principle of Frequency-Modulated Continuous Wave (FMCW). It accurately calculates the aircraft's altitude from 0 to 50,000 feet by measuring the time taken for radio frequency (RF) energy to travel to the terrain and back. The RALT system offers excellent anti-interception and anti-jamming capabilities, and it provides both analog and digital outputs for integration with the aircraft's avionic systems. Additionally, it includes an altitude low (ALOW) warning feature that alerts the pilot if the aircraft descends below the selected minimum altitude threshold. The altitude measurement accuracy is ±2 percent below 5000 feet and ±1 percent above 5000 feet.

The Radar Altimeter information is distributed to various avionics subsystems through the A multiplex (A-MUX) bus. The primary interface for the radar altitude is the Head-Up Display (HUD), where the altitude scale is displayed. In case of low altitude, an ALT LOW indicator is shown, and an aural message "ALTITUDE-ALTITUDE" is heard through the headset. The RADAR ALT failure light is located on the caution light panel, and its power is controlled by the RDR ALT switch on the SNSR PWR Control Panel.

2.1.8.1 LINE REPLACEABLE UNITS (LRUS)

2.1.8.1.1 Receiver-Transmitter (R/T)

This unit generates the transmitted waveforms, processes the received reflections, and performs altitude measurements. It interfaces with other subsystems, provides self-test capabilities for failure detection, and manages the RF transmitted power to enhance low probability of interception (LPI).

2.1.8.1.2 SIGNAL DATA CONVERTER (SDC)

Located next to the R/T, the SDC converts analog and digital signals to and from the A-MUX bus. It handles interface with the A-MUX bus, including altitude data from the R/T, and facilitates display on the HUD. The SDC also manages discretes such as transmit enable and out of track signals.

2.1.8.1.3 FORWARD AND AFT RADAR ALTIMETER ANTENNAS

The forward antenna transmits the RF energy generated by the R/T unit, while the aft antenna receives the reflected RF energy and directs it to the receiver section of the R/T.

2.1.8.2 CARA FUNCTIONAL OPERATION

The functional operation of the CARA system involves FMCW radar technology to determine the aircraft's altitude. The system modulates the transmitted frequency within a predetermined range. The RF signal is generated at the starting frequency and transmitted from the antenna towards the ground. The transmitter then sweeps the transmit frequency at a constant rate. The transmitted energy reflects off the ground and is received by the antenna. By comparing the returned frequency with the current transmit frequency, the system calculates the frequency difference (delta - D). This frequency difference is proportional to the time taken for the RF energy to travel to the ground and back, which relates to the aircraft's altitude. The altitude information is processed by the SDC, transmitted to the Modular Mission Computer (MMC), and distributed to the HUD for display.

The ground tracking capabilities of the CARA system are constrained by the aircraft's pitch and roll angles, which should not exceed the limits set by the receiver/transmitter (R/T) beam width. The CARA antennas are not equipped with roll or pitch stabilization, and as the altitude increases, signal strength diminishes, further limiting the tracking capabilities.

For altitudes below 3000 feet above ground level (AGL), the CARA system can track targets within a range of 30 degrees in pitch and 60 degrees in roll. However, at an altitude of 50,000 feet AGL, both pitch and roll tracking capabilities are reduced to 10 degrees. These limitations represent the intended design capabilities of CARA. Nevertheless, it is worth noting that in practice, the system often surpasses these specified capabilities.

2.1.8.3 RALT POWER

The power for the Radar Altimeter (RALT) can be controlled using the RDR ALT (Radar Altimeter) switch located on the SNSR PWR Control Panel. This switch has three positions:

1. OFF position: In this position, power is not supplied to the RALT, effectively turning it off.

2. STBY (Standby) position: When the switch is set to STBY, power is provided to the RALT, allowing the sensor to initiate its power-up routine without transmitting any signals. This mode enables the pilot to operate the aircraft in a "ready but silent" state, where the RALT is operational but does not actively transmit signals.

3. RDR ALT position: Setting the switch to RDR ALT activates the RALT, enabling it to transmit signals and start tracking the ground. In this mode, the RALT is fully operational and actively tracks the altitude above the ground.

2.1.8.4 RADAR ALTIMETER ALTITUDE LOW WARNING (ALOW)

The Voice Message Unit (VMU) is programmed to provide a single ALTITUDE-ALTITUDE aural warning when the aircraft descends through the CARA ALOW (altitude low) threshold. If the aircraft remains below this threshold, no additional aural warnings will be given until a CARA reset occurs.

It is important to check the ALOW setting after conducting the EPU ground check, as electrical transients during this process can cause the ALOW setting to reset to 500 feet. This issue also disrupts the MUX bus communications of the CARA system and freezes the digital radar altitude display on the HUD. To resolve this, the CARA power should be cycled, and the desired ALOW setting should be reentered.

During normal operation, the CARA system may briefly lose track of the ground and, in its attempt to reacquire the ground, may mistakenly track an RF return from the engine inlet. This false altitude reading, typically between 110 and 180 feet, is processed as valid ground track data by the aircraft's avionic systems. Inlet tracks may resolve automatically or may require a power cycle of the CARA system.

When a descent through the CARA ALOW threshold is detected, the VMU provides an altitude low warning message ("ALTITUDE-ALTITUDE") through the pilot's headset, and an ALOW message is displayed on the HUD. The aural warning message is suppressed if the landing gear handle is down or if CARA senses a rate of climb greater than 1200 feet per minute (fpm). The VMU ALTITUDE warning message is also inhibited when the radar altitude is less than 15 feet above ground level (AGL). However, if the ALOW warning is triggered, the AL mnemonic and the current ALOW setting will flash on the HUD. These flashing indicators will persist whenever the aircraft is below the ALOW setting value, except when the airspeed drops below 80 knots.

With the landing gear handle up, the VMU will deliver the ALTITUDE-ALTITUDE message once through the pilot's headset whenever the aircraft descends below the CARA ALOW setting. The CARA system is reset for subsequent ALOW violations when any of the following conditions are met:

- CARA loses ground track due to maneuvering or malfunction.
- The rate of climb exceeds 1200 fpm, as detected by CARA, due to terrain, climbing, or turbulence.
- The CARA ALOW setting is changed to a lower value than the current CARA altitude.
- The aircraft climbs above the CARA ALOW setting.

After any of these reset conditions, the ALTITUDE-ALTITUDE message will sound again if a CARA ALOW violation is detected. For example, when flying level over uneven terrain or in turbulent conditions, the message may be triggered multiple times.

2.1.8.5 CARA IBIT

The CARA system's built-in test (IBIT) can be initiated by pressing the OSB button next to RALT on the MFD test page. IBIT can be performed with the RDR ALT switch on the SNSR PWR Control Panel in either the STBY or RDR ALT position. The IBIT process takes approximately 5 seconds to complete and will automatically be deselected once finished. During the IBIT, the RALT indication on the MFD will be highlighted, and the mnemonic "300 feet" will be displayed below it. After the IBIT sequence is completed, the CARA system status should be evaluated by monitoring all MFL listings. No radar altitude should be displayed on the HUD during the IBIT.

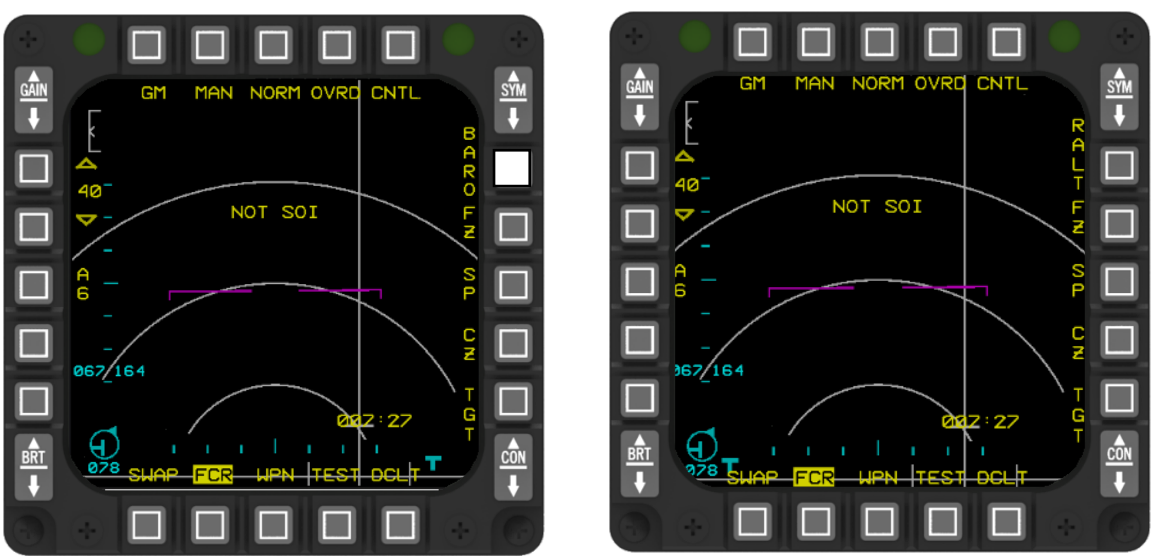
NOTE: The CARA system may occasionally report faults that are not significant. To avoid unnecessary maintenance actions, it is recommended to perform a minimum of three CARA BIT sequences before reporting system faults. If the fault persists or cannot be resolved, then the appropriate subsystem should be reported for maintenance.

While operating on the ground, the CARA system may occasionally provide erroneous altitude information. This is most common when inside hangars or near buildings, workstands, or support equipment. The issue may persist during aircraft taxiing but should cease after takeoff.

If the IBIT is performed in flight while the CARA is in standby (STBY) mode and the ALOW setting is at 500 feet, the ALOW warning function will be tested. The ALOW warning indications (flashing AL mnemonic and ALOW setting on the HUD, as well as the VMU ALTITUDE warning message) should be present. On the ground, the WOW (Weight-On-Wheels) condition will result in no VMU ALTITUDE warning message, and when the airspeed is less than 80 knots, the HUD ALOW displays will be inhibited. Therefore, the ALOW warning function cannot be tested using IBIT except during flight.

2.1.8.6 RALT AS BACKUP BOMBING SENSOR (BBS)

CARA can serve as an alternative to steerpoint elevation/barometric altitude or DTS Passive Ranging (PR) for secondary bombing computations in cases where AGR (Air-to-Ground Ranging) is unavailable. The figures below depict a typical selection of CARA for this purpose. By default, the system operates in barometric altitude (BARO) mode and automatically reverts to it unless RALT (Radar Altimeter) has been manually selected. When CARA is chosen as the secondary sensor, HUD (Head-Up Display) slant range data is indicated by an R prefix.



BACKUP BOMBING SENSOR (BBS)

When employed as a backup bombing sensor, RALT assumes that the measured altitude corresponds to the height of the aircraft above the target (HAT). However, this assumption holds true only in scenarios where the terrain in front of the target is flat and at the same elevation as the target itself. Due to these limitations, this mode is predominantly utilized as a backup option.

2.1.8.7 HUD ALTITUDE SCALE SELECTION

The HUD Control Panel features the ALT switch, which allows for the selection of various display options for CARA. The ALT switch offers three positions: RADAR, BARO, and AUTO. Each position provides different display configurations on the HUD.

Selecting the RADAR position enables the display of the radar altimeter scale along with an R-mnemonic above the index tic mark. The digital representation of radar altitude is shown to the right of the altimeter scale. If radar altitude data is unavailable, the barometric altitude scale is displayed instead.

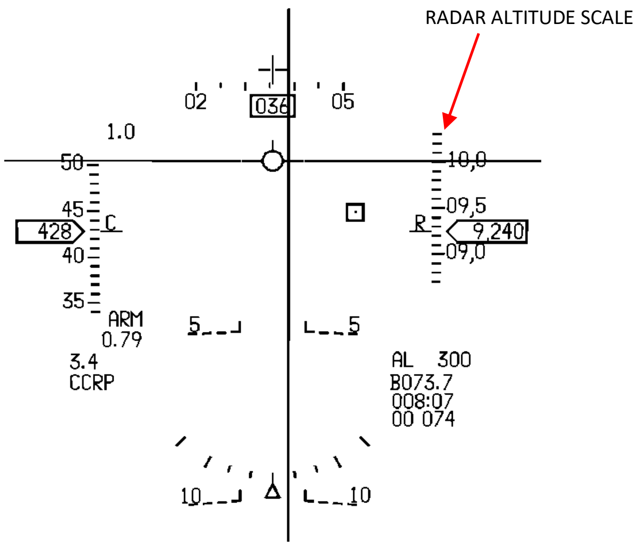
On the other hand, the BARO position shows the barometric scale, similar to the radar scale but without the mnemonic above the index tic mark. The radar altitude digits are presented below the barometric scale.

The AUTO switch offers the flexibility to automatically switch between displaying radar altitude and barometric altitude on the HUD's altimeter, depending on the current altitude above ground level (AGL). When the altitude is above 1500 feet, the radar digits are shown with the R-mnemonic positioned below the barometric scale. As the altitude decreases below 1200 feet during descent or below 1500 feet during ascent, the display transitions to a radar altitude thermometer scale. This thermometer scale includes an AL window that shows the manually set minimum altitude. The AL mnemonic is displayed in front of the current ALOW setting, and a T-bar indicates the current ALOW setting on the scale. Whenever the actual radar altitude falls below the current ALOW setting, the AL mnemonic flashes.

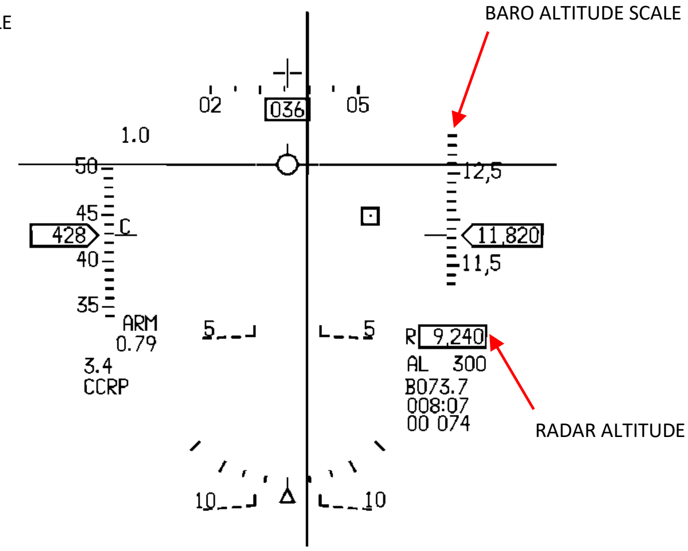
To summarize the ALT switch overview:

- RDR: Displays the Above Ground Level (AGL) Altitude scale.
- BARO: Displays the Barometric Altitude scale, along with the digital AGL altitude.
- AUTO: Displays the BARO/AGL scale, with the mode selected based on the current altitude.

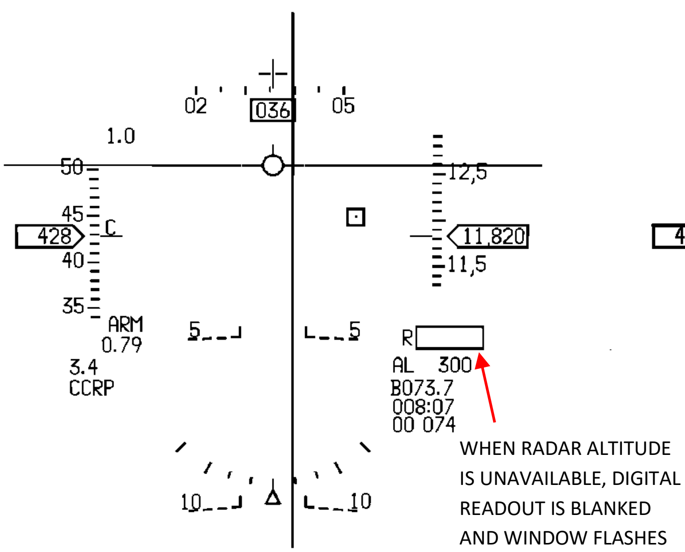
Refer to the next page for HUD Altitude Scale display figures.



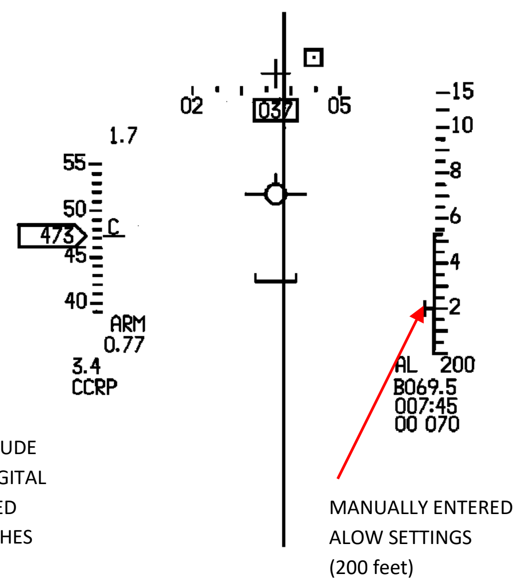
HUD – Altitude Scale - RADAR



HUD – Altitude Scale - BARO



HUD – Altitude Scale – AUTO selected altitude about 1500 feet



HUD – Altitude Scale – AUTO selected-altitude less than 1200 feet descending or less than 1500 feet ascending

2.1.9 GROUND COLLISION AVOIDANCE ADVISORIES

The avionic system's collision avoidance advisories provide pilots with visual and/or aural cues to alert them when there is a predicted risk of the aircraft's flight path leading to a controlled flight into terrain (CFIT).

There are three ground avoidance advisories available in all master modes to warn of a potential controlled flight into terrain (CFIT):

1. Ground Avoidance Advisory Function (GAAF)

2. Predictive Ground Collision Avoidance System (PGCAS)

3. Descent Warning After Takeoff (DWAT)

The GAAF, PGCAS, and DWAT functions provide indications when the aircraft is at risk of colliding with the terrain. These advisories are triggered when the avionic system can predict, with reasonable certainty, that a ground impact is imminent. Once a sufficient recovery maneuver is executed, the advisory is terminated. GAAF predicts the altitude lost during the recovery maneuver and includes a "clearance buffer" for added safety. PGCAS scans terrain elevation data and obstacle databases ahead of the aircraft to compute a recovery maneuver. DWAT predicts an unintended dive or descent and the possibility of a ground collision within the first three minutes after takeoff.

2.1.9.1 GROUND AVOIDANCE ADVISORY FUNCTION (GAAF)

GAAF, being an automatic feature, does not require activation or data entry. It is enabled when the following conditions are met:

- Landing gear is up.
- Aircraft altitude is above 50 feet above ground level (AGL).
- Descent rate is at least 960 feet per minute (greater than 16 feet per second).
- An active sensor can determine the aircraft's height above target (HAT).

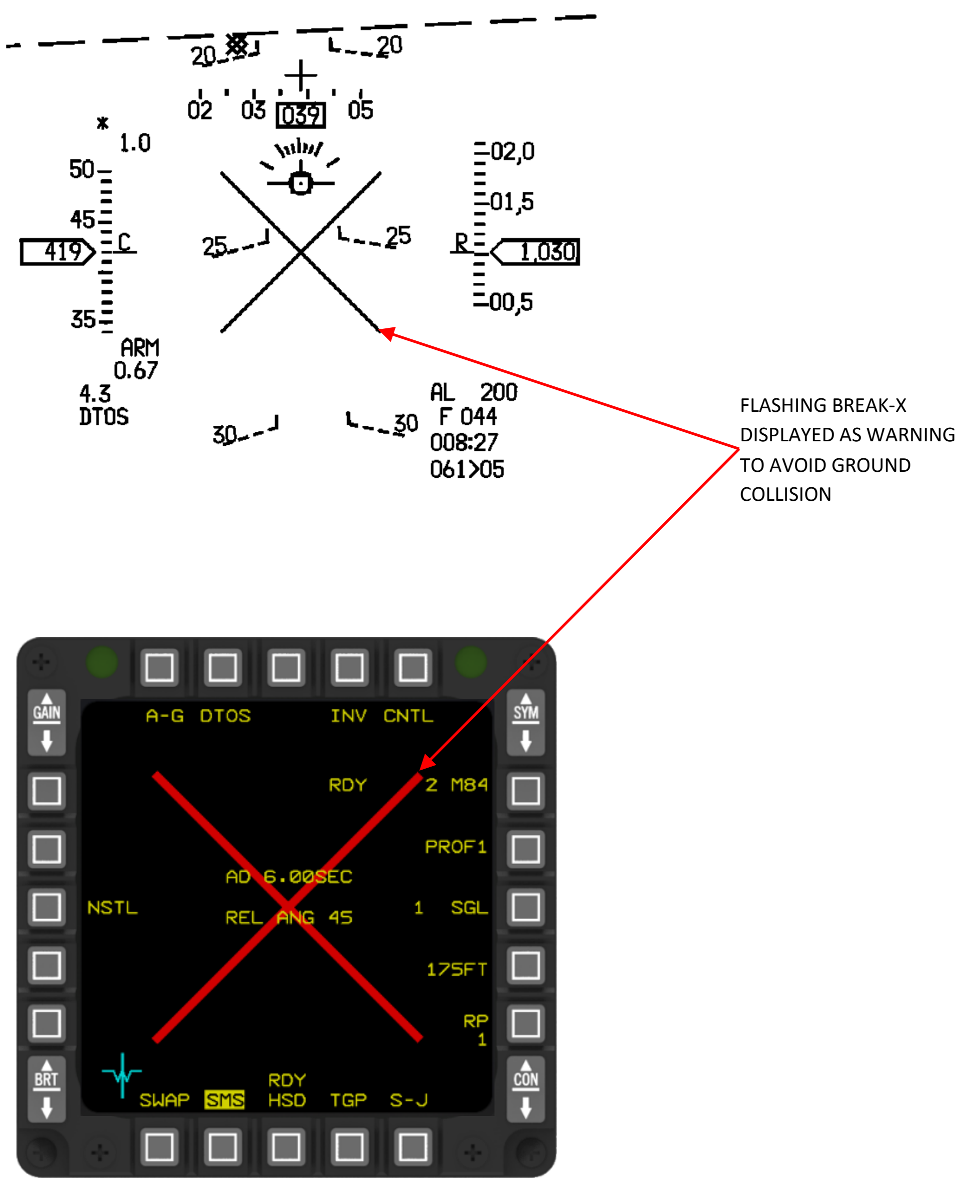
GAAF serves as a backup to PGCAS for ground avoidance advisories and is used in the following cases:

- PGCAS is not selected.
- PGCAS is not valid.
- The digital terrain elevation data (DTED) or obstacle database is not available in the data transfer unit (DTU), rendering PGCAS unavailable.
- The DTED or obstacle database is present but not operational.

2.1.9.1.1 GAAF GROUND AVOIDANCE COCKPIT ADVISORIES

GAAF provides cockpit advisories through visual and aural cues. Approximately 2 seconds before reaching the predicted GAAF advisory altitude, a flashing break-X symbol is displayed on each multifunction display (MFD). At the predicted advisory altitude, a flashing break-X symbol is displayed on the head-up display (HUD), accompanied by a "PULL UP - PULL UP" voice message.

In air-to-ground (A-G) modes, the pull-up anticipation cue (PUAC) ascends towards the flight path marker (FPM), offering advanced indication of the HUD break-X and the PULL UP - PULL UP voice message. Once the PUAC intersects with the FPM, the HUD and voice advisory cues are activated. Additionally, in A-G modes, the pull-up anticipation cue serves to indicate an imminent pull-up situation for fuze arming. The cue responds to the more immediate condition, whether it is ground avoidance or fuze arming.



2.1.9.1.2 GAAF COMPUTATIONS

With the exception of the aural message, the GAAF advisory cues offer affirmative feedback by automatically resetting once the unsafe condition is rectified. The aural message, once initiated, continues until it reaches its completion. If another controlled flight into terrain (CFIT) condition is predicted during recovery maneuvers, the avionic system reactivates the cues. GAAF computations rely on active sensor data to determine the aircraft's height above the terrain. It is important to note that the sensor hierarchy for determining height above ground level (AGL) specifically for the ground avoidance advisory function differs from the sensor hierarchy for the System Point of Interest. The MMC (Mission Management Computer) does not utilize system altitude to calculate AGL height for the ground avoidance advisory function. The sensor hierarchy used to provide this data is as follows:

- Slaved TGP (Targeting Pod) laser ranging.
- FCR (Fire Control Radar) Ranging (AGR) data.
- CARA (Radar Altimeter) data.
- Tracking TGP with Laser Ranging data.
- FCR FTT (Fast Target Track) Tracking data.
- Tracking TGP with CFOV (Continuous Field of View) Ranging data.

Since GAAF does not rely on system (BARO) altitude values, if none of the sensor data mentioned above is available, no GAAF advisory will be issued.

2.1.9.1.2.1 PILOT REACTION TIME

The Mission Management Computer (MMC) takes into consideration the time interval and resulting altitude loss associated with the pilot's response to ground avoidance advisories. The MMC calculates the pilot's reaction time and multiplies it by the vertical velocity of the aircraft to determine the altitude lost due to the pilot's response time.

The assumed reaction time is set at 1 second, accounting for the time required to recognize the advisory and initiate a recovery maneuver. However, in A-G (Air-to-Ground) master modes, the algorithm adjusts the assumed reaction time to 0.45 seconds under specific conditions. These conditions include low dive (or climb) angles (less than or equal to 15 degrees), low bank angles (less than or equal to 20 degrees), and high-speed flight conditions (Calibrated Airspeed of 375 KCAS or higher). This adjustment aims to minimize the occurrence of nuisance GAAF advisory cues, such as unnecessary Break-X symbols, during strafing and low-angle dive bomb deliveries. The reduction in reaction time is implemented smoothly, without introducing any abrupt changes or disruptions.

2.1.9.1.2.2 ROLL RESPONSE TIME

The roll response time of the aircraft refers to the duration it takes for the aircraft to roll to a nearly wings-level position. To predict the altitude loss during the roll and prepare for the subsequent pull-up, the algorithm considers the following factors:

1. Maximum available aircraft roll rate.

2. Compensation for the nose drop caused by the roll.

The maximum aircraft roll rate utilized in this calculation is dependent on the configuration of the SMS (Stores Management System). Additionally, the roll rate used in the computation depends on the position of the CAT Switch (either CAT I or CAT III). It is important to note that discrepancies between the actual aircraft configuration and the selected CAT Switch position may lead to delayed advisories.

2.1.9.1.2.3 ALTITUDE LOST DURING DIVE RECOVERY

The algorithm used by the MMC makes several assumptions and considerations when predicting altitude loss during a dive recovery:

1. It assumes a wings-level pull-up with a target of 4.0 g.

2. However, if the aircraft's weight, airspeed, or external stores prevent achieving 4.0 g, the algorithm estimates the maximum g available instead.

NOTE: Modelling aircraft performance at high gross weights and low airspeeds introduces complexity and reduces the algorithm's safety margin under these conditions.

The MMC's calculation of altitude loss due to pull-up takes into account the following factors and assumptions:

- The use of either 4.0 g or the maximum g available (whichever is lower) to predict altitude loss.
- The current dive angle of the aircraft is considered in the calculation of altitude loss during the pull-up.
- The algorithm calculates the increase in dive angle (nose drop) that occurs when transitioning from high bank angles to a near wings-level attitude.
- The aircraft's gross weight (including internal fuel) and the drag caused by its stores and configuration are accounted for.
- The compensation time for g onset varies based on the vertical g level. For vertical g levels equal to or greater than 4.0, the compensation time is 1 second. For vertical g levels equal to or less than 1.0, the compensation time is 0 seconds. The compensation time decreases linearly from 1 to 0 seconds as the vertical g level decreases from 4.0 to 1.0 g.

2.1.9.1.2.4 CLEARANCE BUFFER

GAAF advisory cues are triggered when the aircraft's altitude above ground level (AGL) is at or below the predicted altitude loss during the pull-up, plus a clearance buffer. The MMC incorporates a buffer and pad to ensure a safe aircraft recovery altitude.

The buffer is determined based on a percentage of the predicted altitude loss and is dependent on the airspeed (Calibrated Airspeed). When the airspeed is less than or equal to 325 knots, the buffer is set at 25% of the predicted altitude loss. For airspeeds equal to or greater than 375 knots, the buffer is set at 12.5% of the predicted altitude loss. For airspeeds between 325 and 375 knots, the buffer decreases linearly from 25% to 12.5% of the predicted altitude loss.

Furthermore, the pad is an additional altitude added to the predicted altitude loss. For airspeeds less than or equal to 325 knots, the pad is set at 150 ft. For airspeeds equal to or greater than 375 knots, the pad is set at 50 ft. For airspeeds between 325 and 375 knots, the pad decreases linearly from 150 ft to 50 ft. These values ensure an appropriate safety margin for the predicted recovery altitude based on the aircraft's airspeed.

2.1.9.1.2.5 TIME UNTIL GROUND AVOIDANCE ADVISORY (TUGAA)

The MMC utilizes a comparison between the current computation of break-X altitude and the aircraft's altitude above ground level (AGL) to determine a Time Until Ground Avoidance Advisory (TUGAA). This TUGAA represents the estimated time remaining until the ground avoidance advisories (both visual and aural) are triggered. The advisories are activated when the MMC predicts that the aircraft is either currently below or on the verge of descending below the advisory altitude. The MMC automatically disables the advisories when the conditions for their display are no longer met.

TUGAA is calculated by dividing the difference between the AGL height and the computed break-X altitude by the aircraft's vertical velocity. The computed break-X altitude is the current estimation of the break-X altitude based on the ongoing pull-up profile, while the vertical velocity corresponds to the aircraft's vertical speed. The AGL height is determined by the sensor used to measure it. This TUGAA calculation allows the MMC to estimate the time remaining before the aircraft reaches the advisory altitude, providing valuable information for timely ground avoidance maneuvers.

2.1.9.1.3 DESCENT WARNING AFTER TAKEOFF (DWAT)

The DWAT function is designed to provide an aural warning, based on the system (baro) altitude, to alert the pilot of a potential unintended dive or descent, which could lead to a ground collision. This warning is specifically applicable within the first three minutes of flight. The aural warning is limited to one occurrence per takeoff. The DWAT function does not offer any selectable options and operates in the background without interfering with the pilot's tasks, except for the aural message.

The VMU advisory, indicated by the message "ALTITUDE - ALTITUDE," is activated when the following conditions are met:

- The landing gear is in the raised position.
- The time elapsed since takeoff is less than three minutes.
- The aircraft has gained at least 300 feet of altitude above the runway altitude, but has not yet exceeded 10,000 feet above the runway altitude.
- The current descent rate suggests that, based on the current flight conditions, the aircraft will descend to the runway altitude within the next 30 seconds. For example, if the difference between the aircraft's mean sea level (MSL) altitude and the runway's MSL altitude is 1000 feet, and the descent rate is equal to or greater than 2000 feet per minute.
- The warning has not been previously activated since takeoff.

It's important to note that if the GND JETT switch is set to ENABLE during takeoff, the duration of the DWAT function will be shorter than three minutes. Enabling the GND JETT switch initiates the DWAT 3-minute timer. Additionally, the DWAT function is deactivated when the MMC power cycles during flight.

2.1.9.2 ALTITUDE ADVISORIES

Two types of altitude advisories are available:

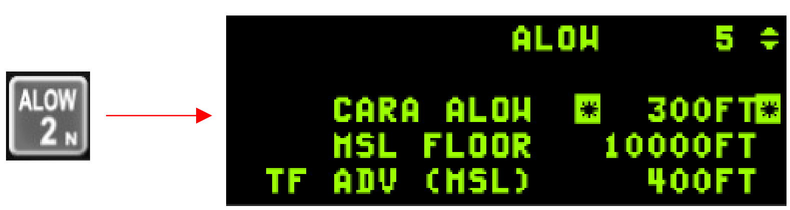
• CARA Altitude Low (CARA ALOW)

• Line-in-the-Sky (LIS), also known as MSL FLOOR advisory.

2.1.9.2.1 CARA ALTITUDE LOW (CARA ALOW)

The MMC assesses whether the digital altitude data from the Combined Altitude Radar Altimeter (CARA) is "frozen" by comparing it to the analog altitude output of the CARA. If there is a significant disparity between the two altitude values, a problem is detected. In such cases, when the MMC triggers a pilot fault message "RALT DATA FAIL," the pilot must resolve the issue by cycling the power of the CARA.

The radar altimeter supplies radar altitude information to the HUD, accompanied by a low-altitude warning. The ALOW setting, typically configured during mission preparation, is entered via the UFC.



DED – ALOW page

NOTE:
When the aircraft's altitude falls below the ALOW altitude setting and it starts gaining altitude at a rate equal to or greater than 1200 feet per minute, the ALOW warning will be deactivated. However, if the altitude rate decreases to 0 ft/sec or below, the warning will be reactivated, indicating to the pilot that the aircraft is descending below the ALOW value after initiating a recovery. Once the aircraft rises above the ALOW value, all indications on the HUD and VMU will be disabled.

If the aircraft descends below the ALOW setting, the following cautions will be provided:

- The HUD will display a flashing AL mnemonic and an altitude low readout.
- The pilot will hear an ALTITUDE - ALTITUDE voice message in the headset.

The ALTITUDE - ALTITUDE caution message will be suppressed under the following conditions:

- The landing gear is deployed.
- The altitude is less than 15 feet.
- The altitude is greater than the ALOW warning setting.
- The climb rate exceeds 1200 feet per minute.

The flashing AL mnemonic and altitude low readout on the HUD will stop flashing when any of the following conditions are met:

- The altitude is less than 15 feet.
- The altitude is greater than the ALOW warning setting.

2.1.9.2.1.1 CARA ALOW PROCEDURES

After performing the EPU ground check with the CARA operating, it is important to verify the ALOW setting. The EPU check and other electrical transients can cause the ALOW setting to reset to 500 feet. This issue also results in the CARA losing MUX-bus communications and freezing the digital radar altitude HUD display. To resolve this problem, the CARA power needs to be cycled, and the desired ALOW setting should be reentered.

During normal operation, there may be instances when the CARA momentarily loses track of the ground and attempts to reacquire it by tracking an RF return from the engine inlet. This false altitude, typically ranging from 110 to 180 feet, is processed as a valid ground track by the avionic systems of the aircraft. In some cases, these inlet tracks may clear on their own, while in other cases, a CARA power cycle may be required.

To set the ALOW value, follow these steps:

1. Enter the ALOW value:

(a) Verify/select CNI display on the DED.
(b) Depress the ALOW button on the ICP and verify the ALOW display.
(c) Verify the desired ALOW value (rounded up to the nearest 10-foot increment) or input a revised ALOW value and press ENTR.
(d) On the SNSR PWR panel, set the RDR ALT switch to RDR ALT position.

2. ALOW operation:

- When the aircraft descends below the preset ALOW value, the ALTITUDE - ALTITUDE voice message, flashing HUD AL mnemonic, and altitude low digital readout will be activated. The ALOW voice message and flashing HUD advisories can be tested during flight by performing the CARA IBIT while the CARA is in standby mode and with an ALOW setting greater than 300 feet (e.g., 500 feet). Please note that the ALOW advisories cannot be tested while the aircraft is on the ground.

2.1.9.2.2 LINE-IN-THE-SKY (LIS)

The LIS (MSL FLOOR advisory) feature offers an altitude advisory cue utilizing barometric MSL altitude. It is important to note that the desired LIS/MSL FLOOR value is set on the DED ALOW page, but the LIS computations operate independently of CARA functionality. Once the aircraft ascends above the entered MSL FLOOR value, the ALTITUDE - ALTITUDE voice message is triggered if the aircraft subsequently descends below that specified altitude.

DED – ALOW page – LIS MSL FLOOR

2.1.9.2.2.1 LIS (MSL FLOOR) PROCEDURES

Set the MSL FLOOR value:

(a) Access the DED and ensure the CNI display is verified/selected.
(b) Press the ALOW button on the ICP and confirm the ALOW page.
(c) Use the DCS to adjust the asterisks positioning around the MSL FLOOR field.
(d) Enter the desired MSL FLOOR value in feet using the ICP keypad and press ENTR.

Note:

- The LIS/MSL FLOOR advisory will be deactivated if a MSL FLOOR value of 0 is entered.
- MSL FLOOR values between -1500 feet and 80,000 feet are acceptable.
- The MSL FLOOR value will be retained even after MMC power cycles.

The ALTITUDE - ALTITUDE voice message will be triggered once when the aircraft descends from above the set MSL FLOOR value to below it.

2.1.9.3 ATTITUDE ADVISORIES

Attitude advisory is provided by the Attitude Advisory Function (AAF).

2.1.9.3.1 ATTITUDE ADVISORY FUNCTION

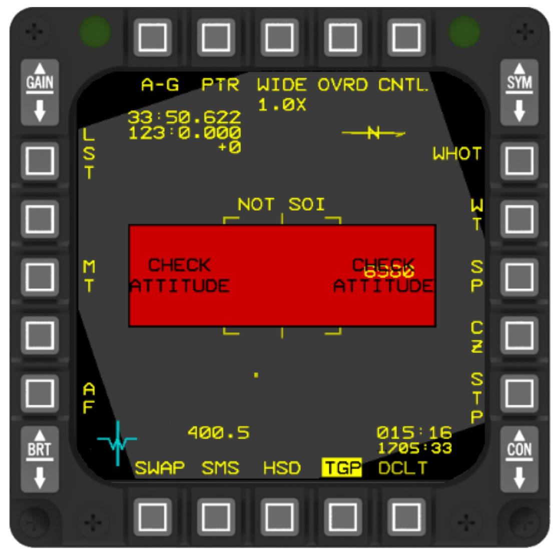
The AAF (Attitude Alert Function) is activated when the following criteria are fulfilled:

1. The TGP (Targeting Pod) MFD (Multi-Function Display) format is being shown.
2. The TGP mode is set to A-G (Air-to-Ground).
3. The INS (Inertial Navigation System) attitude data is valid.
4. The aircraft exceeds any of the defined attitudes:
   a) Bank angle is greater than 75 degrees; pitch angle is less than 0 degrees.
   b) Pitch angle is less than -20 degrees.
5. Additionally, the aircraft enters the predetermined MSL FLOOR, which has been previously set on the ALOW DED (Data Entry Display) page.

Once all the above conditions are met, a flashing rectangular box containing the phrase "CHECK ATTITUDE" will appear on all MFD formats of both displays (See picture on the right side).

To ensure a level video image display on the Targeting Pod (TGP) MFD formats, continuous roll stabilization is automatically applied during TGP operations. This feature aligns the video image horizon horizontally, resulting in the image accurately reflecting the aircraft's attitude only when the aircraft is flying with level wings. However, this constant upright image can lead to a narrowed focus on the TGP format, potentially causing a loss of awareness of the aircraft's attitude.

The attitude advisory is deactivated or turned off when any of the previously mentioned conditions are no longer met. If desired, the attitude advisory function can be disabled by setting the MSL FLOOR value to zero feet. The default color of the "Check Attitude" box is red, but other colors can be loaded via Data Transfer Cartridge (DTC).



ATTITUDE ADVISORY FUNCTION

The MSL FLOOR altitude parameter of the Attitude Advisory Function can be entered by the pilot on the DED ALOW page. Access to the ALOW page can be achieved by selecting the numeral "2" (ALOW) on the ICP priority button.

2.2 COMMUNICATIONS, NAVIGATION AND IDENTIFICATION

In this section, we will explore the placement and purpose of various components within the aircraft's cockpit. These include the Upfront Controls (UFC), the Communication system, the Navigation system, the Identification Friend or Foe (IFF) system, and their respective controls and displays.

2.2.1 UPFRONT CONTROLS (UFC)

The Integrated Control Panel (ICP) houses the Upfront Controls (UFC), which are responsible for accessing commonly used data related to weapons delivery, Communication, Navigation, and Identification (CNI). When accessing the ICP, the data retrieved is displayed on the Data Entry Display (DED). Further details regarding weapons delivery data will be discussed in the upcoming paragraphs. For more comprehensive discussions on CNI, please refer to the relevant system description or consult the TO 1F-16CMAM-1 BMS documentation.

2.2.1.1 UFC SYSTEM DESCRIPTION

The Upfront Controls (UFC) encompass three main components: The Integrated Control Panel (ICP), the Data Entry Display (DED), and the Pilot Fault List Display (PFLD). These UFC components effectively streamline and automate the functions related to communication, navigation, and identification (CNI). The UFC system is designed with a clear partitioning strategy, placing frequently used controls on the ICP while reserving less frequently used controls for the side consoles. Important functions such as override and priority are conveniently accessed through a single pushbutton on the ICP. The DED serves to display relevant data for the selected CNI function, while the Pilot Fault List Display is a dedicated screen that informs the pilot about the status of avionics, flight controls, and engine systems. The PFLD displays pages such as the pilot fault list and a page specifically for MMC failure.

2.2.1.1.1 UPFRONT CONTROL SET

The UFC consists of the following Line-Replaceable Units (LRU):

- Data entry display
- Pilot’s fault list display
- DED/PFLD power supply
- Integrated Control Panel (ICP)
- Common Data Entry Electronics Unit (CDEEU)

2.2.1.1.1.1 DATA ENTRY DISPLAY AND PILOT’S FAULT LIST DISPLAY

The upper right glareshield houses the Data Entry Display (DED), while the forward right console C DF ,positioned above the caution panel (DR on the instrument panel), accommodates the Pilot Fault Display (PFLD). These devices, controlled by the CDEEU, are designed to be easily readable in high-ambient light conditions. The DED and PFLD have the capacity to display up to five rows of alphanumeric characters and symbols, with each row accommodating up to 24 characters. Their display screens consist of a high-resolution dot matrix, containing 64 pixels per linear inch. Overall, the display surface encompasses 192 columns by 64 rows of pixels, providing a visually detailed interface. Communication with the CDEEU occurs through three 1-MHz serial-digital multiplex buses.

2.2.1.1.1.2 DED/PFLD POWER SUPPLIES

The power supply for the DED/PFLD system transforms the aircraft's power into the necessary DC voltages to operate the DED. Each forward C DF and aft DR crew station on the aircraft is equipped with a dedicated power supply for both the DED and the PFLD.

2.2.1.1.1.3 INTEGRATED CONTROL/INTEGRATED KEYBOARD PANEL

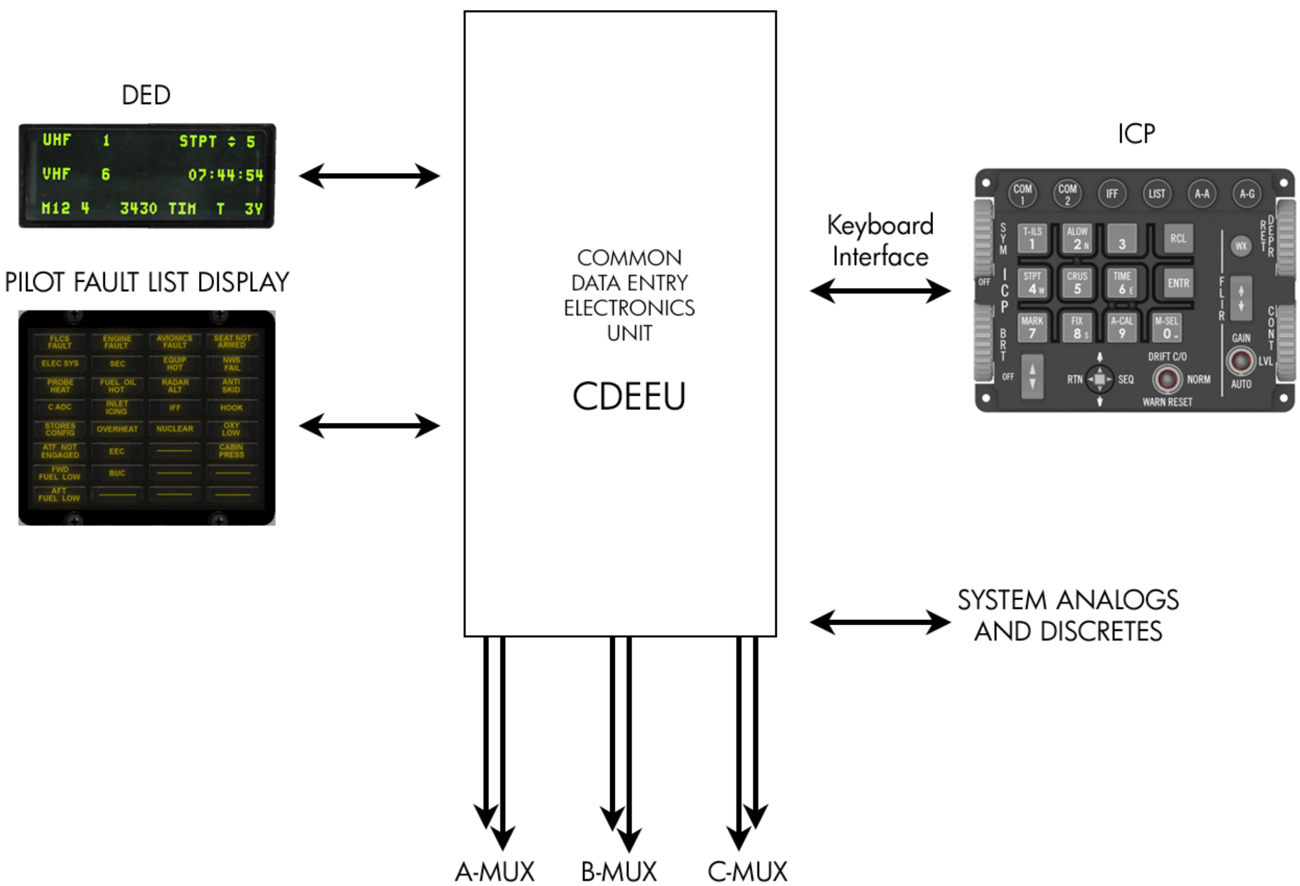
Display information and data entry are efficiently managed through the Integrated Control Panel (ICP), conveniently positioned just below the HUD (Head-Up Display) for easy accessibility using either hand. The Control Display Electronics Interface Unit (CDEEU) receives separate inputs from the ICP and the caution panel.

2.2.1.1.1.4 COMMON DATA ENTRY ELECTRONICS UNIT

The Common Data Entry Electronics Unit (CDEEU) is a microprocessor-based computer responsible for managing control signals to the CNI (Communication, Navigation, and Identification) equipment, data transmission to the DED/PFLD, as well as control and entry data across the multiplex buses within the avionic system.

The UFC (Upfront Controls) is capable of receiving data and control inputs for the CNI equipment even when the equipment itself is powered off. This data is stored in non-volatile memory to ensure the maintenance of current status as required. However, in cases where the UFC power is cycled and the aircraft backup battery voltage drops below 2.4 volts, the current data will not be preserved, and the data will revert to default values.

In case of a DED/PFLD failure, the HUD (Head-Up Display) control panel allows for the viewing of DED/PFLD data on the HUD itself, serving as a backup capability. Similarly, if the CDEEU experiences a malfunction, the backup control for IFF (Identification, Friend or Foe) transponder modes 1, 3/A, 4, and S can be provided by the IFF Control panel. Furthermore, the Have Quick panel offers backup UHF control.



Common Data Entry Electronics Unit

2.2.1.2 INTEGRATED CONTROL PANEL (ICP)

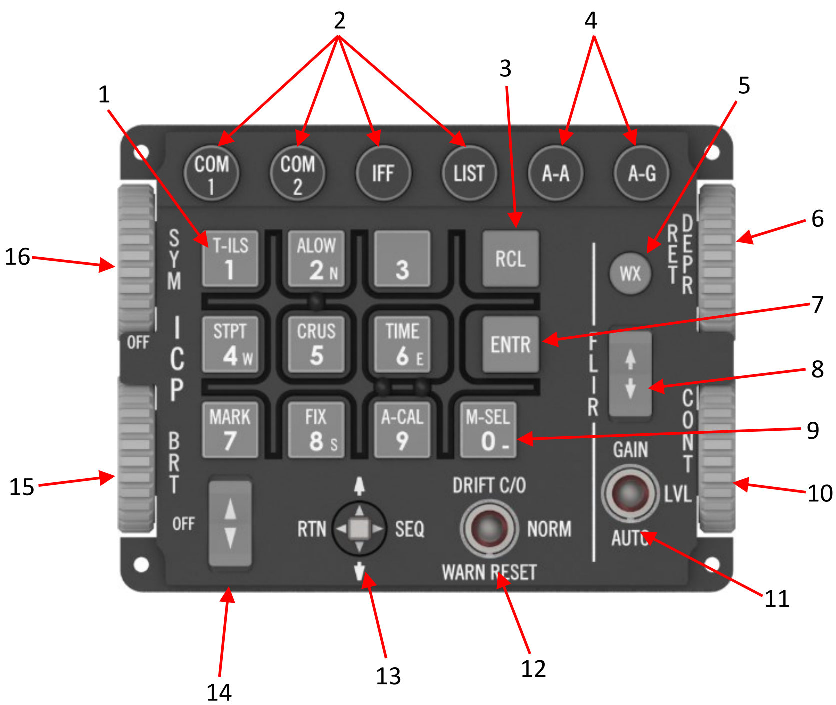
The Integrated Control Panel (ICP) is divided into four primary functional groups, each serving a specific purpose:

1. Master mode pushbuttons: These switches enable the selection of air-to-air and air-to-ground fire control modes with a single press, providing quick access to the desired mode.

2. Override pushbuttons: With these switches, the current Data Entry Display (DED) page can be overridden. They allow for the selection of frequently used functions or a menu of less commonly used functions, as well as providing a swift return to the previously overridden page.

3. Priority pushbuttons: When the CNI (Communication, Navigation, and Identification) page is displayed, these switches allow for the direct selection of frequently used functions, ensuring quick and convenient access.

4. Other UFC switches: This category encompasses a range of switches with various functionalities, including rotary operation, mode selection, increment/decrement functions, data entry, recall capabilities, and error response handling. These switches provide versatile control options for different operations and responses within the UFC system.



1. PRIORITY FUNCTION BUTTONS (1-9) AND NUMERIC KEYBOARD (1-9)
2. OVERRIDE BUTTONS
3. RECALL (RCL) BUTTON
4. MASTER MODE BUTTONS
5. WEATHER BUTTON
6. RETICLE DEPRESSION CONTROL (N/I)
7. ENTER (ENTR) BUTTON
8. FLIR GAIN ROCKER SWITCH
9. MODE SELECT (M-SEL) BUTTON AND ZERO (0) NUMERIC KEY
10. RASTER CONTRAST KNOB
11. FLIR GAIN/LEVEL SWITCH
12. DRIFT CUTOUT/WARN RESET SWITCH
13. DATA CONTROL SWITCH (DCS)
14. DED INCREMENT/ DECREMENT SWITCH
15. RASTER BRIGHT (BRT) KNOB
16. HUD SYMBOLOGY INTENSITY KNOB

ICP functions

2.2.1.2.1 MASTER MODE PUSHBUTTONS

At the top of the ICP, there are two buttons specifically designated for selecting master modes. In the absence of an override mode being engaged through manual controls, the air-to-air or air-to-ground master modes can be chosen simply by pressing the corresponding button. When one of these master modes is selected, the aircraft's avionics system is instantly configured to align with the relevant attack mode profiles and displays. Pressing the same button again will deselect the master mode. If no master mode is selected, the system will default to the navigation (NAV) mode. The master mode pushbuttons are responsible for activating the following master modes:

- Air-to-air combat
- Air-to-ground attack

2.2.1.2.2 ICP OVERRIDE PUSHBUTTONS

The override buttons serve as dedicated controls for high-priority data entry functions, allowing for quick and convenient access and exit. Pressing an override button replaces the current display on the Data Entry Display (DED) with the corresponding display linked to the button being pressed. Pressing the same button again deselects the override display and restores the previously overridden display. In cases where one override page replaces another, the display will prioritize the Communication, Navigation, and Identification (CNI) page upon deselection of the override function.

The override buttons activate the following data entry functions:

- COM 1: Controls related to Communication 1
- COM 2: Controls related to Communication 2
- Identification, friend or foe (IFF): Controls for IFF functions
- Mission preparation and seldom-accessed data entry page menu (LIST): Enables access to mission preparation tasks and infrequently used data entry page menu.

2.2.1.2.2.1 LIST SELECTABLE FUNCTIONS

The LIST page serves as a platform for accessing infrequently used fire control and CNI functions, which are essential for mission preparation. To access the LIST page, simply press the LIST override pushbutton. The LIST page provides the following functions:

LIST	1	DEST	0-1	CORR
	2	BINGO	0-2	MAGV
	3	VIP	0-3	OFP
	4	NAV	0-4	INSM
	5	MAN	0-5	LASR
	6	INS	0-6	GPS
	7	EWS	0-7	DRNG
	8	MODE	0-8	BULL
	9	VRP	0-9	WPT
	RCL	INTG	0-RCL	HMCS
	ENTR	DLNK	0-ENTR	-
	0	MISC	0-0	HARM

ICP – List of functions

2.2.1.2.3 PRIORITY FUNCTION PUSHBUTTONS

The ICP offers nine priority buttons specifically designed for accessing commonly used in-flight functions. When a priority button is pressed, granting access to the corresponding priority function page, the ICP can be utilized for data entry or to select the next item in a rotary control. These priority buttons provide convenient and quick access to frequently utilized functions during flight operations.

1. T-ILS (see T-ILS page)
2. ALOW (see ALOW page)
3. DTS (see DTS page)
4. STPT (see STPT page)
5. CRUS (see CRUS page)
6. TIME (see TIME page)
7. MARK (see MARK page)
8. FIX (see FIX page)
9. ACAL (see ACAL page)

2.2.1.2.4 DATA CONTROL SWITCH (DCS)

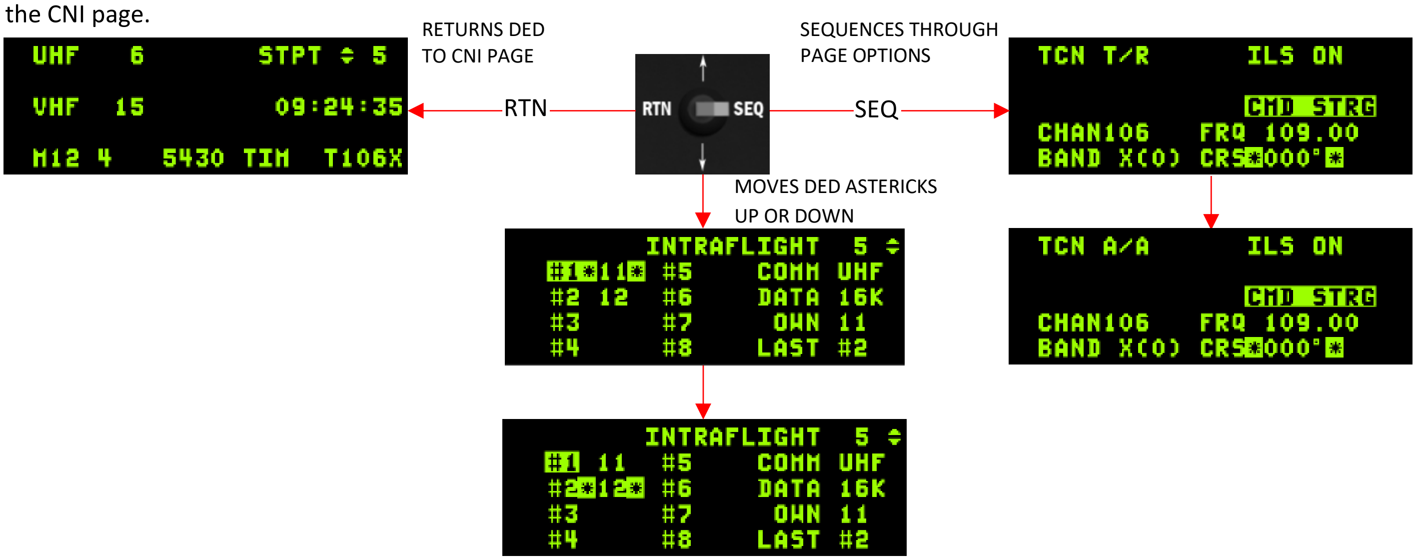
The DCS (Display Control Switch) oversees several functions, which include:

1. Adjusting the positioning of DED (Data Entry Display) asterisks.
2. Enabling page sequencing capability.
3. Providing access to CNI (Communication, Navigation, and Identification) pages.
4. Accessing wind direction and velocity information on the CNI page.

Note: The DCS is commonly referred to as the "Dobber."

The positioning of DED asterisks is limited to enterable data or selectable options and is controlled exclusively through the DCS. By moving the DCS up or down, the asterisks can be shifted from one option to another. Alternatively, holding the DCS up or down allows for sequential navigation through the options. The asterisks wrap around from one end of the page to the other. For example, when the asterisks are near the top of the page, moving the DCS up is the quickest way to select the last option at the bottom of the page.

To select page options, the DCS can be positioned to "SEQ." When a page title corresponds to a subordinate page, positioning the DCS to "SEQ" triggers the display of the next subordinate page. Additionally, positioning the DCS to "RTN" always grants access to the CNI page.



ICP – Data Control Switch functions

2.2.1.2.5 OTHER ICP SWITCH FUNCTIONS

Once the LIST and priority function pages have been accessed, additional ICP switch functions become accessible to manage various operations. These functions include rotary-based option selection, mode selection, data incrementing or decrementing, data entry, and the ability to recall errors.

2.2.1.2.5.1 ROTARY OPERATION

Rotaries consist of non-numerical options. When a rotary contains page title options related to high-priority functions, these options can be viewed by positioning the DCS to SEQ. To select an option, the asterisks need to be positioned around the rotary mnemonic, and any ICP key 1-9 should be pressed.

2.2.1.2.5.2 MODE SELECTION

The M-SEL (mode selection) pushbutton allows the selection of options that are not automatically chosen when displayed on the DED (Data Entry Display). Mode selections typically trigger special displays or computations in other displays and subsystems. To make a mode selection, the DED asterisks need to be positioned around the option mnemonic, and the M-SEL pushbutton should be pressed. The selected option is highlighted on the DED to indicate the choice. The process of deselecting an item follows the same procedure as mode selection, and upon deselection, the highlight is removed. If, for instance, the cruise energy management function's cruise range option is mode selected, the RNG mnemonic on the CRUS RNG page will be highlighted. If the RNG mnemonic fails to highlight when the M-SEL pushbutton is pressed, it indicates that the request for the cruise range option was rejected by the controlling subsystem.

In the cockpit, one or more options may be preselected or set through the mission load of the DTE (Data Transfer Equipment). These preselected options are automatically chosen when accessed later on.

2.2.1.2.5.3 DED INCREMENT/DECREMENT SWITCH

The rocker switch for incrementing/decrementing controls commonly accessed data, such as radio presets and steerpoint numbers. On the DED, this data is indicated by an upward-pointing triangle positioned above a downward-pointing triangle. Pressing the upper or lower half of the switch increases or decreases the identified data item respectively. The switch can be pressed repeatedly to increment or decrement the data in steps, or it can be held to smoothly cycle through the data items as desired. In either case, the data item wraps around from one extreme to the other. For instance, the COM1 and COM2 presets can be continuously incremented beyond preset 20 and wrap back to preset 1.

Typically, only a single item on a page can be incremented or decremented. However, on the CNI page, it is possible to increment or decrement multiple items such as COM1 presets, COM2 presets, and steerpoint numbers. By adjusting the DCS (Data Control Switch) upward or downward, the increment/decrement symbol can be positioned among these options. In cases where the presets are not selectable (for example, when a manual frequency is selected or the radio is turned off), if the increment/decrement symbol is positioned on either UHF or VHF, it will be displayed, but the switch will be non-functional.

2.2.1.2.5.4 ENTER (ENTR) BUTTON

Once data is inputted into the DED (Data Entry Display), the data can be entered into the avionic system by pressing the ENTR button.

2.2.1.2.5.5 RECALL (RCL) BUTTON

Before pressing the ENTR button, if the keyed-in data needs to be rejected and the last valid data recalled, the RCL button can be depressed. Pressing the RCL button once erases the last digit that was inputted. A second depression clears the entire entry field (in non-alphanumeric data entry) or moves the highlight one position to the left (in alphanumeric data entry). A third depression deletes the currently highlighted character (in the alphanumeric data entry method only).

2.2.1.2.5.6 UFC DATA ENTRY AND RECALL

When entering data on the UFC (Up-Front Controller), begin by placing the asterisks around the data entry field, then input the new data using the ICP (Integrated Control Panel), and finally press the ENTR pushbutton. Upon the first keystroke, the previous data is removed, and the field enclosed by the asterisks is highlighted, displaying the newly entered data on the DED (Data Entry Display). Prior to pressing the ENTR pushbutton, you can select RCL to erase the last digit entered. Subsequent use of RCL clears all data displayed in the scratchpad (for non-alphanumeric data entry only). If ENTR has already been pressed, RCL will clear the data entry field, allowing for a new entry to be made. If the currently displayed page is an override page that has replaced another override page, or if the data entered on the page can be verified from the CNI page, pressing the ENTR button will automatically display the CNI page. If an override page is selected or deselected after data entry but before pressing ENTR, the previous data will be recalled, and the data entry highlight will be removed. Please note that once a data entry error occurs, the asterisks cannot be moved.

Certain fields only accept a specific number of digits. Keystrokes beyond the maximum field capacity are ignored. For example, when entering elevation values, only five digits and a sign can be inputted. Additional keystrokes will not be accepted by the system. When entering frequencies on the COM1 and COM2 pages, three or more digits must be entered. The system assumes a trailing zero if not entered (For UHF and VHF frequencies, the DED is programmed to automatically fill in the sixth digit as either a 5 or a 0 based on the fifth digit entered). However, leading zeroes are considered valid. If the data being entered is signed, preceded by symbols such as minus (- [M-SEL]), north (N [2]), south (S [8]), east (E [6]), or west (W [4]), the corresponding pushbutton must be depressed before entering the numerical value. If the data is not signed, a positive value is assumed. It's important to note that the data entry field will be blank and not accept any data entry if the supporting subsystem is malfunctioning or if power is disconnected.

2.2.1.2.5.6.1 UFC ENTRY PARAMETERS

- AN/ARC-164 UHF frequencies from 225.000 to 399.975 MHz in 0.025 MHz steps;
- AN/ARC-164 UHF preset channels from 1 to 20;
- AN/ARC-164 Have Quick net numbers 000 to 999; (Training net numbers/Combat net numbers);
- AN/ARC-186 VHF frequencies from 30.00 to 87.97 MHz in 0.025 MHz steps for FM and from 108.00 to 151.97 MHz in 0.025 MHz steps for AM. (The avionic system provides support for the ARC-186R VHF radio with a 8.33 KHz channel spacing (0.005 MHz steps));
- AN/ARC-186 VHF preset channels from 1 to 20;
- AN/ARC-210 frequencies between 30.000 and 87.975 MHz in 0.025 MHz steps for FM modulation only; between 108.000 to 117.975 MHz in 0.025 MHz steps for AM modulation (receive only);

- ILS frequencies from 108.10 to 111.95 MHz in alternating 0.05 and 0.15 MHz increments;
- ILS course from 0° to 359°;
- TACAN channels from 1 to 126;
- IFF mode 1 code from 00 to 73, with the last digit from 0 to 3;
- IFF modes 2 and 3 code from 0000 to 7777 octal;
- Mode S Address between 1 and 16,777,214. Mode S address is either one of the following: between 1 and 77777776 (Octal), 1 and FFFFFE (Hex) or consists of all 9's ("99999999", Decimal);

- Mode S Aircraft ID consisting of 8 alphanumeric characters (blanks are allowed at the end of the Aircraft ID, but not between other characters);
- Steerpoint number from 1 to 99;
- Destination number from 1-25, 31-99;
- Markpoint number from 26 to 30;
- Visual initial point number from 1 to 25;
- Visual release point target number 1 to 25;

- Offset aimpoint, initial point, or reference point ranges from 0 to 486,090 feet, 0 to 80.000 nautical miles, or 0 to 148.16 kilometers;
- Offset aimpoint, initial point, or reference point elevations from -30,480 to 30,480 meters or -99,999 to 99,999 feet;
- Bullseye point numbers between 1 and 99;
- Various Steerpoint pages' latitudes from 90 degrees 00.0000 minutes north to 90 degrees 00.0000 minutes south (four decimal places (ten-thousandths of a minute)), with minutes limited to 59.999 for all points;
- Various Steerpoint pages' longitudes from 180 degrees 00.0000 minutes east to 180 degrees 00.0000 minutes west (four decimal places (ten-thousandths of a minute)), with minutes limited to 59.999
- System altitude from -1500 to 80,000 feet;
- Bearings from 0.0 to 359.0 degrees;
- TGP and LST Laser codes between 1111 and 2888 with the first digit limited to 1 or 2, and the last three digits limited between 1 and 8;
- Laser start time between 0 and 150 seconds;
- Range Estimate Overlay 0-99,999 feet, 0-30,479 meters, 0-30.47 kilometers, and 0-16.45 nautical miles;
- Altitude low limit from 0 to 50,000 feet;
- Wingspan from 20 to 120 feet;
- Date in MM/DD/YY format, where MM is the month and is between 01 and 12, DD is the day and is between 01 and 31, and YY is the year and is between 87 and 99 or 00 and 47;
- System time from 00:00:00 to 23:59:59 hours, with minutes and seconds limited to 59;
- Time-over-steerpoint (TOS) between -23:59:59 and +23:59:59 with minutes and seconds limited to 59. A negative TOS entry will be blanked;
- Hack time between 00:00:00 and 23:59:59, with minutes and seconds limited to 59;
- Groundspeed from 0 to 1700 knots;
- Heading from 0 to 359 degrees;
- EGI Manual Magnetic Variation between 90.0° east and 90.0° west;
- Data link ownship address from 01 to 99 excluding multiples of 10;
- MIDS TOD entries between 00:00:00 and 23:59:59 with minutes and seconds limited to 59;
- Link 16 Fighter Channel (FC) between 0 and 126;
- Link 16 Mission Channel (MC) between 0 and 127;
- Link 16 Special Channel between 0 and 126;
- Link 16 Voice Call Sign number between 01 and 99;
- Link 16 Voice Call Sign Label entries consist of characters AA, AB, AC,...ZZ only;
- Link 16 Team Member and Donor selection on DED (STN) from 00000 to 77776 (excluding 00077, 00176, 00177, 07777);
- Track number values for the 5 character format - the first two digits can be alphanumeric excluding the alpha characters I and O, and the digits 8 and 9. The remaining 3 digits are numeric 0 to 7 inclusive;
- Link 16 Ownship number between 1 and 4;
- "LINK 16 STN" DED Page PDLT from 0 to 8 for auto PDLT operations;
- Ownship address entries consist of alphanumeric characters 0, 1, 2,....9, A, B, C,...,Z only;
- Intraflight data link team address between 00 to 99 excluding multiples of 10;
- Intraflight Team Size between 2 and 8;
- Data link point number between 71 and 80;
- Data link transmit address between 0 and 99;
- HARM threat table entries between 0 and 4,095;
- Chaff, Flare, Other 1, Other 2 bingo values each between 0 and 99;
- Burst Quantity between 0 and 20;
- Burst Interval between 0.005 and 10.000 seconds in 0.001 second increments;

When there is invalid data present, the field containing the data and all DED data on the HUD (Head-Up Display) will flash to indicate errors. Before entering or modifying data or selecting new pages (excluding override pages), the RCL (Recall) pushbutton must be pressed. Prior to pressing the ENTR pushbutton, if there is keyed-in data that needs to be rejected and the last valid data recalled, the RCL pushbutton can be depressed. Pressing the RCL pushbutton once erases the last digit that was inputted, and a second depression clears the entire entry field (for non-alphanumeric data entry only).

2.2.1.2.5.6.2 ALPHANUMERIC ENTRY MECHANIZATION

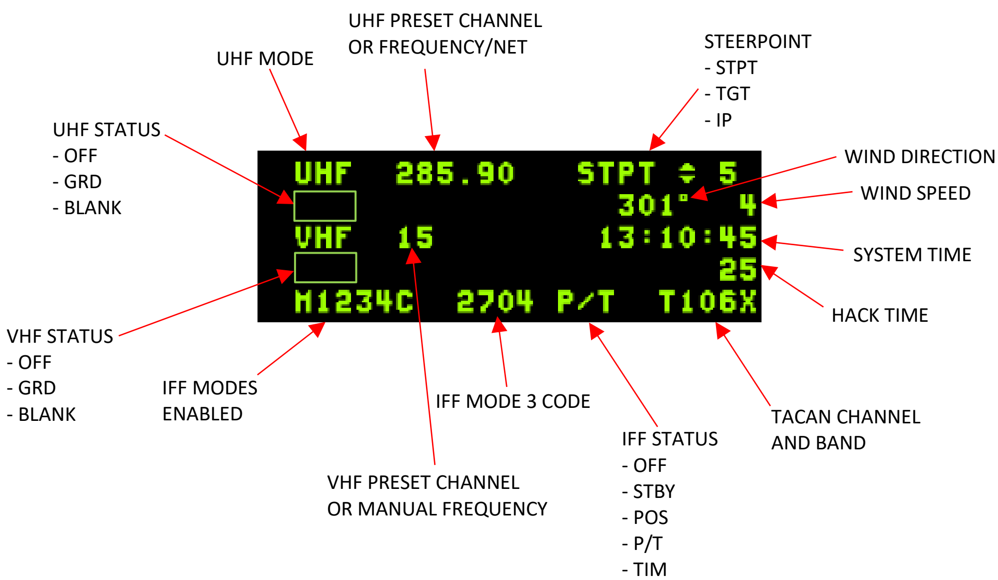
Data entry for the listed DED pages follows a similar pattern to that of a cell phone. Each ICP key, from 0 to 9, corresponds to a specific set of characters, consisting of a number followed by a series of letters. Pressing a key once cycles through the characters one at a time, and when the end is reached, the rotary wraps around to the beginning.

- Mode S Page (Aircraft ID)
- A-G DL Page (Transmit and Ownship Address)
- STPT/DEST Pages (Nav Point ID)
- Markpoint Page (Nav Point ID)

2.2.1.2.6 DED PAGES

The Integrated Control Panel (ICP) is used to access the various display formats of DED (Data Entry Display). The CNI page serves as the main DED page, providing access to most other pages. The ICP offers two primary modes of access: Override and Priority Function pushbuttons. Override functions are high-priority data entry functions that can be accessed directly from any DED page by pressing one of four override pushbuttons: COM1, COM2, IFF, or LIST. On the other hand, the priority function pushbuttons are only active when the CNI (base) page is being displayed.

2.2.1.2.6.1.1 CNI (BASE) PAGE



DED – CNI Base page

The Communication, Navigation, and Identification Data Entry Display (DED) page, known as the CNI page, serves as the default page for the DED. It provides comprehensive information related to the current radio settings for COM1 and COM2 radios, the active steerpoint, current time, IFF mode and codes, as well as the active TACAN or DME when A/A TACAN is engaged.

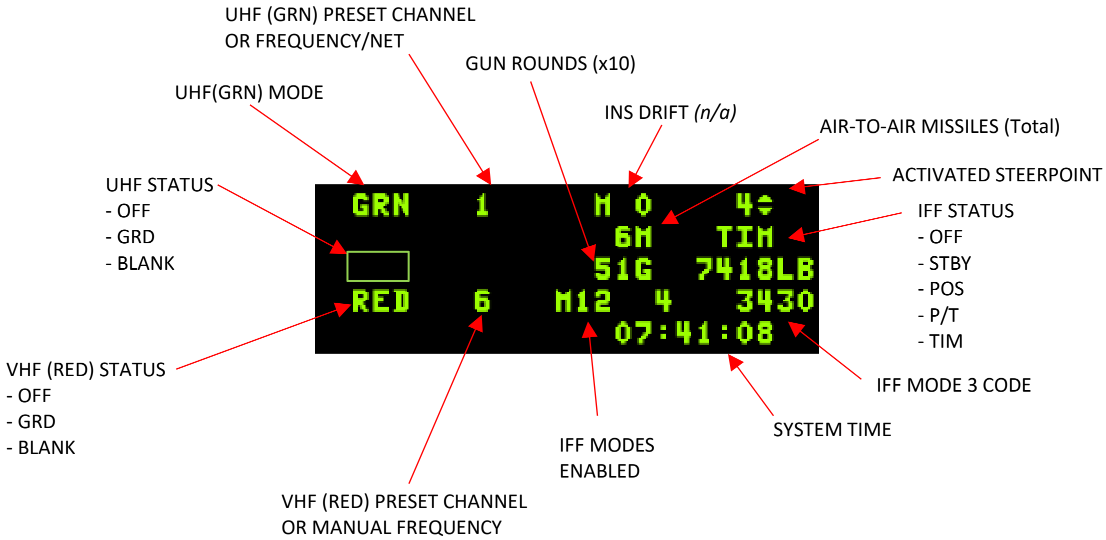
Access to the CNI page is limited to when the CNI switch on the AUX COMMS panel is set to UFC (Up-Front Controller). In the BACKUP position, the UFC becomes non-operational, and all backup systems are activated and controlled from the side consoles.

The presence of the up and down arrow on the steerpoint displayed on the CNI page is worth noting. This indicates that the current steerpoint can be adjusted incrementally or decrementally using the PREV/NEXT button on the Integrated Control Panel (ICP), located on the left side of the Display Control Switch (DCS). This convenient functionality allows for seamless editing of fields without having to navigate away from the CNI page. Similar to the scratchpad, the arrows can be used to cycle through editable fields by moving the DCS up and down.

By moving the DCS to the right and setting it to SEQ on the CNI page, the current wind speed and direction will be displayed on the Data Entry Display (DED). However, it's important to note that reliable wind data is only available when sufficient airflow is supplying information to the probes. Since there is no wind indication available on the ground, it is recommended to request a wind check from air traffic control (ATC) or refer to the Automatic Terminal Information Service (ATIS) for accurate wind information.

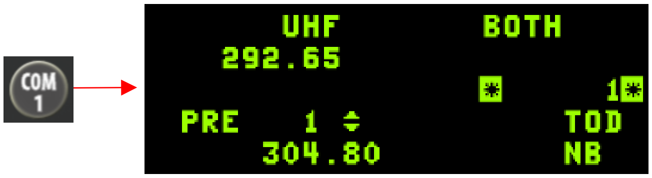
The system time, presented in ZULU format, is constantly displayed on the CNI page. If a hack time is activated, the hack clock will be shown below the system time. For more details on time-related settings, please refer to the TIME subpage.

2.2.1.2.6.1.1.1 SUFA/BARAK CNI (BASE) PAGE



DED – CNI Base page SUFA/BARAK

2.2.1.2.6.1.2 COM1 PAGE



For information about UHF, refer to the ULTRA-HIGH FREQUENCY (UHF) RADIO chapter in this document.

2.2.1.2.6.1.3 COM2 PAGE

For information about UHF, refer to the VERY HIGH FREQUENCY (VHF) RADIO chapter in this document.

2.2.1.2.6.1.4 IFF PAGE

For information about IFF, refer to the Identification Friend or Foe (IFF) chapter in this document.

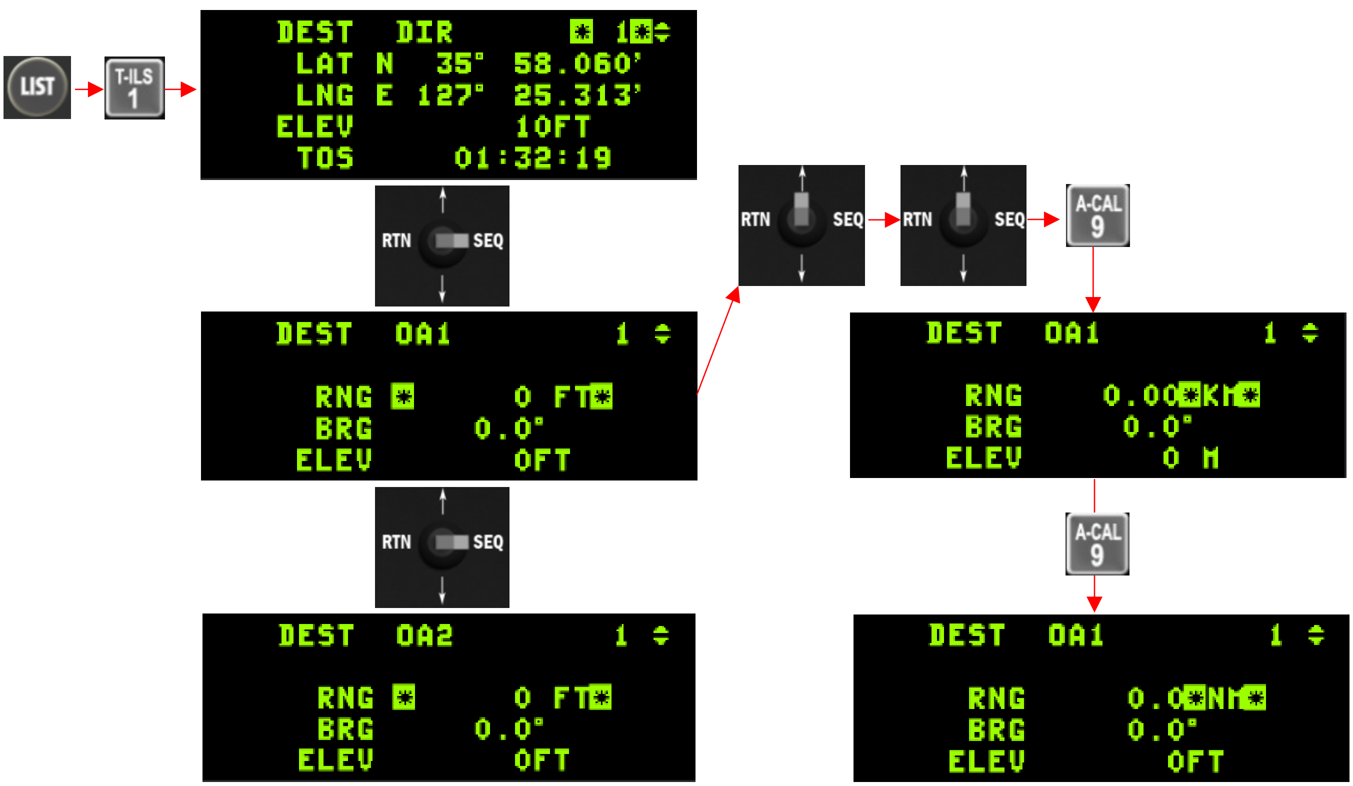
2.2.1.2.6.1.5 LIST PAGE

To access the following DED pages, simply press the corresponding ICP pushbutton while on the LIST page.

2.2.1.2.6.1.5.1 LIST PAGE (SUFA)

For the F-16I Sufa, the process to enable the LIST page is as follows:

2.2.1.2.6.1.5.2 DEST PAGE

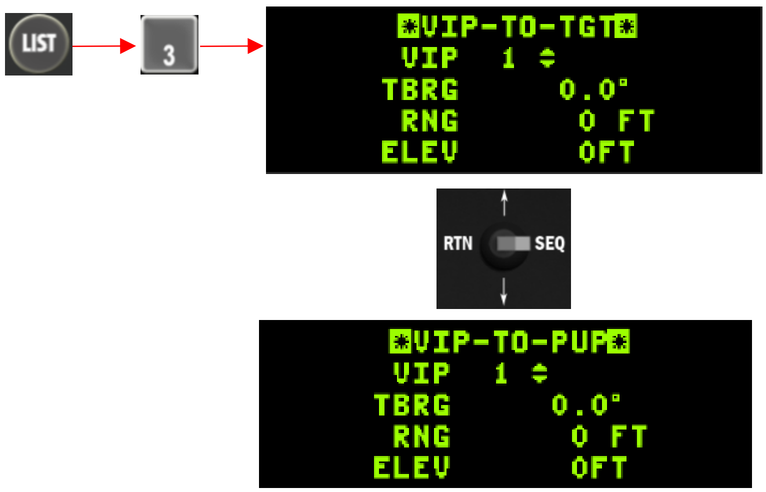


For information about the DEST page, refer to the DESTINATION PAGE DISPLAY chapter in this document.

2.2.1.2.6.1.5.3 BINGO PAGE

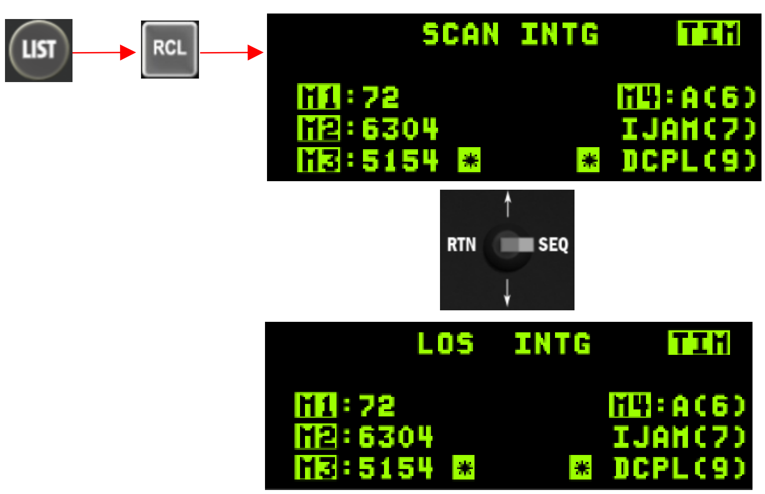
For information about the BINGO page, refer to the chapter FUEL WARNING FUNCTION in this document.

2.2.1.2.6.1.5.4 VIP PAGE



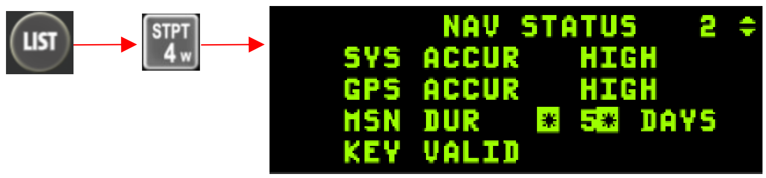
For information about the VIP page, refer to the chapters VISUAL INITIAL POINT SIGHTING (VIP) and POP-UP POINT (PUP) CUE in this document.

2.2.1.2.6.1.5.5 INTG PAGE



For information about the INTG (IFF Interrogation) page, refer to the chapter Identification Friend or Foe (IFF) in this document.

2.2.1.2.6.1.5.6 NAV PAGE



At present, the NAV page remains non-functional despite the complete implementation of the NAV system in BMS.

2.2.1.2.6.1.5.7 MAN PAGE

The MAN page serves the purpose of fine-tuning the GUN EEGS (Gun Electronic End Game System) funnel width setting for cannon firing. The desired setting is inputted in feet and should correspond to the wingspan of the intended target. By default, the value is set to 35 feet and can be adjusted through DTC (Data Transfer Cartridge) settings and also in WDP (Weapon Delivery Planner). Below of this chapter, a table displays commonly used aircraft wingspan values.

Aircraft	***Span (ft)***	***Aircraft***	***Span (ft)***
A-10	58	Mig-21	24
F-111	48	Mig-23	37
F-14	51	Mig-25	46
F-15C/E	43	Mig-29	36
F-16	31	Mig-31	46
F-18C/F-18E|F|G	38/42	Su-24	44
F-4	39	Su-25	51
F-5	27	Su-27/30/33/34/35	42

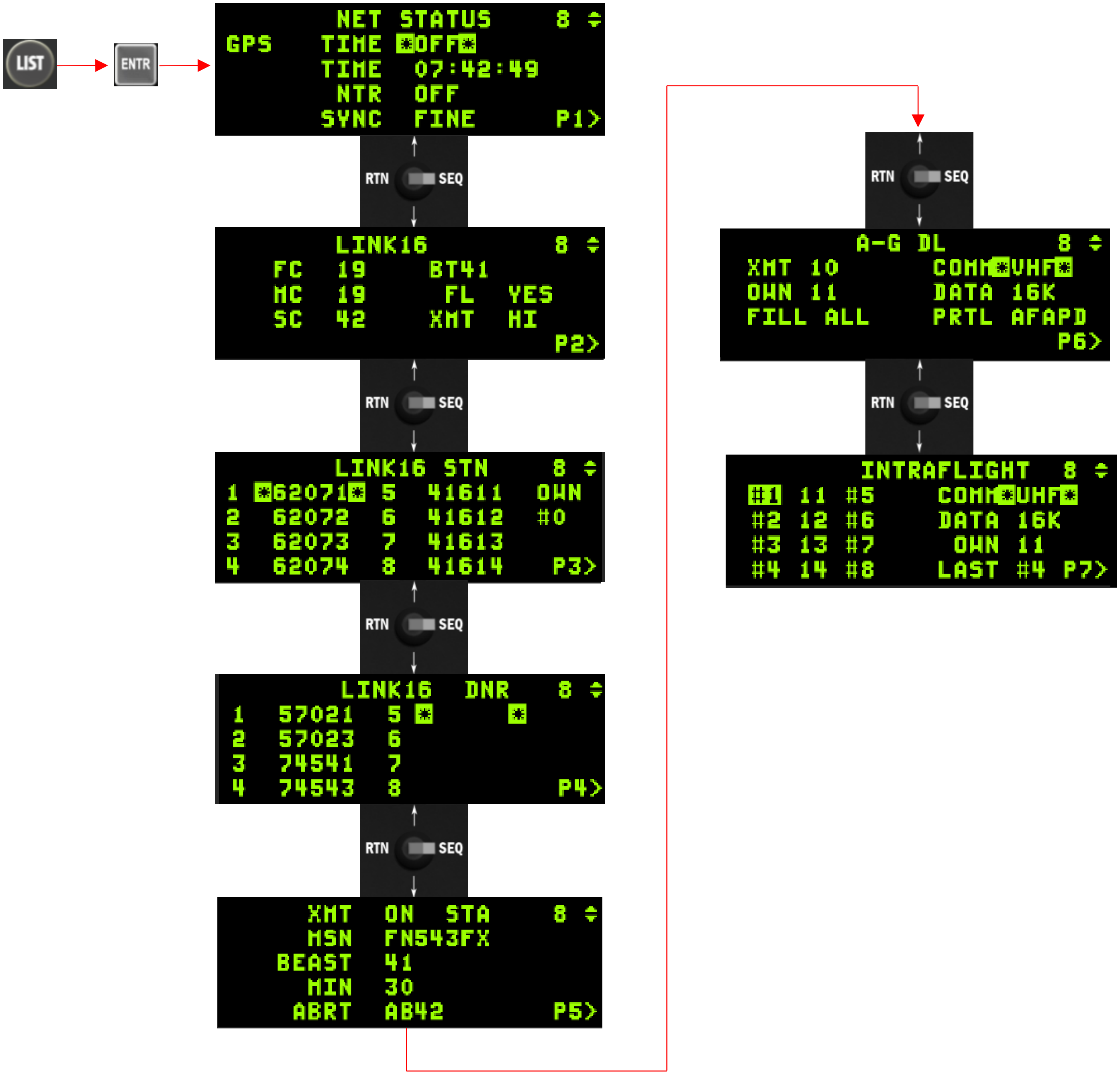
MAN page data

Refer to the chapter GUNSIGHTS for further information.

2.2.1.2.6.1.5.8 INS PAGE

For information about the INS page, refer to the GPS/INS NAVIGATION SYSTEM (EGI) chapter in this document.

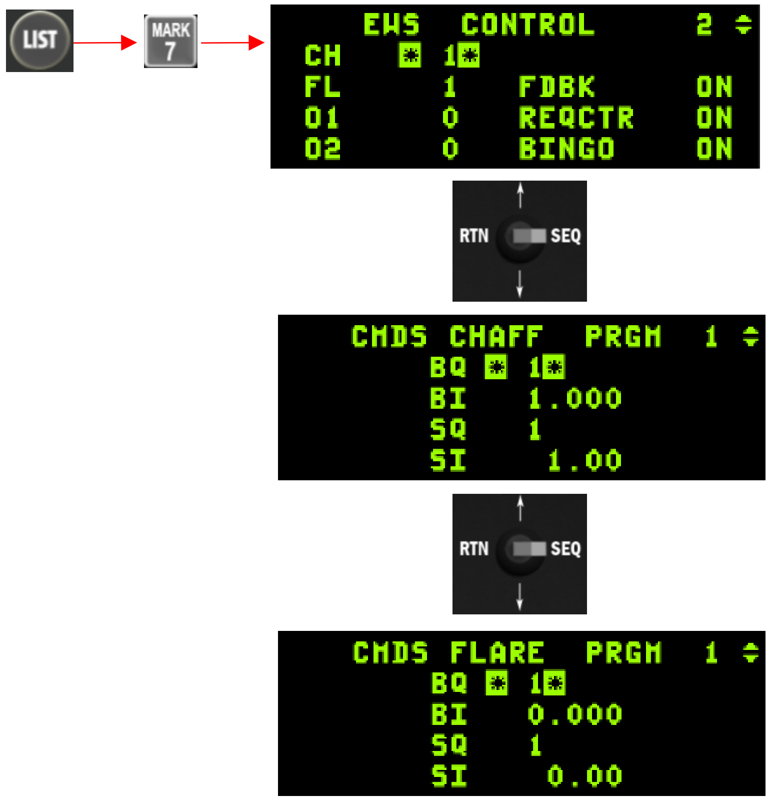
2.2.1.2.6.1.5.9 LINK 16 AND IDM PAGES



For information about the Link 16 pages, refer to the Link 16-DED Pages chapter in this document.

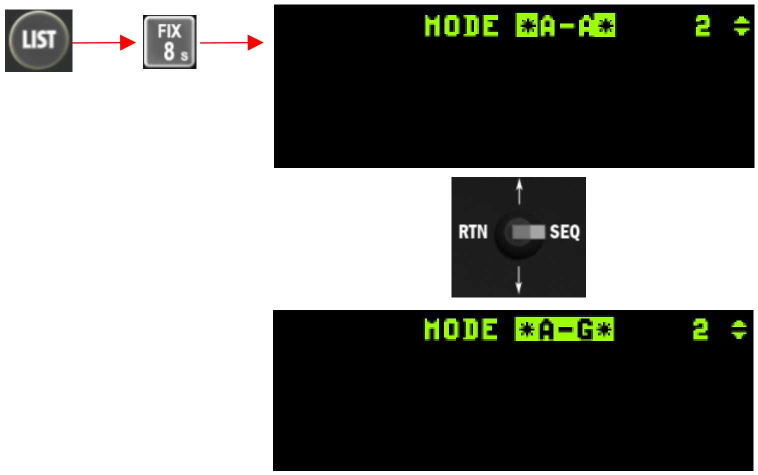
For information about the DLNK (Datalink) pages, refer to the IDM chapter in this document.

2.2.1.2.6.1.5.10 EWS PAGE



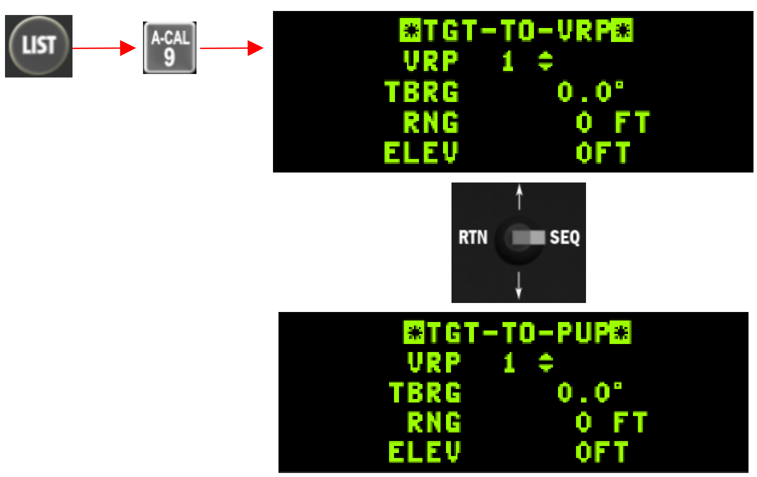
For information about the DLNK (Datalink) page, refer to the EWS DED UPFRONT CONTROLS chapter in this document.

2.2.1.2.6.1.5.11 MODE PAGE



The MODE page offers an alternative method for adjusting the Master Mode without relying on the ICP buttons. By moving the Display Control Switch (DCS) to SEQ, the Master Mode can be toggled, and its activation can be confirmed by selecting it using the M-SEL 0 key. In cases where neither Air-to-Air (A-A) nor Air-to-Ground (A-G) modes are selected, the NAV mode will be set as the default.

2.2.1.2.6.1.5.12 VRP PAGE

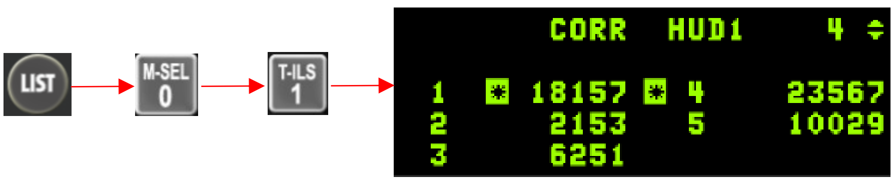


For information about the VRP page, refer to the chapters VISUAL REFERENCE POINT SIGHTING (VRP) and POP-UP POINT (PUP) CUE in this document.

2.2.1.2.6.1.5.13 MISC PAGES

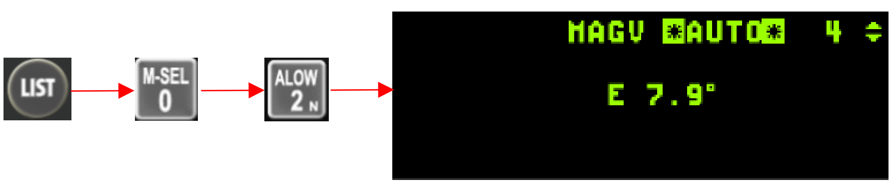
To access the following DED pages, simply press the corresponding ICP pushbutton while on the MISC page.

2.2.1.2.6.1.5.13.1 CORR PAGE



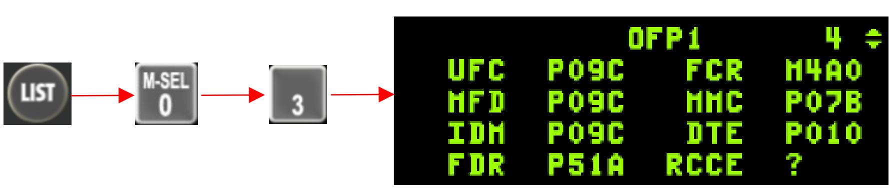
At present, the CORR (Correlation) page remains non-functional.

2.2.1.2.6.1.5.13.2 MAGV PAGE



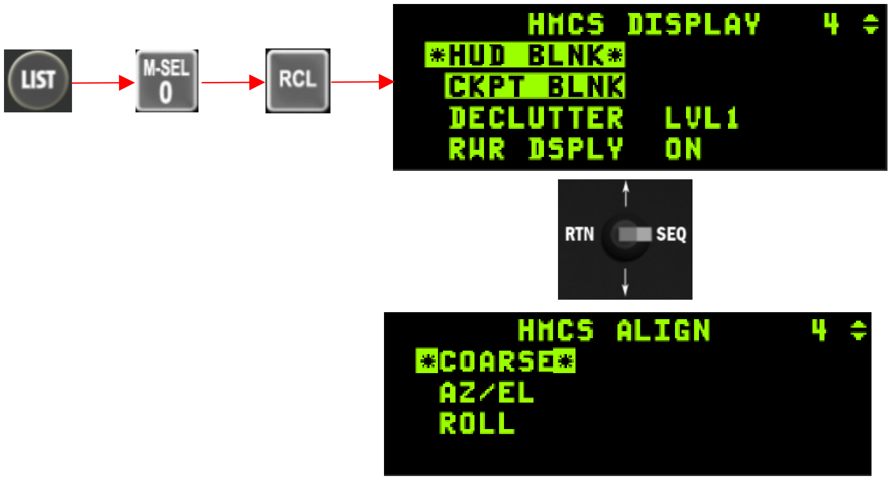
The displayed information represents the current Magnetic Variation (MAGV) at the aircraft's location. This data is utilized in BMS to rectify any potential errors in INS (Inertial Navigation System) navigation. Currently, this correction is implemented automatically through the program's code.

2.2.1.2.6.1.5.13.3 OFP PAGE



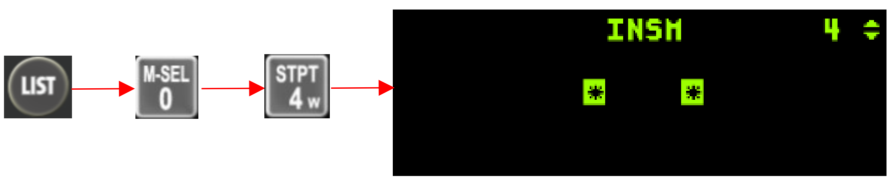
At present, the OFP (Operational Flight Program) page remains non-functional.

2.2.1.2.6.1.5.13.4 HMCS PAGE



For information about the VIP page, refer to the chapter HELMET MOUNTED CUEING SYSTEM (HMCS) in this document.

2.2.1.2.6.1.5.13.5 INSM PAGE



At present, the INSM (Inertial Navigation System Memory) page remains non-functional.

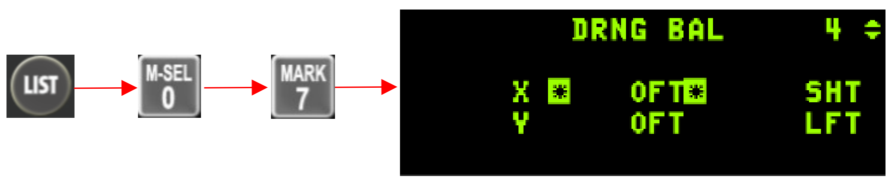
2.2.1.2.6.1.5.13.6 LASER PAGE

For information about the VIP page, refer to the LASER DESIGNATOR/RANGER chapter in this document.

2.2.1.2.6.1.5.13.7 GPS PAGE

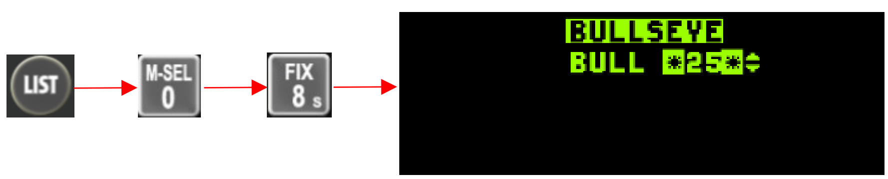
At present, the GPS (Global Positioning) page remains limited functional and provides zulu time, the current date, ground speed (G/S) and magnetic heading of the aircraft. The information is only displayed when “GPS” on the “Avionics Power Panel” is activated.

2.2.1.2.6.1.5.13.8 DRNG PAGE



At present, the DRNG (Delta Bomb Range) page remains non-functional.

2.2.1.2.6.1.5.13.9 BULL PAGE



This page allows you to manage the Bullseye system.

By default, Bullseye is assigned to STPT #25, but you have the option to change it to any steerpoint up to #25 using the PREV/NEXT ICP button.

The display of Bullseye information varies depending on whether BULLSEYE mode is selected or not. To toggle the mode selection, press M-SEL 0 when the scratchpad asterisks surround the 'BULLSEYE' text. By default, the mode is enabled.

When Bullseye mode is selected, the HUD (Head-Up Display) will show the bearing and range to Bullseye in the bottom left corner. However, when Bullseye mode is not selected, there will be no bearing and range indication to Bullseye in the HUD.

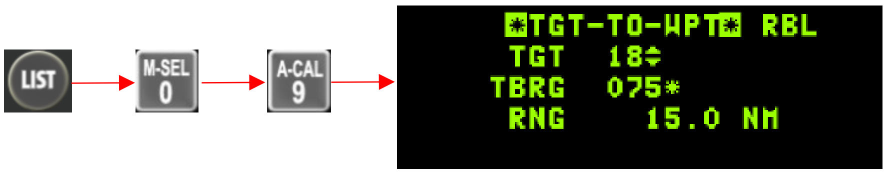
On the MFDs (Multi-Function Displays), specifically the FCR (Fire Control Radar) and HSD (Horizontal Situation Display) pages, the bearing and range information of the cursor position is displayed relative to the Bullseye position when BULLSEYE mode is selected. When BULLSEYE mode is not selected, the bearing and range are shown relative to the active steerpoint. It's important to note that this behavior may vary based on the aircraft's block, with newer blocks consistently displaying the flight director symbol even when BULLSEYE mode is selected. When BULLSEYE mode is not selected, the Bullseye symbol and circle will not be displayed on the MFDs. Instead, a waterline flight director symbol relative to the current active steerpoint will be shown.

For more information about MFD Bullseye information, refer to chapter BULLSEYE BEARING AND RANGE DATA.

Please be aware that when the distance to Bullseye exceeds 99 Nautical Miles, the distance will not be displayed inside the Bullseye circle on the MFD page. Only two digits will be shown.

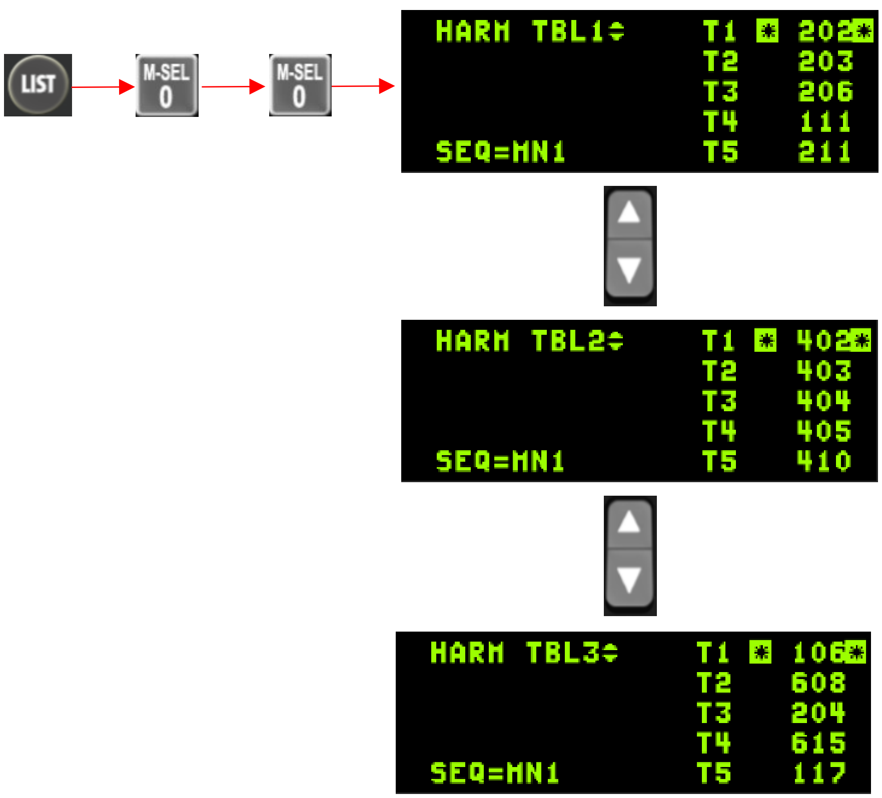
To maintain a clear understanding of the situational awareness during contact calls involving Bullseye bearing and range, it is advisable to have BULLSEYE mode selected, as it is the default setting.

2.2.1.2.6.1.5.13.10 WPT PAGE



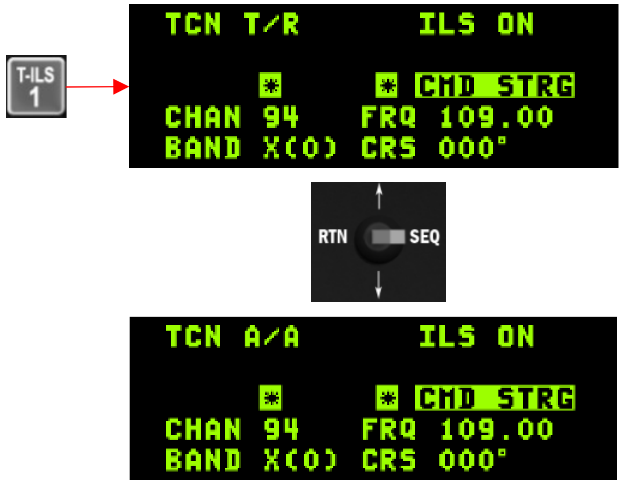
The TGT-TO-WPT page is specifically designed for managing Harpoon waypoints in RBL (Range Before Launch) mode. It is important to note that settings cannot be modified when accessing this page from the LIST page. For information, refer to the chapter AGM-84 HARPOON.

2.2.1.2.6.1.5.13.11 HARM PAGE



For information about the HARM page, refer to the HARM Threat tables chapter in this document.

2.2.1.2.6.1.6 T-ILS PAGE (1)



This chapter pertains to the TACAN (Tactical Air Navigation) and ILS (Instrument Landing System) DED settings. Access to these settings can be obtained through the T-ILS (Tactical ILS) button located on the ICP (Integrated Control Panel).

The first line displayed on the DED (Data Entry Display) provides information about the status of the TCN (TACAN) and ILS. The ILS can be turned on or off using the ILS knob located on the AUDIO 2 panel. The scratchpad, denoted by two asterisks, is positioned on the left side, and it is used for inputting TACAN and ILS frequencies. The system can differentiate between a valid TACAN channel (ranging from 0 to 126) and a valid ILS frequency (VHF, 4 or 5 digits). The following line displays the current active TACAN and ILS frequencies, while the last line indicates the TACAN band (X or Y) and the CRS (Course) set for the ILS approach.

To enter a new TACAN channel or an ILS frequency, simply input the relevant numbers within the asterisks and press the ENTR (Enter) key.

To change the TACAN band, input 0 (zero) in the scratchpad and press ENTR. This action toggles between X and Y bands.

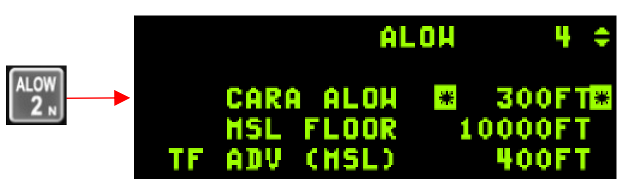
To switch the TACAN mode from T/R (ground domain) to A/A TR (air domain), utilize the DCS (Data Control Switch) SEQ (Sequence) button.

The activation or inhibition of ILS CMD STRG (Command Steering) can be achieved by placing the scratchpad over it and selecting the mode using the M-SEL 0 ICP pushbutton. The CMD STRG line in the DED is highlighted when command steering is active.

To modify the ILS course, position the scratchpad on the CRS field using the DCS up/down controls and enter the correct runway heading for the active ILS. Press ENTR to input the data into the system.

For information about the TACAN, refer to the TACAN chapter in this document.

2.2.1.2.6.1.7 ALOW PAGE (2)

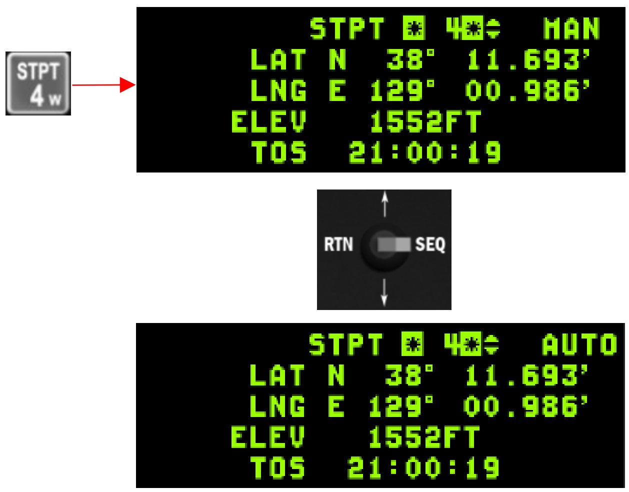


For information about the ALOW page, refer to the CARA Altitude LOW chapter in this document.

2.2.1.2.6.1.8 DTS PAGE (3)

At present, the DTS (Digital Terrain System) page remains non-functional.

2.2.1.2.6.1.9 STPT PAGE (4)



Pressing “4” on the ICP brings the pilot to the Steerpoint (STPT) page. The scratchpad asterisks will initially be at the top as seen above. The pilot may punch another number (4, ENTR) to select a different steerpoint as the current steerpoint. All steering cues will update to reflect the new selection (#4 in this example).

The pilot may “Dobber” down with the Data Control Switch (DCS) to each individual field on the page and edit it as desired: latitude, longitude, elevation and Time on Station (TOS). Note that while editing lat/long, the pilot will see immediate feedback from his steering cues (tadpole, STPT diamond, ETE/ETA, bearing/distance, etc.) in the HUD and in heads-down displays since the STPT he is editing is the current steerpoint. Elevation may be edited as well and it now functions like the real aircraft, i.e. it is the MSL elevation of the steerpoint at ground level. This is automatically set by the campaign/TE flight plan generator for any steerpoints set up in the UI.

The pilot may also toggle auto steerpoint sequencing (AUTO) on/off (MAN) by dobbering right (towards SEQ) on the steerpoint DED page. With auto steerpoint sequencing the system will automatically increment the steerpoint when the aircraft is within 2Nm of the steerpoint and the range is increasing. Auto steerpoint sequencing is indicated on the CNI page with a letter “A” displayed next to the current steerpoint.

2.2.1.2.6.1.10 CRUS PAGE (5)

The cruise energy management options provide different flight profiles for maximizing range, endurance, or fuel efficiency towards a chosen destination. Three fuel warnings (home, trapped, normal) are calculated separately regardless of the selected option. The DED (Data Entry Display) shows and allows selection of the following cruise options for time-over-steerpoint, range, home, and endurance via the rotary control:

- TOS: Time-over-steerpoint
- RNG: Range
- HOME: Home
- EDR: Endurance

The cruise pages can be accessed in any master mode, but the availability of steering cues is limited to specific modes. Fuel warnings and time-over-steerpoint cues are provided in all modes. However, the steering cues for the other cruise options are only accessible in NAV, emergency jettison, and selective jettison master modes.

Cruise pages and guidance cues are applicable to all 99 steerpoints. However, when a steerpoint represents a moving target, the reliability of the cruise energy management data decreases as the target's velocity increases.

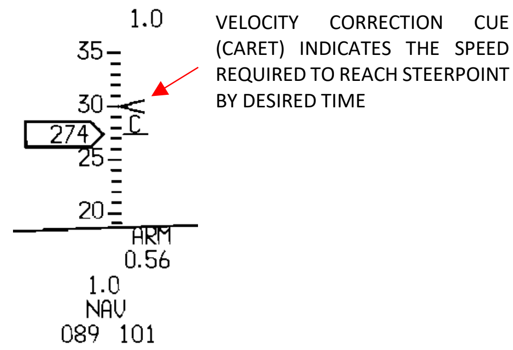
2.2.1.2.6.1.10.1 TIME-OVER-STEERPOINT CRUISE OPTION (TOS)

In the case of TOS mode selection, a caret symbol is shown on the HUD speed tape. It is crucial to adjust your airspeed to align with the caret in order to reach the designated steerpoint on time. Additionally, the Estimated Time of Arrival (ETA) to the steerpoint is displayed on the HUD.

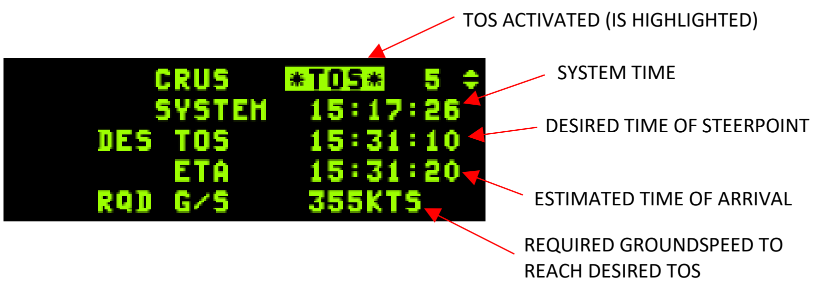
However, when TOS is not selected as the mode, there is no active caret on the HUD speed tape. Instead, the Estimated Time Enroute (ETE) is shown on the HUD.

To modify your TOS and assign a new value, simply enter the desired value in the scratchpad when the asterisks (*) are present around the DES TOS indicator.

The TOS page provides further details, including the current system time, ETA at the steerpoint, and the required ground speed to reach the steerpoint based on the indicated DES TOS value.



HUD – Velocity Correction Cue (Caret)

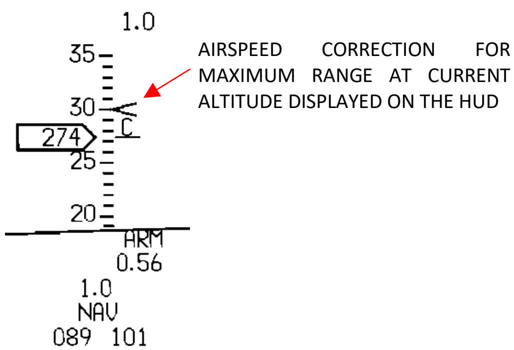


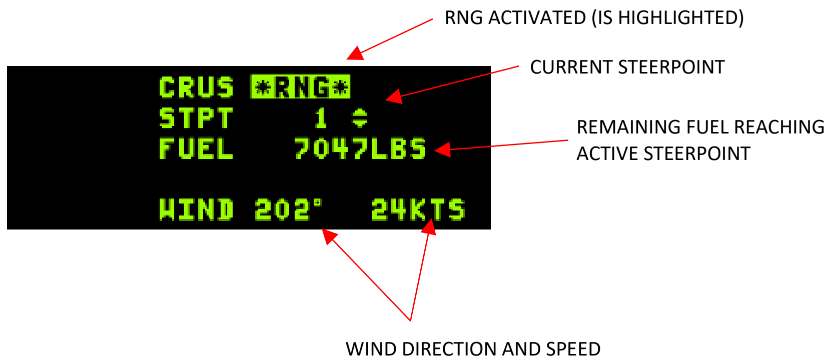
DED – Time-Over-Steerpoint page

2.2.1.2.6.1.10.2 RANGE CRUISE OPTION (RNG)

When the RNG (Range) mode is selected, a caret symbol is shown on the HUD speed tape. This caret represents the optimal airspeed for fuel conservation at the current altitude. It is important to note that the ideal speed for fuel efficiency varies with altitude.

On the other hand, when the RNG mode is not selected, the HUD speed tape does not display a caret symbol. In this mode, only the active steerpoint can be toggled on the subpage. Additional information available on this page includes the remaining fuel upon reaching the active steerpoint, as well as the wind direction and speed.



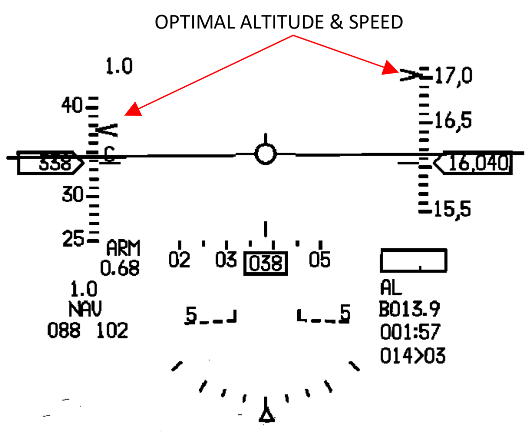


RNG indication for HUD and DED

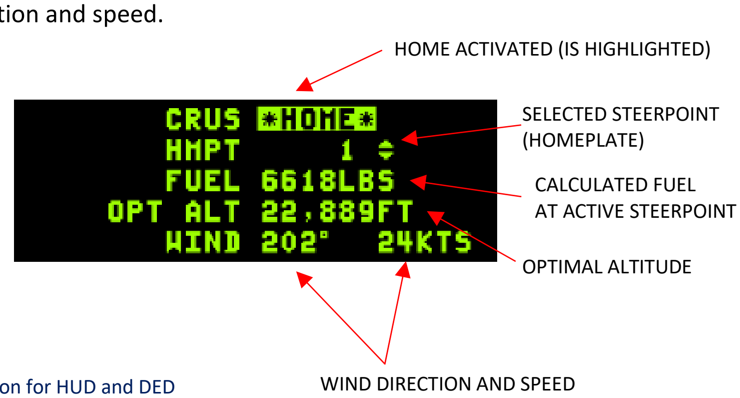
2.2.1.2.6.1.10.3 HOME CRUISE OPTION (HOME)

When the HOME mode is selected, two caret symbols are displayed on the HUD: one on the speed tape and another on the altitude tape. These two carets provide guidance to establish the optimal flight profile for reaching the designated Home Plate (or any steerpoint designated as HMPT).

To follow this profile, the recommended procedure is to select full military power, first reach the speed caret, and then adjust the pitch to reach the altitude mark while maintaining the speed indicated by the caret. It is important to note that the actual altitude may vary as fuel is consumed. The optimal altitude for the HOME profile is indicated in radar altitude on the DED, although it may differ on your HUD scale depending on the altimeter setting. In the provided picture, both carets are being followed, and the optimal altitude displayed in the DED matches the HUD radar altimeter. By following both carets, you will reach the home point at the selected optimum altitude. The altitude caret will disappear once the descent can be initiated.



Additional information displayed on this page includes the home point (which can be changed to any INS steerpoint, such as an alternate destination), the remaining onboard fuel quantity upon reaching the active steerpoint, the optimum altitude for the HOME profile, and the wind direction and speed.

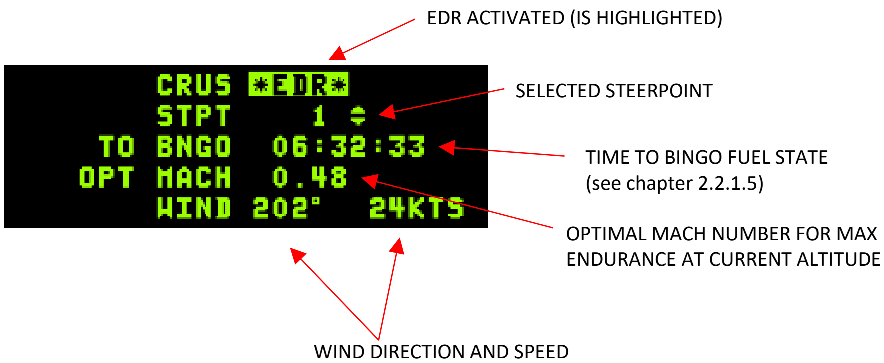


HOME indication for HUD and DED

2.2.1.2.6.1.10.4 ENDURANCE CRUISE OPTION (EDR)

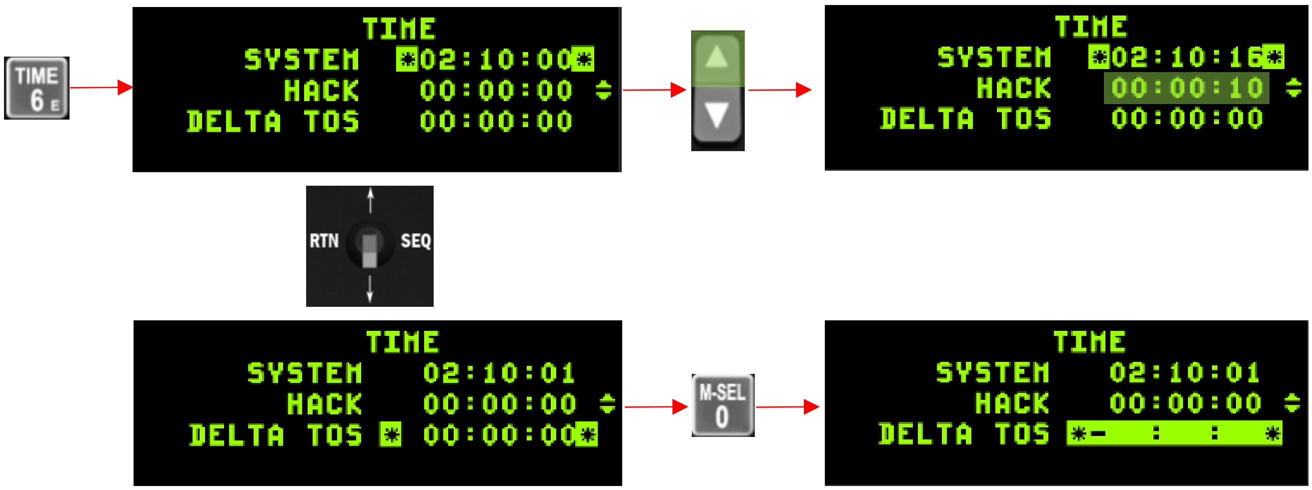
When the EDR (Endurance) mode is selected, a speed caret is displayed on the HUD tape, indicating the reference speed for achieving the best endurance at the current altitude. This feature proves particularly beneficial during holding patterns or when aiming for maximum endurance during a cruise. Additionally, the HUD provides supplementary information such as time to bingo, optimal Mach number, and wind direction with corresponding speed.

It is crucial to understand that when transitioning between different submodes, it is necessary to always select the new mode. Failure to do so may result in the caret being relevant to the previous CRUS submode. To avoid any confusion, it is essential to consistently mode select the appropriate submode.



EDR indication for DED

2.2.1.2.6.1.11 TIME PAGE (6)



The Time page includes the system time, a hack clock time and a delta time on station. The hack clock may be started or stopped by using the ▲▼switch. The DELTA TOS value allows you to adjust TOS to all destinations with one entry, to accommodate changes in takeoff and/or rendezvous times.

Dobber down to the DELTA TOS field and enter the delta time to any steerpoint. If required, press the 0- key prior to your entry to designate it as a negative value (i.e. you want to arrive earlier at all steerpoints). Press ENTR to apply the DELTA TOS to all TOS.

The CNI page on the right side displays the system time. If the GPS is operational, the system time and date will be initialized to the GPS time. When GPS time is being used, the TIME page does not allow for inputting system time and date.

When MMC power is removed, the system time and date are not displayed. However, upon MMC power restoration, the clock starts from the last known time, and the date starts from the last known date.

2.2.1.2.6.1.12 MARK PAGE (7)

For information about the TIME page, refer to the Markpoints chapter in this document.

2.2.1.2.6.1.13 FIX PAGE (8)

At present, the FIX (Fixtaking) page remains non-functional.

2.2.1.2.6.1.14 ACAL PAGE (9)

At present, the A-CAL (Altitude calibration) page remains non-functional.

2.2.1.3 FUEL WARNING FUNCTION

This function aims to alert the pilot regarding critical fuel conditions that demand immediate attention. The warnings encompass present fuel bingo, homepoint fuel bingo, trapped fuel, and fuel switch out of NORM conditions. For further details, refer to TO 1F-16CMAM-1 BMS for supplementary information.

2.2.1.3.1 BINGO WARNINGS

Fuel and home bingo warnings are visually displayed on the HUD to alert the pilot. The bingo fuel option enables manual input of a specific bingo fuel value through the UFC. The warning is manifested through flashing "FUEL" letters in the center area of the HUD, "FUEL" displayed in the lower left corner of the HUD, and an audible voice message (BINGO, BINGO) from the VMU in the headset.

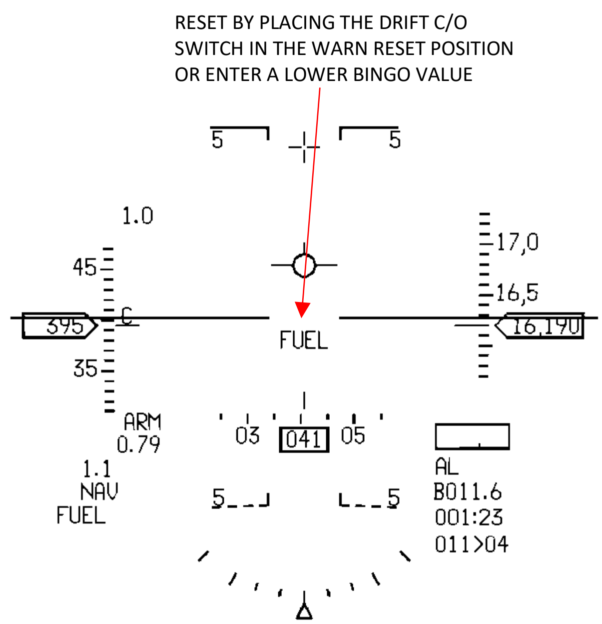
The trigger mechanism for the bingo warning is as follows:

When the FUEL QTY SEL knob is in NORM position, the bingo computation considers the lesser value between fuselage fuel weight and total fuel weight. Thus, if either the fuselage fuel or total fuel falls below the bingo fuel value, the bingo fuel warning is activated.

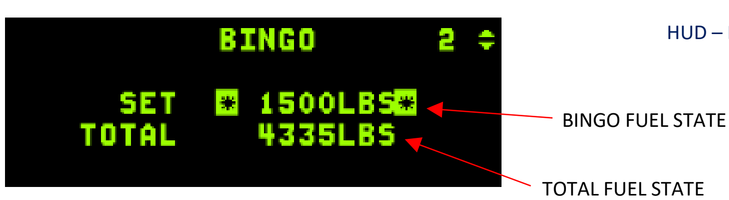
When the FUEL QTY SEL knob is out of NORM position, the warning is triggered only when the total fuel drops below the bingo value. However, it is important to note that if external fuel becomes trapped, there is a risk of fuel starvation before the bingo warning is activated (unless the "FUEL SW" caution provides timely alert to the pilot).

The home bingo warning is displayed when the predicted fuel remaining at the home point is less than 800 pounds. This is indicated by flashing "FUEL" letters (see picture on the right) in the center of the HUD, and the estimated fuel quantity above the home point is displayed in hundreds of pounds at the lower left of the HUD. In case both fuel and home warnings occur simultaneously, both the bingo "FUEL" mnemonic and the home point fuel estimate are displayed at the lower left of the HUD.

To reset the flashing "FUEL" mnemonic at the center of the HUD and the aural advisory, the DRIFT C/O switch should be positioned to WARN RESET. The desired bingo fuel value is typically set during mission preparation but can be adjusted during the flight through the DED.



HUD – Fuel warning



DED – BINGO page

2.2.1.3.2 TRAPPED FUEL

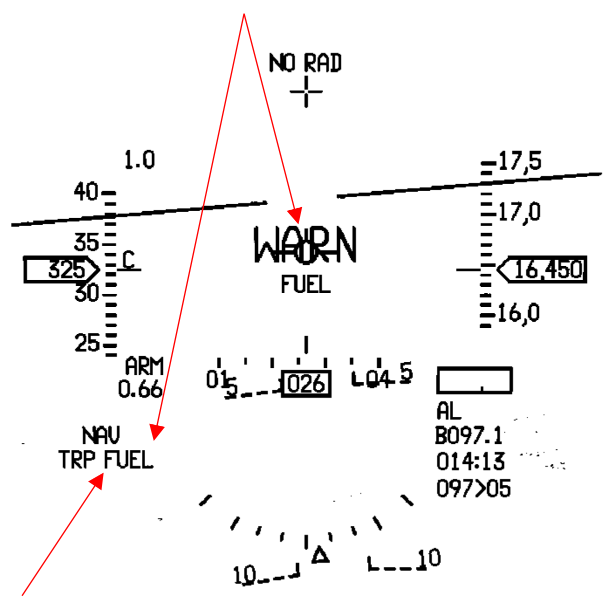
The MMC (Master Mode Computer) provides indications for trapped fuel. A TRP FUEL warning will be triggered only if the following five conditions are met:

- The FUEL QTY SEL knob is in the NORM position.
- Aerial refueling has not occurred within the past 30-90 seconds.
- The fuselage fuel level has remained at least 500 pounds below the fuselage capacity for 30 seconds.
- The total fuel level has remained at least 500 pounds above the fuselage fuel level for 30 seconds.
- The fuel flow has been below 18,000 pounds per hour (pph) for 30 seconds.

Please note that trapped fuel calculations are based on fixed values for fuselage fuel capacity: 5900 lbs for single-seat aircraft and 4600 lbs for dual-seat aircraft.

Additionally, a trapped fuel condition can occur if the aerial refueling door is open, causing depressurization of external fuel tanks and preventing fuel transfer into the internal wing tanks. Similarly, a malfunctioning fuel valve can also result in trapped fuel if it hinders fuel transfer.

The indications for trapped fuel on the MMC are a flashing "FUEL" in the center of the HUD and a flashing "TRP FUEL" in the lower left corner of the HUD (see picture on the right side). To reset the "FUEL" mnemonic, the DRIFT C/O switch should be positioned to WARN RESET. The "TRP FUEL" indication will be removed when the trapped fuel condition no longer exists or when the aircraft is refueled with at least 500 pounds of fuel. In the event of a power cycle for the MMC, any existing trapped fuel condition will be treated as a new trapped fuel condition, resulting in the flashing "FUEL" in the center of the HUD and "TRP FUEL" in the lower left corner of the HUD. It is important to note that the display of "TRP FUEL" takes precedence over other fuel warnings.



HUD – Trapped Fuel Warning

2.2.2 COMMUNICATIONS

2.2.2.1 F-16 COMMUNICATIONS

The F-16 aircraft in BMS is equipped with the following communication systems:

- AN/ARC 210 Dual Band Radio
- Improved Data Modem (IDM) – see chapter IDM
- Link 16 Multifunction Information Distribution System (MIDS) – see chapter Link 16

2.2.2.2 ULTRA-HIGH FREQUENCY (UHF) RADIO

By pressing the COM1 Integrated Control Panel (ICP) button, the UHF radio page is accessed. The first line of the page provides the current status, which in this case is set to BOTH (Preset & Guard), with a frequency of 304.800 MHz.

The scratchpad is available for entering a new frequency or a new preset. Presets can be configured through the user interface (UI). Alternatively, the UHF radio can be modified directly by using the ICP NEXT/PREV buttons. These buttons are accompanied by double arrows next to the number 4, indicating their functionality in changing the presets.

It is important to note that when the UFC (Up-Front Controller) UHF radio is set to BOTH, it can simultaneously listen to the GUARD frequency while transmitting and receiving on the preset frequency. However, by moving the Display Control Switch (DCS) to the right, the display will change from BOTH to MAIN, and the UHF radio will no longer receive the GUARD frequency unless it is tuned to 243.0 MHz.

2.2.2.3 VERY HIGH FREQUENCY (VHF) RADIO

Pressing the COM 2 Integrated Control Panel (ICP) button displays the VHF radio page. The first line provides the current status of the radio, which in this instance is set to ON, with the frequency assigned to preset 15. It is important to note that the UFC VHF radio is incapable of monitoring the GUARD frequency while operating on a preset. In order to listen to the GUARD frequency, it must be manually tuned to 121.5 MHz.

2.2.2.4 OPERATING PROCEDURES FOR FREQUENCY/PRESET SELECTION

To enter a new active frequency or preset number, follow these steps:

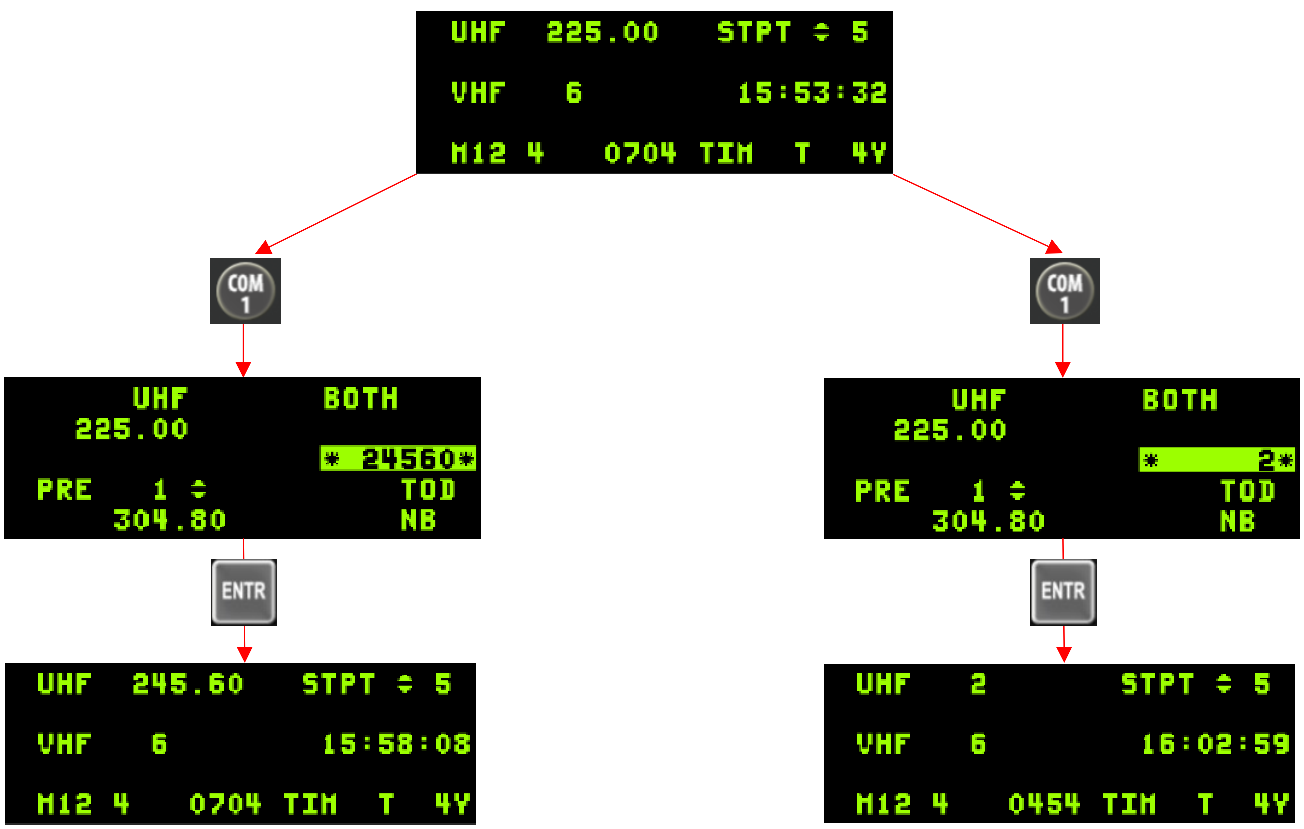
1. Press the COM 1 override pushbutton on the ICP (Integrated Control Panel) to display the COM 1 page on the DED.
2. Verify that asterisks are positioned around the scratchpad, indicating the previously active frequency or preset.
3. Enter the desired value using three digits for a frequency (trailing zeros are not necessary) or one or two digits for a preset number. Press the ENTR pushbutton. Confirm that the display returns to the overridden page. If the CNI (Communication, Navigation, and Identification) page is accessed, verify the active frequency or preset number.

To recall the previous active frequency or preset number, follow these steps:

1. Press the COM 1 override pushbutton on the ICP to display the COM 1 page on the DED.
2. Verify that asterisks are positioned around the scratchpad, indicating the previously active frequency or preset.
3. Press the ENTR pushbutton and confirm that the display returns to the overridden page. If the CNI page is accessed, verify the active frequency or preset number displayed.

To change the frequency associated with the displayed preset number, follow these steps:

1. Press the COM 1 override pushbutton on the ICP to display the COM 1 page on the DED.
2. Increment or decrement to the desired preset number.
3. Position the asterisks around the displayed preset frequency.
4. Enter the desired value and press the ENTR pushbutton.



UHF Frequency selection (Left side) | Preset selection (right side)

2.2.3 NAVIGATION

2.2.3.1 GPS/INS NAVIGATION SYSTEM (EGI)

The LN-260 Embedded GPS/INS (EGI) is a navigation system that combines an embedded Fiber Optic Gyro (FOG) INU and a SAASM (Selective Availability Anti-Spoofing Module) Embedded GPS Receiver (EGR) known as the GEM VI.

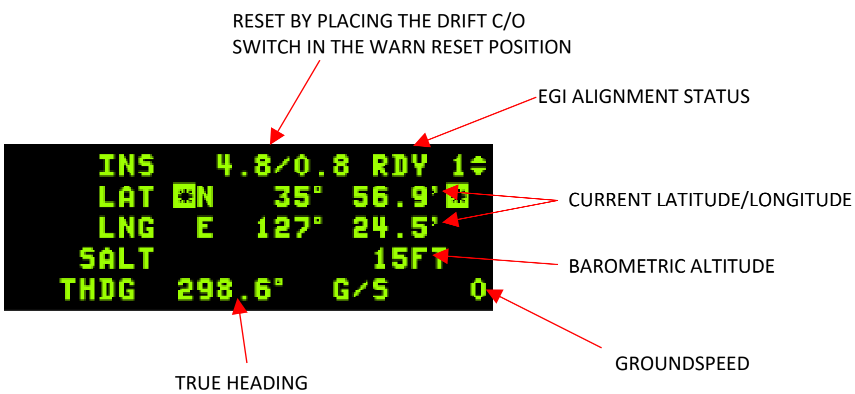
The EGI system employs GPS and INS to maintain an estimate of the aircraft's position, velocity, heading, attitude, and altitude. This estimate is referred to as the system navigation solution, which is obtained by blending the information from these two sources using a Kalman filter. By mathematically combining the data from these sensors, the Kalman filter enhances the accuracy of the aircraft's position estimate beyond what each sensor could achieve individually.

To ensure the accuracy of the navigation solution, the system incorporates INS performance model information in conjunction with GPS data to determine the drifting behavior of the INS. This approach allows the system to maintain accuracy even in situations where GPS information is lost/ or deactivated.

2.2.3.2 GPS/INS INITIALIZATION

Initializing the GPS receiver reduces the time required to track and acquire satellites. However, in the absence of initialization, the GPS receiver can still track satellites for an extended period as long as the antenna has an unobstructed view of the sky. It is necessary to initialize the GPS receiver in two scenarios: when the EGI battery is replaced and when the entire EGI system is replaced.

To access the INIT page, follow these steps: Select LIST-0 to access the MISC page, and then choose option 6.



INS Page

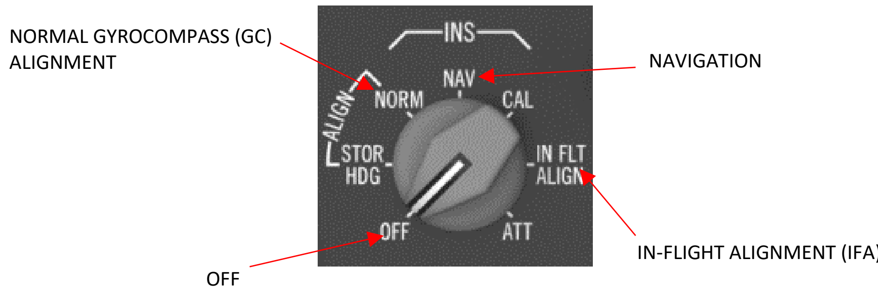
The INS page provides information about the Inertial Navigation System, consisting of five lines of data. The first line displays the status of the INS. Moreover, you can conveniently change the active steerpoint without leaving this page by using the NEXT/PREV ICP buttons.

The second line displays your current latitude, while the third line displays your current longitude. The following line presents your barometric altitude, and the last line shows your true heading and groundspeed. Groundspeed information is particularly valuable during taxiing as it provides the only means to access information about your taxi speed.

2.2.3.3 EGI ALIGNMENT

For precise navigation, it is necessary to align the EGI before taking off. The alignment data and progress can be viewed on the INS DED (List, 6) page. This page is displayed when the EGI function knob is set to an operating position. The pilot has access to the following EGI alignment methods:

- Normal Gyrocompass (GC) Alignment
- In-Flight Alignment (IFA)



EGI Knob Functions

2.2.3.3.1 NORMAL GYROCOMPASS (GC) ALIGNMENT

The normal gyrocompass alignment method enables the EGI to achieve a precise and wide-angle alignment based on manually and automatically input latitude and longitude values. This alignment process levels the inertial platform and calculates the true heading. To initiate the alignment and access the DED INS page, set the EGI function knob to NORM. The DED INS page displays the following data necessary for initializing the current position:

- Latitude (LAT)
- Longitude (LNG)
- System altitude (SALT)
- True heading (THDG)
- Time into alignment (first row, following INS)
- Alignment status code (first row, following the slash)
- RDY - Indicates the availability of degraded navigation performance (flashes to indicate full accuracy)

The EGI utilizes the present position latitude to determine the true heading using gyrocompass techniques. Typically, it takes approximately four minutes for the EGI to complete the alignment process. During alignment, the DED displays the time elapsed into the alignment and the alignment status code. As the alignment duration increases, the accuracy of the alignment improves, and the status code decreases accordingly.

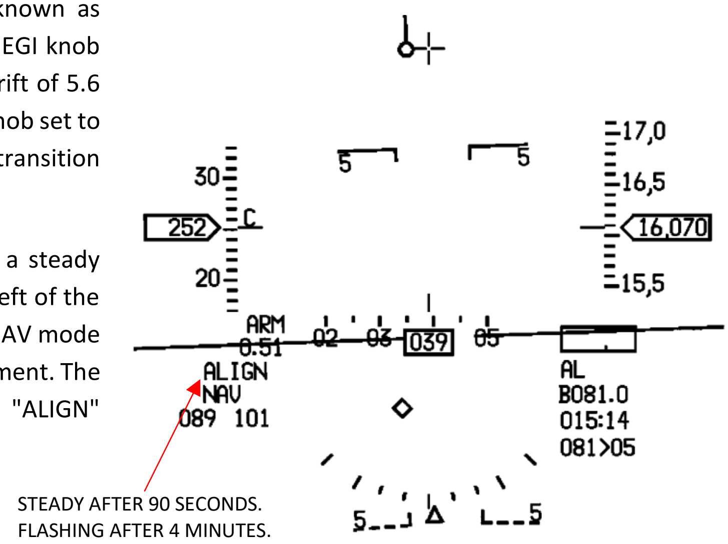
It's important to note that while the alignment status does not decrease after 4 minutes, remaining in an alignment state for a longer period (DED timer increasing beyond four minutes) can result in enhanced INS performance even without any further decrease in the alignment status.

EGI Function Selector	DED Timer	CEP	ACTIONS	DED “RDY” INDICATION	HUD INDICATION
NORM	0,0 min	10,0NM/hr	-	OFF	Max G
	0,3 min	Decreasing	ADI OFF flag retracts		
	1,5min	5,6NM/hr	ADI AUX flag retracts	RDY steady	“ALIGN” steady
	4,0 min	0,8NM/hr	Alignment complete, NARFing	RDY flashing	“ALIGN” flashing
NAV	4,0 min	0,8NM/hr	Full NAV performance	Off	Max G

Normal GC Status

Once 1.5 minutes have elapsed, the EGI enters a phase known as "degraded alignment." In this state, if the pilot switches the EGI knob to NAV, the free INS solution will experience a theoretical drift of 5.6 NM/hr. However, if the pilot engages in taxiing with the EGI knob set to NORM before achieving full NAV performance, the EGI will transition into the auto-IFA state.

During the standard GC alignment process, the DED shows a steady "RDY" mnemonic at the upper right corner, while the lower left of the HUD displays the "ALIGN" mnemonic. This signifies that the NAV mode can be selected, although it will result in a degraded INS alignment. The alignment process for achieving this steady "RDY" and "ALIGN" indication typically takes around 1.5 minutes.



HUD – Alignment status

2.2.3.3.2 IN-FLIGHT ALIGNMENT (IFA)

The EGI has the capability to conduct in-flight alignment (IFA) or realignment, whether the aircraft is stationary or in motion, by utilizing GPS data and all the available sensor information. This mode is supported by both Standard Positioning Service (SPS) and Precise Positioning Service (PPS) GPS signals.

Unless explicitly deselected, the IFA process will continue until the EGI Kalman filters project a free inertial accuracy that is equal to or surpasses the accuracy achieved through a standard ground gyrocompass (GC) alignment.

In-flight alignment (IFA) can only be accomplished when GPS assistance is available. It's important to note that during the time when the ALIGN mnemonic is displayed on the HUD, the INU data and the performance of related avionics subsystems are both degraded.

In cases where a degraded alignment (alignment status of 5.6 NM/hr) occurs, there is a possibility of targeting pod coordinate degradation due to blended solution inputs if the GPS solution is unreliable. If an auto-IFA occurs on the ground, it is advisable for the pilot to initiate another alignment. However, if an IFA is performed in-flight, it is recommended to wait until a full performance GC alignment status of 0.8 is achieved before utilizing the TGP (Targeting Pod) functionality (Maximum G and FPM values are displayed on the HUD). It's worth noting that engaging the laser for visual weapon guidance does not require a full performance GC alignment.

EGI Function Selector	Timer	CEP	ACTIONS	DED “RDY” INDICATION	HUD INDICATION
NORM	0,0 min	9,9NM/hr	-	OFF	STBY
	0,3 min	Start decreasing	ADI OFF flag retracts		
	4,0min	5,6NM/hr		RDY Steady	“ALIGN” steady
	15,0 min	0,8NM/hr	Full NAV performance	RDY flashing	“ALIGN” flashing
NAV				Off	Max G

IFA Status

2.2.3.4 GPS/INS MAGNETIC VARIATION

The displayed information represents the current Magnetic Variation (MAGV) at the aircraft's location. This data is utilized in BMS to rectify any potential errors in INS (Inertial Navigation System) navigation. Currently, this correction is implemented automatically through the BMS code.

2.2.3.5 STEERPOINT MANAGEMENT

2.2.3.5.1 NAVIGATION DATABASE

There are 1-99 possible steerpoints (STPTs) in BMS. They are broken down as follows:

STPT#	Usage
1-24	Navigation route / general flight planning
25	Bullseye (automatically assigned)
26-30	MARK Points created by the pilot
31-54	HSD lines (4 lines with up to **6** points in each line)
56-70	Preplanned threats (PPTs saved to DTC during preflight planning)
71-80	Datalink MARK points – large “X” (inverse video if selected)
81-99	Open

Steerpoint assignments

Steerpoint numbers 1-24 are regular flight planning ones for use in the Campaign or TE mission planning screen for an aircraft’s flight plan. Numbers 26-30 are reserved for MARK points created by the pilot.

The pilot may go to the Bullseye DED page (LIST 0 8) and select any steerpoint from 1-25 as bullseye, however the ‘normal’ campaign/TE bullseye is stored in STPT 25 by default. If the pilot chooses another steerpoint other than 25, AI aircraft and AWACS will *still* continue to use the BE as set by the campaign engine (i.e. the coordinates in STPT 25). Being able to select a specific steerpoint as your Bullseye is more useful for TE missions with human pilots involved, like Force on Force.

Note also that since all steerpoints can be edited in the STPT or DEST DED pages, you can overwrite your copy of the campaign Bullseye — be careful! For similar reasons, **do not** make flight plans with more than 24 STPTs.

STPT AUTO mode no longer wraps at the last STPT that is designated as part of your flight plan. The ▲▼arrows on the ICP will get you to any STPT from 1-99 as opposed to just those on your flight plan. Cycling to steerpoints not assigned will show all 0s in the latitude/longitude fields.

HSD lines now have up to 6 points available per line with 4 lines available.

2.2.3.5.2 DESTINATION PAGE DISPLAY

To access the destination pages, the pilot can utilize the LIST and 1 pushbuttons on the UFC (Up Front Controller). By toggling the DCS (Data Control Switch) to sequence and selecting the desired page, the pilot can easily view the UTM (Universal Transverse Mercator) and/or geodetic (latitude/longitude) coordinates in the desired format.

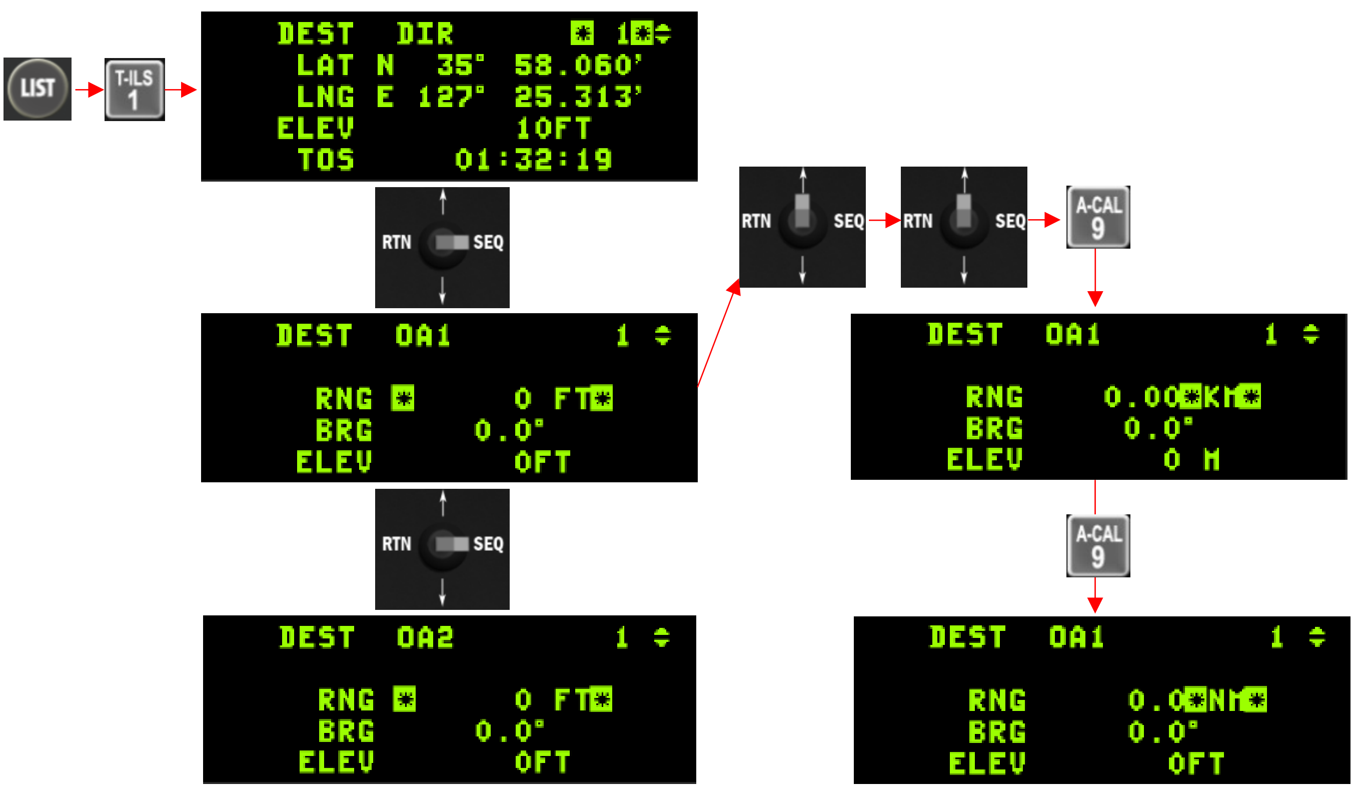
When the UTM DEST page is displayed, the pilot has the option to manually input 100,000-meter square, easting/northing offsets, and/or elevation. After conversion, toggling the DCS to sequence reveals the DEST DIR page, which displays the equivalent latitude/longitude coordinates. On the DEST DIR page, the pilot can manually enter the latitude, longitude, elevation, and time over steerpoint (TOS).

By further toggling the DCS to sequence through the OA1 and OA2 pages, the pilot can view the UTM DEST page with the corresponding UTM coordinates.

The DESTination page bears a resemblance to the STPT page, but with a key difference: modifying the coordinates of any steerpoint on the DEST page does not immediately impact the HSD (Horizontal Situation Display). In contrast, when altering a steerpoint on the STPT page, the changes take effect instantly since that specific steerpoint is active. The DEST page proves particularly useful for refining the precision of existing steerpoints or adding new ones.

Please note: Similar to the STPT page, any inputted coordinates on the DEST page must commence with the corresponding cardinal ICP key: N(2), E(6), W(4), or S(8). The scratchpad will not respond until the cardinal key is pressed.

By depressing the DCS (Data Control Switch) to SEQ while having any steerpoint selected, you can access the Offset Aimpoint 1 & 2 subpages. This allows the pilot to establish two offset aimpoints for each INS steerpoint. You have the ability to switch the range unit from FT (feet) to KM (kilometers) or NM (nautical miles) on the RNG line. Pressing DCS up until you see FT (scratchpad asterisks surrounding FT) and then any number key can be used to cycle through FT, KM, and NM.



2.2.3.5.3 MARKPOINTS

When entering DED MARK page (ICP 7) the MARK mode will be set automatically according to the Master Mode and relevant sensor state.

- **FCR** - If the system is in NAV or AG master modes, the FCR is in AG mode (not AGR), the FCR is the SOI and the FCR is designating something, MARK mode will be automatically set to FCR. When entering MARK page at this state, a FCR MARKPOINT will be recorded when you TMS Up.

- **TGP** - If the system is in NAV or AG master modes, the TGP is in AG mode, the TGP is the SOI and ground stabilized, MARK mode will be automatically set to TGP. When entering MARK mode at this state, a TGP MARKPOINT will be recorded when you TMS Up.

- **OFLY** - If the system is in AA master mode, MARK mode will be automatically set to OFLY. When entering MARK mode at this state, an OFLY MARKPOINT will be recorded immediately. No TMS Up is needed.

- **HUD** - If the system is in NAV or AG master modes and conditions are not sufficient to set FCR or TGP modes, MARK mode will be automatically set to HUD and a HUD Mark Cue (HMCS - a 12mr circle with a 1mr aiming dot inside it) will appear on the FPM in the HUD. This is pre-designate mode.

The HMCS can be cursor-slewed to the desired position and TMS Up ground stabilizes it (post-designate mode). The position may be refined using the cursors and then a second TMS Up will save the Markpoint.

In post-designate with the HMC ground stabilized, a TMS Down will cancel the stabilization and return to pre-designate mode, and the HMC will again be tied to the FPM. Note that if trying to ground stabilize or mark with TMS Up when the cue is not on the ground, nothing will happen.

If you select a MARK mode with the ICP sequence (SEQ) button which does not match the current system and sensor state (for example setting FCR MARK when the system is in AA master mode), an OFLY MARKPOINT will be recorded when you TMS Up.

When the MARK DED page is displayed and the current MARKPOINT is valid (has positional data) then depressing the M-SEL button (ICP 0) will set that MARKPOINT as the current active steerpoint.

The MARK mode rotary will cycle through the 4 existing modes in this order: HUD, TGP, OFLY, and FCR. When the MARK DED page is displayed and one of the 1-9 ICP buttons is pressed, a MARK mode change will happen (just like using the sequence button).

A Markpoint is just like any other steerpoint and can be sent to another aircraft via the IDM.

2.2.3.5.4 ELECTRONIC HORIZONTAL SITUATION INDICATOR (EHSI)

The Block 50 and Block 52(+) aircraft have recently undergone an upgrade, introducing the electronic version of the Horizontal Situation Indicator (EHSI). As the primary flight instrument for navigation, the EHSI provides a comprehensive view of the aircraft's position, featuring a top-down perspective with the aircraft at the center and a surrounding compass rose. To fully grasp the functionality and operation of the EHSI, I recommend referring to the BMS Comms and Nav book, which covers both fundamental and advanced concepts of radio-navigation.

The EHSI instrument comprises two knobs and one M button located at the bottom. The left knob, denoted as HDG for Heading, allows the pilot to set a heading caret on the compass rose, serving as a visual cue for the desired heading. Conversely, the right knob, labeled CRS for Course, enables manual entry of a specific course value, which is then reflected on the course deviation indicator. This value is displayed on the top right window of the instrument. Additionally, the top left window provides information on the range to the selected destination in Nautical miles, according to the current EHSI mode. It is important to note that the DME (Distance Measuring Equipment) is now displayed in tenths of nautical miles. The M button facilitates the toggling of available modes, including TCN, PLS (Precision Landing system = ILS), PLC/NAV, and PLS/TCN. When no power is available, the instrument is flagged as OFF.

For a comprehensive and detailed understanding of EHSI utilization, I encourage you to consult the BMS-Comms-Nav-book located in your Docs folder. It provides an in-depth review of EHSI functionality, as well as an explanation of various radio-navigation aspects.

2.2.4 IDENTIFICATION FRIEND OR FOE (IFF)

The Identification Friend or Foe (IFF) system serves the purpose of identifying aircraft as friendly entities. It operates by employing an interrogator to send radio queries, while a transponder responds to these queries. In the current version of BMS, IFF interrogation is primarily conducted by human operators, as ATC and AWACS do not perform interrogations. However, AI-controlled fighters may initiate IFF interrogations during Beyond Visual Range (BVR) intercepts, and all AI aircraft respond to IFF interrogations using their transponders.

It is crucial to understand that despite its name, IFF can only ascertain the friendly nature of targets and is incapable of identifying hostile ones definitively. If an IFF interrogation fails to receive a response or receives an invalid response, the object in question cannot be confirmed as friendly, but it also cannot be conclusively labeled as a foe. As a result, it will be categorized as a "bogey." Additionally, numerous factors can cause friendly aircraft to not respond appropriately to IFF. It is important to recognize that IFF should not be solely relied upon as the ultimate solution to prevent fratricide incidents, but rather as an additional tool to aid in averting such occurrences.

2.2.4.1 IFF Modes

In BMS, the IFF system encompasses five modes, each associated with specific codes or cryptographic keys: Modes 1, 2, 3, 4, and C. However, Mode S is not fully implemented and lacks support for simulating Mode S reply or address entry.

The availability of IFF modes varies depending on the aircraft in BMS, as not all aircraft are capable of supporting Mode 4 or Mode C.

Here is a breakdown of the different IFF modes and their characteristics:

- Mode 1: This military mode operates with non-cryptographic codes ranging from 00 to 73. The first digit of the code never exceeds 7, and the second digit never exceeds 3. For example, codes like 41 and 22 are valid Mode 1 codes, while 44 and 81 are not. Mode 1 normally provide information about mission type and role.

- Mode 2: Also a military mode, Mode 2 employs non-cryptographic codes ranging from 0000 to 7777. Similar to Mode 1, the digits in the code never exceed 7. Thus, a code like 4484 is invalid, while 4625 is valid. Mode 2 includes a unique identification code for the aircraft

- Mode 3/A: This mode serves both military and civilian purposes and utilizes non-cryptographic codes ranging from 0000 to 7777. Mode 3/A is commonly found in most aircraft for Air Traffic Control (ATC) purposes in real-world scenarios.

- Mode C: Operating in the civilian domain, Mode C provides information about the transponder aircraft's pressure altitude.

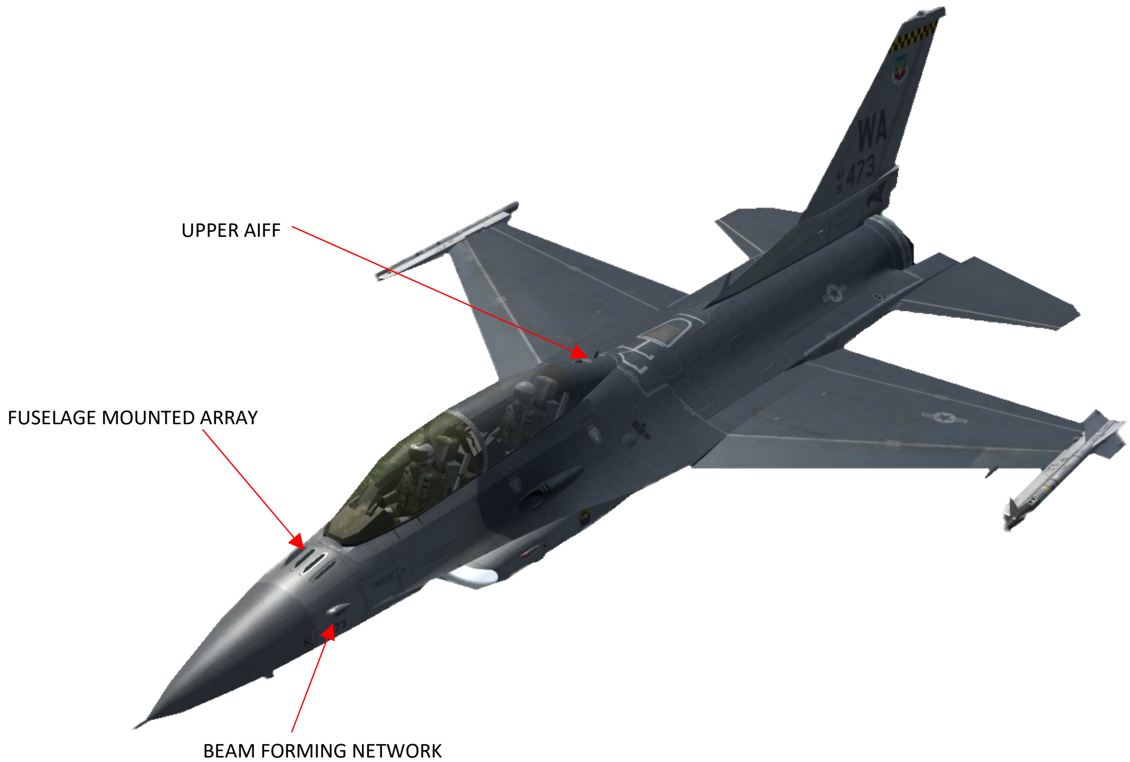
- Mode 4: Mode 4 is a military mode that employs cryptographic techniques and represents the closest implementation to a true "Identification Friend or Foe." Interrogations in Mode 4 involve a sequence of rapid challenges encrypted with a specific key, and the transponder must correctly respond to these challenges using the same key.

- Mode 5: Mode 5 is an updated version of Mode 4, but it is not currently implemented in BMS.

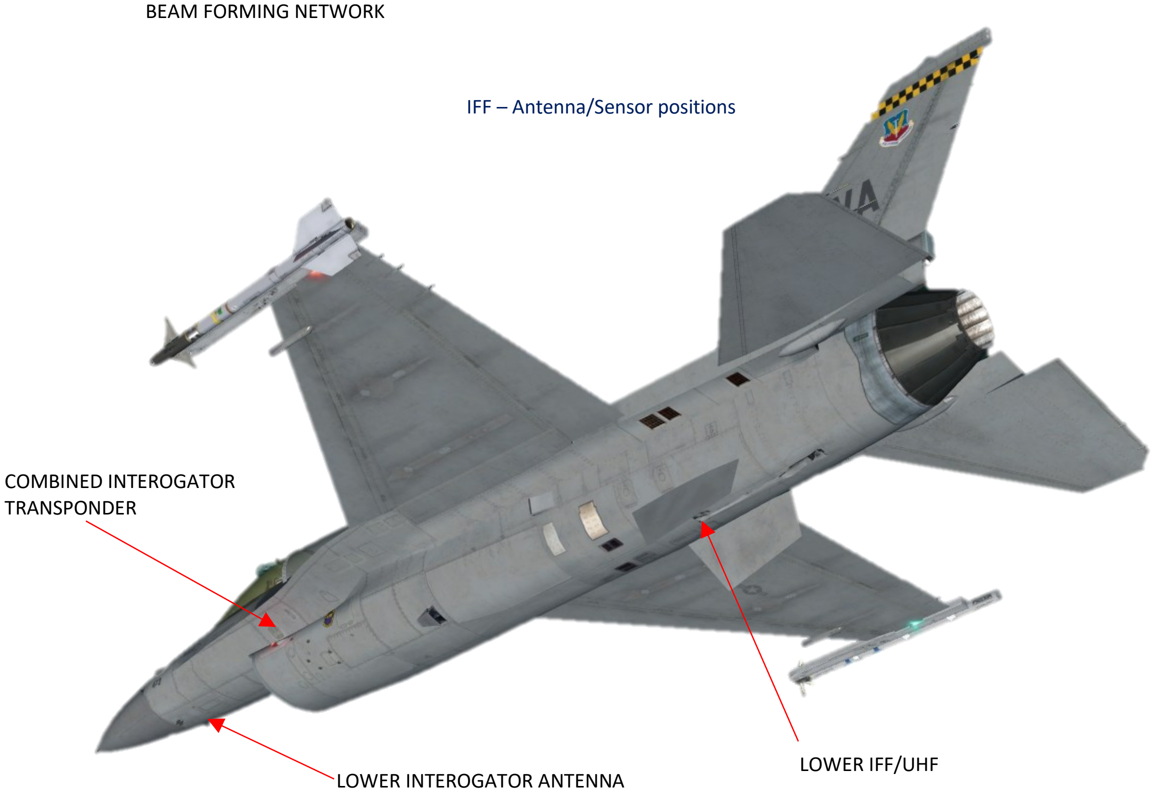
- Mode S: Mode S represents an updated civilian transponder mode, but its implementation in BMS is limited to visual representation without full functionality.

2.2.4.2 AN/APX-113(V) Advanced Identification Friend or Foe (AIFF) Description

The aircraft is outfitted with the APX-113(V) Advanced Identification Friend or Foe (AIFF) set. The AIFF set serves as a Combined Interrogator/Transponder (CIT) and enables the aircraft to perform interrogations in four different modes. Additionally, it is capable of responding to correctly coded interrogations in six modes. The AIFF set comprises various components, including a beam forming network (BFN) LRU, a lower conformal interrogator antenna, an upper fuselage mounted antenna (FMA) array, as well as upper and lower transponder blade antennas.



IFF – Antenna/Sensor positions



2.2.4.3 IFF Control Panel

The F-16 block 50 & 52 models have undergone updates that include the integration of an AIFF (Advanced Identification Friend or Foe) system. As part of this update, the AUX COMM panel has been replaced with the IFF panel. It is important to note that the TACAN management, which was previously performed on the AUX COMM panel, is now accessible through an MFD (Multi-Function Display) page accessed from the MFD menu.

The IFF system can be activated and its operational mode can be adjusted using the IFF MASTER switch, which offers options such as OFF, STBY, LOW, NORM, and EMER.

When the C&I (Communication & Identification) switch is set to UFC (Up Front Controller), all IFF settings can be modified using the UFC pages.

The IFF system consists of two components: the IFF Transponder and the IFF Interrogator. The IFF Transponder is managed through the IFF override button, granting access to pages such as STAT, POS, and TIM (as displayed in the left DED image). On the other hand, the IFF Interrogator is controlled using the LIST and RCL (INTG) buttons, providing access to pages like interrogator SCAN and LOS (as depicted in the right DED image).

It is crucial to understand that while all aircraft have transponders, not all of them possess interrogator capabilities. In case of backup control, the IFF panel is utilized when the C&I switch is set to the BACKUP position.

In EMER, the IFF can interrogate but responds to interrogations with a fixed emergency code: (Mode 1: 70; Mode 2: 7777 and Mode 3: 7700; Mode C and Mode 4 response is normal).

2.2.4.4 IFF Operations

2.2.4.4.1 IFF Transponder

The transponder, which functions as a receiver and transmitter, is a solid-state device employed in IFF (Identification Friend or Foe) and SIF (Selective Identification Feature) applications. This unit receives coded radio signals from IFF/Air Traffic Control (ATC) interrogator stations on the ground, on ships, or in the air. These interrogation signals are detected, decoded, and used to automatically transmit a coded response. The AIFF transponder subsystem offers the following capabilities:

- Identification position (I/P) for Modes 1, 2, 3/A.
- Emergency identification for Modes 1, 2, 3/A.
- Encrypted responses to interrogations in Mode 4.
- Altitude information in Mode C.

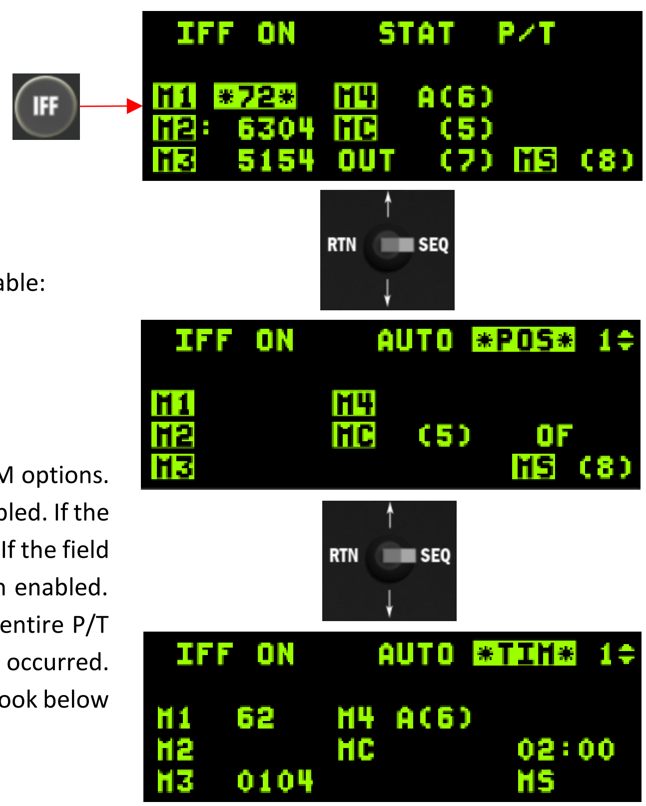
The transponder receives RF interrogations through two antenna systems, decodes them into the appropriate mode, encodes the selected reply, and transmits the coded RF response through the corresponding antenna. It includes a diversity receiver that automatically selects the optimal signal from either the upper or lower antenna. An override switch on the antenna select panel allows manual selection of the upper or lower antenna, disabling the receiver's automatic antenna selection.

The transponder's BIT (Built-In Test) circuits continuously monitor critical parameters and provide notifications in case of faults. The backup control functions for Modes 1, 3/A and 4 are located on the IFF control panel.

2.2.4.4.1.1 IFF Transponder Pages

The transponder page can be accessed by pressing the IFF ICP button. This page is used to manage the responses to IFF queries.

The main page is the STATUS page, which displays the currently active modes (highlighted) and their corresponding codes. It is important for these codes to align with the briefed IFF policy.



By pressing DCS right (SEQ), the page will change to the TIME and POSITION pages. These pages are preconfigured based on the DTC setting and will modify the IFF transponder according to the specified time (TIM) and/or position (POS) events outlined in the BMS UI briefing page and BMS UI DTC page.

Depending on the activated mode, the following status modes are available:

POS - Displayed when position event has been enabled

TIM - Displayed when time event has been enabled

P/T (STAT page only) - This field indicates the status of the POS and TIM options. When the mnemonic is displayed, it signifies that an event has been enabled. If the mnemonic is highlighted, it means that the selected event has occurred. If the field is blank, it indicates that no changes in time and/or position have been enabled. The field remains blank if neither TIM nor POS has been selected. The entire P/T mnemonic will be highlighted when either a POS and/or TIM event has occurred. To determine if a POS or TIM event (or both) has occurred, the pilot can look below the P/T mnemonic to check if a POS or TIM event is displayed.

The IFF transponder is designed to be transparent in its operation. Once properly set (by loading the DTC into the aircraft via the DTE page), the IFF transponder will be configured according to the briefed IFF policy, minimizing the need for in-flight adjustments.

However, if there is a need to change modes in all IFF pages (transponder and interrogator), the following ICP commands can be used:

- Pressing ICP 1 followed by ICP ENTR toggles Mode 1 between Active and Inactive.
- Pressing ICP 2 followed by ICP ENTR toggles Mode 2 between Active and Inactive.
- Pressing ICP 3 followed by ICP ENTR toggles Mode 3 between Active and Inactive.
- Pressing ICP 4 followed by ICP ENTR toggles Mode 4 between Active and Inactive.
- Pressing ICP 5 followed by ICP ENTR toggles Mode C between Active and Inactive.
- Pressing ICP 8 followed by ICP ENTR toggles Mode S between Active and Inactive (not implemented).

Codes can also be changed as follows:

- To change the Mode 1 code, enter a valid two-digit code followed by ENTR in the scratchpad.
- To change the Mode 2 code, enter '2' followed by a four-digit code followed by ENTR (total of five digits).
- Entering a three or four-digit code followed by ENTR will change the Mode 3 code.
- The Mode 4 key cannot be changed directly. You can toggle between A and B keys by entering ICP key 6 followed by ENTR.
- Mode C is a request for pressure altitude, so there is no correct answer to that interrogation.
- Mode S is not implemented.

2.2.4.4.1.2 IFF Interrogation Response

By default, pilots are unaware when their aircraft is being interrogated by another IFF system. However, it can be useful to have this information, especially when being interrogated in Mode 4 without the ability to provide the correct response. To enable audio cues for this purpose:

On the IFF STAT page, the center of the bottom line displays "OUT (7)". Pressing ICP 7 followed by ENTR will toggle the IFF Mode 4 feedback between the available options:

IFF – Interrogation Response – AUD selected

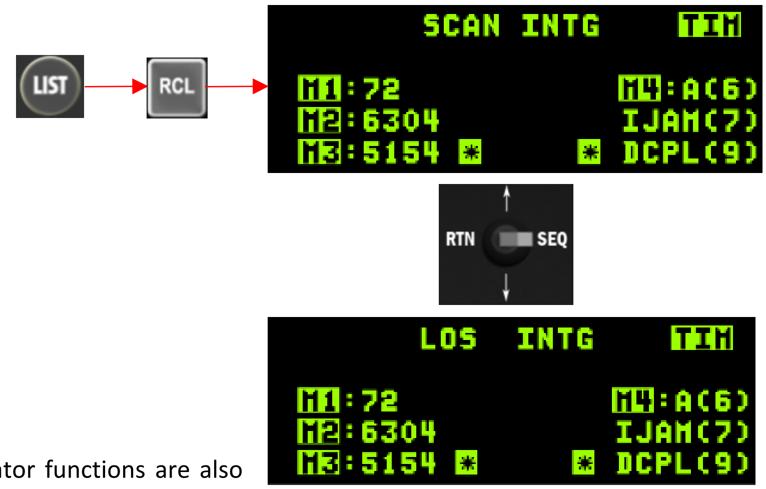
- OUT: No feedback at all (default option).
- LIT: Visual feedback with the 4 symbol highlighted on the UFC CNI page whenever the aircraft is interrogated in Mode 4.
- AUD: In addition to the visual signal (LIT), an audio tone will be played if the aircraft is interrogated in Mode 4 and the interrogation key does not match the aircraft's key.

Selecting AUD is recommended as it provides both visual and aural cues when the aircraft is unable to answer the Mode 4 interrogation correctly.

2.2.4.4.2 IFF Interrogator

2.2.4.4.2.1 IFF Interrogator Pages

Aircraft equipped with an interrogator feature two modes of interrogation: SCAN and LOS (Line of Sight). Each mode has its own DED page, accessible by pressing the LIST RCL button. By default, the SCAN INTG (Interrogator) page is displayed, while the LOS page can be accessed by pressing DCS right (SEQ). Both pages share the same format and operate independently.



It is possible to select different active modes and codes for each page. These settings are remembered, allowing pilots to customize their interrogation schemes for SCAN and LOS modes.

It's important to note that the transponder and interrogator functions are also independent of each other. While active modes may be set according to the IFF policy on the transponder page, pilots have the flexibility to customize their interrogation sequence based on their preferences.

2.2.4.4.2.1.1 IFF SCAN Mode

During a SCAN interrogation, the system can display up to 32 AIFF target replies, 8 jamming indicators, or a combination of up to 7 jamming indicators and up to 32 target replies. It's possible for jamming indicators and target replies to be reported for the same beam.

The SCAN interrogation mode is activated when the TMS (Target Management Switch) is pressed to the left for less than 0.6 seconds. In SCAN CPL (Coupled) mode, the MMC (Multi-Mode Controller) sends the FCR (Fire Control Radar) "scan centers" and "widths" to the AIFF (Airborne Identification Friend or Foe). The AIFF uses this information to determine which beams to interrogate in order to provide coverage over the FCR field-of-regard. The interrogation sequence is not synchronized with the existing radar antenna sweep. Responses outside the FCR field-of-regard are filtered out of the system and not displayed.

When the scan volume is coupled to the radar field of regard, only the necessary beams to cover the specified azimuth of the volume are activated. The AIFF elevation is filtered to comply with the specified volume. The AIFF beams may overlap the boundaries of the specified volume, in which case target replies are filtered before being displayed on the avionic system. If a jamming indication is detected in a volume overlapped by two beams, the indicator is displayed in both beam areas.

Valid replies for a SCAN interrogation are displayed for 2 seconds per mode on the MFD (Multi-Function Display). If SCAN DCPL (Decoupled) mode is selected and the TMS is pressed to the left for less than 0.6 seconds, the AIFF antenna sequentially interrogates each of the eight beam positions, starting from the left side of the aircraft and moving through each of the four antenna elements to the right side of the aircraft, covering a full scan volume of ±60 degrees in azimuth and elevation.

As the scan volume progresses from left to right, the target replies are maintained and reported to the avionic system at the end of the last beam position. If there are more than 32 aircraft that respond to an interrogation, the AIFF subsystem sorts the aircraft so that only the closest 32 are reported to the avionic system. If a jamming indication is detected in a beam area, a jamming indicator is reported for that particular beam area. To help the pilot differentiate between multiple mode interrogations, the mode mnemonic changes at OSB 16 (On-Screen Button 16) to reflect the currently displayed mode, in addition to the same mode indication being positioned next to the acquisition cursors. The corresponding interrogated mode is also displayed within the AIFF reply symbology. Additionally, the highest numerical mode enabled is interrogated first to aid in organization.

2.2.4.4.2.1.2 IFF LOS Mode

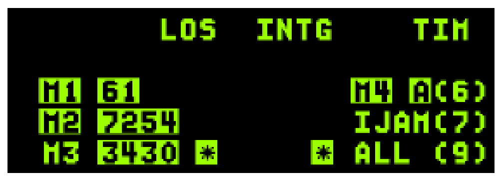
When the TMS (Target Management Switch) is pressed to the left for at least 0.6 seconds, the system switches to LOS (Line of Sight) mode. In this mode, the MMC (Multi-Mode Controller) sends the FCR (Fire Control Radar) scan centers, which represent the initial positions of the acquisition symbols, to the AIFF (Airborne Identification Friend or Foe). The AIFF then determines the two beams that provide the best coverage. It's important to note that due to fixed interrogator beam positions, the two AIFF beams may not always be perfectly centered around the exact cursor position.

In LOS mode, AIFF responses are filtered in range, starting from the cursor's current range position and extending to the maximum currently selected range on the MFD (Multi-Function Display). However, there is no elevation or azimuth filtering applied in LOS mode. During a multiple interrogation sequence in LOS mode, the cursor position is not updated between the different modes being interrogated. If the cursor is moved a significant distance during the multimode interrogation, the responses will not appear near the currently displayed cursor position.

A LOS interrogation can be initiated in any air-to-air radar mode, whether in standby or off. When a LOS interrogation takes place, the system can display up to 16 AIFF target replies. The beams required to cover the specified area are activated, with the scan volume centered around the acquisition cursor. If more than 16 aircraft respond to an interrogation, the AIFF subsystem sorts them, reporting only the closest 16 aircraft to the avionic system. The valid replies for a LOS interrogation are displayed for 1.5 seconds per mode on the MFD.

2.2.4.4.2.1.3 IFF DECOUPLE

By default, both INTG DED pages (SCAN and LOS) feature a setting labeled DCPL (9). The acronym DCPL stands for "decoupled" and indicates that the interrogator is disconnected from the transponder. To switch to coupled mode (CPL), you can press ICP key 9 and then press ENTR.



The available options for this setting are DCPL (decoupled), ALL (all modes are coupled), and SOME (some modes are coupled).

When you enter ICP key 9 and press ENTR, the corresponding interrogator mode (SCAN or LOS) is set to ALL, coupling all interrogation modes to the transponder modes. All codes will be highlighted and display the same code as the transponder's STAT page. For instance, if all interrogator codes are highlighted, it means they are all coupled with the transponder codes.

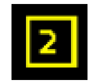
Toggling ICP key 9 and ENTR again will put the relevant interrogator mode back to DCPL, where the codes from the interrogator may differ from the transponder codes. In this case, all codes will not be highlighted.

It is also possible to decouple a single mode. To do this, first couple all modes and then enter the code you want to decouple. Let's say you wish to decouple Mode 1, which is currently set to 22 (same as the transponder). You would type 31 in the scratchpad and press ENTR. The LOS interrogator's Mode 1 will then be set to 31, and it will no longer be coupled to the transponder's M1 code (61). The code 31 will no longer be highlighted, and the CPL/DCPL status will change to SOME. A colon will appear next to M1, indicating that this mode is decoupled.

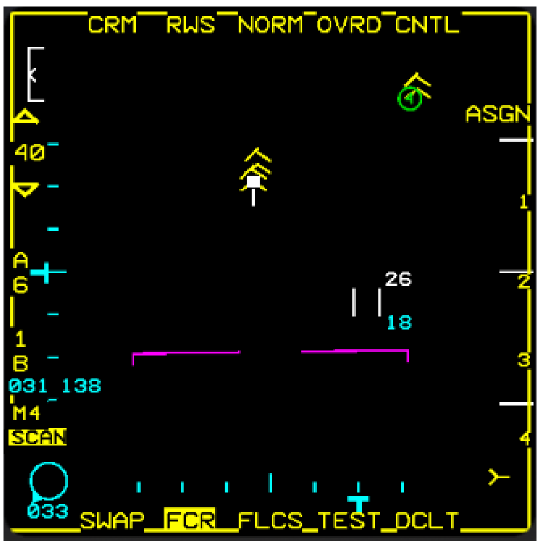
2.2.4.4.2.2 IFF Interrogation - Responses

- A green circle displaying the mode indicates a correct answer and categorizes the target as friendly.

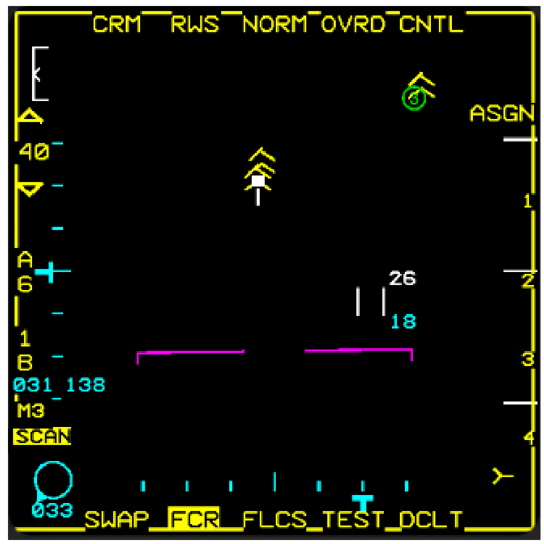
- A yellow square displaying the mode indicates an incomplete answer and categorizes the target as unknown or a bogey.



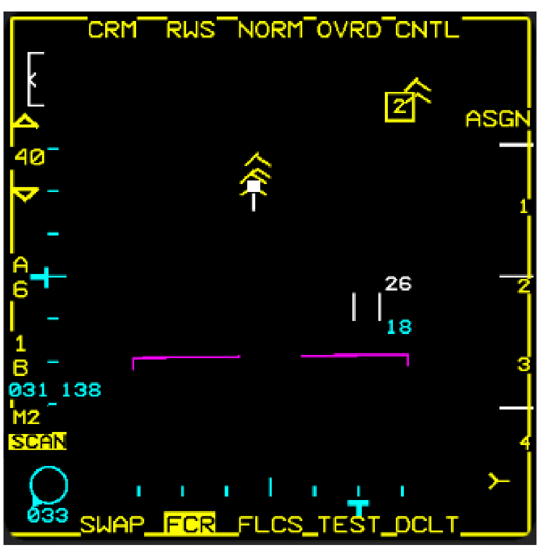
- During the interrogation process, the current interrogation mode is shown to the left of the acquisition cursor (captain's bars). The display of "M+" (OSB #16) is replaced by the actual mode being interrogated by the IFF system. Additionally, the type of interrogation (in this case, SCAN) is highlighted and displayed below the mode mnemonic.



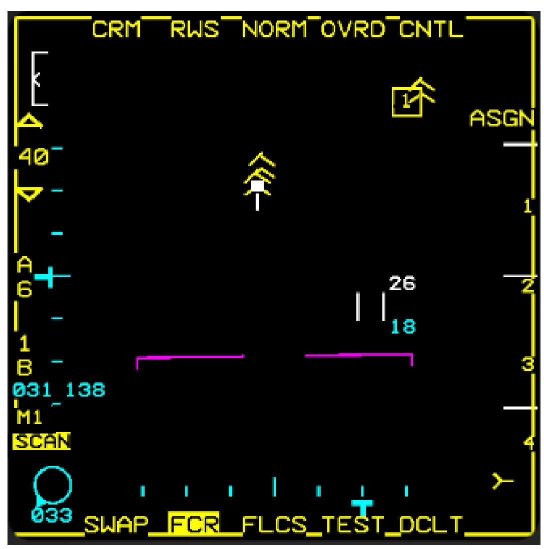
M4 INTERROGATION RESPONSE



M3 INTERROGATION RESPONSE



M2 INTERROGATION RESPONSE



M1 INTERROGATION RESPONSE

2.3 RADAR SYSTEMS

2.3.1 AN/APG-68(V)5 FIRE CONTROL RADAR

2.3.1.1 BACKGROUND

The AN/APG-68(V)5 fire control radar (FCR) is a multimode, digital sensor designed to provide all-weather air-to-air and air-to-ground modes with dogfight and weapons delivery capabilities. Introduced with F-16 C/D Block 50/52 aircraft (and export specific variants) it is a descendent of the AN/APG-68(V)1 fitted to Block 40/42 aircraft, the AN/APG-68 (Block 25 and onwards) and the AN/APG-66 family of radars that were used in earlier F-16 A/B and MLU versions.

The air-to-air modes detect and track targets at forward aspects of maximum ±60° off boresight in elevation and ±60° off boresight in azimuth at all altitudes, either in the clear or with ground clutter.

Target data in the air-to-air modes is presented as synthetic video on a B-scope display. Air-to-ground modes provide mapping and navigation as well as target detection, location, and tracking.

2.3.1.1.1 RADAR THEORY

Air-to-Air radar detects aircraft by emitting radio frequency (RF) energy in a narrow beam and then detecting RF energy reflected by the target.

Low frequency is more effective for long range detection but requires large, heavy equipment. High frequency has shorter range capacity but higher accuracy needed for targeting and requires smaller, lighter equipment.

Transmissions are sent out in pulses so that the transmitter and receiver can share one antenna. The APG-68 antenna is a mechanically scanned phased array design driven by electric motors and gimballed in two axes. It provides coverage of 120° in azimuth and in elevation.

Pulse Recurrence/Repetition Frequency (PRF) is the number of pulses of RF that are transmitted every second. The APG-68 has low, medium and high PRF capability. Low PRF is best for long range detection. High PRF is better for accuracy at the expense of range.

Pulse radars detect targets by detecting the raw returns from these transmissions and display everything in raw video with no filtering. These images require skill to interpret and targets are easily lost in look-down situations due to ground clutter masking the real target return.

Doppler shift is a small change in RF frequency as a result of relative motion between a transmitter and target which can be used to calculate velocity.

Pulse Doppler radars, such as the APG-68 rely on a Doppler filter and reject targets below a set speed threshold called the Moving Target Reject (MTR). Doppler Effect is also used to filter out ground returns so that returns with closure similar to aircraft groundspeed are not displayed. This creates a small range of masked closure rates around aircraft groundspeed called the Doppler Notch. The real APG-68 has selectable notch values.

Pulse Doppler radars have a high resistance to chaff as target detection is based on relative velocity. Chaff once dispensed decelerates rapidly as it disperses and is quickly rejected by the Doppler filter.

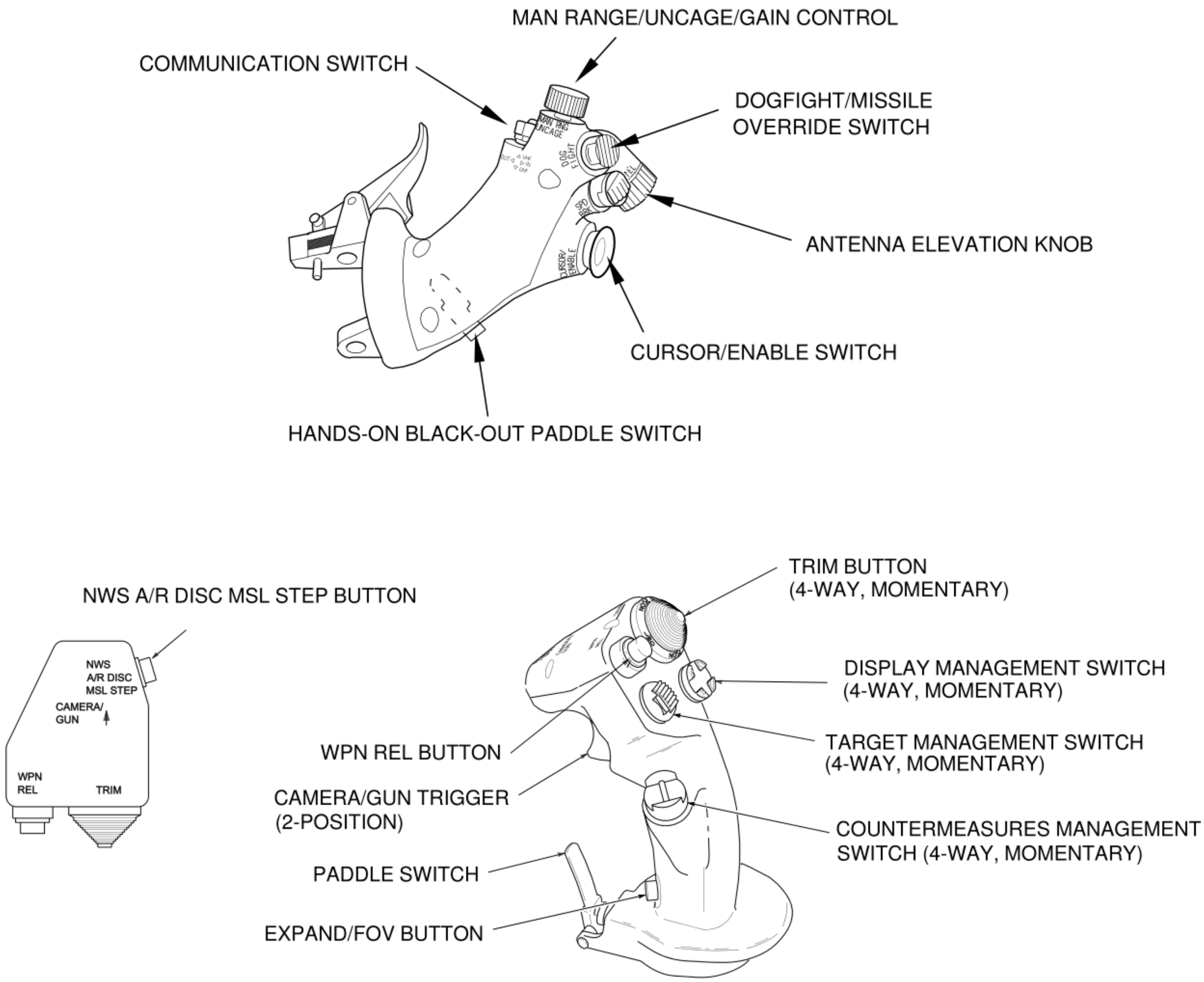
Pulse Doppler radars are however susceptible to beaming when the perceived closing velocity of a target can fall below the threshold set by the filter.

Target range is calculated by measuring the time between transmission and reception of RF energy.

The position of the radar antenna, both in azimuth (left/right) and elevation (up/down), is used to determine the position of the target(s).

2.3.1.2 FCR CONTROLS

2.3.1.2.1 HOTAS



HOTAS Throttle (TQS) and Stick (SSC) Controls

2.3.1.2.1.1 MANUAL RANGE/UNCAGE/GAIN (MAN RNG/UNCAGE) CONTROL

Operation of the MAN RNG/UNCAGE control is a function of the system mode. In ground-map (GM) modes, the gain knob controls radar map gain. Rotating the knob clockwise or counter clockwise increases or decreases the gain, respectively.

2.3.1.2.1.2 ANTENNA ELEVATION (ANT ELEV) KNOB

The ANT ELEV knob provides manual control of antenna elevation. Rotating the knob clockwise or counter-clockwise from the 0° detent position causes the antenna scan center to move upward or downward to the maximum antenna elevation limit of ±60°. Antenna elevation angle can be manually adjusted in A-A search modes. In A-G mapping modes, the tilt control offsets the antenna tilt angle from MMC commanded cursor position. The knob has no effect in radar track modes.

2.3.1.2.1.3 COMMUNICATION SWITCH

The A-A FCR B-scope may be decluttered of IDM symbology by a Communication switch left for less than 0.5 seconds. The display will remain decluttered until Comms switch left <0.5 secs is toggled again.

2.3.1.2.1.4 DOGFIGHT/MRM OVERRIDE SWITCH

The three-position DOGFIGHT/MRM override switch provides a hands-on override of all master modes except emergency jettison. The DOGFIGHT, or outboard, position provides both gun firing and missile delivery. The missile override, or inboard, position provides missile delivery only. Any air-to-air radar mode may be programmed for either switch position.

2.3.1.2.1.5 RDR CURSOR/ENABLE CONTROL

The multidirectional tilt feature of the CURSOR/ENABLE switch controls cursor slewing on the SOI display. Because the throttle grip slides forward, down, backward, and up to control engine thrust, controller deflection is more accurately described with respect to the position of the base of the thumb. For example, tilting the switch to the left of the base of the thumb moves the cursor on the SOI display to the left. The cursor control portion of the CURSOR/ENABLE control allows A-G cursor slewing in normal fields of view, video slewing in expanded fields of view, acquisition cursor slewing in A-A FCR modes, and scan slewing in slewable ACM.

2.3.1.2.1.6 EXPAND/FOV BUTTON

The EXPAND/FOV button is used to select available expanded or alternate FOVs for the SOI by stepping through the selectable options.

2.3.1.2.1.7 DISPLAY MANAGEMENT SWITCH (DMS)

The DMS, which is spring-loaded to the center position, controls SOI selection and format (MFD page) stepping.

2.3.1.2.1.8 TARGET MANAGEMENT SWITCH (TMS)

The spring-loaded TMS controls target designation and data on the FCR display according to master mode (A-A, A-G), radar mode and submode. Master mode specific information is detailed below.

2.3.1.2.2 SENSOR POWER (SNSR PWR) PANEL

The SNSR PWR panel is located on the forward section of the pilot's right console and contains four ON/OFF switches. The third switch from the left, labelled FCR, applies power to the Fire Control Radar.

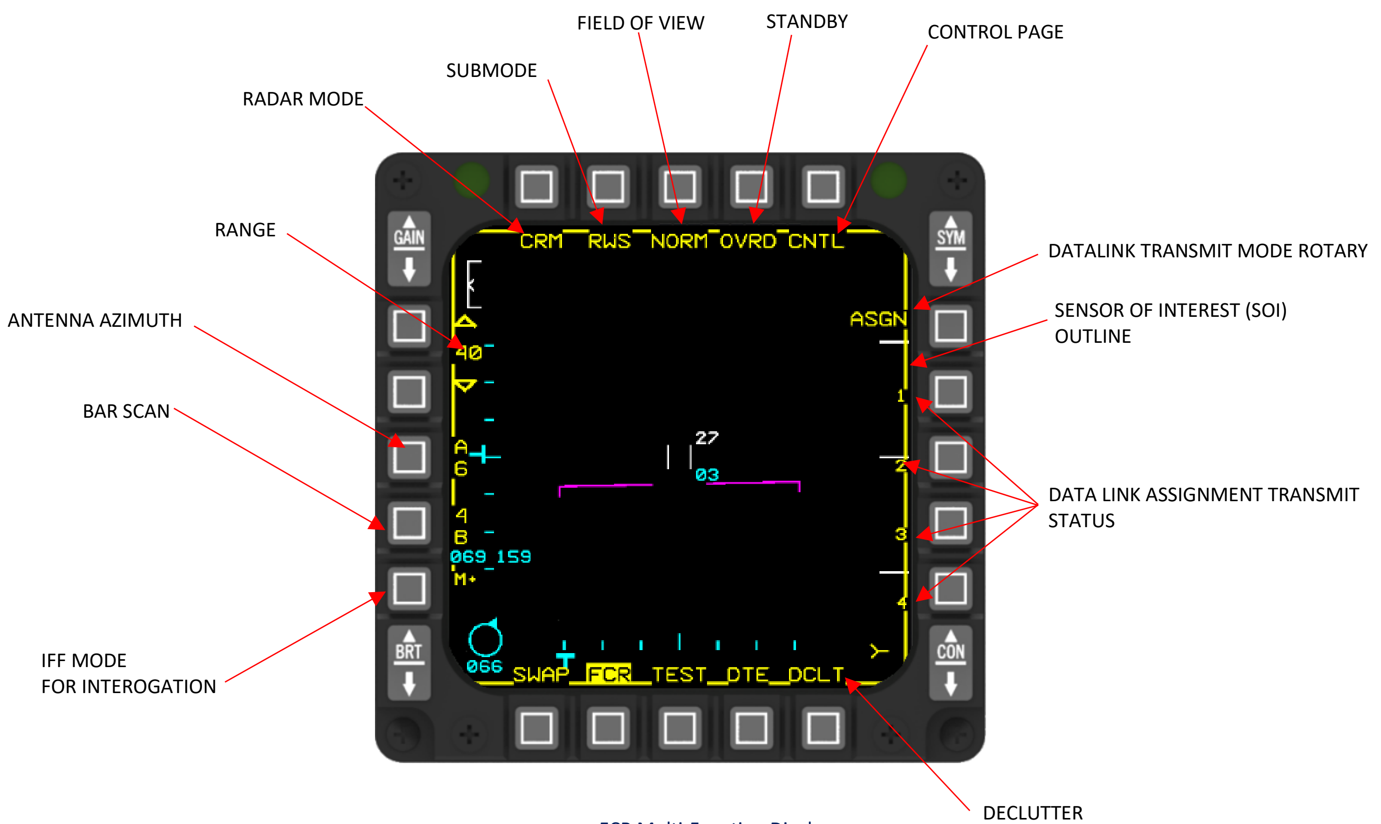
2.3.1.2.3 QUIET / SILENT SWITCH

The FCR will not emit RF energy if the RF Mode switch is moved to Quiet or Silent in BMS. NO RAD is displayed in the HUD when the MMC silences the FCR Transmitter.

2.3.1.3 MFD - MULTI FUNCTION DISPLAY

The multi-function display is the primary interface to the radar and is used to select radar modes and parameters. The MFD features the following:

- 20 Option Select Buttons (OSB) aligned along the borders
- 4 Rocker Switches (GAIN, SYM, CON, BRT)



FCR Multi-Function Display

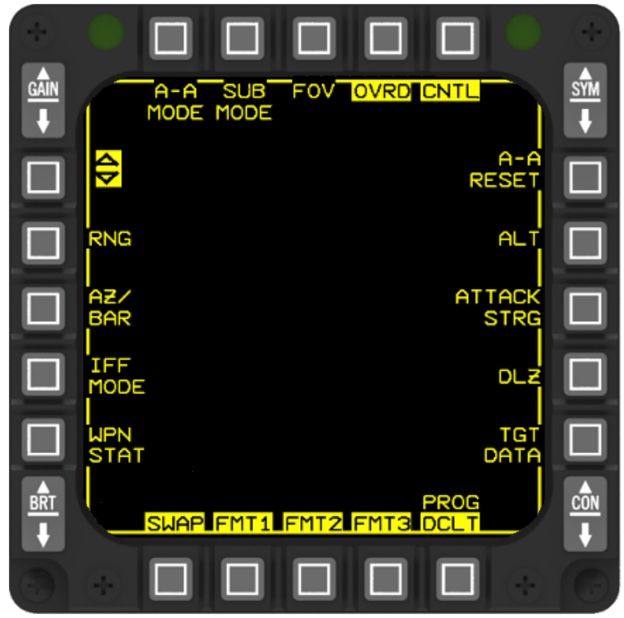
For information about Multi-Function-Displays (MFDS), refer to chapter 2.1.6 of this document.

2.3.1.3.1 FCR DCLT (DECLUTTER)

A declutter feature is available to remove most of the OSB labels from the selected display. By briefly pressing the DCLT OSB, the MFD highlights the letters "DCLT" and eliminates the labels associated with the OSBs located on the left, top, and right edges of the MFDs. However, alphanumeric data unrelated to the OSBs (such as range scale mnemonic and the gain gauge) and the labels at the bottom of the MFD remain visible. To disable the declutter feature, press the DCLT OSB again within 1 second.

It's important to note that even when OSB labels are decluttered, the OSBs themselves remain active and functional.

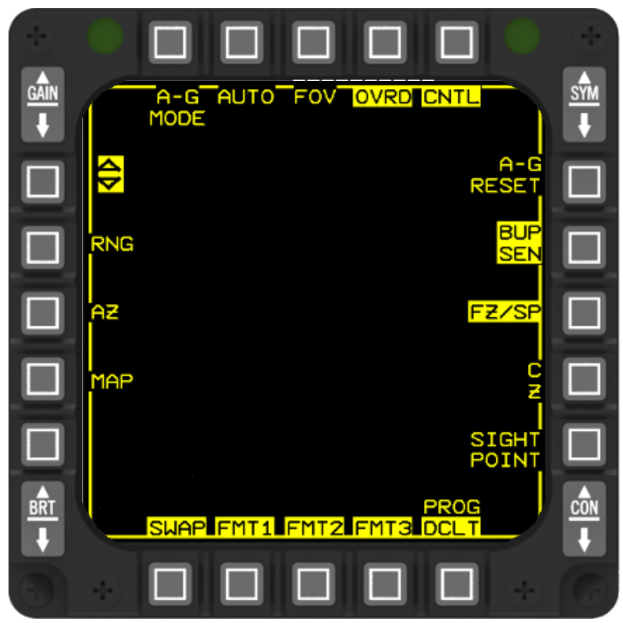
The declutter state is retained based on the MFD format, except for the radar. For radar, the declutter state is retained based on whether the A-A FCR or A-G FCR mode is active. The declutter setting will persist unless manually deselected by the pilot or because of Pan MFDS power cycle. When the decluttered CRM (Common Radar Modes) is selected, the declutter state is maintained when transitioning to the ACM (Air Combat Maneuvering) mode. The same applies when transitioning from GM (Ground Map) to GMT (Ground Moving Target) mode. It's important to note that the declutter option is only available on base pages.



FCR - A-A mode – Declutter page

You can program certain FCR display mnemonics and symbology for decluttering. By pressing OSB 11 (located next to the DCLT mnemonic) for at least 1 second, you can access the programmable declutter page. On this page, the decluttered items are initially highlighted.

To declutter a specific mnemonic or symbol, simply press the OSB next to it, which will highlight and select it for decluttering. If you want to exit the programmable declutter page and return to the previously displayed page, press OSB 11 again for at least 1 second.



FCR - A-G mode – Declutter page

To reset the declutter items, follow these steps:

- Press OSB 6, located next to the A-A RESET or A-G RESET mnemonic, on the A-A MODE or A-G MODE programmable declutter page.
- Press OSB 1, located next to the PROG DCLT RESET mnemonic, on the master format menu.

Please note that the selected declutter items are not retained through power cycles or auto restart. Upon exiting the page, only the default items will be highlighted.

For a list of programmable declutter items, please refer to the table one the next page.

OSB	A-A FORMAT		A-G FORMAT	
	MMENONIC	ITEM DECLUTTERED	MMENONIC	ITEM DECLUTTERED
1	A-A MODE	Selected mode mnemonic	A-G MODE	Selected mode mnemonic
2	FCR SUBMODE	Selected submode mnemonic	AUTO/MAN	Automatic/manual range scale option mnemonic
3	FOV	Selected field-of-view option mnemonic	FOV	Selected field-of-view option mnemonic
4	OVRD *	Standby override mnemonic	OVRD *	Standby override mnemonic
5	CNRL *	Control page mnemonic	CNRL *	Control page mnemonic
6	A-A RESET	All default declutter items only	A-G RESET	All default declutter items only
7	ALT	Minimum & maximum search altitude readouts	BUP SEN *	Backup sensor mnemonic
8	ATTACK STRG	AIM-120 ASEC Minimum & maximum search altitude readouts	FZ/SP *	Freeze/snowplow option mnemonic
9	DLZ	AIM-120 time remaining AIM-120 time-of-flight Dynamic launch zone	CZ	Cursor zero option mnemonic
10	TGT DATA	Expanded target data: aspect angle, calibrated airspeed readout, target count, NCTR data, magnetic ground track and closure rate	SIGHT POINT	Sighting point option mnemonic
11	PROG DCLT *	If OSB is depressed for <1 sec declutter mnemonic; if depressed > 1 sec, MFD returns to base page	PROG DCLT *	If OSB is depressed for <1 sec declutter mnemonic; if depressed >1 sec, MFD returns to base page
12	FMT3 *	MFD format mnemonic	FMT3 *	MFD format mnemonic
13	FMT2 *	MFD format mnemonic	FMT2 *	MFD format mnemonic
14	FMT1 *	MFD format mnemonic	FMT1 *	MFD format mnemonic
15	SWAP *	SWAP mnemonic	SWAP *	SWAP mnemonic
16	WPN STAT	Weapon status mnemonic	N/A	N/A
17	IFF Mode	IFF mode label	MAP	MAP mnemonic and inc/dec symbol
18	AZ/BAR	Antenna azimuth scan mnemonic & number	AZ	Antenna azimuth scan mnemonic & number
19	RNG	Selected range scale readout	RNG	Selected range scale readout
20	INC/DEC Symbol *	Range scale increment/decrement symbol	INC/DEC Symbol *	Range scale increment/decrement symbol
* Default clutter item				

FCR – Declutter Items

2.3.1.3.2 FCR DISPLAY COORDINATE SYSTEMS

There are three coordinate systems used by the radar displays and the antenna scan pattern generator: Space Stable, Drift Stable, and Body Stable.

In a Space Stable system the elevation and azimuth angles are relative to the horizon and aircraft heading respectively and are independent of ownship pitch and roll. When the tilt is set to 0°, for example, the antenna will scan parallel to the earth about the ownship heading regardless of the pitch and roll angles of the aircraft.

In a Body Stable system, like ACM 30x20, the azimuth and elevation angles are relative to the aircraft body axis and the scan patterns will follow the aircraft as it pitches and rolls.

A Drift Stable system is very similar to the Space Stable system in that it too is roll and pitch independent except that the azimuth angle in a Drift Stable system is relative to the platform azimuth angle of the velocity vector and not the aircraft heading. The center of the display at 0° azimuth in a Drift Stable system represents the velocity vector which may be 10° in a Space Stable system when the drift angle is equal to 10°.

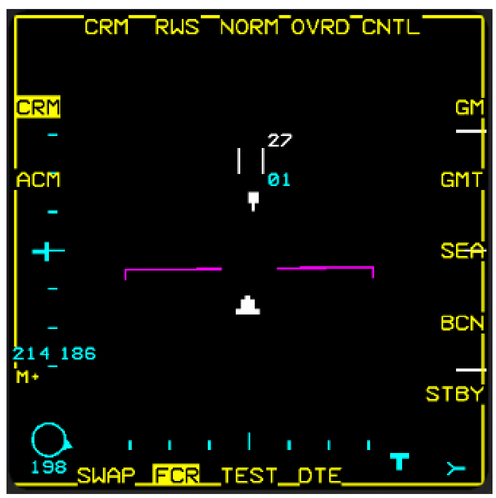
Radar Mode	Coordinate System
RWS, ULS, VSR, SAM, TWS, STT	Space Stable
30x20, 10x60, Boresight	Body Stable
Slewable ACM	Space Stable
GM, GMT, SEA, DBS	Drift Stable
FTT	Drift Stable
AGR	Space Stable

Display Coordinate Systems by Radar Mode

2.3.1.3.3 FCR RADAR MODE PAGE

Depressing the button adjacent to the radar mode indicator accesses the radar mode menu page and displays radar modes available for the selected master mode. The FCR Mode Menu is shown below.

All radar modes except AGR and BIT are available in the NAV Master Mode. Depressing the FCR mode OSB accesses the selected mode and returns to the basic FCR format page. FCR A-A or A-G modes can be selected before takeoff, via the FCR mode menu page, or simply loaded from the Data Cartridge (DTC). During flight the mode menu page may be selected without interrupting the present FCR operating mode. Whenever communication between the MFDs and FCR is missing FCR OFF is displayed in the center of the MFD.



2.3.1.4 RADAR MODES

2.3.1.4.1 FCR FORMATS

The FCR format (page) provides radar video, controls and status as a function of one of the following FCR modes:

- Standby (STBY)
- Built-in test (BIT)

2.3.1.4.1.1 AIR-TO-AIR MODES

The available air-to-air modes in BMS are:

- Combined Radar Mode (CRM):
  - Range-While-Search (RWS)
  - Situation Awareness Mode (SAM)
  - Single Target Track (STT)
  - Up-Look Search (ULS)
  - Velocity Search with Ranging (VSR)
  - Track-While-Scan (TWS)
- Air Combat Mode (ACM)

2.3.1.4.1.2 AIR-TO-GROUND MODES

The available air-to-ground modes in BMS are:

- Ground map (GM)
- Fixed Target Track (FTT)
- Ground Moving Target (GMT)
- Sea (SEA)
- Beacon (BCN) (displayed on Menu page but not implemented)
- Air-to-Ground Ranging (AGR)

Depressing OSB 1 above the present mode mnemonic accesses the FCR mode menu page and displays the FCR modes available in the selected master mode. Depressing the OSB adjacent to the desired FCR mode deselects the current mode, accesses the selected mode and returns the display to the basic FCR format for that mode.

2.3.1.4.2 FCR TURN-ON/OFF

2.3.1.4.2.1 FCR POWER-ON

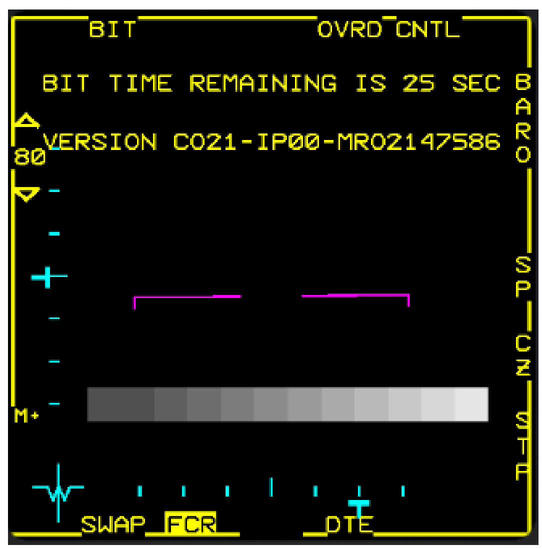
Before power can be applied to the FCR and other avionic subsystems, proper cooling from the Environmental Control System (ECS) must be present, i.e. ensure the AIR SOURCE knob position is set to NORM, otherwise the FCR will shut down automatically to avoid overheating. The MMC, MFDs and UFC should be operating prior to power-on.

The FCR format display page is accessed by depressing the FCR button on the basic MFD format and menu page or by depressing the highlighted primary format mnemonic on a MFD page other than the FCR page. Following FCR power application the FCR page will continue to display “FCR OFF” during the initial warm-up period (approximately 30 seconds after the application of power). The FCR then enters Built-In-Test (BIT) at Power- On.

2.3.1.4.2.2 FCR POWER-OFF

Placing the FCR Power Switch to OFF will start a power down sequence. This sequence lasts for approximately four seconds. If the switch is returned to ON/FCR before four seconds has elapsed the FCR software is reinitialized in a quick restart; the FCR will enter a shorter BIT and the transmitter does not have to “time-out” (perform its usual 3 minute warm-up). The FCR will re-enter the mode in which it left before the FCR switch was momentarily turned off and assume initial default conditions.

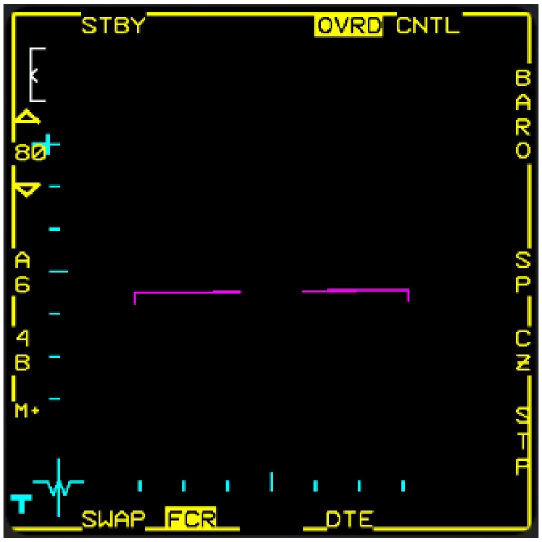
2.3.1.4.3 BIT - RADAR BUILT IN TEST



The AN/APG-68 performs a sequence of tests to alert for any FCR related problems. These tests, known as BITs, are a group of sequenced tests either automatically initiated at FCR power-on, referred to as BIT at Power-On (around 3 minutes), or manually initiated (via the TEST page), referred to as Pilot Selected BIT (approx. 30 seconds). BIT provides a thorough indication of operational system readiness.

During the BIT you can preset the desired antenna elevation and range (though the physical antenna remains stowed in the full up/left position) which will be selected as soon as you no longer have weight on wheels (WOW). If you leave the Power-On BIT to run its course the FCR will go to STBY mode after completion. If you press OSB 1 (BIT) while the Power-On BIT is running you can preselect the desired FCR mode from the Radar Mode page.

2.3.1.4.4 STANDBY (STBY)/OVERRIDE (OVRD)



STBY is automatically entered after the completion of BIT (if no other mode has been selected). STBY mode can be manually selected by either of the following two methods:

1. From a FCR mode display, depress the OVRD button (OSB 4).
2. From the FCR mode menu page display, depress the STBY button (OSB 1).

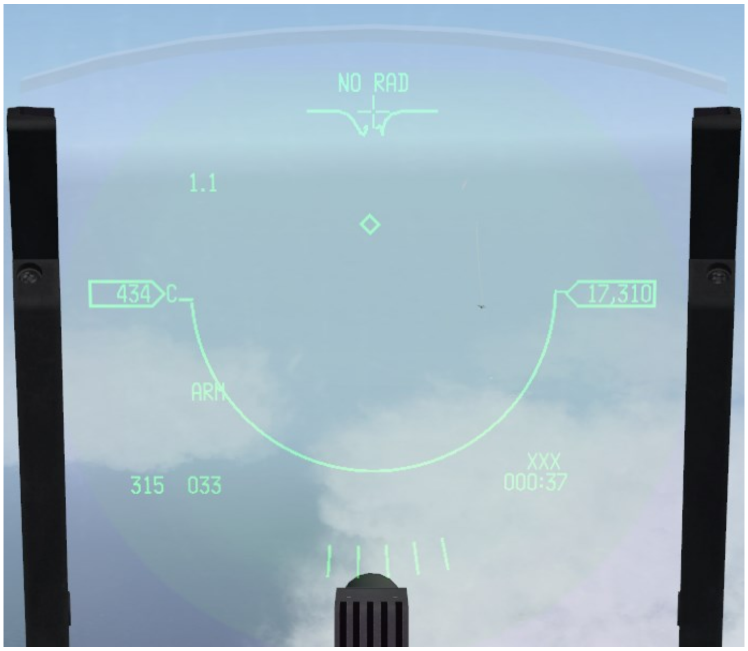
The OVRD button has the same function as the STBY button; depressing either button commands the FCR to STBY mode. At mode entry the mnemonic STBY appears in the upper left hand corner of the MFD and the OVRD mnemonic is highlighted. The OVRD button gives a quick way of selecting the STBY mode at any time, without having to select the FCR mode menu page first.

2.3.1.4.5 NO RAD / NOT SOI DISPLAY

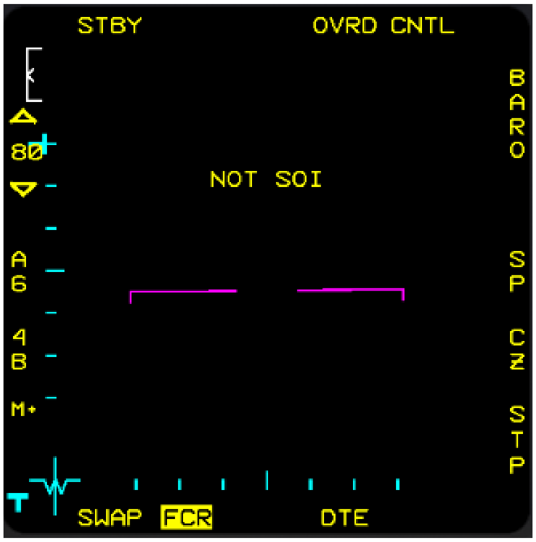
Two displays are provided on the MFDs and HUD/HMCS to improve response to FCR operations.

The NO RAD display is provided on the HUD/HMCS to indicate that the FCR is not radiating. Situations that create this possibility are as follows:

- STBY/OVRD submode selected.
- RF switch in QUIET or SILENT.
- ACM:
    - Initial entry into ACM (without a bugged target from another air-to-air mode) 30x20 NO RAD.
    - From any ACM radiating submode, TMS down also enters ACM 30x20 NO RAD.
    - With HUD as SOI, TMS down commands ACM BORE NO RAD when the FCR is slaved to the HMCS.
    - With HUD as SOI, TMS up and held commands ACM BORE NO RAD when the FCR is slaved to the HMCS in BORE.
    - With FCR as SOI and ACM radiating, TMS down rejects the target and commands 30x20 NO RAD (if FCR is not slaved to the HMCS in BORE).



The NOT SOI display is provided on (FCR, TGP, and WPN) MFD displays to indicate that the format is not currently the Sensor of Interest. Since the SOI symbol has a tendency to blend with the video, this display reduces time spent searching for a possibly nonexistent SOI symbol.



2.3.1.4.6 FCR INFORMATIONAL MESSAGES

FCR informational messages are displayed on the MFD when certain conditions within the FCR occur. These messages inform what corrective action, if any, should be initiated to make the FCR operational again.

2.3.1.4.6.1 "WAIT"

The "WAIT" message occurs when the FCR system is being reset. The length of time that the FCR needs to be reset is dependent on the condition which caused the message to appear. The FCR will start operation in 4 or 12 seconds without intervention. Once the commanded mode is entered, the message will clear.

2.3.1.4.6.2 "CHK FCR CONTROL PAGE"

The "CHK FCR CONTROL PAGE" message will be displayed after the FCR restarts and the BIT has completed. The purpose of this message is to inform the pilot that all pilot selectable parameters, i.e. control page values, azimuth selection, elevation bars and range scales are back to default values. The corrective action, if any, will be to reinitialize these to the desired values.

2.3.1.5 RADAR AIR-TO-AIR MODES

The complement of air-to-air radar modes provides the capability for search, detection and track of multiple targets to provide situation awareness and to support air-to-air weapon delivery. The air-to-air modes are divided into two top level radar modes:

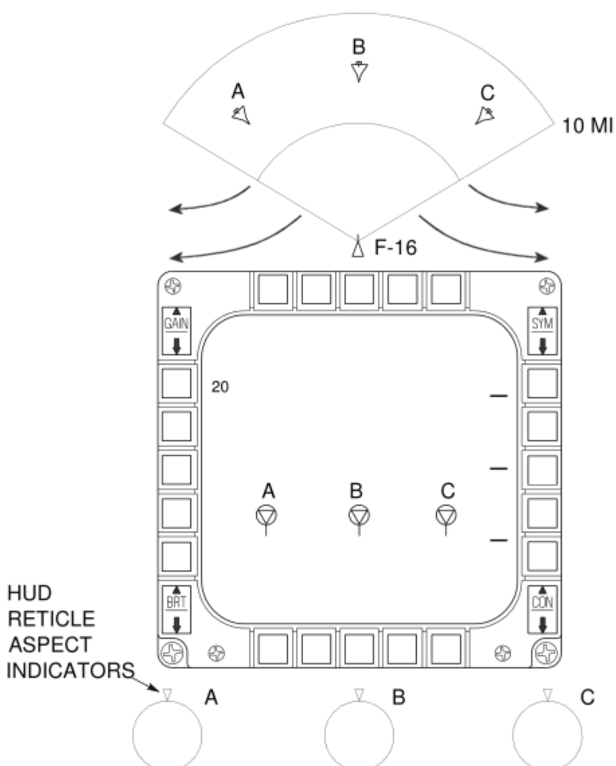
Combined Radar Mode (CRM) and Air Combat Maneuvering (ACM) mode.

2.3.1.5.1 MFD SYMBOLOGY AND DATA

2.3.1.5.1.1 B-SCOPE DISPLAY

Air-to-air FCR modes use a synthetic display, called the B-scope (aka B-scan), produced by the radar signal processor. It takes the radar cone and stretches the bottom of the cone along the bottom axis of the display. The entire bottom of the scope represents your F-16's position, not just the center. The target symbol as displayed on the radar represents your line of sight to the target.

This helps to separate contacts as they get closer, but is not as intuitive at first. To visualize the difference the figure below shows how the bottom of the pie-shaped radar coverage is stretched to fit the square B-scope display.



B-Scope

2.3.1.5.1.2 CURRENT FCR OPERATING MODE (OSB 1)

Possible mnemonics are:

- CRM: Combined Radar Mode
- ACM: Air Combat Mode

2.3.1.5.1.3 CURRENT CRM/ACM SUBMODE/TRACK STATUS (OSB 2)

Possible mnemonics are:

- CRM Submode:
    - RWS: Range-While-Search Mode
    - ULS: Up-Look Search Mode
    - VSR: Velocity Search w/ranging Mode
    - TWS: Track-While-Scan Mode
- ACM Submode:
    - 20: 30 x 20°
    - SLEW: Slewable
    - BORE: Boresight
    - 60: 10 x 60°

2.3.1.5.1.4 FCR A-A FIELD OF VIEW SELECT (OSB 3)

Options are:

- NORM: Normal FOV
- EXP: Expanded FOV

2.3.1.5.1.5 STANDBY OVERRIDE SELECT/DESELECT (OSB 4)

“OVRD” selects FCR standby page.

2.3.1.5.1.6 CONTROL PAGE SELECT (OSB 5)

The FCR Control Page is accessed via OSB 5 above the CNTL mnemonic. Depressing the OSB highlights the CNTL mnemonic and displays the control page options. The Control page may be accessed during flight without interrupting the present operating mode.

Currently only TGT HIS and AIFF CPL/DCPL is implemented in BMS.

2.3.1.5.1.6.1 TARGET HISTORY (TGT HIS) ROTARY (OSB 18)

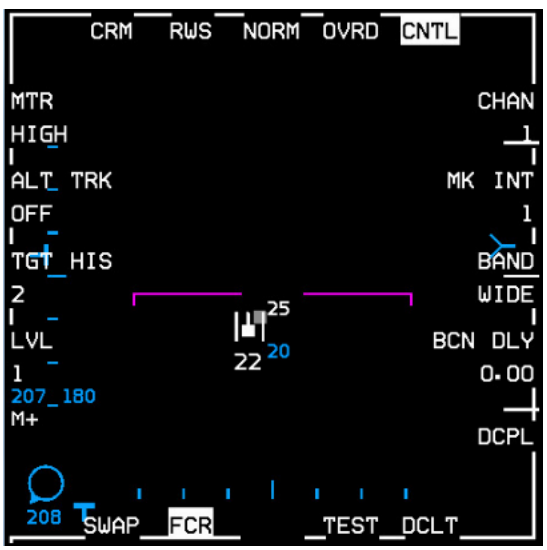
This rotary controls the display of target position history from the current frame and up to three previous frames.

- TGT HIS 1 displays targets detected on the current frame.
- TGT HIS 2 displays targets detected on the current and the preceding frame.
- TGT HIS 3 displays targets on the current and two previous frames.
- TGT HIS 4 displays all targets detected on the current and three previous frames.

Each history symbol becomes dimmer the longer it is displayed, disappearing entirely after it has been displayed the selected number of times. Initial value at power up in BMS is TGT HIS 2.

2.3.1.5.1.6.2 AIFF COUPLE/DECOUPLE (OSB 10)

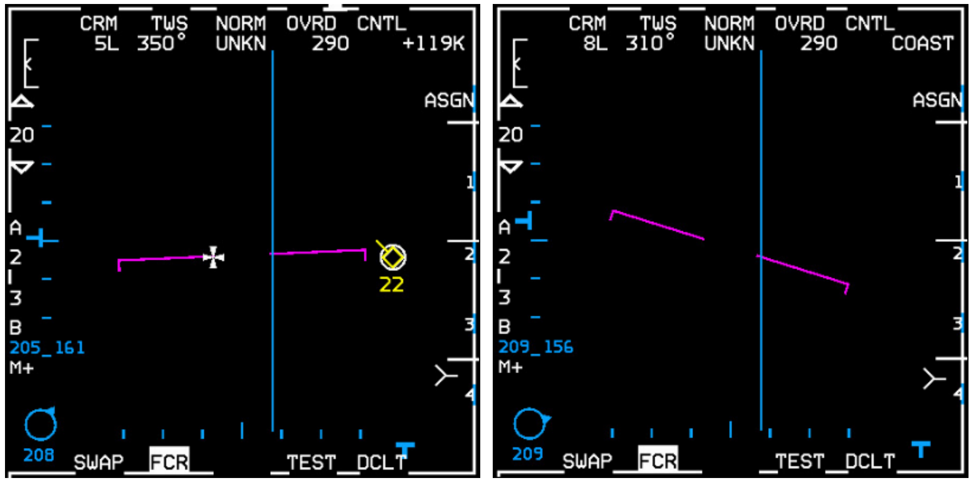
Advanced IFF (AIFF) CPL/DCPL is displayed adjacent to OSB 10. Selection couples the AIFF Interrogator FOV to the FCR FOV in the AIFF scan mode.



FCR – CNTL (Control) page

2.3.1.5.1.7 EXPANDED TARGET DATA (BELOW OSB 1-5 MNEMONICS)

Target Aspect Angle. Target aspect angle is displayed in tens of degrees (°) for the tracked target at the upper left corner of the MFD and is defined as the angle between the target longitudinal axis projected to the rear and the line of sight from the target to the aircraft. When the angle is at 0° the aircraft is on the tail of the target; at 180° the aircraft is on the nose of the target. Aspect angles from 0 - 70° indicate a tail aspect, 70 - 110° indicate a beam aspect, and 110 - 180° indicate a front aspect. The L or R mnemonic displayed next to the aspect angle readout indicates the target wing closest to the aircraft.



Expanded Target Data (left) and FCR in COAST (right)

Target Ground Track. Target magnetic ground track is displayed in 10° increments immediately to the right of the target aspect angle at the upper left of the MFD. Non Cooperative Target Recognition (NCTR). If NCTR has been successful in identifying the bugged target the target ID (e.g. MG29) will be displayed under the FOV mnemonic, otherwise it will read UNKN (unknown).

Calibrated Airspeed for Bugged/Priority Target. Target calibrated airspeed (KCAS) is displayed in 10 knot increments below the OVRD mnemonic. Target Closure Rate. Target closure rate is displayed in knots true airspeed (KTAS) at the upper right of the MFD. When in Coast the MFD displays “COAST”.

2.3.1.5.1.8 DATA LINK MODE (OSB 6). IDM DATA LINK MODE ROTARY

IDM Data Link Mode rotary:

- ASGN
- CONT
- DMD

2.3.1.5.1.9 DATA LINK ASSIGNMENT TRANSMIT STATUS (OSB 7-10)

Depression of OSB 7-10 (representing flight member numbers 1-4) transmits an IDM Assignment to that flight member and causes “XMT” to be displayed for 2 seconds.

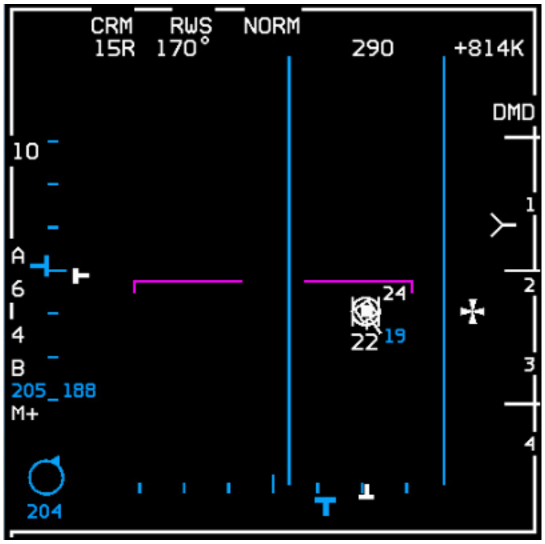
2.3.1.5.1.10 AIM-120 DYNAMIC LAUNCH ZONE (DLZ)

The dynamic launch zone consists of various range scales displayed along the right side of the MFD and HUD when the AIM-120 is the selected weapon.

Missile Time Remaining, Post Launch Range or Missile Time of Flight are displayed below the DLZ. See also AIM-120 Advanced Medium Range A-A Missile (AMRAAM) and Dynamic Launch Zone (DLZ).

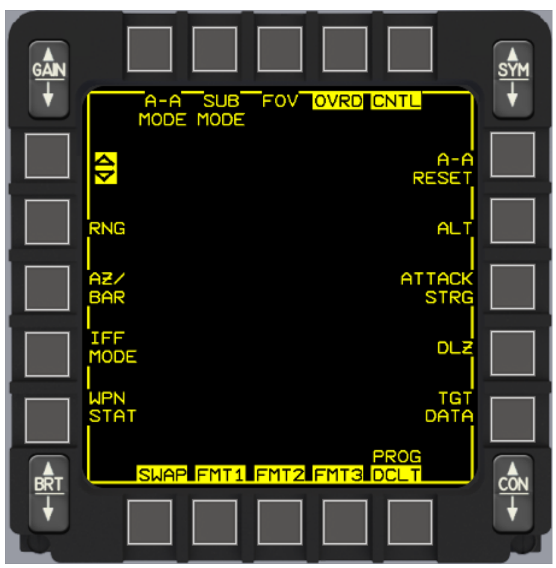
2.3.1.5.1.11 FCR A-A DECLUTTER SELECT/DESELECT (OSB 11)

When the DCLT OSB is depressed selected items are removed from the MFDs. Declutter is deselected by depressing the DCLT OSB a second time.



FCR Page decluttered

By pressing DCLT OSB long you can change different declutter options which were introduced in 4.36.
Decluttering is especially useful to “Clean up” the FCR and blend out certain symbology.
It can be used to blend out certain target information such as altitude, attack steering, DLZ, TGT data, etc. as well as your own weapon state and sensors. Set your values to your taste and task.



FCR DCLT CNTL

2.3.1.5.1.12 AIFF INTERROGATION DATA (ADJACENT TO OSB 16)

The Interrogator Type mnemonic (M1/M2/M3/M4/M+/OFF) and the Interrogator Mode (SCAN/LOS) are displayed on the air-to-air FCR page. See IDENTIFICATION FRIEND or FOE (IFF) chapter and the AIFF chapter in the Dash-1.

2.3.1.5.1.13 BULLSEYE SYMBOL/BEARING AND RANGE (ADJACENT TO OSB 16)

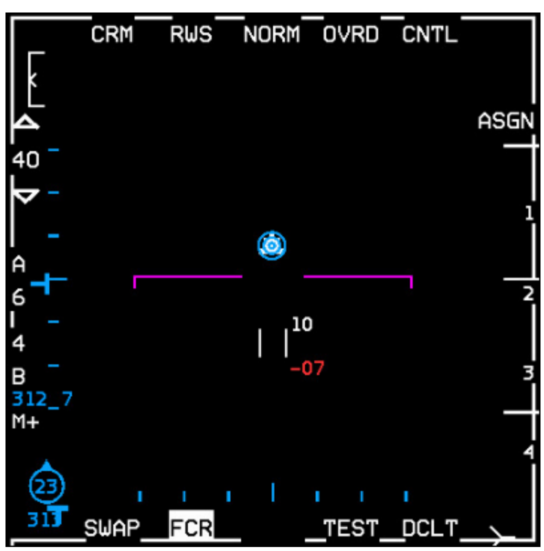
The bullseye bearing and range are computed by the MMC and displayed at the lower left corner of the FCR and HSD pages adjacent to OSB 16. There are four possible bearing and range solutions (depicted above the bullseye circle) based on the mode of the radar page. The four bearing and range solution possibilities are:

1. From the mode-selected bullseye to the cursor. Bullseye is mode-selected and the cursor is present on the radar page.
2. From the mode-selected bullseye to the TOI (bugged target). Bullseye is mode-selected and the cursor is not present (the radar is in Single Target Track (STT) or suspended SAM).
3. From the currently selected steerpoint to the cursor. Bullseye is not mode-selected and the cursor is present on the radar page.
4. From the currently selected steerpoint to the TOI. Bullseye is not mode-selected and the cursor is not present (the radar is in STT or suspended SAM).

For solutions 3 and 4 the bullseye LOS Bearing and Range circle displayed at the lower left corner of the MFD is replaced with the Aircraft Reference symbol.

The bullseye LOS Bearing and Range circle displayed at the lower left corner of the MFD indicates the bearing and range from the current aircraft position to the bullseye (bearing solution A). The directional tic on the circle indicates the bearing to the bullseye while the 2-digit number inside the circle indicates the range (2-digit so max 99 NM).

The 3-digit number below the circle indicates the magnetic bearing from the bullseye to the current aircraft position (bearing solution B). Magnetic bearing and range from bullseye to ownship are also displayed on the HUD.



Merged Bullseye and Steerpoint Symbols

2.3.1.5.1.14 RADAR SCAN COVERAGE (OSB 17-18)

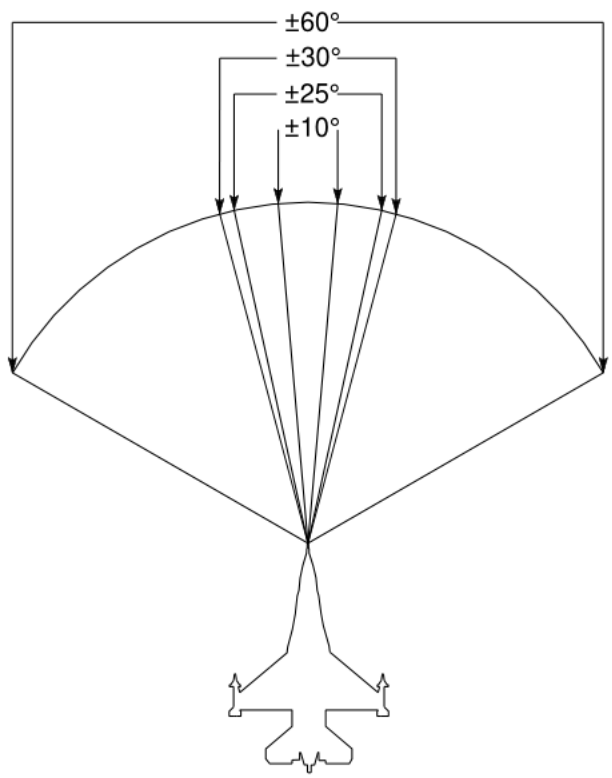
You control the power of the transmitter by setting the radar range and specify where the radar looks by controlling the position of the radar antenna.

The FCR can scan forward ±60° left and right as well as ±60° up and down, which means that the F-16 radar can scan a block of 120° by 120°. You control where the radar looks by first pointing your aircraft in the general direction of interest. Then you control the specific area by specifying the magnitude of the azimuth and elevation scan. You can also physically point the radar up or down, left or right within its gimbal limits of ±60°.

While the radar antenna has this physical range of motion, it is important to understand that you will not be able to scan this entire volume at once. Think of each of the air-to-air radar modes as providing a certain amount of focus to the viewing area, like shining a torch in a dark room. As you narrow the beam of light from the torch and get more focus, you can acquire more information, but the area you can look at gets correspondingly smaller and anything you are looking at is more likely to notice you!

You control the azimuth by adjusting the scan volume. The azimuth scans, depending on the mode, can be ±60° (the whole width of the radar scope) centred about the nose, or ±30°, ±25°, ±20° or ±10° centred about the acquisition (ACQ) cursor anywhere within the ±60° gimbal limits.

The ±25° azimuth (3 bar) scan is exclusive to Track-While-Scan (TWS) and Dual Target (DT) SAM modes.



FCR Azimuth Limits

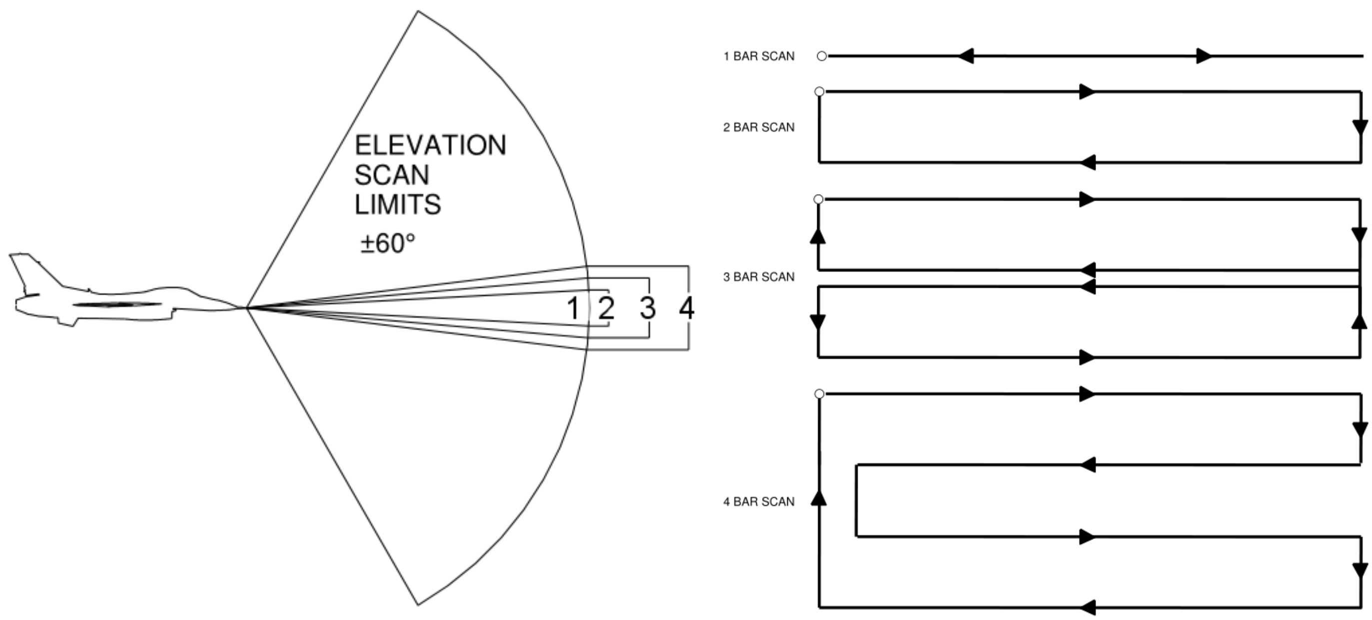
Radar elevation scan volume is controlled by specifying the bar scan. The beam that the antenna normally emits is not able to scan more than 4.9° in the vertical. If the radar just moves left to right and back that is considered 1 bar as it will scan just the single 4.9° slice of airspace. However, the radar can scan a larger area of vertical space if it moves down after a scan.

On a 2 bar scan, for example, the radar scans left to right, moves down a few degrees and scans back right to left. Because the radar antenna is pointing lower the return scan looks at a different area of space than the first scan.

Bar spacing is 2.2° for the 2 bar, 3 bar and 4 bar scans to overlap and avoid gaps in radar coverage.

A 4 bar scan covers the most area but takes the longest to complete. A 1 bar scan covers the least area but is the fastest; the 2 bar scan falls in between. You trade off coverage for increased refresh rate of targets.

3 bar (±25° azimuth) scans are only available in Track-While-Scan (TWS) and Dual Target (DT) SAM modes.



FCR Elevation Scan Limits (left) and Antenna Elevation Scan Coverage (right)

2.3.1.5.1.14.1 RADAR ANTENNA ELEVATION

The scan pattern is adjusted for altitude coverage by the position of the ANT ELEV thumbwheel located on the throttle. The scan pattern tilt angle can be centerd from +60° to -60°. The scan pattern is roll and pitch stabilized with the tilt angle referenced to the horizon.

2.3.1.5.1.14.2 ANTENNA ELEVATION CARET

Antenna elevation is indicated by the position of the horizontal **T**-shaped antenna elevation caret along the left edge of the MFD. The range is space referenced and runs from +60° at the top of the MFD to -60° at the bottom. On the left side of the display are 7 elevation tics, each representing 10° (-30° to +30°).

The number of elevation bars that the radar scans is controlled via OSB 17, adjacent to the B mnemonic and one of the elevation bar mnemonics (1, 2, 3, or 4).

2.3.1.5.1.14.3 MINIMUM/MAXIMUM (MIN/MAX) SEARCH ALTITUDES

To aid in adjusting antenna elevation in TWS and RWS, Min/Max Search Altitudes (rounded to the nearest thousand feet) are displayed to the right of the ACQ cursor. Altitudes are at the ACQ cursor range and take into account antenna beam width, bar spacing and antenna elevation.

2.3.1.5.1.14.4 ANTENNA AZIMUTH

Antenna azimuth is indicated by the position of the **T**-shaped antenna azimuth marker along the bottom of the MFD, where the left edge of the FCR video represents -60°, the center of the video represents 0° and the right edge represents +60°. The antenna azimuth marker is space referenced in RWS. When not in ±60° two vertical scan lines are displayed in search, spotlight, and SAM to indicate minimum and maximum azimuth scan limits. The vertical azimuth scan limit lines are also available in TWS but are not available in TWS Expand or in STT. The lines are blanked as they approach the edge of the MFD.

Scan width may be changed by moving the ACQ cursor to the left or right edge of the MFD, causing the scan width to toggle between ±30° and ±60°. If the present scan width is ±10° (commanded via OSB) then ACQ cursor deflection toggles the scan width to ±30°. Subsequent ACQ cursor control inputs toggle the scan width between ±30° and ±60°.

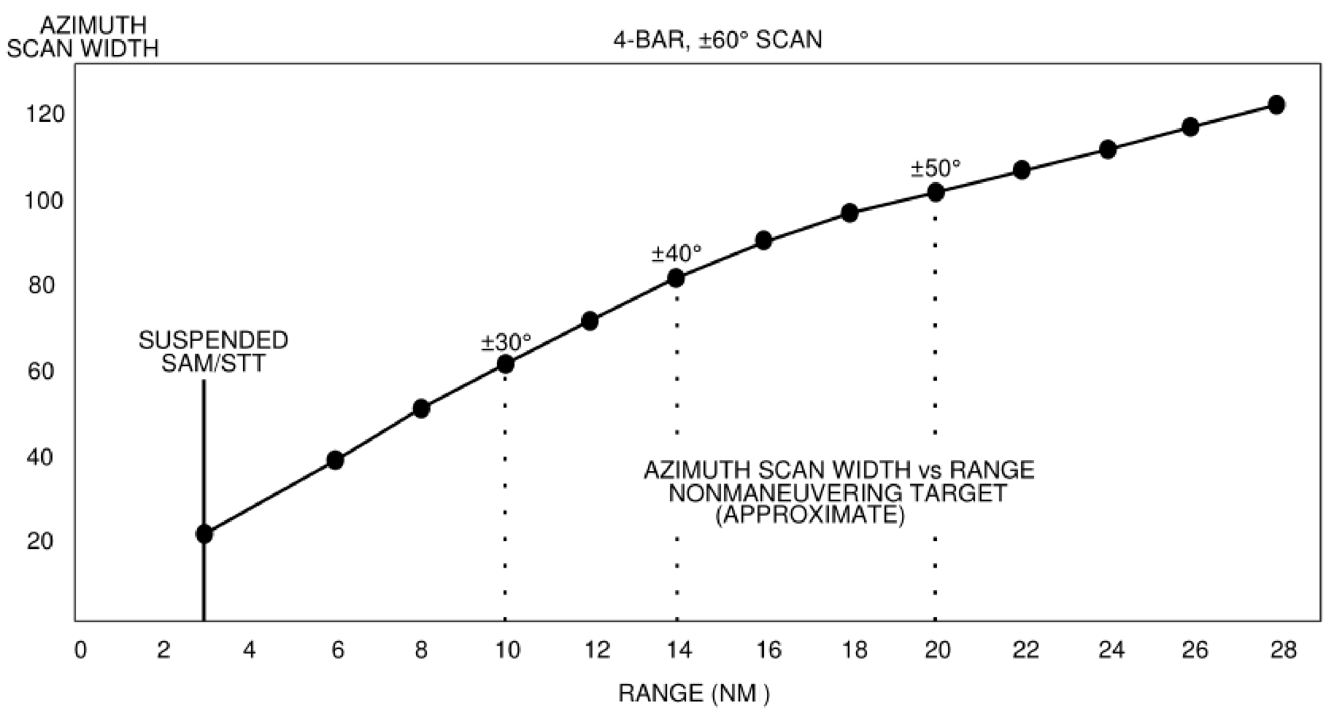
The ±60 degree azimuth scan width is the initial selection on the FCR format. Depressing OSB 18, adjacent to the A mnemonic selects one of the following scan width mnemonics in the rotary from wide to narrow:

6 - ±60° scan width, centerd about the nose (not available in TWS).

3 - ±30° scan width, centerd about the ACQ cursor (not available in TWS).

2 - ±25° scan width, centerd about the ACQ cursor (TWS & DT SAM only).

1 - ±10° scan width, centerd about the ACQ cursor.



SAM Azimuth Scan Width vs Range

In all A-A search modes except TWS, search volume control allows the ACQ cursor to be placed anywhere within the FCR scan volume. Azimuth gates no longer move with the ACQ cursor unless you get close to them and bump them. When the center of the ACQ cursor is within 4° of the edge of the search volume, the search volume center will move with ACQ cursor motion.

In SAM, the pilot has control of the maximum size and location of the antenna scan pattern as in RWS. Typically, the radar displays azimuth scan limits on the MFD indicating the actual scan volume. The azimuth scan limits on the MFD may be less than the pilot scan width because there are occasions when the scan volume is reduced in order to allow SAM to maintain quality tracks on the SAM targets; see above for scan width vs. range in SAM.

In DT SAM, the radar supports the pilot selected scan pattern until one of the targets has a range of less than 10 NM or an AMRAAM has been launched. In either case, the radar will enter the SAM Dual Target Track (DTT) submode, where it sequentially updates each of the SAM targets (ping pong) and does not interleave search processing.

2.3.1.5.1.15 FCR RANGE DISPLAY (OSB 19-20)

Target range can be determined by observing the target symbol position along the MFD range scale. Each of the three tic marks positioned along the right edge of the display dived the range into 4 equal sections. Range scale options are available as an increment/decrement function adjacent to the range △ ▽ OSBs. The range scale is selected from a rotary containing: 5, 10, 20, 40, 80 and 160 NM ranges. Depressing either of these OSBs will step through the rotary.

The range scale can also be changed hands-on while in search via the cursor controller function of the CURSOR/ENABLE control. If the ACQ cursor is slewed to a position of either less than 5% or greater than 95% of the selected range scale, the next lower or higher scale will be selected and the ACQ cursor will be positioned to approximately 50% in range of the selected scale and at the same azimuth as the previous scale. Range scale switching will not occur if it causes the target track to move off the display.

2.3.1.5.1.16 TARGET SYMBOLOGY

Search targets are displayed as solid squares with an aspect "Head" or "Tail" indicator. A bugged target is represented on the MFD as a circle around a solid square with a velocity vector. The tracked target may later be represented by a different symbol following identification of the bugged target. The bugged target is represented on the MFD by placement of a circle around that target symbol. In STT all other search targets are removed from the display and only the bugged target is displayed.

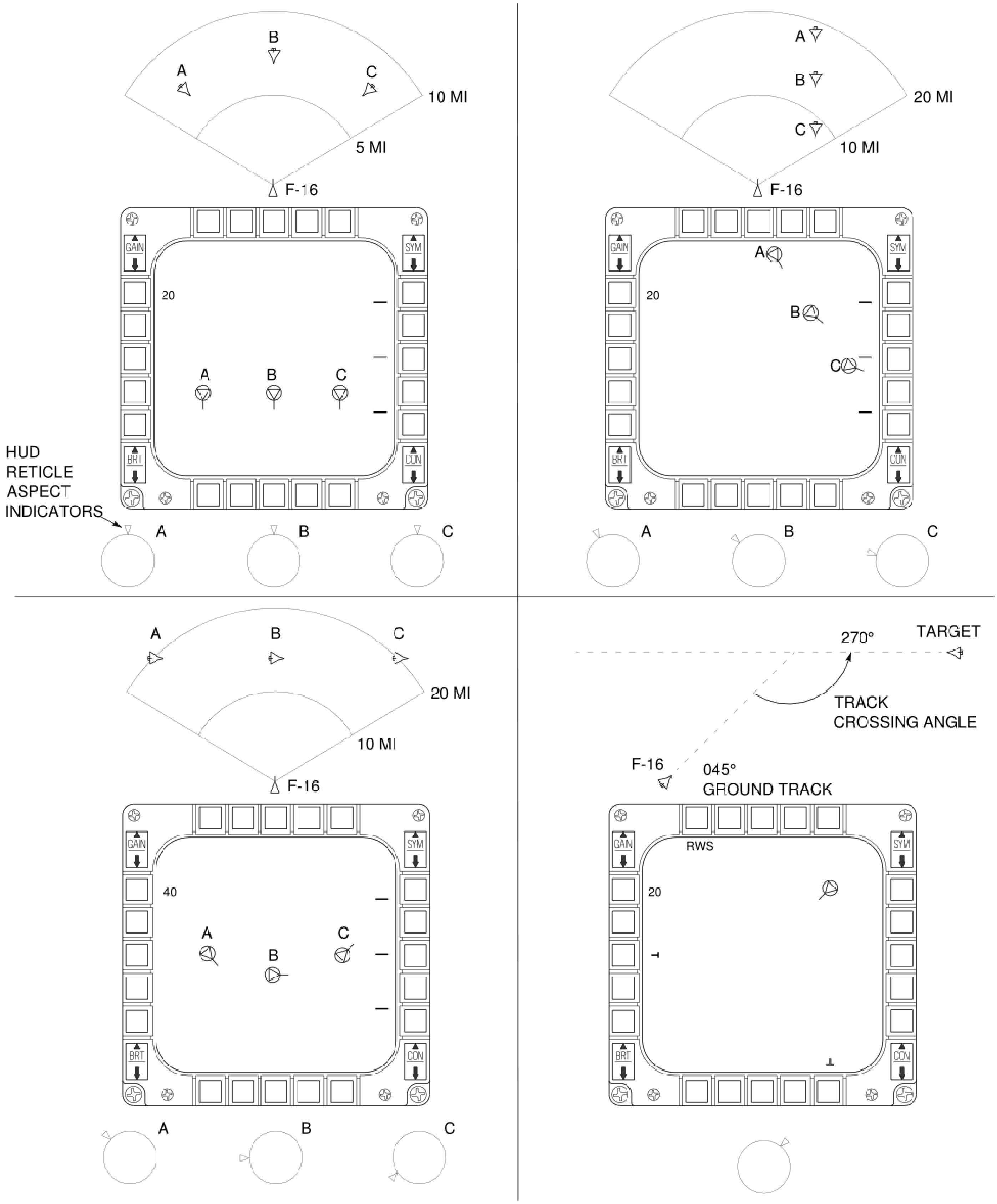
The bugged target is the highest priority target in all track modes (TWS, SAM, DTT). The bugged target altitude is displayed numerically in thousands of feet MSL, just below the bugged target. Target aspect angle, magnetic ground track, calibrated airspeed (KCAS) and closure rate (KTAS) are displayed across the top of the MFD. Only one bugged target may exist.

The tracked target symbol provides additional data. The symbol rotates in 11.25° increments defined by the aspect angle. A line extending from the nose of the symbol increases in length as absolute target velocity increases. Target altitude is displayed in thousands of feet beneath the symbol.

The target symbol as displayed on the radar represents your line of sight to the target. In the example top left you can see that any contacts moving directly down the B-scope display are always coming straight towards you.

In the example top right, when you look at Target A (which is further away), you see more of the target's front quarter (which is why the aspect angle is closer to 0°).

Even though Target C is pointed in the same direction as Target A its orientation on the radar display (and its aspect angle) are closer to the 9 o'clock position because it is closer, so you see more of its right side.



Tracked Target Symbology

2.3.1.5.1.17 ACQUISITION (ACQ) CURSOR

The cursor symbol "| |" displayed during search consists of two parallel vertical lines. Search targets are locked on by slewing the cursor over the search target symbol via the CURSOR/ENABLE control and designating via a TMS up. The maximum search altitude readout is displayed digitally in thousands of feet at the upper right of the ACQ cursor; the minimum search altitude readout is displayed at the lower right.

The width of the ACQ cursor = FCR range / 10, e.g.: on a 40 NM range scope the ACQ cursor width will be 4 NM.

2.3.1.5.1.18 STEERPOINT SYMBOLOGY

The pyramid-shaped (wedding cake) steerpoint symbol is displayed at the computed ground range and relative bearing from the aircraft to the selected steerpoint.

2.3.1.5.1.19 HORIZON LINE

The horizon line indicates the aircraft roll and pitch angles.

Aircraft roll angle is read by comparing the angle the horizon line makes with the normal level position (parallel with the top/bottom edges of the MFD) zero.

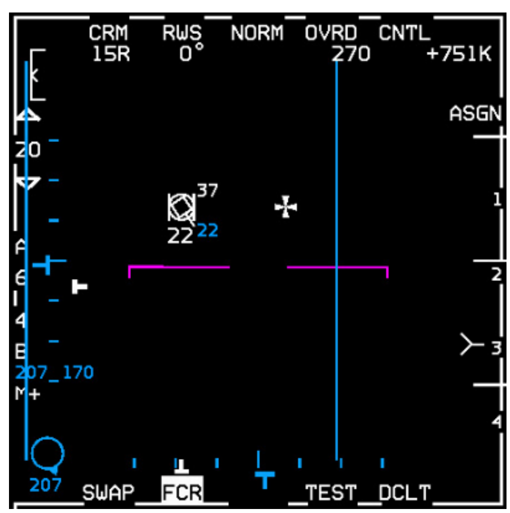
Aircraft pitch angle is read by observing how far the horizon has advanced from the center of the display. The edges of the display represent ±60° pitch.

The horizon line is limited at the edge of the display for angles greater than ±60°. Each end of the horizon line represents 30° left and right of aircraft flight path.

2.3.1.5.1.20 COLLISION ANTENNA TRAIN ANGLE (CATA)

The CATA steering symbol "✠" provides horizontal steering to the tracked target and is displayed at target range. The CATA symbol is not displayed when the collision angle exceeds 60°. To intercept the target the aircraft should be maneuvered toward the CATA to place the CATA at the center of the FCR display.

The CATA symbol is not displayed in newer blocks when the AIM-120 AMRAAM missile is selected; the ASC is used for steering until the range is 1.2 x R_{AERO}.



CATA

2.3.1.5.2 AIR-TO-AIR FEATURES

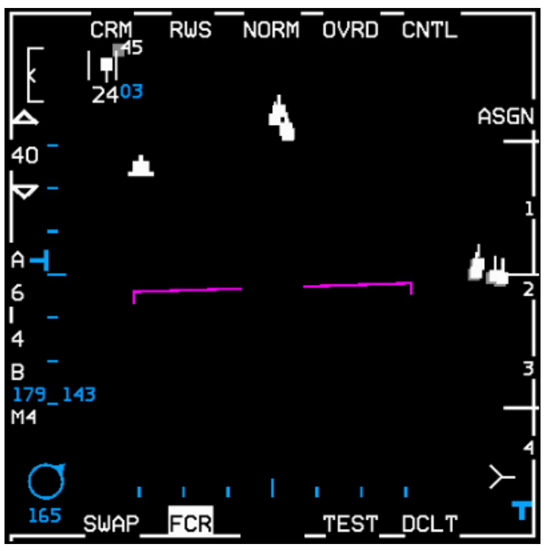
2.3.1.5.2.1 ENHANCED SEARCH DISPLAY (ESD)

ESD automatically includes a “Head” or “Tail” indicator on all search targets. The ESD provides a target aspect indication for all search targets with Doppler. The aspect indication provides the pilot with increased target information by displaying a short line attached to the search target symbol showing whether a target is head or tail aspect. When a target is head/high aspect (including near beam targets at 100° right/left) the indication will be pointing down. When a target is tail/low aspect (including near beam targets at 80” right/left) the indication will be pointing up from the search target. This is available in RWS, VSR, TWS, SAM, and DT SAM display modes.

2.3.1.5.2.2 SEARCH ALTITUDE DISPLAY (SAD)

The SAD capability is a feature which provides an estimate of a search target’s altitude. The SAD feature is displayed in RWS, SAM, DT SAM and TWS when the ACQ cursor is slewed over a search target symbol.

The SAD value is displayed as thousands of feet above Mean Sea Level (MSL), rounded off to the nearest thousand feet. If the FCR is in a single bar search scan, the altitude reported by SAD will be approximately the altitude corresponding to the center of the beam. The SAD is removed when the ACQ cursor is moved away from the search target.



ESD & SAD

2.3.1.5.2.2.1 CURSOR AREA OF EFFECT

The cursor area of effect is actually slightly larger (105%) than the size of the ACQ cursor (aka captain's “| |” bars) displayed on the screen. This means you will get SAD display as the cursor moves very close to but not quite over a radar target on the display. This greatly improves sorting capability without having to expand the field of view to separate the contacts.

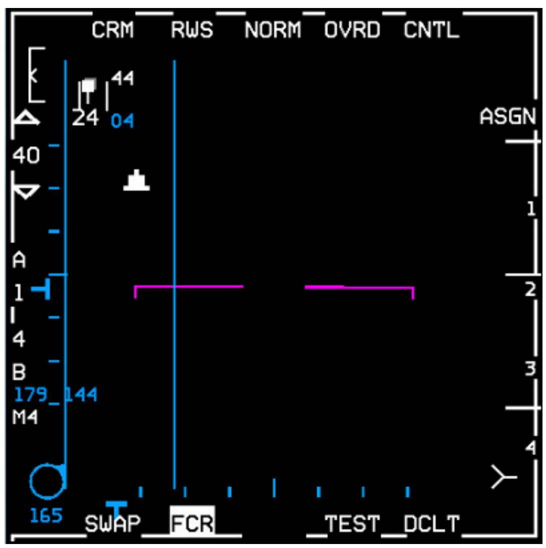
For example, to sort (i.e. designate/bug) the trail aircraft in a lead-trail group high-aspect on you simply move the cursor up to the upper side of the group and TMS Up. The larger cursor area will allow you designate the trailing contact without having to put the cursor precisely over the exact contact you want.

2.3.1.5.2.3 SPOTLIGHT SEARCH

Spotlight search provides hands on temporary switching to a 4 bar ±10° scan pattern, increasing opportunity for target detection in RWS and TWS.

Depressing and holding TMS Up for longer than 1 second will command the radar to spotlight search. The scan is centerd about the acquisition (ACQ) cursor and elevation (ANT ELEV) wheel setting and can be slewed. When slewing the ACQ cursor, the spotlight scan pattern will remain centerd in azimuth on the ACQ cursor. The scan coverage reverts to the previous pattern when TMS is released, unless a target is beneath the ACQ cursor, at which time the radar will attempt to acquire and track the target. Spotlight search is not available in RWS EXP.

Spotlight scan in TWS is similar to spotlight scan in RWS. The TWS spotlight search volume is initially centerd about the ACQ cursor. The spotlight search volume is not biased by the TWS track files, but is controlled through the use of the ACQ cursor and the ANT ELEV thumbwheel. In other words, the pilot can override the TWS bug priority in azimuth and elevation. Spotlighting outside the TWS priority scan volume will help establish track files on groups outside the previous TWS scan volume. Track updates on the target of interest (TOI) and targets with AIM-120 missiles in flight will only occur if the spotlight scan volume includes these targets.



Spotlight search

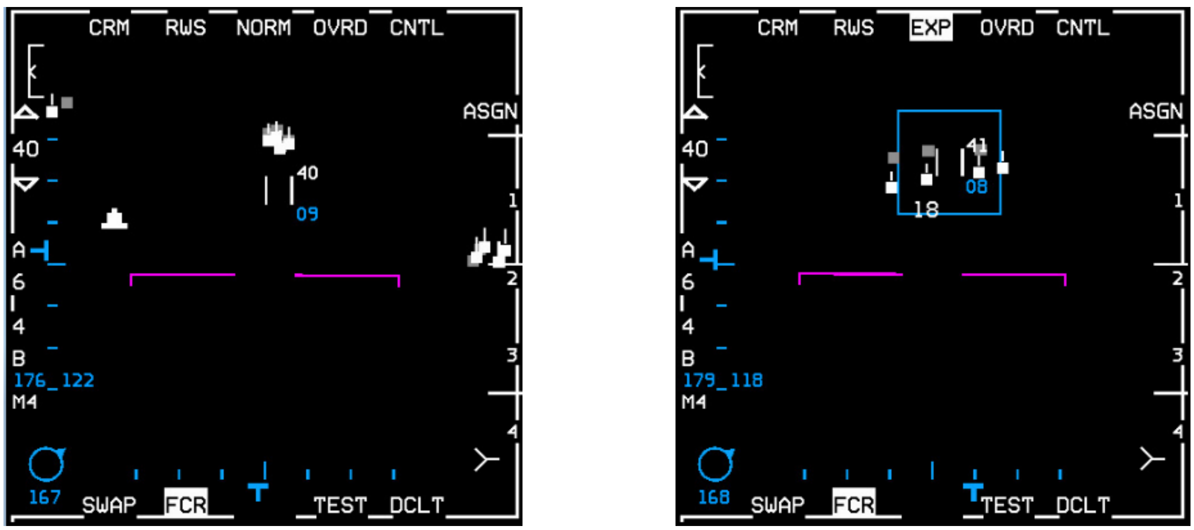
2.3.1.5.2.4 EXPANDED (EXP) DISPLAY

An EXP A-A display is available to more clearly resolve closely grouped targets in RWS, SAM and TWS. A 4 to 1 expansion in range and azimuth about the ACQ cursor is commanded by using either the EXPAND/FOV button (aka Pinky switch) on the stick, or by pressing the Field of View (FOV) OSB 3 on the MFD. The same switch actions toggle back to the normal (NORM) display.

The MFD displays a NORM or a flashing EXP mnemonic to indicate the current FOV. The ACQ cursor remains at its true range and azimuth in reference to the unexpanded display, while all other targets are expanded 4 to 1 about the ACQ cursor.

Coverage, location, and size of the antenna scan pattern remain unchanged in EXP; only the location of the targets on the display changes. Bump AZ and Auto Range scale changes due to target range are disabled during EXP.

The radar will automatically exit EXP when STT is commanded.

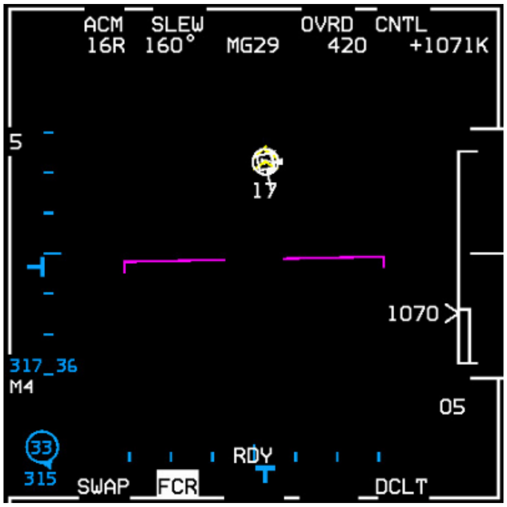


RWS NORM and EXP Display

2.3.1.5.2.5 NON-COOPERATIVE TARGET RECOGNITION (NCTR)

In STT mode the radar will use Non Cooperative Target Recognition (NCTR) algorithms to attempt to identify the aircraft being tracked. NCTR analyses returns from the radar and compares them to stored profiles.

NCTR in the F-16 relies on the turbine blade return from each aircraft and hence will only work if the target aircraft is head-on and the turbine blades are visible to the radar. If the radar cannot 'see' the turbines clearly and is unable to identify the target "UNKN" will be displayed. "WAIT" means that radar is analysing data.



NCTR

2.3.1.5.3 COMBINED RADAR MODE (CRM)

The CRM is designed to simplify pilot switchology by providing hands-on accessibility of Range While Search (RWS), Up-Look Search (ULS), Velocity Search with Ranging (VSR) and Track While Scan (TWS) modes. CRM is divided into two modes of operation - a search mode and a multiple target track mode. The search modes available are RWS, ULS, and VSR. The multiple target track mode is TWS. RWS, ULS, VSR, and TWS are referred to as CRM submodes.

Both the Situation Awareness Mode (SAM) and Single Target Track (STT) are supported by CRM. STT is available in all A-A modes while SAM is available in RWS and ULS. SAM can support up to two track files while maintaining situation awareness.

2.3.1.5.3.1 MODE ENTRY

The submode that the radar enters when the pilot selects CRM is dependent upon whether the radar has been in CRM previously. If CRM is being selected for the first time since power up, the radar will enter RWS. However, if the radar has previously been in CRM, the radar will enter the CRM search submode last exited (RWS, ULS, or VSR). Therefore the CRM submode selection is not master mode dependent.

Upon CRM entry from ACM STT, SAM will be entered if the radar was in RWS or ULS the last time CRM was left and VSR STT will be entered if the radar was in VSR last.

2.3.1.5.3.2 SUBMODE SELECTION

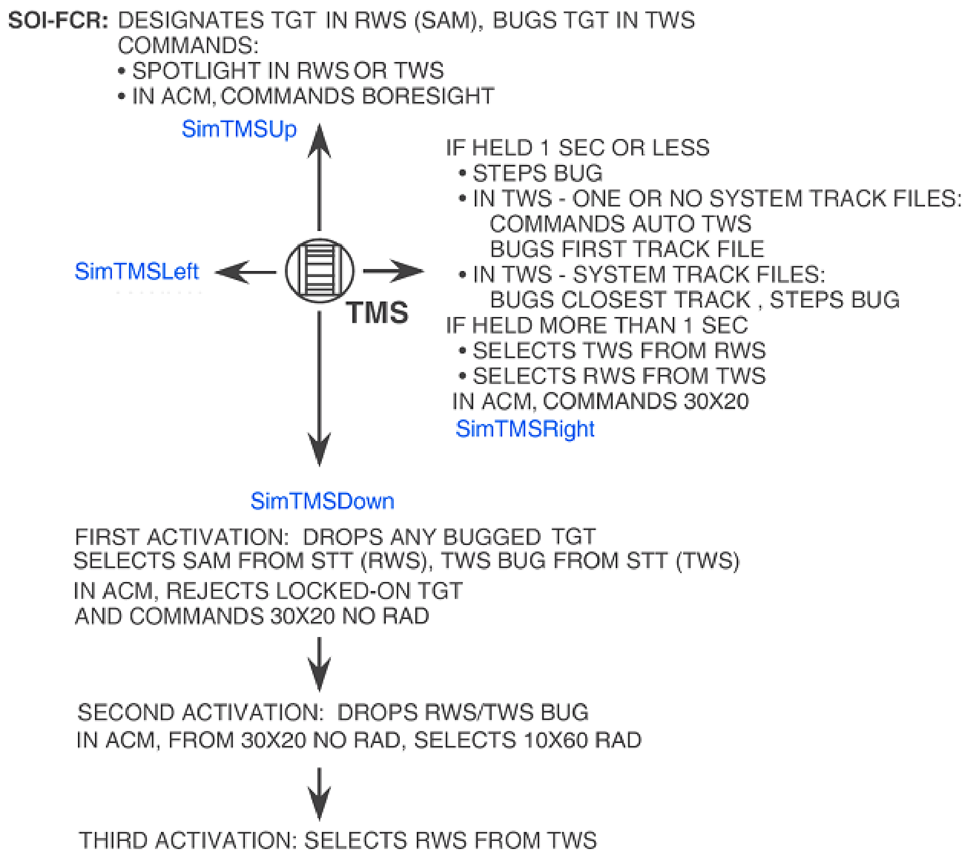
Once the radar has entered CRM, the pilot has the capability of entering TWS from any CRM search submode by pressing the Target Management Switch (TMS) right for more than 1 second. The pilot can return to the CRM search submode by depressing OSB 1 on the MFD and then reselecting "CRM" from the menu. If there was a bugged target in TWS this target will become the SAM target if the CRM search mode is RWS or ULS, or the STT target if VSR was selected.

There are three hands-on methods to return to the CRM search submode:

- To transfer without maintaining track on a TWS bugged target, a TMS down (Return-to-Search) followed by a TMS right and hold, **or** TMS down 3 times, will clear all track files and transfer back to the CRM search mode last exited.
- To maintain track on the TWS bugged target the pilot can make a quick, momentary transfer to Dogfight (DGFT) and back (Air Combat Maneuvering (ACM) must be the DGFT programmed mode).
- And lastly, the pilot can command the last CRM search submode by holding TMS right for more than 1 second. Upon return, the previously selected search mode will be selected and the TWS bugged target will become a SAM or STT target.

CRM has a search mode rotary: RWS → ULS → VSR. The CRM search mode is changed by depressing OSB 2 which causes the next search mode in the rotary to be selected.

2.3.1.5.3.3 TARGET ACQUISITION AND MANAGEMENT



A-A HOTAS TMS functions (FCR SOI)

The following paragraphs provide an overview of CRM operations using the Target Management Switch (TMS):

- Designating (TMS up) on an RWS search target changes it to a bugged/priority target and places the FCR into the SAM submode.
- Holding TMS up will initiate spotlight search. Upon release of the TMS, acquisition/track is attempted if a search target is bracketed by, or very close to, the ACQ cursor.
- Designating on a *second* RWS search target while tracking a target in SAM will transition the radar to dual target (DT) SAM submode. When DT SAM is entered, the first bugged target remains the primary target, the second designated target becomes the secondary target and the scan volume is adjusted to allow each target to be updated as the radar continues to search in RWS.
- When both the bugged/primary target and the secondary target are beyond 10 NM the search volume is fixed at ±25° azimuth, 3 bar. The scan pattern is centerd in azimuth on the ACQ cursor and is controlled in elevation via the ANT ELEV wheel. TMS right for less than 1 second will step the bug between the two targets. When either target is within 10 NM search is suspended and the radar spends all its time tracking the bugged and secondary targets (aka ping pong).
- When the scan pattern is moved off of both targets in DT SAM the scan width will adjust to optimize track versus search time. As the scan pattern is moved away from both targets the scan width will become narrower. When the bugged target is within 3 NM the radar automatically drops track on the secondary target and switches to STT on the bugged target.
- Designating on a bugged SAM target also places the radar into STT.

- Designate actions (TMS up) change submodes from RWS ⟶ SAM ⟶ DT SAM ⟶ STT. Return-to-Search (RTS) actions (TMS down) change the submodes back the other way. For example, if the pilot designates a target and puts the radar into SAM submode a subsequent TMS down will return the bugged target to a search target and the radar will return to RWS. TMS down in STT will switch the radar to DT SAM if a secondary target is being extrapolated, or to SAM if there is no secondary target. TMS down from DT SAM will switch the radar to SAM. TMS down from SAM will return the radar to RWS.
- Depressing TMS right for more than 1 second, from any CRM RWS mode with or without a tracked target (SAM, DT SAM, or STT), transitions the radar to TWS and retains any pre-existing bugged targets.
- Commanding TMS right and hold from TWS with a bugged target and system track files will transition the radar to DT SAM. The bugged target in TWS will become the primary (bugged) target in DT SAM. The TWS system track file selected as the DT SAM secondary target is based on MMC and FCR prioritization, e.g. ACQ cursor over target or system track file.

2.3.1.5.4 RANGE-WHILE-SEARCH (RWS) MODE

In the Range-While-Search (RWS) mode the radar searches a selectable volume of space and displays the position of any detected targets on the MFD. No track data (target range, velocity, angle or ground track) is available on these detected targets.

A specific target can be tracked/bugged by slewing the acquisition (ACQ) cursor over the target and depressing and releasing TMS up (designate). This causes entry into Situation Awareness Mode (SAM). TMS right for less than 1 second steps the bug to the next priority target in DT SAM.

Holding TMS right for more than 1 second changes the mode to TWS. Stepping the radar target of interest (TOI), or bugged/priority target, is limited to targets that are displayed on the currently selected FCR range scale.

In RWS, the ACQ cursor is used to:

- Request the Search Altitude Display (SAD).
- Select a target for SAM or STT.
- Change the search pattern azimuth width.
- Change the display range scale.
- Position the EXP square when EXP is entered.

2.3.1.5.5 UP-LOOK SEARCH (ULS)

The ULS mode is a search submode of the CRM and in the real APG-68 is designed to detect aircraft at high altitudes in look-up, clutter-free situations. Clutter is not rejected in ULS. When the scan coverage illuminates the ground or certain cloud formations, many false targets are displayed. ULS is able to detect targets at longer ranges than RWS since its processing is designed for use in a clutter- free environment. As these differences are not currently modelled in BMS ULS is functionally identical to RWS in BMS.

In the real APG-68 ULS is identical to RWS in the areas of target display, cursor control and scan coverage but Enhanced Search Display is not presented in ULS since Doppler information is not available in ULS.

Manual acquisition to SAM or STT from ULS is identical to acquisition from RWS.

2.3.1.5.6 VELOCITY SEARCH WITH RANGING (VSR)

VSR is a search submode of the CRM that interleaves high and medium Pulse Repetition Frequency (PRF) waveforms to provide long range detection of forward aspect targets. VSR is designed to detect forward aspect targets only. In order to be displayed in VSR, targets must have a velocity component along the radar's LOS directed toward the F-16. Hence this mode will only display contacts that are closing; contacts that are moving away (extending) are not displayed.

Contact detection and display in VSR is a two-step process consisting of a high PRF scan followed by a medium PRF scan. The first scan is called the Alert scan during which a contact is first detected and its azimuth and velocity are stored. Immediately after a Confirm scan is initiated with which the range is determined. After the contact has been detected in both Alert and Confirm scans, the target is displayed.

Targets are displayed on the MFD as solid squares in a B-scope presentation similar to RWS. Only contacts that are closing are displayed.

Manual Acquisition is the method by which the pilot selects a target to track in STT. Acquisition from VSR is the same as from RWS, except that a single Designate (TMS up) switches to STT. SAM cannot be entered directly from VSR.

The cursor is used to select a target for STT, initiate SAD (Search Altitude Display), move the antenna search pattern in azimuth, change the search pattern azimuth selection and change the displayed range scale.

Although only closing targets are detected and displayed in VSR search, acquisition of other targets is not specifically inhibited. This allows the pilot to acquire a turning target that was forward aspect or closing in VSR search, but has turned to a tail aspect or extending target by the time acquisition is commanded, or acquire a tail aspect target that just by coincidence happens to be in the same angular line of sight as an alert for a forward aspect target.

Since the VSR mode is specifically tailored for detection of long range closing targets, it is the optimum mode for a corridor search mission. Although it can be operated with larger scan volumes, frame times lengthen and reduce the effectiveness of the mode, so VSR is best utilized with a small search pattern (1 or 2 elevation bars by ±10° or ±30° in azimuth).

2.3.1.5.7 TRACK WHILE SCAN (TWS)

TWS is the multiple target track submode of the CRM and is designed to automatically track multiple airborne targets. Track information is formulated from repetitive search target detections as the antenna sweeps the scan volume.

Options are available for target display, target prioritization, selecting search volumes, and target rejection. While TWS tracks multiple targets, the pilot may select a target for STT to improve the accuracy of the track data for that target.

2.3.1.5.7.1 SCAN PATTERNS

To switch to the TWS submode, the pilot may press OSB 2 until "TWS" is displayed, or hold TMS right for more than 1 second to switch from RWS/ULS to TWS. Upon entering TWS the radar azimuth will initialize to an "A2" or 50° azimuth scan (±25° either side of boresight) and the elevation will initialize to a 3 bar "3B" scan.

Three scan patterns are available in TWS. They are:

±60°, 2 bar

±25°, 3 bar

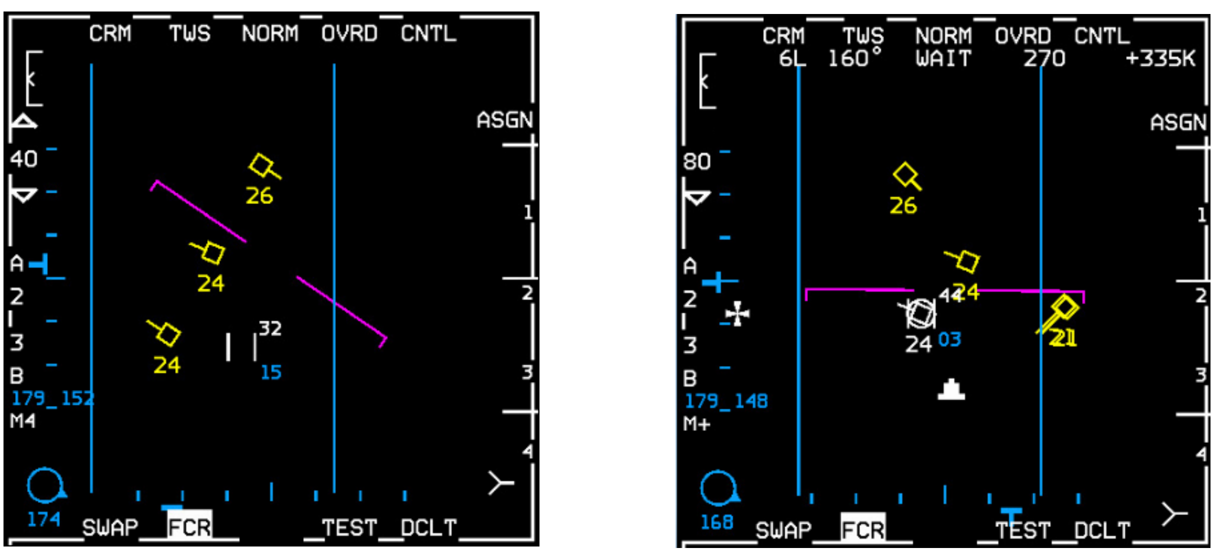
±10°, 4 bar

2.3.1.5.7.2 TWS MECHANIZATION

As its name implies, TWS tracks multiple targets while searching for others. It is mechanized to begin forming track files automatically from RWS search targets (solid squares) when the radar receives two hits (the radar detects something twice) in 6.5 seconds.

The radar is able to track 10 targets simultaneously. Since the radar does not pause on the track files while scanning, the track's positions are extrapolated in between updates (when the radar detects them again).

If a target is not updated, i.e. detected in 13 seconds, the radar will dump the track file until the target is detected again, whereupon it will rebuild it into a track file. A dump could happen for a number of reasons, including a target moving out of the radar's current azimuth scan, elevation scan, or both. In the picture right below the track files at 21,000ft are outside the scan coverage, being extrapolated and about to be dumped.



TWS (left) and TWS with bugged/priority target (right)

Also for example, if the pilot is tracking 10 targets and decides to designate on a search target, the radar will dump the lowest priority track and automatically upgrade the search target into a track file. If the radar has not received a hit on a track on its return scan where the radar thinks it should be based on the target's last heading and speed, the track file will turn from yellow to red to indicate this. When the track is detected again, it will turn back to yellow.

If a track is no longer detected it will turn red like previously mentioned and extrapolate for 13 seconds total. The last 5 seconds before the radar dumps the track, the track will begin to flash. Tracks are prioritized by range and the order in which they were built.

Without a bugged target, the azimuth scan centers on the cursors and elevation is controlled manually. When a target is bugged the azimuth is biased to keep the bugged target in the scan and the elevation is centerd on the bugged target. If the antenna elevation is tilted while the pilot has a bugged target, upon dropping the bug, the elevation scan will move according to what the pilot commanded to reflect the position set by the antenna elevation controls.

2.3.1.5.7.3 TARGET MANAGEMENT (MOVING THE "BUG")

There are two ways to bug targets. The pilot may either slew the cursors over to a track file (or search target) and designate, or may TMS right to jump to the closest track file. TMS right again will step the bug to the next highest priority track file and so on.

The pilot may enter STT (Single Target Track) by slewing the cursors over the bug and pressing TMS up. This will erase all search targets and tracks from the radar, although the tracks will extrapolate for 13 seconds. TMS down (aka RTS (Return-to-Search)) is used to return to TWS, the extrapolated tracks will reappear and the target will be bugged. If RTS is commanded again, the pilot will drop the bug and the radar will continue to TWS. If RTS is commanded a third time, the radar will dump all tracks and begin rebuilding tracks automatically. If RTS is commanded a fourth time, the radar will go back to RWS.

Targets are detected in TWS as they are in RWS, and search detection symbols (small filled squares with head or tails) are displayed at the target range and azimuth. Search targets may be either manually or automatically acquired and tracked. Search detections whose ground speed along the radar line of sight is greater than 200 knots will be automatically acquired and tracked by the radar as described above. Targets whose speed is slower than 200 knots can be acquired manually by placing the ACQ cursor over the target and designating. The speed gate prevents using a track slot for a low threat target or a potential false alarm.

2.3.1.5.7.4 TWS OPERATIONAL CONSIDERATIONS

TWS provides a multiple target track situation awareness capability by limiting the time spent on updating track files. In contrast, STT spends considerably more time updating the bugged target at the expense of situation awareness (SAM provides track quality between TWS and STT quality).

Since TWS limits the amount of time that is spent updating a target a maneuvering target can be a significant distance away from its expected position at the time of the next track update. The error introduced during the interval between track updates can result in "jumpy" TWS track symbology on the MFD and HUD as compared to SAM and STT, or even track files disappearing and reappearing.

Aside from some jumps of the TWS track symbology, the time between updates makes TWS an undesirable mode for target ranges of less than 5 NM when the target is maneuvering. If a target engagement is expected, the pilot should consider entering STT or SAM.

2.3.1.5.8 SINGLE TARGET TRACK (STT)

STT is a submode of all radar modes. It is designed to automatically maintain a highly accurate track of a single airborne target for weapon delivery.

2.3.1.5.8.1 STT DISPLAY

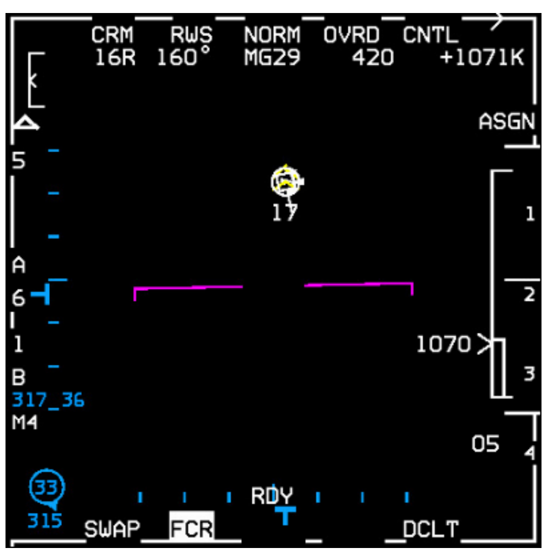
A STT bugged target is displayed just like all other bugged targets. Target altitude and target data are presented just like TWS and SAM bugged targets.

When the target is acquired in RWS, ULS and VSR, the target symbol changes from a small square (search target symbol) to an open square enclosed in a circle (tracked target symbol). When the target is acquired in TWS, the target symbol remains the same and all other targets displayed (if any) are blanked from the MFD display and extrapolated by the radar software for a maximum of 13 seconds from the last time each target was updated. In ACM, the target acquired will appear as an open square enclosed in a circle. In the missile modes, this symbol will also have a tail if a slaved AIM-120 missile has been launched at the target. The target range can be determined by comparing the position of the symbol to the range marks on the right edge of the display or using the HUD/HMCS range window. The lateral position of the symbol represents azimuth.

Several features are available to aid in visually locating, intercepting and evaluating the target including:

- A target designator box or locator line is displayed on the HUD/HMCS.
- An intercept steering symbol is displayed on the radar format.
- Target data is displayed digitally on the radar format and, to a lesser extent, on the HUD/HMCS.
- The radar range scale is switched automatically to keep the target symbol in the central area of the MFD.

During STT a cross "✠" is displayed on the radar format at target range to aid in performing various intercept maneuvers. By comparing the position of the symbol versus the centerline of the MFD, the pilot can fly collision, pursuit, or lead steering. This intercept steering symbol provides horizontal steering only, not vertical. If the collision angle exceeds ±60°, the intercept steering symbol disappears off the edge of the MFD.



STT

2.3.1.5.8.2 STT MECHANIZATION

The radar filters ground clutter to enable lookdown operation. When the target is in the clutter (where the target's Doppler frequency falls within the band of frequencies occupied by the clutter aka Doppler Notch), the closure rate is uncertain. When this happens, the closure rates displayed in the upper right of the MFD and next to the target range cue are replaced with the mnemonic COAST. COAST is also indicated by a dashed TD Box and Target Locator Line (TLL) in the HUD/HMCS. In COAST the target position is extrapolated from the last known information (i.e. it is no longer the actual position as in previous versions) and the FCR searches for the target leaving the ground clutter's Doppler region to resume a normal active track. If unsuccessful the FCR will return to the previous search mode.

Currently in BMS a track target will flash after one failed update but is not dropped until 13 seconds have elapsed; the COAST indication happens only 5 seconds before the track is dropped. So there is a period of around 8 seconds when the TD box and TTL in the HUD/HMCS isn't dashed.

With a bugged or STT target the FCR should not drop track when the target exits the FCR gimbals. The FCR will enter COAST as above and the TTL will point to the estimated target position, therefore the TLL can display a number higher than the gimbal limit of 60°. If the target is brought back inside the FCR scan volume within those 13 seconds the FCR will attempt to reacquire a valid track on the target with a high chance of success. If unsuccessful at reacquiring the target the FCR will return to the previous search mode.

If a high line of sight (LOS) target is gimbaled and is within 3 NM range, it will be dropped immediately instead of extrapolated. This is helpful in a visual turning fight to avoid having to TMS down (RTS) to stop the FCR extrapolating every time a bandit with a high LOS rate goes outside gimbals.

2.3.1.5.8.3 STT MODE SWITCHING

The radar can enter STT from any search mode. From RWS or ULS, the ACQ curser is slewed over a search target, then TMS up (designate) and release twice; this bypasses SAM mode. From SAM or TWS, the ACQ curser is slewed over the bugged target, then TMS up and release. Double designating the SAM secondary target, when the radar is in DTT, will cause the newly designated target to become the STT target. From ACM, once a scan pattern has been selected and a target has been detected, STT is automatically entered.

If ACM is selected from STT, or SAM, and the target is outside 10 NM, the target will continue to be tracked at the extended range. When STT is terminated, ACM will revert to the 10 NM search processing.

When RTS is commanded (TMS down in STT), the STT bugged target becomes the SAM primary target and SAM operation is resumed. Two successive RTS commands in STT will result in a transition directly back to RWS. RTS from TWS STT and the STT target becomes the TWS primary target and TWS operation is resumed. If RTS is commanded when the upper level mode is ACM, the radar will return to ACM 20 NO RAD.

2.3.1.5.8.4 STT OPERATIONAL CONSIDERATIONS

STT is the mode of choice for retaining a highly accurate track of a single airborne target for weapon delivery, as the antenna beam remains constantly centerd on the target. As a result using STT to obtain target information can reveal your position or intent to any enemy with a Radar Warning Receiver (RWR).

STT is best used, therefore, to prosecute an attack once weapon parameters are reached, when you care less about giving away your intentions and more about maximizing the success of your attack.

2.3.1.5.9 SITUATION AWARENESS MODE (SAM)

Situation Awareness Mode (SAM) provides the capability to simultaneously track either a single target (ST SAM) or dual targets (DT SAM) and search a controlled volume of space. The search volume is controlled via the hands-on antenna controls and MFD selected parameters. The search volume may be reduced in azimuth (or even suspended) in order to maintain track on the target(s) of interest.

2.3.1.5.9.1 SAM DISPLAY

The Primary SAM target (also referred to as the TOI or the bugged target) is displayed on the MFD like an STT target. Immediately under the Primary SAM target, the target altitude is displayed numerically in thousands of feet above sea level. In addition, numerical data associated with the Primary SAM target is presented across the top of the display indicating target aspect angle, magnetic ground track, calibrated airspeed and closure rate.

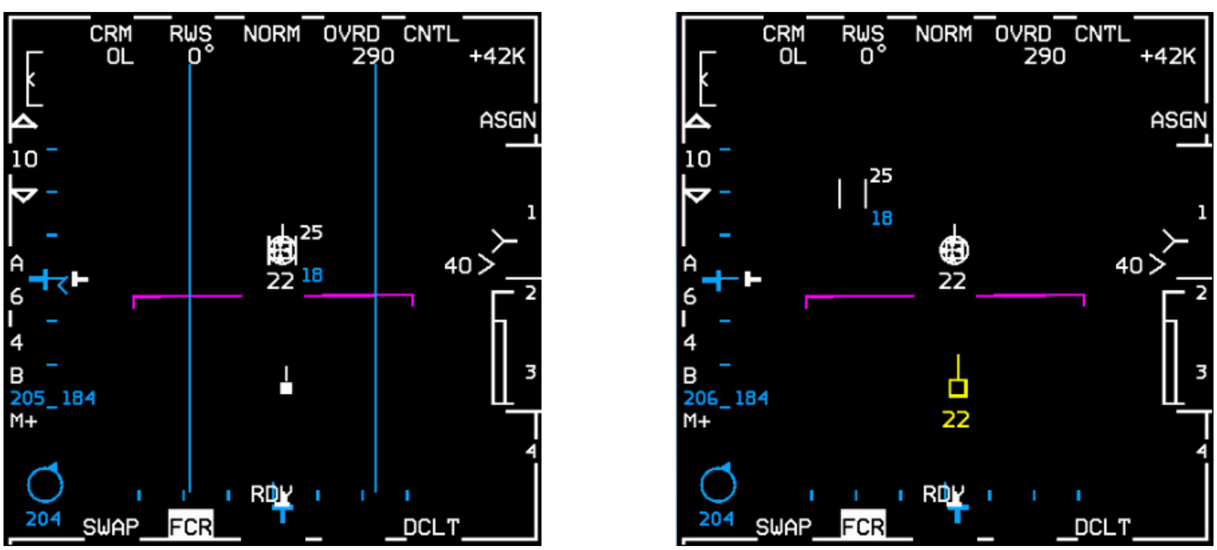
The Secondary SAM target is displayed on the MFD like a TWS system track file. Immediately under the Secondary SAM target the target altitude is displayed numerically in thousands of feet above sea level.

2.3.1.5.9.2 SCAN COVERAGE

The pilot has control of range and maximum size and location of the antenna scan pattern as in RWS. Typically, the radar displays azimuth scan limits on the MFD indicating the actual scan volume. The azimuth scan limits on the MFD may be less than the pilot-selected scan width because there are occasions when the scan volume is reduced in order to allow SAM to maintain quality tracks on the SAM targets.

In DT SAM, the radar supports the pilot selected scan pattern until one of the targets has a range of less than 10 NM or an AMRAAM has been launched. In either case, the radar will enter the SAM DTT submode where it sequentially updates each of the SAM targets and does not interleave search processing.

Azimuth scan limits are not displayed on the MFD when the radar has entered Suspended SAM Search or DTT. The scan limits are not displayed in order to cue the pilot that the radar is not providing any new situation awareness.



ST SAM entry > auto SAM (left) and DT SAM > DTT submode (right)

2.3.1.5.9.3 CURSOR CONTROL

SAM has the same ACQ cursor control and SAD (Search Altitude Display) capability as RWS when the radar is not in a Long Track Update or the DTT submode of SAM.

Upon ST SAM entry, the acquisition cursor is positioned over the SAM target and the cursor follows the target until the cursor is slewed; this is known as auto SAM and allows for quick entry into STT. Moving the acquisition cursor disables auto SAM and full control of the search area is available; this is known as manual SAM. Search elevation is then centerd at the elevation selected by the ANT ELEV knob. A quick TMS forward and TMS down sequence over the SAM target will resume auto SAM.

Upon entry into DT SAM, auto SAM is applied to a target that is upgraded to the target of interest via designating, but not to a target that is upgraded via TMS right. DT SAM simultaneously tracks two targets while maintaining a RWS scan volume centerd on the secondary (non-bugged) target.

The azimuth and elevation of the primary SAM target are indicated by the position of the horizontal **T**-symbol and **T**-symbol on the left and bottom edges of the MFD respectively.

2.3.1.5.9.4 SAM TRANSITIONS

The SAM submode is entered and exited using the designate (TMS up) and return-to-search (TMS down) commands or by a mode transition to RWS from another air-to-air radar mode. Transition to RWS from another mode will enter ST SAM if there is only one system track file or DT SAM if there are two or more system track files.

The bugged target, if it exists, will always be the primary SAM target. For DT SAM, the primary SAM target is the highest priority target and the secondary SAM target is the second highest priority target.

If the FCR loses the bugged target while in DT SAM, the radar returns to ST SAM and the secondary target becomes the new bugged target. Loss of the bugged target while in ST SAM results in a return to the search mode (RWS or ULS).

2.3.1.5.9.5 SAM TRACK

The FCR performs an initial or long track update on a search target that is designated. This track update typically lasts from 1 to 1.5 seconds. Following successful entry into ST SAM or DT SAM, the FCR periodically exits the search phase to perform track update(s). These track updates require approximately one-half second.

There are three conditions when the search processing is interrupted and the FCR will discontinue the search volume:

1. The first of these conditions occurs in ST SAM and DT SAM, as the FCR enters suspended search to dedicate all of the resources to supporting the Primary SAM target. A dedicated track on the SAM Primary target occurs if the Primary target range is less than 3 NM. When the FCR suspends search from DT SAM, the cursors, scan limit lines and secondary target symbol are removed from the display.
2. The second condition occurs when the radar must dedicate all of the resources to supporting the Secondary SAM target. The only time all the resources are dedicated to supporting the Secondary SAM target is when an initial track update is being performed on it.
3. The third condition also occurs in DT SAM when the radar has two targets to support and has entered the dual target track (DTT) submode of SAM. The DTT submode is the submode where the radar performs sequential updates (also known as ping-pong) on the two SAM targets and does not have any search processing interleaved. DTT will be entered when one of the targets has a range of less than 10 NM. The scan lines are removed in this case; however, the cursors remain displayed.

2.3.1.5.9.6 SAM TARGET EXTRAPOLATION

A radar track will start degrading if the radar doesn't pick it up again within a reasonable (pattern dependent) time frame. If the radar has not detected the tracked target lately (for example in the last 5 paints where the beam passes over the target aircraft but doesn't get a strong enough return) and the radar is coasting (4 seconds since the last actual hit) extrapolation continues. After the coast time the symbol will flash to indicate imminent loss of track status; sometimes you won't see this depending on where the target was in the scan pattern. In this situation the track will disappear unless you get a paint and detection almost immediately.

2.3.1.5.9.7 SAM OPERATIONAL CONSIDERATIONS

SAM offers some significant operational advantages compared to the other radar modes. One of its main advantages lies in its usefulness in sorting long range targets. In addition, SAM provides a reduced chance of being detected or considered a threat - especially when compared to STT. Using SAM reduces the time that the radar antenna is directly pointed at the enemy aircraft. Therefore, the probability of revealing ownship position or intent to the enemy may be reduced. Furthermore, if the ownship position is revealed in SAM, the detection may not be considered a threat by the enemy because of the small amount of time the F-16 radar is performing a SAM track.

SAM also provides significant advantages as compared to TWS. SAM provides a more flexible situation awareness capability because the search volume in SAM does not need to include the SAM track targets. In addition, SAM provides a higher quality track on two targets than provided in TWS, especially when the radar is in DTT.

2.3.1.5.10 AIR COMBAT MODE (ACM)

ACM is designed to automatically acquire aircraft at short range. Four scan patterns, including three referenced to the body of the F-16, allow the pilot to select the most appropriate submode for quick acquisition in STT.

2.3.1.5.10.1 ACM DISPLAY

Search targets and target history settings are not used in ACM since automatic acquisition is employed. The target is displayed on the MFD as a circled triangle and other track information when valid track data is available.

Maximum acquisition range is 10 NM for all ACM submodes. When a target is acquired, automatic range scale switching is enabled. If a target is acquired at (or subsequently moves to) a range greater than 9 NM, the range scale automatically increases to the next larger scale. If a target is acquired (or subsequently moves to) a range less than 8 NM, the range scale automatically decreases to the 10 NM range scale.

2.3.1.5.10.2 ACM SCAN COVERAGE

There are four scan patterns or submodes available in ACM: 30° x 20°, 10° x 60°, Boresight and Slewable, represented on the MFD below OSB 2 by the mnemonics: 20, 60, BORE and SLEW respectively. They all have in common:

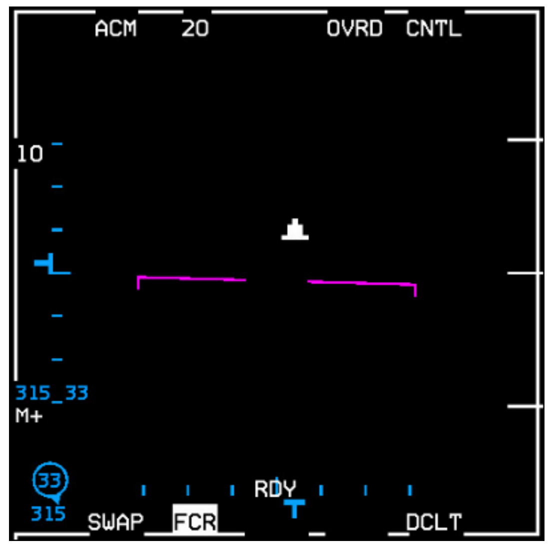
- ACM automatically acquires and tracks the first target detected within submode search range.
- Holding the TMS forward commands BORE and inhibits auto-acquisition until TMS is released.
- ACQ cursor and search target symbols are not displayed.
- While in ACM STT: TMS up, TMS right or CURSOR/ENABLE slew will not cause a radar break lock nor command a new scan pattern.

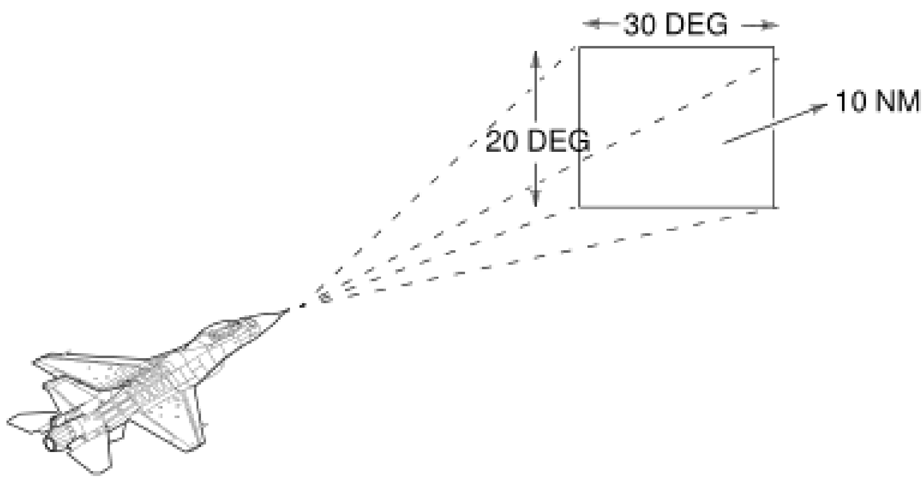
2.3.1.5.10.3 30° X 20° SUBMODE

The 30x20 ACM submode is the default selection commanded upon entry into ACM from any other mode. It is body stabilized and searches the entire HUD field of view such that any target seen by the pilot in the HUD should be acquired by the radar in the 30x20 submode. The 30x20 submode can be entered from any other ACM submode by selecting OSB 2 on the MFD.

The 30° x 20° scan pattern searches an area slightly larger than the HUD FOV. The 30° x 20° ACM submode is indicated as follows:

- The scan pattern is referenced to the F-16 body.
- The scan center is 6° below the HUD bore cross and uses a 4-bar pattern to cover the 30° wide, 20° high area. There is no HUD symbology associated with the 30x20° scan pattern.
- Contact range scale is 10 NM.





ACM 30° x 20°

2.3.1.5.10.4 BORESIGHT SUBMODE

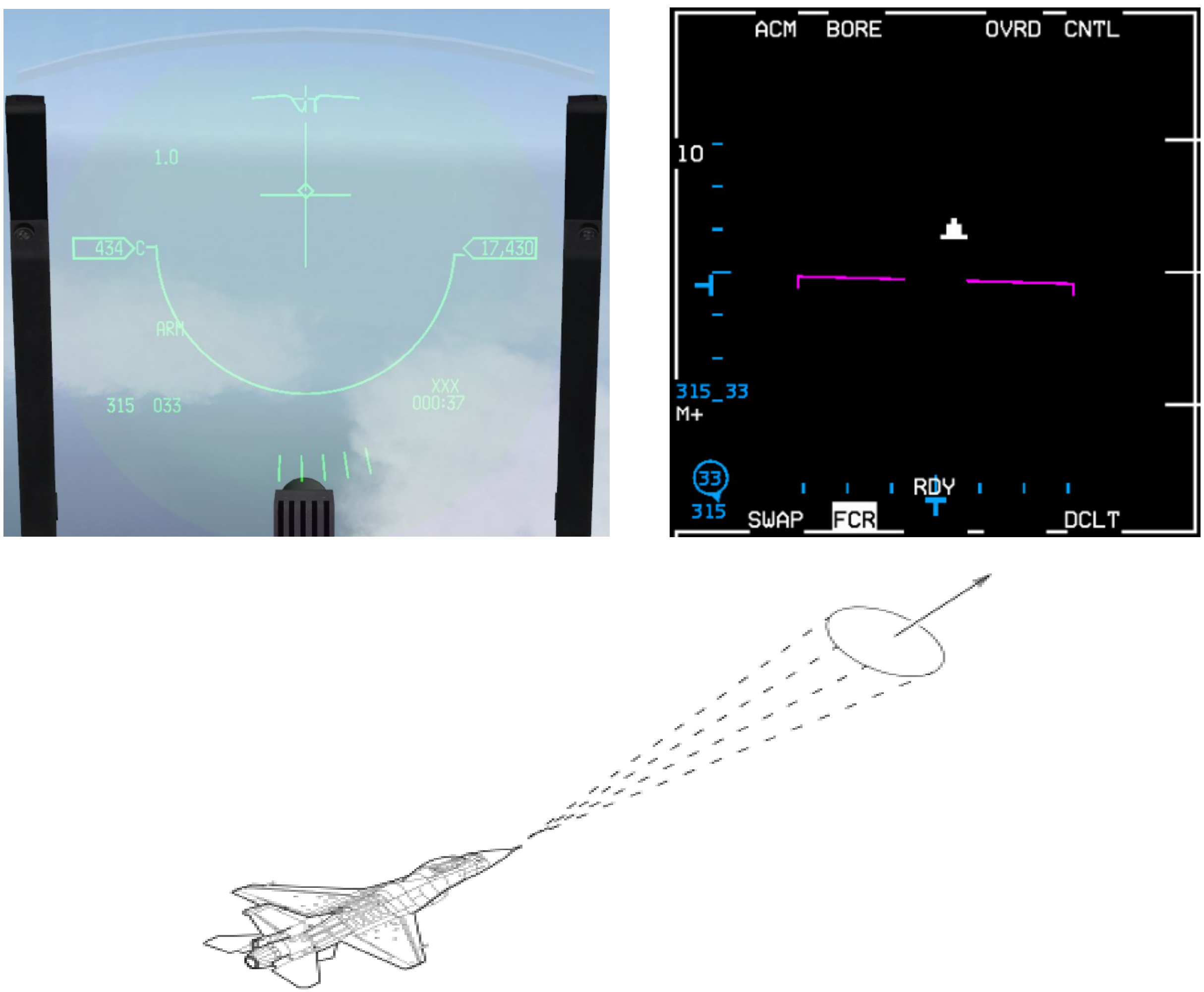
The Boresight submode is non-scanning and body stabilized, designed to allow the pilot to point the antenna at a selected single target from a group of targets seen in the HUD. Pressing and holding TMS up inhibits acquisition. Once the desired target enters the cross depicting BORESIGHT coverage in the HUD, releasing the TMS enables acquisition. The BORESIGHT scan pattern searches a one-beamwidth area centerd on the F-16 fuselage reference line.

TMS up and hold, while slewing, allows the pilot to slew the BORESIGHT cross and scan pattern within the HUD FOV.

When the FCR is placed in ACM BORE, the FCR can also be slaved to the HMCS Aiming Cross LOS. The FCR is commanded to the HMCS LOS when: ACM BORE mode is selected, the FCR is SOI and TMS up is held.

The BORESIGHT ACM submode is indicated as follows:

- The scan pattern is the antenna beam located 3° below the HUD bore cross.
- A cross is displayed on the HUD with its intersection 3° below the bore cross to aid in positioning the target in the radar beam.
- Contact range scale is 10 NM.

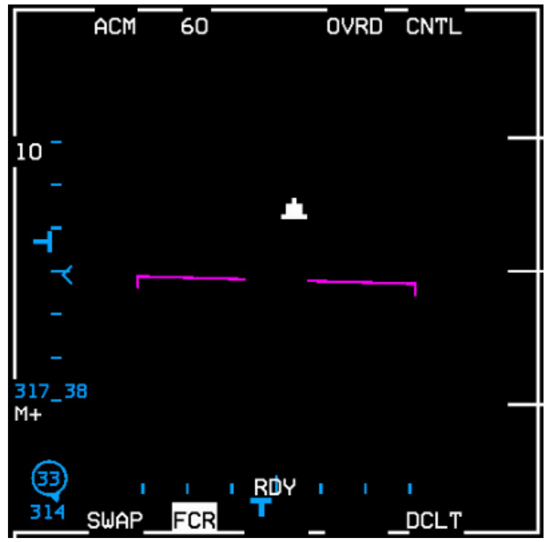


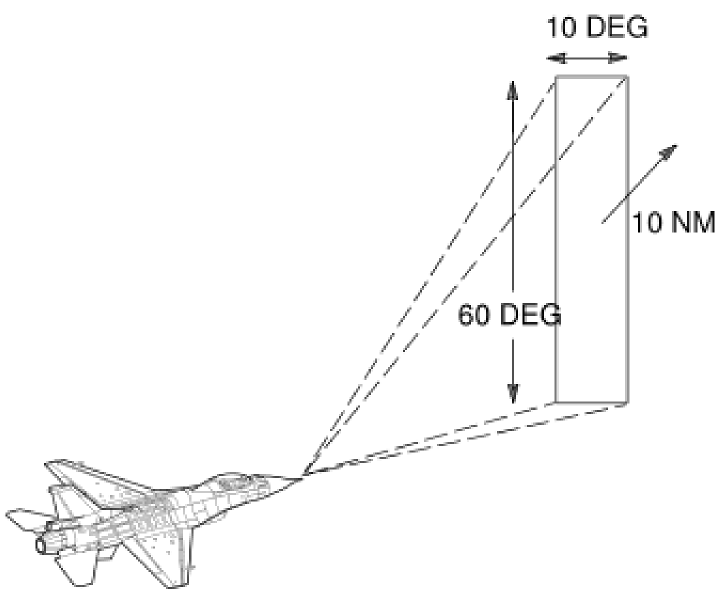
ACM Boresight

2.3.1.5.10.5 10° X 60° SUBMODE

The 10° x 60° scan pattern searches a narrow volume extending upward from the center of the HUD and is used in high G situations where the F-16 is pulling into the target. The 10° x 60° ACM submode is indicated as follows:

- The scan pattern is referenced to the F-16 body.
- Scan center is 23° above the HUD bore cross and uses a 4 bar pattern to cover the 10° wide, 60° high area.
- Total vertical coverage is 53° above to 7° below the HUD bore cross.
- A vertical line extends from the HUD bore cross to the bottom of the HUD.
- Contact range scale is 10 NM.



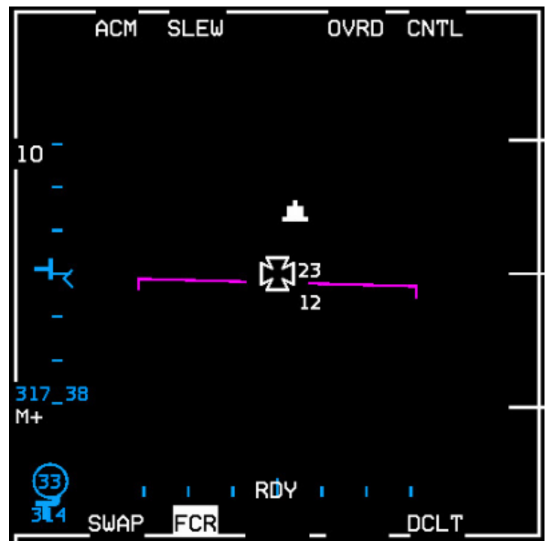


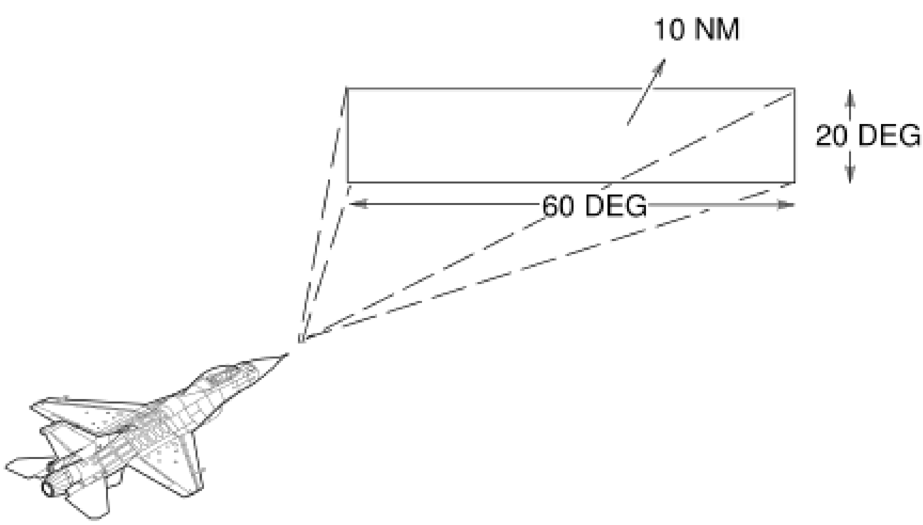
ACM 10° X 60°

2.3.1.5.10.6 SLEWABLE SUBMODE

The slewable scan pattern is activated and controlled hands-on via the CURSOR/ENABLE control. Scan center initializes to 0° azimuth and 0° elevation. Further cursor control moves the scan center. The SLEWABLE scan pattern searches a relatively large area whose center can be slewed up/down and left/right. It is indicated as follows:

- The scan pattern is space-stabilized in pitch and roll. When the scan center is slewed, HUD and MFD symbols move in the same directions regardless of the roll angle. The SLEWABLE ACM circle is also locally stabilized.
- The scan pattern is approximately 20° high by 60° wide with scan center initialized to the horizon and 0° azimuth position.
- Minimum and maximum search altitudes are based on 5 NM range and the position of the scan center. Search altitudes are displayed in the center of the MFD and above/below the 8 mR circle on the HUD.
- The antenna-pointing symbol (8 mR circle on the HUD, iron cross symbol on the MFD) is positioned at the center of the scan. A large cross-positioned at 3° below the boresight cross marks the initialized scan position.
- Contact range scale is 10 NM.





ACM Slewable

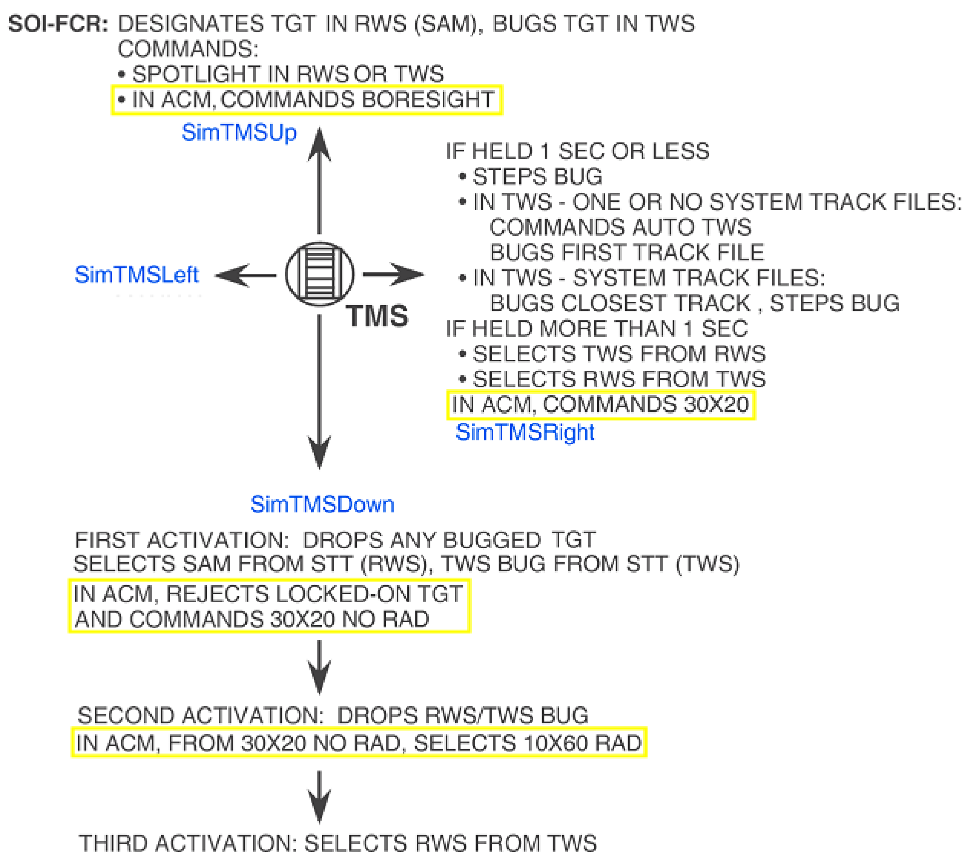
2.3.1.5.10.7 ACM MODE SWITCHING

Upon selecting ACM, 30° x 20° submode is automatically entered. If the radar is not already tracking a target, the transmitter will be turned off and “NO RAD” will be displayed above the HUD Boresight cross. The radar will begin transmitting when any submode is selected.

TMS down is the only switch action that commands a break lock from an ACM track mode.

In any radiating ACM mode, TMS down will drop the current radar track (if there is one) and command 30x20 NO RAD. TMS down again, the radar will switch to 10x60 and radiate. TMS down again to switch to 30x20 NO RAD again. With a track in any of the ACM modes, switching to another mode (with the exception of 10x60) will not drop the current track, but only switch modes, e.g.: BORE mode → TMS right → 30x20.

In BMS 4.34 the DLZ and the IR diamond now also use extrapolated info. Before, if you were in SLAVE, the IR missile would automagically lock (or try to lock) on the FCR target; it usually didn’t matter if you had another target closer in the same direction. So in SLAVE, as long as you had tone, you didn’t need to uncage at all. Now, in SLAVE, it will look for targets in the same way as it does in BORE, except along the FCR target LOS (line of sight). So make sure you always uncage, and then check the missile is tracking the correct target, before you fire!



A-A HOTAS TMS functions (FCR SOI) ACM specifics highlighted

2.3.1.5.11 AIM-120 ADVANCED MEDIUM RANGE A-A MISSILE (AMRAAM)

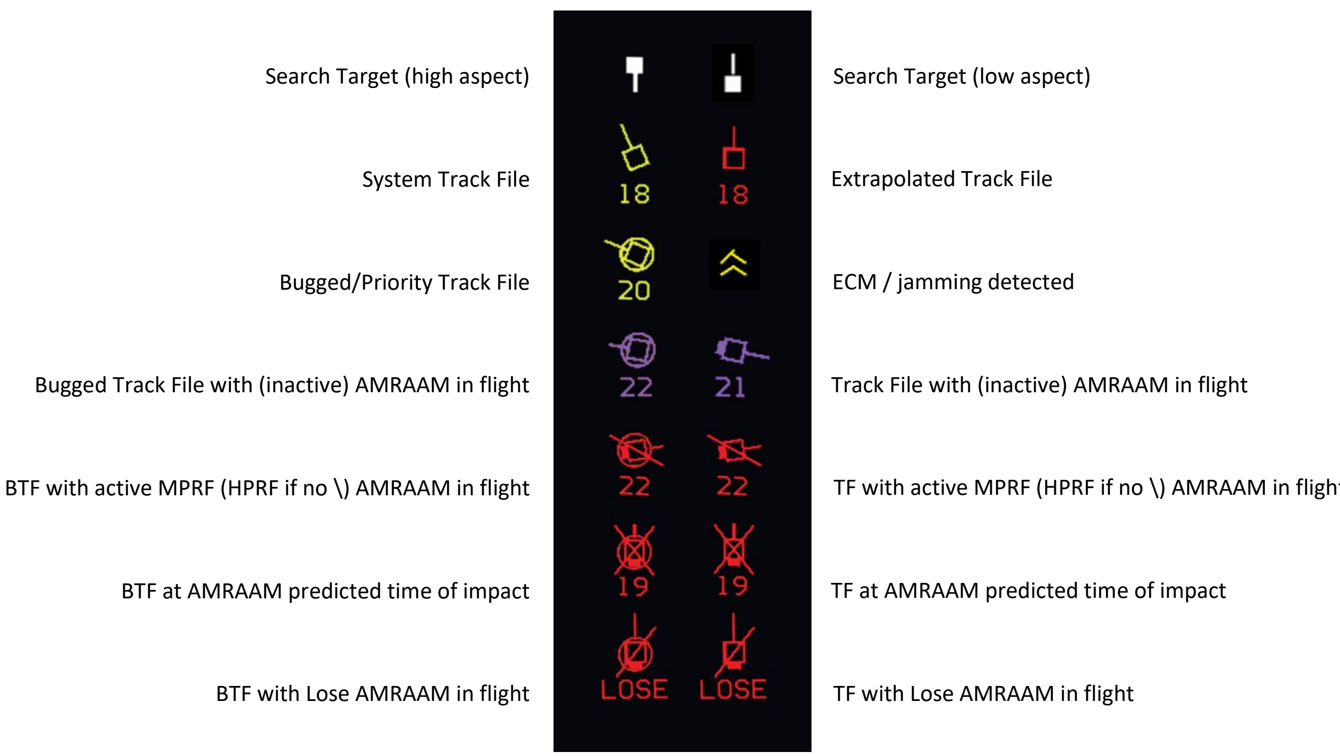
2.3.1.5.11.1 MFD SYMBOLOGY

The normal TWS, SAM, STT and DTT display symbology will be maintained during AIM-120 DL. In addition, there will be MFD and HUD symbology related to the launch and control of the AIM-120 missile. This allows head-up or head-down weapon delivery. The symbology on the B-scope when an AMRAAM is in flight is stored when the pilot bugs another contact.

When a slaved AIM-120 is launched against the target, a tail is displayed on the target symbol. The tail flashes at a 3Hz rate when the missile goes HPRF active. A slash is placed over the symbol when the missile goes MPRF active. An X is placed over the symbol at calculated missile impact for 8 seconds. After 8 seconds, the X flashes at a 5Hz rate for 5 seconds and is then removed from the display. When the missile is calculated to miss the target, the word LOSE will alternate with the target altitude at a 3Hz rate.

2.3.1.5.11.2 AMRAAM MECHANIZATION IN TWS

The pilot fires on a bugged/priority track/TOI (target of interest) and the normal AMRAAM symbology is displayed. The pilot may then bug another track or TMS right and fire on another track. The first track's symbology will be retained and the track will turn magenta in colour. The pilot may bug additional tracks and shoot missiles. The AMRAAM missile timing information will be retained for all missiles in flight for their respective track files, and displayed for the current bugged/priority track.

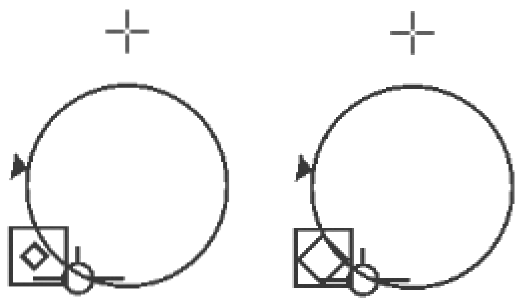


Air-to-Air FCR Symbology

2.3.1.5.12 HUD SYMBOLOGY FOR INFRARED MISSILES

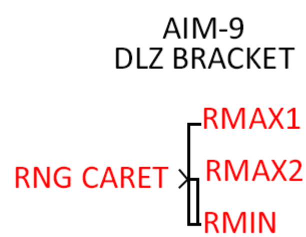
There are a few HUD symbols specific to Sidewinders. First, the missile diamond will be displayed in the HUD to tell you where the missile seeker is looking. The missile diamond changes in size, according to its caged or uncaged status. When caged, the missile diamond is half the size as it is uncaged.

In the following example the missile diamond is within the TD box, as we have a radar lock, but it is the same behavior (without the TD box) when the radar does not have a valid lock.



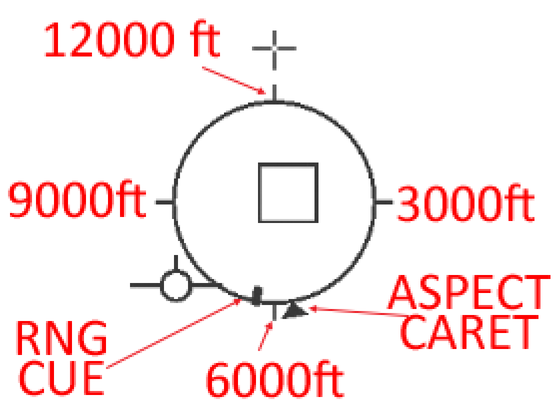
The left image shows the missile diamond with radar contact when caged. The right image shows the increased sized missile diamond after uncaging.

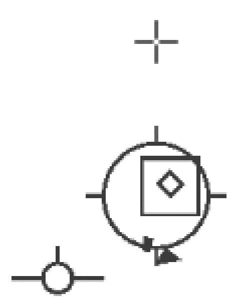
When a contact is radar designated a Dynamic Launch Zone (DLZ) is displayed on the right side of the HUD. This bracket tells you if you are in range for a missile shot. A range cue caret slides along the DLZ to signify the range. When the cue is at RMAX1, the missile is at maximum range. If the target maneuvers, it will probably miss. When the cue is at RMAX2, you are within maneuvering range; the missile circle and diamond will start to flash. RMAX2 is a more reliable max range, because even if the target starts maneuvering, the missile will still have a good chance of hitting it anyway.



When the cue hits RMIN (there are actually RMIN1 & RMIN2) you are too close for a missile shot and a large break X will appear on the HUD.

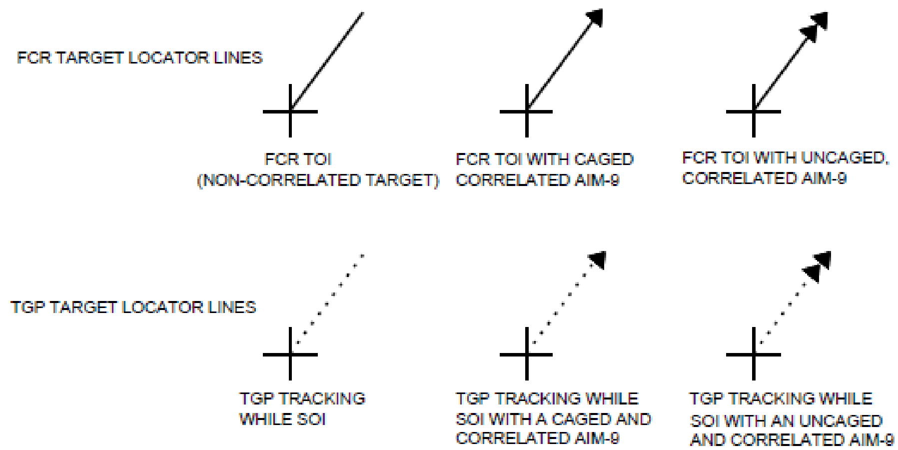
Once within 2 Nm or 12000 feet of the target the seeker head field of view will change and display 4 range marks; respectively for 12000, 9000, 6000 & 3000 feet. A range cue moves along the inner missile field of view circle to give an indication of range. The aspect caret is a triangle moving around the circumference of the circle and indicates the aspect angle of the bugged target.



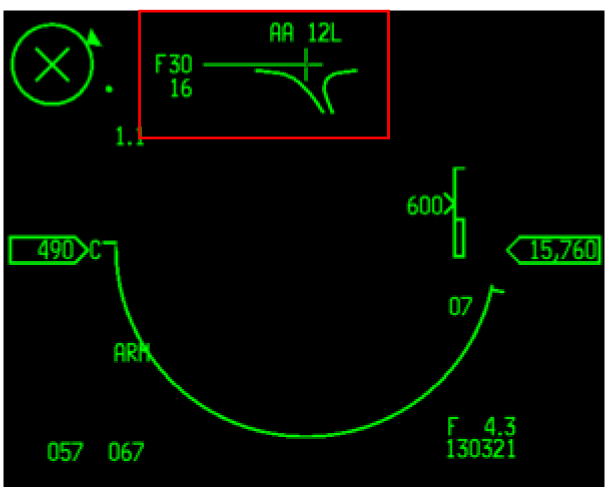


Left shows the display for the AIM-9M, above is the display for the AIM-9P.

In addition to the HUD symbology, sidewinders will emit an audio tone providing feedback on the quality of the missile track. If the tone is faint, the track is faint. If the tone is loud, the track is solid. Trust the heat tone as range is one thing but never forget an infrared missile needs a heat source to guide on. Tone will also change according to CAGED / UNCAGED status. Since 4.36 there's an enhanced symbology for IR missile correlation (TLL = Target Locater Line) implemented:



The missile LOS is considered correlated with the tracking sensor LOS when they are within ±1.5 degrees of each other. When an AIM-9 is caged and correlated to a target locator line (TLL), a single arrowhead is displayed on both the HMCS and HUD at the end of the associated FCR or TGP TLL. When an AIM-9/AIM-120 is uncaged and correlated to a TLL, a double arrowhead will be displayed on both the HMCS and HUD at the end of the associated FCR or TGP TLL. The FCR TLL is represented by a solid line, and the TGP TLL is represented by a dashed line.



TLL Symbology (Dogfight mode)

TLL Symbology (A-A mode)

F Active sensor: F = FCR | T = TGP

30 Offset from the own heading in degrees (Range 0-135° will be displayed, greater 135° will initiate a loss of the lock).

16 Altitude of the looked target

AA 12L Aspect Angle (in this example: 120 to the left)

The same symbology is shown in all AA modes (DGFT, AA, MSL, OVRD). The HMCS shows the same symbology as well (see chapter 2.11.5.5).

2.3.1.6 RADAR AIR-TO-GROUND MODES

The radar provides A-G modes for ground map, target detection, tracking and air-to-ground ranging. The modes are GM, SEA, FTT, GMT, AGR and BCN (not implemented).

All modes, except air-to-ground ranging, are used to locate preplanned targets presenting a radar return. The ground map video may be expanded, frozen, or have Doppler Beam Sharpening (DBS) applied as aids in positioning the radar cursor over the target. Fixed targets may be acquired and tracked in the GM and SEA modes. The GM mode provides accurate cursor placement on conventional GM video for stationary targets. The GMT mode provides detection of moving ground targets. The SEA mode provides sea clutter reduction in moderate sea states for direct and offset sighting options and fixed target track. The AGR mode provides automatic ranging data for determining height above the target.

2.3.1.6.1 AIR TO GROUND RANGING

The Air−to−Ground Ranging (AGR) mode provides accurate range to a ground point for visual air to ground delivery modes, marking, FIX and altitude calibration.

AGR is automatically commanded by the MMC/FCC when the following modes are selected, (unless the pilot selects Standby or Override).

- CCIP
- DTOS
- EOVIS
- STRAFE
- HUD MARK
- HUD FIX (N/I)
- HUD ACAL (N/I)

2.3.1.6.1.1 BASICS

AGR provides real-time slant range measurements to a point on the ground indicated in the HUD or HMCS, using a pencil beam.

A process called Lobe on Receive Only (LORO) changes the receive characteristic of the antenna to squint first above and then below the center of the radiated beam. Knowing that the transmit beam illuminates the ground point undisturbed and assuming the ground point and the area near it provide a consistent radar return, differences in the two received signals above and below the ground point are used to determine an accurate range measurement to the center of the beam.

AGR provides ranging for all roll angles. This is accomplished by changing the LORO mechanization at the appropriate roll angles from up-down to left-right with reference to the body of the aircraft.

While AGR ranging is possible at all roll angles, bombing accuracy improves as the attitude at bomb release approaches wings level. Bombing accuracy is also a function of grazing angle and slant range. Bombing accuracy increases with increasing angle or with decreasing slant range.

The AGR mode provides automatic ranging data for determining the height of the aircraft (HAT) above the target, by measuring accurate slant range along the radar line of sight to the surface target.

Using AGR, FTT, TGP in a track mode, laser ranging or RALT as the backup bombing sensor SALT is removed from the MMC/FCC's HAT determination. If there is a SALT error, or if the entered target elevation is incorrect, inaccurate HAT and bomb range calculations will result. This will cause a long or short miss.

2.3.1.6.1.1.1 TARGET SELECTION

AGR ranges to the point on the ground indicated by weapons delivery/FIX symbology in the HUD and HMCS.

Depending on the submode selecting AGR, the symbol in the HUD may be slewed to the desired point, or the aircraft can maneuver to place the symbol at the desired point, or a combination of both. The symbol on the HMCS is initially moved on the ground point with head movement. Once the symbol is ground stabilized, it may be slewed. The CURSOR/ENABLE switch is used to slew the symbol. Three different symbols are used to indicate the ranging point depending on the submode.

SUBMODE	SYMBOL	POINTING METHOD
HUD MARK /HMCS MARK	12mr 	HUD :SLEW / HMCS Head movement or SLEW.
CCIP	12mr 	Maneuver Aircraft.
STRAFE	12mr or 40mr 	Maneuver Aircraft.
DTOS / HMCS DTOS	10mr 	HUD : SLEW or Maneuver Aircraft. HMCS : Head movement ,SLEW or Maneuver Aircraft
E0-VIS / HMCS EO-VIS	10mr 	HUD : SLEW or Maneuver Aircraft . HMCS : Head movement ,SLEW or Maneuver Aircraft
(N/I) FIX / ACAL	6mr 	SLEW.

2.3.1.6.1.1.2 VISUAL AIR TO GROUND

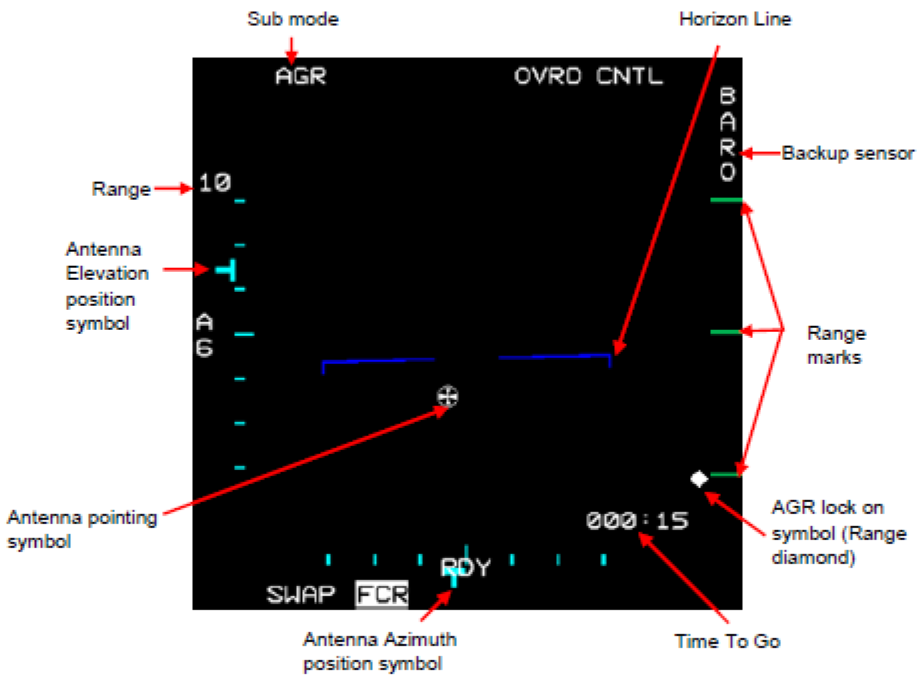
Visual air to ground weapon delivery modes use AGR range to determine in range and time to release cues for the selected weapon. AGR range is also used to determine the pull−up cues to avoid ground clobber. In the event the radar can no longer determine a valid range measurement, weapon delivery solutions are based on the F−16’s SALT, which defaults to barometric when the Inertial Navigation Unit (INU) goes down, and the current selected steerpoint elevation.

2.3.1.6.1.1.3 AGR DISPLAYS

AGR information is presented on the MFD, HUD, HMCS and DED.

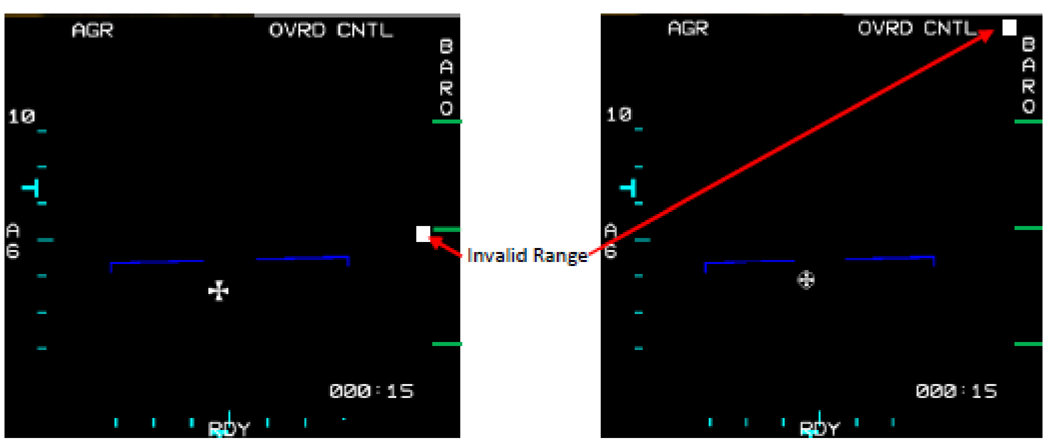
2.3.1.6.1.1.4 MFD

Range to the point is indicated by a solid diamond on the right side of the MFD. The diamond is positioned based on the range to the top of the MFD equaling 10 NM. Field-of-view options are not available; only the 10-nautical-mile range scale is used and cannot be changed. The gain gauge is not displayed; and antenna azimuth and elevation markers are body-referenced.

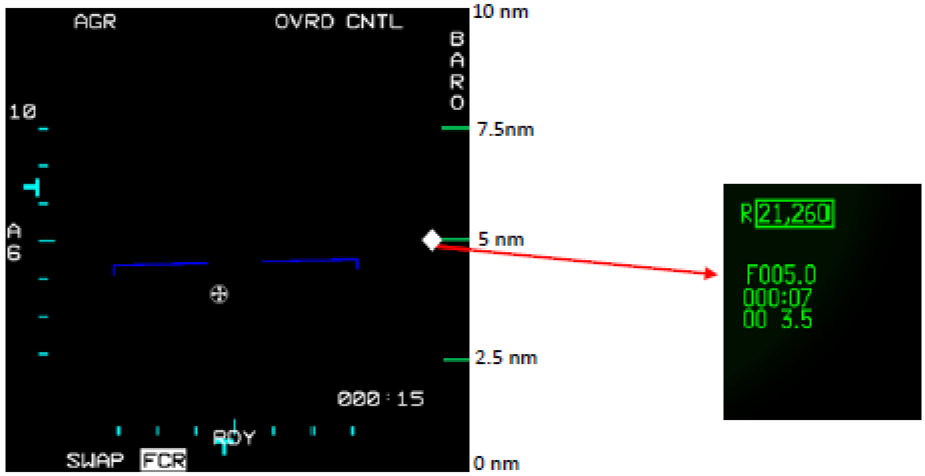


MFD Sensor AGR

The diamond changes to a square located at the last valid range for about 0.5 sec. When valid range can no longer be determined and then will be pegged at the top right corner of the MFD.



MFD Sensor Invalid Range



MFD & HUD Range

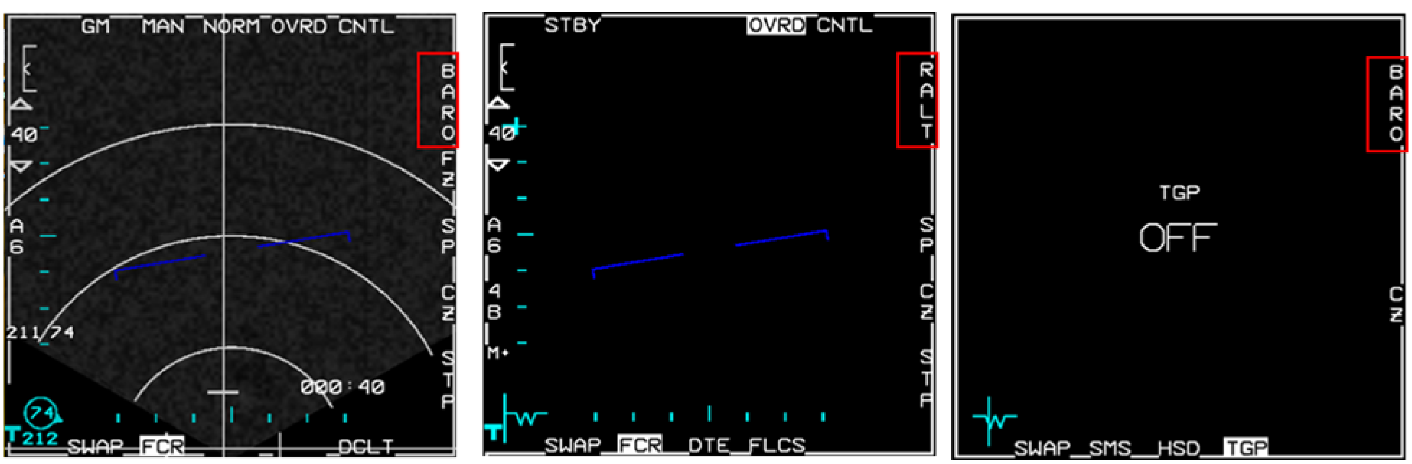
2.3.1.6.1.1.5 ANTENNA POINTING SYMBOL

A St. George's cross indicates antenna azimuth and elevation and is displayed in addition to the azimuth and elevation carets on the MFD.

The Antenna position is displayed with respect to the body axis of the F-16 along with antenna carets on the bottom and left side of the display.

2.3.1.6.1.1.6 BACKUP BOMBING SENSOR

The backup bombing sensor rotary at OSB 6 on the FCR MFD page shows which sensor is being used to determine the height above target (HAT). The rotary defaults to BARO at FCC/MMC power-up. With BARO displayed, SALT (System Altitude) is used to determine HAT. The other option is RALT. When RALT is displayed, the CARA (Combined Altitude Radar Altimeter) will be used to determine HAT. Since the CARA measurement will be height above the release point rather than HAT, use of RALT as a backup sensor should only be used over flat terrain. The backup sensor can be accessed also from any OFF MFD page.



2.3.1.6.1.1.7 HUD

Slant range on the HUD is displayed in tenths of nautical miles for ranges greater than 1 nautical mile and hundreds of feet for ranges less than 1nm.

The letter preceding the slant range value indicates the sensor that is being used to calculate the slant range.

If the AGR is returning a valid range the FCR (F) indication will precede the slant rage

If the AGR is not able to provide a valid range, the active backup sensor will be automatically used.

If BARO is selected B will be displayed.

If RALT is selected R will be displayed.

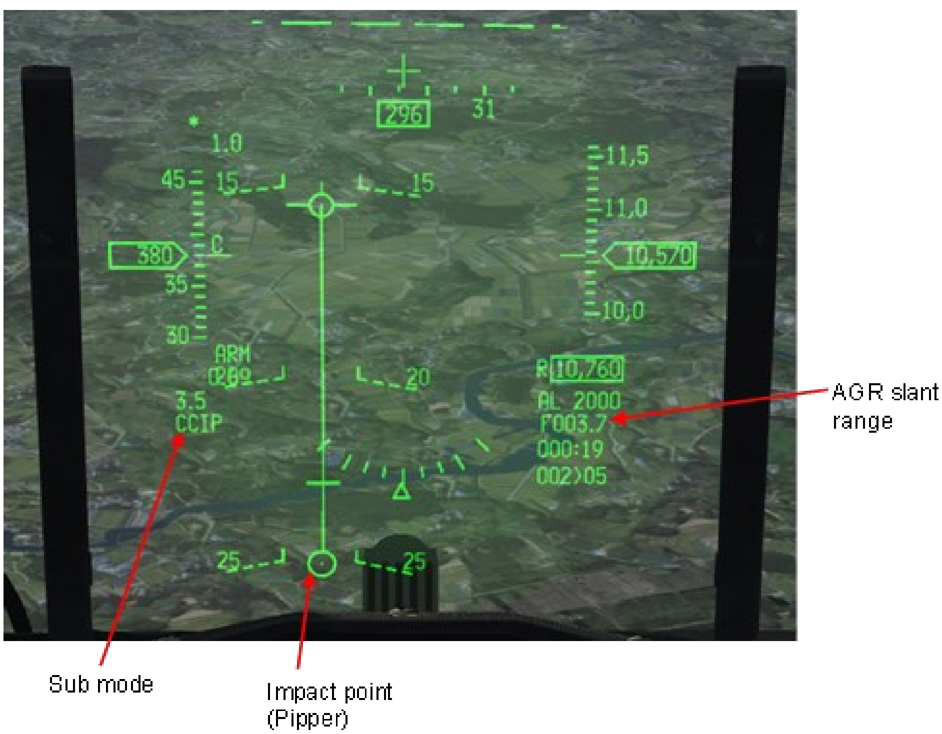
When ranging data is unavailable, XXX will be displayed.

When DTOS submode is selected the TGP can be used as a backup ranging sensor

T is displayed when the targeting pod is in AG mode, is the priority sensor and is in a track mode.

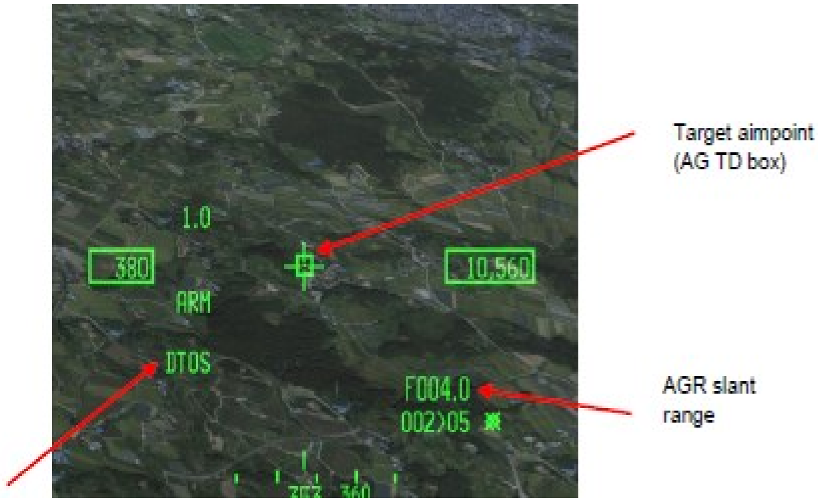
L is displayed when the targeting pod is in AG mode, is the priority sensor is in a track mode and the laser is firing.

To select the TGP as the BUP sensor, move the SOI from the HUD to the TGP and select AREA track mode. The DTOS TD box will be ground stabilized and slewed to the point of interest.



HUD CCIP

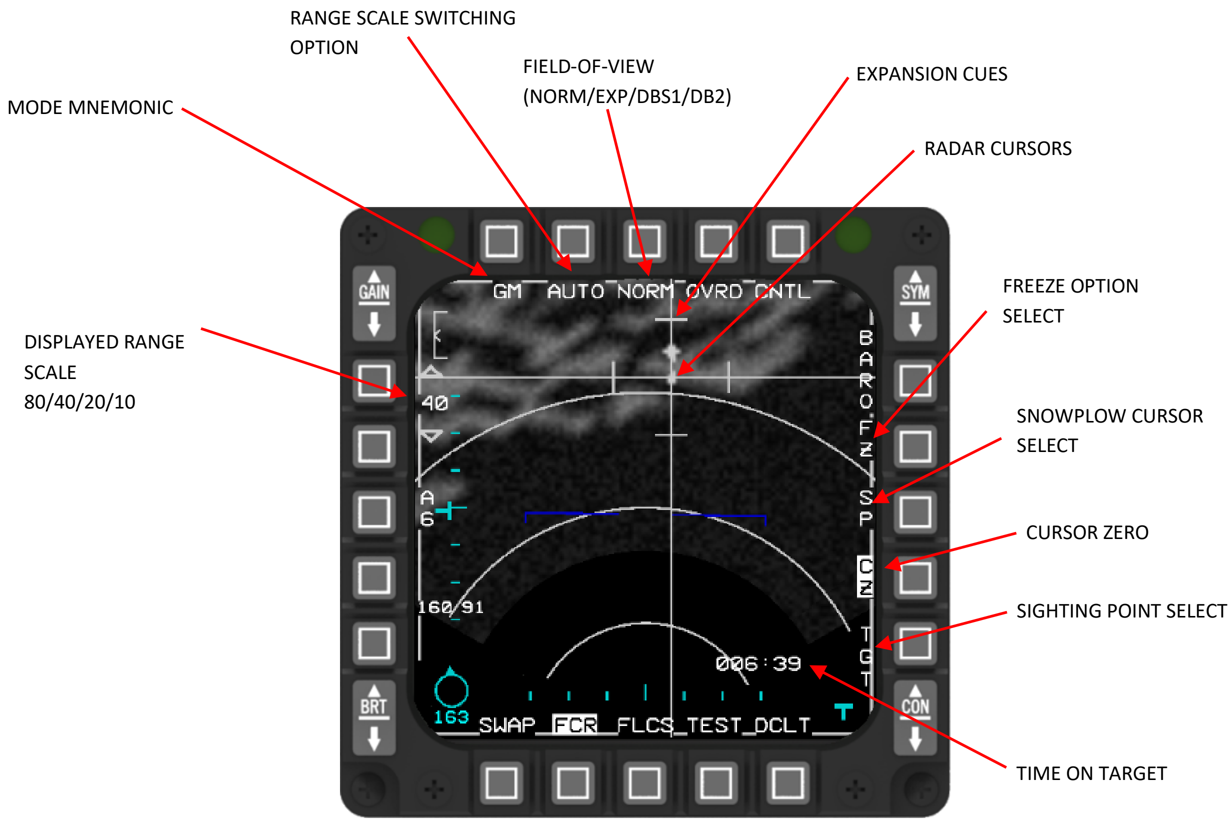
2.3.1.6.1.1.8 HMCS



HUD Target Aimpoint

2.3.1.6.2 AIR-TO-GROUND FCR MFD SYMBOLOGY

A typical A-G MFD display (in Ground Map mode) is shown below:



Air-to-Ground (GM mode) Display

2.3.1.6.2.1 CURRENT FCR OPERATING MODE (OSB 1)

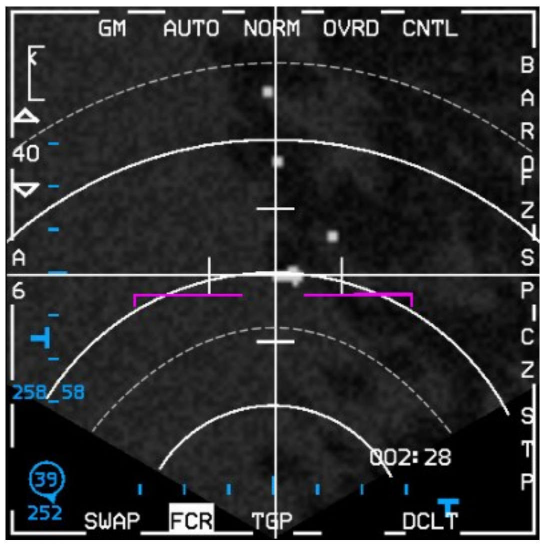
Possible mnemonics are:

- GM: Ground Map Mode
- GMT: Ground Moving Target Mode
- SEA: Sea Navigation Mode

2.3.1.6.2.2 RANGE SCALE SELECTION (OSB 2)

An automatic range scale option is available in the following modes: GM, EXP, DBS1, DBS2, FTT, SEA and GMT. Auto range scale switching is enabled via OSB 2 which toggles AUTO or MAN. AUTO range scale switching, which is on by default, may be disabled by depressing OSB 2 or by manually changing the range scale. Any range scale change made via OSB will return the radar to manual (MAN) range scale operation.

For A-G search operation the AUTO range scale (cursor bump) will increase the FCR range if the cursor is at 95% of the way up the MFD and decrease it if the cursor is at 42.5% of the way up the display, or less. These switch points are shown in below as grey dashed lines. Note the bump will only happen if and when the cursor is not being slewed. This function will allow you to refine the cursor position without interruption if an auto range scale change is required. For FTT and GMTT the target position is the determining factor in changing range scales.

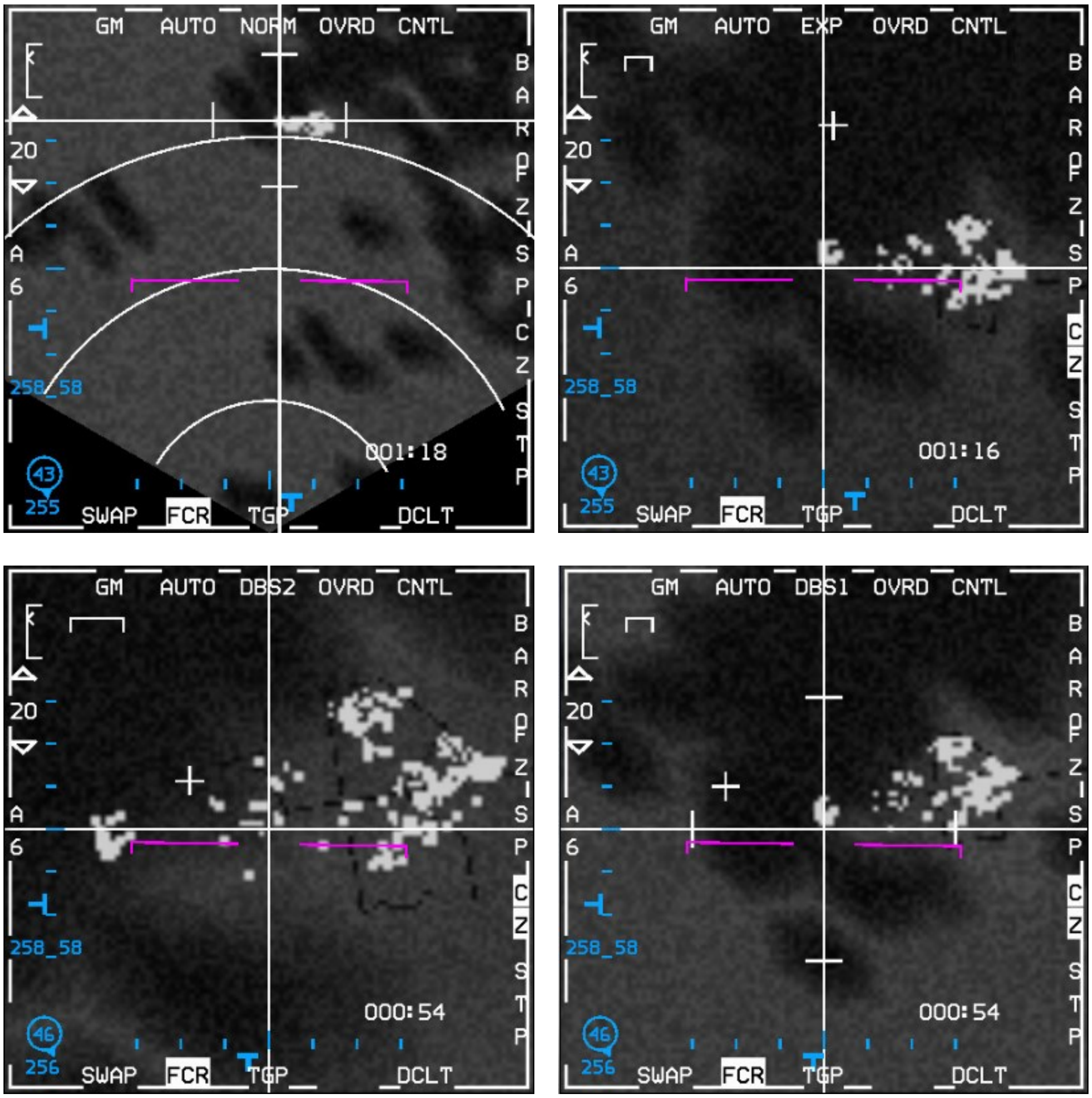


Auto Range Scale Switch Points

2.3.1.6.2.3 FIELD-OF-VIEW (FOV) OPTIONS (OSB 3)

In all A-G mapping modes the expanded (EXP) FOV option is available. Selection of EXP FOV results in a 4:1 range and azimuth expansion of the patch of map surrounding the cursor position.

For GM mode only, two Doppler Beam Sharpening (DBS1 and DBS2) FOV's are also available. Selection of DBS1 will provide the same FOV as with EXP, but with improved resolution (8:1). DBS2 will provide a FOV roughly double the zoom of EXP and DBS1 with improved resolution (64:1). Either the EXPAND/FOV button on the stick or OSB 3 above the FOV mnemonic can be used to select the available FOV's in A-G mapping modes.



FOV options (clockwise from top left: NORM, EXP, DBS1 and DBS2)

Expansion Cues. In the normal GM, SEA and GMT displays, four expansion cues (tick marks) are provided on the X-Y cursors to define the area that would be displayed upon selection of the EXP FOV. Similarly, in the GM mode, when the DBS1 FOV option has been selected, expansion cues will be provided to define the area that will be displayed upon selection of DBS2. (See above - note the cursor was slewed to the right and up to encompass the whole area of interest before the screenshot was taken for the DBS2 image above.)

Situation Awareness Symbol. In any of the expanded ground map type mode FOV options including DBS1 and DBS2, a situation awareness symbol (a thin cross) will be positioned on the display to show where the X-Y cursors would be upon return to the unexpanded (NORM) display. This may be used to determine range to the selected sighting point.

Quarter Mile Scale Reference. In any of the EXP FOV options including DBS1 and DBS2, a horizontal line is displayed in the upper left-hand corner of the display to indicate a length of 0.25 NM (1500 feet).

2.3.1.6.2.4 STANDBY OVERRIDE SELECT/DESELECT (OSB 4)

"OVRD" selects FCR standby.

2.3.1.6.2.5 FCR CONTROL PAGE SELECT (OSB 5)

"CNTL" selects the FCR control page.

2.3.1.6.2.6 BACKUP BOMBING SENSOR (BBS) (OSB 6)

Refer to chapter 2.4.6.7

2.3.1.6.2.7 FREEZE (FZ) SUBMODE (OSB 7)

The FZ option terminates radar transmissions although the antenna continues scan movements. A frozen map display suitable for navigation and weapons delivery is retained. The pilot can still refine cursor position. With a patch of the PPI sector frozen, cursor refinements result in the movement of the vertical and horizontal lines depicting cursor position relative to the map. An aircraft position symbol, depicted as a bold cross, is displayed on frozen scenes and is continuously updated. This symbol represents the position of the aircraft relative to the frozen scene; that is, the symbol appears over that point on the map that is presently directly beneath the aircraft. The FZ option may be deselecting by changing the FOV, changing the FCR mode, or by depressing the FZ OSB again.

2.3.1.6.2.8 SNOWPLOW (SP) SUBMODE (OSB 8)

Depress OSB 8 next to the SP mnemonic to select the snowplow option. The mnemonic highlights indicating that you are in SP mode. SP sighting directs each sensor line-of-sight straight ahead in azimuth; it is not referenced to any steerpoint. In GM, GMT and SEA modes, the cursor will be positioned in the center of the MFD. The cursors remain fixed while the ground map video moves, or "snowplows," across the MFD.

At this point, there is no sensor of interest (SOI) and the cursors cannot be slewed. TMS up establishes the radar as SOI, ground-stabilizes the cursor and enables cursor slewing with the CURSOR/ENABLE switch. TMS up again with the cursor over a target will command target track. All cursor slews in SP are zeroed when SP is deselected.

After ground stabilizing, the point under the cursors at the time of stabilization effectively becomes your steerpoint. All NAV and weapon delivery steering and symbology, including great circle steering, will be referenced to this "pseudo steerpoint." Displays return to the previously selected sighting point when SP is deselected.

TMS down will only drop a ground target lock, placing the cursor at the same point it was before a lock attempt was made.

SP is deselected any of the following ways:

- Depressing OSB 8 adjacent to the SP mnemonic.
- Entering any air-to-ground visual submode (CCIP, DTOS, STRAFE, EO-VIS).
- Changing steerpoint (only if SP is ground stabilized; pre-designate changes of steerpoint have no effect).
- Entering any air-to-air radar mode.

As SP mode is not tied to a steerpoint it is particularly useful where target coordinates are not known in advance; either because specific enemy battalions are on the move, or for finding targets of opportunity. It can also be useful to scan ahead for potential ground threats or terrain obstacles while navigating, especially at low altitude.

2.3.1.6.2.9 CURSOR ZERO (CZ) (OSB 9)

Depressing the OSB adjacent to the CZ mnemonic will zero accumulated A-G cursor corrections (slews). This mnemonic is available on all A-G FCR base pages, TGP base pages and OFF pages when in A-G or NAV master modes. See also SPI MANAGEMENT.

2.3.1.6.2.10 SIGHTING POINT ROTARY (OSB 10)

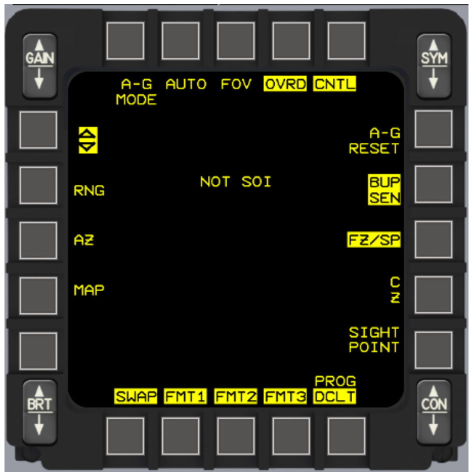
The sighting point rotary determines the System Point of Interest (SPI). Depressing OSB 10 adjacent to one of the following mnemonics selects the next available option in the rotary. Depressing TMS right will accomplish the same thing if the SOI is the HUD or FCR (and the radar is in air-to- ground mode). This causes the tracking sensors to break lock and select the next option in the rotary just as the OSB does.

- TGT/STP - TGT or STP sighting, positions the cursor directly over target or steerpoint; i.e., destination coordinates plus cursor corrections are at the entered target location when using VRP sighting. The option selected is a function of the operating mode or submode.
- OA1/OA2 - OA1 or OA2 positions the cursor at the entered range and bearing from the selected steerpoint. If an offset aimpoint has a range of zero, it will not be in the sighting point rotary.
- IP/RP - If the selected steerpoint is equal to the initial or reference point, the selected IP or RP sighting option causes the cursor to be directly over the IP or RP. The option selected is a function of the operating mode or submode.

The air-to-ground tracking sensor will break track when the sighting point rotary is changed by the MFDs.

2.3.1.6.2.11 FCR A-G DECLUTTER SELECT/DESELECT (OSB 11)

By pressing DCLT OSB long you can change different declutter options which were introduced in 4.36.
Decluttering is especially useful to "Clean up" the FCR and blend out certain symbology.
It can be used to blend out certain target information such as altitude, attack steering, DLZ, TGT data, etc. as well as your own weapon state and sensors. Set your values to your taste and task.



2.3.1.6.2.12 TTG, TUI, AND TOF ON FCR (ABOVE OSB 11)

The FCR STBY, BIT, A-G Base page, and A-G Ranging (AGR) page (as well as the HSD and TGP) display the appropriate time-to-go (TTG), time-until-impact (TUI), and time-of-flight (TOF) information in the lower right corner. Time-on-target (TOT) depiction is placed directly below the time-to-pull-up/time-to-impact data.

2.3.1.6.2.13 BEARING AND RANGE TO SYSTEM POINT OF INTEREST (SPI) (ABOVE OSB 15)

In any GM mode, location of the SPI is provided in two digital formats on the MFD. If the mode-selectable bullseye is not selected, the location of the SPI relative to the system STP is displayed above the backup steering symbol (flying W) on the MFD. If the mode-selectable bullseye has been selected, the flying W is replaced by ownship bullseye symbology, the same as on A-A FCR displays. Location of the SPI is then displayed relative to the bullseye. In either case, location of the SPI relative to ownship is also displayed to the right of the flying W or ownship bullseye symbology.

2.3.1.6.2.14 AZIMUTH SCAN PATTERN (OSB 18)

In all A-G mapping modes, the antenna azimuth scan pattern is initialized at ±60°. OSB 18 will cycle through the available antenna azimuth scan patterns; A1, A3, or A6 for ±10°, ±30°, or ±60° azimuth scans respectively.

Antenna Azimuth Symbol. The radar antenna angle in azimuth is indicated by a **T**-symbol that moves along the bottom of the MFD display. The azimuth angle of the antenna is estimated by observing the position of the azimuth caret relative to the display width, which represents ±60° in unexpanded displays (in A-G modes, 0° is along the aircraft ground track).

2.3.1.6.2.15 FCR RANGE DISPLAY (OSB 19-20)

FCR range scale with △ ▽ (INC/DEC) switches are displayed.

2.3.1.6.2.16 GAIN CONTROL

The GAIN rocker switch, located at the top left of the MFD, adjusts the map gain around the default gain established by the radar. Hands-on gain adjustment is available by rotating the MAN RNG/UNCAGE control. The map gain is increased or decreased by approximately ±20% of the base setting when the knob is rotated.

In order to provide additional gain, an indicator is displayed top left, next to the rocker switch. With maximum gain, the caret will be located at the top of the indicator; with minimum gain, the caret is located at the bottom.

2.3.1.6.2.17 ELEVATION SCAN PATTERN

Elevation scan pattern is not selectable in A-G modes. The scan pattern is a 1-bar scan except when in FTT, GMTT, or AGR.

Antenna Elevation Symbol. The radar antenna angle in elevation is indicated by a horizontal **T**-symbol that moves up and down the left side of the MFD display. The elevation angle of the antenna is estimated by observing the vertical position of the elevation caret relative to the display height, which represents ±60°.

2.3.1.6.2.18 RANGE MARKS

For unexpanded GM-type modes, the range marks consist of a series of concentric arcs. The number of range marks is a function of the selected range scale as follows:

Range Scale	Range Marks	Miles/Mark
10	1	5
20	3	5
40	3	10
80	3	20

Range Marks

2.3.1.6.2.19 GROUND TARGET TRACK

In GM, SEA, and GMT modes, if a target is being tracked, the target will appear as a solid diamond at the intersection of the X-Y cursor and range will be displayed in the HUD slant range window.

2.3.1.6.2.20 GROUND MAP (GM)

GM mode is designed to provide a map display on the MFD suitable for navigation and for target detection. Weapons delivery is supported by a ground stabilized cursor whose position is indicated on the map display and is used to center the scan coverage. GM returns are displayed on a plan position indicator (PPI) (polar coordinates) sector format. The submodes EXP, 8:1 DBS1, and 64:1 DBS2 magnify a patch of the PPI sector resulting in increased resolution of the map and more precise cursor placement.

Transition to FTT is available from GM NORM, EXP and DBS.

STP, OA and SP cursor position are used for weapons delivery and centring of the map coverage. A STP, OA or SP can be selected as an initial cursor position. STP and OA information is used to continually determine the cursor range in all three axes from the aircraft to the STP. Therefore, the cursor is ground stabilized at that location.

SP allows observation of the map area in front of the aircraft without having to constantly select steerpoints located ahead of the aircraft. Pressing TMS up creates a pseudo-steerpoint at the current cursor position. At this time, cursor position is ground stabilized, similar to selecting a steerpoint for the initial cursor position, and cursor placement may be adjusted.

Cursor position is depicted relative to the map at the intersection of the horizontal and vertical lines on the MFD and is also indicated by the steerpoint diamond in the HUD. The CURSOR/ENABLE control is used to move the cursor onto the feature of interest on the displayed map.

Pressing CZ on the MFD removes previous adjustments made to the initial A-G cursor position. This is useful if adjusting gain, changing submodes, or lowering range scale. In this case, the A-G cursor may be displaced from the correct position over the target.

Scan pattern size and location in GM are controlled both automatically and manually. A 1-bar scan is roll and pitch stabilized with ±10, ±30, or ±60 azimuth scan width selections available from the MFD.

Range resolution increases by 2:1 for each decrease in range scale while in the NORM, EXP and DBS1 submodes. Changing range scales in DBS2 has no effect on range resolution.

2.3.1.6.2.21 SEA

SEA mode is designed to detect sea-borne targets in low sea states. SEA mode processing differs from GM in that more samples are integrated to produce the map. This requires a slightly slower scan rate to increase the integration time on sea targets.

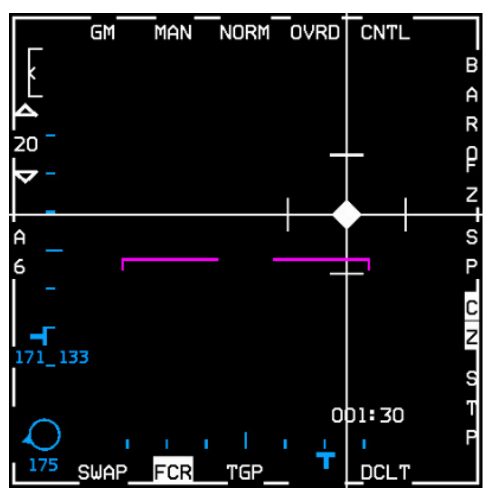
Control and operation of SEA mode is identical to GM except for the processing differences described above, and the lack of DBS submodes. The NORM and EXP submodes are available as well as the FZ option and transition to FTT.

2.3.1.6.2.22 FIXED TARGET TRACK (FTT)

FTT is designed to automatically maintain an accurate track of a stationary discrete target for weapon delivery. FTT is available in GM, SEA or DBS modes and is initiated with a TMS up. This action initiates an acquisition sequence where the radar searches for targets about the cursor position with greater reflected intensity than the background clutter.

2.3.1.6.2.22.1 MULTIFUNCTION DISPLAY (MFD)

Track targets on the MFD are displayed as a solid diamond. The lines previously used to indicate cursor position now indicate target position with the solid diamond at the intersection. The range rings and expansion cue are not displayed during FTT. A typical FTT display is shown below:



FTT display

2.3.1.6.2.22.2 HEAD-UP DISPLAY (HUD)

FTT targets can be seen visually through the HUD. For weapon delivery, an A-G TD box is positioned at the target location. Slant range to the target is also presented on the HUD.

2.3.1.6.2.22.3 FTT ACQUISITION

Transition to FTT is available from all GM submodes (NORM, EXP, DBS1, and DBS2). If the SP option is selected, the cursor must first be ground stabilized before acquisition of a target can be attempted. The pilot first selects a discrete ground return to track in FTT. Accurately slewing the ground stabilized cursor to the target and pressing TMS up and release designates the target and initiates the acquisition process.

If acquisition is successful, then the lines previously indicating cursor position now indicate the tracked target position, with a solid diamond placed at the intersection. The FTT display format is a PPI sector similar to the GM NORM submode, but without the map information, range rings or expansion cues.

It is generally preferable to acquire targets from EXP or DBS, since signal and thus image quality is increased, and it is easier to differentiate targets.

2.3.1.6.2.22.4 LOSS OF TRACK

If FTT processing can no longer detect the target, or track is terminated due to signal fade, the cursor on the MFD is placed at the last tracked position.

Return to search is commanded by TMS down. FTT is stopped and the previously selected search mode is resumed, with the FOV option in effect at the time of designate. The cursor on the MFD is placed at the last tracked position.

FTT is exited and the previously selected search mode is resumed when the antenna reaches its mechanical gimbal limits. The cursor on the MFD is placed at the gimbal limit position.

2.3.1.6.2.22.5 MODE SWITCHING

Changing to any other mode while in FTT results in an immediate mode change and the track is terminated.

2.3.1.6.2.23 GROUND MOVING TARGET (GMT)

GMT mode is designed to detect moving targets on land or sea. Moving vehicles including cars, tanks, trucks, ships, aircraft while taxiing or helicopters in flight can be detected at low speeds. A background map is available for navigation and detection of stationary targets. Normal (NORM) and expand (EXP) submodes are available along with the FZ option similar to GM.

Acquisition to Ground Moving Target Track mode (GMTT) is available for tracking moving targets in the real APG-68; however, in BMS it is not currently modelled. Targeting pods (AN/AAQ-14 LANTIRN or AN/AAQ-33 Sniper) will allow you to acquire and track moving vehicles once detected with GMT mode.

2.3.1.6.2.24 AIR-TO-GROUND RANGING (AGR)

The AGR mode is designed to provide accurate range to a ground point for visual A-G delivery modes (CCIP, DTOS, STRAFE, EO-VIS). The radar is automatically commanded to AGR when the appropriate A-G weapon submode is selected (unless STBY or OVRD is selected).

AGR ranges to the point on the ground indicated by weapons delivery symbology in the HUD. Depending on the submode selecting AGR, the symbol in the HUD may be slewed to the desired point, or the aircraft can manoeuvre to place the symbol at the desired point, or a combination of both. The CURSOR/ENABLE switch on the throttle is used to slew the symbol. Different symbols (see below) are used to indicate the ranging point depending on the submode.

Submode	Symbol	Pointing Method
HUD Mark	CCIP Pipper (circle with dot)	Slew
Visual Air-to Ground STRAFE CCIP	CCIP Pipper (circle with dot)	Manoeuvre aircraft
DTOS EO-VIS	A-G TD Box (square with dot)	Manoeuvre aircraft Slew

2.3.1.7 FCR IFF MODE

Depending on the IFF scan priority, you can select the IFF mode with OSB16 you want to interrogate.

Mode	FCR Symbol
Mode 1-4 (Starting with Mode 1 in sequence to mode 4)	M+
Mode 1 (Mode 2 only)	M1
Mode 2 (Mode 2 only)	M2
Mode 3 (Mode 3 only)	M3
Mode 4 (Mode 4 only)	M4

By pressing TMS left long, you can interrogate in the LOS mode. For more information, please refer to the IFF chapter.

2.3.1.8 FCR FAULTS

PFL	MFL	EFFECT	ACTION	LIGHTS
FCR BUS FAIL	FCR 003	FCR INOPERATIVE	N/A (NOT RECOVERABLE)	AVIONICS FAULT
FCR XMTR FAIL	FCR 094	FCR INOPERATIVE	N/A (NOT RECOVERABLE)	AVIONICS FAULT

FCR Faults

2.3.1.9 FCR LINK 16 INFORMATION

Please refer to the Link 16 Messages (FCR) chapter.

2.4 TACAN / MIDS / LINK 16 / IDM

2.4.1 TACAN

TACAN means TACtical Air Navigation and is primarily a military navigation aid. It essentially combines two navigation from civilian air navigation: VOR (VHF Omni directional Range) and DME (Distance Measuring Equipment). Often, a VOR and a TACAN are combined into a unique system called a VORTAC. Usually, only military airbases are equipped with TACAN, but since it is the only navigational aid we have in Falcon, civilian VORDMEs & VORTACs in the real Korea have been associated with TACANs in Falcon.

TACAN is a radio signal (UHF 960-1215 MHz) and as such depends on Line of Sight (LOS). That means if a mountain is between your aircraft and the TACAN station, your instrument will not be able to receive the signal. You will get longer TACAN range when flying at high altitude. When down in the weeds the TACAN signal will probably be degraded because of the limited line of sight.

TACANs are set with a channel (from 0 to 126) and a band (X or Y) (252 channels total) and an operating mode, air-to-ground or air-to-air (T/R and A/A TR). The F-16 has two ways to set the TACAN system: One primary and one backup.

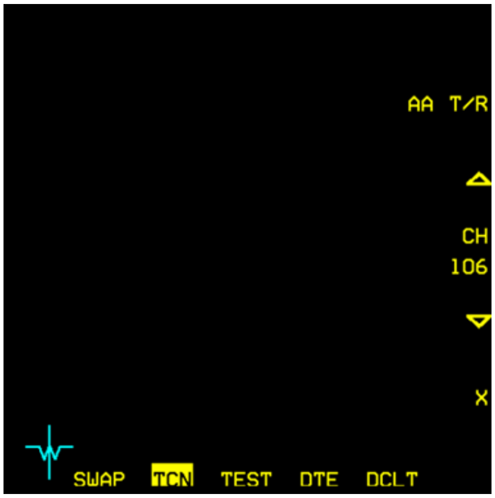
For older F-16 blocks, the backup system is set through the AUX COMM panel where the channel, band and mode are set and will work as long as the CNI switch is set to BACKUP.

AUX COMM Panel

Newer or upgraded blocks may have an IFF panel instead. On these panels backup TACAN controls have been replaced by backup IFF controls and the CNI switch is now labelled C&I.

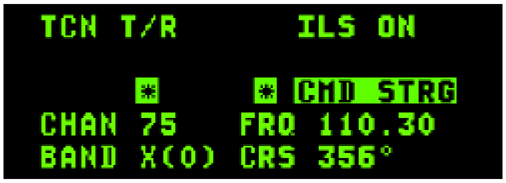
IFF panel

In these jets, backup TACAN controls have a dedicated MFD page. It is advisable to set this up during ramp start in case you lose both MFDs during the mission.



Backup TACAN MFD page

The primary way to set up TACAN is the UFC (Up Front Controller) and is used as soon as the CNI / C&I switch is set to UFC. On the ICP T-ILS sub-page, enter the channel in the scratchpad, press M-SEL/0 to toggle the band (X or Y) and DCS right to toggle the mode (T/R or A/A TR).



T-ILS (TACAN-ILS) DED page

2.4.1.1 AIR-TO-GROUND MODELLING

TACAN can be used in both air-to-ground (A-G) and air-to-air (A-A). A-G obviously is used for tuning a ground navigation station and using it to navigate your airplane to/from a fixed ground location. Currently in BMS all ground stations are in the X TACAN band. Refer to the charts (in the *\Docs\03 KTO Charts* folder) for specific TACAN channels.

To tune into a ground station, simply input the TACAN channel and band into your navigation system and set your HSI to TACAN mode. If the TACAN is in range and within line of sight, all relevant information on the instrument will be relative to that ground station.

2.4.1.2 AIR-TO-AIR MODELLING

Aircraft are also equipped with TACAN emitters as in real life. Depending on the type of aircraft, only distance information or both distance and bearing are transmitted. In Falcon BMS, only the KC-10 has both; all the other aircraft (F-16 included) are only able to transmit range information via DME (Distance Measuring Equipment).

A-A TACAN is a little bit more complicated than A-G. The channels between the two coupled aircraft need to be 63 apart. The maximum allowed channel is 126, one way or another. So if you want to tune into another aircraft that is on channel 11, you need to input channel 74 (11+63= 74). If the other aircraft is on channel 80, you will have to set channel 17 (80-63= 17). You can't set 80+63=144Y as that's over the 126 limit. In A-A mode the band can be X or Y, but the mode needs to be set to A/A TR.

When two aircraft are tied with A-A TACAN, the DME information appears in the DME window of the HSI and on the lower right corner of the DED if the A-A TACAN signal is valid. The bearing pointer on the HSI (set to TCN) will spin at 30°/s when no bearing information is received, or will point to the direction of the emitter when receiving bearing information (KC-10 only).

In addition, regardless of HSI mode selection, if you put the TACAN in A/A TR mode, the DED CNI page will show you DME to the aircraft your TACAN is locked on to if one exists (either as XX.X if less than 100Nm range or XXX miles if greater). If you see "-----" instead, then you have selected a channel that has no partner aircraft to lock on to.

Humans can select any TACAN channel and any band for A-A TACAN. If more than one receiver is tied, only the DME range to the closest one will be displayed.

Example: Flight with #2 in Fighting Wing and #3 in Spread. Fighting wing is a visual formation and #2 does not really need A-A TACAN. The guy in spread might use an A-A TACAN though, especially in a simulated environment where judging distance on a flat screen might be a problem. So lead sets an A-A TACAN of 10Y and transmits that information to his flight members. If both #2 and #3 set their TACAN to 73Y (10+63=73Y), both will get the distance from their lead but lead will only get the distance from the closest tied aircraft. Obviously, that's #2, when he does not need to know the distance from his immediate wingman. To avoid that, lead and element lead can tie together and wingmen can tie together as well on a different TACAN channel/ band. It can be one channel apart or even better one band apart but on the same channel, e.g.: Lead (#1) on 10Y paired with Element Lead (#3) on 73Y and lead's wingman (#2) on 73X and element lead's wingman (#4) on 10X. That way, element leads are tied together and wingmen are tied together as well, but by simply changing the A-A TACAN band (X ⇄ Y); they can quickly make a check on their respective lead, or switch to those channels if the elements split to maintain better SA.

While humans can select any channel and band, AI aircraft use fixed TACAN channels in the Y band. The first AI flight will use: 12, 22, 75 & 85Y. The next AI flight is one number higher: 13, 23, 76 & 86Y. BMS can support up to five flights of AI with this system. That means that you can always find an AI controlled aircraft in the first 5 flights.

Refuelling aircraft use fixed TACAN channels. The first tanker in the TE is assigned channel 92Y. This is the most "logical" tanker channel to use because the reciprocal channel is easy to find: 92-63=29Y – the digits are simply reversed.

If there is more than one tanker in the TE, then the next one will default to 126Y, then 125Y and so on. To tie on them, pilots will set 63Y, 62Y, etc. You can always ask AWACS (if one is available) for a vector to the nearest tanker; the response will include the tanker's TACAN channel (and UHF frequency, position and several other bits of information very handy when you're getting low on gas), but remember that the operator in the AWACS will always give you the TACAN channel that you need to enter in your UFC to tie with the tanker.

Finally note that you can operate the up-front controls (ICP/DED) TACAN settings and those will govern the operation of your onboard TACAN as long as the AUX COMM panel CNI (or IFF panel C&I) switch is in "UFC". If the switch is in "BUP" then the TACAN settings on the AUX COMM panel (or TCN MFD page for IFF panel aircraft) will be used for TACAN operation. This can come in handy if you want to switch quickly between two separate aircraft. There is still only one TACAN transceiver available though.

2.4.2 MIDS

This portion delineates the whereabouts and operational aspects of the Multifunction Information Distribution System (MIDS), along with its associated controls and displays.

Please note that not all F-16 in BMS has MIDS implemented (see chapter 6.7 in this document). For those non-MIDS aircraft F-16 blocks, the general TACAN implemented. Information about TACAN can be found in chapter 2.4.1.

2.4.2.1 MULTIFUNCTION INFORMATION DISTRIBUTION SYSTEM (MIDS)

The Multifunction Information Distribution System Low Volume Terminal (MIDS LVT) facilitates Tactical Air Navigation (TACAN) and Link 16 data link capabilities.

The MIDS operates on 115Vac 3-phase power, regulated by the MIDS power switch located on the AVIONICS POWER panel. Initialization of the system occurs either through data transfer from the Data Transfer Cartridge (DTC) or by utilizing preloaded network data (MIDS initialization (INIT) file). Activation of TACAN and/or Link 16 functions takes place upon selection of any TACAN or Link 16 mode from the Up-Front Controller (UFC). Even when the MIDS power switch is turned OFF, with electrical power still supplied to the aircraft, voltage persists to the main terminal to maintain the loaded crypto codes.

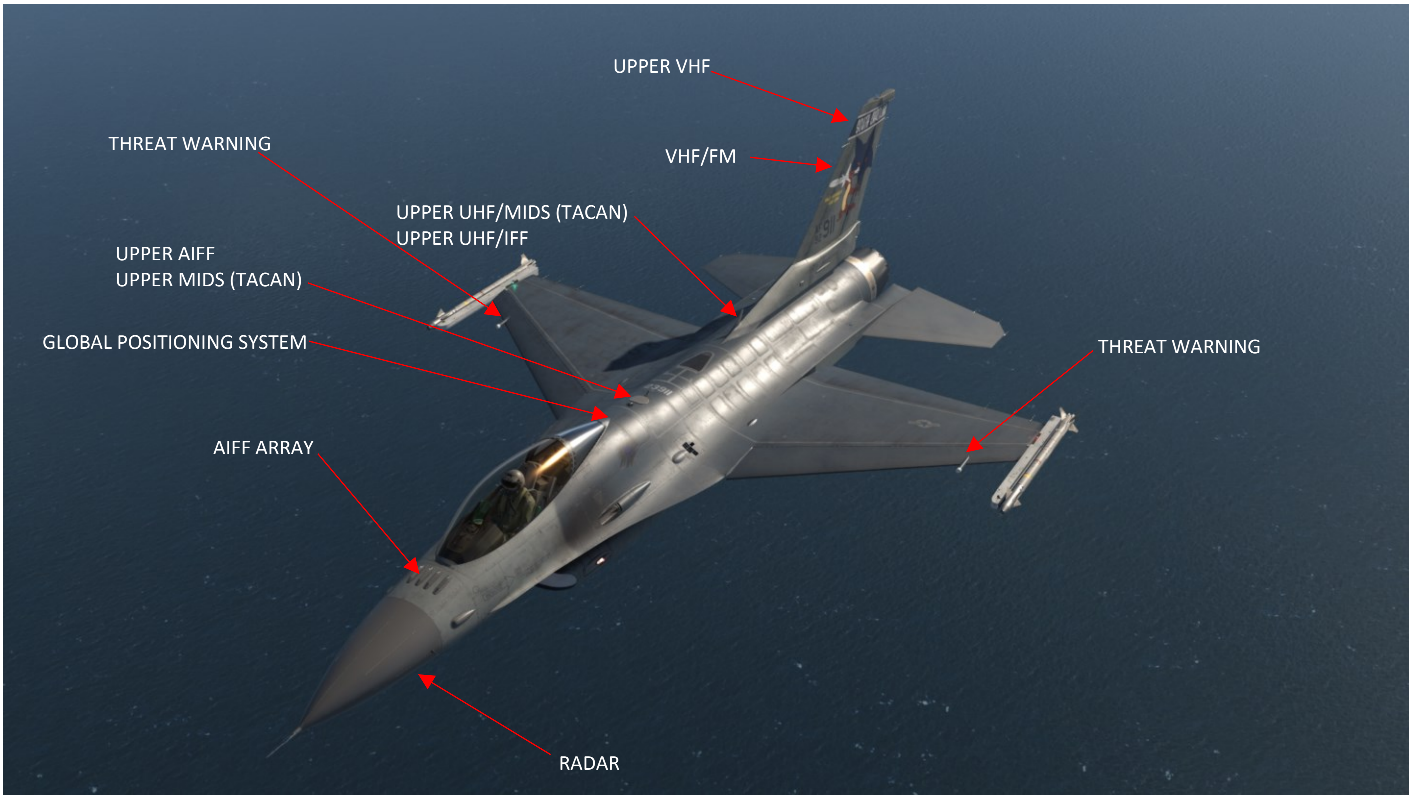
2.4.2.1.1 ANTENNA MODE CONTROL NOTCH FILTER

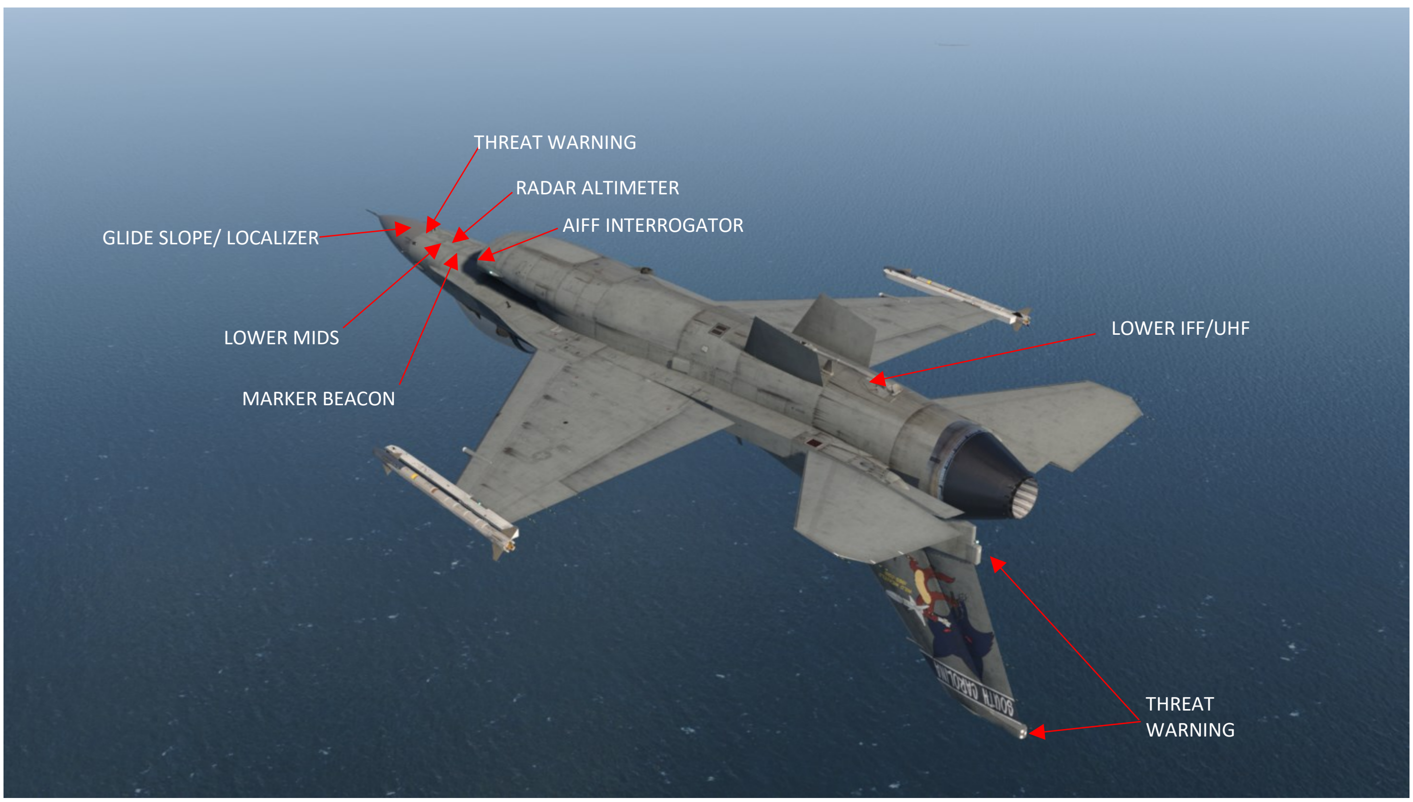
A study on F-16 MIDS-LVT radio frequency (RF) compatibility uncovered multiple instances of RF interference occurring between the MIDS and the AIFF.

The MIDS LVT utilizes both upper (antenna A) and lower (antenna B) L-Band antennas for the operation of the Link 16 data link (MIDS Time Division Multiple Access (TDMA)) and MIDS TACAN transmit-receive functions. To prevent interference with the AIFF system, both antennas are equipped with radio frequency dual notch filters, centred around 1030 and 1090 MHz. The upper antenna is equipped with a permanent notch filter, which adversely affects TACAN performance on approximately one third of the TACAN channels. In contrast, the lower antenna features a switched notch filter that allows TACAN transmissions while preventing interference from Link 16 transmissions on AIFF. The TACAN lower antenna is set as a standard through the MIDS NDL. The use of the upper antenna may lead to degraded TACAN performance.

During AIFF INTGs (IFF Interrogation), the MMC instructs the MIDS terminal to transition its TDMA (Link 16) transmissions exclusively to the upper antenna, rather than utilizing both the upper and lower antennas. Upon the conclusion of the INTG, the MMC directs the MIDS terminal to return to employing both the upper and lower antennas.

In the event of a failure in the lower antenna notch filter, the Link 16 and MIDS TACAN transmit-receive functions will be automatically shifted to the upper antenna. Consequently, TACAN operations will also be switched to the upper antenna. This configuration persists until an MMC power cycle is executed, another Link 16 DTC load is conducted, and the notch filter failure is rectified.





A/C Antenna Locations (Typical)

2.4.2.1.2 MIDS CONTROLS

The MIDS power switch, positioned on the AVIONICS POWER panel, features three positions: ZERO/OFF/ON. To transition to the ZERO position, the switch must be lifted. The TACAN volume knob on the AUDIO 2 panel exclusively regulates TACAN volume. When the MIDS is inactive, "TACAN OFF" will be indicated on the MFDS TCN page and "TCN OFF" will be displayed on the T-ILS DED page.

Please note:

- The MMC should be activated at least 10 seconds prior to turning on the MIDS. Failure to do so may cause the MMC to overlook the activation of MIDS power. If the MMC fails to detect the MIDS, cycle the MIDS power and try again.

- MIDS/LVT power must be activated for the MIDS TACAN to function.

When the ON position is engaged, power is supplied to the MIDS, triggering the transmission of a MIDS power-on signal to the MMC. Within 20 seconds, the MIDS is expected to initiate responses on the MIDS MUX bus. Following power application and completion of startup BIT, the MIDS starts communicating on the MUX. The sequence of powering the MIDS in relation to GPS and INS should not disrupt overall system functionality. However, turning on the MIDS after the EGI has entered NAV mode and the GPS is aligned can prevent spurious MFLs and the transmission of inaccurate aircraft positions. Hence, the recommended power application sequence is outlined as follows:

1. Follow the standard avionics power-up procedure, including activating the EGI.

2. Once the EGI is in NAV mode and the GPS is aligned, switch on the MIDS (Refer to Note below).

3. Allow 30 seconds for the MIDS to initialize on the MUX and complete data requests/feedback with the MMC.

4. Attempt to display the NET STATUS page on the DED (LIST, ENTER).

Confirmation of MIDS initialization should be obtained by displaying the DED NET STATUS page (LIST, ENTER) before inputting any TACAN data or loading the NDL. Failure to wait for initialization after power-up (or after MMC power cycles, MMC restarts, or MIDS power cycles during flight) could lead to incorrect antenna selection (indicated by loss of TACAN DME reception from certain TACAN stations).

5. Once the NET STATUS page is visible, proceed to load "Link 16" DTC from the MFD, even for TACAN-only.

Please note:

The pilot must ensure that the GPS is aligned before activating the MIDS. When the GPS is in track, accurate date information is transmitted to the MIDS terminal, enabling it to determine the appropriate crypto key location.

• Activating the MIDS before the GPS is in track may result in insufficient accuracy for the MIDS to achieve FINE sync.

• It's advisable to delay MIDS power-on for at least 10 seconds after applying power to the MMC. This allows the MMC to initialize before attempting to establish communication with the MIDS. If communication isn't established, MIDS power should be recycled.

Switching to the MIDS LVT OFF position cuts off main power to the MIDS. To prevent depletion of MIDS battery, it should be turned OFF before shutting down the aircraft's main electrical power source.

Note: MIDS batteries are not rechargeable by the aircraft. While the MIDS accepts keys in both ON and OFF positions, in the ON position, it may trigger temporary faults MIDS 074 (PFL: LK16 INIT REQD) during key loading. These faults should clear once the key-loader is disconnected from the aircraft.

2.4.2.1.3 BIT COMMAND AND STATUS

The initiation of the MIDS start-up built-in test (BIT) occurs when the MIDS power switch transitions from OFF to ON. Throughout the start-up BIT process, all MIDS terminal modules undergo thorough testing of their functions, excluding Radio Frequency transmissions. The start-up BIT continues for 20 seconds until completion. In case of a power interruption lasting less than 10 seconds during the start-up BIT, the BIT process is terminated and must be reinitialized. However, for power interruptions exceeding 10 seconds, the start-up BIT is automatically re-initialized.

To initiate the MIDS manually initiated Built-In Test (IBIT), press and release (D&R) MIDS OSB 8 on the MFDS BIT2 page. This action triggers the testing of the entire MIDS system, including TACAN functionality.

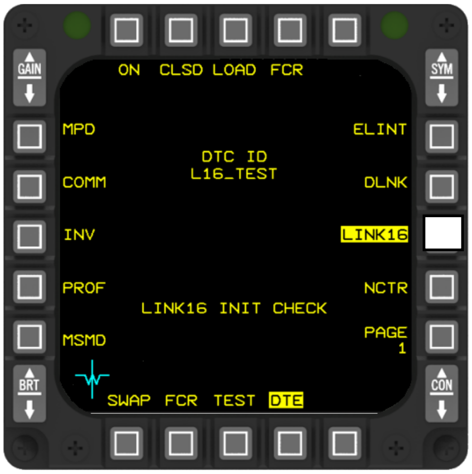
The MIDS IBIT conducts checks on both the MIDS and TACAN systems. Throughout IBIT, round trip timing (RTT) interrogations involving RF transmissions take place, unless run silent mode is chosen (details on MIDS run silent are provided later). The MIDS OSB 8 remains highlighted on the BIT2 page until the check is completed, typically lasting around 20 seconds. The manual MIDS IBIT cannot be halted before completion. During IBIT, the MIDS loses network synchronization. Upon IBIT completion, the MIDS automatically returns to the initial entry process, re-establishes synchronization with the network, and resumes the previous mode of operation.

2.4.2.1.4 RF SWITCH FUNCTIONALITY

The RF switch is situated on the MISC panel. When set to QUIET, the RF switch commands the output power to be reduced to low power for any MIDS transmit power setting other than NONE. If the RF switch is moved to SILENT or the MIDS XMIT power setting is switched to NONE, the DED will indicate that the MIDS has automatically turned off the NTR by displaying "NTR OFF" on the DED page. Subsequently, if the RF switch is shifted out of SILENT or the MIDS XMIT power setting transitions from NONE to HIGH, the NTR setting will remain off (and this status will also be shown on the DED page).

When the radio frequency (RF) switch is set to QUIET or SILENT, the TACAN is compelled into receive-only mode, leading to the loss of DME and A/A TACAN functionalities. Although the operator retains the option to select the desired mode, the TACAN remains instructed to receive until the RF switch is set back to NORM. Upon returning the RF switch to NORM, the previously selected TACAN mode is once again activated.

2.4.2.1.5 MIDS DTC INITIALIZATION



The Link 16 network operates by initializing subsystems through the DTC. Like IDM implementation, adjustments to certain initialized parameters can be made during flight. D&R OSB 3 (LOAD) loads all file sets shown on the initial DTE page, with Link 16 A/B OSB 8 files, if visible, loaded last.

Due to the MIDS's inability to process initialization changes until it confirms the usability of the current initialization data stored in its non-volatile RAM, the LINK16 label and stored set label are omitted from the DTE page for roughly 30 seconds after powering up the MIDS. Once the MIDS verifies the stored initialization data, these labels reappear.

The F-16 enables the loading of two complete initialization sets and activates the set identified under the LINK16 label OSB 8 on the DTE page. Upon entry to the DTE page, the label for the currently active MIDS stored set (A or B) is displayed. If only one set or no set is stored in the MIDS (unless the DTC loads two sets into the MIDS), the 'A/B' label remains blank. The pilot can switch the active set by pressing OSB 8 for equal to or greater than 0.5 seconds, toggling the stored set to the inactive set. If "Start Net Entry" is enabled in the NDL, the MIDS may automatically restart net entry with the new NDL.

CAUTION: A short press of LINK16 (OSB 8) resets the Link 16 parameters to the values loaded on the DTC.

A momentary (<0.5 seconds) D&R of OSB 8 (LINK16) commands the transfer of both A&B MIDS initialization (INIT) files from the DTC and activates the set identified under the LINK16 label. The LINK16 label is highlighted while the MMC transfers the DTC files from the DTE to the MIDS and flashes if a transfer error occurs. No load errors are reported if the MIDS is powered off. After successfully transferring the file sets (approximately 8 seconds), the MIDS checks the data (approximately 4 seconds). During this time, no DTC data is passed to the MIDS, and the message "LINK16 INIT CHECK" is displayed on the data link DTE page, while the LINK16 OSB 8 becomes inactive.

Upon completion of the verification of the DTC load, the "LINK 16 INIT CHECK" message disappears. If the load is valid, no further messages are displayed, and the Link 16 network entry is automatically attempted if specified in the NDL for the network established by the active stored initialization set. If the MIDS indicates an error in the initialization data, the MFD displays the message "LINK16 INIT ERROR," indicating that another LINK16 DTC load should be attempted.

Please note that FILE A / B must contain data in the DTC (DTC tab in BMS UI). If no data is available, a selection between File A and B for OSB 8 is not accessible.

2.4.2.1.6 MIDS TACAN

The TACAN subsystem serves as a 252-channel airborne navigation receiver/transmitter, furnishing the EHSI with relative bearing and slant range distance information to and from a TACAN ground station (surface beacon) or cooperating TACAN reference aircraft, alongside an audio identification tone of the ground station to the pilot. Operating within two bands, X (962 to 1213 MHz) and Y (1025 to 1150 MHz), it boasts a line-of-sight range of 390 nautical miles from a ground station or 200 nautical miles from a cooperating reference aircraft. However, operational effectiveness is subject to line-of-sight transmission limitations imposed by surrounding terrain and aircraft altitude. The TACAN system comprises the following components:

- Receiver/transmitter (R/T)
- Digital-to-analog adapter
- Electrical equipment mounting base
- Upper antenna
- Lower antenna
- Controls (including segments of the CDEEU, ICP, IKP, DED, and AUDIO 2 panel)

Its functionalities include:

- Distance to ground station (DME)
- Distance to cooperating aircraft (A/A mode)
- Bearing information on the EHSI
- Beacon recognition capability
- Aural identification of received TACAN beacon identity
- Indication of invalid information
- Availability of 126 X and 126 Y channels.
- Primary control on the UFC.
- Backup control on the MFD

2.4.2.1.6.1 POWER ON/OFF CONTROL

In the MIDS LVT configuration, TACAN power is activated via the MIDS Avionic switch on the Avionics Power panel. The TACAN power/volume knob located on the Audio 2 panel specifically manages the TACAN volume (hardcoded to ON in BMS).

2.4.2.1.6.2 BIT COMMAND AND STATUS

MIDS enters the Built-In-Test (BIT) mode when commanded through OSB 8 on the MFDS TEST BIT2 page. In this mode, both the Time Division Multiple Access (TDMA) and the TACAN components of MIDS undergo testing. The TACAN portion of MIDS offers a comprehensive test through a single user-accessible BIT function. Alongside BIT faults, the bus controller also identifies normal bus communication faults for the TACAN.

2.4.2.1.6.3 TACAN MODE CONTROL

There are two TACAN modes in BMS:

• Transmit/receive (T/R).

• Air-to-air transmit and receive (A/A T/R).

The selection of TACAN modes (T/R, and A/A T/R) is accomplished through the DED T-ILS page by rotating through the modes using the DCS. The commanded TACAN mode is then displayed on the UFC.

CAUTION:

During the loading of the MIDS NDL from the DTC to the MIDS, the TACAN settings (mode, channel, and band) will be set according to the NDL contents. If the pilot had previously set the TACAN to a local station (e.g., 24X) before the NDL load, the MIDS TACAN settings will be overwritten by the NDL data. It's essential to verify the TACAN channel/band/mode after an NDL load to ensure alignment with the intended station.

The TACAN modes (T/R and A/A T/R) are selected via the mode sequence rotary on the DED T-ILS page. When the mode rotary is sequenced, there may be a brief delay before the newly commanded mode is displayed.

2.4.2.1.6.4 CHANNEL SELECTION

The TACAN system operates within the valid channels of 1 to 126, available in both the X and Y bands. Operators are responsible for selecting the channel and band for TACAN usage, with these choices transmitted to the TACAN unit. To select a desired channel, enter a number ranging from 1 to 126 into the scratchpad of the DED T-ILS page. Alternatively, inputting a 0 toggles between the X and Y bands. The acceptable bands are X and Y.

Any numbers entered outside of the specified ranges (0, 1-126) either adjust the ILS frequency (which ranges from 108.10 to 111.95 in alternating increments of 0.05 and 0.15) or are rejected outright.

2.4.2.1.6.5 RF SWITCHING PROCESS

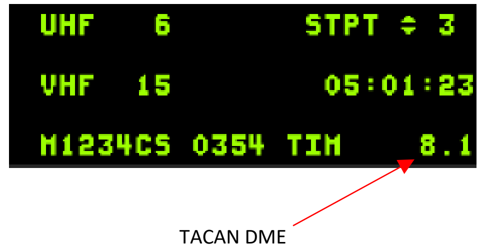
When the RF switch is in QUIET or SILENT, the TACAN is compelled into receive-only mode, leading to the loss of both DME and A/A TACAN functionalities. Although the pilot retains the ability to select the desired mode, the TACAN remains in receive mode until the RF switch is returned to NORM. Upon transitioning the RF switch to NORM, the previously selected TACAN mode is re-commanded.

2.4.2.1.6.6 TACAN INITIALIZATION

The NDL dictates the initial TACAN channel, band, and mode. Loading an NDL file from the DTC will replace the presently selected TACAN settings.

2.4.2.1.6.7 BEARING AND RANGE OUTPUT

The TACAN system provides measurements of both bearing and range, with range indicated in tenths of miles. These data are then displayed on the EHSI (Electronic Horizontal Situation Indicator).

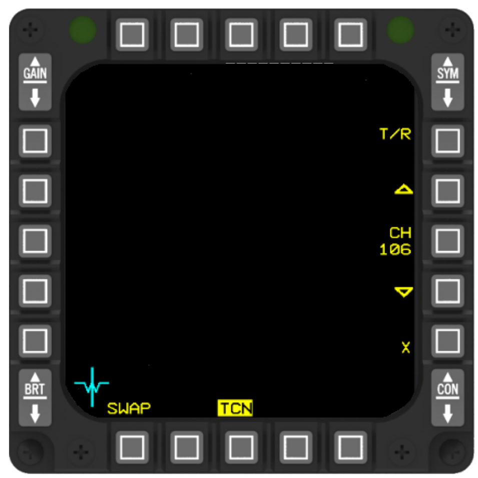


In A-A transmit/receive (A/A T/R) mode, the TACAN system displays the distance to the TACAN station instead of the selected TACAN channel on the CNI (Communication, Navigation, and Identification) page. In this mode, the "T" for TACAN is omitted, allowing for the display of the DME (Distance Measuring Equipment) range in three digits, followed by a decimal point and one decimal digit.

If the range exceeds 99.9 nautical miles (NM), the decimal point and decimal digit are not shown on the display. Additionally, if the TACAN range data is invalid due to a lack of TACAN lock, the TACAN range field is filled with dashes.

2.4.2.1.6.8 BACKUP TACAN CONTROL

Backup TACAN control can be accessed through the Multi-Function Display (MFD). To navigate to the TACAN page, select TCN (OSB 11) on the master format menu page. On the MFD's TACAN page, users can input the TACAN channel (1-126), TACAN band (X or Y), and TACAN communication mode (T/R, A/A TR). The displayed data reflects the current values reported by the TACAN.



The TCN page offers the following functionalities:

- Channel Select (OSB 8): Accesses the data entry page with numeric labels 0 through 9.
- Channel Select INC/DEC (OSB 7 & 9): Allows users to increment or decrement through channels. Input is restricted to integers 1 through 126.
- Band Select (OSB 10): Utilizes a two-position rotary for selecting the X or Y band.
- TACAN Mode Select (OSB 6): Operates a two-position rotary switch for choosing between T/R and A/A TR modes.

Backup TACAN control is only accessible in the event of a single failure, specifically the UFC. It is not available if the MFDS serves as the backup bus controller during MMC degraded operations and the UFC has failed.

2.4.3 LINK 16

2.4.3.1 INTRODUCTION AND BACKGROUND

Link 16 stands as a collaborative, multinational datalink system designed to furnish users with situational awareness data and command and control capabilities within a network of participants. Selected by the Department of Defense (DoD) as the principal tactical datalink across all services for command and control (C2), intelligence, and weapon systems whenever feasible, Link 16, also known as the NATO term for the US TADIL "J" datalink standard, operates as a high-capacity, secure, and jam-resistant Tactical Digital Information Link (TADIL). Integration of Link 16 capability was realized in the M3 configuration through the incorporation of the Multi-Function Information Distribution System (MIDS) - Low Volume Terminal (LVT).

Various radio systems, including the Joint Tactical Information Distribution System (JTIDS), MIDS-LVT, and MIDS Fighter Datalink (FDL), are employed to support Link 16. The F-16 utilizes the MIDS-LVT. Link 16 integration has been and continues to be accomplished using different radio systems across numerous platforms, including but not limited to USAF E-3 Airborne Warning and Control System (AWACS), NATO E-3, UK & French E-3D, Joint Surveillance Target Attack Radar System (JSTARS), USAF Rivet Joint (RJ), USAF Airborne Battlefield Command and Control Center (ABCCC), USN and French aircraft carriers, USN Aegis cruisers, USN submarines, F-14, F-15C, F-15E/F, F/A-18, Modular Control Equipment (MCE), USA Theater High-Altitude Area Defense (THAAD) and Patriot stations, USA Comanche helicopter, Eurofighter, UK F3 Tornado, UK Sea Harrier, F-22, F-35 Joint Strike Fighter (JSF), and F-16, among others.

Link 16's specifications are outlined in MIL-STD-6016 for the US and in STANAG 5516 for NATO. Both documents provide a comprehensive description of Link 16's operation, including the format and transmission/reception requirements of the J-Series messages. The standard undergoes dynamic modifications through the approval of Interface Control Proposals (ICPs), which originate from users, integrators, and defense agencies. ICPs require coordination and approval within the Air Force, then by the Joint Change Control Board (CCB) across other services, and finally through NATO.

These documents include appendices describing the minimum implementation requirements (MIN IMP) associated with Link 16. MIN IMP specifies the transmission/reception requirements of certain J-Series messages and their content for Link 16 participants based on their functions. For the F-16, these functions were derived from the Link 16 Operational Requirements Document (ORD) issued by Air Combat Command (ACC). MIN IMP aims to maintain a certain level of interoperability among Link 16 participants.

Though MIL-STD-6016 allows for variations in Link 16 implementation and utilization even with MIN IMP, the Air Force established a working group to develop a coordinated approach to Link 16's operational concept. The Link 16 Air-to-Ground Working Group (A-G WG) convened technical interchange meetings, with participation from representatives of the US Air Force, Navy, and Army, platform integrators, hardware developers, Link 16 experts from the System Integration Organization (SIO)/Mitre at Hanscom AFB, Aerospace Command and Control Agency (AC2A/C2FT), European Participating Government (EPG) Senior National Representatives, and others. The A-G WG, through various activities and investigations, formulated the Air Force Concept of Link 16 Employment (COLE) document, finalized on April 13, 2001. The COLE serves as a framework for USAF requirements offices and platform System Program Offices (SPOs) to determine their implementation strategies and understand their impact on other platforms. Additionally, it ensures that individual platform implementations align coherently within the broader Link 16 network. COLE delineates Link 16 employment concepts pertinent to counterair, interdiction, and close air support (CAS) missions, including participant roles, datalink architecture, data exchange throughout mission phases, and Information Exchange Requirements (IERs). Special topics such as strike packages, intelligence considerations, network capacity, gateways to/from other datalink systems, control backlink, and MIL-STD-6016 MIN IMP analysis are also addressed in COLE. LM Aero F-16 system design, alongside specific user candidates, incorporates COLE and MIL-STD-6016 in defining the F-16's Link 16 capabilities.

2.4.3.2 LINK 16 DESCRIPTION

The F-16 Link 16 system utilizes a dedicated radio known as MIDS, which operates within the TACAN frequency range of 960-1215 Mega-Hertz (MHz), equipped with filters for IFF frequencies 1030 and 1090 MHz. This radio offers anti-jam capabilities by rapidly hopping frequencies at a rate of 77,000 hops per second and ensures security through data encryption. Installed in place of the AN/ARN-118(V) TACAN Line Replaceable Unit (LRU), MIDS performs both Link 16 and TACAN functions.

Link 16 facilitates the exchange of various data types including surveillance track files, electronic warfare tracks, fighter targets, friendly position, and status updates, and supports command and control (C2) functions through a standardized message format known as J-series messages.

Compared to earlier Tactical Data Link (TDL) systems such as Link 11A, Link 11B, and Link 4, Link 16 significantly improves datalink capabilities in areas such as jam protection, security, capacity/speed, and the number of participants. Its broadcast architecture allows uninterrupted operation even if network participants are dropped from the link (non-nodal), unlike other datalink systems with critical nodes.

The Link 16 network employs Time Division Multiple Access (TDMA), allocating specific time slots or a pool of time slots to participants for transmitting information. Participant transmissions are segregated in time, thus implementing time division multiple access.

For MIDS to function within the Link 16 network, it requires time slot assignments and related information. Initialization data stored on the Data Transfer Cartridge (DTC) provides network information to MIDS, with limited cockpit modification capabilities using the Data Entry Display (DED).

Since Link 16 is a multinational datalink involving various platforms, network design is managed by a network manager. The net manager collects datalink requirements from different platforms, which are input into the Link 16 user database. A computer-aided design tool is employed to create the network design based on the needs identified by different platforms and theatre battle plans. Once developed, networks are stored in the JTIDS network library for selection.

The network designer chooses the appropriate network from the library and distributes a Network Design Load (NDL) to user communities. The parameters provided in the NDL are merged with platform-specific parameters to generate the actual Link 16 terminal initialization load file. Once loaded with network information, the Link 16 terminal (MIDS in the F-16) controls information distribution on the network when data is provided by the host platform's avionic system. Certain network initialization parameters may be modified during missions via initialization change requests provided by the host.

2.4.3.3 LINK 16 GENERAL TERMS

FC Fighter Channel (automatically set by BMS), can be manually set between 0 and 126-> is responsible for exchanging information between fighter aircraft *(tracking and lock information -> not implemented yet).*

MC Mission Channel (automatically set by BMS), can be manually set between 0 and 127-> is responsible for exchanging information with AWACS or other C2 platforms (SURV air track data).

STN Source Track Number. Contains all members of your own flight by default, can be manually changed between 00000 and 77776 (excluding 00077, 00176, 00177, 07777).

PPLI Air Precise Participant Location Identification is a transmission from Link 16 air participants, furnishing network participation status, identification details, positional data, and relative navigation information. It encompasses the voice call sign, position coordinates (latitude/longitude), altitude, course, IFF codes, air platform type (e.g., fighter, bomber, attack), and air platform activity (such as engaging, investigating, etc.).

SURV This message serves to share air track data, predominantly disseminated by a command and control (C^2) agency. It comprises details regarding exercise/non-exercise tracks, including track number, strength, position, speed, course, identity (such as pending, unknown, assumed friend, friend, neutral, suspect, hostile), IFF codes, air platform type (generic categories like fighter, bomber, attack, etc.), and specific air platform type (e.g., F-15, F-16, Mig-29, etc.).

JDN Joint Data Net is an interconnected network of JTIDS/MIDS–based systems, which links air and missile defense command and control and weapons systems across armed forces.

NPG FC and MC channels are part of dedicated NPG's (Network Participation Group). Each channel and its number define what data can be exchanged on the channel. If you create a package for example, all Link 16 capable aircraft of this package will have the same MC (because one AWACS controller will be responsible for this package).

2.4.3.4 LINK 16 INITIALIZATION

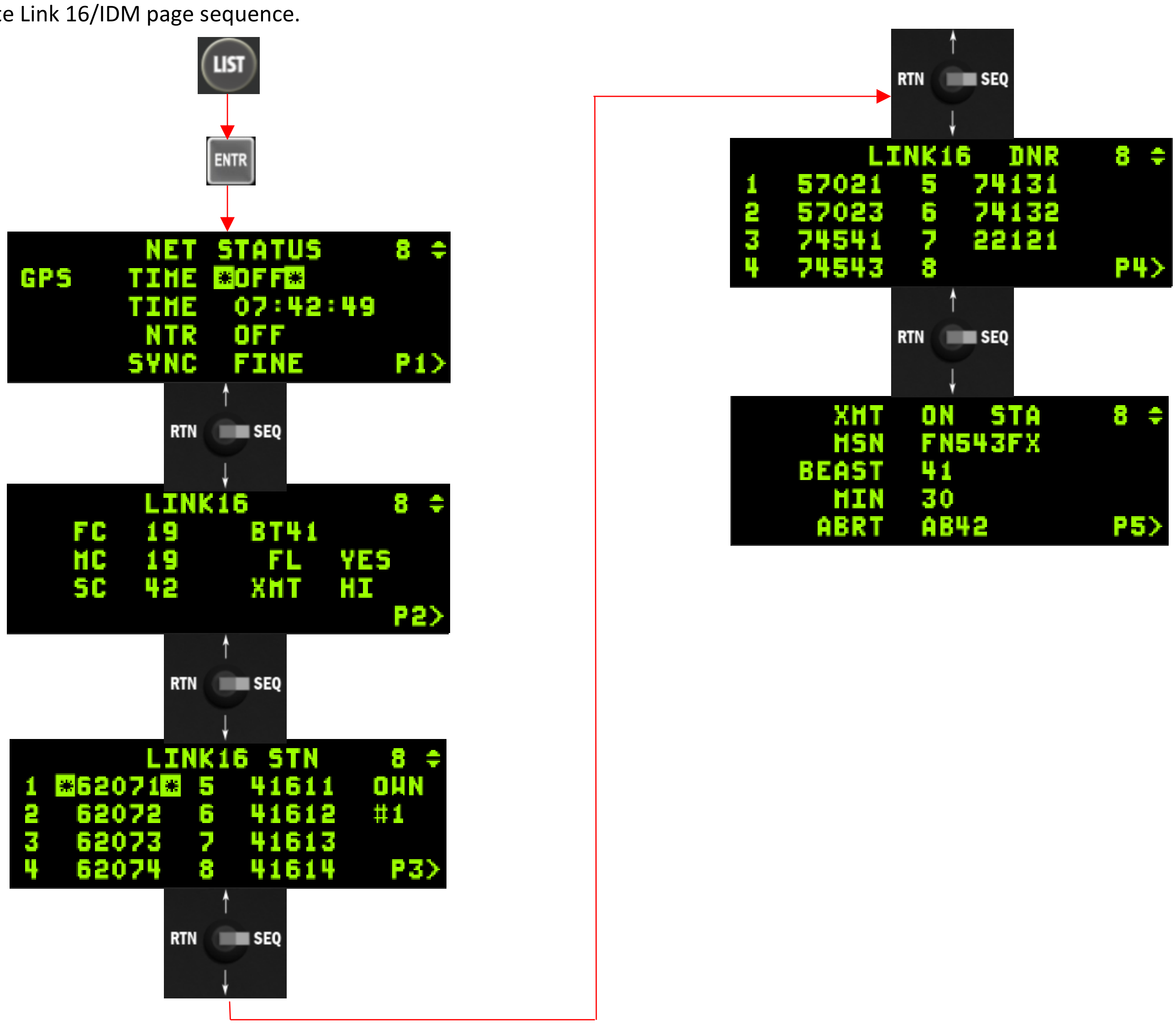
2.4.3.4.1 LINK 16 ID-TREE AND SOVEREIGNTY DATA INITIALIZATION

The Link 16 DTC load furnishes guidelines for categorizing system tracks (whether onboard or offboard) as unknown, neutral, suspect, hostile, or friendly. These categories aid in establishing rules of engagement. Known as an ID-tree, this set of rules can be selected during mission planning and is uploaded alongside other Link 16 initialization data.

Moreover, the DTC loaded air target data table (ATDT) enables the mapping of aircraft types to either FRIEND, UNKNOWN, or HOSTILE designations. This ATDT is essential for supporting the aircraft sovereignty ID-tree criteria. Both the ID-tree and ATDT tables persist through an MMC power cycle but are not maintained through a mission cycle involving activation of the weight-on-wheels switch.

2.4.3.5 LINK 16 DED PAGE ACCESS

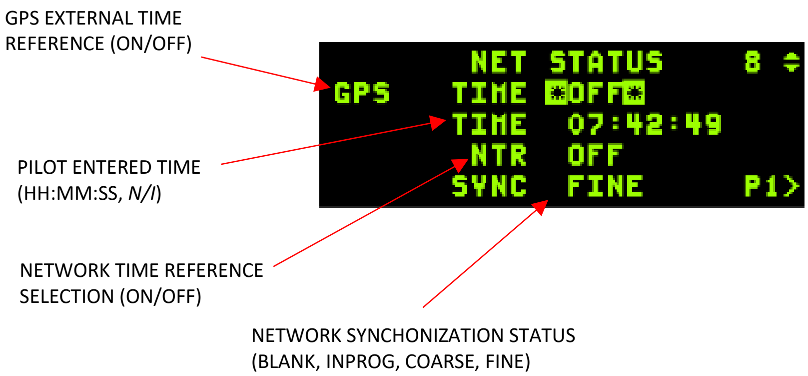
The DED DLNK page rotary comprises six pages as needed. During Link 16 initialization, page 1 (NET STATUS) is accessed when the MIDS finishes start-up procedures, and MIDS DTC loading is not underway. Pressing ENTR from the DED LIST page triggers this entry. If the MIDS is in the process of powering up, pressing Enter (ENTR) displays the A-G DL page, provided the IDM is accessible. However, if both IDM and Link 16 subsystems are unavailable (e.g., during a DTC load), ENTR input is disregarded. This outlines the complete Link 16/IDM page sequence.



DED Data Link Initialization Pages

2.4.3.5.1 LINK 16 INITIALIZATION PAGE 1 - NET STATUS

This page provides status of the F-16's network status and allows modification, if required.



DED Link 16 Initialization Page 1

2.4.3.5.2 GPS EXTERNAL TIME REFERENCE

The MIDS terminal requires network time information, which is conveyed through the External Time Reference (ETR) when GPS data is accessible. In a synchronized Link 16 network utilizing GPS time, a separate Network Time Reference (NTR) isn't necessary for ongoing operation. However, the NTR serves to initiate coarse synchronization by providing the network entry message.

The DTE load informs the MIDS whether GPS time will be utilized. The setting for ETR usage is included in the NDL load along with other parameters. The status of GPS time (ON/OFF) is visible on the NET STATUS page, reflecting the DTE-loaded setting. Pilots can switch between GPS TIME ON and GPS TIME OFF by manipulating the asterisks and pressing any key from 1 to 9.

In GPS-based missions where the GPS is operational, manual time entry isn't required (the TIME entry field on the NET STATUS page will be blank). Such missions facilitate synchronization between GPS and MIDS using a GPS time strobe, with the MMC transmitting GPS time information to the MIDS.

In future development of BMS, JTIDS (F-15C) and MIDS (F-16) GPS time sync will be implemented. Switching OFF or ON of the GPS TIME function has no effect yet in BMS.

2.4.3.5.3 PILOT ENTERED TIME

The pilot entered time is not implemented yet.

2.4.3.5.4 NETWORK TIME REFERENCE (NTR)

The Network Time Reference (NTR) is the designated terminal responsible for defining network time. Having an NTR is crucial for both GPS and non-GPS modes when initially entering the network. Ownship can be set as the NTR through the DED Link 16 page 1. In GPS modes, pilot-entered time isn't required for the MIDS when it's designated as the NTR and GPS is functioning.

In future development of BMS, JTIDS (F-15C) and MIDS (F-16) NTR sync will be implemented. Switching OFF or ON of the NTR function has no effect yet in BMS.

2.4.3.5.5 NETWORK SYNCHRONIZATION STATUS

The synchronization status is displayed on the Link 16 initialization page 1 and indicates the ability of the MIDS to communicate on the Link 16 network. If the DTC initialisation of L16 was successful, the network status will change from blank to INPROG (Net entry in progress) to COARSE (Coarse synchronisation) to FINE (Fine synchronisation).

2.4.3.5.6 LINK 16 NET ENTRY PROCEDURES

1. EGI in NAV - Verified.

2. MIDS - ON

3. DTE Page - LINK 16 (short push initiates LOAD).

   (a) Verify LINK 16 INIT CHECK is displayed on the DTE page

   Please note: if the LINK 16 isn’t loaded properly, the fault “LINK16 INIT REQD” will appear in the DTE page.

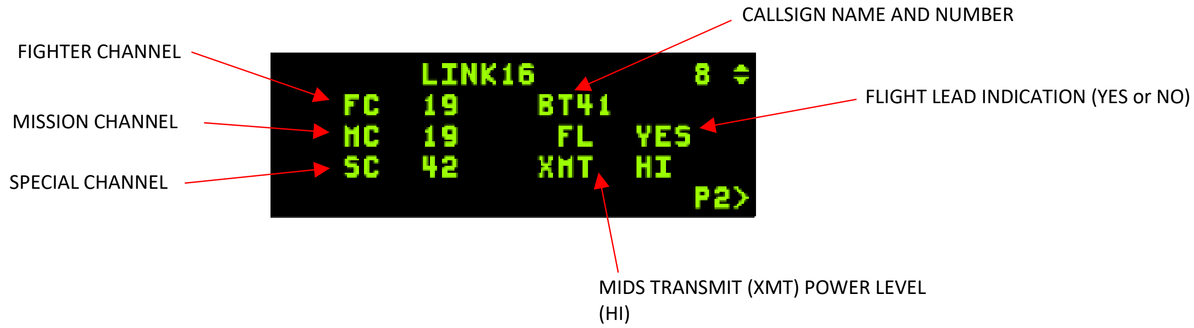
4. LINK 16 A or B file on DTE page - Selected (as desired - if two files are available-> long push OSB 8 to switch files)

   Please note: if File A or B is changed, repeat step 3.

5. Verify/modify Link 16 parameters on DED initialization.

2.4.3.5.7 LINK 16 INITIALIZATION PAGE 2 - LINK16

Every parameter pertaining to Link 16 on this page can be loaded via DTC. Furthermore, they are all included in the Network Design Load (NDL) and can be adjusted during mission planning. Settings cannot be modified in the cockpit, only in the BMS DTC UI tab.



DED Link 16 Initialization Page 2

The contents and asterisk rotary for the Link 16 initialization page 2 are as follows:

• Fighter Channel (FC) - Fighter-to-fighter network participation group (NPG) net number (0-126). This is commonly referred to as the fighter-to-fighter (F-F) net.

• Mission Channel (MC) - Control NPG net number (0-127, where 127 disables the mission control channel (Setting the PG 9 net number to value 127 turns off the PG 9 slots)).

• Special Channel (SC) - This is a US-only net number (0-126) for SEAD and identification -> not implemented in BMS yet.

• Voice Call Sign number (41) - Pilot's voice call sign number, 2 coded characters (0-99).

• Voice Call Sign label (BT) - Pilot's voice call sign label, 2 coded characters (A-Z).

• Flight Lead (FL) - Identifies ownship as flight leader (YES/NO).

• Transmit Power (XMT) - TDMA transmit power selection (HI).

2.4.3.5.8 FIGHTER, MISSION CHANNEL, AND SPECIAL CHANNEL SELECTION

Differentiating by function, the TDMA transmit and receive time slots are designated by the network Participation Group (NPG) they serve. When the host aircraft sends a message, it specifies the NPG for the MIDS to transmit the message. The Link 16 subnet selection determines the frequency-hopping pattern associated with the transmit and receive slots assigned to the NPG. To transmit and receive NPG messages, other Link 16 participants must operate on the same subnet (with the same hopping pattern).

On Link 16 initialization page 2, the channels represent NPGs typically separated or stacked between groups of participants. Only specific participants are assigned to a given subnet for these NPGs, sharing information among themselves. The rest of the Link 16 community shares information on their own subnet. The main or surveillance subnet (the Joint Data Net (JDN)) communicates the overall battle picture and is not stacked. The JDN, usually assigned channel number zero, is unmodifiable in the cockpit. Changes to a channel number cannot be made in the DED/ICP, only in the BMS UI Link 16 tab.

The fighter channel (FC) establishes the subnet for intraflight communications (NPG 19), facilitating sharing of ownship targets within a flight. Pilots adjust the FC to receive target information from aircraft on a different fighter-to-fighter subnet (e.g., different donors) or to join another flight. All flight members must select the same FC to ensure reception of Link 16 target sorting messages.

The mission channel (MC) sets the subnet for C2 aircraft operations, such as AWACS or ABCCC. The control NPG enables C^2 (Command and Control) to transmit assignments to the flight lead and for the flight lead to transmit responses and report assignment status. During a flight's progression to the target area, the controlling aircraft may change. In such cases, the current controller sends a request for handover message to the flight, indicating the new controller's subnet (i.e., MC). Upon accepting the handover request, flight members switch the MC to communicate with the new controller.

The special channel (SC) establishes the subnet for the SEAD NPG and identification information which is not part of BMS yet.

2.4.3.5.9 LINK 16 INITIALIZATION PAGE 3 - LINK16 STN

Link 16 initialization page 3 features the flight member's Link 16 STN and appears when transitioning from Link 16 page 2 by pressing DCS to SEQ.

2.4.3.5.9.1 LINK 16 SOURCE TRACK NUMBERS (STN)

The Link 16 STNs consist of five-digit numbers, comprising octal digits 0 through 7, specifically assigned to F-16s by the network manager who defines the NDL. The asterisk rotary is intuitive, automatically advancing to the next team member's STN in the rotary after pressing ENTR. The OWN# field indicates which STN corresponds to the ownship, with OWN1 indicating that the ownship is #1 in the list and has an STN of 62071.

STNs entered on this page determine which messages received from the fighter channel (FC) and mission channel are relayed to the MMC for display in the cockpit. Messages received on the FC from participants whose STNs are not entered as team members or donors are disregarded and purged. The first four STNs (#1-#4, immediate flight/flight members) dictate the recipients for C2 messages transmitted on the mission channel. The second set of addresses (#5-#8) corresponds to another flight of interest (Team Members).

2.4.3.5.9.2 OWNSHIP NUMBER CHANGE

To modify the ownship number, place the asterisks around the OWN# field and input a new number from 1 to 4. This adjustment enables a flight member (1-4) to adopt the ownship and STN of another flight member (1-4). Subsequently, all following flight members can do the same as needed.

For instance, let's consider a scenario where the team lead (Ownship #1/STN 62071) encounters a mechanical issue necessitating a ground abort. Typically, in such a situation, the next most experienced pilot, who is in ownship #3/STN 62073, would aim to assume the role of team lead. Thus, they would position their asterisks around the OWN# field and input 1 before pressing the ENTER button on the ICP. This action allows them to take on the OWNSHIP #1 and STN 62071 position.

OWNSHIP #3

ENTER IN 1 AND DEPRESS ENTER ON THE ICP

2.4.3.5.10 LINK 16 INITIALIZATION PAGE 4 - LINK16 DONOR (DNR)

DONOR POSITION 1-8

2.4.3.5.10.1 DONOR (DNR)

For situational awareness (SA) during a mission, pilots may want to monitor targets reported by aircraft that aren't part of their flight or team. These aircraft, known as donors, can be designated during mission planning, and their selection or deselection can be managed in the cockpit through the Link 16 DNR page on the DED.

Aircraft using Link 16 periodically transmit their positions via a PPLI message. When a PPLI message is received from a designated donor aircraft, the donor symbol is displayed. Donor symbols appear on both the HSD and A-A FCR formats, featuring a friend symbol (green PPLI circle) and a two-digit altitude below (also green). Donor symbols on the Multifunction Displays (MFD) are displayed at a reduced size (75%) and have a green dot in the middle.

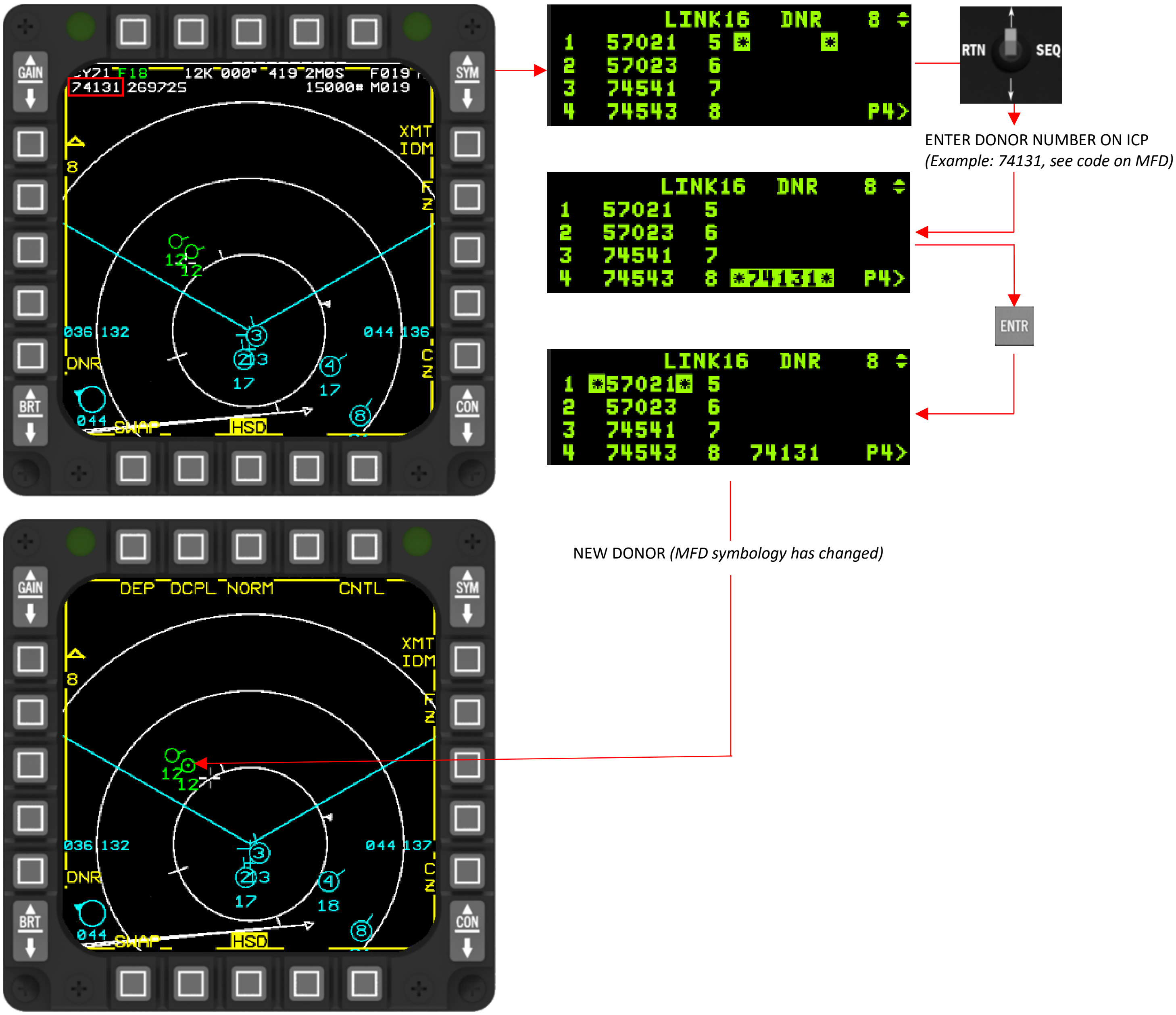
Upon receiving target sorting messages from a donor, these messages are processed similarly to the flight members' target sorting messages for display on the HSD and FCR pages.

Please be aware that different F-16 blocks have different donor settings. For example: a USAF Blk50 has eight (8) possible donor entries while the MLU version only have four (4) available entries.

Refer to chapter 6.7 for a complete overview of each F-16 variant in BMS and its Link 16/IDM capabilities.

2.4.3.5.10.2 DONOR SELECTION ON THE DATA ENTRY DISPLAY (DED)

Donors can be manually inputted on the DED Donor Page. Pressing the DNR OSB on the HSD allows access to the DED Donor Page. Since there is no Pilot Data Link Terminal (PDLT), scratch pad entries are not permitted.

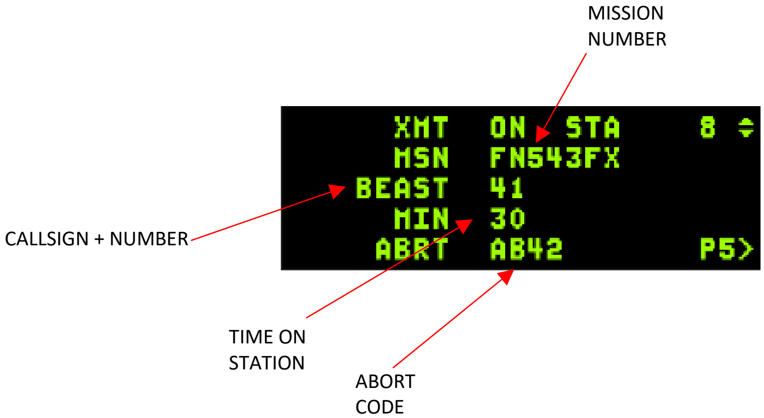


To select a donor using the DED method:

- Depress and release the DNR OSB on the HSD;
- Dobber up or down to move the DED cursor to the desired position;
- Enter the 5 digit source track number;
- Depress and release ENTR to complete donor selection and step the asterisks;
- Enter another donor STN or Dobber left to return to the CNI Page.

2.4.3.5.11 LINK 16 INITIALIZATION PAGE 5 – CAS ON STATION MESSAGE

Data Link Close Air Support (CAS) enables the F-16 to send an On Station message through IDM.
With the current development phase in BMS, this DED page is non-functional.



2.4.3.6 LINK 16 MFDS DISPLAY

The MFDS imposes restrictions on the HSD presentation of Friendly and Non-Friendly steerpoints to adhere to system update standards. To optimize the utility of incoming data, Link 16 symbology is showcased across various MFD formats. This includes all Link 16 air-to-air tracks featured on both the HSD and Air-to-Air FCR pages.

2.4.3.6.1 LINK 16 MESSAGES (HSD)

Different L16 messages are identified to exchange information between tactical command, control, and communication.

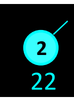
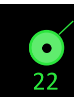
2.4.3.6.1.1 IMPLEMENTED LINK 16 DATA LINK MESSAGES

A summary of implemented Link 16 messages is provided in the table below:

NUMBER	TITLE	DESCRIPTION
J0.0	Initial Entry	Initial Entry Used for initial entry into the Link 16 network.
J2.2	Air PPLI	Air Precise Participant Location Identification is a transmission from Link 16 air participants, furnishing network participation status, identification details, positional data, and relative navigation information. It encompasses the voice call sign, position coordinates (latitude/longitude), altitude, course, IFF codes, air platform type (e.g., fighter, bomber, attack), and air platform activity (such as engaging, investigating, etc.).
J3.2	SURV Air Track	This message serves as a means to share air track data, predominantly disseminated by a command and control (C^2) agency. It comprises details regarding exercise/non-exercise tracks, including track number, strength, position, speed, course, identity (such as pending, unknown, assumed friend, friend, neutral, suspect, hostile), IFF codes, air platform type (generic categories like fighter, bomber, attack, etc.), and specific air platform type (e.g., F-15, F-16, Mig-29, etc.).

2.4.3.6.1.2 J2.0 AND J2.2 PPLI AIR TRACKS

The table below illustrates the PPLI symbology for flight team members (members 1-8), donors, and other friendly units. Ownship PPLI transmission and the reception of air PPLIs are refreshed at intervals determined by the NDL (currently set at 2 seconds). Between updates of air PPLIs, the positions of PPLI symbols are extrapolated and maintained for up to 13 seconds to reduce abrupt changes in displaying track positions between Link 16 update messages. Air PPLI tracks are removed if no update has been received for 13 seconds.

DISPLAY FORMAT	J2.0 Indirect Air PPLI		J2.2 Interface Unit PPLI (FLT/TEAM)		J2.2 Interface Unit PPLI (DONOR)		J2.2 Interface Unit PPLI (FRIENDLY)	
	Correlated to Onboard	Correlated to Offboard	Correlated to Onboard	Correlated to Offboard	Correlated to Onboard	Correlated to Offboard	Correlated to Onboard	Correlated to Offboard
HSD/FCR								

Flight/team PPLIs are generated by analyzing the J2.2 (air PPLI) message and cross-referencing the source track number with the flight team STNs. The flight team STN addresses are established either through DTC loading or adjusted using the UFC. These PPLIs appear in cyan color, with the team member number (1-8) visible inside. During the HSD zoom function, symbols representing flight members (1-4 excluding your ownship number) expand to 100% size to aid in distinguishing them from other PPLIs.

PPLI AIR TRACK Restrictions

The following conditions must be met to transmit/receive PPLI data from other network members:

1. Flights/packages must be connected via the same FC (Fighter channel) and NPG (Net Participation Group).
2. F-16 range to transmit/receive PPLI tracks is ~150nm.
3. System Track File (STF) container capacity is up to 40 air tracks.

   Note: SURV will always be prioritized if conditions permit.

Link 16 - Net Participation Groups (NPG's)

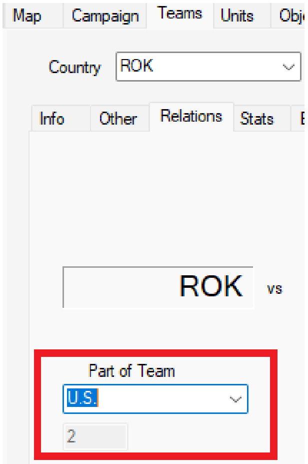
FC and MC channels are part of dedicated NPG's. Each channel and its number define what data can be exchanged on the channel. If you create a package for example, all Link 16 capable aircraft of this package will have the same MC (because one AWACS controller will be responsible for this package).

Offensive flights (flights that are crossing enemy territory) will always have dedicated MC/FC channels and NPG's as well as defensive flights (flights that are not crossing enemy territory).

Link 16 – Team restrictions

A Link 16 network can be established between members who are part of the same team (team 1-7 in BMS) only. If you want to make sure that allies also can use the Link 16 network of the nation you want to fly in, you must modify your mission/campaign in mission commander.

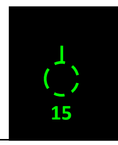
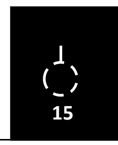
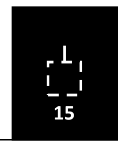
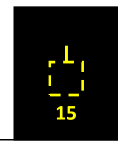
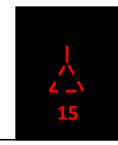
Open the Teams/Relations tabs and set "Part of Team" according to the nation who should be the Link 16 team member (example on the right: "U.S." is Link 16 host so "Part of Team" for ROK needs to be modified).

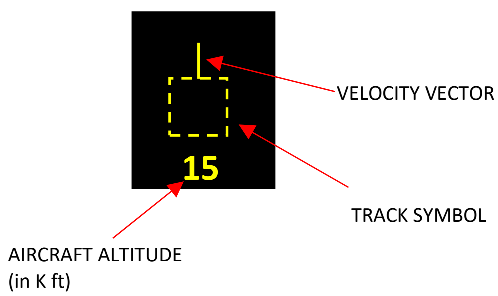


2.4.3.6.1.3 J3.2 SURVEILLANCE (SURV) AIR TARGET TRACKS

Surveillance air target tracks are transmitted by surveillance and C2 platforms via the Link 16 network to enhance situational awareness for all network participants. These track data encompass the location, speed, heading, identity (e.g., friend, hostile, neutral, etc.), type, and other pertinent attributes, along with a track quality (TQ) assessment. The F-16 aircraft receives, processes, and retains a subset of the surveillance picture, considering factors like track type, , identity, and other status details associated with the track.

Surveillance tracks are typically updated every 12 seconds. During intervals between the reception of surveillance track updates, the track positions are extrapolated and sustained for up to 20 seconds to mitigate excessive fluctuations in displaying track positions between successive Link 16 update messages. Air surveillance tracks are removed if no update has been received for 20 seconds.

DISPLAY FORMAT	FRIEND	NEUTRAL	UNKNOWN/ ASSUMED FRIEND/ PENDING	SUSPECT/ ASSUMED HOSTILE/ PENDING	HOSTILE
HSD/FCR					



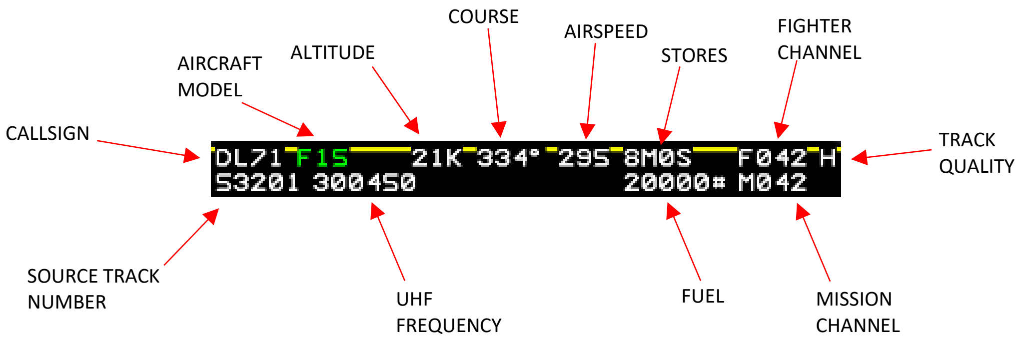
SURV AIR TRACK Restrictions

The following conditions must be met to receive Air Target Tracks from AWACS (C²):

1. AWACS must be on station.
2. AWACS and flight/package must be connected via JDN (Joint Data Network) -> automatically done in BMS if in the same team.
3. AWACS must be correctly fragged. Factors are SURV transmission range (~400km/215nm) and altitude sufficient to avoid terrain line-of-sight obstruction.
4. Air Target Tracks will be declared unknown/hostile if IFF is not responding in Mode 4.
5. F-16 range to receive SURV air tracks is ~100nm.
6. System Track File (STF) container capacity is up to 40 air tracks. Note: SURV will always be prioritized if conditions permit.

2.4.3.6.1.4 AIR-TO-AIR TRACK EXPANDED DATA (HSD) – FRIENDLIES/PPLI

In A-A tracks, the displayed fields include the Number, Strength, and type of platform (represented by a generic aircraft type). Target-specific messages are received within J3.2 (air track) messages. Below are the individual data fields that provide support for expanded PPLI track data shown in the HSD:



2.4.3.6.1.4.1 CALLSIGN (HSD)

This field consists of four alphanumeric characters: two alphabetic characters followed by two numeric characters (ranging from 0 to 9), which denote the voice call sign linked with the track. The call sign is obtained through a J2.2C2 (Air PPLI mission information continuation word) message. Text within this field is consistently displayed in white. The MIL STD for this field allows for the use of alphanumeric characters in all four positions.

2.4.3.6.1.4.2 AIRCRAFT MODEL (HSD)

This is a six-character alphanumeric field aligned to the left and filled with blanks, representing the aircraft platform type (e.g., F16, F15, etc.). It displays the specific aircraft model or series, such as F16A or F16C. In cases where no specific aircraft type is received, the generic type is displayed instead. Text within this field is coloured green.

2.4.3.6.1.4.3 ALTITUDE (HSD)

This field consists of three characters filled with zeros, following the format nnK, where 'n' can be any number from 0 to 9 and 'K' is a fixed character indicating thousands of feet. It signifies the aircraft altitude rounded to the nearest thousand feet. Altitude data is acquired from both the J2.2 (Air PPLI Initial Word) message and the J2.0I (Indirect Interface Unit PPLI Initial Word) message. The text within this field is consistently displayed in white.

2.4.3.6.1.4.4 HEADING (HSD)

This field consists of four characters filled with zeros, following the format nnn_, where 'n' represents any number from 0 through 9 (ranging from 000 to 359). It denotes the aircraft's magnetic ground track. Heading information is obtained as course in both the J2.2E0 (Air PPLI Extension Word) message and the J2.0E0 (Indirect Interface Unit PPLI Extension Word) message. The text within this field is consistently displayed in white.

2.4.3.6.1.4.5 AIRSPEED (HSD)

A 3 character, right justified field representing the aircraft calibrated air speed in knots. The airspeed is received in the J2.2 message and the J2.0 message. The text in this field is always white.

2.4.3.6.1.4.6 STORES (HSD)

This is a six-character field in the format Mx Sx/A-Jx, where 'x' can be any number from 0 through 9.

'M' represents medium-range air-to-air missiles.

'S' represents short-range air-to-air missiles.

'A' represents AGM series (AGM-65 etc., not AGM-88/45/78 > see 'H').

'C' represents cluster munition (CBU series).

'G' represents general purpose bombs (Mk-82/84/etc.).

'H' represents Anti-Radiation weapons (AGM-88/45/78/etc.).

'L' represents Laser Guided weapons (GBU-12, etc.)

'J' represents IAM munition (JDAM, JSOW, JASSM).

2.4.3.6.1.4.7 FIGHTER CHANNEL (HSD)

A 3-character numeric field representing the Link 16 fighter-to-fighter channel for the associated track. The fighter channel number is received as a J2.2 message. The text in this field is always white.

2.4.3.6.1.4.8 TRACK QUALITY (HSD)

A 1-character alphabetic field representing the position quality of the PPLI track. 'H' stands for high quality, 'M' for medium and 'L' for low quality.

	PPLI/SURV Deviation
L	<4,4 Nm
M	<1,1 Nm
H	<0,0281 Nm

2.4.3.6.1.4.9 MISSION CHANNEL (HSD)

A 3-character numeric field representing the Link 16 mission channel. The text in this field is always white.

2.4.3.6.1.4.10 FUEL (HSD)

This is a six-character field in the format xxxxx#, where 'x' represents any number from 0 through 9. It displays values up to 99999 pounds. Text within this field is consistently displayed in white. The fuel field updates every 180 seconds, contingent on NDL. Notably, the F-16 includes fuel state information in the PPLI transmission.

2.4.3.6.1.4.11 UHF FREQUENCY (HSD)

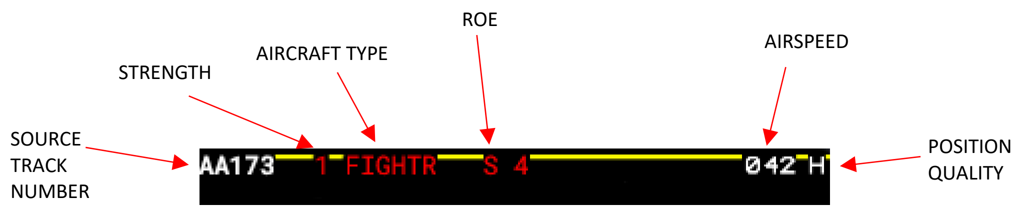
The UHF frequency received in the J2.2 PPLI message is displayed. The text in this field is always white.

2.4.3.6.1.4.12 SOURCE TRACK NUMBER (HSD)

The STNs are comprised of five-digit numbers, featuring octal digits ranging from 0 through 7, uniquely allocated to the F-16s by the network manager, who defines the NDL. Text within this field is consistently displayed in white.

2.4.3.6.1.5 AIR-TO-AIR TRACK EXPANDED DATA (HSD) – UNKNOWN/HOSTILE

In cases where A-A tracks are unknown/hostile, the system presents the following details: track number, aircraft count (strength), aircraft type, rules of engagement data, target airspeed, a miscellaneous field, and a track quality indication. Messages specific to target details are received within J3.2 (Air Track) messages. The following parameters are shown in the HSD:



2.4.3.6.1.5.1 Source Track Number (HSD)

The track number is represented by a 5-character alphanumeric field in the format AANNN, where "A" stands for a character from A to Z excluding I and O, or a numeric character from 0 to 7, and "N" represents a numeric character from 0 to 7. This field corresponds to the Link 16 system's track number for the respective target. The track number is received through the J3.2I (Air Track Initial Word) message. The text in this field is consistently displayed in white color.

2.4.3.6.1.5.2 Strength (HSD)

Strength is represented by a 3-character, right-justified field, with the following formats:

a. "bbN" or "bNN" - indicates strengths up to 12, where "b" denotes a blank space, and "N" represents numbers 1 through 9.

b. "2-7" - denotes a strength between 2 and 7 units.

c. "b>7" - indicates a strength greater than 7 units.

d. ">12" - represents a strength exceeding 12 units.

Strength data is received via the J3.2I message. When the received strength is unspecified, it defaults to "1." The text color in this field corresponds to the sovereignty associated with the aircraft type.

2.4.3.6.1.5.3 Aircraft Type (HSD)

This field is a 6-character, left-justified, alphanumeric representation of the aircraft platform type. The Aircraft Symbol Type (AST) is received in a J3.2C1 (Air Track Amplification Continuation Word) message. The text color in this field corresponds to the AST selected via the mission planning system, which may differ from the symbol color.

Platforms are:

FIGHTR =	Fighter Aircraft	EW=	Electronic Warfare Aircraft
FTBMR =	Fighter bomber Aircraft	ASW=	Anti-Submarine Aircraft
ATTACK=	Attack Aircraft	AEW=	AWACS
BOMBER=	Bomber Aircraft	ABCCC=	J-STARS
RECON =	Reconnaissance Aircraft	RECHEL=	Recon Helicopter
TANKER =	Tanker Aircraft	ATKHEL=	Attack Helicopter
TRNSPT=	Transport Aircraft	RSHEL=	Transport Helicopter
		UAV=	Unmanned Aerial Vehicle

If expanded data from AWACS has the highest quality (depending on distance to AWACS and terrain), detailed aircraft type information can be exchanged (for example: “SU-27”).

2.4.3.6.1.5.4 Rules of Engagement (ROE) for Surveillance Sovereignty (HSD)

An "S" character appears when displaying the aircraft type and type sovereignty is selected within the ATDT ID-tree criteria. If the aircraft type is obtained through surveillance but type sovereignty isn't selected in the ID-tree criteria, this character will be blank. Its color reflects the sovereignty linked to the aircraft type.

2.4.3.6.1.5.5 ROE for IFF Mode 4 (HSD)

This field indicates the status of IFF mode 4 based on the ATDT ID-tree criteria:

- It displays a "4" if IFF mode 4 is selected.
- It remains blank if IFF mode 4 is not included in the criteria.

The appearance of the "4" varies in color:

- White indicates that the track hasn't been interrogated.
- Red signifies that the track was interrogated but received no response or an invalid one.
- Green indicates a positive response after interrogation.

Mode 4 data is transmitted via a J3.2C1 message. It's worth noting that onboard F-16 AIFF responses aren't linked to radar tracks and therefore don't influence this field.

2.4.3.6.1.5.6 Airspeed (HSD)

Airspeed is represented by a 3-character, right-justified field indicating the track's calibrated airspeed in knots. Track speed data is received via a J3.2E0 (Air Track Extension Word) message. The text in this field is consistently displayed in white.

2.4.3.6.1.5.7 Track Quality (HSD)

See chapter 2.4.3.5.1.4.8 Track Quality.

2.4.3.6.1.5.8 LINK 16/IDM TRANSMIT (XMT L16/XMT IDM)

OSB 6 regulates the transmission of the current SPI or steerpoint. With support for both IDM and L16 A-G SPI transmissions, toggling OSB 6 switches between IDM and L16 functionalities. By default, XMT IDM is selected.

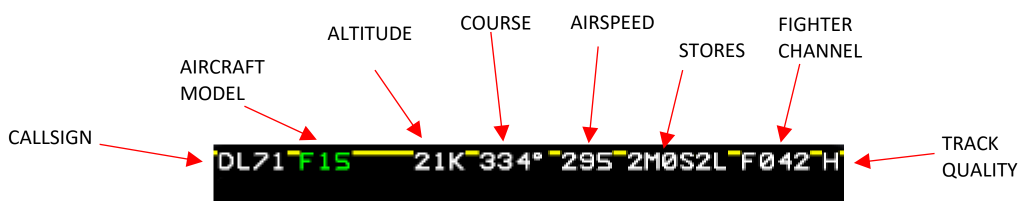
For now, the XMTL16 option serves no different purpose then the XMT IDM option in BMS.

2.4.3.6.2 LINK 16 MESSAGES (FCR)

Different L16 messages are identified to exchange information between tactical command, control, and communication.

2.4.3.6.2.1 AIR-TO-AIR TRACK EXPANDED DATA (FCR) – FRIENDLIES/PPLI

In A-A tracks, the displayed fields include the Number, Strength, and type of platform (represented by a generic aircraft type). Target-specific messages are received within J3.2 (air track) messages. Below are the individual data fields that provide support for expanded PPLI track data shown in the FCR:



2.4.3.6.2.1.1 Callsign (FCR)

This field consists of four alphanumeric characters: two alphabetic characters followed by two numeric characters (ranging from 0 to 9), which denote the voice call sign linked with the track. The call sign is obtained through a J2.2C2 (Air PPLI mission information continuation word) message. Text within this field is consistently displayed in white. The MIL STD for this field allows for the use of alphanumeric characters in all four positions.

2.4.3.6.2.1.2 Aircraft Model (FCR)

This is a six-character alphanumeric field aligned to the left and filled with blanks, representing the aircraft platform type (e.g., F16, F15, etc.). It displays the specific aircraft model or series, such as F16A or F16C. In cases where no specific aircraft type is received, the generic type is displayed instead. Text within this field is colored green.

2.4.3.6.2.1.3 Altitude (FCR)

This field consists of three characters filled with zeros, following the format nnK, where 'n' can be any number from 0 to 9 and 'K' is a fixed character indicating thousands of feet. It signifies the aircraft altitude rounded to the nearest thousand feet. Altitude data is acquired from both the J2.2 (Air PPLI Initial Word) message and the J2.0I (Indirect Interface Unit PPLI Initial Word) message. The text within this field is consistently displayed in white.

2.4.3.6.2.1.4 Heading (FCR)

This field consists of four characters filled with zeros, following the format nnn_, where 'n' represents any number from 0 through 9 (ranging from 000 to 359). It denotes the aircraft's magnetic ground track. Heading information is obtained as course in both the J2.2E0 (Air PPLI Extension Word) message and the J2.0E0 (Indirect Interface Unit PPLI Extension Word) message. The text within this field is consistently displayed in white.

2.4.3.6.2.1.5 Airspeed (FCR)

A 3 character, right justified field representing the aircraft calibrated air speed in knots. The airspeed is received in the J2.2 message and the J2.0 message. The text in this field is always white.

2.4.3.6.2.1.6 Stores (FCR)

This is a six-character field in the format Mx Sx/A-Jx, where 'x' can be any number from 0 through 9.

'M' represents medium-range air-to-air missiles.

'S' represents short-range air-to-air missiles.

'A' represents AGM series (AGM-65 etc., not AGM-88/45/78 > see ‘H’).

'C' represents cluster munition (CBU series).

'G' represents general purpose bombs (Mk-82/84/etc.).

'H' represents Anti-Radiation weapons (AGM-88/45/78/etc.).

'L' represents Laser Guided weapons (GBU-12, etc.)

'J' represents IAM munition (JDAM, JSOW, JASSM).

2.4.3.6.2.1.7 Fighter Channel (FCR)

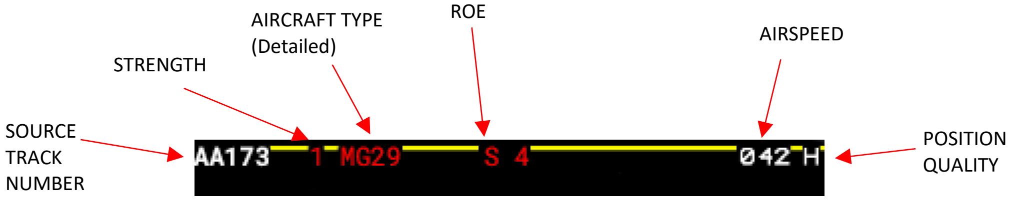
A 3-character numeric field representing the Link 16 fighter-to-fighter channel for the associated track. The fighter channel number is received as a J2.2 message. The text in this field is always white.

2.4.3.6.2.1.8 Track Quality (FCR)

See chapter 2.4.3.5.1.4.8 Track Quality.

2.4.3.6.2.2 AIR-TO-AIR TRACK EXPANDED DATA (FCR) – UNKNOWN/HOSTILE

In cases where A-A tracks are unknown/hostile, the system presents the following details: track number, aircraft count (strength), aircraft type, rules of engagement data, target airspeed, a miscellaneous field, and a track quality indication. Messages specific to target details are received within J3.2 (Air Track) messages. The following parameters are shown in the FCR:



2.4.3.6.2.2.1 Source Track Number (FCR)

The track number is represented by a 5-character alphanumeric field in the format AANNN, where "A" stands for a character from A to Z excluding I and O, or a numeric character from 0 to 7, and "N" represents a numeric character from 0 to 7. This field corresponds to the Link 16 system's track number for the respective target. The track number is received through the J3.2I (Air Track Initial Word) message. The text in this field is consistently displayed in white color.

2.4.3.6.2.2.2 Strength (FCR)

Strength is represented by a 3-character, right-justified field, with the following formats:

a. "bbN" or "bNN" - indicates strengths up to 12, where "b" denotes a blank space, and "N" represents numbers 1 through 9.

b. "2-7" - denotes a strength between 2 and 7 units.

c. "b>7" - indicates a strength greater than 7 units.

d. ">12" - represents a strength exceeding 12 units.

Strength data is received via the J3.2I message. When the received strength is unspecified, it defaults to "1." The text color in this field corresponds to the sovereignty associated with the aircraft type.

2.4.3.6.2.2.3 Aircraft Type (FCR)

This field is a 6-character, left-justified, alphanumeric representation of the detailed aircraft type or aircraft plaform. The Aircraft Symbol Type (AST) is received in a J3.2C1 (Air Track Amplification Continuation Word) message. The text color in this field corresponds to the AST selected via the mission planning system, which may differ from the symbol color. Platforms are:

Platforms are:

FIGHTR =	Fighter Aircraft	EW=	Electronic Warfare Aircraft
FTBMR =	Fighter bomber Aircraft	ASW=	Anti-Submarine Aircraft
ATTACK=	Attack Aircraft	AEW=	AWACS
BOMBER=	Bomber Aircraft	ABCCC=	J-STARS
RECON =	Reconnaissance Aircraft	RECHEL=	Recon Helicopter
TANKER =	Tanker Aircraft	ATKHEL=	Attack Helicopter
TRNSPT=	Transport Aircraft	RSHEL=	Transport Helicopter
		UAV=	Unmanned Aerial Vehicle

Please note that in the FCR detailed information about the aircraft type (for example: “MG29” = Mig29) are available if AWACS identified the aircraft. In the HSD, this detailed information is not shown, only the data about aircraft platform is available.

2.4.3.6.2.2.4 Rules of Engagement (ROE) for Surveillance Sovereignty (FCR)

An "S" character appears when displaying the aircraft type and type sovereignty is selected within the ATDT ID-tree criteria. If the aircraft type is obtained through surveillance but type sovereignty isn't selected in the ID-tree criteria, this character will be blank. Its color reflects the sovereignty linked to the aircraft type.

2.4.3.6.2.2.5 ROE for IFF Mode 4 (FCR)

This field indicates the status of IFF mode 4 based on the ATDT ID-tree criteria:

- It displays a "4" if IFF mode 4 is selected.
- It remains blank if IFF mode 4 is not included in the criteria.

The appearance of the "4" varies in color:

- White indicates that the track hasn't been interrogated.
- Red signifies that the track was interrogated but received no response or an invalid one.
- Green indicates a positive response after interrogation.

Mode 4 data is transmitted via a J3.2C1 message. It's worth noting that onboard F-16 AIFF responses aren't linked to radar tracks and therefore don't influence this field.

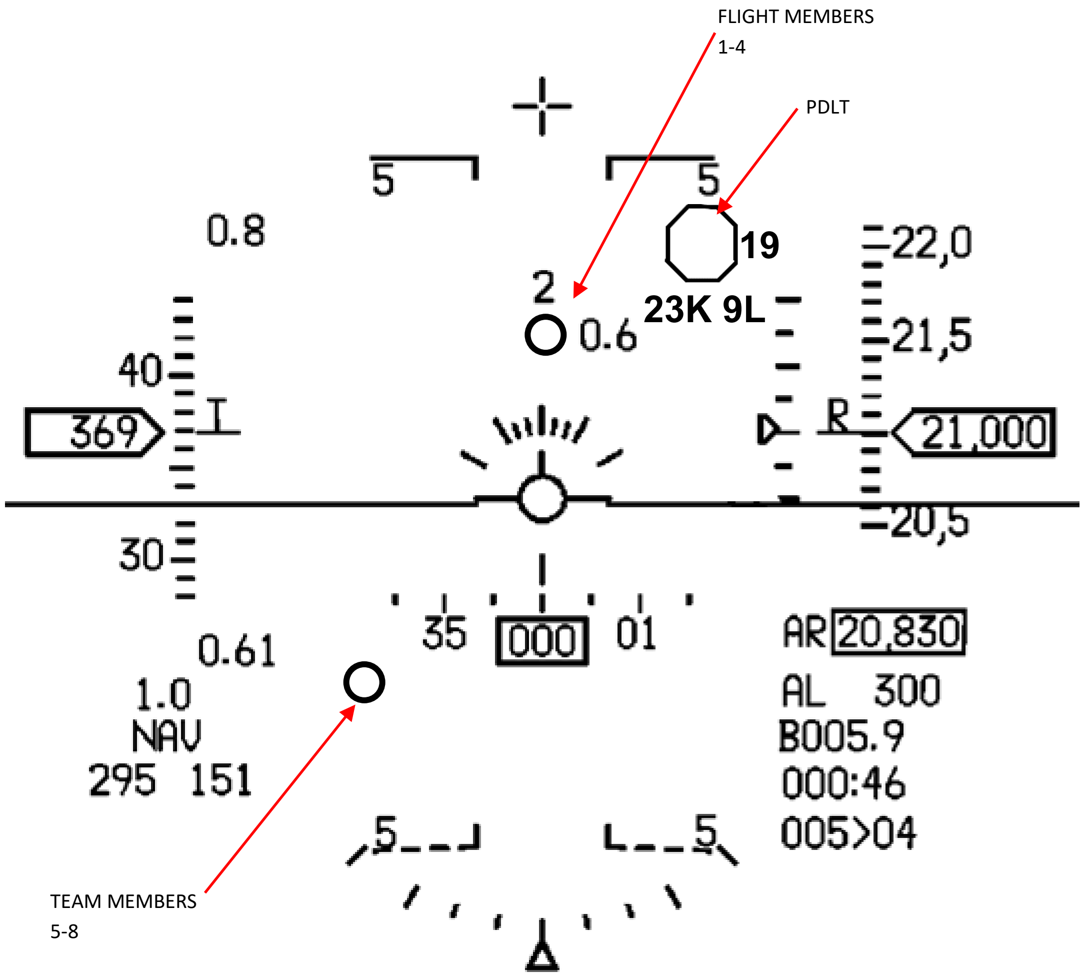
2.4.3.6.2.2.6 Airspeed (FCR)

Airspeed is represented by a 3-character, right-justified field indicating the track's calibrated airspeed in knots. Track speed data is received via a J3.2E0 (Air Track Extension Word) message. The text in this field is consistently displayed in white.

2.4.3.6.2.2.7 Track Quality (FCR)

See chapter 2.4.3.5.1.4.8 Track Quality.

2.4.3.7 LINK 16 HUD/HMCS DISPLAY OPTIONS

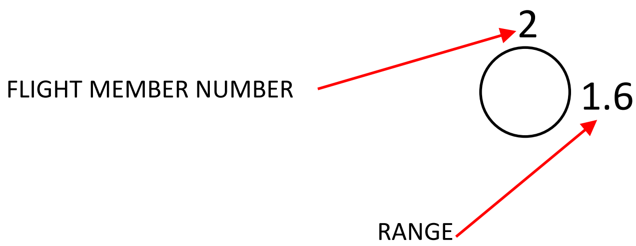


HUD – Link 16 Symbology

2.4.3.7.1 LINK 16 FLIGHT MEMBER SYMBOLOGY

To enhance situational awareness, the HUD/HMCS now showcases symbols representing up to three flight members (numbered 1-4) when they are within the field of view and possess valid altitudes from Link 16. These symbols are visible in various modes including A-A, A-G, DGFT, NAV, and MSL OVRD.

Each flight member is depicted within a 15 mR circle, labeled with their corresponding flight number (1-4) above the symbol. The range is indicated adjacent to the circle, following the same mechanized format as the PDLT range. Flight members beyond the HUD/HMCS field of view do not trigger any indications. These symbols remain visible across all master modes.



2.4.3.7.1.1 DISPLAY FRIENDLIES

In all master modes, the HUD/HMCS now exhibits symbols representing Link 16 Team Members 5-8. These team members are depicted through four 10 mR circles, visible upon receiving a valid altitude via Link 16. These circles standalone without any additional windows, symbols, or accompanying text. No indications are given when a team member exits the HMCS field of view.

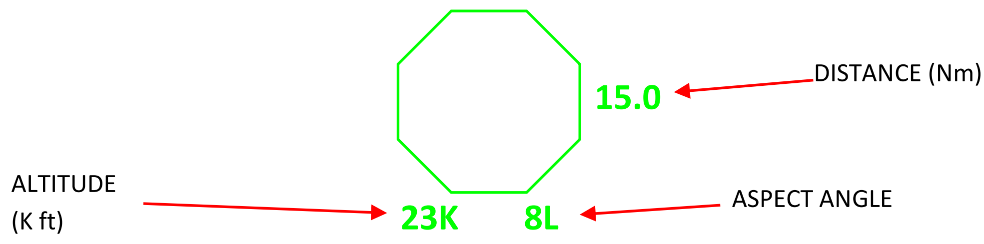
Additionally, if HUD blanking is activated, the display of Team Members 5-8 on the HMCS will be blanked out when the pilot directs their attention to the HUD.

Please note that entries for Donor STN are not displayed in the HUD/HMCS.

2.4.3.7.2 PRIMARY DATA LINK TRACK (PDLT)

A Primary Data Link Track (PDLT) refers to a Link 16 air track, such as an air target track or PPLI, singled out by the pilot for special attention. To distinguish it, an octagon is encompassed around the Link 16 air track, adopting the color of the associated symbol. This octagonal symbol is visible across various formats like A-A FCR, HSD, HUD, and HMCS.

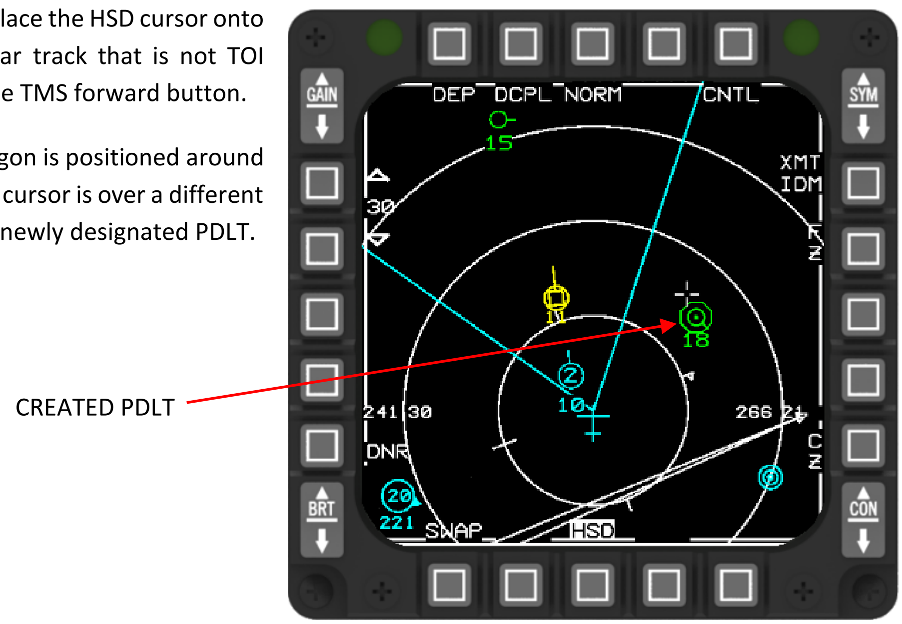
The HUD/HMCS displays both slant range and digital aspect angle (AA) alongside the PDLT symbol. The AA is positioned below the octagon and next to the PDLT altitude. Aspect angle is depicted in tens of degrees, followed by either "L" for left or "R" for right aspect. The altitude/AA window follows the format "ddd#ddd," allowing for up to two characters for altitude (in thousands of feet) followed by the letter "K," one blank space, and a maximum of two digits for AA, denoted by "L" or "R." Small font characters are utilized on both the HUD and HMCS. Distance in shown in Nm.



2.4.3.7.2.1 DESIGNATING A PDLT

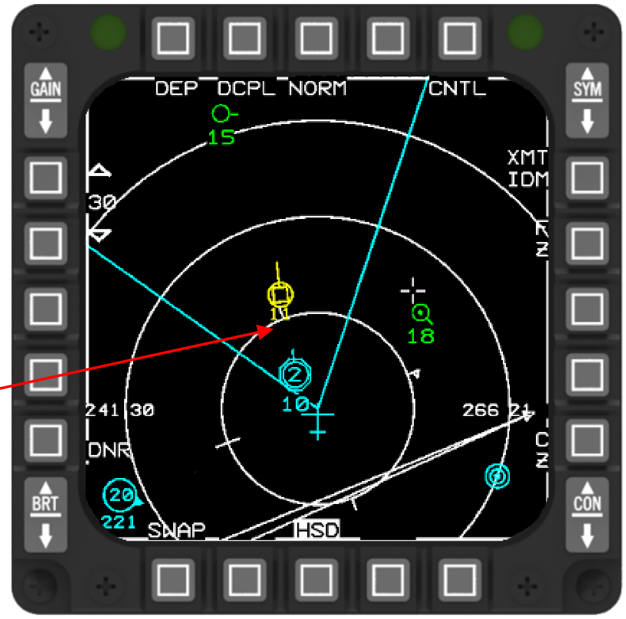
To create a PDLT, you shift the SOI to the HSD, place the HSD cursor onto a Link 16 air data link track or a Link 16 radar track that is not TOI correlated, and then designate it by pressing the TMS forward button.

To mark a Link 16 air track as the PDLT, an octagon is positioned around its symbol. By using TMS forward while the HSD cursor is over a different DL target on the HSD, the octagon shifts to the newly designated PDLT.



2.4.3.7.2.2 STEPPING THE PDLT

When the HSD is the SOI and a PDLT is present on the HSD, you can cycle through DL and radar correlated tracks on the HSD using TMS right depressions. The PDLT moves to the next DL target in the stepping sequence, bypassing radar TOI and proceeding to the subsequent DL track. This sequence follows a pattern from bottom to top and from right to left.



2.4.3.7.2.3 DROPPING THE PDLT

When the HSD is the SOI and a PDLT is present, pressing TMS Aft removes the PDLT octagon unless the HSD cursor is positioned over a preplanned threat with its threat ring visible. In such a case, TMS Aft removes the threat ring, requiring a second press of TMS Aft to drop the PDLT. It's not necessary for the cursor to be directly over the PDLT to remove it with TMS Aft, but it must not be over a preplanned threat with an active threat ring.

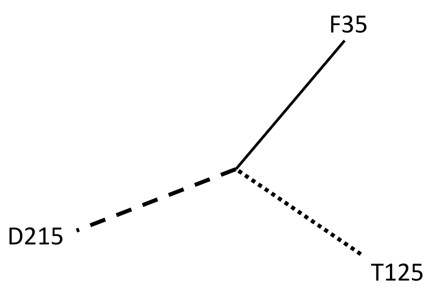
2.4.3.7.2.4 DL TARGET LOCATOR LINE (TLL) HUD (PDLT)

If a PDLT is present and falls beyond the HUD's field of view, a DL Target Locator Line (TLL) appears on the HUD. This TLL is represented by a dashed line spanning 40 milliradians in length, projecting outward from the boresight cross towards the PDLT's direction.

Radar - SOLID LINE

Targeting Pod - DOTTED LINE

Data Link - DASHED LINE



The DL TLL remains visible on the HUD as long as a PDLT is designated and lies outside the HUD's field of view. Should the PDLT be shifted to another DL track beyond the HUD's field of view, the TLL adjusts accordingly to indicate the new PDLT direction. However, if the new PDLT falls within the HUD's field of view, the PDLT octagon appears on the HUD instead. When the PDLT moves into the HUD's field of view, the PDLT octagon replaces the DL TLL. The DL TLL disappears when the PDLT is no longer designated.

2.4.3.7.2.5 DL TARGET LOCATOR ANGLE (TLA) ON HUD

When a PDLT is present and a DL TLL appears on the HUD, the Target Locator Angle (TLA) is also shown. The DL TLA indicates the angle off boresight, positioned at a distance of 57 milliradians from the boresight cross along the center of the DL TLL Line of Sight (LOS). This 57 milliradian distance ensures that the DL TLA does not obstruct an arrowhead at the end of the FCR TLL or TGP TLL. As the DL TLA window shares the same distance from the boresight cross as the TGP TLA window and the FCR TLA, if the DL TLA window begins to overlap with either the TGP TLA or the FCR TLA, the DL TLA is concealed to prevent overlapping with the other TLA's. Despite this, the DL TLL remains visible even when the DL TLA is hidden. The DL TLA holds the lowest priority among all TLAs.

2.4.3.7.2.6 PRACTICAL APPROACHES USING THE PDLT

Since the PDLT works independently from the radar, a practical approach to enhance your SA and to gain a tactical advantage is to operate without any radar emission (= no RWR indication for your possible opponent) in an air-to-air environment. If it is known that the enemy side doesn't have Link or early warning capabilities, it is with greater chance to succeed sneaking behind enemy lines or sweeping an area more efficient.

Another approach could be to use the PDLT as a tool to enhance your SA for example in an BVR engagement. In the example below your see that a Mig-29 is engaged (is TOI). Another contact to the right of the TOI is already marked as PDLT to indicate your possible next target. If you get target fixated and loss focus on the other contact, the PDLT will help you to gain back SA quickly.

2.4.4 IDM

The MD-1295A Improved Data Modem (IDM) provides the capability to transmit and receive air-to-air and air-to-ground data link messages between aircraft (intraflight).

The IDM is essentially a wireless digital modem that operates in conjunction with on-board radios and the rest of the avionic system to provide data communications with other users. In order to communicate with each other, each user must have an IDM terminal that is operating on a radio tuned to the same frequency and has compatible initialization parameters set. The IDM converts digital data to audio data for UHF or VHF radio transmission. When data is received from other users, the IDM converts the audio data to digital data and sends it to the avionics system for display in the cockpit.

The IDM in the F-16 helps the pilot increase situational awareness (SA) by providing the ability to pass positional information about each jet in the flight to all flight members, to target flight members on to specific air or ground targets, to easily execute tactics outside the visual arena and to more easily regain visual mutual support should a flight member become a “lost wingman”.

2.4.4.1 DATA LINK OPERATION OVERVIEW

The Data Link system allows up to 8 IDM equipped aircraft to transmit and receive intraflight data link messages.

Data link transmissions are initiated using the 4-position COMM switch on the throttle. Depressing the COMM switch inboard transmits air-to-ground information and COMM switch outboard transmits air-to-air information.

For HOTAS Cougar users, SimCommsSwitchLeft (used for A-A operations) should be programmed to the “IFF OUT” switch and SimCommsSwitchRight (used for A-G operations) should be programmed to the “IFF IN” switch. This is set up by default with the profile included in the *Hotas**TM Cougar* folder. For other joystick users, it is highly recommended to have these programmed as well to allow easy hands-on control.

Note: IDM operates over VHF or UHF radio, so you cannot transmit on VHF or UHF and send/receive data link transmissions over the same radio at the same time.

Transmitted air-to-air information consists of ownship position, altitude, velocity, magnetic ground track, flight member number, and the position of the ownship’s bugged target.

Air-to-ground data link information consists of the selected steerpoint which may be a markpoint, a navigation steerpoint, or the FCR air-to-ground cursor position.

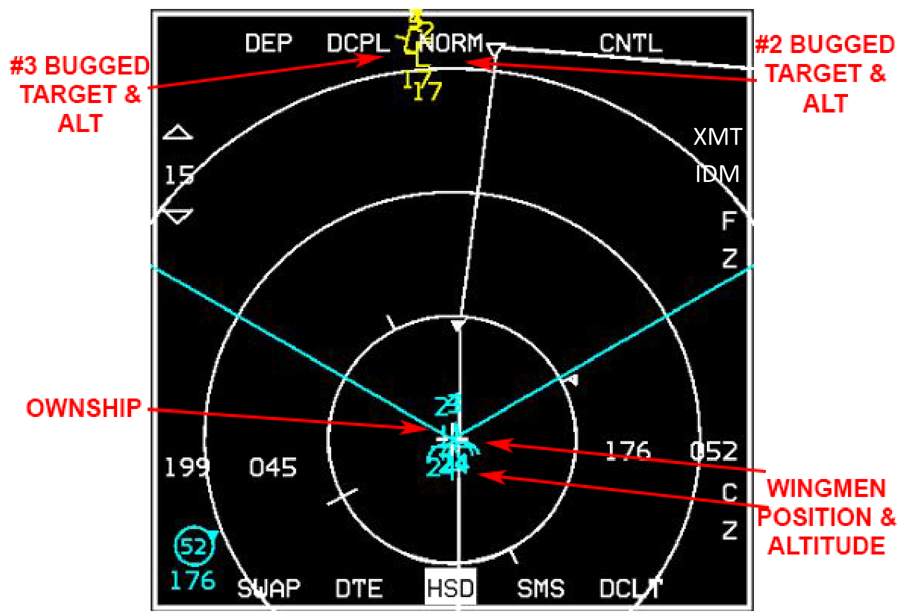
Air-to-air and air-to-ground data link information may be selected for display on the HSD MFD format by selecting ADLINK (OSB 16) and/or GDLINK (OSB 17) on the HSD Control page (both are on by default). When ADLINK is selected, intraflight member’s ownship positions and the locations of their bugged targets are displayed on the HSD. This same symbology is also displayed on the FCR, provided the FCR is in one of the air-to-air radar modes.

When GDLINK is selected, data linked steerpoint (or markpoint) and FCR air-to-ground cursor positions will be displayed on the HSD.

2.4.4.2 DATA LINK SYMBOLOGY

The data link symbology displayed on the HSD is shown in below.

- Data Link Friendly. Wingmen are displayed on the HSD by a half circle with a line projecting from the top of the half circle. The symbols are oriented on the HSD based on ground track. Flight member number is displayed at the top of the symbol and altitude is displayed at the bottom of the symbol.
- Data Link Unknown. Ownship and wingmen's bugged targets are depicted as half squares with a line projecting from the top half of the half square. Flight member assignment number and target altitude are displayed at the top and bottom of the symbol, respectively.
- Data Link Targets. Outside the HSD FOV. Data link friendly or data link unknown targets which are outside of the HSD field-of-view are indicated by an arrow pointing in the direction of the target positioned on the outer range ring of the HSD.
- Data Link Steerpoints are stored in steerpoints 71-80. Ownship markpoints are shown as a small X. Datalink steerpoints are shown as a big x. If you select one as your active steerpoint the X or x will be highlighted in inverse video.
- Data Link FCR A-G Cursor. The data link A-G cursor position is displayed on the HSD as an asterisk with the sending flight member's number above it.



HSD Data Link Symbology

2.4.4.3 DATA LINK INITIALIZATION VIA THE UFC

To effectively exchange information, each participating data link user must have compatible parameters initialized into his respective IDM terminal. In Falcon BMS, initialization parameters are automatically fed into the IDM, to an extent.

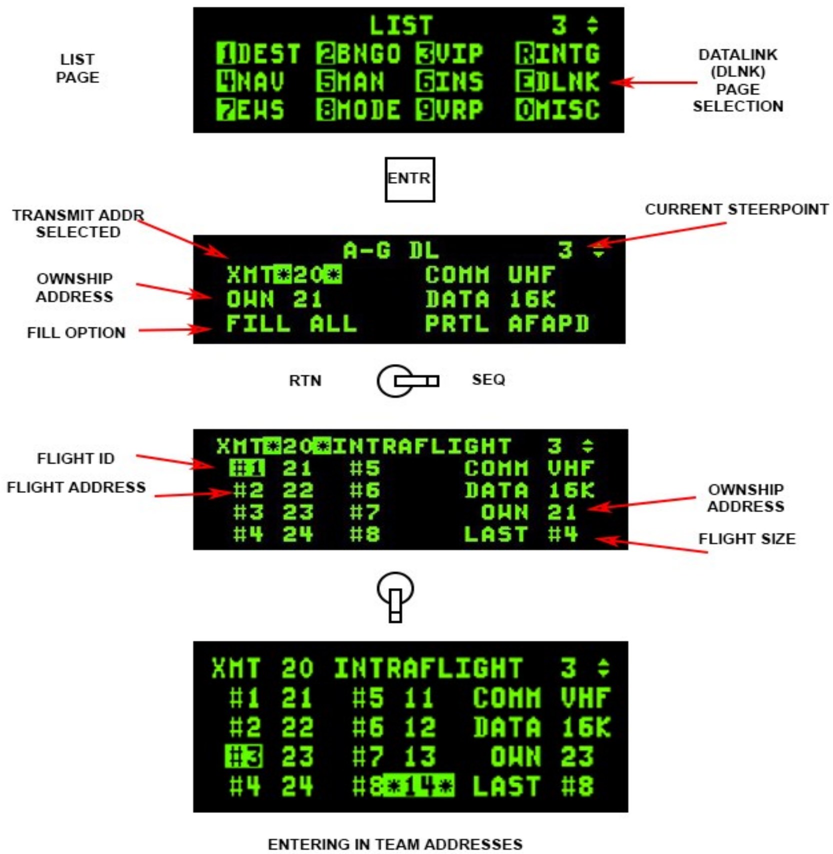
Ownship team address numbers and other flight member team addresses are done for you. These addresses are for you and the rest of your flight. The additional team addresses 5-8 are not filled in and must be keyed in manually, based on pilot preference, or as briefed by your flight lead or package commander. This will be discussed later. IDM initialization through the DTC is not implemented. Using the UFC (Up-Front Controls) the pilot can confirm and manually change a number of IDM parameters.

The first step in initializing the system is to position the Data Link power switch located on the AVIONICS POWER Panel to the DL position.

Once powered up, presse LIST → ENTR and DCS-SEQ until A-G DL page. There are now 4 selectable options on this page:

- **COMM** (UHF/VHF) – this option toggles which radio A-G datalink messages will be transmitted over. Note: everyone must be on the same frequency, whichever radio is used. By default, VHF is used for A-G datalink, with UHF used for A-A (INTRAFLIGHT) datalink messages. This can be toggled by moving the * * asterisks around VHF/UHF using the DCS switch and pressing a number key 1-9 on the ICP.
  Note: while humans can use any radio/frequency, AI are always on UHF TACTICAL (UHF PRESET 6 by default).
- **XMT** (Transmit Address) – this is the address (0-99) of the aircraft you want to send the datalink message to. By default this is set to broadcast (multicast) to all members of your flight.
  The transmit address on the A-G-DL page represents a unique destination address sent in every A-G datalink transmission. The destination address indicates which receiving IDM will process the message by specifying its address. All IDMs will receive the message but will ignore it if not addressed to them.
  Transmit addresses that end with a 0 are used to multicast to groups or teams with the same first digit in their ownship address, e.g.: the 1st flight in a package will be 10, the 2nd flight will be 20 and so on.
  0 is used to broadcast to *all* IDMs that are tuned to the same radio frequency.
- **OWN** (Ownship Address) – this is the address of your aircraft and follows the same format as above, e.g.: flight lead of the 1st flight in a package will be set up by default as 11, his/her wingman will be 12, the element leads 13 etc. The address range is from 11-99.
- **FILL** (ALL/NONE) – The FILL option determines whether the system stores (ALL) or ignores (NONE) any received data link steerpoints (71-80). By default, ALL is selected and the system will store the first message in STPT 71 and fill each subsequent STPT until it hits 80, then it will wrap around to the oldest location (71) and overwrite that data. When NONE is selected, no HUD or VMU (Voice Message Unit) messages are provided for these messages. The FILL option has no impact on A-A intraflight or A-G cursor messages; they will be processed normally.

Sequencing right with the DCS switch (SEQ) changes to the INTRAFLIGHT page, where team addresses can be reviewed and changed.



Data Link Initialization UFC Pages

Please note that since 4.37 U4 it is substantial to adjust the flight size manually (minimum 1, maximum 8). BMS will not add those values anymore automatically.

LAST#: Controls the number of team ID's in that can be set into the intraflight page. The default LAST# value will be equal to the number of aircraft that are in your flight, so no need to do any prep work.

If you wish to add ID's, you must manually increase the LAST # value. Example: If your flight is a 2-ship F-16's and you wish to add another 2 ship flight to receive or send data, you will need to increase the LAST # value to 4.

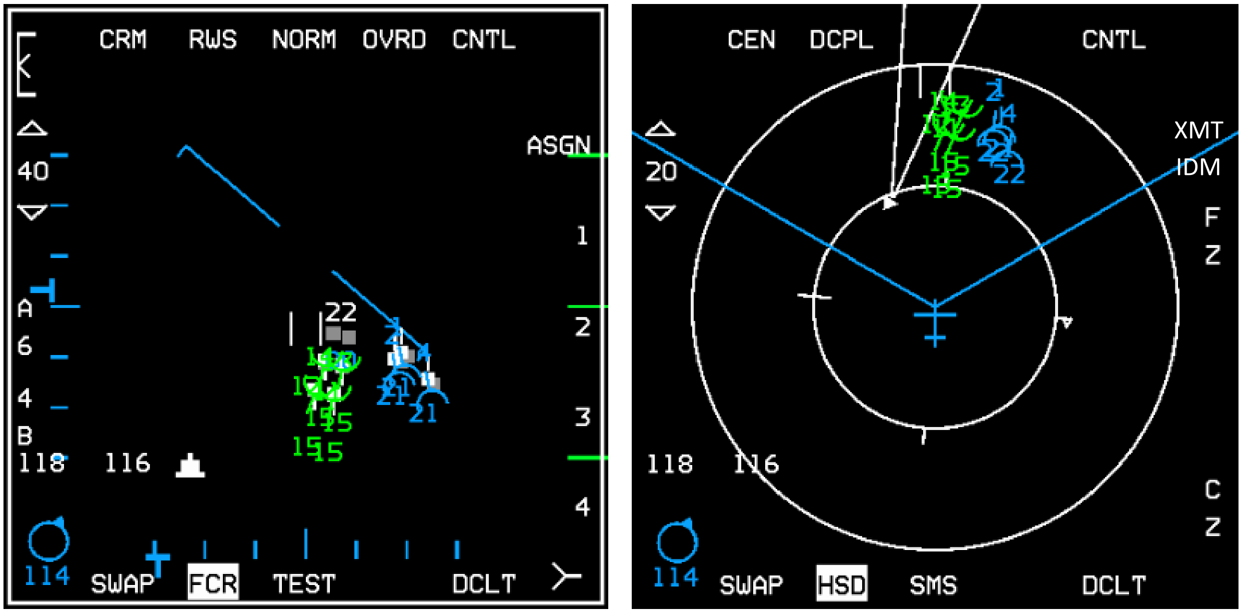
Decreasing the LAST # value will delete TEAM ID addresses. Example: A 4-ship flight with LAST # set to 4. Setting LAST# as 2, will delete the ID #3 and #4 team addresses.

LAST # has an autofill function. For team ID's 1 to 4, it will automatically fill the empty team address incrementally. Example: If LAST # is set as 2 and the team address is 11 and 12, increasing the LAST # to 4, will automatically fill the address for team ID #3 with 13, and team ID #4 with 14.

Flight Adress (#1 – #8): Any address that is manually entered to a team ID # that is above the LAST # value will be rejected and the entry field flashes. A new manually entered address that has the same value with any existing team address, will not be rejected. It will delete the existing address, and fill it into the new team ID. You can now change your own team ID, by simply entering you OWN number in any team ID 1-4.

Valid flight addresses are : 11-99

Your team ID address must be the same as the OWN #. If you wish to enter a different address into your team ID, it will be rejected. You will need to change to OWN # to match your new address.



All IDM addresses filled and displayed on FCR and HSD

2.4.4.4 AIR-TO-AIR INTRAFLIGHT DATA LINK

The A-A intraflight data link has 3 modes selectable by the pilot to assist in situational awareness and employ coordinated support and targeting of airborne targets: Demand (DMD), Assign (ASGN) and Continuous (CONT).

Note: to send/receive data link updates with AI you will need to be on their UHF TACTICAL frequency (UHF preset 6 for that flight). Data link with humans can be done on any valid frequency, on either radio. The Data Link switch located on the AVIONICS POWER Panel must be in the DL position for the system to function.

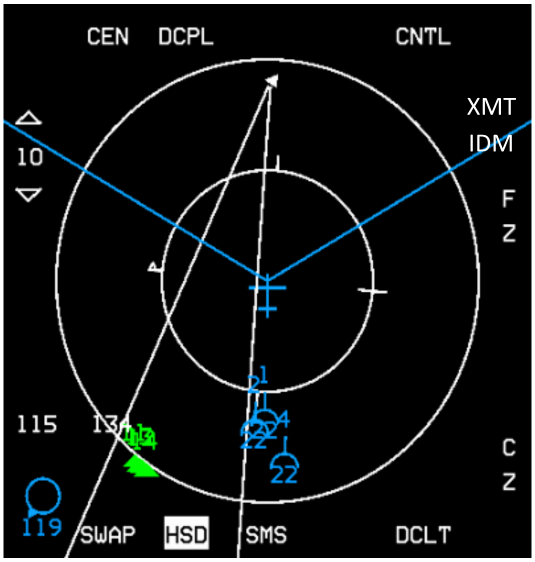
2.4.4.4.1 MODES OF OPERATION

2.4.4.4.1.1 DEMAND MODE OPERATION

The Demand (DMD) and Assign (ASGN) data link modes allow a team member to obtain a “one-shot” team situational awareness update (an intraflight transmission round) on an “as needed” basis. The DMD and ASGN modes also enable the option to make assignments to other flight members. When the IDM is in DMD or ASGN mode and is commanded to transmit, the IDM transmits an A-A Request message to the intraflight team (up to four jets in a flight). The request message contains current aircraft position, heading, and velocity.

If an FCR target of interest (TOI) is available at the time of transmission, the position, heading, and velocity of the TOI is also sent in the request message. Each receiving aircraft then transmits an A-A Reply message (in turn based on their sequential order requested by the request message). The A-A Reply message contains ownship and TOI data similar to the request message. The messages transmitted allow each member to see the positions and headings of other members and their bugged target on the HSD page and FCR page.

Both A-A Request and A-A Reply messages are snapshots in time. For example, once the pilot’s IDM receives A-A Reply messages, the wingmen team symbols (cyan-coloured unless High Contrast MFDs option is selected with the Configuration tool) and their bugged targets are extrapolated for 8 seconds. Once this extrapolation period ends, the symbols will disappear and another data link round must be initiated by a team member (unless CONT mode is used). If heavy maneuvering occurs during an extrapolation period, the next transmission round may result in wingmen symbols and their bugged target symbols jumping on the displays (HSD and FCR) to their new location.



Friendly wingmen off HSD (bottom left)

The following applies to the initiation and verification of a successful data link transmission round:

1. Verify data link mode DMD or ASGN (not CONT) is displayed next to OSB 6 on the A-A FCR. Press OSB 6 if necessary to cycle through the modes.
2. Depress COMM switch left for >0.5 sec (on the throttle if you have them programmed on the Cougar, else “Delete” or whatever keystroke you have them assigned to); verify DMD or ASGN mnemonic is highlighted for 2 seconds.
3. Verify display of intraflight data link symbology (i.e., your wingmen team members) on the HSD when the reply messages are received from team members.
4. Verify display of intraflight data link symbology on the A-A FCR page when the replying team members are in front of ownship.
5. To declutter A-A intraflight data link symbology on the FCR page, depress COMM switch left for <0.5 sec. The decluttered state will remain until you depress COMM switch left for <0.5 sec again.

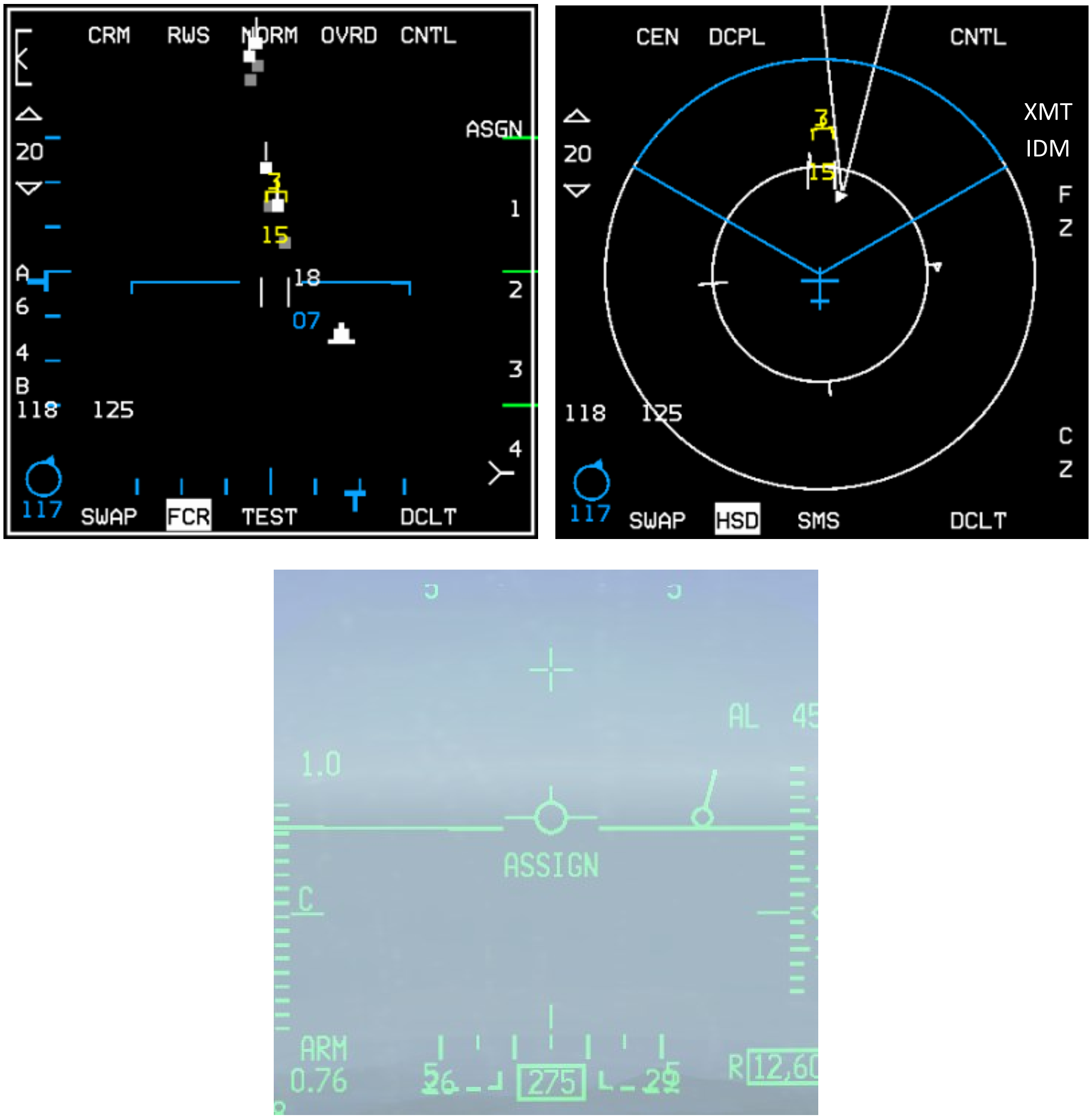
The following applies to making a data link A-A assignment:

1. Ensure the system currently has a FCR TOI (Target of Interest).
2. Depress the OSB (7 through 10) adjacent to the ID associated with the assignee team member (addresses in slots #1, 2, 3, or 4 on the INTRAFLIGHT page); verify assignment ID is replaced by highlighted “XMT” mnemonic for 2 seconds.
3. Verify display of the team member ID above the FCR target symbol on the FCR page. The ID is displayed until the FCR track is no longer valid or a different target is assigned to the same team member.

Received messages are extrapolated and displayed on the HSD for 8 seconds. During this period, the data link ignores any A-A Request command (COMM switch left >0.5 sec).

The following applies to assignment operation for receiving aircraft. Reception of an assignment message is independent of data link mode. The following process describes the reception of an assignment message:

1. Upon reception (indicated by the tone in the headset), verify display of “ASSIGN” in the upper middle part of the HUD. The ASSIGN cue is displayed for 8 seconds or until depression of WARN RESET on the ICP.
2. Verify VMU (a.k.a., Bitchin’ Betty) message “DATA” in the headset if ownship was the assignee.
3. Verify display of data link assignment symbol on the FCR and HSD pages.



Assignee (#3's) FCR, HSD and HUD

Data link assignment target positions are extrapolated and displayed for 8 seconds similar to other A-A data link symbology. The data link system will maintain 4 different slots for reception of assignment messages of the 4 team members. For example, if the flight lead assigns targets one after another (including one to himself), it is possible for team members' displays to contain 4 different assignment symbols (with different ID's) indicating the assigned targets of each team member.

During the 2 seconds that XMT is displayed, another FCR target can be selected as the TOI; however another assignment cannot be made until XMT is removed. The data link system also allows an assignment to be made to oneself by depressing and releasing the OSB adjacent to own ship member number. This message is transmitted to all teammates similar to other assignments.

Although a data link assignment message is broadcast to all members of the intra-flight team (up to 4 members currently – in the future this may expand to 8), assignments can only be made to members whose addresses are entered in the left 4 slots (#1, #2, #3, #4); hence, assignment ID's 1-4 on the A-A FCR page.

2.4.4.4.1.2 CONTINUOUS MODE OPERATION

The Continuous (CONT) mode allows the pilot to request continuous update of request and reply intra-flight messages. This is the mode that also requires coordination amongst flight members if you are flying in the multiplayer environment, as only one aircraft needs to be in CONT mode and initiates the CONT data link round.

All messages are broadcast to the intra-flight team. The CONT loop starts when a team member (most likely the flight lead) transmits an A-A Request while in the CONT mode. The CONT label is highlighted to show the aircraft is the controller of the CONT round. The request message from the network controller is followed by the replies of team members and a time delay. The sequence of the team member replies are dependent on the sequence of replies requested by the controller.

The aircraft automatically selects the reply sequence and it is not pilot changeable. This time delay (CONT mode delay), allows a time window for transmissions of other non-A-A messages. After the delay period has expired, the controller aircraft automatically resends the request message. The CONT loop ends when the pilot of the controller aircraft deselects the CONT mode.

Received data link A-A Request and Reply messages are displayed on the HSD and FCR the same as DMD and ASGN modes. Assignments of air targets can also be done in the CONT mode similar to DMD and ASGN modes using the “1, 2, 3, 4” labels next to OSB’s 7-10.

2.4.4.4.1.3 SYSTEM MASTER MODE VERSUS A-A INTRAFLIGHT DATA LINK

The ability to initiate an A-A Intraflight data link loop and to automatically reply is independent of system master mode and data link mode. When A-A data link has been selected for display using the HSD Control page, all valid A-A data link symbols are displayed on the HSD (when within the HSD FOV) independent of system master mode and data link mode.

This is consistent with the god’s eye situation awareness philosophy for the HSD. The radar page displays A-A data link symbols only when the radar mode is one of the A-A modes.

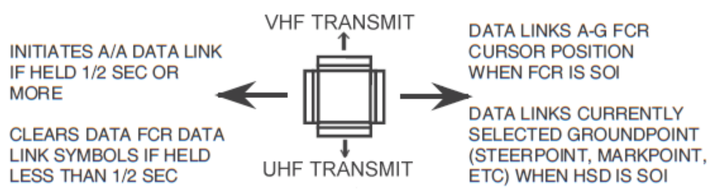
2.4.4.5 AIR-TO-GROUND INTRAFLIGHT DATA LINK

The A-G intra-flight data link function allows the transmission of data associated with the currently selected steerpoint or the A-G radar cursor position, which can then be used by flight members to move their sensors (A-G radar cursors, TGP, etc.) onto a target or point of interest.

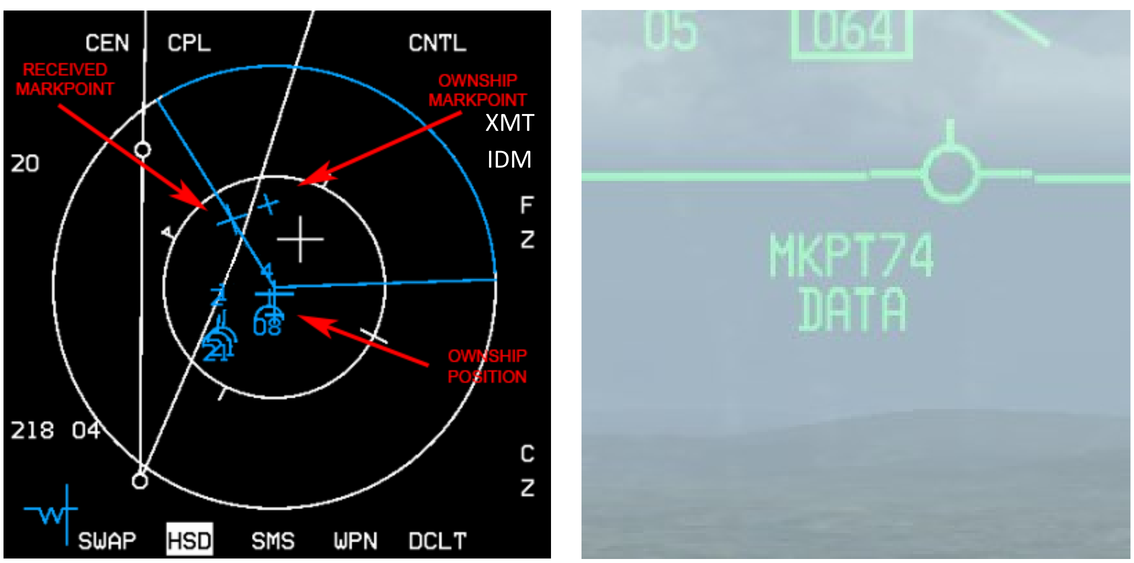
2.4.4.5.1 AIR-TO-GROUND DATA LINK STEERPOINT

A-G steerpoint data link is accomplished hands-on using the HSD as SOI. The HSD can be selected as the SOI using the DMS (Display Management Switch) down position, upon which the MFD SOI (Sensor of Interest) box (around the MFD perimeter) is placed on the HSD.

Hands-on selection of the steerpoint location is done by placing the HSD cursor on the desired steerpoint and designating with TMS Up. Transmission of the A-G data link message is accomplished by depressing the Comms switch right while the HSD is SOI and also triggers an audible tone in the headset. A highlighted XMT will also be displayed adjacent to OSB 6 on the HSD base page. Alternatively, the pilot may select the steerpoint he wants to data link via the UFC (Up-Front Controls – ICP), switch the SOI to the HSD and then depress Comms switch right. Data link steerpoints show up as a large X symbol on the HSD and are stored in steerpoints 71-80, which allows multiple DL steerpoints to be retained by the navigation system. Once they are all filled up, #71 will be overwritten and subsequent DL STPTs will overwrite the other numbers.



Data link Switch Summary



Assignee (#3's) HSD and HUD showing data linked Markpoint

2.4.4.5.1.1 Operational Considerations for A-G Data Link Transmit Address

The transmit address may be changed before transmitting a STPT or A-G cursor position (A-G cursor position is described below). The system default is your flight's broadcast address (a number ending in "0", i.e., 20 if you are the second flight in a package). Transmitting to this broadcast address will send the data to individual groups or teams with the same first digit in their ownship address: e.g., transmit address 20 will transmit to addresses 21-24.

If, for example, the flight leader of four F-16s wants to data link a markpoint to all members of his flight and their addresses are 21 through 24, he would enter a transmit address of 20 in the XMT field and initiate data link transmission with SimCommsSwitchRight (Page Down). The data linked markpoint would be displayed on the HSDs of all flight members in the intraflight link. Likewise, if his 4-ship is a part of a package of 8 aircraft and the other flight's broadcast address was 10, he could enter 10 and transmit A-G data to the other flight of four.

A transmit address not ending in zero is directed to a single respective aircraft. For example, if a pilot wanted to send a mark point to only his #3 wingman, and the wingman's team address is 23, the pilot would have to enter 23 (the wingman's address) in the transmit address field on the A-G DL page. When the pilot transmits the message, only wingman #3 will have the markpoint displayed on his HSD.

Entering in a specific transmit address is only for A-G operations and does not affect the A-A intraflight data link. Transmission of data to a single aircraft can be done to a member outside of your immediate 4-ship team. In other words, if you were address 21 and there was a flight of 4 with addresses 11-14 and you wanted to transmit a mark point to only the leader of that flight, you would enter 11 as the transmit address and initiate the data link transmission as above.

2.4.4.5.2 AIR-TO-GROUND DATA LINK CURSOR POSITION

The A-G cursor function provides hands-on transmission of A-G FCR cursor position. This function is independent of system master mode or data link mode while the FCR is in ground map (GM), ground moving target (GMT), or SEA modes and requires the FCR to be the sensor of interest (SOI) for transmission.

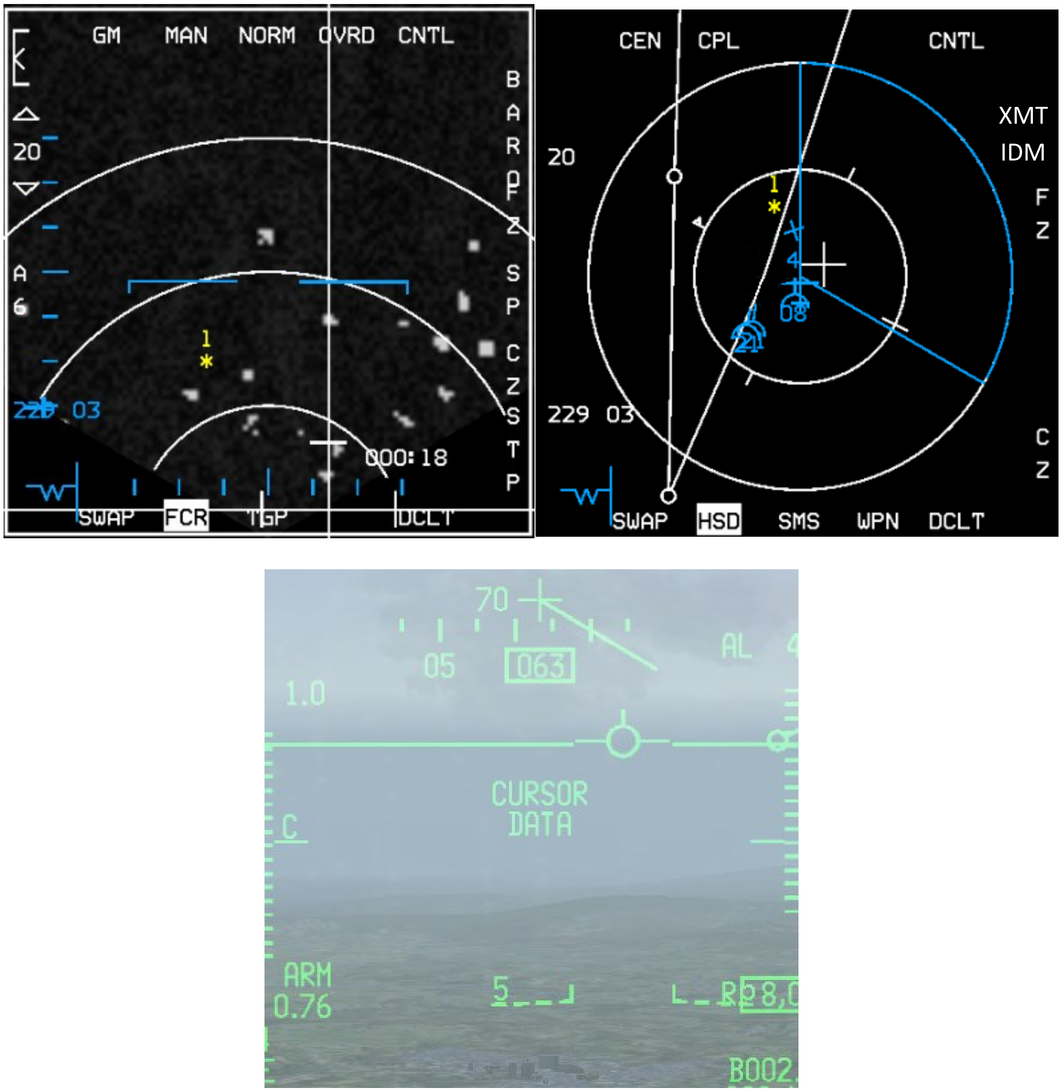
Transmitting ownship A-G cursor coordinates is accomplished hands-on by making the FCR the SOI, slewing the radar cursor with the CURSOR/ENABLE control to the point-of-interest and then depressing Comms switch right on the throttle (Page Down). An audio tone is audible in the headset and the mnemonic XMT is highlighted for two seconds adjacent to OSB 6 on the HSD. The pilot will not see his own A-G cursor position data link symbol, which is a yellow asterisk (*) symbol).

Reception of A-G cursor data link message is independent of the current data link mode. Several cues are provided by the avionics system to indicate reception of a data link message. An audio tone is activated followed by the aural VMU message "DATA" in the headset and the HUD message, "CURSOR" and "DATA" in the middle of HUD. This HUD message remains until the DRIFT C/O switch is positioned to WARN RESET on the ICP or the data is no longer valid (i.e. 13 seconds has elapsed since cursor reception). After reception of an A-G cursor message, the HSD and/or FCR (if it is in one of the three ground-map modes – GM, GMT, SEA) displays the data linked A-G cursor symbol (*).

However, this symbol is blanked on the FCR if FZ is selected, or the radar is in FTT (fixed target track). The symbol is displayed with an ID (1-4) which represents the message source (team member 1-4), or displayed as a 2-digit number representing the IDM address of another member of the 8-ship team if not from team member 1-4.

This symbol remains on screen for a total of 13 seconds and begins flashing during the last 5 seconds if it is within display FOV. If ground datalink has been decluttered (via OSB 17) on the HSD control page, no A-G cursor symbol will be displayed on the HSD.

The system stores and displays a maximum of 3 different data linked cursor positions simultaneously; subsequent receptions overwrite existing locations in a rotary fashion. The data linked cursor position is not stored as a steerpoint.



Assignee (#3's) FCR, HSD and HUD. Assigner (#1) sent cursor data NNE of ownship Markpoint

"Datalink Ground Target" is a wingman/element command that will request the AI to datalink his A-G FCR cursor position of his target of interest as described above. Note that this command only works if you are either a flight lead or an element lead (#3) and have an AI wingman under your command.

Please note that newer USAF blocks will send its cursor position as DATA LINK STEERPOINT.

2.4.4.6 IDM USE SCENARIOS

2.4.4.6.1 AIR-TO-AIR

You are the flight lead of a 4-ship of human wingmen in a multiplayer OCA mission. Your role is to conduct a sweep to clear the airspace of enemy fighters before the strikers behind you bomb their target. Armed with AIM-120s, AIM-9s and your trusty IDM, you're ready to deal with any enemy groups that come your way.

After getting safely airborne, your wingman, element lead and his wingman gain visual and join up in fluid 4. You briefed your flight that you as flight lead would be the IDM controller for Continuous mode. You initiated the IDM "round" with "Comms switch left >.5 secs" right after takeoff and have been receiving data link rounds from your flight ever since.

After fencing in and getting ready for combat, your formation picks up two groups split in azimuth 10 miles apart – it looks like both groups are 2-ships. They are hot and have moved into factor range and you decide to commit on them. Knowing that you can assign targets in CONT mode (even without the wingman labels showing on the FCR), you bug the eastern group lead contact and hit OSB 9 on the FCR to transmit an assignment for #3 to target that group followed by a radio call to your #3: "Viper13, target group bullseye 090/20, twenty thousand, data". Number 3 responds: "3!" then does almost the same steps as you did and targets his wingman, #4, onto the second contact in his group.

Next you slew your radar cursors to the group you intend to target, bug the second contact in that formation and hit OSB 8 followed by a radio call to your wingman: "Viper12, sort group bullseye 090/10, twenty thousand, data". Number two sees the IDM assignment and quickly calls: "2, sorted". Lastly you lock up the lead contact in your group and hit OSB 7 to send an assignment to your flight indicating your targeting assignment. Since you're in CONT mode, from here on out, your flight member's bugged targets continue updating on the HSD and FCR every 8 seconds, along with their ownship positions, ensuring everyone has situational awareness on both groups and each other. Soon, AIM-120s are screaming to their targets – it's a quick kill on all four.

2.4.4.6.2 AIR-TO-GROUND

In today's tasking, you've been assigned to hit a column of T-62 tanks that are on their way towards the border, intending on attacking friendlies. You're the flight lead of a 2-ship of BLK 40 F-16s. You're armed with 2 x CBU-87, 2 x GBU-12 and a targeting pod. Prior to taking off, you brief to your wingman that you will be the IDM net controller and will be using CONT mode.

After takeoff your wingman checks his IDM mode is set to ASGN and then moves his Comms switch left for >.5 secs to request a one-off situational awareness update from the flight. He uses 5 Nm scope in RWS, sees your IDM team member symbol next to his radar contact and begins a quick rejoin.

After fence in you Comms switch left for >.5 secs and begin initiating a continuous loop. You're getting close to where the tanks are expected to be now, so you begin searching in GMT for the column. You pick up a line of movers 5 Nm north of your steerpoint. You switch to SP mode, TMS forward and slew up to the movers. You Comms switch right with the radar as SOI and send your GMT radar cursor position to your wingmen. Bitchin' Betty gets his attention aurally in addition to the visual message in the HUD. He's got your GM cursor symbol (*) on both his HSD and FCR and slews to that position.

Next, you decide to create a markpoint at the location of the column. You hit MARK 7 on the ICP, SEQ Right to select FCR and then TMS Up; you've got a markpoint. Mode-selecting it with the M-SEL 0 button makes it the active steerpoint. You hit CZ to zero out your cursor slews, then switch SOI to the HSD and Comms switch right again.

This time it sends a datalink steerpoint to your wingman, which is a more permanent means for him to maintain SA on the position of the column. He then switches to STPT 71, so you're both referencing the same steerpoint. After positive ID of the column, you and your wingman begin a high wheel attack on the column and lay down some serious punishment.

With the background text and two examples, you should have a good working idea of the capabilities of IDM and how useful it can be in the tactical environment. Practice and experimentation will lead to understanding and developing proficiency with this valuable tool.

2.4.4.7 IDM OPERATIONAL CONSIDERATIONS

There are a few last considerations you need to know about the IDM system in Falcon. During mission planning/ mission building, when you are building a package of aircraft, the first flight (in this case a 4-ship) in a package will be assigned addresses 11-14. The next flight will be 21-24 and so on. If during planning you adjust takeoff times so that, for example, the first flight you created takes off later than another flight in the package, the first flight you created will *still* use addresses 11-14. This is important because your IDM addresses may be different than what you thought they were going to be if you were not familiar with the order in which the flights within the package were created.

A good technique is to check the order of the flights in your package on the Briefing page in UI before you commit to 3D; it will list them in order. This can help you select the right transmit addresses for other flight in your package (if there are several flights in the package and you want to monitor the location of any of those flights).

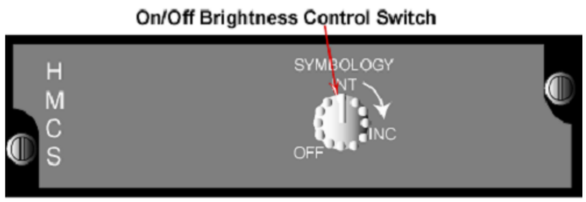
Another consideration is the flexibility of the IDM. For example, you are 2-ship of DCA and the first flight of a package that has 4 flights in total. You are addresses 11-12; already in the left column. You decide that you want to maintain situational awareness primarily on the flight leads of the other flights. You can enter 21, 31, and 41 in the IDM and receive their positions on the HSD, or you can enter 2 of those addresses in the left column and also receive information on any radar contacts they lock up if you are in IDM CONT or use Comms switch left to get an update.

The last consideration involves contingency planning. Normally the flight lead would be the net IDM controller of a flight. If he is shot down, another flight member (normally #3) will have to take over and set CONT mode and reinitiate the DL rounds.

2.5 HELMET MOUNTED CUEING SYSTEM (HMCS)

The Helmet Mounted Cueing System (HMCS) is an Electro-Optical (E-O) device that serves as an extension of the HUD by displaying weapon, sensor, and flight information to the pilot. Combined with high off-boresight missiles, the system gives first look, first shot, first kill capability in the visual arena.

The HMCS is only available in aircraft in the database that have the “Has HMS” flag option selected. The HMCS is controlled via HMCS symbology rheostat (OFF/ON & brightness control) in the 3d pit or with the [ ] keystrokes.



On/Off Brightness Control Switch

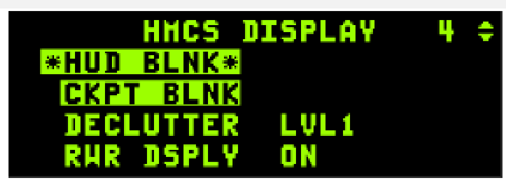
The HMCS is basically an extension of the HUD, and as such the HUD and HMCS are considered as one SOI (i.e. they share the same hands-on-control switchology). The HMCS FOV is defined as a 20° diameter circle centred on the HMCS LOS. Wherever the pilot looks within the HMCS field-of-regard (FOR), appropriate symbols from the aircraft are accurately displayed, based on the current HMCS LOS.

The HMCS performs different functions:

1. Off boresight slaving of FCR in the DGFT Mode
2. Off boresight slaving of AIM-9 missiles
3. Ownship performance information and status

2.5.1 CONTROL PAGES

The HMCS has two DED control pages. The first is accessed by pressing LIST > 0 > RCL. The second is accessed by pressing SEQ on the ICP. The first allows HUD and cockpit blanking, which allows the HMCS to turn off with the pilot looks either towards the HUD or down in the cockpit. The second is allows for alignment of the system.



2.5.1.1 HUD BLANKING

The HMCS and HUD share many symbols, which tend to visually conflict with one another when looking through the HUD and an HMCS. Forward (HUD) blanking is a declutter feature that removes all HMCS symbols (in A-A or A-G mode) when the HMCS LOS (borecross) is within the inside edge of the HUD instantaneous FOV. The HUD blanking region applies when the difference between the HMCS LOS and the CTFOV of the HUD is less than +10° in azimuth and +10° in elevation.

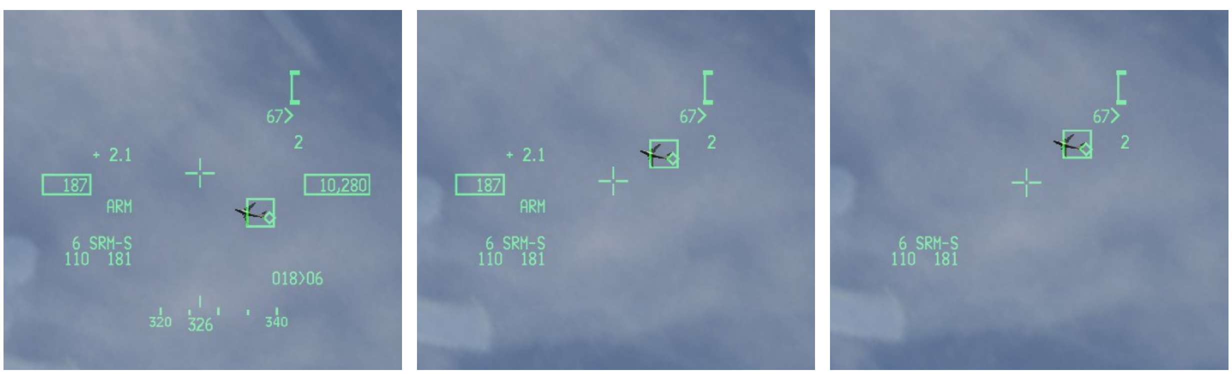
The HUD blanking feature is controlled from the DED HMCS DISPLAY page by placing the asterisks around HUD BLNK and depressing M-SEL on the ICP. When mode selected, HUD BLNK highlights and remains highlighted until deselected and the asterisks auto step to cockpit blanking (CKPT BLNK). HUD blanking is deselected by placing the asterisks around the highlighted HUD BLNK and depressing M-SEL. Invoking HUD BLNK has no impact on the ability to slave missiles to the HMCS LOS.

2.5.1.2 COCKPIT BLANKING

The cockpit blanking (CKPT BLNK) feature is a selectable declutter feature that removes all HMCS symbols except the missile diamond, steerpoint diamond, aiming cross, ACM bore symbol, and TD box from the display when the HMCS LOS is below the cockpit canopy rails. The HMCS aiming cross, target locator line, and TD box will stay displayed on the HMCS when cockpit blanking is enabled and the HMCS LOS is in the cockpit blanking region. Cockpit blanking reduces eye clutter when performing heads-down (in-cockpit) tasks. Cockpit blanking is controlled in a manner similar to HUD blanking.

2.5.1.3 DECLUTTER

The HMCS has 3 levels of declutter available. To advance through the levels, position the asterisks around DECLUTTER and depress any key 1-9. LVL1 is the lowest declutter state and includes all HMCS information. LVL2 declutters by removing altitude, range to steerpoint, and helmet heading scale. LVL3 declutters by removing altitude, range to steerpoint, helmet heading scale, airspeed, normal acceleration, and ARM status window.



Level 1 / Level 2 / Level 3

2.5.2 ALIGNMENT

The HMCS uses a magnetic field sensor to determine the position and orientation of the pilots head. In order to function correctly the system requires alignment at ramp-start. As the system builds up errors after take-off and over time, it is recommended to re-align every 20 minutes and/or during FENCE checks.

The alignment menu is accessed by SEQ from the initial HMCS control page. The alignment modes can be selected by highlighting the respective lines. Activate or deactivate the alignment mode is using M-SEL on the ICP.

2.5.2.1 COARSE ALIGNMENT

The first alignment is performed during ramp start and is considered “coarse” based on how accurate the symbology in relation to physical points of interest is. Upon activating the coarse mode (ICP LIST > MISC > RCL > SEQ and press M-SEL) an alignment cross is shown on both HMCS and the HUD. Align both crosses and hold the HMCS position and orientation steady while pressing the cursor enable on the throttle. After 2 seconds the system will report the test result. If the alignment failed, another cursor enable command will restart the alignment procedure. If the alignment succeeded, then an “Align OK” is displayed. Coarse alignment is recommended before take-off. If starting on the taxiway with a hot jet the Course alignment has been accomplished.

2.5.2.2 FINE ALIGNMENT

For final adjustment after coarse alignment or to re-align during flight, fine alignment is to be used. Upon activating a fine alignment mode, the HUD and HMCS alignment crosses appear showing the current alignment error. To eliminate the alignment errors, use the cursor slew to align the crosses.

The system can buffer small movements, but in principle during fine alignment the position and orientation of the HMCS must be maintained. Fine alignment is recommended after take-off or whenever HMCS alignment is mission critical. A good technique is to perform this step during the FENCE-In checks.

2.5.3 HANDS-ON HMCS BLANKING

The display management switch (DMS) enables and disables HMCS display. A DMS-Down and hold for ≥ 0.5 seconds toggles the HMCS between displaying symbology and not displaying symbology. This feature is independent of the HUD or CKPT blanking states. Hands-on-control blanking overrides all other blanking including the HUD blanking feature and cockpit blanking feature until the HMCS display is redisplayed via a second DMS-aft for ≥ 0.5 seconds. When the symbology is being blanked, the system behaves as if a helmet is not in the avionic system and returns to baseline ACM operation and baseline missile bore operation.

2.5.4 HMCS DYNAMIC AIMING CROSS

The HMCS dynamic aiming cross is designed to allow the pilot to easily slave weapons to the HMCS LOS during high G, high look-up angle conditions. The cross moves linearly in elevation only from the centre of the HMCS FOV to plus 168-mR head elevation changes from +30° to +80°.

2.5.5 JHMCS AIR-TO-AIR OPERATIONS

The HMCS A-A mechanization provides the capability to slave the AIM-9 A-A missiles to the HMCS aiming cross LOS when the missile is in the BORE LOS mode. In addition, when the FCR is placed in ACM BORE, the FCR is commanded to the HMCS LOS if ACM BORE mode is selected and the FCR is SOI.

The HMCS populates its display with data and position symbols based on the same conditions and requirements for displaying data and symbols on the HUD.

2.5.5.1 AIM-9 MISSILE BORE OPERATION

When an AIM-9 missile is selected with HMCS and the missile LOS is BORE (cursor-z depression), the avionic system slaves the missile LOS to the HMCS aiming cross LOS. Note that when the AIM-9 missile is uncaged, the enlarged missile diamond is displayed on the HMCS. If HMCS is off, the missile diamond is displayed only on the HUD.

When SLAVE is selected with a TOI, the avionic system slaves the missile to the FCR LOS and the missile diamond is displayed at the FCR LOS on the HMCS. With SLAVE selected and no TOI, the missile seeker points three degrees down from the HUD bore cross.

NOTE: The missile diamond will be displayed in the center of the HMCS up to 28° from boresight. Beyond 28°, the missile diamond will move from the center of the display until it reaches the edge of the HMCS display. Upon reaching this point, an X is displayed over the missile diamond.

2.5.5.2 SLAVING FCR ACM BORE WITHOUT A TOI (FCR NOT LOCKED ON)

When ACM BORE is selected and TMS-forward is held, the radar is slaved to the HMCS aiming cross LOS in a non-radiating state. The FCR ACM BORE ellipse is displayed on the HMCS at the FCR LOS. The radar is commanded to radiate when TMS-forward is released. The radar automatically attempts to acquire a target in the ACM BORE ellipse when TMS-forward is released. Note that if the HMCS LOS is moved past the FCR gimbal limits, the avionic system continues to try to slave the FCR LOS to the HMCS LOS even though the FCR gimbal limits have been reached. In this case, the FCR ACM BORE ellipse remains displayed over the HMCS aiming cross, even though the FCR is at its limit and can no longer attain the actual HMCS LOS.

2.5.5.3 SLAVING FCR ACM BORE WITH A TOI (FCR LOCKED ON)

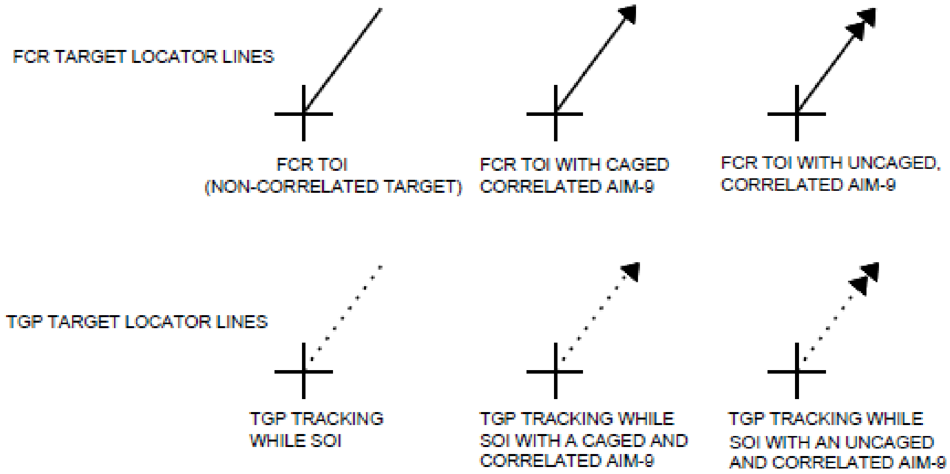
If there is a valid Target-Of-Interest (TOI) upon entry into ACM, the avionic system controls the ACM submodes per baseline.

2.5.5.4 BORE/SLAVE TOGGLE

Changing the BORE/SLAVE option on the SMS base page for either the AIM-9 or AIM-120 will simultaneously change BORE/SLAVE status for both missile types (master mode dependent). The cursor-z axis can also be used to change to the opposite state as long as the switch is held. Upon release of the cursor-z axis, the state returns to the original state (“dead-man” function). The HMCS will indicate SRM-S or MRM-S for SLAVE, and SRM-V or MRM-V for Visual BORE.

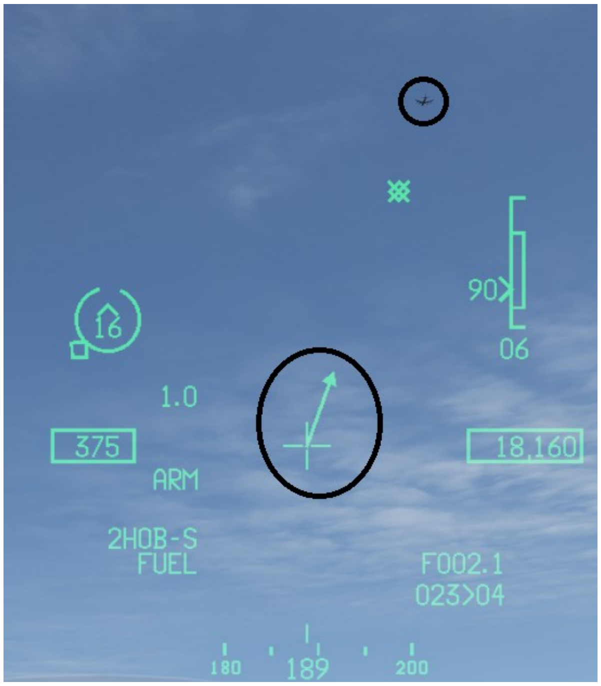
2.5.5.5 HMCS A-A TARGET LOCATOR LINES (AATLL).

The HMCS is now displaying Air to Air target locator lines. Those AATLL will be either plain or dashed according to which sensor is locked on the air-to-air target. Either FCR or TGP.

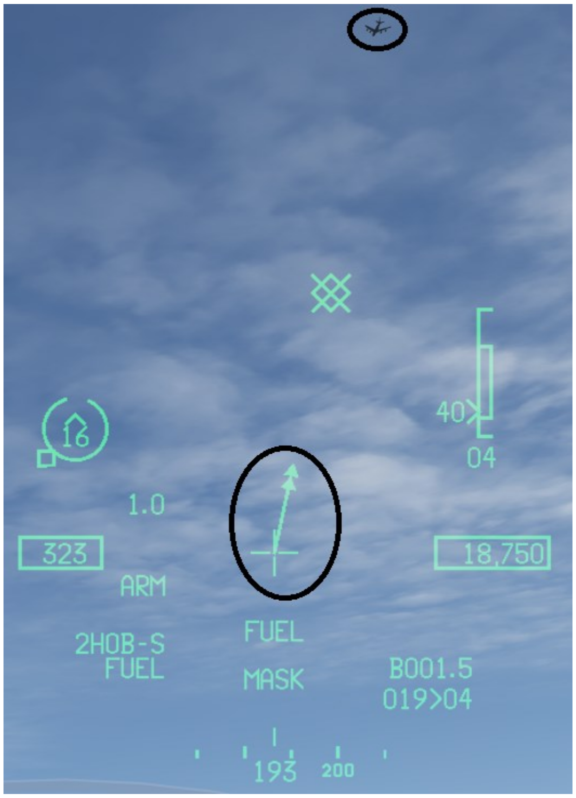


Here are a few examples of it in BMS:

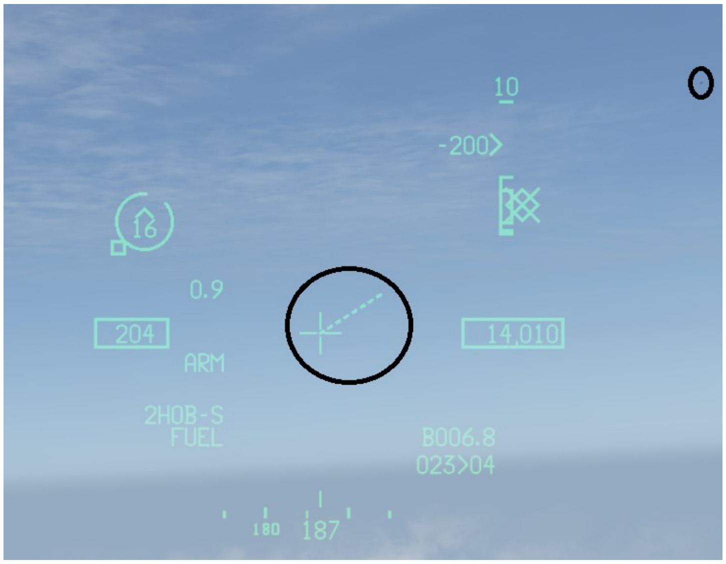
FCR TOI (Non Correlated Target)



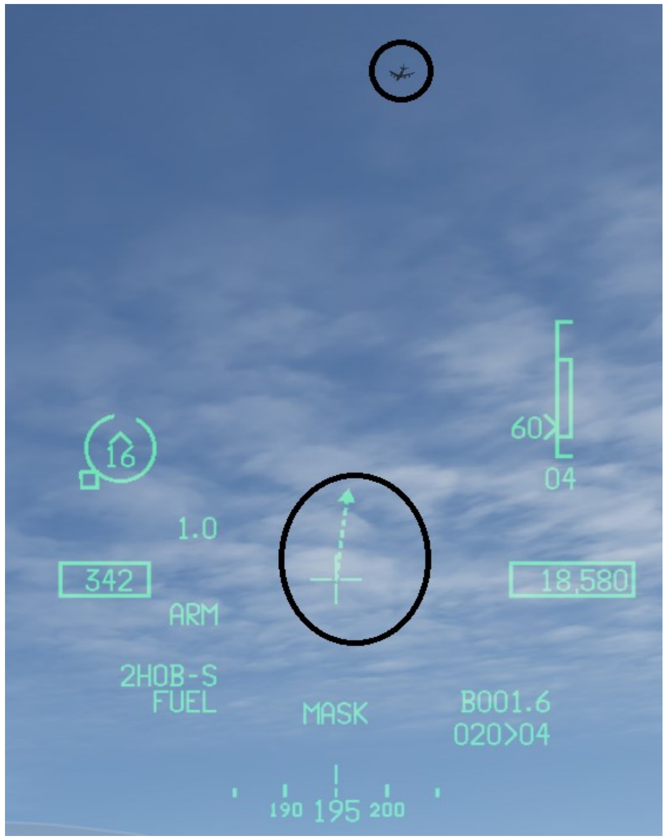
FCR Toi with Uncaged Correlated AIM-9



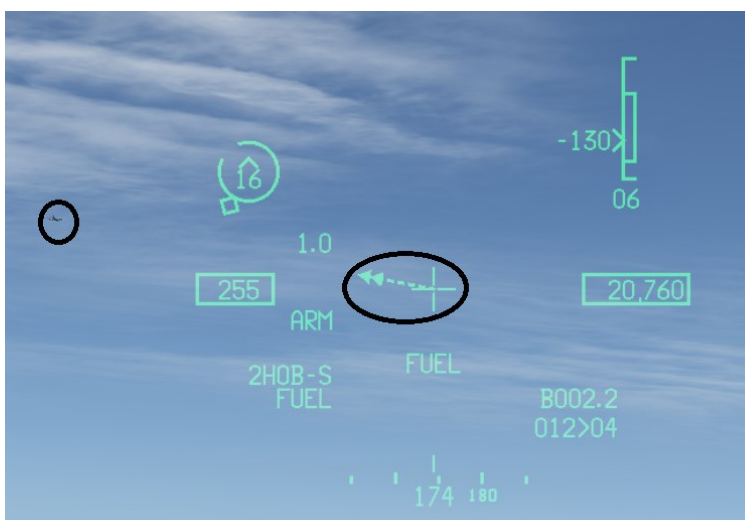
TGP Tracking while SOI



TGP tracking while SOI with a caged and correlated AIM-9



TGP tracking while SOI with an uncaged and correlated AIM-9



2.5.6 JHMCS AIR TO GROUND OPERATIONS

The JHMCS can be used in the Air to Ground mode, in BMS 4.36 the following functions have been modeled:

- HMCS Mark
- HMCS Dive Toss
- HMCS EO VIS
- HMCS Target Locator Line

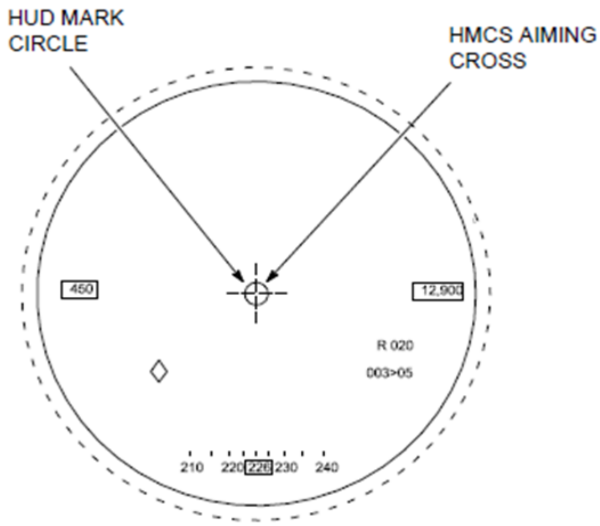
2.5.6.1 HMCS MARK

The HMCS mark function allows you to slave the HUD mark cue to your HMCS aiming cross. This is done by accessing the Mark function via the UFC.

HUD Mark

NOTE: When selecting the ICP 7 key in the air to ground mode and the TGP is SOI, the mark page on the DED will by default to the TGP as the sighting point. The same logic applies when the FCR is SOI, the sighting point of reference will be the FCR.

To slave the HUD mark cue to the HMCS aiming cross, press TMS up for more than 0.5 seconds.



HUD Mark Circle

When the symbol is limited on the total field-of-view, an "X" is superimposed over it.

NOTE: *The system estimates of target position, based on HMCS LOS calculations see section HMCS ranging.*

2.5.6.2 OPERATING PROCEDURE FOR HMCS MARK

With the CNI page displayed on DED, depress ICP Button 7 (MARK).

Sequence to HUD as the sighting point (if required), the SOI goes to the HUD.

Verify the MARK cue is slaved to the FPM.

TMS forward (first) > 0.5 seconds slaves the MARK LOS circle to the HMCS aiming cross.

Align the LOS circle with the MARK location via head movement.

TMS forward (second) to ground stabilize.

Refine MARK LOS via cursor controller and TMS forward (third) to store MARK data, or

TMS aft to re-slave the MARK LOS circle to the HMCS aiming cross.

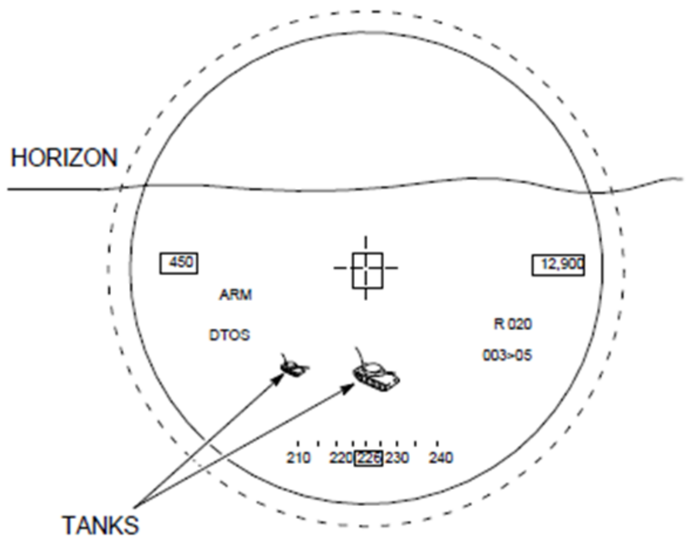
TMS aft a second time to re-slave the LOS circle to the FPM on the HUD (ready for HUD MARK).

Dobber-left returns to the CNI page and returns the SOI to last left.

2.5.6.3 HMCS DIVE TOSS

Dive Toss is a visual bombing mode using AGR. The HMCS Dive Toss function allows the pilot to command AGR outside of the HUD's field of view. When selecting DTOS mode, the HUD is automatically set as SOI and the FCR is in AGR mode.

2.5.6.3.1 DTOS PREDESIGNATE WITH THE HMCS



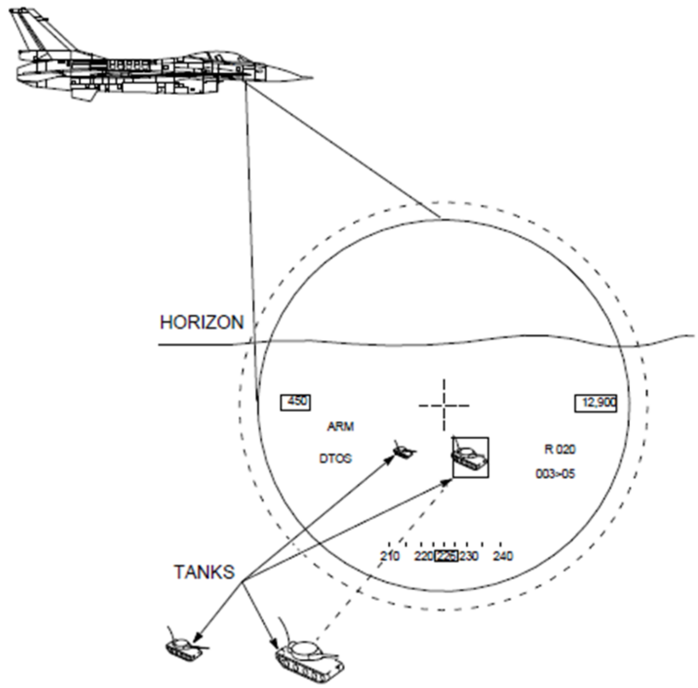
HMCS Ground

To slave the HUD TD box from the FPM, TMS UP is held for more than 0.5 seconds. The TD box will be slaved to the HMCS aiming cross, the TD box will be blanked from the HUD. To unslave the TD BOX from the HMCS aiming cross TMS AFT must be held for more than 0.5 seconds to slave it back to the FPM.

Pre-designate slew with the cursors enable switch is not available with the HMCS. The logic behind that is that the pilot can move his head around to pre-designate. Pre-designate slews are possible when the HUD is used to position the TD box.

The HUD TD box is more precise than the HMCS TD Box placement, therefore the pilot should anticipate refinement when the HMCS is used to place the TD box. The FCR keeps accurate ranging to the TD box placement if the Target is kept within the +/- 60° azimuth/elevation limit of the FCR and in less than 45° bank angle.

2.5.6.3.2 DTOS POST DESIGNATE WITH THE HMCS



DTOS

DTOS Post designate mode is entered with a second TMS UP. A post designate slew via the cursor enable switch is necessary to obtain the most accurate FCR ranging. This is since the AGR is updated and used by the MMC only when the TD box is slewed via the cursor enable switch.

2.5.6.3.3 OPERATING PROCEDURE FOR HMCS DTOS

SUBMODE SELECTION:

A-G display - Selected.

DTOS submode - Selected.

STORES RELEASE (SLEW METHOD):

MASTER ARM switch - MASTER ARM or SIMULATE.

(Optional) LASER ARM switch - LASER ARM.

TMS - Forward (> 0.5 sec).

Move TD box over target via pilot head action.

TMS - Forward (to designate target position and refine via cursors).

(Optional) Laser ranging employed by depressing trigger to first detent.

Follow HUD steering indications.

Depress WPN REL button and hold.

STORES RELEASE (PICKLE AND PULL METHOD):

MASTER ARM switch - MASTER ARM or SIMULATE.

(Optional) LASER ARM switch - LASER ARM.

TMS - Forward (> 0.5 sec).

Move TD box over target via pilot head action.

(Optional) Laser ranging employed by depressing trigger to first detent.

Follow HUD steering indications.

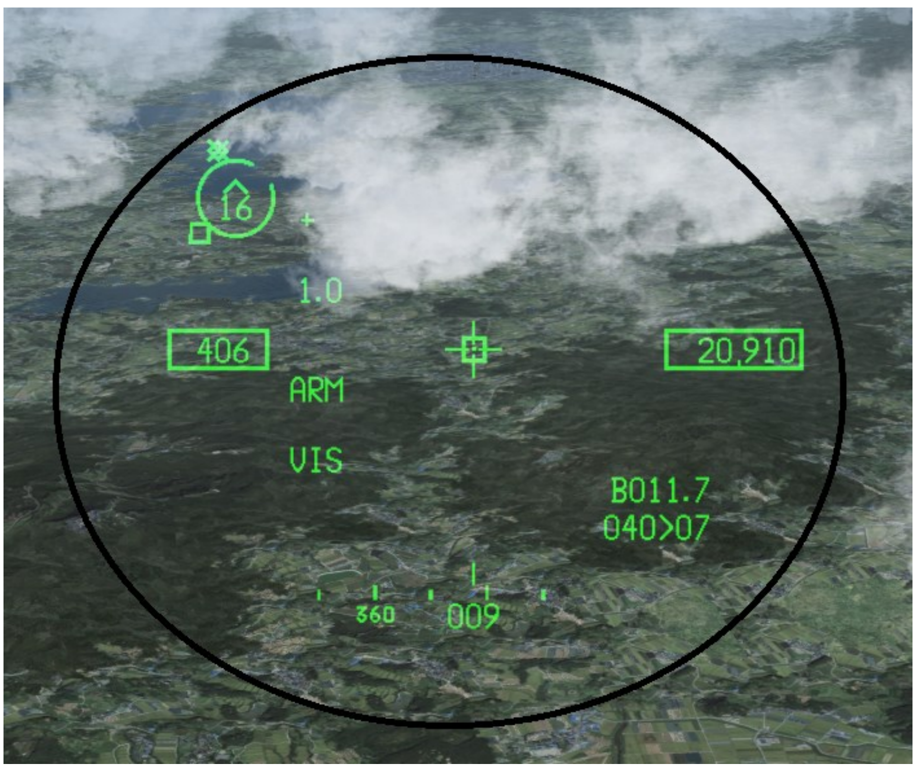
Depress WPN REL button and hold.

To complete the DTOS maneuver, point the nose of the aircraft at the ground stabilized TD BOX and place the FPM on the azimuth steering line and fly until the release solution.

2.5.6.4 HMCS EO-VIS

The HMCS EO-VIS mode allows the pilot to visually acquire a target and fire an AGM-65 in the VIS submode.

When entering the VIS submode for the AGM-65, the Maverick line of sight can be slewed to the HMCS gun cross by selecting TMS up for more than 0.5 seconds.

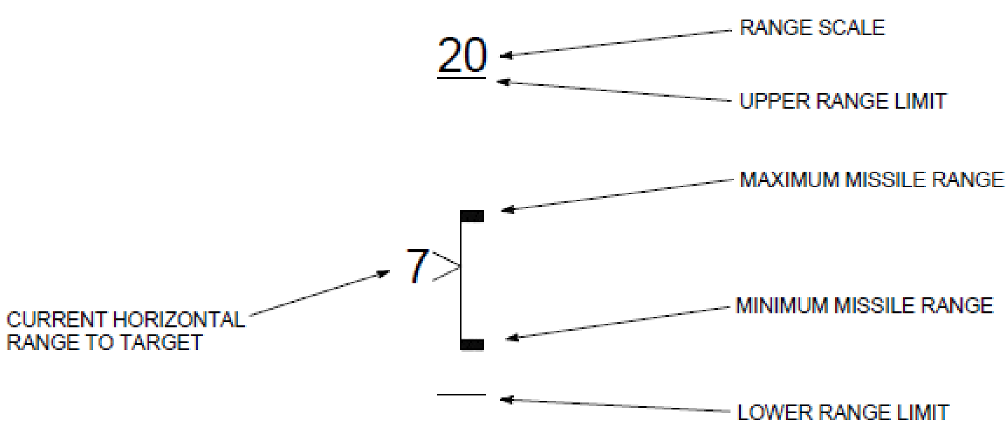


HMCS Mav

Once the the pilot has found a suitable target, the pilot actions TMS-UP one more time in order to get launch parameters displayed on the HMCS.

HMCS Mav Selected

On the HMCS, the AGM-65 MLE is displayed.



2.5.6.5 OPERATING PROCEDURES FOR THE EO VIS SUBMODE USING HMCS

Slaved AGM-65 Launch:

1. A-G mode - selected
2. AGM-65 - Selected.
3. Verify the following configuration:
    a. Either MFD: SMS format and VIS delivery submode.
    b. HUD - VIS symbology and SOI symbol.
4. MASTER ARM switch - MASTER ARM or SIMULATE

Select WPN format:

1. POWER - ON
2. AGM-65 - UNCAGE to blow dome cover and obtain video.

Establish acquisition line-of-sight:

1. Verify that HUD is SOI.
2. TMS - Forward (^{3}0.5 sec).
    a. TD box caged to HMCS aiming cross.
3. Maneuver aircraft or move TD box over target via pilot head action.

NOTE: Actual HMCS symbol slew direction with the HMCS LOS away from the HUD might be counterintuitive.

4. TMS - Forward.
    a. To designate and ground-stabilize TD box.
5. AGM-65 MLE - Displayed.
6. TD box - Refine.
7. TMS forward or DMS aft to move SOI to MFDS WPN page. Verify SOI moves to MFDS WPN page.

Refine targeting as follows:

1. AGM-65 video over target on WPN format - Verified.
    a. If the video is over target, TMS forward and release to command the AGM-65 to track, then go to Weapon Release.
    b. If the video is not over target, go to step 2 (AGM-65 cursor - Slew).
2. AGM-65 cursor - Slew.
    a. Slew cursor over the target by moving the CURSOR/ENABLE control switch to align the video with the target, then TMS forward and release to command the AGM-65 to track.

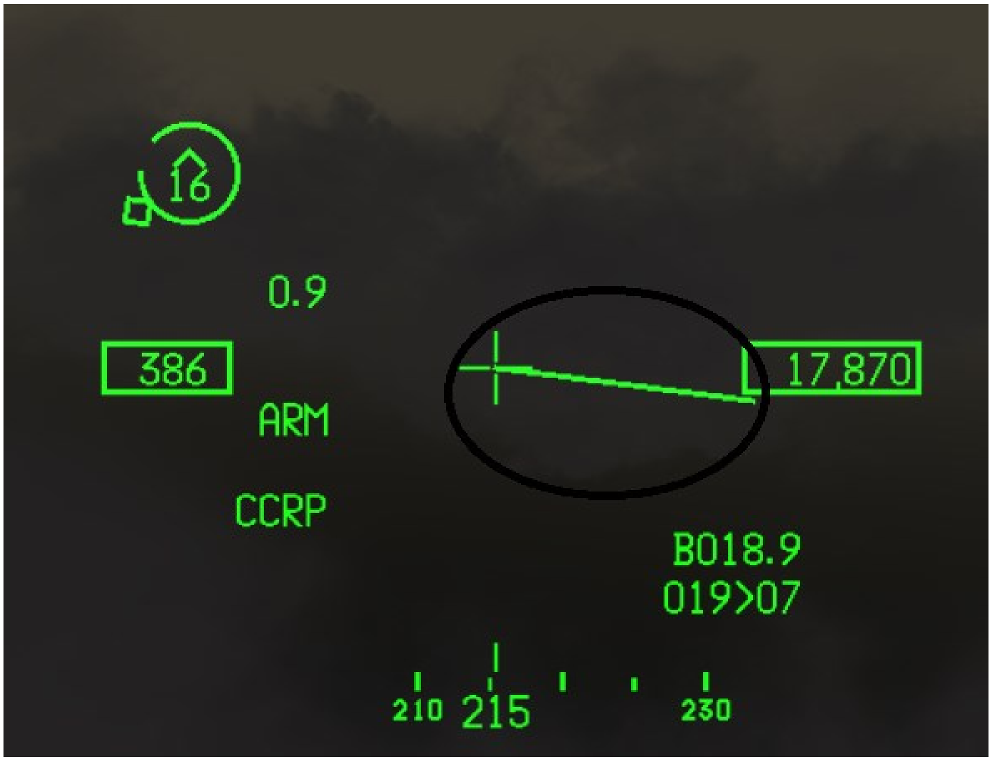
Weapon Release:

1. Weapon and target track on WPN format - Verified.
    a. Pointing cross not flashing.
2. Target is in range via the AGM-65 MLE - Verified.
3. WPN REL button - Depress.

2.5.6.6 HMCS A-G TARGET LOCATOR LINE (AGTLL)

The A-G target is indicated on the HMCS using a A-G TD box.

When the A-G target is not within the HMCS FOV, the HMCS displays a TLL pointing to the target location. The TLL extends from the HMCS aiming cross in azimuth/elevation out toward the target. The A-G TLL takes the form of a variable length line originating from the CTFOV of the HMCS.

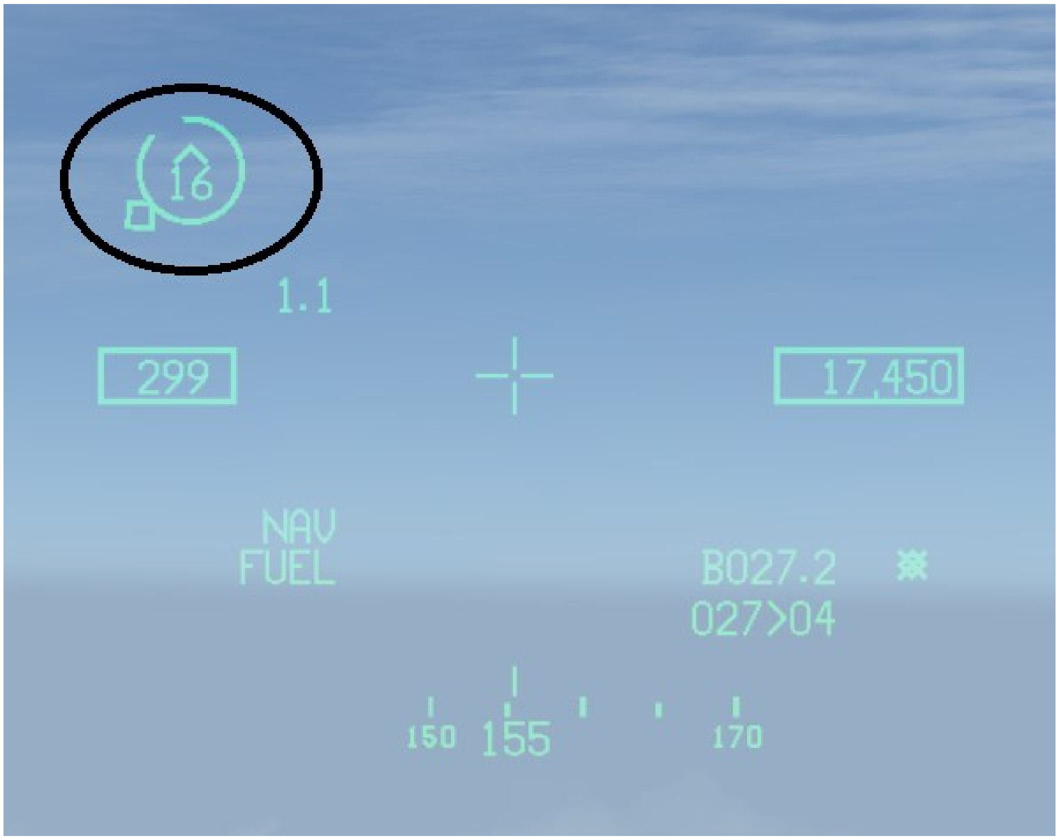


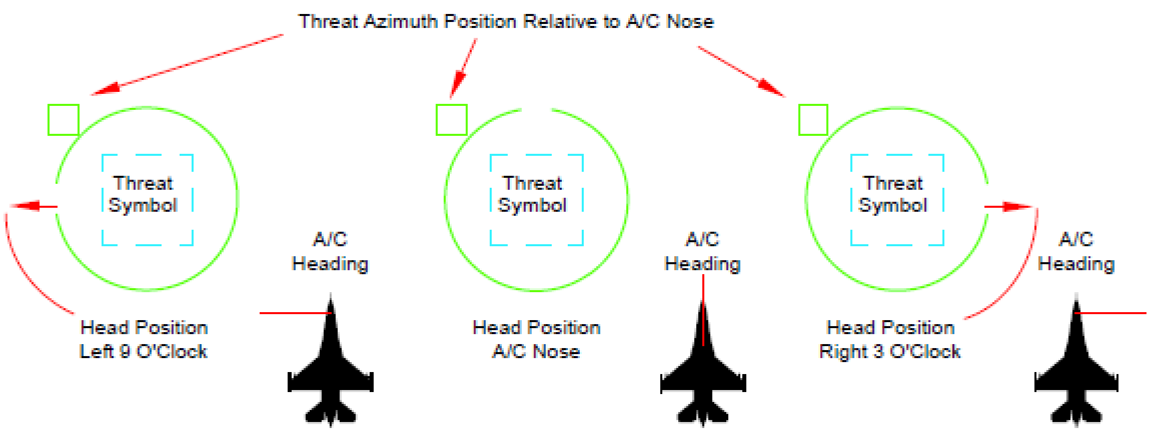
RWR Threats On HMCS

The pilot has the capability to display RWR threats on the HMCS. When selected, the pilot receives an indication in azimuth of the highest priority threat currently being received by the RWR. Threat elevation depictions cannot be provided due to the inherent elevation inaccuracies of current RWR systems.

The HMCS displays a circle (with a gap) that rotates around the circle symbol. The rotating circle gap shows the pilot's head position relative to the nose of the aircraft. The azimuth to the RWR priority threat is represented by a diamond, which is placed with one-point tangent to the circle at the RWR priority threat azimuth relative to the nose of the aircraft. An attached field, which represents RWR threat ID symbology is placed in the center of the circle symbol. The pilot can attempt to acquire the RWR threat visually by moving his head to center the circle gap at the threat diamond.

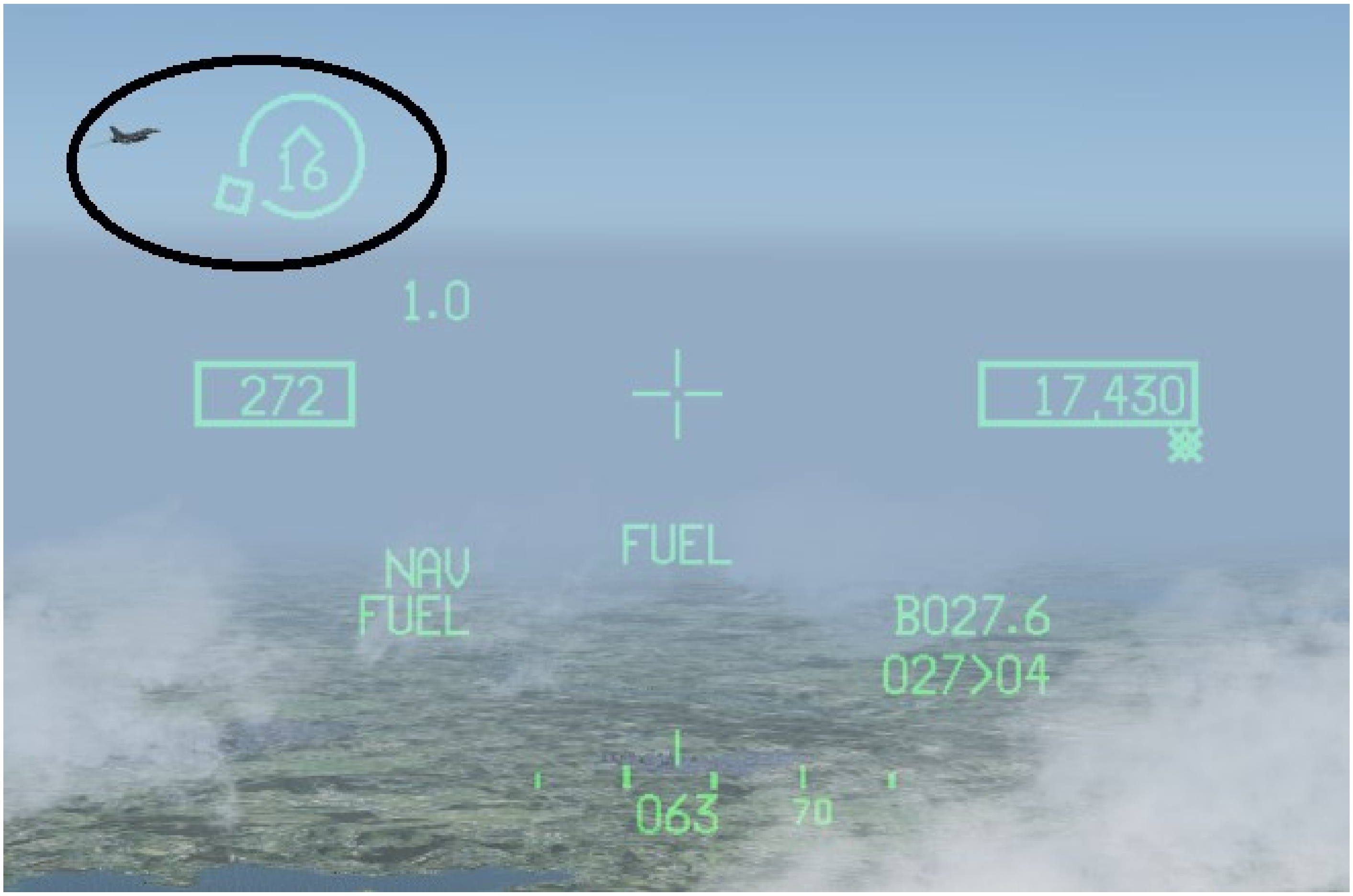
The RWR priority threat symbol (diamond) is always placed at the line of bearing relative to the nose of the aircraft, and the circle with the gap symbol rotates such that the line drawn through the center of the circle and through the center of the gap represents the pilot's head position relative to the nose of the airplane.


1.1
299
17,450
NAV
FUEL
B027.2
027>04
150
155
170

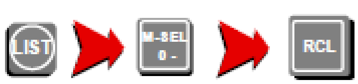

Threat Azimuth Position Relative to A/C Nose
Threat Symbol
Threat Symbol
Threat Symbol
A/C Heading
A/C Heading
A/C Heading
Head Position Left 9 O'Clock
Head Position A/C Nose
Head Position Right 3 O'Clock

Looking directly at the threat:

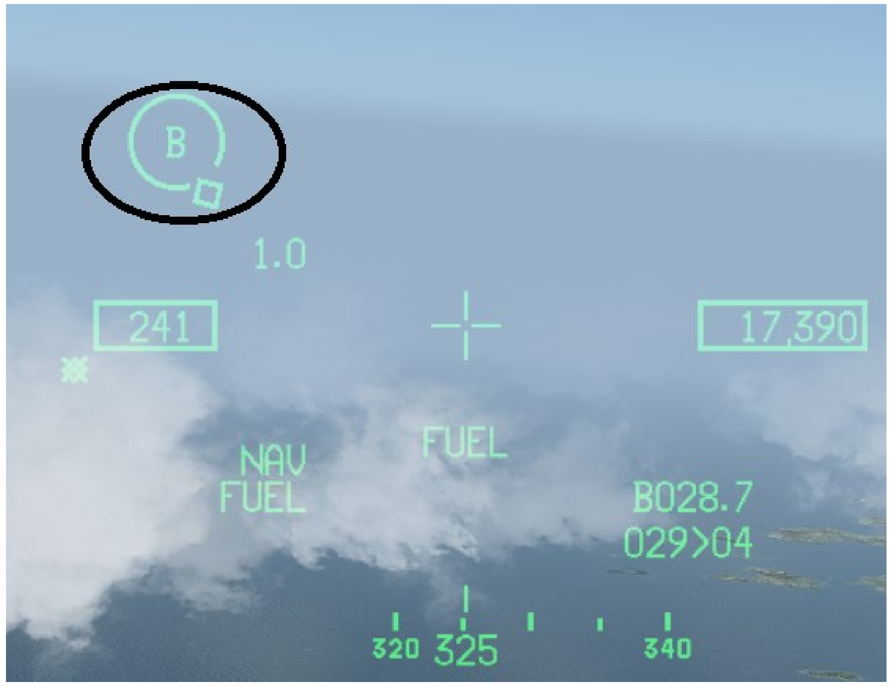
In this case an F-16



RWR symbology is only displayed when a RWR priority threat exists and the RWR display is selected ON via the RWR DSPLY field on the HMCS DISPLAY DED page.



In this case a Barlock radar:



Conditions for the RWR threat to be displayed on the HMCS:

An RWR Priority Threat exists.

RWR is in floating mode, latched or transient mode.

By default, at Power Up the RWR is in floating mode. Pushing and holding the Handoff switch transitions the diamond to the lower priority threats (transient mode) and when the Handoff switch is released, the diamond latches onto the last symbol surrounded by the diamond (latched mode).

Short pushes (less than one second) will toggle the RWR system between floating mode and hand-off "OFF" mode. In the hand-off "OFF" mode, there is no diamond over the threat on the RWR azimuth indicator and there will not be a threat displayed on the HMCS.

The HMCS displays only the threat with the diamond around it. If the RWR is commanded to latch to the priority threat, then floating the priority threat by the RWR is prohibited. This could cause the situation where a higher priority threat, such as a SAM site or higher priority air interceptor, launches a missile, and the RWR will not automatically step to this threat because the current priority threat is "latched." In this case, the pilot would be directing his attention to a lower priority threat which is being displayed on the HMCS.

The following cues can alert the pilot that the RWR has detected another higher priority threat in the case of a missile launch:

The pilot will get the missile launch tone in the headset.

The RWR will flash a circle about the threat on its scope.

If the signal emitting from the threat is correlated with a target tracking radar, a box will be drawn around the symbol.

The LAUNCH button on the threat warning prime control panel will flash red.

It is advised that pilots should not exclusively rely on the HMCS priority threat especially if the threat has been latched.

2.5.7 HMCS LINK 16 SYMBOLOGY | TOI | PDLT

Please refer to the Link 16 Flight Member Symbology chapter in this document.

2.6 PODS

2.6.1 SNIPER ADVANCED TARGETING POD (ATP)

2.6.1.1 BACKGROUND

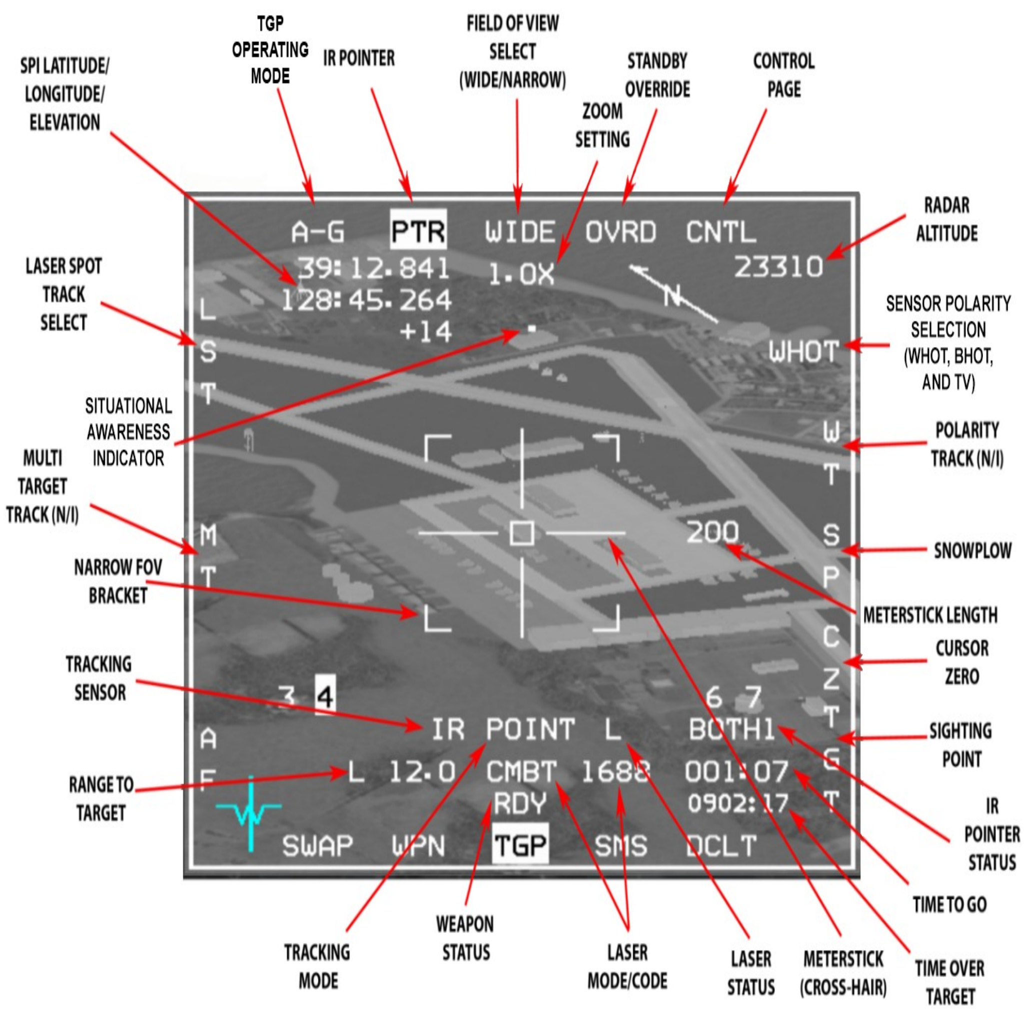
The AN/AAQ-33 Sniper Extended Range (XR) ATP is an electro-optical targeting system in a single, lightweight pod that is compatible with the latest precision-guided weapons for detecting, identifying and engaging multiple moving and fixed targets in air-to-air and air-to-ground engagements.

With capabilities including long-range target detection and identification and continuous stabilized surveillance, Sniper enables aircrews to find and destroy targets outside of jet noise ranges.

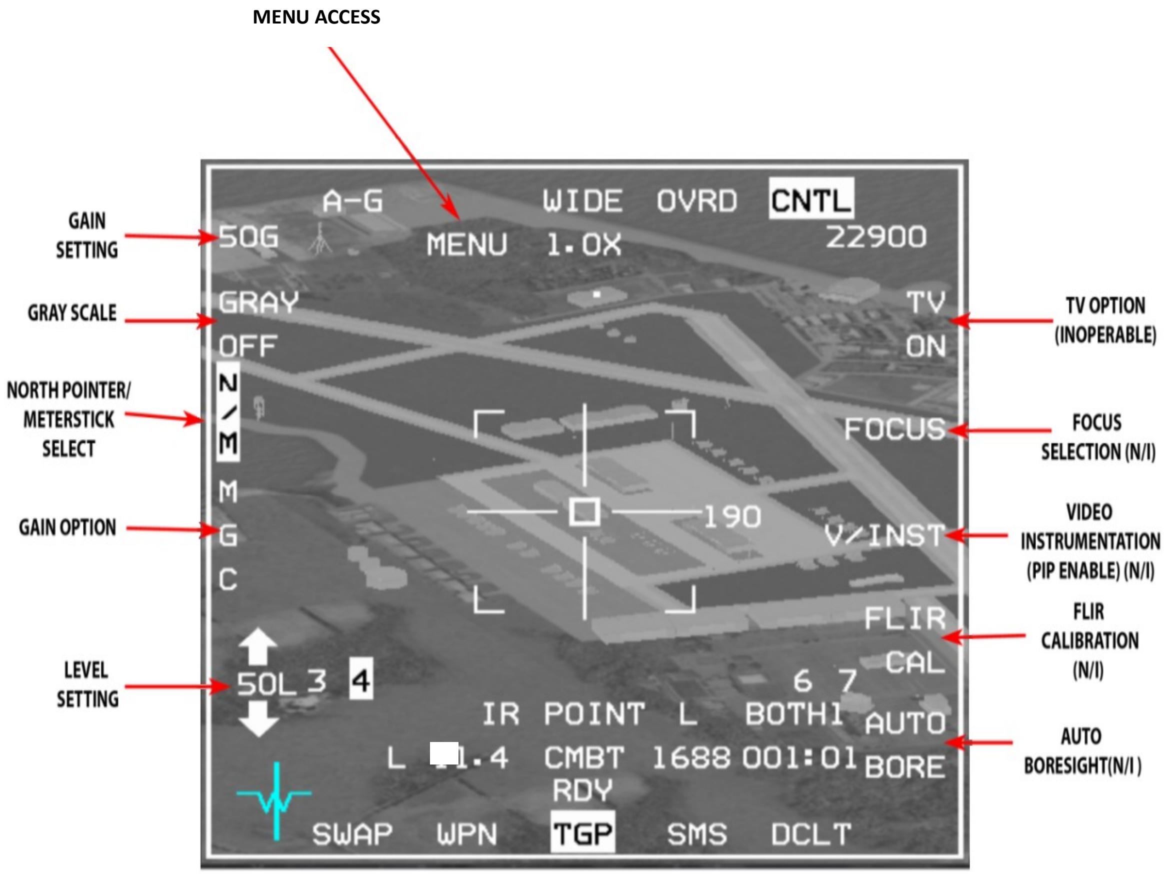
Sniper contains a diode-pumped laser with cockpit selectable tactical and eye-safe wavelengths, a laser spot tracker for acquiring laser designations from other aircraft and laser marker (IR pointer) illumination for night vision goggles and target coordination.

The Sniper XR ATP installs under the engine inlet on the right side of the aircraft as with previous targeting pods, yet is considerably narrower in diameter and lighter in weight, offering corresponding drag benefits.

2.6.1.2 TGP BASE AND CONTROL PAGES FOR SNIPER XR ATP



Sniper XR Base Page



Sniper XR Control Page

"NOTE: AN/AAQ-14 LANTIRN and AN/AAQ-33 Sniper Targeting Pods are functionally identical. Refer to the AN/AAQ-33 SNIPER XR ADVANCED TARGETING POD chapter for information on the AN/AAQ-33 Targeting Pod."

2.6.1.2.1 OPERATING MODE

OSB 1 displays the current operating mode and accesses the Mode Menu page. The TGP Mode Menu page provides switching between TGP modes and displays only those modes available. Operating mode selection is Master mode dependent; for the A-A Master mode, the TGP may be in A-A or STBY; for the A-G Master mode, the TGP maybe in A-G or STBY; and for the NAV Master mode, the TGP may be in A-A, A-G, or STBY.

2.6.1.2.2 MENU ACCESS

Pressing OSB 2 in the Sniper Control page will bring up the Menu. Currently the Menu supports 2 functions: Frag circle and IR pointer pattern selection.

- Frag circle – This is a circle displayed in a selected radius around the TGP position. The radius of the circle and the option to display the circle are defined inside the menu.
- IR Pointer pattern ID – IDs 1-4 are available for the IR pointer pattern. Selection of an option will command the IR pointer to fire the IR beam in a different pattern.

Navigating in the menu is performed as follows:

- TMS-Up – Select/change the option that is currently pointed by the menu selection arrow.
- TMS-Right – Move the menu selection arrow 1 step down.
- TMS-Left – Move the menu selection arrow 1 step up.

2.6.1.3 FLIR SENSOR

The FLIR sensor detects relative temperature differences between an object and its surroundings and displays them, roll-stabilized, as different shades of grey on the MFD TGP page.

The FLIR video can show white objects as hot (WHOT) or black objects as hot (BHOT). Polarity can be changed by pressing OSB 6 hands off or by TMS-left on the HOTAS (with TGP as SOI).

2.6.1.3.1 GAIN AND LEVEL CONTROL

Gain and level control allows you to adjust the gain and level of the picture. For now real gain and level values have no effect on the picture. Level values may change by using OSBs 16 and 17 when in MGC (Manual Gain Control) mode, but will have no effect on the video image. Gain control may be switched between MGC and AGC via OSB 18.

2.6.1.3.2 FIELD OF VIEW (FOV)

The Sniper has 2 FOVs for the FLIR sensor: Wide and Narrow. The FOV can be switched between WIDE and NARO via OSB 3 or with the Expand/FOV switch (Pinky) on the HOTAS. WIDE or NARO will display above OSB 3 accordingly. The wide FOV is 3.6° x 3.6° degrees, while the narrow FOV is 1.0° x 1.0°.

NOTE: Although *Sniper XR is simulated, for now actual XR capability is not implemented.*

2.6.1.3.3 VARIABLE ZOOM

The Sniper provides electronic zoom control that can be changed from 1x to 4x using the MAN RANGE/UNCAGE knob on the HOTAS. The variable zoom stays the same between sensor changes and the variable zoom setting label appears below the FOV label under OSB 3.

2.6.1.3.4 TV SENSOR

The TV sensor can be selected by pressing OSB 6 or by clicking TMS Left twice in less than 0.5 seconds. The TV has only 1 FOV 0.5° x 0.5° and one polarity, so TMS-Left will not change anything in this mode. Variable zoom can expand the picture from 1x to 4x. When switching to TV, IR FOV and polarity are saved and will be restored when switching back to the IR sensor.

2.6.1.3.5 NORTH POINTER / METERSTICK

By selecting N/M via OSB 19 in the Control page the longitude, latitude and elevation of the current System Point Of Interest (SPI) position will be displayed in the upper left corner of the MFD display along with an arrow pointing north in the upper right corner and a number to the right of the meter stick (cross-hair) which is the length in meters of each line of the cross-hair.

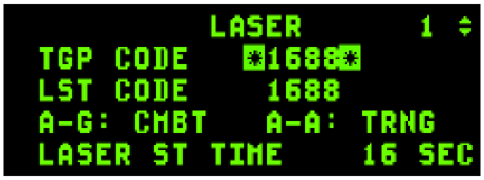
2.6.1.4 LASER DESIGNATOR/RANGER

The Sniper XR ATP integrates a laser designator suitable for ranging and target designation of either own or a wingman's laser guided munitions.

2.6.1.4.1 LASER CHARACTERISTICS

The Sniper XR ATP provides a laser transmitter and receiver operating at both combat and eye-safe wavelengths. The laser may be used for ranging to update the navigation system, mark points or designating for laser guided munitions delivery.

The laser and LST codes and modes may be set in the DED laser page (ICP LIST 0 > 5). The laser may be set to any allowed code from 1511-1788 in either training (TRNG) or combat (CMBT).

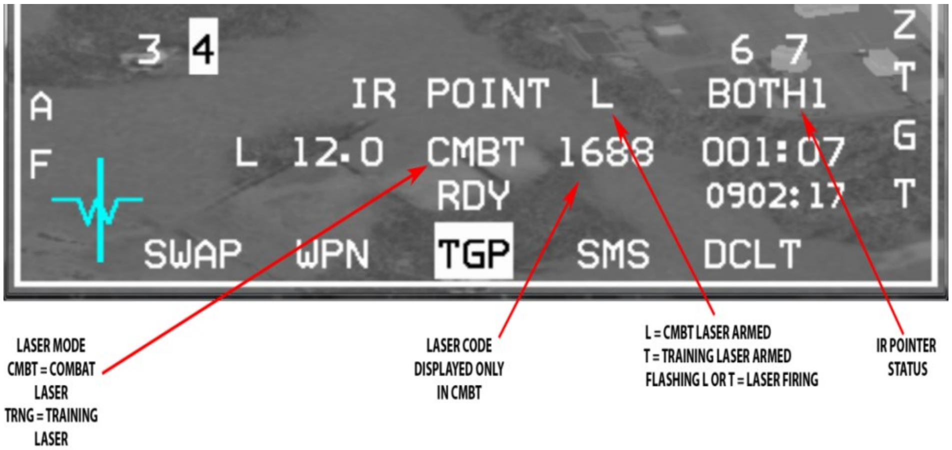


Laser DED page

2.6.1.4.2 COMBAT/TRAINING LASER MODE SELECTION AND STATUS INDICATION

The laser mode is set to Training by default for both AA and AG modes. The pilot can change the laser code to Combat for AG submode by placing the asterisks on the laser mode label and pressing any numeric key (1-9) on the ICP.

When the laser is armed additional information is included on the lower part of the pod display, below the track status field. The laser mode (CMBT or TRNG) is displayed along with the selected laser code (combat laser only).



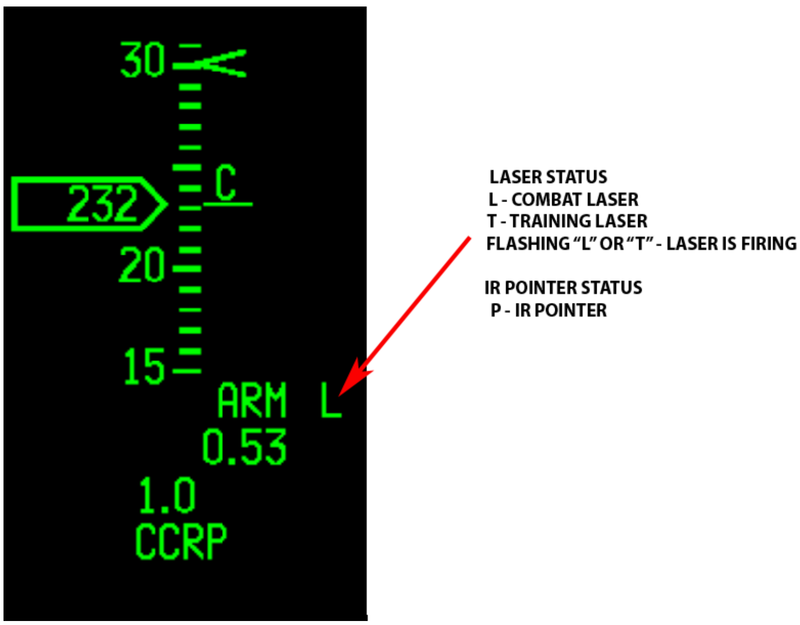
Laser Mode & Code and Laser/IR Pointer Status Indications

Since the combat mode laser is not eye-safe (in the real world), even for scattered/reflected energy, it is imperative that the laser beam does not hit the aircraft. To accomplish this safety consideration, the TGP determines if it is looking at the aircraft structure or stores. When the TGP LOS is pointed at the aircraft, laser fire is inhibited. The mask zone blocks off the area surrounding the wing tanks on stations 4 and 6 and a LANTIRN navigation pod on station 5L. All other stores are blocked by the wing tanks. Indications of a masked condition includes an M on the TGP page to the right of the L or T in the bottom right portion of the MFD and MASK adjacent to the flight path marker on the HUD. There is a warning zone outside of the actual mask zone which alerts the pilot that a mask condition is approaching. When in the warning zone the TGP crosshairs flash and MASK flashes on the HUD. When conditions warrant for a MASK condition, MASK is displayed steadily on the above mentioned displays.

When the laser is armed a laser status indication (L for combat or T for training) will appear to the right of the track status label. The L or T will flash whenever the laser is firing (manual or automatic mode). If the IR Pointer is enabled a PTR label will be displayed under the station numbers in the right bottom corner of the display; when the IR pointer is fired, then the PTR label will flash.

When changing laser status, the CMBT or TRNG labels will flash for a couple of seconds on the MFD and on the DED. While the status is changing the laser is unavailable to fire and the laser status L T label will blank from the display.

L or T will also appear in the lower right corner of the HUD and will also flash when the laser is firing. When the IR Pointer is selected a P will appear next to the L or T and the P label will similarly flash when the IR Pointer is fired.



Laser/IR Pointer Status On HUD

2.6.1.4.3 LASER OPERATION

The following conditions must be met in order to fire the laser:

- LASER ARM switch in the LASER ARM position.
- A-G – MASTER ARM switch in the ARM or SIMULATE position.
- A-A – MASTER ARM switch in the ARM position, pod is tracking.
- Weight off wheels.
- Pod LOS not masked.
- Altitude at 50,000 feet or below.
- Pod not in LST mode.

The laser and IR Pointer are fired by pressing the first trigger detent. The laser will also fire momentarily when holding the pickle until bombs are released.

2.6.1.4.4 LASER RANGING

When the laser is firing and the laser beam can reach the SPI position (laser is valid) an L will replace the T on the TGP MFD page next to the range in the lower left corner. This indicates that the aircraft is measuring range to the SPI position using the laser beam, which is the most accurate ranging sensor and takes precedence over other sensors. When laser ranging happens then the range to SPI (slant range) information in the lower right of the HUD will be preceded by an L as well.

NOTE: In order for the laser to be valid, the range to the lased spot must be sufficient and the laser beam must have a clear path. Cloud cover or even single clouds which are in the way of the beam may interrupt and prevent the laser being valid. If the laser is not valid, an “L” will not precede the slant range value.

2.6.1.4.5 LASER GUIDED BOMBS OPERATION

To guide LGB’s the A-G laser must be set to CMBT and the laser code must match the laser code that was set for the bombs (using the SET CODE button on the LOADOUT screen) or the bomb(s) will not guide on the laser spot.

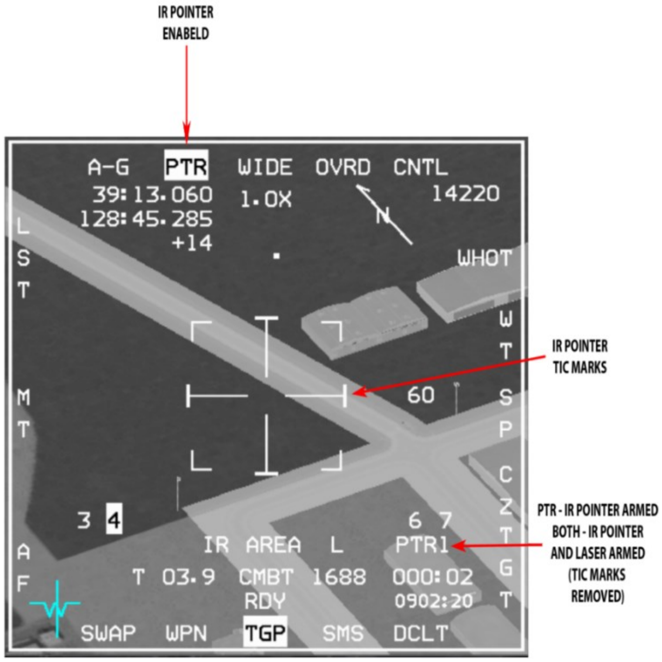
During LGB delivery the laser is designed to fire automatically for terminal guidance at the pre-defined time from bomb impact that is set on the laser DED page; the laser will keep firing until 2 seconds after the expected impact time. The pilot can choose to fire the laser manually by using the first trigger detent after bomb release. Pressing the pickle will also cause the laser to fire, but only until the bombs release, then the laser will stop firing even if the pickle is kept depressed. The laser will fire only if all conditions to fire the laser are met.

NOTE: A flashing L does not always indicate that the laser spot is valid for LGB guidance; it only indicates that the laser is firing. In order to make sure the laser is valid, the pilot should verify that the laser is ranging (E.G. Direct line-of-sight is maintain during the entire flight of the munition).

2.6.1.5 IR POINTER

2.6.1.5.1 IR POINTER CHARACTERISTICS

The Sniper can fire an IR Pointer beam that can be detected by NVGs. IR pointer status can be selected by pressing OSB 2 on the MFD or by 2x TMS-Right < 0.5 seconds. The IR pointer is disabled in CCIP and CCIP-rockets mode and also if the laser is fired for self-designated LGB delivery in auto-lasing mode, unless the BOTH option is selected.



IR Pointer Indications

2.6.1.5.2 USE OF IR POINTER WITH LASER DESIGNATOR/RANGER

When the IR pointer is selected, the PTR label under OSB 2 will be highlighted and a number 1-4 will show up in the lower right corner next to PTR. The number 1-4 indicates the flash pattern that the PTR is using; this way it's possible to distinguish between 4 different IR pointers being fired at the same time. A P label is displayed in the bottom left corner of the HUD when the IR Pointer is enabled and the P will flash when the IR Pointer is being fired.

2.6.1.5.3 SWITCHING BETWEEN IR POINTER AND THE DESIGNATING LASER

The IR Pointer status can be selected hands-off with OSB 2 and on the HOTAS via 2xTMS-Right < 0.5 seconds. The options for IR Pointer are:

- Disabled – PTR label not highlighted under OSB 2.
- Enabled – PTR label highlighted under OSB 2.
- BOTH – BOTH label under OSB 2.

The IR Pointer is fired by pressing the trigger detent to either position. When the IR Pointer is fired, the PTR or BOTH labels under OSB 2 and in the lower right corner of the MFD will flash. If BOTH mode is selected the IR Pointer and laser can be fired simultaneously. IR Pointer firing is independent of the LASER ARM switch position. IR Pointer will be inhibited during auto-lasing while the Sniper is self-designating for an LGB attack.

2.6.1.5.4 IR POINTER OPERATION

The following conditions must be met in order to fire the IR Pointer:

- Pod not in LST mode.
- IR Pointer enabled (Tick marks at the end of the cross-hairs or BOTH mode).
- Weight off wheels.
- Pod LOS not masked.

NOTE: The IR Pointer arms and fires regardless of the Laser Arm switch position.

2.6.1.6 SNIPER XR ATP CONTROLS AND DISPLAYS

Control	Functionality	Condition
TMS-Up & hold	Commands AREA track mode	A-G mode only
TMS-Up & release	Commands POINT track on center of FOV	
TMS-Right	Commands AREA track mode	A-G mode only
2x TMS-Right < 0.5 seconds	Toggle IR Pointer mode: PTR unlit → PTR highlighted → BOTH → PTR unlit	
TMS-Left	Toggle Polarity	IR Sensor only
2x TMS-Left < 0.5 seconds	Change sensor: IR → TV → IR	
TMS-Aft	Break track and return to slave mode	
Trigger first detent	Fire Laser or IR pointer or both	
Trigger second detent	Fire Laser or IR pointer or both If depressed in CCIP mode the laser fire is latched for 30 seconds	
Expand/FOV	Toggle FOV Wide → Narrow → Wide	IR Sensor only
WPN REL	Fire laser	CCRP or DTOS modes only until bombs are released
CURSOR/ENABLE	Slew SPI if in Slave mode Slew pod tracker if in track mode	
MAN RNG/UNCAGE Rotate	Change variable zoom	
MAN RNG/UNCAGE Press	Toggle LST mode	

Sniper XR ATP Controls

2.6.1.7 POD MODES

2.6.1.7.1 MODES

Standby (STBY): Standby mode is the default mode when the pod is powered up.

Air to Ground (A-G): Pilot selected. The pod is configured for A-G operations while in this mode. The pod is capable of entering all submodes and functions.

Air to Air (A-A): Pilot selected. The pod is configured for A-A operations while in this mode. In this mode the pod cannot fire the laser in CMBT mode, fire the IR Pointer, or enter AREA or LST modes. The TGP is slaved to the FCR when in A-A mode. When a target is bugged the TGP will display the target. Otherwise the LOS will be positioned 3 degrees below the aircraft boresight (gun cross).

2.6.1.7.2 SUBMODES

The TGP incorporates 6 submodes. The specific submodes are closely tied to how the pod LOS is controlled. The following submodes are available with the Sniper XR ATP:

- Slave (A-A and A-G modes)
- LST (A-G mode)
  - LST Search (LSRCH)
  - LST Track (LTRACK)
- Point Track (A-A and A-G modes)
- Area Track (A-G mode)
- Inertial Rates (A-A and A-G modes)
- Menu Selection

2.6.1.7.3 SLAVE SUBMODE

In Slave submode the Sniper follows the System Point Of Interest (SPI) position. In A-G mode the SPI position is determined by the current sensor that controls the SPI. In A-A mode the Sniper is slaved to a bugged target or will center just below the aircraft's boresight.

NOTE: In slave submode the pods tracker does not actually work and the pod attempts to maintain its position without it. This creates undesirable wobble movements when the aircraft accelerates in any direction (when the control surfaces are moving via input commands, either from pilot input or from other aircraft systems). The wobble should stop when acceleration stops.

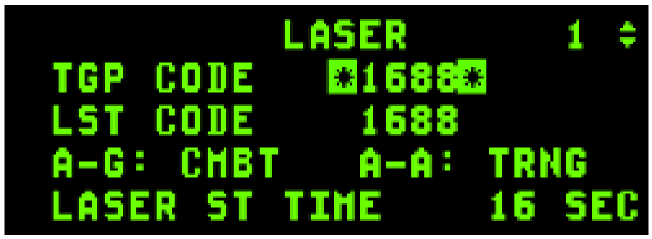
NOTE: When the pod is slewed in A-G mode and slave submode, the pod LOS will not move directly as it does in tracking modes. The aircraft SPI is slewed indirectly and the pod tries to maintain the LOS to that point. Because of this indirect slewing of the SPI, the slewing is more similar to the way the A-G radar is slewed rather than normal pod slewing. For example, if the SPI position is behind a mountain which denies direct LOS, slewing the pod in slave submode will keep moving the SPI although the pod itself can't really follow the point. If you then enter a tracking submode, the pod's LOS will align its position (and the SPI position) on the mountain that covered the initial point. The pod's geographical coordinates will reflect this difference in the position that the pod is following.

2.6.1.7.4 LASER SPOT TRACKER (LST) SUBMODES

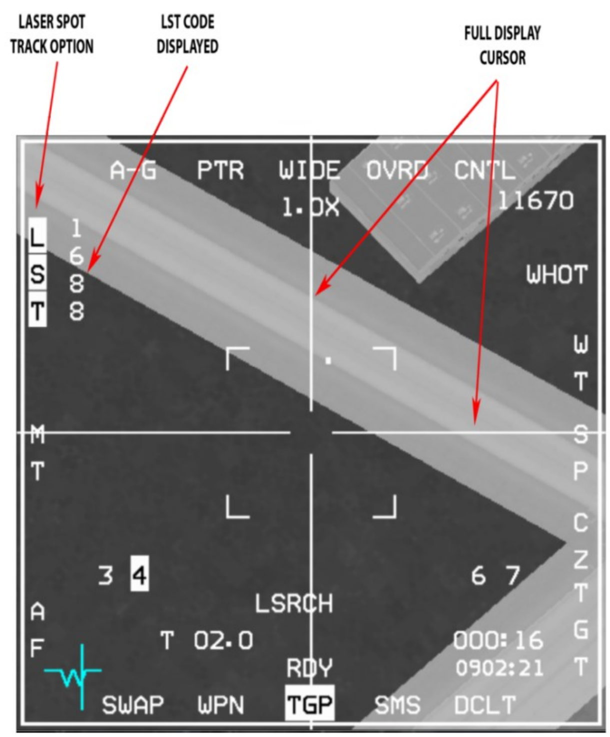
The Sniper XR provides LST capability. The LST can detect and track laser spots being designated by other aircraft in BMS. The LST detection FOV is 3°. The code of the fired laser must match the LST code that is set on the DED Laser page. The LST code range is 1111-1788.

When using the LST the laser and IR pointer cannot fire.

LST mode is only available when the pod is in A-G mode, the pilot can select LST mode hands-off via OSB 20 or hands-on by pressing the MAN RNG/UNCAGE knob.



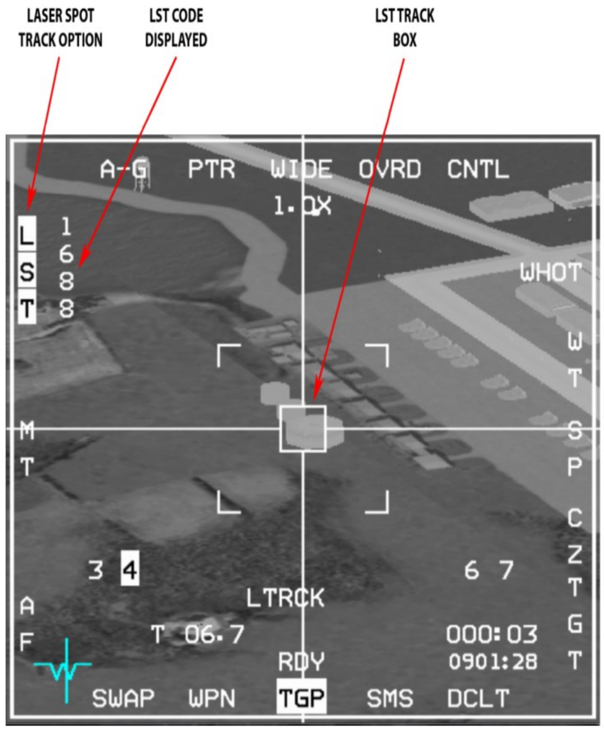
Laser Codes on the DED Page



Laser Spot Track Selection

When in LST mode its code is displayed vertically adjacent to the LST label adjacent to OSB 20 on the TGP base page. The LST label highlights when LST mode is on and the crosshairs are extended to the edges of the MFD.

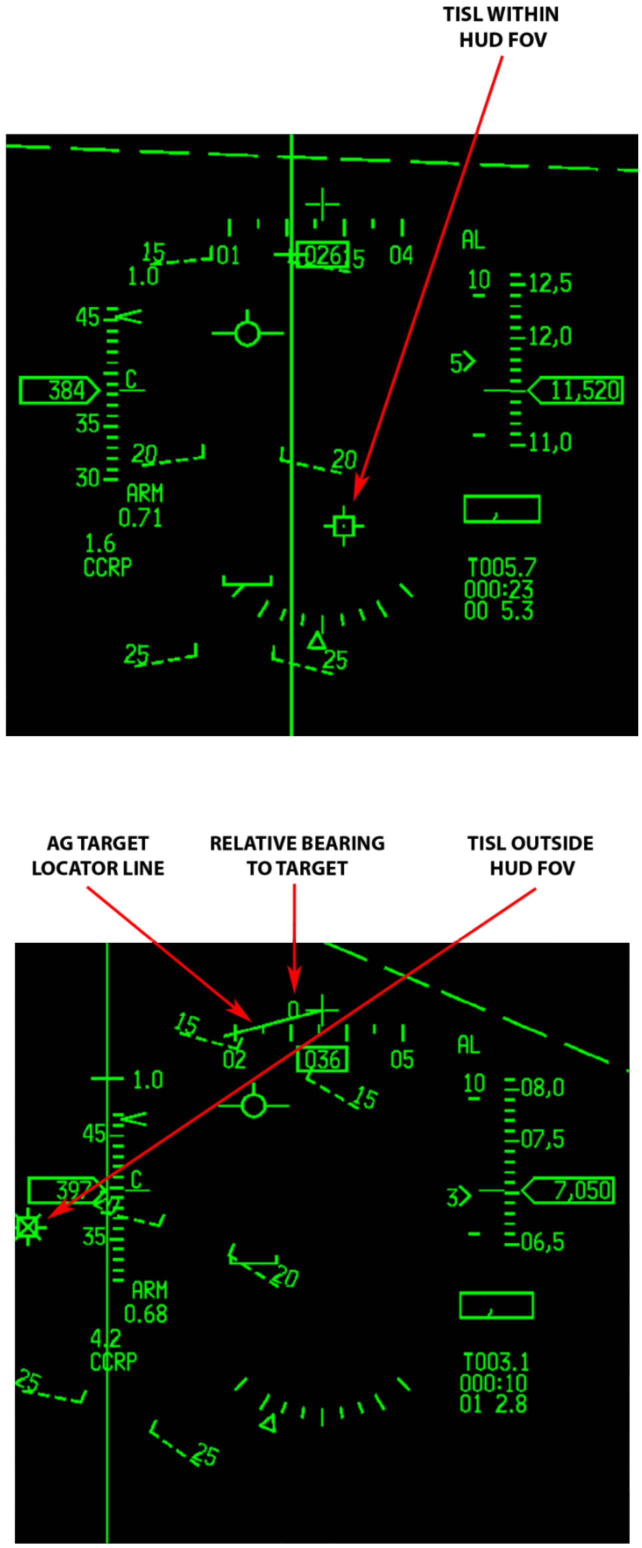
When the LST function is started, the pod starts a search for a laser illuminated spot inside a 3° FOV around the SPI position. When a laser spot with laser code that matches the LST laser code is detected the Sniper tracks the spot and a small tracking box is displayed at the crosshairs. LST mode is exited when the pilot commands AREA or POINT track, enters slave mode with TMS-Aft, or by pressing the MAN RNG/UNCAGE knob or OSB 20. Three TGP messages are displayed at the lower center area of the display to provide the status of the Laser Search and Track. These include LSRCH for LST search, DETECT for LST detection of laser energy prior to full track and LTRACK for LST track.



Laser Track Display

NOTE: The SPI position and the LST tracked spot position may not coincide. FCC solution and HUD symbology reflects the SPI position and not the LST track spot position. The pilot should command AREA or POINT track before dropping ordnance on the SPI.

The HUD also provides LST symbology. If the LST laser spot is inside the HUD FOV, a target identification set, laser (TISL) symbol is displayed. If the target is outside the HUD FOV then the TISL will be displayed with an X mark on it and it will be located at the edge of the display in the direction of the tracked spot position. In addition, a TLL line is displayed from the bore cross in the direction of the target, and the angle to the target is indicated to the left of the bore cross.

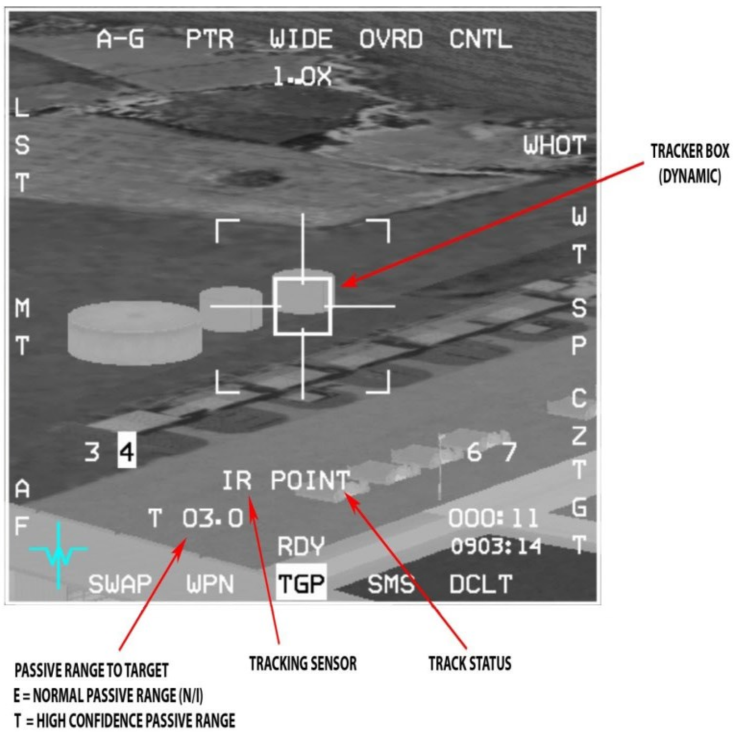


LST Indications in the HUD

2.6.1.7.5 POINT TRACK

POINT track mode will track single objects with well-defined edges, e.g. vehicles, some buildings. When POINT Track is established a box grows from the center of the crosshairs until the edges of the target are enclosed by it. The TGP tracker continuously updates the tracker box such that, when the aircraft is maneuvered, the tracker box changes to the new viewing aspect of the target. POINT is displayed below the crosshairs, indicating that track has been established. AREA track mode may be selected with TMS-up and hold when the TGP as SOI. Return to POINT Track mode by releasing TMS-up.

If the TGP cannot maintain POINT track because LOS to the target is blocked (pod masked or target hidden behind another object for example) then the pod will switch to INR or AREA track until the pilot commands POINT track again on the target. It will not return to POINT unless a new POINT Track command is initiated. If the pilot commands slewing when in POINT track then the pod will drop the track and will attempt to reacquire POINT track once the slewing stops.



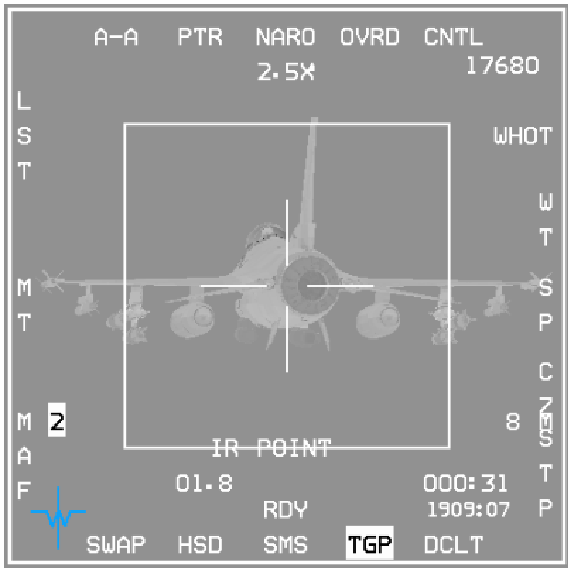
Point Track Display

TMS-aft commands the TGP to break track and return to the SLAVE mode and slaved back to the radar LOS. If the target cannot be POINT tracked because the target does not have sufficient edge detail, the TGP automatically defaults to AREA Track.

NOTE: *Laser or GPS guided munitions may be dropped on a target in either AREA or POINT track mode.*

2.6.1.7.5.1 A-A MODE

The TGP A-A mode provides visual target identification and tracking of A-A targets. In A-A the TGP is initially commanded to the FCR LOS if the FCR is tracking an A-A target. If the TGP is not the SOI and the FCR is not tracking a target, the TGP LOS is positioned to 0 degrees' azimuth and –3 degrees' elevation. The TGP can track and maintain an A-A target independent of the FCR LOS, resulting in two A-A target designator (TD) boxes or target locator lines (TLL's). Once the TGP has been commanded to track (TMS-up with TGP SOI), the TGP LOS and the FCR LOS are independent. The TGP LOS is shown as a dotted 50-mr A-A TD box in the HUD. If the TGP LOS is outside the HUD field-of-view, a dotted TLL and target angle are displayed. The FCR A-A TD box is a solid 50-mr box.



TGP in A-A Mode

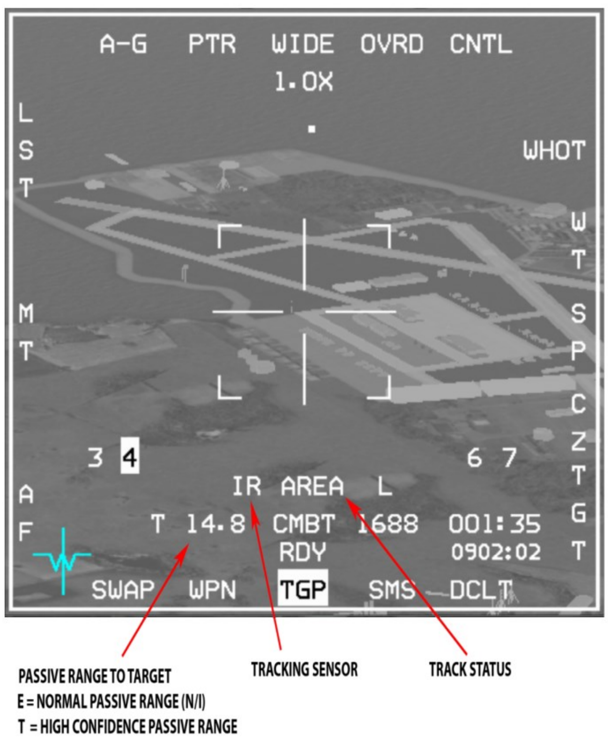
TGP TD Box in HUD – TGP in A-A Mode

2.6.1.7.6 AREA TRACK

AREA track can track areas which are not capable of being point tracked (POINT track fails to lock and track) or when POINT track is not desired (for example if targeting to place a bomb between two vehicles).

AREA track is generally commanded first with TMS-up & TGP in SOI, in order to help stabilize the TGP display before selecting a specific target with TMS-up again to be POINT tracked. AREA track may be also used for POINT trackable targets where AREA track provides higher precision for tracking a specific part of a large object, like a building. When the AREA tracker is controlling LOS, AREA is displayed centered below the crosshairs. AREA track is not available when the pod is in A-A mode.

When in POINT track mode, AREA track may be commanded by TMS-Right on the side stick controller when TGP is SOI, or TMS-Up and hold (release commands POINT track) when the pod is in A-G mode.



Area Track Display

2.6.1.7.7 INERTIAL RATES (INR)

The Sniper pod also has an Inertial Rates (INR) track mode. INR track is entered automatically when the pod cannot track the scene with POINT or AREA tracking modes. This occurs mostly when the aircraft structure or stores mask the target. When in INR track the POD LOS will usually drift slowly away from the target and the TGP will usually need to be manually slew back to the target and reacquire a POINT or AREA track when you exit the masked situation.

2.6.1.8 AGM-65 HAND OFF

One beneficial ability the TGP has is slaving its LOS to that of the AGM-65 D/G Maverick. This is accomplished through the avionics system routing the Maverick's video to the TGP. The TGP's missile boresight correlator then compares the Maverick's video to the TGP video and aligns the Maverick to the same target, commanding the missile to track. This benefits the pilot by seeing greater distances since the TGP can zoom farther than the Maverick's lens.

During a hand-off the message HANDOFF IN PROGRESS STATION X (where X is the appropriate missile station) is displayed on the weapon (WPN) page. Hand-off status is displayed above the station number on the TGP page. Further discussion on this topic may be found in section 4.3.8.

The following summarizes status indications:

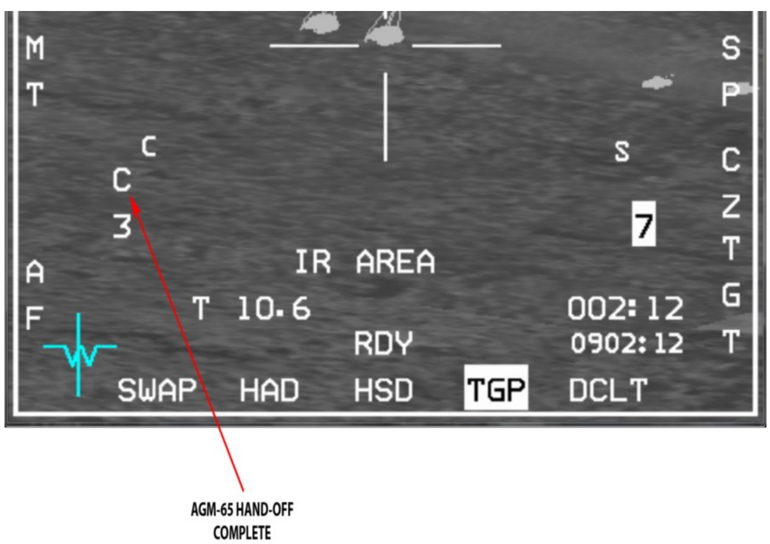
S – Slave, the missile is not tracking.

1 – Slew, the TGP is moving the missile LOS based on comparison of the Missile LOS and the TGP LOS.

***2** – Slew, TGP is moving the missile LOS based on comparison of the Missile video and the TGP video (N/I).*

T – Track, the TGP has commanded the missile to track.

C – Complete, Hand-Off is complete, missile is tracking.



AGM-65 Handoff Status

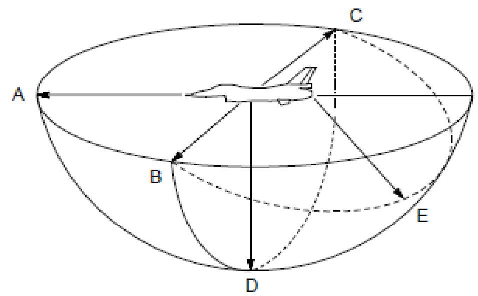
2.6.1.9 MISCELLANEOUS SYMBOLOGY

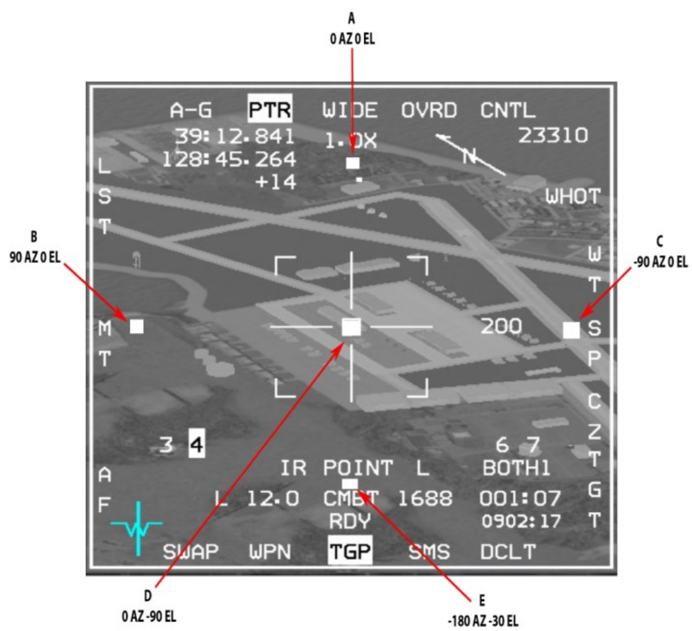
Range to CFOV (center Field of View) Symbology is displayed in the lower left area of the video display. If the pod is in A-A or A-G mode and laser range is valid the TGP will display the range preceded by an L. A valid laser range will take precedence over the other range types. If laser range isn't available but the pod is tracking in A-G, the pod will display a computed range, preceded by a T. If the pod is not in track mode and SPI range is available from the aircraft, the pod will display that. Range is displayed in nautical miles and tenth of nautical miles, unless the range is less than one nautical mile. If the range is less than a mile then the range is displayed in hundreds of feet with no decimal place.

2.6.1.9.1 SITUATIONAL AWARENESS INDICATOR SYMBOLOGY

The Situational Awareness Indicator (SAI) symbology is a 6 x 6-pixel square which represents where the pod's LOS is, relative to the aircraft. The SAI is displayed whenever the pod is in A-A or A-G modes. The position of the SAI can be thought of as a tip of the unit vector (arrow shown below) in the direction of the LOS. Viewed from the aircraft's perspective looking down it is a projection as defined by the aircraft X-Y coordinates system.

The picture below shows TGP LOS positions relative to the aircraft.





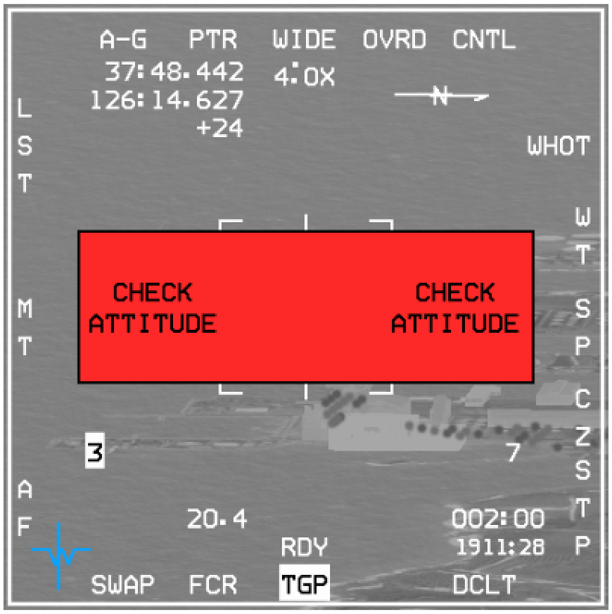
Situational Awareness Indicator

2.6.1.9.2 ATTITUDE ADVISORY FUNCTION (AAF)

A flashing red rectangular box with a double set of words CHECK ATTITUDE is displayed on both MFDs (all formats). If the TGP is in A-G mode, TGP format is displayed and the aircraft exceeds any of these defined attitudes:

a) Bank > 75°; Pitch < 0°.

b) Pitch < -20°



CHECK ATTITUDE on MFD

2.6.1.9.3 RADAR ALTITUDE SYMBOLOGY

With radar altitude data from CARA is valid, radar altitude is displayed in both A-A or A-G mode. The altitude symbology is displayed in the upper right corner of the video display.

2.6.1.10 ADDITIONAL NOTES

Sharing Between Players - Laser and IR Pointer spots are shared between players in MP. When a player is lasing or firing the IR Pointer, an MP message is sent every 0.5 seconds and shared by all players.

LGB Code – Laser Guided Bombs use a pre-set laser code and can guide only on laser energy of the same code. The laser code for the LGBs is set at the UI LOADOUT screen in the SET CODE field. Once applied the code is programmed into all the LGBs mounted on the aircraft and cannot be changed once airborne.

Buddy Lasing - Buddy lasing is possible by simply dropping LGBs in the vicinity (LGB basket) of a laser spot being fired from another human pilot's laser (AI wingman lasing is not implemented). The laser code *must* match the laser code of the LGB being deployed. The bomb will track any laser, of the same code, being emitted. If a spot being lased is lost, the bomb will track any other lased spot. If more than one spot is detected, the bomb will arbitrarily pick any one of the lasers to track to. It is recommended the pilot delivering the LGB turn off its laser.

Laser Ranging - In order to know if the target lasing is valid, simply fire the laser with the first trigger detent and check for a flashing "L" next to the range on the TGP page. An invalid ranging means that the laser is not detecting enough light energy to illuminate the spot. This will occur if the range is too great (the laser has limited range) or weather is obscuring the LOS. In such cases the laser will not be able to guide LGB's or tracked by LST.

LGB LOS - LGB's will not guide on a lased spot if the LOS between the bomb and the spot is masked by clouds.

Training and Combat Laser -The Training laser has much lower energy output and is not for operational use. When guiding LGB's or firing a laser that should be detected by LST, ensure that the Combat Laser mode is selected.

IR Pointer – When manually firing the laser, its energy is visible by the TGP as a flashing dot. It is also visible at night when using NVG's. There are 4 patterns of IR Pointer flashing, selectable from the TGP MENU page (OSB 5 – CNTL, then OSB 2 – MENU). The IR Laser Pointer validity also depends on range and LOS.

Time to Steerpoint/Release/Impact: Time to steerpoint, release, or impact is displayed in the lower right corner of the TGP page depending on the master mode and whether a weapon has been released. In NAV master mode, this display indicates time to steerpoint. In A-G master mode, this display indicates time to weapon release. Upon weapon release the time changes to estimated time to impact.

Now with a basic understanding of the Targeting Pod, take a moment to practice with the TGP in a TE or campaign before moving on to more advanced employment.

2.6.1.11 OPERATIONAL CONSIDERATIONS

The advanced employment abilities of the Targeting Pod are merely combining its employment with other aircraft sensors such as the FCR or Mavericks in an operational scenario. By combining these separate capabilities, the aircraft may deliver precision munitions efficiently with a higher probability of kill at greater stand-off ranges.

Using the TGP with Mavericks is discussed further in this manual. Reference section 4.3.8 for information relating to missile Hand-off.

2.6.1.11.1 AIR-TO-GROUND

To begin, the standard scenario is a *hot* jet with all systems powered on to include the TGP. The *MFD standard* is the TGP on the right MFD and all other sensors (FCR or Weapons Page) is on the left MFD. Personal preferences may dictate otherwise, but for clarity sake, the "MFD Standard" will be implied on all scenarios.

Once airborne, ensure the Master Arm switch is in the ON position and then select the Air-to-Ground (AG) master mode. (Again, *MFD Standard* set-up will have the Ground Mapping radar on the left MFD). Bring up the TGP page. Select OBS 1, above the "STBY", OBS 6 ("A-G") to place the TGP into A-G Mode. A video picture should now be visible on the TGP page. By default, if the ground radar is selected, the TGP is automatically slewed to the radar's cursor, so whatever is under the radar's cross-hairs is where the TGP is looking.

From this point, determining which FCR radar mode and submode to select becomes *situationally dependent*. Is the target a building or bridge, or an enemy battalion? Is the building/bridge selected as a pre-planned steerpoint or a "target-of-opportunity".

If it's a battalion, is it moving or static? Is lasing required? And if so, will it be continuously lased, delayed/ automatic or buddy lased? All of these *situations* should be considered during mission planning.

NOTE: To arm the Laser, Master Arm *must be on*. For practice or training purposes, placing Master Arm Simulate will suffice.

2.6.1.11.2 S SCENARIO 1 – FIXED TARGET, ONE PASS

In the first example, the target is nuclear plant, employing 2 GBU-10s rippled in pairs from 22,000 ft. Precise coordinates for the target is entered into STPT 5. On the LASR page, lasing is set to begin automatically lasing at 20 seconds prior to impact. Confirm Master Arm switch is ON and Laser switch is set to Armed. Select the SMS page to ensure GBU10 is the selected weapon and rippling is enabled. (This weapons cross-check is a good technique when carrying multiple types of weapons). The radar will remain in GM mode with STP/TGT (steerpoint/target) mode selected. This allows the GM radar to point/aim at the selected steerpoint, thus removing some *pilot-workload* by not needing to search for the desired target. Beginning from 20 NM to the target, the power plant structures should be visible on the ground radar. TMS-Up to STT the structure. Next, DMS (display management switch) down/aft to change the Sensor of Interest (SOI – denoted by the highlight box on the outer edge of the MFD) on the TGP MFD.

With the SOI box on the TGP page, TMS-Up (or TMS-Right) to ground stabilize the TGP in AREA track. The target should be visible. Move the TGP camera with the throttle's cursor control switch and refine the point-of-impact. TMS-Up again to lock that point. Note that if the TGP does not switch to POINT mode, then the target may be too far away for the TGP camera to distinguish the contrast in its edges. Continue in-bound towards the target and try again.

The normal delivery cues should be visible in the HUD. Follow them as necessary and drop the munition upon reaching the desired cue. When slewing with the cursor control, be gentle especially if the TGP is not ground stabilized. If this does occur, it should be easily fixed by selecting "CZ" on the FCR page. This will move the TGP back to the steerpoint which in this case is the target.

Once the bombs are dropped be careful not to manoeuvre too aggressively. Excessive manoeuvring will cause the TGP to lose lock or mask the laser causing the bombs to go "stupid". A good technique is to start a gentle turn away from the target toward an egress direction to offset. Remember the semi-circle under the jet. As long as the underside of the jet is pointed towards the target the TGP and laser should have a clear LOS to the target. Flying directly over the target is also an option provided the air defence threat is low. (Remember to keep an eyeball scanning for threats). At 20 seconds prior to impact confirm the laser is firing by noting the flashing "L" on the TGP page. At 0 seconds watch the bombs impact. SHACK! After impact POINT mode should revert to AREA mode and the laser will cease firing. Egress from the area and clean up the jet for A-A engagement or navigate back to homeplate.

2.6.1.11.3 SCENARIO 2 – MOVING TARGETS, MULTIPLE PASSES

In this scenario the target is a column of T-62 tanks that are rapidly moving south. It is time to reduce their numbers. The loadout is 4 GBU-12's (nearly the same as the previous scenario's GBU-10's). These will be dropped in singles. The target STPT 5 is in the vicinity of where the column is expected to be, but with all moving targets, they will never be in the same place as they were during mission planning.

Again, once safely airborne and enroute complete a FENCE check (Technique only, but a perfect opportunity to set up the aircraft systems in preparation for target engagement): Master Arm to ON; Laser Armed and set to CMBT; A-G mode, ground radar on, weapon selected and set; and TGP on and set. The differences from this scenario to the previous is the use of STP submode in the GMT mode. From 25-30 NM out begin looking for movers at STPT 5. They generally show up as a solid line on the radar. At 10 NM expect to pick up some movers 5 miles to the north of the STPT. Since this scenario does not incorporate friendly-forces nearby this is definitely the T-62 battalion. (It is important to note how powerful a tool the TGP is in similar scenarios where friendly-forces are co-located. The chaos of the battlefield dictates that visually identifying the target is crucial to winning the battle).

At this point, the radar may be slewed with the cursor control while in STP submode. Or, *Snowplow* (SP) submode may be selected. Snowplow mode is considered better suited for looking at targets away from the steerpoint. With the FCR as SOI, TMS-Up to enable SP Mode and use cursor control. Again, the TGP is slaved to the the radar. Slew over to the line of tanks and TMS-Up again to lock one up. Next, DMS-Down to switch the SOI to the TGP. TMS-Up to stabilize the TGP and slew it slowly until a tank (or any vehicle) comes into view. Use the manual range dial on the throttle to zoom in and out, and the pinky button on the stick to go from Wide to Narrow fields of view. At last we see some tanks moving. Slew any vehicle into the TGP cross-hairs and TMS-Up once more to lock the TGP into POINT mode. Using the CCRP cues fly towards the target and pickle. As with the GBU-10 scenario, either turn away in a safe egress direction or over-fly the target. Watch for the flashing "L" at 20 seconds before impact and keep the other eye scanning for threats. At 0 seconds...SHACK!

For extra added complexity, try the other bomb runs without auto-lasing, instead continue to press the first trigger detent and manually lase the bomb all the way to target. Or another challenge is to leave the TGP in AREA mode and manually move the cursor with the target (it is recommended to keep auto-lasing on for this challenge). And as a final level of complex challenges, pickle a GBU, count 5 seconds and pickle a 2nd GBU. With the TGP in AREA mode, drop one GBU on a tank and then slew the cross-hairs over to a 2nd tank to kill it. (Remember, there is 5 seconds to acquire the 2nd tank! This works really well with a moving column of vehicles when the distance to slew from one target to the other is reduced by the 2nd vehicle moving towards the cross-hairs by itself).

NOTE: It is important to cease slewing before commanding a POINT track or the cursor will "jump" off the target when attempting to lock up the mover. Practice this to see exactly what happens. This will also occur if the cursor control is inadvertently bumped. If the intent is to move the cursor off the locked target it is recommended to place the TGP into AREA mode, slew to the new target then re-lock by placing the TGP back into POINT Mode. The cursors jumping off is a bug and of course this makes POINT tracking a mover very challenging. It is best to lead the mover and let it drive into the cursors cross-hairs, then TMS-Up to command POINT track. Also note that aggressive manoeuvring or a MASK condition can break a POINT track; and the size of the object is important in the TGP. Change the FOV to get a POINT track. By selecting TMS-Down, the TGP will be slaved back to the radar, and another search is required. Another technique is after slewing the radar cursors to the column and create a Markpoint. This essentially creates a new steerpoint to aid in navigation and delivery. Select ICP 7 (MARK), then SEQ Right until "FCR" is selected. Hit ENTR (or TMS-Up) to make a mark point on this location. Now switch to that markpoint (ICP 4, then key in 26, then ENTR). Hit M-SEL, then press CZ to zero out the cursor slews, to aid in navigation and delivery, or just use it as a reference on the HSD to build situational awareness. Realize if the column continues to move, they will eventually move away from the Mark. Another consideration is to ensure enough time and distance so as not to rush the bombing run and make a sloppy delivery. A waisted bomb does nothing for the "cause", thus good rule-of-thumb is commence the run at a minimum of 8 NM. Pacing and patience is important in learning this new system. There are many methods, techniques and procedures to employ effectively, but practice is the biggest key and expanding techniques can pay off in the long run.

2.6.1.11.4 AIR-TO-AIR

The TGP is a great asset in the A-A role. Its advanced optics and IR capabilities can see much farther than the "Mark 1 eyeball", making it an excellent ID tool for BVR or near-BVR ranges. As stated above, by default it slaved to the radar. It may also work independently of it, just as in A-G mode. This allows the ability to monitor or track a target with the TGP but use the FCR to continue searching or tracking other bandits. The TGP is available in all A-A submodes. The importance cannot be understated while either positively ID'ing beyond visual-range or selecting the correct "blip" to engage when a friendly aircraft is in the merge.

It is recommended to mount a targeting pod during any mission, whether ground attack or CAP. While enroute to the target area lock up other aircraft that are flying with the TGP on and set for A-A (Select OBS 1 "STBY", then OBS 20 "A-A"). Zoom in and notice how easy it is to determine friend from foe. DMS-Down to make the TGP as SOI and note the distance at which a TGP lock is achieved. This can be especially advantageous when an air threat is Jamming. (Remember, ECM Jammers do not effect the visual or IR spectrum of the TGP).

If the TGP drops a POINT track, a TMS down *with* the SOI on the TGP may be necessary to re-slave the TGP to the FCR. Also, display polarity selection is also available. At range, the TGP may display a better picture in WHOT compared to TV mode. With the TGP as SOI, TMS-Left or OBS 6 will cycle display polarity options (WHOT – BHOT – TV).

Using the TGP effectively in combat requires proficiency with the switchology. But once learned it is a valuable tool.

2.6.2 LANTIRN

The Low Altitude Navigation and Targeting Infrared for Night (LANTIRN) is an imaging infrared system providing tactical aircraft with a day/night under-the-weather attack capability. LANTIRN consists of three main components: AN/AAQ-13 navigation pod (NVP), AN/AAQ-14 targeting pod (TGP) and a wide angle raster (WAR) Heads-Up Display (only on Block 40/42 and some export models). It will also work with the more widespread wide angle conventional (WAC) HUD. Carried on the left and right chin stations, either side of the intake, LANTIRN is designed to employ a wide variety of conventional and precision-guided munitions at night using day-like tactics and deliveries.

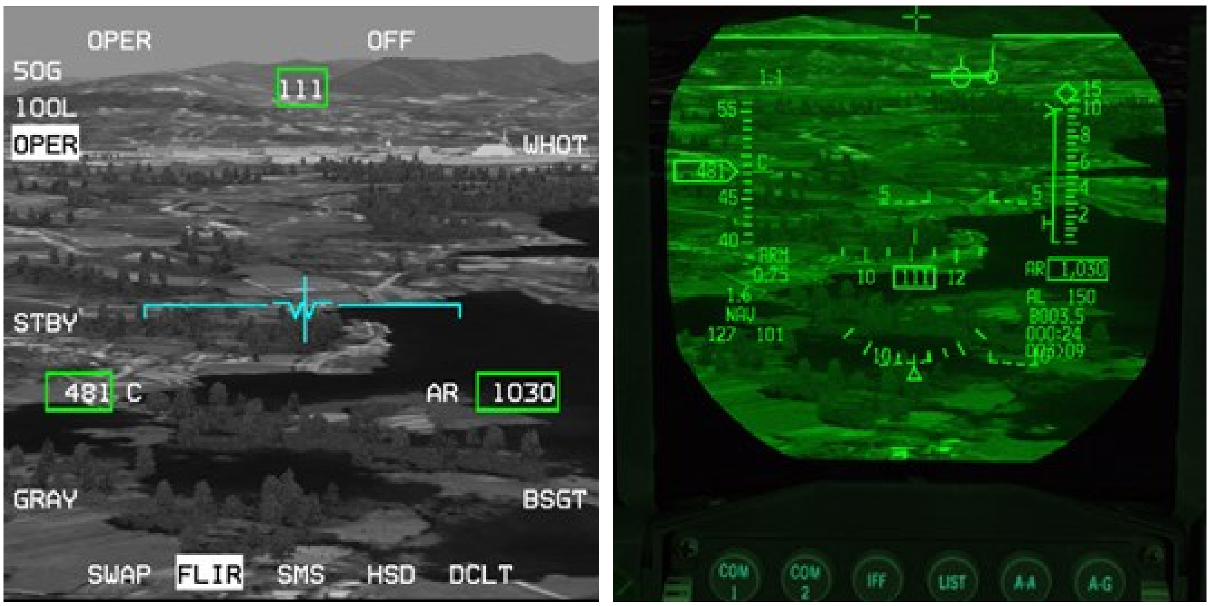
NOTE: Pods are independently selectable in the UI LOADOUT screen. The AN/AAQ-13 Navigation Pods will automatically be fitted to the left chin station and AN/AAQ-14 Targeting Pods will be mounted on the right chin station.

PODS - LANTIRN

2.6.2.1 AN/AAQ-13 NAVIGATION POD (NVP)

The AN/AAQ-13 navigation pod (NVP) has two main components: the Forward-Imaging Navigation Set (FINS) sensor and the Ku-band Terrain Following Radar (TFR).

The FINS, a WFOV FLIR system, provides the pilot with an IR image of the terrain and airspace in front of the aircraft on the HUD. It includes a look-into-turn (LIT) mode, which enables the pilot to look in the direction of a turn and a snap-look mode which provides enhanced left, right, up, and down viewing controls while flying level, or in conjunction with LIT during turns. FINS functions include video polarity control, video gain and level adjustment options, and a grey scale capability for manual gain and level setting.



FLIR image in MFD and HUD

OSB 18 places the FLIR in standby. OSB 20 places the FLIR in operational mode (OPER). The FLIR needs between 8 and 15 minutes to cool down before use. It is recommended to begin the process as soon as possible during ramp start for missions requiring FLIR. The FLIR will be ready to operate as soon as the NOT TIMED OUT message disappears from the MFD.

Once operational the FLIR page will display the infrared view in front of the pod. The image can be repeated on the HUD by rotating the BRT ICP wheel upwards. The FLIR level can be changed with the ICP up and down FLIR arrows. The current gain and level values are displayed on the top left corner of the FLIR MFD.

2.6.2.1.1 FLIR BORESIGHTING

OSB 10 is the boresight (BSGT) option. On the ground the FLIR camera is boresighted to the top of the HUD. This may induce parallax errors. The boresight procedure is used to align the image in the HUD with the image from the FLIR camera. Do not boresight on close objects. It is advised to boresight on the furthest clearly defined visible object seen on the horizon of the HUD, such as the edge of a mountain or a road to minimise distracting parallax errors.

Depressing OSB10 and highlights the BSGT mnemonic. Then slew the HUD FLIR image with the throttle cursor switch. Once both images are superimposed correctly, depress OSB10 again and the BSGT mnemonic will return to its initial state.

Once the FLIR image is displayed on the HUD the MFD page does not need to be active, though it is advisable to have it on one of the DA buttons for easy access when boresighting.

2.6.2.1.2 LOOK-INTO-TURN (LIT) AND SNAPLOOK

LOOK-INTO-TURN (LIT) and SNAPLOOK capabilities are available on the HUD.

LIT: when the bank angle is above 5°, holding DMS Up will shift the FLIR view slightly into the turn to provide lead obstacle clearance. The FLIR image reverts to forward looking when DMS Up is released.

SNAPLOOK: The view can be shifted further in flight by holding DMS Up and moving the cursors in any direction, even in a turn. The view will revert to forward looking when DMS Up is released.

When LIT or SNAPLOOK are active the FPM is dashed.

NOTE: *Terrain Following Radar is handled separately in the* Terrain Following Radar (TFR) *chapter.*

2.6.2.2 AN/AAQ-14 TARGETING POD (TGP)

The AN/AAQ-14 targeting pod contains a high-resolution FLIR sensor, a laser designator/rangefinder for precise delivery of laser-guided munitions, a missile boresight correlator for automatic lock-on of the AGM-65 Maverick imaging infrared missiles and software for automatic target tracking. These features simplify the functions of target detection, recognition and attack and permit pilots of single-seat fighters to attack targets with precision-guided weapons on a single pass.

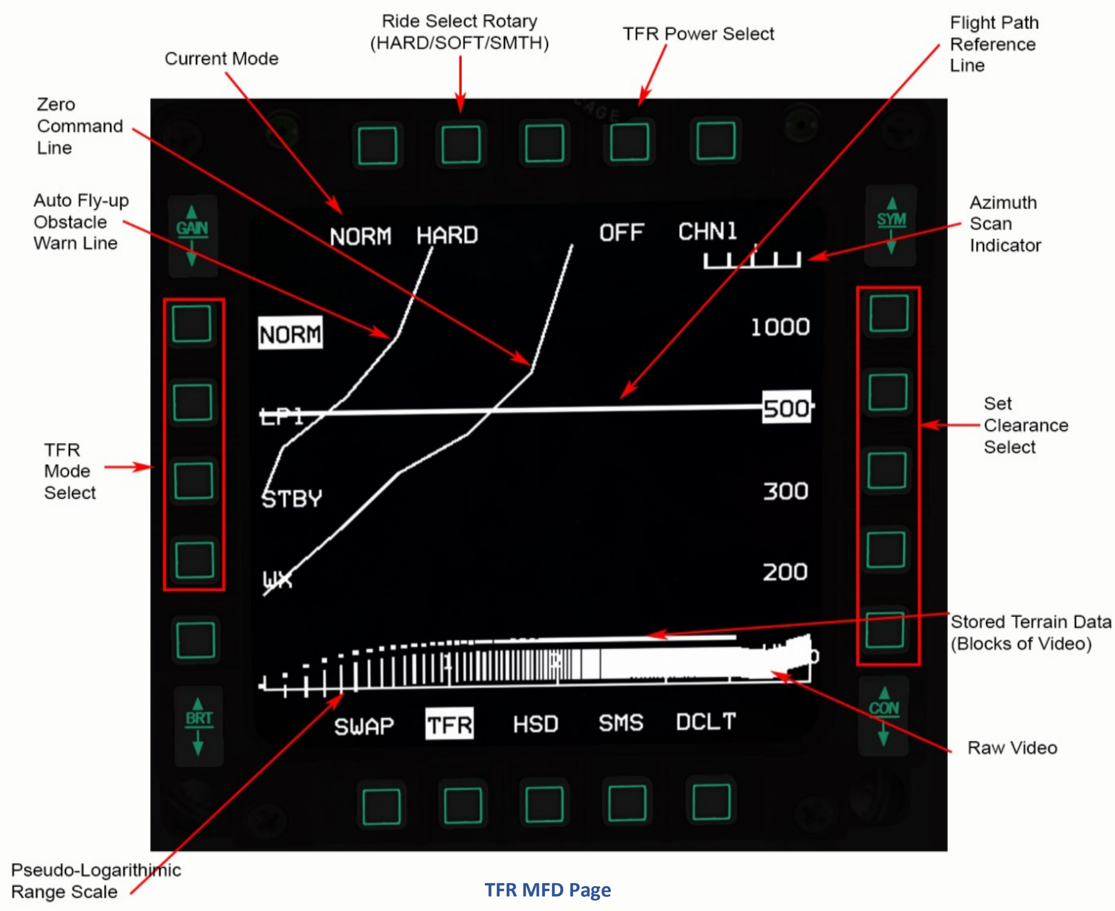
NOTE: AN/AAQ-14 LANTIRN and AN/AAQ-33 Sniper Targeting Pods are functionally identical. Refer to the chapter 2.6.1 for information on the AN/AAQ-33 Targeting Pod.

2.6.3 TERRAIN FOLLOWING RADAR (TFR)

NOTE: *TFR is only available on F-16s carrying an AN/AAQ-13 LANTIRN navigation pod.*

The primary function of the TFR is to detect the terrain along the aircraft flight path and to generate vertical steering commands (g-commands) for the pilot, in manual mode, or the FLCS, in auto mode, in order to maintain a pilot-selected altitude above the ground.

The TFR features include terrain following, obstacle warning and limited inclement weather flying. The Set Clearance Plane (SCP) may be set between 200 and 1000 feet AGL in the normal mode. Other modes available for specific operating conditions are: Weather (WX), Low Probability of Intercept (LPI) and Very Low Clearance (VLC).

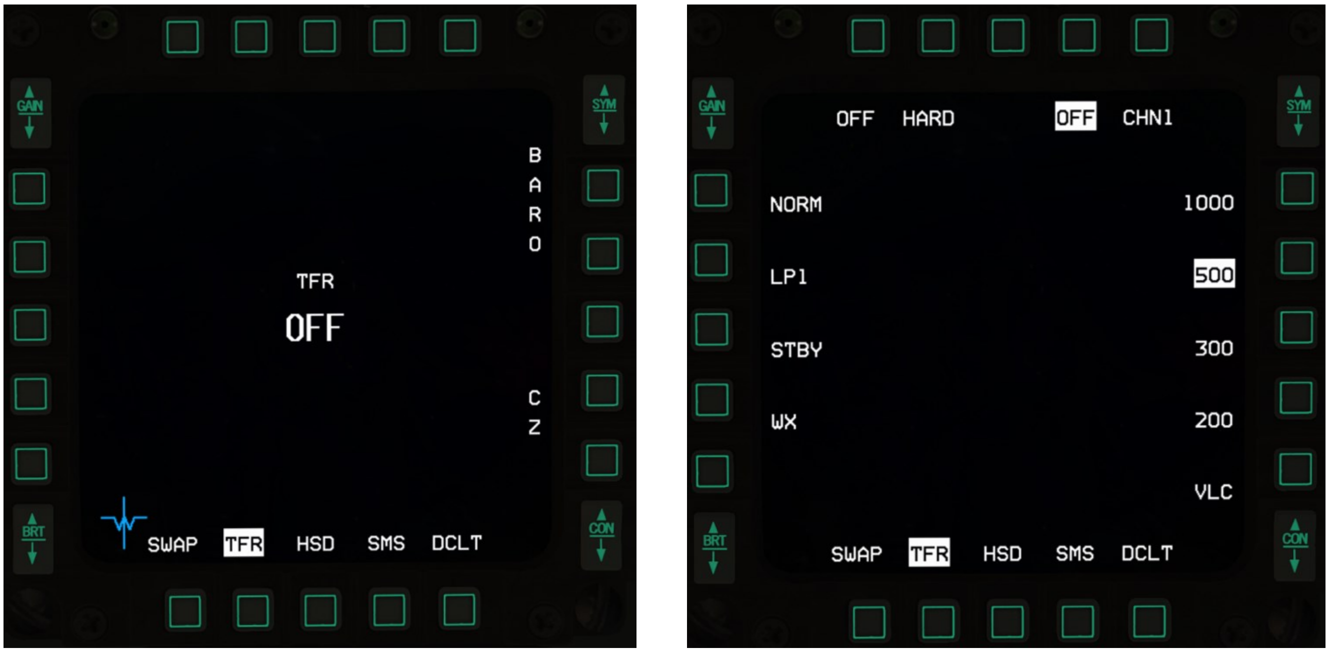


TFR MFD Page

2.6.3.1 TERRAIN FOLLOWING RADAR MFD PAGE

The SNSR PWR control panel located on the right console contains the power switches for the left hardpoint (LEFT HDPT) and right hardpoint (RIGHT HDPT) that are both used for the LANTIRN pods. The LEFT HDPT switch applies power to the Navigation Pod (NVP), located on the left chin pylon. The right pylon holds the Targeting Pod (TGP).

Access the TFR page via the MFD Menu Page and assign it to one of the quick access buttons (OSB 12-14). If the TFR page is accessed before power is applied to the NVP, TFR OFF will be displayed on the MFD.

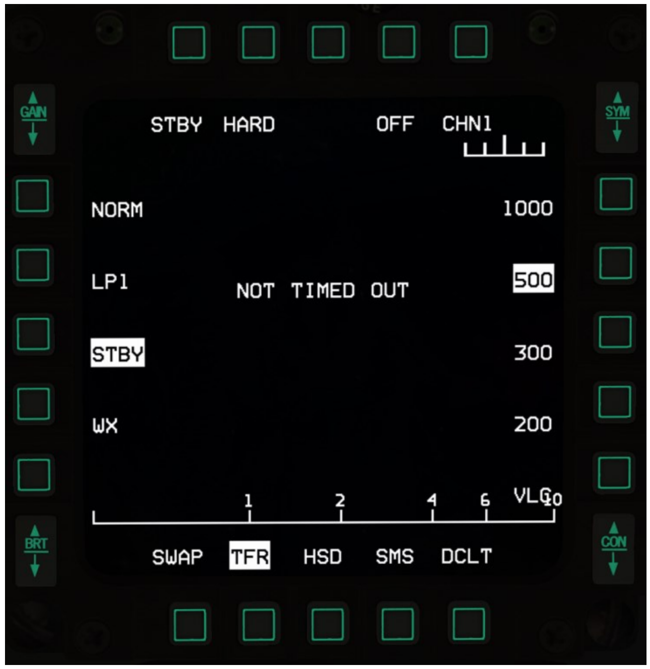


TFR Operation

2.6.3.1.1 TFR MFD PAGE OSB DESCRIPTION

OSB 1	No function – displays the TFR Mode status.
OSB 2	HARD/SOFT/SMTH (Smooth) Rotary.
OSB 4	TFR power.
OSB 5	Brings up a menu of TFR frequency channel numbers which allows the pilot to select a TFR frequency that will not interfere with other TFR radars. (N/I)
OSB 6	1000ft AGL clearance option.
OSB 7	500ft AGL clearance option.
OSB 8	300ft AGL clearance option.
OSB 9	200ft AGL clearance option.
OSB 10	VLC - Set clearance of 100ft.
OSB 11	DCLT (Declutter).
OSB 17 - 20	TFR Mode.

ON/OFF TFR power is controlled with OSB 4. The TFR is automatically placed in STBY mode after power on. TFR power is off when the OSB 4 mnemonic (OFF) is highlighted. TFR power ON can be also selected via OSB 18 (STBY).



TFR in STBY

After power is applied the TFR enters STBY mode. The NOT TIMED OUT advisory is displayed across the top of the MFD during its cool-down period. During the NOT TIMED OUT period only the ride control, clearance settings and TFR power can be selected. TFR timeout takes approximately 3 minutes.

2.6.3.2 TFR OPERATING MODES AND OPTIONS

The TFR mode options are selected with their corresponding OSB buttons along the left side of the MFD.

NOTE: *Weather mode can be selected via OSB 17 on the TFR page, or by pressing the WX button on the ICP.*

2.6.3.2.1 NORM (NORMAL)

Transmits vertical steering cues to the HUD for manual terrain-following, or g-commands to the FLCS for automatic terrain-following for day or night low altitude flight. Normal mode has the highest accuracy terrain following performance with turning flight capability and look into-turn. The TFR performance may also be refined by ride control and clearance options.

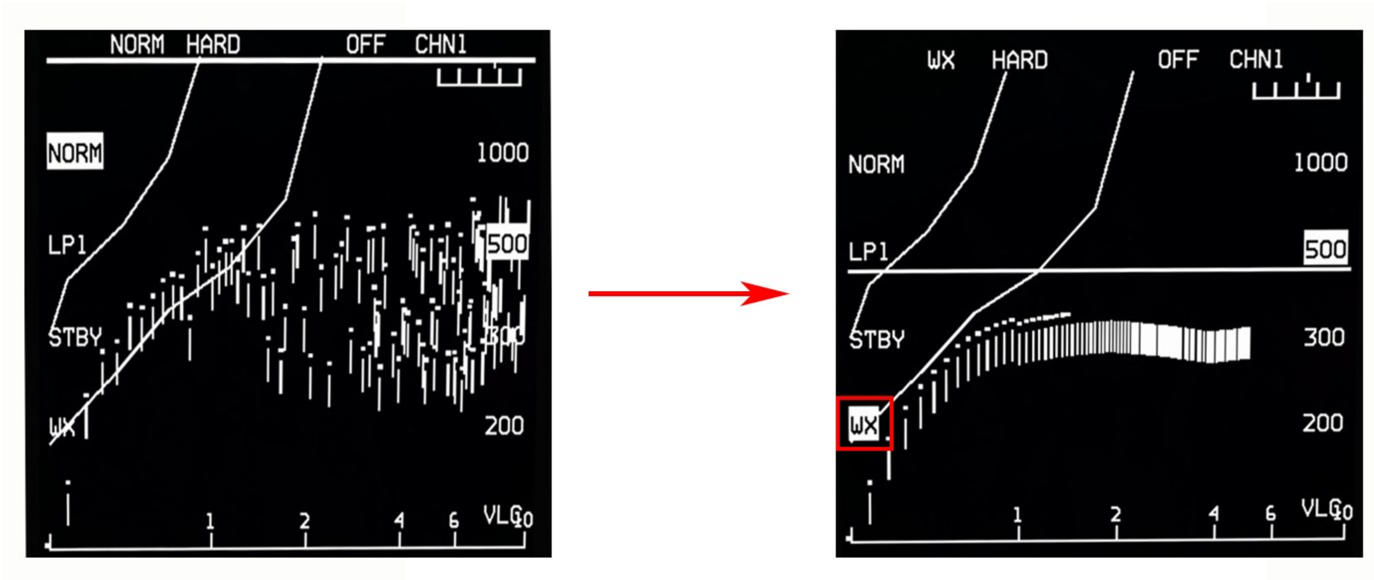
2.6.3.2.2 LPI (LOW PROBABILITY OF INTERCEPT)

Designed to minimize electronic detection of TFR transmission. Ride control and set clearance options are available. Because of limited transmissions, turning flight is allowed at a reduced turning rate only and look into-turn is not available at all.

STRG SEL and HDG SEL functions of AUTO TF are therefore disabled in this mode.

2.6.3.2.3 WX (WEATHER)

The WX mode uses circular polarization and reductions in receiver sensitivity, processing range, and antenna up scan to minimize the interference of false returns from rain and clouds. When flying, or about to fly, through inclement weather WX mode should be engaged with the WX button on the ICP or OSB 17 to avoid uncommanded fly-ups. The figures below show the the effects weather has on the terrain following radar and how the WX mode filters out precipitation.



TFR in WX mode

2.6.3.2.4 VLC (VERY LOW CLEARANCE)

Not displayed as a TFR mode option, but automatically selected when in NORM and the VLC option is selected. VLC should only be used over water or extremely flat terrain. Turning rate is significantly reduced in this mode.

STRG SEL and HDG SEL functions of AUTO TF are also disabled in this mode.

2.6.3.2.5 TFR RIDE OPTIONS

The TFR ride options are selected via OSB 2 (HARD, SOFT, SMTH).

SOFT ride limits pull-up commands to 2.0 G and pushover commands to -0.5 G.

HARD and SMTH ride options both limit pull-up commands to 2.0 G and pushover commands to -0.9 G, but SMTH ride provides peak-to-peak flying. Comparing the HARD and SOFT rides, the HARD ride allows the aircraft to fly closer to an obstacle before commanding a climb.

2.6.3.2.6 TFR SET CLEARANCE OPTIONS

The TFR set clearance options are selected via the OSB's adjacent to the set clearances along the right side of the MFD. The set clearance options are as follows: 1000 feet, 500 feet, 300 feet, 200 feet, VLC.

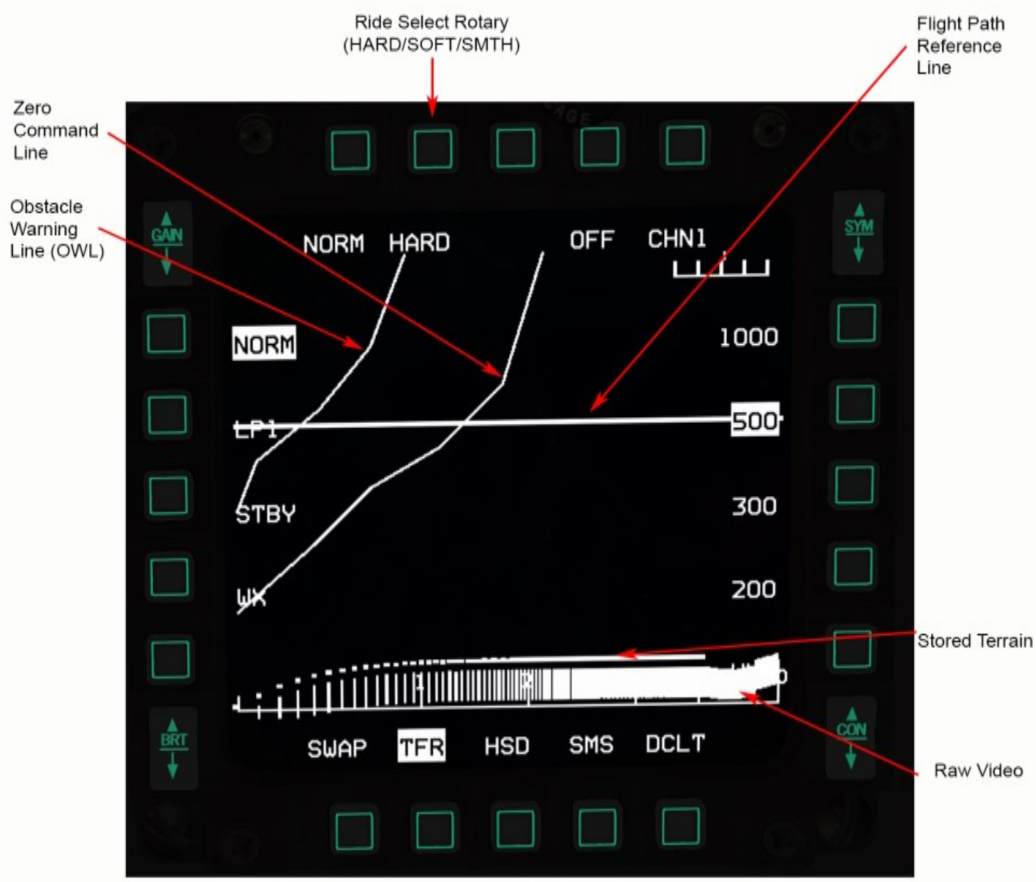
Aircraft altitude is continually monitored against the selected set clearance and a vertical clearance warning is issued if the aircraft is below 75 percent of the set clearance. A LO TF message will be displayed on the HUD and a fly-up will occur if in AUTO TF only.

2.6.3.3 TFR CONFIDENCE DISPLAY

The TFR confidence display provides terrain-following anticipation in bad weather via an E-squared (elevation versus exponential range) format. Terrain video is displayed across the display from right to left. The zero command line (ZCL) is displayed as a ground reference line and the horizontal flight path reference line is displayed as an aircraft reference line. Small symbols displayed with video represent processed video 'stored terrain'. The vertical lines represent unprocessed video from the primary bar that the TFR is using at the time. The unprocessed video may be used to identify weather conditions. In addition, E-squared video is displayed in order to give the pilot confidence that the TF system is working correctly. This capability is useful when flying AUTO TF.

The terrain video, zero command line, and obstacle warn line on the E-squared display is blanked if:

- Bank angle > 85 degrees
- Drift angle > 10 degrees
- Pitch angle > 40 degrees nose up or 20 degrees' nose down
- Flight vector > 40 degrees nose up or 20 degrees' nose down



TFR Confidence Display

2.6.3.4 TFR CONTROLS

2.6.3.4.1 ADVANCED (ADV) MODE SWITCH

The ADV MODE switch, located on the miscellaneous panel, selects the desired terrain following (TF) mode. This switch is a dual-lighted push-button with the labels ACTIVE and STBY on the upper and lower halves of the switch.

The top half of the switch illuminates green when selected to indicate activation of the advanced mode (AUTO TF). The bottom half of the switch illuminate's amber to indicate that the advanced mode is in standby.

ADV Mode Switch

2.6.3.4.2 RF SWITCH

When the RF switch is in NORMAL all TFR modes are available.

When the RF switch is placed in QUIET from NORM while the TFR is in NORM, VLC, or WX mode the TFR will transition to LPI. If the TFR is in LPI, STBY, or OFF when the RF switch is placed in QUIET from NORM, the TFR mode will remain unchanged. While in QUIET only requests for LPI, WX, STBY, or OFF are actioned. Function requests (clearance, ride, etc.) are honored.

When the RF switch is moved from QUIET to NORM the TFR will remain in the last allowable mode selected while in QUIET. If no selection was made while in QUIET, the TFR will transition to the last mode selected while in NORM.

When the RF switch is moved from QUIET to SILENT the TFR will transition to STBY.

While in SILENT, only requests for STBY or OFF are honored.

Note: When the RF switch is moved from NORM to SILENT, or QUIET to SILENT while AUTO TF is selected a TF fail indication and fly-up will occur.

When the RF switch is moved from SILENT to QUIET the TFR will remain in the last allowable mode selected while in SILENT. If no selection was made while in SILENT the TFR will return to the last mode selected while in QUIET.

RF SWITCH NORM	RF SWITCH QUIET	RF SWITCH SILENT
NORM		
WX	WX	
LPI	LPI	
VLC		
STBY	STBY	STBY
OFF	OFF	OFF

TFR RF Control available modes

2.6.3.4.3 PADDLE SWITCH

While the autopilot is engaged, depressing the paddle switch will disconnect the current TFR mode. Thus all fly-ups are inhibited and the pilot has full control of the aircraft.

2.6.3.5 TFR MODES

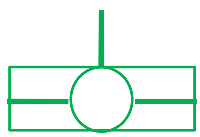
The TFR has 3 modes MANUAL TF, AUTO TF and BLENDED TF.

2.6.3.5.1 MANUAL TF

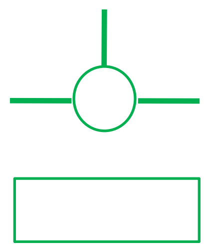
Manual operation allows pilot control of flight and is automatically selected when TFR is operating; this is indicated by an unlit ADV Mode switch on the MISC Panel.

The HUD manual TF cue is displayed as a box symbol in which the flight path marker is flown in the center off.

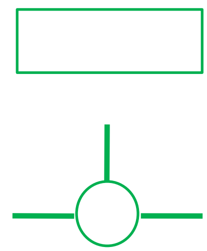
MAN TF



on SCP



above SCP



below SCP

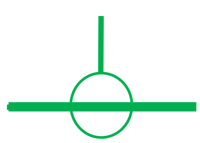
2.6.3.5.2 AUTO TF

Depressing the ADV MODE switch with manual TF active engages automatic TF. The green ACTIVE light illuminates as an indication along with a horizontal line in the HUD as a TF cue.

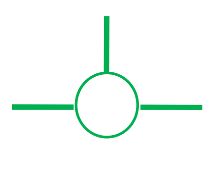
When auto TF is engaged, the currently selected roll autopilot mode is also activated. Pitch and roll trim from the stick will be inoperative and the pitch trim wheel will be centred. Roll trim inputs can be made on the manual trim panel.

NOTE: *Due to limited turning flight capability in LPI and VLC modes, steering and heading select functions of auto TF are disabled.*

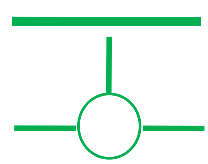
AUTO TF



on SCP



above SCP

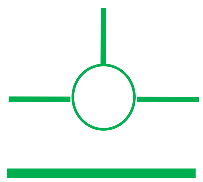


below SCP

2.6.3.5.3 BLENDED TF

The TF system can also be used in conjunction with the pitch autopilot in a blended mode. When this mode is in effect, the more positive of the TF command and the attitude or altitude pitch autopilot command is used. The autopilot will hold the selected MSL altitude or pitch attitude unless it has to fly higher to maintain selected terrain clearance. This mode also supports all three roll autopilot modes (heading select, attitude hold and steering select).

Blended mode can be entered in three ways. The first two are by turning on the pitch autopilot from manual TF or auto TF. In these cases, the STBY light illuminates. The third is to have the pitch autopilot already on when entering TF (TFR switched to an operating mode). Due to autopilot interactions, the incremental g-command range for this mode is minus 0.5g to plus 2.0g. The TF HUD cue in blended mode is the same line as in auto TF.



BLENDED TF *above SCP*

2.6.3.6 CAUTIONS, WARNINGS AND ADVISORIES

The TFR provides many cautions and warnings to maximize pilot safety. Due to antenna scan limitations, valid g-commands can only be made within certain limits of aircraft roll, dive, speed, turn rate, and turn acceleration.

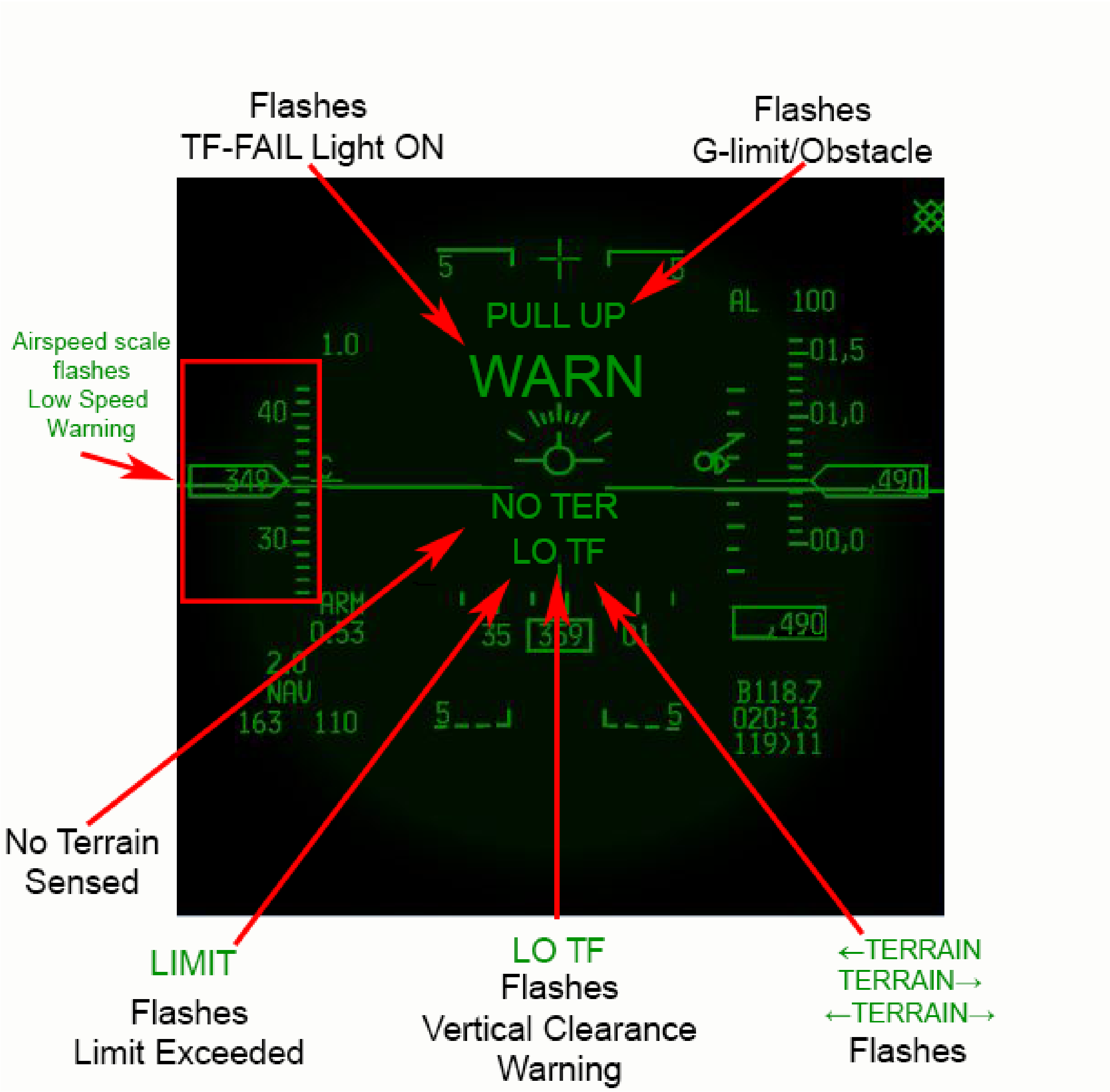
When these limits are exceeded the message LIMIT appears on the HUD and flashes. If the limits are exceeded for too long the HUD TF box blanks.

Cautions, warnings and advisories are a combination of visual cues on the HUD/ MFD, aural warnings, warning light illumination and auto FLCS fly-ups.

2.6.3.6.1 SYSTEM WIDE INTEGRITY MANAGEMENT (SWIM)

The FLCS provides a safety check on the NVP and the TF critical systems via the SWIM monitors. When malfunctions of the TF system are detected, the SWIM function provides for safe recovery and transition to manual flight control

2.6.3.6.2 HUD CAUTIONS AND WARNINGS AND ADVISORIES



TFR HUD warnings

2.6.3.6.2.1 LIMIT

A flashing LIMIT appears on the HUD and flashes when TFR limits are exceeded. If the limits are exceeded for too long the HUD TF box blanks.

2.6.3.6.2.2 WARN / TF-FAIL

If the TFR fails (as detected by either the NVP or the FLCS) the TF FAIL light on the glare shield illuminates, WARN is displayed on the HUD and the aural “PULL-UP” message is activated.

2.6.3.6.2.3 LO TF VERTICAL CLEARANCE WARNING

A vertical clearance warning is issued if the aircraft is below 75 percent of the set clearance plane. A LO TF message will be displayed on the HUD and a fly-up will occur if in AUTO TF.

2.6.3.6.2.4 NO TER

The NO TER message will be displayed on the HUD when the TFR is not sensing terrain within the terrain present gates. As the aircraft comes closer to reflective terrain the NO TER message should blank (the NO TER message may not blank over areas of low reflectivity such as smooth water).

2.6.3.6.2.5 TERRAIN

The TFR provides right and left turn advisories when terrain to the right or left of the aircraft will cause a command greater than 2.0 G. In this case, the HUD will display ←TERRAIN, ←TERRAIN→, or TERRAIN→.

2.6.3.6.2.6 PULLUP

PULLUP is displayed on the HUD when a G-LIMIT/OBSTACLE WARNING occurs. An automatic fly-up is issued always in AUTO TF, or in MAN TF only if the MANUAL TF FLY-UP switch is set to ENABLE.

2.6.3.6.2.7 SPEED SCALE

Flashing of the airspeed scale and the word LIMIT on the HUD occurs when the aircraft velocity is below 360 KCAS.

The TFR system is designed to perform from 300 to 600 knots groundspeed. However, at very low speeds (below 300 knots), where g-response cannot attain the commanded value, the set clearance of the aircraft cannot be maintained. In addition, at low speeds, fly-up capability will also be impaired.

2.6.3.6.3 AURAL CAUTIONS AND WARNINGS AND ADVISORIES

2.6.3.6.3.1 PULLUP

An Aural "PULLUP" message will be heard when:

- TF-FAILS
- Limits exceeded too long (AUTO TF)
- Vertical Clearance Warning (AUTO TF)
- G-Limit / Obstacle Warning
- Low Speed Warning

2.6.3.6.3.2 LOW SPEED TONE

When the aircraft slows to below 300 KCAS the low speed warning tone is generated, all TF symbology disappears and, if in AUTO TF, the ATF NOT ENGAGED caution light illuminates.

2.6.3.6.4 MFD CAUTIONS AND WARNINGS AND ADVISORIES

2.6.3.6.4.1 TFR LIMITS

A flashing TFR LIMITS will be displayed on both MFDs when:

- TF Fails
- TFR limits exceeded
- TFR limits exceeded too long
- Vertical clearance warning
- Low speed advisory
- Low speed warning

2.6.3.6.4.2 G-LIMIT / OBSTACLE WARNING BREAK X

A break X on the MFD indicates that an obstacle warning or g-limit has occurred. This will result in a 4 G or 3 G incremental fly-up, respectively, to avoid the terrain at the set clearance plane. If this warning should occur an immediate fly-up should be made (an automatic fly-up is issued if MANUAL TF FLYUP is set to ENABLE).

	TF COMMAND CUE					HUD MESSAGE							AURAL WARNING			FLYUP			MFD MESSAGE		
	CUE BLANKED	2 G COMMAND	3 G COMMAND	4 G COMMAND	NO CHANGE	WARN	LIMIT	LO TF	PULLUP	←NO TERRAIN→	NO TER	FLASHING AIRSPEED	PULLUP	LOW SPEED TONE	NONE	ALWAYS	IF ENABLED	NONE	FLASHING LIMIT	BREAK X	NONE
TF FAIL	MAN & AUTO					MAN & AUTO							MAN & AUTO			AUTO TF	MAN TF		MAN & AUTO		
LIMIT EXCEEDED					MAN & AUTO		MAN & AUTO								MAN & AUTO			MAN & AUTO	MAN & AUTO		
LIMIT EXCEEDED TOO LONG	MAN & AUTO						MAN & AUTO						AUTO TF		MAN TF	AUTO TF		MAN TF	MAN & AUTO		
VERTICAL CLEARANCE WARNING		MAN & AUTO						MAN & AUTO					AUTO TF		MAN TF	AUTO TF		MAN TF	MAN & AUTO		
G LIMIT			MAN & AUTO						MAN & AUTO				MAN & AUTO			AUTO TF	MAN TF			MAN & AUTO	
OBSTACLE WARNING				MAN & AUTO					MAN & AUTO				MAN & AUTO			AUTO TF	MAN TF			MAN & AUTO	
TURN CAUTIONS					MAN & AUTO					MAN & AUTO					MAN & AUTO			MAN & AUTO			MAN & AUTO
NO TERRAIN					MAN & AUTO						MAN & AUTO				MAN & AUTO			MAN & AUTO			MAN & AUTO
LOW SPEED ADVISORY					MAN & AUTO		MAN & AUTO					MAN & AUTO			MAN & AUTO			MAN & AUTO	MAN & AUTO		
LOW SPEED WARNING	MAN & AUTO													MAN & AUTO				MAN & AUTO	MAN & AUTO		

MAN & AUTO (green) **AUTO TF** (red) **MAN TF** (orange)

TFR Warnings / Cautions / Advisories chart

2.6.3.6.5 LANTIRN TFR ATTITUDE ADVISORY FUNCTION (AAF)

The AAF provides a head-down advisory to the pilot when the aircraft has exceeded specific criteria of pitch and/or roll attitudes with the TFR in operation. AAF operation is dependent on an advisory altitude. During mission planning the pilot selects an altitude at which the AAF is enabled and this is downloaded to the aircraft via the DTE. The pilot may also enter the advisory altitude into the avionic system via the ALOW DED page (ALOW button on ICP).

If there is a MMC power cycle with the gear up, the avionic system retains the advisory altitude value that was last entered into the system.

During the mission the AAF is triggered when the following conditions are met:

1. The TFR is in an operating mode (i.e. NORM, WX, VLC, or LPI) and
2. The aircraft is below the advisory altitude and
3. The aircraft exceeds either of the attitudes defined below:
    a) > 75° bank and pitch < 0°
    b) < 75° bank and pitch > -20°

This advisory consists of a flashing rectangular box containing a double set of words reading CHECK ATTITUDE, which is displayed on both MFDs. The pilot can disable the AAF by entering an advisory altitude of 0 feet.

LANTIRN AAF CHECK ATTITUDE

Note: this is not to be confused with the TGP Attitude Advisory. The TGP Attitude Advisory is displayed when:

- *TGP format is displayed*
- *TGP mode is A-G*
- *INS roll/pitch data is valid*
- *Aircraft exceeds either of the following attitudes:*
    - *Bank angle greater than 75° and pitch less than 0° or*
    - *Pitch less than -20°*

2.6.3.6.6 ATF NOT ENGAGED CAUTION LIGHT

The ATF NOT ENGAGED light will illuminate immediately with any of the triggers shown below:

Note: the light will not illuminate during a fly-up.

1. ADV MODE switch is depressed when the TFR is not in an operate mode.

2. AUTO TF engaged and:
    - AR Door - OPEN
    - AOA > 29°
    - Aircraft low speed warning
    - Alt flaps - EXTEND (if below 400 KCAS)
    - Gear handle - DOWN
    - NVP low speed warning (VGS < 300 knots)
    - Trim A/P DISC – DISC

3. BLENDED TF engaged and:
    - AR Door - OPEN
    - AOA > 29°
    - Aircraft low speed warning
    - Alt flaps - EXTEND (if below 400 KCAS)
    - Gear handle - DOWN
    - STBY GAINS
    - Manual Pitch Override - OVRD
    - CADC failures
    - NVP low speed warning (VGS < 300 knots)
    - Trim A/P DISC – DISC

2.6.3.6.7 TFR FAULTS

PFL	MFL	EFFECT	ACTION	LIGHTS
NVP BUS FAIL	NVP 003	NVP INOPERATIVE	LHDPT OFF THEN ON. RUN IBIT.	AVIONICS FAULT
NVP COMM FAIL	NVP 014	INS DATA INVALID	CHECK INS	AVIONICS FAULT
NVP COMM FAIL	NVP 015	RALT INVALID	CHECK RALT	AVIONICS FAULT
>SWIM ATTD FAIL<	FLCS 075	AUTO FLY-UP	PADDLE PRESS CHECK NVP COMM FAIL	TF-FAIL
>SWIM RALT FAIL<	FLS 080	AUTO FLY-UP	PADDLE PRESS. CHECK NVP COMM FAIL	TF-FAIL

TFR Faults

2.6.3.7 FLY-UPS / ROLLOUTS

A roll to wings level fly-up is implemented in the FLCS to avoid potential impact with terrain during unsafe operating conditions.

The commanded rollout rate for symmetric wing stores/fuel is 20 degrees per second for bank angles of 45 degrees or less. Above 45 degrees' bank, the commanded rollout rate increases linearly from 20 to 35 degrees per second as bank angle goes from 45 to 75 degrees. Asymmetric wing stores/fuel will decrease the roll rate; however, even at the maximum allowable asymmetry, a minimal roll rate is still available. Beyond 75 degrees of bank, there is no rollout or fly-up. If the pilot maneuvers back within 75 degrees of bank with a failure which would normally cause a fly-up, a fly-up will then occur.

Fly-ups may be interrupted at any time by depressing the paddle switch on the stick.

Note: A roll to wings level fly-up does not occur during a LIMIT EXCEEDED TOO LONG condition in blended auto TF and pitch autopilot mode of operation.

When the TF system (either auto or manual) is operating properly, it never takes more than 2.0 incremental g's to clear a detectable obstacle in the flight path. Hence if a TF system failure is detected immediately a fly-up of 2.0 incremental g's should be sufficient to safely clear the terrain. If the TFR detects something requiring more than its normal 2.0 incremental g's to clear, it issues a g-limit warning, resulting in a 3.0g incremental fly-up. If more than 3.0 incremental g's are necessary to stay clear of the terrain, the NVP issues an obstacle warning which the FLCS turns into a 4.0g incremental fly-up. This obstacle warning could be the result of turning flight or rain if the TFR is not in WX mode.

In summary, the fly-up levels are:

- 4 G incremental – obstacle warning
- 3 G incremental – g-limit, vertical clearance warning, DBU
- 2 G incremental – everything else

All fly-ups are terminated at 300 knots or 45 degrees pitch attitude to prevent a possible stall. A departure from controlled flight may be possible if the aircraft is not controlled by the pilot beyond this 45 degree point.

In all fly-up cases the VMU will generate an aural “PULL UP – PULL UP”. In auto TF these words will be accompanied by an automatic fly-up. In manual TF the automatic fly-up will only occur when the MANUAL TF FLY-UP switch is in ENABLE. Hence, when using the TFR, the pilot’s first response to any aural “PULL UP– PULL UP” should be to fly-up.

Some failures will cause fly-ups which will remain latched, and other conditions will cause fly-ups which will not.

Unlatched fly-ups will be caused by g-limit, obstacle, limit exceeded too long and vertical clearance warnings. As soon as the condition which caused this unlatched fly-up is cleared, the fly-up will terminate and TF can be resumed. If the pilot interrupts an unlatched fly-up with the paddle switch, the fly-up will resume when the paddle switch is released if the conditions that caused the fly-up still exist.

A system malfunction will cause a latched fly-up. This latched fly-up command will remain until a FLCS reset (or paddle switch release for SWIM faults) is performed. If the pilot interrupts a latched fly-up with the paddle switch, releasing the paddle switch attempts a SWIM reset. If the reset is successful, TF can be resumed. If the reset is not successful, the active fly-up will not resume, but the TF FAIL light will remain illuminated and no TF commands will be present.

When radar altimeter data is invalid or missing for 1 second the terrain following system will declare a radar altimeter data bad MFL (FLCS 80), (NVP 015) and a TF RALT FAIL, NVP COMM FAIL PFL. These PFLs and MFLs are usually the result of switching the NVP to an operating mode before setting the radar altimeter to an operate mode or when a radar altimeter break track occurs. In this situation, it is appropriate to execute a SWIM reset and resume TF. If altimeter data is still missing (CARA inoperative) TF will not resume. A bad INS will also trigger a SWIM fly-up with (NVP 014), (FLCS 075) MFLs and SWIM ATTD FAIL, NVP COMM FAIL PFLs.

2.6.3.8 TFR PROCEDURES

These procedures can also be found in the *\Docs\02 F-16 Checklists* folder.

2.6.3.8.1 BEFORE TAXI

1. Sensor power panel - LHPT ON.
2. MFD - Select TFR page.
    (a) Press OSB 4 or OSB 18 STBY and verify NOT TIMED OUT displayed.
3. MFD - Select Test page.
    (a) TFR OSB. Verify TFR BIT displayed for ~1 minute (TFR BIT cannot be run until TFR timeout has occurred).

2.6.3.8.2 BEFORE TAKEOFF CHECKS

1. MANUAL TF FLYUP switch - ENABLE.
2. TFR - STBY.
3. SCP - 1000 feet.
4. Ride - HARD.
5. ALOW - 900 feet.
6. CARA - ON.

2.6.3.8.3 TFR IN-FLIGHT CHECKS

1. After takeoff accelerate to 350 KCAS and climb above 1000 feet AGL.

    (a) CARA - verify reading ±50 feet over known elevation.

    (b) TFR - NORM, verify:

        (1) Flashing LIMIT and airspeed scale displayed in HUD.

        (2) Flashing TFR LIMITS displayed on MFDs.

        (3) TF command box (manual TF) appears.

2. Accelerate to 400 KCAS and verify flashing airspeed limits disappear accelerating through 360 KCAS.

3. Bank aircraft past 60 degrees.

    (a) Flashing LIMIT displayed in HUD.

    (b) Flashing TFR LIMITS displayed on MFDs.

    (c) TF command box (manual TF) disappears when turn held for more than 2 seconds.

4. Roll out and verify flashing turn limits disappear when TFR within limits and TF command box reappears.

5. Accomplish the following check over level terrain (if possible):

    (a) AMS - Depress (verify ACTIVE light illuminates and AUTO TF line is displayed).

    (b) Verify ground return in E-squared scope and NO TER not present in HUD.

    (c) Verify aircraft commands level off at 1000 feet SCP.

    (d) Establish gradual descent by pushing stick and verify:

        (1) Aural ALTITUDE message at 900 feet AGL (ALOW).

        (2) Vertical clearance fly-up at 750 feet AGL (LO TF HUD advisory, TFR LIMITS on MFDs and aural PULLUP MESSAGE).

(e) Allow fly-up to level/climbing attitude, then paddle switch - Depress (STBY light illuminates).

(f) AMS - Depress.

(g) Paddle switch - Release and verify ACTIVE light is out and manual TF box displayed.

(h) Re-establish descent (push over) until approximately 500 feet AGL and verify:

(1) G-LIMIT/OBSTACLE WARNING fly-up occurs.

(2) PULLUP displayed on HUD.

(3) Flashing break X displayed on MFDs.

(4) Aural PULLUP message.

(i) Allow fly-up to level/climbing attitude, then paddle switch - Depress.

(j) SCP - Select minimum mission SCP.

(k) Paddle switch - Release.

(l) Follow manual TF command box to minimum mission SCP and check for correct level flight programming.

6. Establish 15-30-degree bank and perform RALT TEST (TEST page > OSB 7 RALT) and verify:

(a) Manual TF command box disappears and SWIM failure roll to wings level fly-up occurs.

(b) Aural PULLUP message.

(c) WARN displayed on HUD.

(d) TF FAIL warning light illuminated.

(e) TF FAIL PFL on PFLD (only if below 4500 feet AGL).

7. Paddle switch - Depress and hold.

8. Paddle switch - Release when RALT TEST is complete.

9. Mission parameters - Verify/select:

(a) ALOW - As required.

(b) Ride - As desired.

(c) SCP - As desired.

(d) TFR mode - As desired.

2.6.4 HARM TARGETTING SYSTEM (HTS)

The HARM targeting system equips the aircraft with the ability to launch an AGM-88 (HARM) missile using a known range mode. Positioned on the right hardpoint of the engine nacelle, the HTS pod facilitates this functionality. Meanwhile, the left hardpoint continues to support the navigation pod. Power is supplied through the LEFT HDPT switch on the SNSR PWR control panel.

The HTS pod incorporates an advanced receiver that captures precise direction finding information about potential targets. However, to ensure proper operation, the HTS pod must be programmed with ELINT data via the DTE (Data Transfer Equipment). In the event that power to the HTS pod is interrupted, the ELINT data within the pod is reset to zero, necessitating the reloading of ELINT data via the DTE.

Please refer to the HARM ATTACK DISPLAY (HAD) chapter in this document for more information.

2.7 DEFENSIVE AVIONICS

2.7.1 ELECTRONIC COUNTERMEASURES SYSTEM

2.7.1.1 ECM SUBSYSTEM OPERATION

Single point control of the aircraft's ECM systems (ATD's, CMDS, and ECM pods) is accomplished via the position of the CMS relative to the RF switch. The CMS aft position (ECM consent) always gives consent to the ECM systems regardless of the position of the RF switch. However, moving the RF switch out of the NORM position always overrides a previous ECM consent command and places all the ECM systems in standby.

CMS POSITION	ECM/PODS*	ALE-47	ALE-50 *****
Forward	N/A	Program 1-4 **	N/A
Aft	Transmit	Automatic Dispense *** and/ or Consent to Dispense ****	Transmit
Left	N/A	Manual Program 6	N/A
Right	Receive/Standby	Receive/Standby	STBY

* Assumes ECM panel in both cases is set up to transmit.
** Depends on selected manual program on panel.
*** Assumes CMDS Panel mode switch is in auto.
**** Assumes that the CMDS has requested to dispense.
***** Assumes that a decoy is deployed and ready to transmit.

The ECM Enable Light on the MISC panel reflects the jamming/transmit status of the ATD and ECM pod. The ECM state must be consent (CMS aft) and the ECM pod must be in the operate mode, or the ATD must be transmitting, for the light to be illuminated. Otherwise, the light is off.

When in the semiautomatic mode, the ALE-47 (CMDS) must receive consent before it can dispense automatic programs. When the voice message COUNTER is heard, the CMDS is requesting the pilot to dispense. Consent is given by positioning the CMS aft which will dispense one program. When the CMDS is in automatic mode, dispensing is automatic and requires no pilot action. Automatic operation is disabled by positioning the CMS right. Automatic operation is also disabled when MMC power is cycled, the RF switch is moved out of the NORM position, or when the landing gear is not up and locked.

Automatic operation is enabled whenever CMS aft is selected regardless of MODE switch position; however, auto dispensing will not occur until AUTO is selected. When the voice message COUNTER is heard, the CMDS is requesting pilot consent for automatic operation. Manual dispensing is permitted by positioning the CMS forward (manual programs 1-4) or left (manual program 6) or depressing the CHAFF/FLARE dispense button (manual program 5).

The ALE-50 gives consent to transmit when CMS aft is selected with a deployed decoy. When CMS right is selected, transmit consent is removed.

NOTE

Whenever the CMS aft is selected consent is also being given to all other ECM systems, therefore, be aware of which systems are turned on or deployed.

WARNING

If the CMS is held in the aft position, the ECM pod may radiate until the CMS is released even though the aircraft is on the ground. Prior to enabling ECM pod, ensure ground personnel are clear of the radiation area.

To perform high-level BIT on the ECM pods prior to take-off, the ECM pod can be enabled on the ground using the countermeasures management switch (CMS). The ECM pod will be enabled as long as the CMS is held aft. The operator can verify the ECM consent state by the ECM enable light illuminating on the left miscellaneous panel. Upon release of CMS-aft on the ground, the ECM consent state reverts to Standby, and the ECM enable light goes out. Thus, the pilot needs to hold CMS-aft for the duration of ECM pod high-level BIT. (Not implemented yet).

For safety reasons, the ECM state on the ground is normally standby. Once airborne, consent (CMS aft) must be given to operate the ECM subsystems.

The RF switch position only affects the ATD and ECM state when the state is consent. In this state, positioning the RF switch from NORM to QUIET or NORM to SILENT changes the ATD and ECM state to standby. Transitioning from QUIET to SILENT or SILENT to QUIET has no effect on the ATD or ECM state if the state is consent.

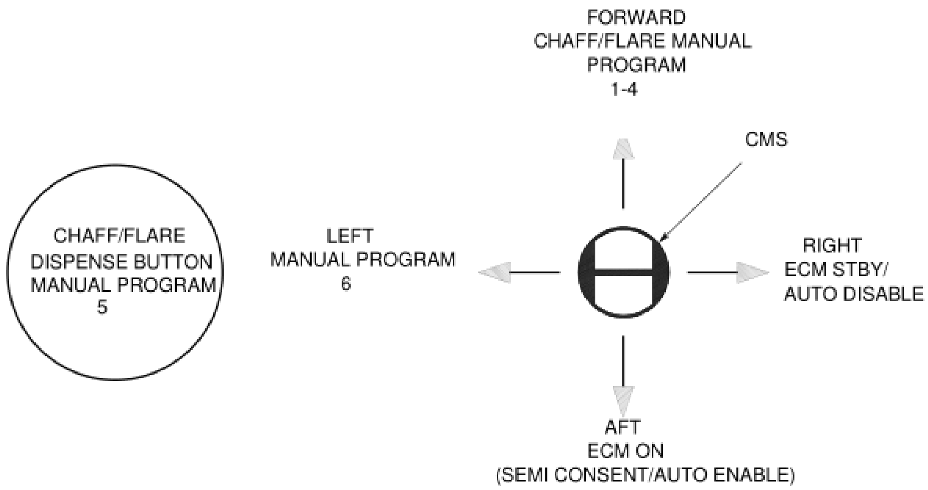
The RF switch position has no effect on the ATD or ECM state during transitions from SILENT or QUIET to NORM. Consent from the pilot must be given in order for the ATD or ECM state to transition to consent.

2.7.2 COUNTERMEASURES DISPENSER SET (ALE-47)

The ALE-47 is capable of 6 chaff/flare programs:

- Programs 1-4, selected on the CMDS control panel, activated in MAN mode with CMS up, or in SEMI / AUTO modes with CMS down, manual
- Program 5 is a manual program activated via the cockpit slap switch and manual
- Program 6 is also a manual program activated with CMS left.

To program the HOTAS to operate realistically, the switch layout is as follows:



CMS Switch

CMDS Cockpit Control Unit (CCU)

2.7.2.1 CMDS MODES

In **AUTO** (automatic), consent is given, for the system to run the selected program (1-4) continuously with CMS down until it is explicitly cancelled with a CMS right, or all chaff or flare expendables are exhausted. The ECM will continue to emit until it is turned off with CMS right.

In **SEMI** (semi-automatic), consent allows the CMDS to run the selected program once only. If the system determines that the threat persists after that (or another has appeared) then it will prompt you for consent again with the "COUNTER" VMU message.

In **SEMI AUTO**, when dispensing is warranted, the DISPENSE RDY display illuminates and the COUNTER voice message is heard (if activated).

NOTE: For SEMI and AUTO, the consent state is tracked even if the CMDS is not yet in SEMI/AUTO. So, if previous consent was initiated (CMS down) and then switched to AUTO, the CMDS will begin dispensing immediately if a threat is detected, and continue until expendables are exhausted or disabled with CMS right. It is recommended to inhibit release prior to entering SEMI or AUTO so as to not inadvertently expend all countermeasures. If the CMDS thinks it should be dispensing in SEMI or AUTO and consent has not been given, it will always prompt with "COUNTER".

The way SEMI and AUTO modes work now is analogous to the difference between semi-automatic and automatic weapons. For AUTO, once consent has been given, the CMDS unit will keep on dispensing, i.e. rerunning the program over and over until the threat is no longer detected or out of things to dispense. In SEMI the CMDS unit will dispense once, when consent is given. If a threat is still being detected after that program is complete in SEMI, the "COUNTER" VMU message will play again to prompt for additional consent.

The **MAN** (manual) position of the MODE knob gives the pilot finer control of countermeasure expenditure as each press of CMS up will result in the relevant program (1-4) being executed only once.

The **BYP** (bypass) position of the MODE knob will result in exactly one chaff and one flare for any dispense request commanded manually (there is no auto or semi-auto dispense in BYP). This can be useful to conserve chaff & flare when expendables are low.

STBY (standby) mode is used to inhibit chaff/flare release while making changes to any of the CMDS programs in the UFC. It is the only mode in which changes to the programs can be made.

NOTE: Auto dispensing is disabled following an MMC power cycle, when the RF switch is moved out of the NORM position, or when the landing gear is down.

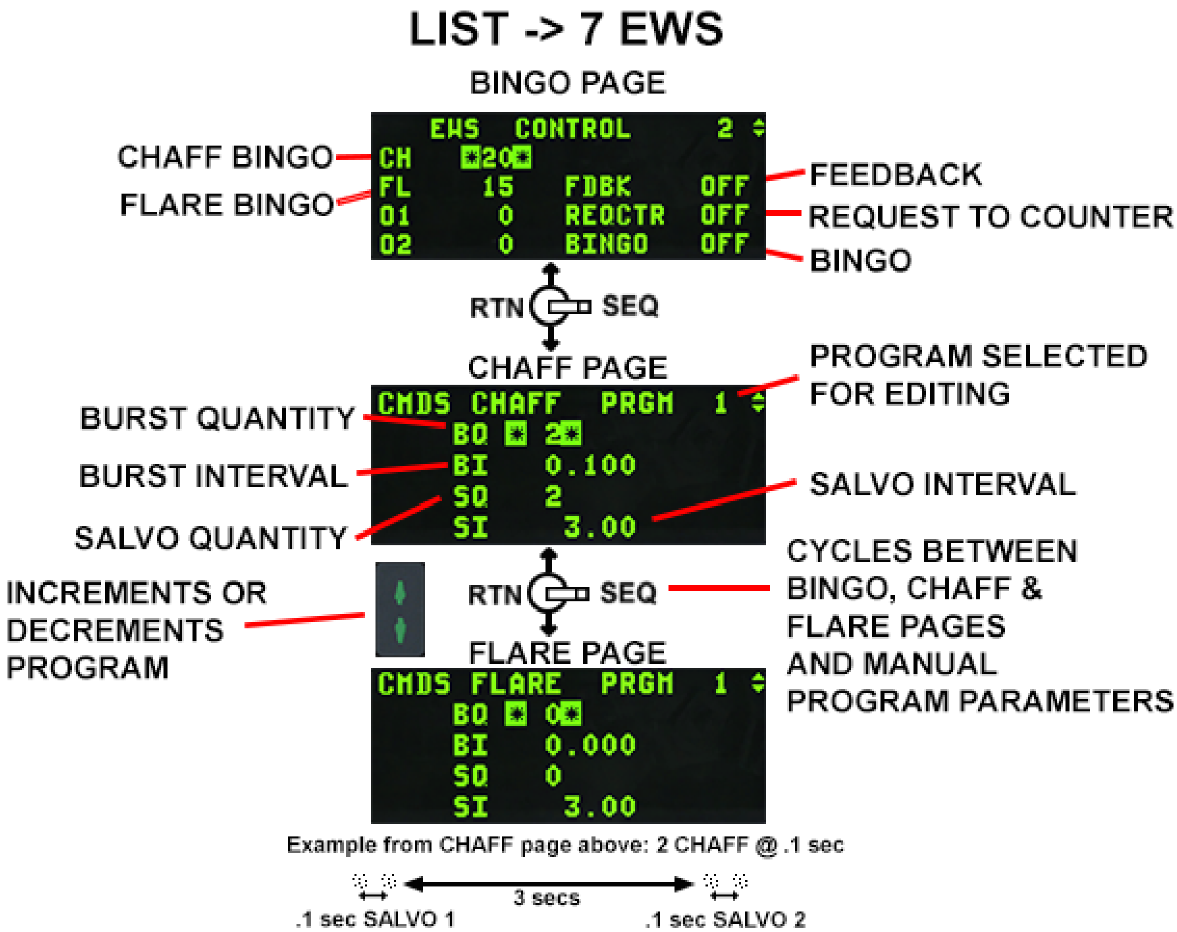
2.7.2.2 CMDS PROGRAMS

With the MODE knob in MAN (manual), SEMI or AUTO, the CMS up (run program) command will manually activate the program currently selected via the PRGM knob (i.e. 1-4). Manual activation will override any automated-initiation dispense program that may be running. Programs 1-4 will run when consent is given and a threat (i.e. missile launch detected) is present. If after running the manually commanded program run the threat is still being detected, AUTO will once again commence running programs for you.

The other two programs can run at any time. Program 5 is always activated by the slap switch ('S' key by default - in the real jet this is a big button on the cockpit wall just outboard of and above the throttle grip). Program 6 is always activated with CMS left.

Therefore, it is possible to have one-touch control of three separate programs, without changing the knob(s) on the CMDS panel. For example, a pilot could set their system up so that programs 1-4 are different chaff programs for countering specific radar threats, while 6 is a flare only program for close range A-A engagements or low level MANPAD defence and 5 is a chaff/flare combo, designed to react quickly to unexpected or unknown threats.

2.7.2.3 EWS DED UPFRONT CONTROLS



DED EWS Pages

The CMDS DED upfront controls are located on the EWS BINGO page (ICP LIST 7) and CMDS CHAFF and FLARE PGM pages. Bingo quantities for expendables are DTC loadable and can be changed via the UFC only if the CMDS CCU mode knob is in STBY.

The REQCTR (request to counter) option enables/disables the "COUNTER" VMU message used to indicate that the EWS has determined that expendables should be dispensed and consent is requested.

The BINGO option enables both the "LOW" VMU message used to indicate that an expendable has reached the bingo quantity and the "OUT" VMU message used to indicate that an expendable is depleted. Bingo quantity can be set to any value between 0 and 99.

The FDBK (feedback) option enables/disables the "CHAFF FLARE" VMU message, used to indicate that an expendable program has been initiated.

The CMDS PGMs can be changed when the CMDS CCU mode knob is in STBY. Positioning the DCS to SEQ selects the expendable category (CHAFF first then another SEQ for FLARE) for the countermeasures program number shown in the upper right corner. The program being displayed/changed is selected via the INC/DEC switch. Positioning the DCS up or down moves between the different fields (burst quantity, burst interval, salvo quantity and salvo interval).

The program parameters can be changed to any value within the following limits:

- Burst Quantity – 0 to 99.
- Burst Interval – 0.020 to 10.000 seconds.
- Salvo Quantity – 0 to 99.
- Salvo Interval – 0.50 to 150.00 seconds.

2.7.3 RADAR WARNING RECEIVER (RWR)

The Radar Warning Receiver consists of several antennas, a processing unit, a radar library and a display. It allows the aircraft to detect and identify radio emissions of radar systems reaching the aircraft and is a vital tool in both A-A and A-G operations for identifying, avoiding, evading or engaging threats.

Previous versions of Falcon had a RWR which was unrealistically accurate in identifying emissions and their direction and distance from the aircraft. Additionally, the various RWRs equipping all F-16 variants were modelled on a single RWR, the ALR-56 equipping USAF F-16s. This version features the majority of RWRs present in most variants, each having custom modes of operation, displays, sounds, controls and direction-finding accuracy. In addition, the distance of the emitter symbol from the center of the scope will not always be proportional to the actual distance, some ambiguities have been introduced.

2.7.3.1 GENERAL INFORMATION AND DEFAULT MODES OF OPERATION

This section describes in-depth the default modes of operation of the RWR, primarily based on the ALR-56M. Specific RWR models and their idiosyncrasies are described starting from section 2.7.3.2 and 2.7.3.3.

2.7.3.1.1 HANDOFF MODES

How long the HANDOFF button is pressed determines what operating mode the RWR is in. The following describes the button operation:

Short push = less than 1.0 second.

Long push = more than 1.0 second.

NOTE: *Short push and long push are general RWR "control" terms and apply to using both a keystroke as well as using the mouse to click the 3d cockpit. However, using these controls vary a little bit when using a keystroke versus the mouse.*

There are 4 operational modes of the RWR. They are: normal, diamond float, transient and latch modes.

2.7.3.1.1.1 NORMAL

Using the HANDOFF button controls how each of these modes are entered and controls the function of the diamond symbol on the display. In normal, the diamond symbol is inhibited and threat audio is limited to "new guy" (or new threat) alert and missile launch audio. New guy audio is 3 bursts of sound in 1.5 seconds of that emitter. New guy alert is also seen visually by symbols alternating between normal size and 1.5 times normal size for the first 4 seconds of display. Normal mode will yield a fairly quiet RWR.

2.7.3.1.1.2 DIAMOND FLOAT

Diamond float mode is entered via a short push of the HANDOFF button. In this mode the diamond symbol on the HANDOFF button illuminates and the diamond on the display floats to the highest priority symbol. Sound for that emitter is heard continuously. Another short push of the HANDOFF button will deselect this mode and go back into normal mode. This mode is recommended for maximum SA.

2.7.3.1.1.3 TRANSIENT

Transient mode is entered by pressing and holding the HANDOFF button. In this mode the diamond symbol steps from the highest priority symbol to the next highest in descending priority order. The diamond will continue stepping for as long as the HANDOFF button is held and audio is played as the diamond enhances the symbol. Releasing the button changes the mode to latched.

2.7.3.1.1.4 LATCH

In latched mode the diamond symbol remains on the last symbol it was on when the HANDOFF button is released. Sound for that emitter is heard continuously. If the symbol times out (emitter no longer detected), the RWR will go back to diamond float mode.

2.7.3.1.2 USING HANDOFF

The HANDOFF button may be actuated with a keystroke or with the cockpit art. For simplicity, it is recommended that pilots map a keystroke to the keyboard or HOTAS, as the short and long pushes are modelled correctly as stated above. In the 3d cockpit, clicking the mouse works as follows:

Left-click = short push.

Right-click = long push; then to “release” a long push, either left or right click.

2.7.3.1.3 NOISE BARS AND CYCLE TIMER

The RWR scope also consists of four noise bars located around the center circle at 6, 9, 12 and 3 o’clock. They indicate the status of noise in the bands 0, 1, 2, and 3 respectively; however this is not implemented and is graphical only. There is a cycle timer on the left end of the band 3 noise bar. This is a vertical bar that moves up and down. As the RWR becomes saturated with signal activity the cycle timer moves progressively slower. With no signal activity, it moves up and down in 1 second. With full RWR activity, it moves up and down at a rate of 2.6 seconds.

2.7.3.1.4 RWR CONTROL HEAD BUTTONS

This section describes the function of the buttons and the illumination pattern of the associated legends for the THREAT PRIME and THREAT AUX control heads that are used to manage the RWR in the F-16.

All lamping should show green legends when illuminated and dark when not illuminated unless otherwise noted.

All button legends are white and visible when power is both on and off.

ALR-56M Buttons and Indicators

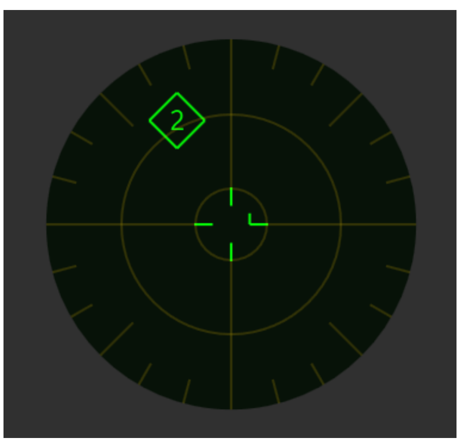
BUTTON LEGEND	LAMP	LAMP OPERATION DESRIPTION	BUTTON PRESS FUNCTION
HANDOFF	diamond	On only when a HANDOFF mode is engaged (FLOAT, TRANSIENT or LATCH). Off otherwise.	See description of HANDOFF function above.
	| H |	On full time but only when power is present to the RWR.	
MODE	PRI	On provided there is power to the RWR and the PRIORITY mode is engaged. Mutually exclusive with the OPEN lamp. This lamp will also flash at 4Hz in PRIORITY mode and the RWR is tracking more than 5 radar sources painting ownship.	Press to toggle between OPEN and PRIORITY mode. OPEN mode shows up to 12 tracks normally or 16 when UNKNOWN mode is engaged. PRIORITY mode shows only the most lethal 5 tracks that the RWR currently tracks.
	OPEN	On provided there is power to the RWR and the PRIORITY mode is NOT engaged. Mutually exclusive with the PRI lamp.	
LAUNCH	MISSILE	Red. On provided there is power to the RWR and if a radar missile is being guided on ownship. Flashes at a 4Hz rate when "on".	No button function implemented.
	LAUNCH	Red. On provided there is power to the RWR and if a radar missile is being guided on ownship. Flashes at a 4Hz rate when "on".	
T	TGT SET	On provided there is power to the RWR and the target separate function has been selected by the player.	Pressing this button will spread out the currently displayed emitter symbols for 5 seconds whereupon it returns to normal display without further player action.
	TGT SEP	On full time but only when power is present to the RWR.	
SYS TEST	ON	On when selected. Self-test shows two test screens.	Initiates self-test. Can be used to 'reset' the RWR if you get the 'stuck RWR bug'.
	SYS TEST	On full time but only when power is present to the RWR.	
ship symbol	U	Can only be on if there is power present to the RWR and one of the following conditions is true: a) UNKNOWN mode has been selected by the player (lamp on full time in this case); or b) UNKNOWN mode is not engaged but the RWR detects unknown type radars painting ownship (U flashes at 4Hz rate).	Press to toggle between UNKNOWN mode on and off. When unknown mode is on, the display will show up to 16 emitter symbols including any that are in the list of unknown type.
	UNKNOWN	On if there is power to the RWR and UNKNOWN mode has been selected on by the player.	

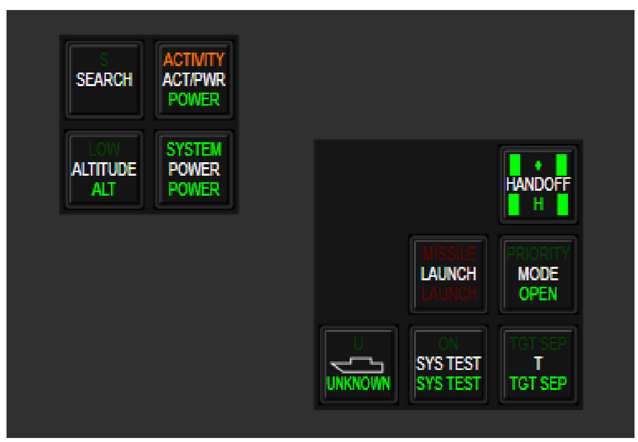
SEARCH	S	Can only be on if there is power present to the RWR and one of the following conditions is true: a) SEARCH mode has been selected by the player (lamp on full time in this case); or b) SEARCH mode is not engaged but the RWR detects search mode radars painting ownship (S flashes at 4Hz rate).	Press to toggle between SEARCH mode on and off. When search mode is on, the display will show S symbols for emitters that are detected as being in an air search radar mode.
ACT/PWR	ACTIVITY	On when there is power to the RWR and the RWR detects missile activity (guide or tracking modes).	No button function implemented.
	POWER	On full time but only when power is present to the RWR.	
ALTITUDE	LOW	On when there is power to the RWR and the player has selected LOW altitude threat preferences.	Press to toggle between LOW and HIGH altitude threat assessment biasing. SAM dat files assign relative threat for a given SAM radar's base lethality score for both LOW and HIGH cases which the RWR uses in assessing relative threat in real time.
	ALT	On full time but only when power is present to the RWR.	
POWER	SYSTEM	On full time but only when power is present to the RWR.	Press to toggle between RWR power on and off.
	POWER	On full time but only when power is present to the RWR.	

2.7.3.2 SYSTEMS (LORAL) AN/ALR-56M

C/D band (0.5-2 GHz) and E through J band (2 to 20 GHz)

Direction-finding accuracy: 15 degrees (E through J band); omnidirectional (C/D band)





2.7.3.2.1 OPERATIONS

After boot up I indication is in middle of scope, after while it changes to WO indication in middle of scope. After initial BIT finishes indications disappear.

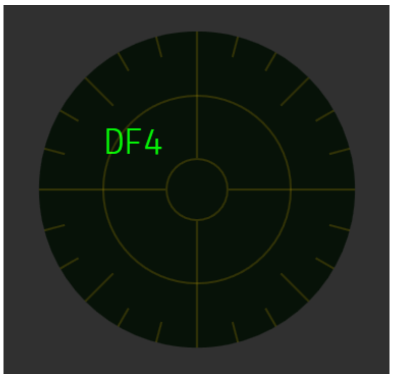
System runs periodical self-tests in background. Pilot can initiate manual Self-Test.

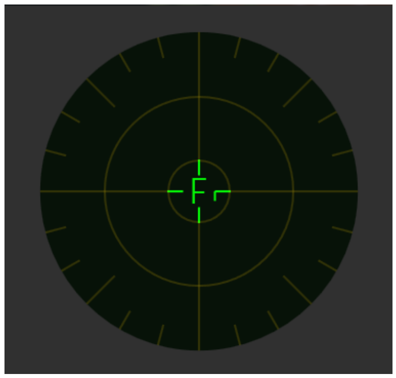
POWER Button	Power ups system
ALTITUDE Button	Selects low alt thread threat table, L indication in middle of scope
SEARCH Button	Shows search (S symbol) radars, S indication in middle of scope
ACT/PWR Lights	Indicates system power and activity on scope
TGT SEP Button	Separates overlapping contacts on scope
SYS TEST Button	Initiates self-test
UNKNOWN Button	Shows unknown contacts, U symbol flashes when there is filtered out unknown contacts
MODE Button	Selects priority mode
LAUNCH Button	Indicates launch, initiates launch light test when pressed
HANDOFF Button	Select highest priority target for composite audio, held for selection browsing

2.7.3.2.2 SELF-TEST

Self-test shows two test screens.

After that if any fault is detected shows faults list screen and reverts to normal display with F in middle indicating fault.



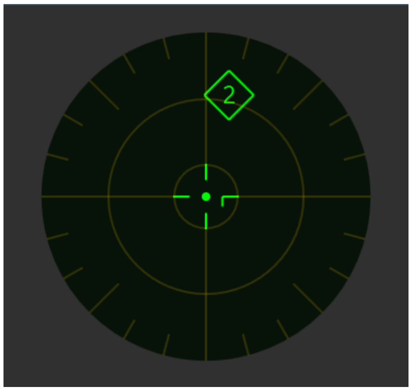


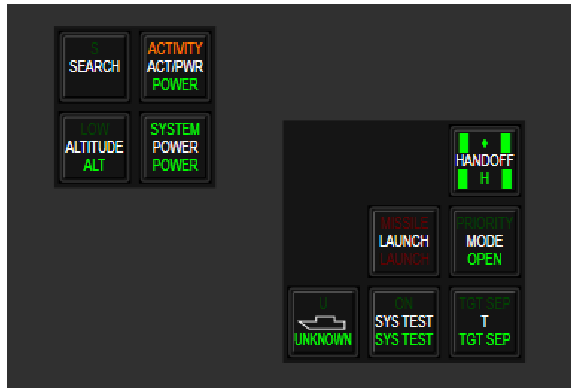
2.7.3.2.3 BUTTONS AND LIGHT MAPPING

Mappings are not changed from default ones.

2.7.3.3 RAYTHEON (LITTON) AN/ALR-69(V)

C/D band (0.5-2 GHz) and E through J band (2 to 20 GHz)
Direction-finding accuracy: 15 degrees (E through J band); omnidirectional (C/D band)





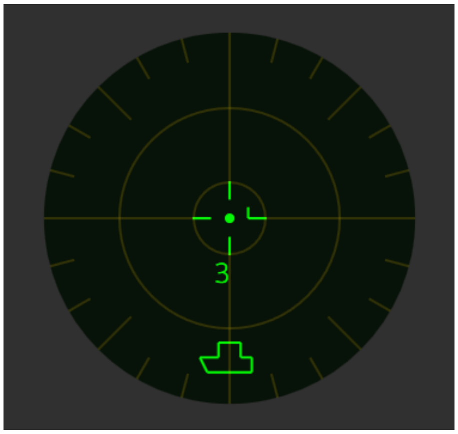
2.7.3.3.1 OPERATIONS

After boot up test patter is on scope, after while F appears in middle of scope for a moment. After initial BIT finishes indications disappear.

System runs periodical self-tests in background. Pilot can initiate manual Self-Test.

POWER Button	Power ups system
ALTITUDE Button	Selects low alt thread threat table, L indication in middle of scope
SEARCH Button	Shows search (S symbol) radars, S indication in middle of scope
ACT/PWR Lights	Indicates system power and activity on scope
TGT SEP Button	Separates overlapping contacts on scope
SYS TEST Button	Initiates self-test, if pressed and within 0.5 sec UNKNOWN button is pressed then it toggles naval mode
UNKNOWN Button	Shows unknown contacts, U symbol flashes when there is filtered out unknown contacts
MODE Button	Selects priority mode
LAUNCH Button	Indicates launch, initiates launch light test when pressed
HANDOFF Button	Select highest priority target for composite audio, held for selection browsing

2.7.3.3.2 NAVAL MODE INDICATION



2.7.3.3.3 SELF-TEST

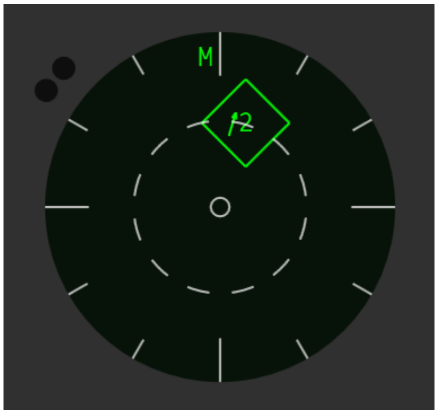
Self-test shows two test screens. If any fault is detected it will be indicated on second test screen with flashing BAD text. Scope reverts to normal display with F in middle indicating fault.

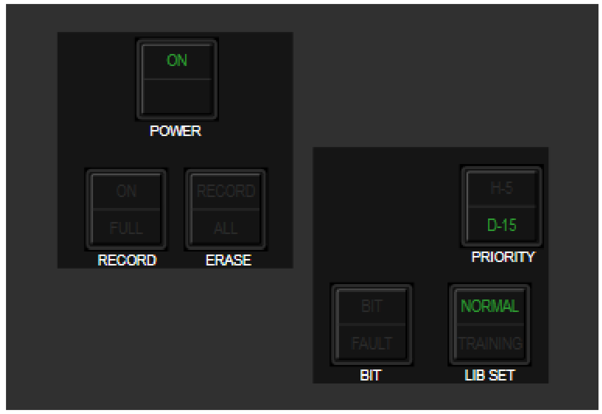
2.7.3.3.4 BUTTONS AND LIGHT MAPPING

Mappings are not changed from default ones.

2.7.3.4 RAYTHEON (LITTON) AN/ALR-93(V)1

C/D-band (0.5-2 GHz) and E through J band (2-20 GHz)
Direction-finding accuracy: 15 degrees (E through J band); omnidirectional (C/D band)





2.7.3.4.1 OPERATIONS

System runs periodical self-tests in background. Pilot can initiate manual Self-Test.

On the top of scope are indications of CMDS mode and ECM state. On the bottom is possible ECM interference indications (repeated on FCR/TFR MFD and HUD). On the right side is ECM unavailable indications.

POWER Button	Power ups system
BIT Button	Initiates self-test if fault detected FAULT light will be on
LIB SET Button	Toggles normal and training libraries, normal one doesn't contain search radars
PRIORITY Button	Selects priority mode

2.7.3.4.2 SYMBOLS

 Highest priority

 Lethal threat

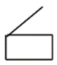
 Launch

 SAM

 Airplane

 Search radar

14 Unknown emitter

 AAA

2.7.3.4.3 SYMBOL CODES

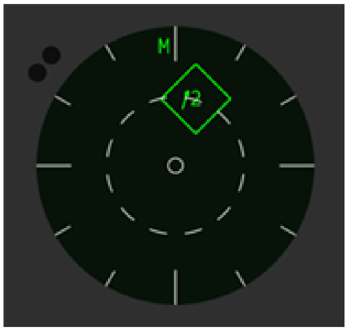
For AAA, SEARCH, UNKNOWN, CW Emitters

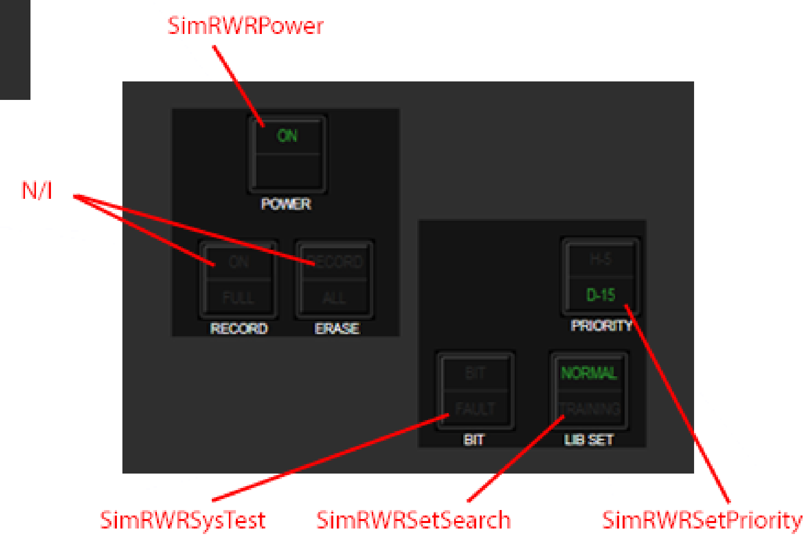
PRI value (ms)	Symbol (first character of unknown emitter symbol)
200	0
201 - 300	1
301 - 400	2
401 - 500	3
501 - 700	4
701 - 900	5
901 - 1200	6
1201 - 1500	7
1501 - 2000	8
2001 - 10000	9

Band	Symbol
E	1
F	1
G	2
H	2
I	3
J	4
anything else	1

T means track-mode and is displayed after single-character emitters, e.g. 6T, for radars that are in track-mode.
A two characters' limit means T cannot be displayed next to emitters that already have 2 characters, so to differentiate the radar mode: octagon + beep every 7 seconds = lock (STT); if you do not hear a beep = track (SAM/TWS or similar).

2.7.3.4.4 BUTTONS AND LIGHT MAPPING

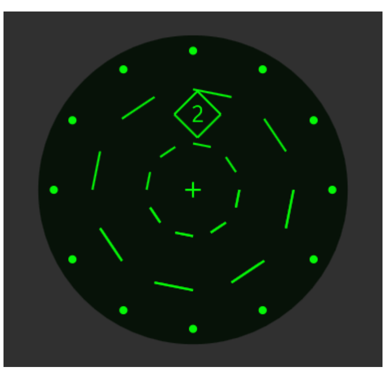




2.7.3.5 THALES AIRBORNE SYSTEMS CARAPACE

Detects C through K band (0.5 to 40 GHz).

Direction-finding accuracy: 1 degree (C through K band);



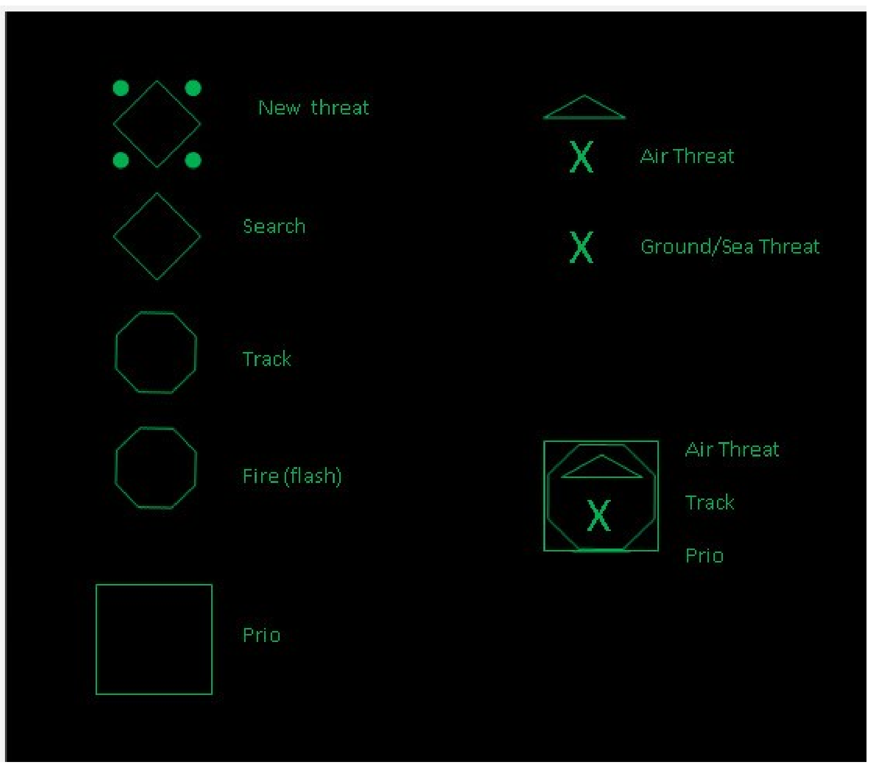
2.7.3.5.1 OPERATIONS

The system will run periodical self-tests in background. Pilots can also initiate a manual Self-Test.

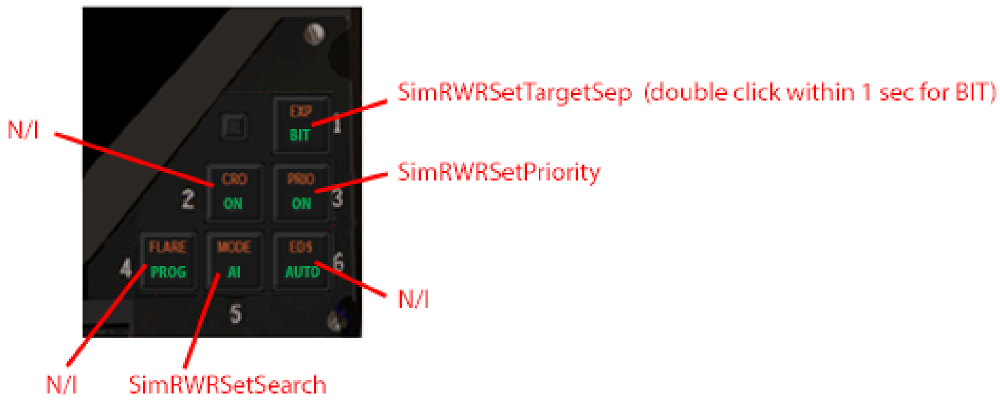
After power up, a female voice informs of any faults. A small FAIL light indicates fault as well. This can be cleared only by power off/on cycle.

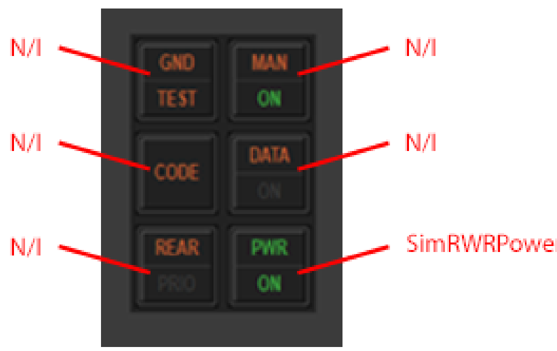
FAIL Light	Indicates fault
EXP Button	Separates overlapping contacts on scope, double click within 1ses initiates self-test indicated by BIT light
PRIO Button	Selects priority mode
MODE Button	Toggles libraries, when AI indicator is on search radars are included
EDS AUTO Light	Indicates CMDS AUTO MODE
MAN ON Light	Indicates CMDS MANUAL MODE
PWR Button	Power ups system

2.7.3.5.2 SYMBOLS



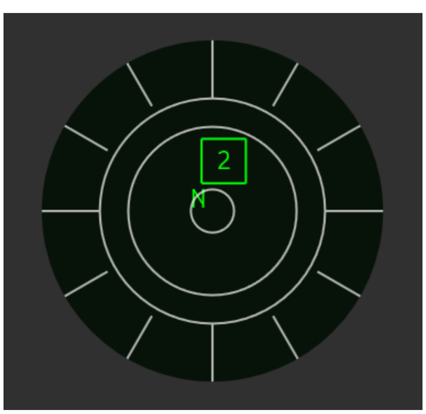
2.7.3.5.3 BUTTONS AND LIGHT MAPPING

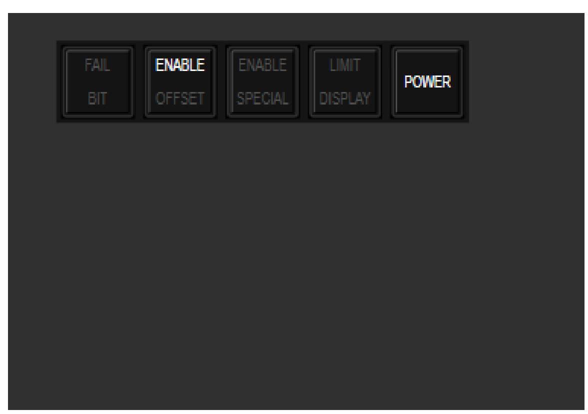




2.7.3.6 RAYTHEON (LITTON) AN/ALR-67(V)3

Detects E through K band (2 to 40 GHz)
Direction-finding accuracy: 15 degrees (E through K band); omnidirectional (C/D band)





2.7.3.6.1 OPERATIONS

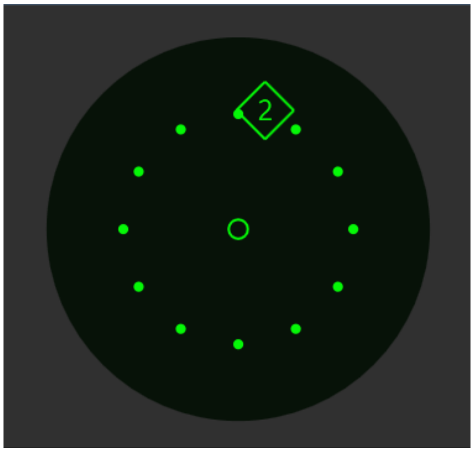
The system will run periodical self-tests in background. Pilots can also initiate a manual Self-Test.

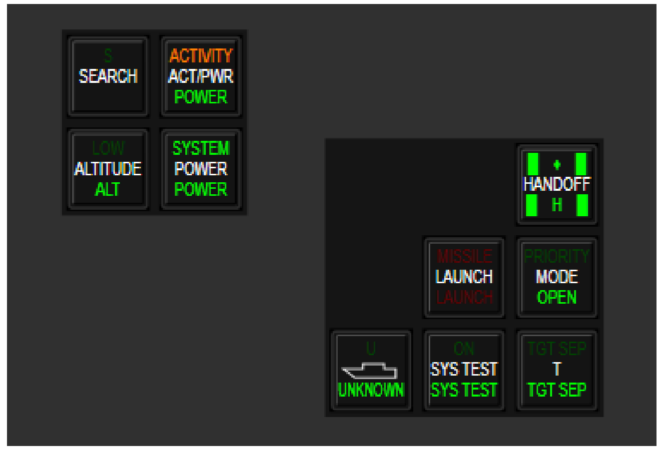
ENABLE OFFSET Button	Select highest priority target for composite audio, held for selection browsing
ENABLE SPECIAL Button	Separates overlapping contacts on scope
LIMIT DISPLAY Button	Selects priority mode
POWER Button	Power ups system

2.7.3.6.2 BUTTONS AND LIGHT MAPPING

2.7.3.7 ELISRA SPS-1000V-5

Detects Bands 0.5 - 18 GHz (band C to J)
Direction-finding accuracy: 15 degrees (C through J band)





The ELISRA SPS-1000V-5 is used in the IAF F-16C-30 Barak I.

2.7.3.7.1 OPERATIONS

Same as ALR-69, except there is no test mode display

2.7.3.7.2 BUTTONS AND LIGHT MAPPING

Mappings are not changed from defaults.

2.7.3.8 ELISRA SPS-3000

C/D-band (0.5-2 GHz) and E through J band (2-20 GHz)
Direction-finding accuracy: 15 degrees (E through J band); omnidirectional (C/D band)

The ELISRA SPS-3000V is used in the IAF F-16C-40 Barak II and F-16C-52+ SUFA.

2.7.3.8.1 OPERATIONS

Same as ALR-93(V1) except ECM operations:

JMR Light	Indicates internal Jammer is ON or in STBY
PRI Light	PRI (PRIORITY) selector button and indicator Light. Yellow when PRI Selected--- Only 5 Of highest display priority threats will be displayed on RWR azimuth indicator/scope
OPN Light	OPN (non-priority) selector button and indicator Light. If in OPN, all threats were displayed.

The status of the JMR is displayed on the down right corner of the FCR.

ECM STBY = ECM is not active

ECM AVNC (Avionics)= XMT 2 (ECM is in AUTO ECM PRIORITY mode)

ECM ECM = XMT 3 (ECM is in ACTIVE JAM mode)

The ECM mode also is displayed in the RWR. STBY = OFF, A = ECM AVNC, E = ECM ECM

For more info, refer to chapter 2.7.4.1.1 of this document.

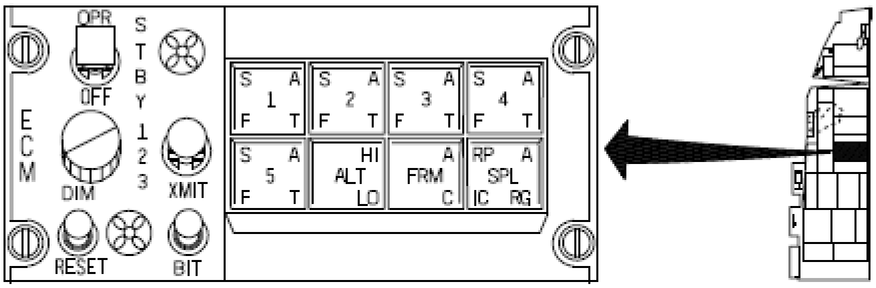
2.7.3.8.2 BUTTONS AND LIGHT MAPPING

Mappings are not changed from defaults.

2.7.4 JAMMER (JMR)

2.7.4.1 ECM POD CONTROL PANEL

The C-9492 ECM pod control panel is located on the left console.



2.7.4.1.1 USAF ECM PODS

The ECM (AN/ALQ-131 and AN/ALQ-184 pods) can be operated through 5 programs. Each program can jam specific radar frequency bands.

Program 1: A-B-C

Program 2: D-E

Program 3: F-G

Program 4: H-I

Program 5: J-K

Depressing the appropriate Control Button puts that program in one of two states – Off or Standby. Once enabled and consent given, each program has four different states.

Control Button	Program Status
Not Pressed	OFF
Pressed	S – Program in Standby
	A – Program is Active
	T – Program Transmitting
	F – Fault

After initial powering of the ECM, the system requires 5-6 minutes to warm-up. During warm-up, the lamps “S” flash. After warm-up, the power switch may be placed to OPR. Once ECM consent has been given (CMS Down), the ECM Enable (ECM ENBL) light illuminates and the programs go from Standby to Active. CMS Right cancels the ECM consent and puts the program(s) back in Standby. The ECM ENBL light does not indicate that the system is necessarily jamming, but that ECM consent has been given.

The Green ECM ENBL light.

NOTE: The green ECM ENBL light is not necessarily an indication that the internal or external Jammer is Jamming unlike previously modelled in BMS. The T on the ECM Control Panel will confirm if the Jammer is jamming, for USAF F-16’s.

The 3 positions Transmit (XMIT) switch allows the pilot to choose operation mode of the ECM.

XMIT 1: ECM is in AUTO AVIONICS PRIORITY mode. If consent is given, the ECM will start jamming a threat radar when detected by the RWR. In XMIT 1, priority is given to other transmitting avionics and only the AFT antenna will transmit. The FWD antenna is inhibited in order to avoid interfering with the aircraft radar (FCR), terrain following radar (TFR), HARM (HAS or HTS pod), or AIM-120 datalink (signals from the FCR). When no threats are detected, the ECM stops transmitting and falls back to active mode.

XMIT 1 with the program in Standby.

XMIT 2: ECM is in AUTO ECM PRIORITY mode. If consent is given, the ECM will start jamming a threat radar when detected by the RWR. In XMIT 2, ECM is operating in ECM priority where both FWD and AFT antennas are transmitting, however other transmitting and/or receiving systems (FCR, TFR, HARM) will be impacted and degraded. When no threats are detected, the ECM will stop transmitting and falls back to active mode.

XMIT 2 with all 5 programs being Active.

XMIT 3: ECM is in ACTIVE JAM mode. If consent is given, the ECM will start transmitting continuously on both FWD and AFT antennas independently of any threats detected by the RWR. This mode will also degrade aircraft emitters/receivers.

XMIT 3 with the jammer transmitting in all 5 programs.

2.7.4.1.2 IMPROVED DEFENSIVE INTERNAL AVIONIC SYSTEM - IDIAS

There are no programs to select as the ECM automatically selects the proper band to jam based on the threat classification by the RWR.

The primary modes are standby and operate (STBY/OPER) and are controlled by the XMTR push button the ECM panel. During warm-up, STBY flashes. The operation modes of ECM (ECM priority), AVNC (Avionics Priority), and STBY are controlled by the CMS LEFT switch. The switch sequence is STBY => AVNC => ECM => AVNC => ECM. AVNC and ECM act as ECM consent. CMS RIGHT changes the operational mode to STBY. Avionics priority vs ECM priority as described above still apply.

1. Operational modes are only available if the XMIT button is pressed and OPER is indicated.

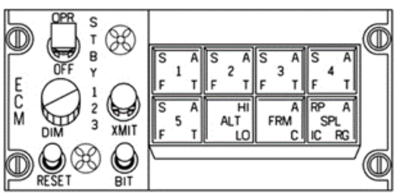
2. Operational modes are displayed on the HUD, FCR, RWR, and TFR page.

In OPER, if after 8 seconds the threat is not detected, the jammer puts itself in a standby mode and both OPER/STBY are lit on the panel. The jammer is still actively ready to jam if the operational mode is AVNC or ECM.

During ECM operations, the RWR exhibits which sensors are impacted during active jamming:

F = FCR, T = TFR, and M = MULTIPLE (FCR + TFR)

2.7.4.1.3 CONTROLS AND INDICATORS



USAF – ECM POD Control Panel

1. Power switch (2 positions) - OFF, Operate (OPR). Note: Standby (STBY) is not implemented yet

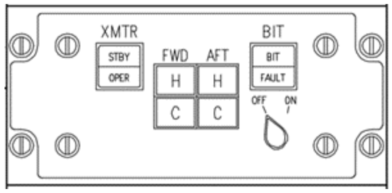
2. Transmit (XMIT) switch (3 positions) - 1, 2, 3

3. Brightness knob (not implemented)

4. Reset switch (not implemented)

5. BIT switch - Checks lights only (actual BIT not implemented)

6. Control buttons (8) - Buttons 1-5. (ALT, FRM, SPL not implemented)



IDIAS – ECM control panel

1. Power switch - OFF, ON

2. XMTR switch - STBY, OPER

3. FWD/AFT Overheat/Overcurrent Indicators (not implemented)

4. BIT - Checks lights only (actual BIT not implemented)

2.7.4.2 JAMMING OPERATIONS

2.7.4.2.1 ECM - KEY PRINCIPLES

The ECM (jammer) subsystem has received significant upgrades based on information found in the public domain. The ECM pod can jam all frequencies in the A-K band. Two types of avionics have been implemented USAF and Improved Defensive Internal Avionic System (IDIAS). The original implementation of the ECM system was inaccurate and therefore should not be taken as reference.

The ECM operations are totally independent from the CMDS (ALE-47) modes. The ECM is coupled with the Radar Warning Receiver (RWR) in order to detect, classify, and jam threats.

Frequency Range	EW Frequency Band	Radar Design Frequency Band
0-250 MHz	A	HF/VHF
250-500MHz	B	UHF
500-1000 MHz	C	UHF
1-2 GHz	D	L
2-3 GHz	E	S
3-4 GHz	F	S
4-6 GHz	G	C
6-8 GHz	H	C
8-10 GHz	I	X (8-12.5 GHz)
10-20 GHz	J	Ku (12.5-18 GHz)
20-40 GHz	K	K (18-26.5 GHz)
40-60 GHz	L	Ka (26.5-40 GHz)
60-100 GHz	M	40-100 Millimeter

Radar Frequency Band Designation

Please note that all bands of the implemented radar emitters in BMS are explained in the "BMS Threat Guide". The previous chapter 2.8.9 from this document released with 4.37.0 has been removed due to the purpose of this document.

2.7.4.2.2 RWR INTEGRATION AND INDICATION

For the IDIAS only, when a threat is classified dangerous by the RWR and jamming is required, the symbols "> <" flash around the threat (i.e., >2<). If the threat is not properly jammed, the "> <" symbol flashes and "jammer-jammer" voice message is played every 8 seconds. Once the threat is properly jammed, "> <" remains static over the threat symbol. The USAF version functions similarly in terms of jamming threats, but no indications are present on the RWR. Except for wingmen, the RWR cannot distinguish between friend or foe and therefore jamming requests are triggered even by friendly radars. No configurable threat database programming exists currently. The "jammer-jammer" voice message can be deactivated via Integrated Control Panel (ICP) menu: LIST => 7 EWS => REQCTR in both USAF and IDIAS. Turning off the JMR switch on the CMDS panel (IDIAS only) will disconnect the RWR from the ASPIS panel and will not jam threats properly. The JMR switch on the ALE-47 (USAF) is inoperative and has no function.

RWR Jamming required and Jamming Symbols.

2.7.4.2.3 ECM INTERACTION WITH ONBOARD EMITTERS/RECEIVERS

When the ECM FWD antenna is transmitting the following emitters/receivers are degraded or unusable:

1) When I-band (program 4) jamming is in progress, the FCR's detection capability is degraded by approximately 30%.

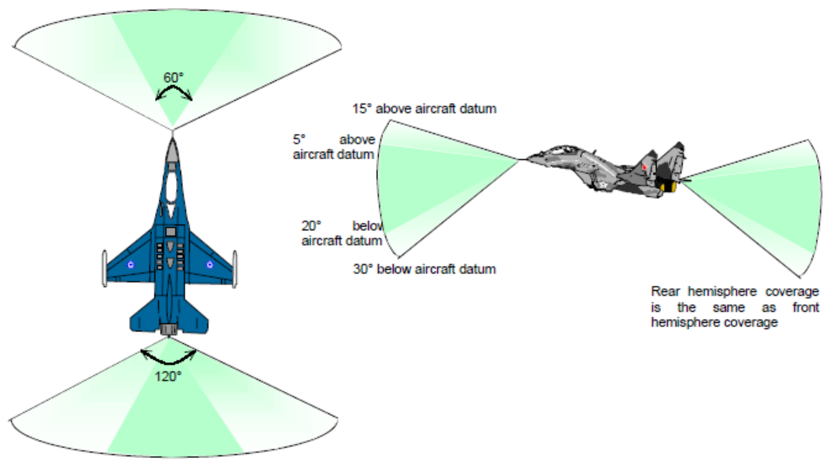
2) The HARM Targeting System (HTS) and HARM As Sensor (HAS) are unusable and will not detect threats.

3) When K-band (program 5) jamming is in progress, the Terrain Following Radar (TFR) cannot be operated.

4) When an active radar homing missile (ARH, i.e., AIM-120, etc.) is fired, the datalink stage inhibits the FWD antenna from jamming any threats, regardless of the ECM transmit mode selected.

2.7.4.2.4 ECM COVERAGE ZONES

ECM coverage zones and reduced power away from the main zone still apply. The primary zone for azimuth is 30◦ either side of the FWD/AFT antennas, and then degrades past 30◦ and becomes ineffective at 60◦ and beyond. The parameters for elevation are full jamming power 5◦ above the horizontal plane to 20◦ below the horizontal plane. Power decreases from 5◦ above to 15◦ above and from 20◦ below to 30◦ below. Above 15◦ elevation up and below 30◦ low, the jammer is totally ineffective.



ECM Coverage Zones (Source: Realism Patch 5 Manual)

2.7.4.2.5 OPERATING PROCEDURES - USAF (ALQ-184/ALQ-131)

This procedure information is additional to the BMS checklists:

Prior to Engine Start.

1. ECM pod power switch - OFF.
2. Control buttons - Verify not depressed.

After Engine Start and Prior to Takeoff.

1. ECM pod power switch - STBY.

After Takeoff.

WARNING

Check that ECM pod power switch is in STBY during air refueling operations.

1. ECM pod power switch - OPR (as required).
2. XMIT switch - 1, 2, or 3 (as required).
3. Control buttons - Depress (as required).
4. CMS - Aft to enable pod transmissions.
   (a) Verify ECM Enable Light illuminated.
5. CMS - Right to disable pod transmissions.
   (a) Verify ECM Enable Light extinguished.

NOTE

Positioning the RF switch to QUIET or SILENT disabled ECM pod transmissions; however, returning the RF switch to NORM does not enable ECM pod transmissions. The CMS must be positioned aft to enable ECM pod transmissions. CMS aft overrides any RF switch position and allows ECM pod transmissions.

Prior to Landing.

1. ECM pod power switch - STBY.

After Landing and Prior to Engine Shutdown.

1. ECM pod power switch - OFF.
2. Control buttons - Deselect.

2.7.4.2.6 OPERATING PROCEDURES - IDIAS

This procedure information is additional to the BMS checklists.

Prior to Engine Start.

1. ECM pod power switch - OFF.

After Engine Start and Prior to Takeoff.

1. ECM pod power switch - ON.

After Takeoff.

WARNING

Check that XMTR switch is in STBY during air refueling operations.

1. XMTR switch - STBY or OPER (as required).
2. CMS - Left to enable pod transmissions.
   (a) Verify ECM Enable Light illuminated.
   (b) Verify operational mode (as required).
3. CMS - Right to disable pod transmissions.
   (a) Verify ECM Enable Light extinguished.

NOTE

Positioning the RF switch to QUIET or SILENT disabled ECM pod transmissions; however, returning the RF switch to NORM does not enable ECM pod transmissions. The CMS must be positioned AFT to enable ECM pod transmissions. CMS AFT overrides any RF switch position and allows ECM pod transmissions.

Prior to Landing.

1. ECM XMTR switch - STBY.

After Landing and Prior to Engine Shutdown.

1. ECM pod power switch - OFF.

PART III - WEAPON SUSPENSION SYSTEMS

3.1 WEAPONS MANAGEMENT

In this section, you will find detailed information about the position and purpose of the Stores Management System (SMS), the Suspension Systems, Miscellaneous Equipment, as well as the associated controls and displays.

3.1.1 STORES MANAGEMENT SYSTEM (SMS)

The primary function of the Stores Management System (SMS) is to effectively manage various components such as weapons, racks, subracks, launchers, and fuel tanks. It achieves this by establishing an electrical connection between the pilot, the weapon delivery avionics, and the stores suspension equipment.

The SMS facilitates weapon delivery by providing pilots with displays that indicate the status of the stores, weapon delivery modes, and the ability to input delivery options while in flight using Color Multifunction Displays (CMFDs) and hands-on controls. Typically, all SMS-related information is loaded into the system using the Data Transfer Cartridge (DTC/ADTC). The pilot's main role with the SMS is to monitor the weapons' load and status, as well as to activate loaded weapons by adjusting settings such as missile tuning and cooling. Manual loading of SMS information is also available as an alternative option.

3.1.1.1 SMS DESCRIPTION

The modular mission computer (MMC) serves as the system responsible for carrying out the Stores Management System (SMS) function. Within the MMC, the SMS function enables both automatic and manual control over the selection, arming, and delivery of weapons, utilizing various cockpit controls, displays, and integrated electronics.

Initiation of the SMS functions occurs from the cockpit through the Color Multifunction Displays (CMFD), the integrated control panel (ICP), side stick controllers, throttle grips, and other cockpit switches. The SMS encompasses the following components:

- MMC Power
- Stores Standby Power
- Weapons Multiplex Bus (W-MUX)
- Remote Interface Units (RIUs)
- Stores Management Control
- Master Arm and Release Power

For weapons to be properly managed, they must be programmed into the memory of the MMC via the CMFD. Standby power is only applied to the specific stations that are loaded in the memory. During a mission, when a store or weapon is selected on the CMFD, a command signal is transmitted to the designated Remote Interface Unit (RIU) to activate the corresponding station. Following a command switch from the cockpit controls, the selected store or weapon is released, and a signal is sent back to the cockpit display, confirming the successful completion of the task.

3.1.1.1.1 MMC POWER

When the Avionics power panel's MMC power switch is set to the MMC position, power is supplied to MMC power relays A and B, resulting in their activation. The following SMS functions are regulated through MMC commands and executed by the remote interface units (RIUs):

- Master mode and submode control
- Store identification, inventory, and status monitoring
- Store activation and control
- Store release, launch, and jettison
- Store sequencing and delivery rate
- Store verification and system integrity checks
- Video switching and power control at weapons stations

3.1.1.1.2 STORES STANDBY POWER

When both the MMC and ST STA power switches are turned ON, standby power is automatically directed to wing weapons stations that have stores loaded in the MMC memory. This standby power is available to supply the necessary power when an action or command is initiated. The routing of power to wing weapons stations 1 through 9 is facilitated by the stores standby power matrix assemblies.

Specifically, wing stations 3, 4, 6, and 7, along with fuselage station 5, require standby power. It's important to note that the power inputs to station 4 and 6 differ from those on stations 3, 5, and 7. This distinction is due to the potential presence of ECM (Electronic Countermeasures) stores loaded on the latter stations, which necessitates unique power considerations.

3.1.1.1.3 WEAPONS MULTIPLEX BUS (W-MUX)

The weapons multiplex (W-MUX) bus comprises the essential wiring and matrix assemblies that enable communication between the MMC, different RIUs, advanced weapons, and sensors. The W-MUX is present at all nine weapons stations and fulfills the interface requirements for seamless integration of weapons and sensors.

3.1.1.1.4 WEAPONS REMOTE INTERFACE UNIT (RIU)

The Remote Interface Unit (RIU) serves as the intermediary between the MMC and the racks and weapons loaded on the weapon stations. It acts as a multiplex terminal and switching center for power, control, release, store status, and analog signals within the Stores Management System (SMS). The RIUs are passive devices and operate under the control of the MMC. They cannot transmit signals unless specifically prompted by the MMC.

It's important to note that only the J/R RIUs are considered integral parts of the SMS. The other RIUs, although crucial components of the SMS, are categorized as weapon suspension equipment. This is because they are installed within and form an integral part of each wing weapons pylon, the centerline pylon, and the missile launchers.

3.1.1.1.5 MASTER ARM AND RELEASE MATRIX ASSEMBLY

In order to release weapons other than EJ (External Jettison), two hardware functions are essential: the MASTER ARM switch and the Weapon Release switches. Proper operation requires positioning the MASTER ARM switch to the MASTER ARM position, while simultaneously depressing and holding either the Weapon Release (WPN REL) or Alternate Release (ALT REL) switch.

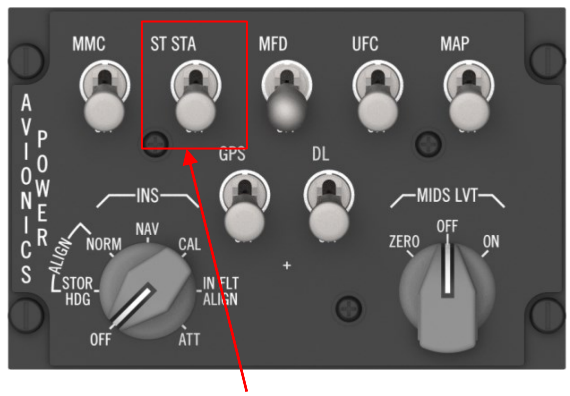
The ALT REL switch functions in parallel with the WPN REL switches, which are located on both the forward and aft side stick controllers. The forward WPN REL switch and the ALT REL switch are powered independently to ensure system redundancy. The aft WPN REL switch is linked to the ALT REL switch, providing a streamlined connection between the two.

3.1.1.1.5.1 SMS RELATED COCKPIT SWITCHES

3.1.1.1.5.1.1 STORE STATION (ST STA) POWER SWITCH

The power-up process of the Stores Management System (SMS) is initiated by the Store Station (ST STA) Power Switch. While the AVIONICS POWER panel itself is not an SMS Line-Replaceable Unit (LRU), it does include the ST STA power switch, which governs the aircraft's power supply to the SMS.

When both the MMC and ST STA power switches are set to ON, standby power is automatically directed to wing weapons stations that have stores loaded in the MMC memory. This ensures that the necessary power is available for those stations.



ST STA Power Switch

When the ST STA switch is set to the "on" position and the MMC switch is also set to "on," the following events occur:

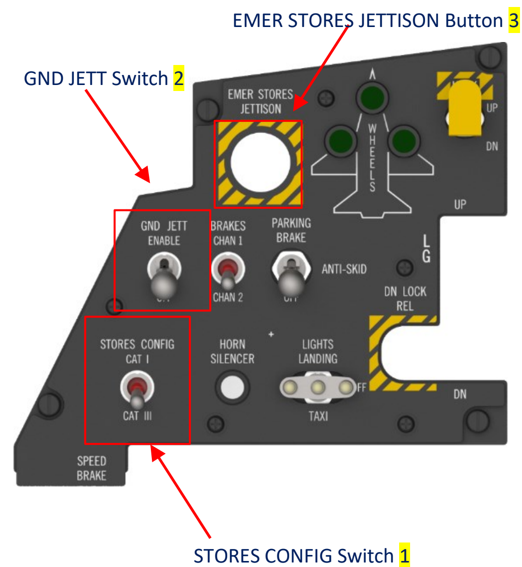
- Power is supplied to store stations that are loaded with inventory.
- Upon transitioning the switch to "on," the master mode is reassessed based on the previously selected master mode before setting the ST STA switch to "off." This reassessment takes into account the positions of the DOGFIGHT/MSL OVERRIDE switches, the EMER STORES JETTISON Button, and the current inventory load. It is as if an MMC power cycle had taken place.
- The Multifunction Display (MFD) presents the appropriate SMS page corresponding to the current master mode and the selected weapon.
- Access to SMS Built-In Test (BIT) is allowed, enabling diagnostic testing of the system.

When the Store Station (ST STA) power switch on the AVIONICS POWER panel is switched to the OFF position, the following actions occur:

- The MMC (Modular Mission Computer) withdraws standby power from the SMS (Stores Management System) Remote Interface Units (RIUs).
- All master modes, except for EMER STORES JETTISON, are deselected, and the reported master mode defaults to Navigation, provided EMER STORES JETTISON is not chosen.
- The master mode remains set to Navigation until either the ST STA switch is activated or EMER STORES JETTISON is selected and executed. After either of these actions, the MMC reverts back to the Navigation master mode.

3.1.1.1.5.1.2 STORES CONFIGURATION (STORES CONFIG) SWITCH

The Landing Gear panel features a two-position switch known as the STORES CONFIG switch (1), which enables the selection of either full or limited flight control laws. In the CAT I position, the full flight control laws are engaged, while the CAT III position imposes restrictions on the angle-of-attack (AOA) and g-forces based on factors such as aircraft gross weight, wing flutter, and aircraft loading.



The avionic system performs checks on the stores loaded in memory and determines if a CAT III condition is present. If there is a mismatch between the stores load and the position of the STORES CONFIG switch, both the MASTER CAUTION and stores configuration lights on the caution panel will illuminate. In such a case, the following procedures should be followed:

1. Verify that the STORES CONFIG switch is in the correct position.
2. Confirm that the stores load is accurate.

3.1.1.1.5.1.3 GROUND JETTISON (GND JETT) SWITCH

The GND JETT switch (2) is a lever-lock switch with two positions, locked in the OFF position. In the OFF position, the switch establishes a circuit to the ground through the right main landing gear down-and-locked (RMLG D&L) relay and the weight-on-wheel (WOW) relay, completing the connection with the MMC.

When the GND JETT switch is moved to the ENABLE position, the ground inputs from the WOW and RMLG D&L relays are disconnected from the MMC, simulating an airborne condition. Consequently, functions dependent on the weight-on-wheel status are not operational when the GND JETT switch is set to ENABLE.

3.1.1.1.5.1.4 EMERGENCY STORES JETTISON (EMER STORES JETTISON) BUTTON

By pressing the EMER STORES JETTISON button (3), power is immediately applied to the MMC jettison circuitry, resulting in the safe release of all conventional stores loaded in stations 3 through 7. However, it's important to note that air-to-air missiles mounted on stations 1-3 and 7-9 are not jettisoned, and ECM pods remain unaffected regardless of the station.

Emergency jettison operates with the highest priority and supersedes any existing mode of operation, including a weapon release input. Its primary function is to ensure the prompt and overriding disposal of stores in critical situations.

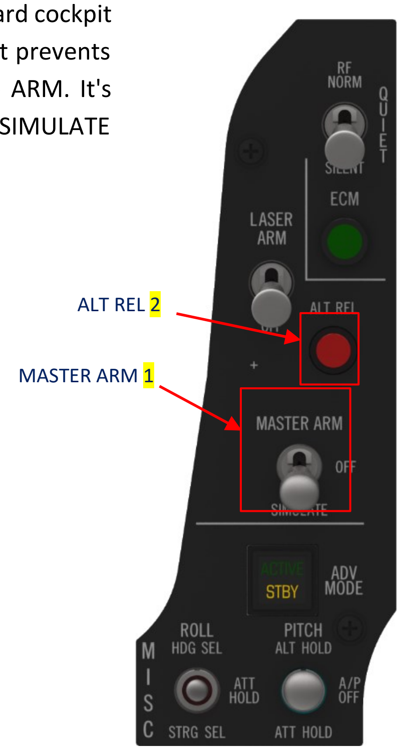
The entry into E-J (Emergency Jettison) mode is restricted by a few conditions. The presence of Weight-On-Wheels (WOW) signal can be bypassed by enabling the GND JETT switch to simulate an airborne condition. Additionally, an AIM-120 missile in the midst of being launched, SMS Built-In Test (BIT), MMC BIT, or failure of the dual redundant E-J switch can also inhibit entry into E-J mode.

When either the forward or aft cockpit button is pressed and held for more than one second, the MMC sends a dual fire signal to stations 3 through 7, which may contain MAU-12 racks and/or fuel tanks. If the MMC power is off at the time, pressing and holding the button activates MMC power, similar to positioning the MMC power switch to MMC.

The Emergency Jettison input operates with dual redundancy, meaning that two signals must be present to initiate mode selection. It is designed in this way to ensure that no single failure can cause or prevent mode selection. These switches require a pressure of 3 to 6 pounds to be depressed.

3.1.1.1.5.2 ARMAMENT CONSENT (ARMT CONSENT) SWITCH

The armament consent switch is connected in series with the MASTER ARM switch in the forward cockpit and is safeguarded in the ARMT CONSENT position. When the switch is in the OFF position, it prevents the arming of weapon/store stations and the gun when the MASTER ARM switch is set to ARM. It's important to note that the armament consent switch does not have any effect when the SIMULATE position of the MASTER ARM switch is selected.



3.1.1.1.5.2.1 MASTER ARM SWITCH

The MASTER ARM switch (1) is an integral part of the circuit responsible for enabling the arming and release of weapons on the F-16, whether in actual combat or simulated scenarios. It is connected in series with the armament consent switch located in the aft cockpit and grants permission for the arming and release of the stores displayed on the Multi-Function Display (MFD). When set to SIMULATE, the MMC responds as if it were in a ready (RDY) condition. This allows for full exercise of the integrated avionics system without actually arming or releasing any weapons. The only noticeable difference in the displays between the MASTER ARM and SIMULATE positions is the word shown in HUD window #3 and HMCS ASCII Window #1, where "SIM" is displayed instead of "ARM." Other than that, the HUD displays remain identical in both positions.

3.1.1.1.5.2.2 ALTERNATE RELEASE (ALT REL) SWITCH

The ALT REL switch (2) is designed as a push-button type switch and operates in parallel with the WPN REL switch located on the control stick. Its main function is to supply power input for weapon release commands to both the MMC and the master arm and release matrix assembly. The ALT REL switch is equipped with an independent power source that ensures continued functionality even in the event of power failure, providing an additional layer of protection against complete loss of function.

3.1.1.2 SMS FORMAT

The SMS format encompasses various aspects such as stores inventory, loading, weapons delivery mode selection, and weapons release parameter selection. These controls and data primarily depend on the specific SMS mode, which will be further explained in the following paragraphs.

The controls and data for the mentioned functions are provided through various SMS page-displays:

- OFF (SMS off): This display is shown when the MMC and ST STA power switch is off or if there is a communication issue between the MFDS and the SMS.
- INV (inventory): Automatically displayed when accessing the NAV master mode and can be selected in all SMS modes except E-J, S-J, and BIT.
- S-J (selective jettison): Accessed through OSB 11, located near the S-J mnemonic, on all SMS pages except BIT, data entry, and E-J.
- E-J (emergency jettison): Activated by pressing the EMER STORES JETTISON button on the landing gear panel, overriding all other master modes.
- AAM (air-to-air missile): Selected through the AAM/GUN rotary (OSB 1) on the SMS mode page when the A-A master mode is chosen.
- MSL (missile override): Activated manually by using the DOGFIGHT/Missile Override switch, overriding all master modes except emergency jettison.
- DGFT (dogfight): Activated manually using the DOGFIGHT/Missile Override switch, overriding all master modes except emergency jettison. The enhanced envelope gunsight (EEGS) gunnery option is included in the dogfight master mode and can be identified by the EEGS designation adjacent to OSB 2.
- GUN (gunnery): Selected through the AAM/GUN rotary when A-A is selected or the A-G/GUN rotary when A-G is selected. It is located adjacent to OSB 1 on the SMS mode page.

    - EEGS: Accessible when both A-A master mode and the GUN mode on the SMS format page are selected.
    - STRF (strafe): Accessed when both the A-G master mode and the GUN mode on the SMS format page are selected.

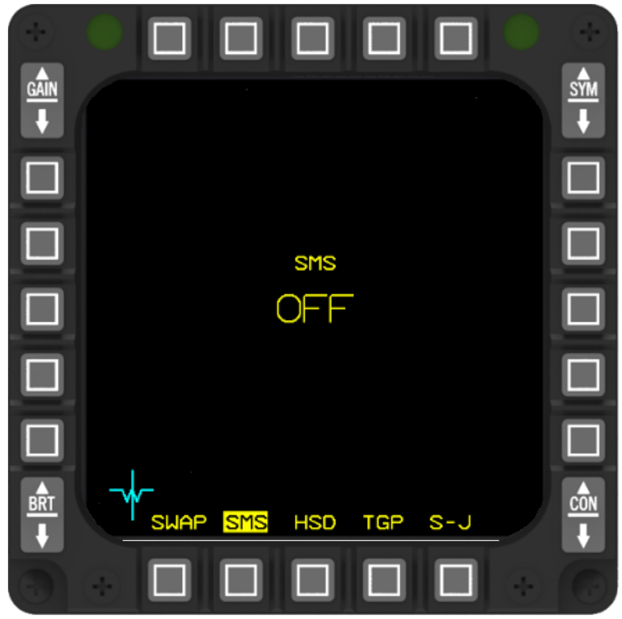
- A-G (air-to-ground): Selected through the A-G/GUN rotary, adjacent to OSB 1, when the A-G master mode is chosen.
- BIT (built-in test): Selected through the MFD TEST page for performing built-in tests.

MASTER MODE	AVAILABLE SMS PAGES
NAV	INV
A-A	INV
	AAM
	GUN
A-G	INV
	A-G
	GUN
DGFT	MSL
	INV
S-J	S-J
E-J	E-J

Available SMS pages for all master modes

3.1.1.2.1 SMS OFF PAGE

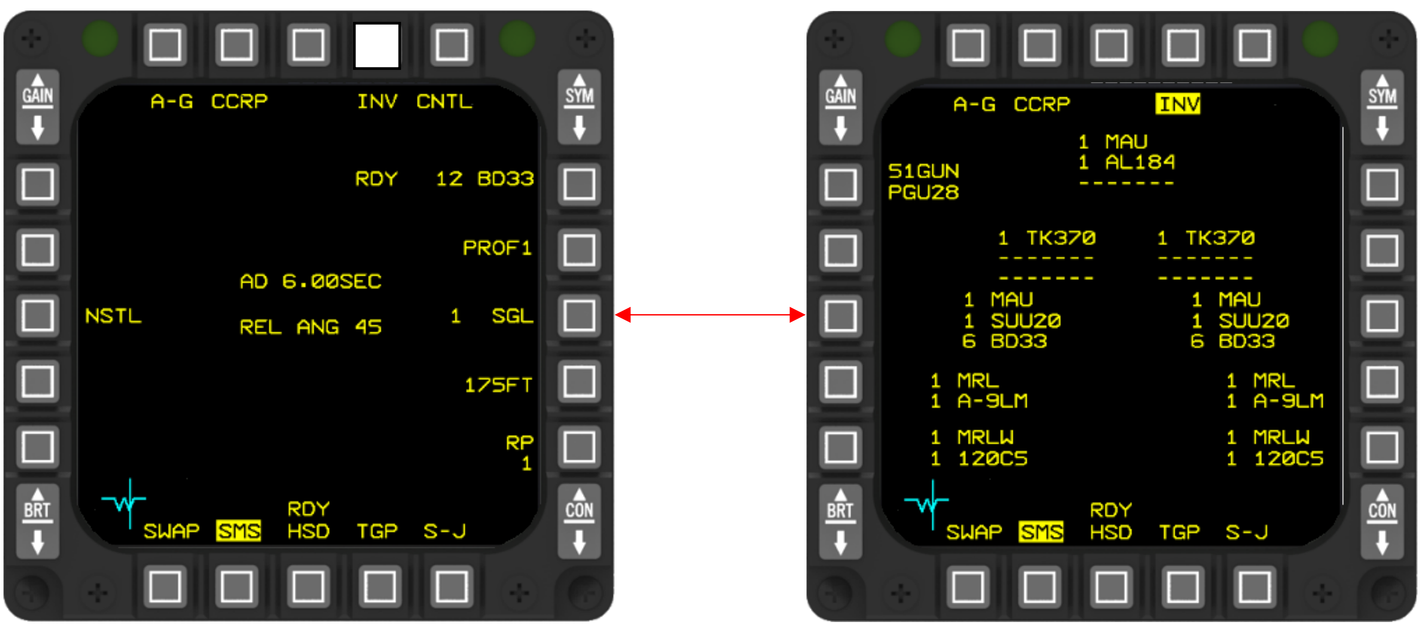
When the communication between the MFDS and the MMC is disrupted or the store station power switch is in the OFF position (excluding SMS BIT), the SMS OFF mnemonic is shown at the center of the MFD. On the OFF page, only cursor zero select and backup sensor functionalities are accessible.



SMS OFF Page

3.1.1.2.2 SMS INV PAGE

The verification, modification, and input of stores inventory are performed through the INV and menu pages. Whenever the navigation master mode is activated or when operating in a different master mode, the INV page is automatically displayed on the SMS format. However, if the system is in a non-navigation master mode, pressing OSB 4 next to the INV mnemonic on any displayed SMS format will access the INV page. Similarly, pressing OSB 4 next to INV on the INV page will bring up the SMS base page corresponding to the selected master mode. This allows for easy navigation and interaction with the SMS functions.



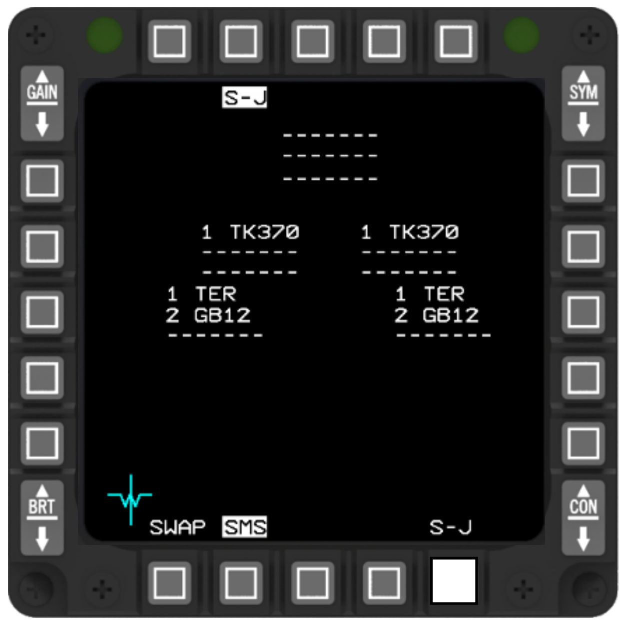
The SMS does not allow for the entry of NVP and TGP on stations 5L and 5R. The CRUS modes, however, consider the drag index of the TGP even when the hardpoint power is not activated. The drag caused by NVP is not taken into account. To establish power and communication to these hardpoints, you can simply select LEFT HDPT and RIGHT HDPT on the SNSR PWR panel respectively, and the connection will be automatically established.

The stores inventory is presented in numerical order based on the station number. The stations are arranged on the page in the shape of an inverted V, with station 1 located at the lower left corner, station 5 at the top center of the MFD, and station 9 at the lower right corner. Racks and weapons are displayed simultaneously at their respective stations, following the loading sequence. If a station has no stores loaded, it is indicated by dashed horizontal lines, each representing a potential weapon or rack that can be loaded at that station. Adjacent to OSB 20 of the MFD, you will find the GUN mnemonic and the number of 20mm rounds remaining (displayed in tens). Below the XXGUN mnemonic, the type of 20mm ammunition loaded into the SMS inventory is displayed.

WARNING: The accurate placement of the pull-up cue and the initiation of the break-X warning depend on the SMS (Stores Management System) stores loading data. Ground collision, pull-up cue, and break-X computations utilize this data. If the SMS store inventory does not accurately reflect the actual stores loading, these computations will result in errors. As a consequence, early or late pull-up warnings may occur.

3.1.1.2.3 SELECTIVE JETTISON (S-J) MODE PAGE

The S-J mode allows for the release of specific stores from chosen stations in an unarmed or unguided state. For detailed procedures on Selective Jettison, please refer to TO 1F-16CMAM-1 BMS.



SMS S-J Page

The S-J mode operates concurrently with the A-A and A-G modes, but it has lower priority compared to the override modes. It is important to note that the S-J mode is not accessible when the Weight-on-Wheel (WOW), Right Main Landing Gear Down and Locked (RMLG D&L), SMS BIT, or MMC BIT inputs are active in the MMC (however, enabling GND JETT can bypass both WOW and RMLG D&L signals, simulating an airborne condition).

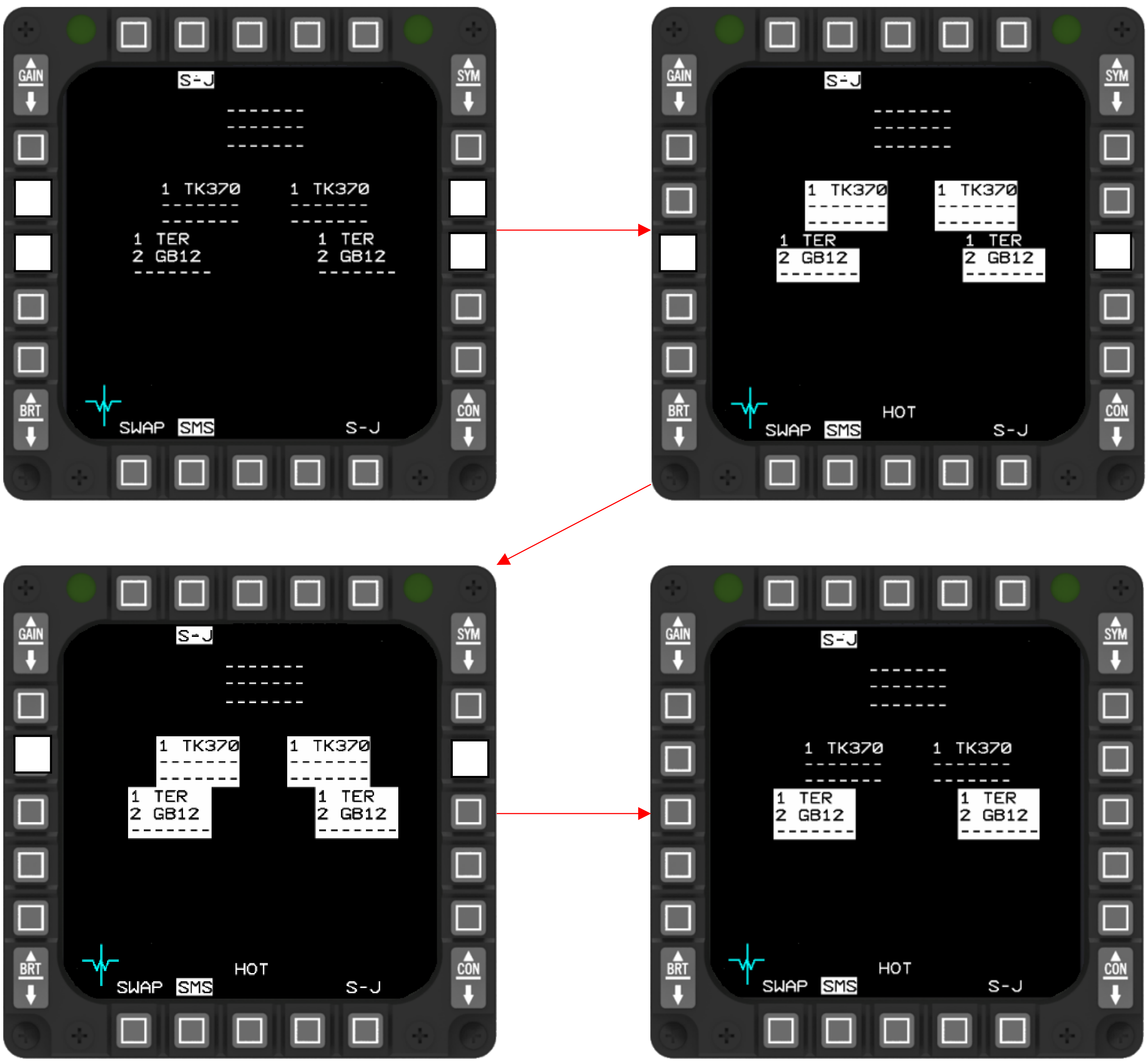
The selective jettison mode allows for the preselection of stores to be jettisoned, and the chosen configuration is stored by the MMC (Multi-Function Control) even during mode transitions and power cycles. The MMC communicates the selected jettison configuration to the pilot by highlighting the corresponding store mnemonics on the MFDS (Multi-Function Display System) Selective Jettison page. Furthermore, the MMC is responsible for determining the appropriate type of release command to be applied to a selected jettison station, which can include the following options:

- Dual cartridge fire: This applies to various stores, such as the 300/370 Gallon Tank, BRU-57/A, TER-9A, LAU-117, SUU-20, MK-84, GBU-31, BLU-109, BLU-107, AGM-158A, GBU-10, GBU-24, and all IAMs directly loaded on a MAU-12. These stores are released using the dual cartridge fire release command.
- Single cartridge fire: This release command is used for stores like BDU-33, and MK-82, except when an AGM-65 is loaded on a LAU-117/A.
- Release consent: This applies to specific stores like HARM, which require release consent before being released.
- BRU-57 cartridge fire: This release command is specific to GBU-12 on a smart rack and all IAMs that can be carried on a BRU-57. These stores are released using the BRU-57 cartridge fire release command.

To select stores, simply press the OSB (On-Screen Button) located next to the desired store. The selection process varies based on the number of stores loaded on a station:

- If only one store is loaded on a station, pressing the adjacent OSB once will select and highlight the store. Pressing it a second time will deselect the store.
- If two stores are loaded on a station, pressing the adjacent OSB once will select the bottom-most store. Pressing it a second time will select both the bottom-most and top-most stores. Pressing it a third time will deselect both stores.

It is possible to jettison racks and weapons from different stations with a single depression of the WPN REL (Weapon Release) switch. Once the switch is pressed and the store release is confirmed, the highlight is removed from the corresponding store mnemonics, and the quantity readouts associated with the stores will display zero.



SELECTION AND DESELECTION OF MULTIPLE STORES ON S-J PAGE

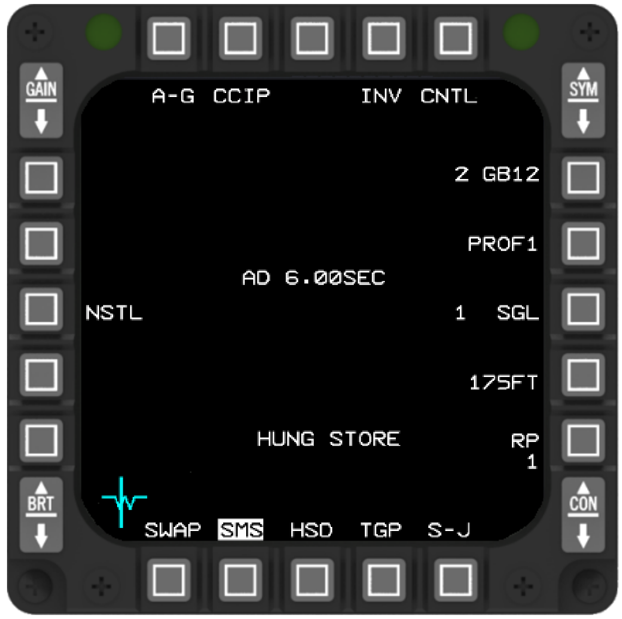
3.1.1.2.3.1 SELECTIVE JETTISON (S-J) SYSTEM STATUS

During the Selective Jettison (SJ) master mode, the MMC (Multi-Function Control) assesses the system status for the selected stations based on the following criteria:

- REL: This status indicates that a release signal has been issued for the selected station. The MMC has initiated the release command.
- HOT: In this status, the weapon on the selected station is not armed, but the release is commanded after the weapon release button is pressed. The MMC awaits the weapon release command.
- SIM: This status is applicable when the MASTER ARM switch is in the SIMULATE position. It signifies that the system is in a simulation mode rather than an actual operational state.
- MAL: MAL indicates a communication failure between the MMC and the RNRIU, disrupting status monitoring.

These status indications help determine the actions and responses related to the selected stations while operating in the SJ master mode.

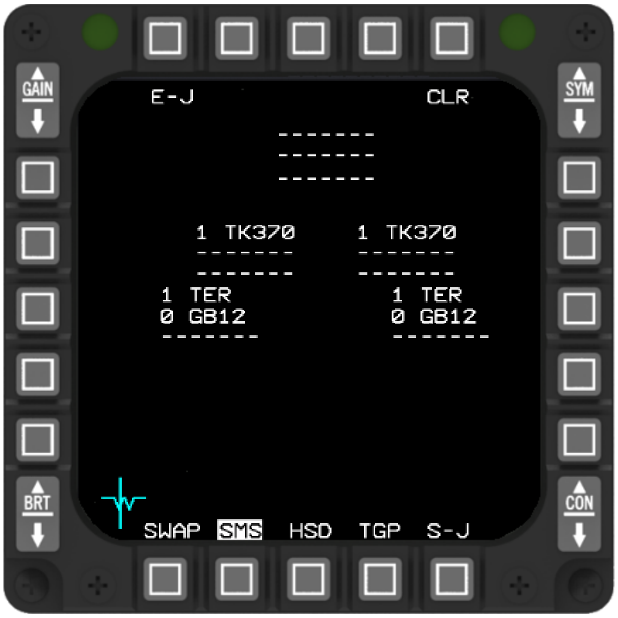
When there are hung stores detected, the MFD (Multi-Function Display) will show the HUNG STORE advisory at the bottom center of the screen, along with the corresponding station numbers. This visual indication alerts the operator to the presence of hung stores on the aircraft.



HUNG STORE ADVISORY DISPLAY

3.1.1.2.4 EMERGENCY JETTISON MODE PAGE (E-J)

The E-J page shares a similar format to the INV (Inventory) and S-J (Selective Jettison) pages and is displayed in E-J mode. Emergency jettison is a straightforward process that clears all carted conventional stores from stations three through seven. It's important to note that air-to-air missiles loaded on stations 1-3 and 7-9, as well as ECM pods, are not jettisoned.



E-J PAGE

To initiate emergency jettison, the frangible emergency stores jettison (EMER STORES JETTISON) cover on the landing gear panel needs to be broken. Then, the button beneath it must be depressed and held for a minimum of 1 second. This action selects the emergency jettison mode, overriding the selected master mode for as long as the button is held down. The stores will be jettisoned in an unarmed or unguided state. Releasing the button restores the overridden master mode.

There are certain conditions that prohibit emergency jettison, including weight-on-wheels being set (unless GND JETT is enabled to remove the Weight-on-Wheel (WOW) signal and simulate an airborne condition), an AIM-120 missile being in the process of launching, a failed E-J switch, or SMS BIT being enabled. For detailed procedures on Emergency Jettison, please refer to TO 1F-16CMAM-1 BMS.

When the ST STA (Station Status) is switched off, pressing the EMER STORES JETTISON button provides electrical power to the ST STA. However, it's important to note that emergency jettison functionality is only available if either the main generator or the EPU (Emergency Power Unit) generator is operational.

While in Emergency Jettison mode, the MMC (Multi-Function Control) automatically selects all air-to-ground (A-G) stations for a dual cartridge fire jettison. It reports that all A-G stations are chosen for jettison. The MMC first issues disarm commands to the CRIU/ACRIUs (Control and Release Interface Units). Subsequently, the MMC continuously sends sets of dual cartridge fire commands to the SMS (Stores Management System). Both the left and right J&R RIUs (Jettison and Release Interface Units) receive commands to perform a cartridge fire for each station. The initial set of dual cartridge commands initiates the firing sequence. The second set of dual cartridge fire commands is sent to obtain the status of the cartridge fire relays. This status is returned to the MMC in the form of a "wrap status" from the SMS, indicating the open/close status of the cartridge fire relay. If the SMS fails to provide any status to the MMC, an MFL (Maintenance Fault Log) is reported for the malfunctioning J&R RIU.

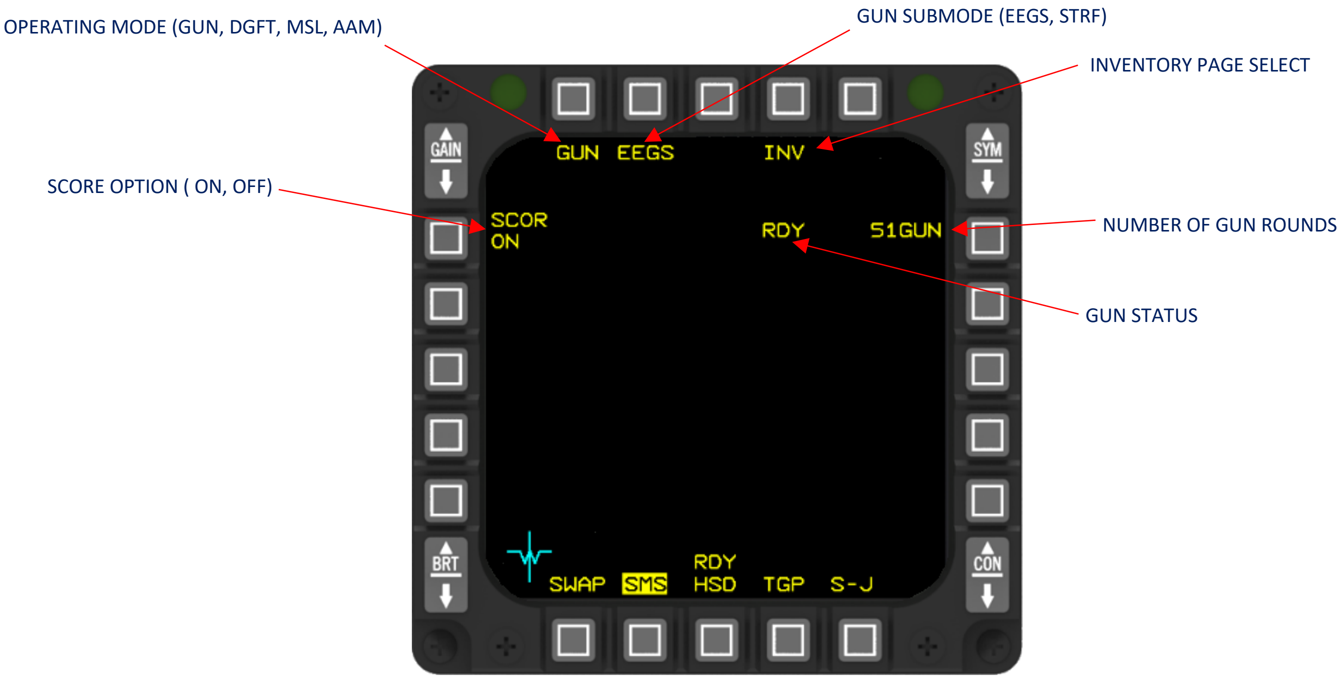
To mitigate the risk of collision upon release, special logic is implemented for jettisoning fuel tanks. If there are no stores present at station 3 or 7, a normal release is carried out. However, if there are stores at either station 3 or 7, the MMC checks for the presence of fuel tanks at stations 4 and 6. If no fuel tanks are detected, a normal release is performed. On the other hand, if fuel tanks are found at both stations 4 and 6, the release of the tank at station 6 is intentionally delayed by 150 milliseconds.

3.1.1.2.5 GUNNERY, AIR-TO-AIR MISSILE, MISSILE OVERRIDE AND DOGFIGHT MODE PAGES

The GUN/AAM mode pages are designed to facilitate control and display for both gunnery and air-to-air missile operations. This mode allows for effective engagement in air-to-air combat using guns or AIM-9 and AIM-120 missiles. The selection of the GUN/AAM mode is made through the master mode rotary located below OSB 1. If the GUN mode is chosen, the option to utilize the enhanced envelope gunsight (EEGS) for gunnery is indicated below OSB 2. For a comprehensive explanation, please refer to the detailed description provided in the AIR-TO-AIR section.

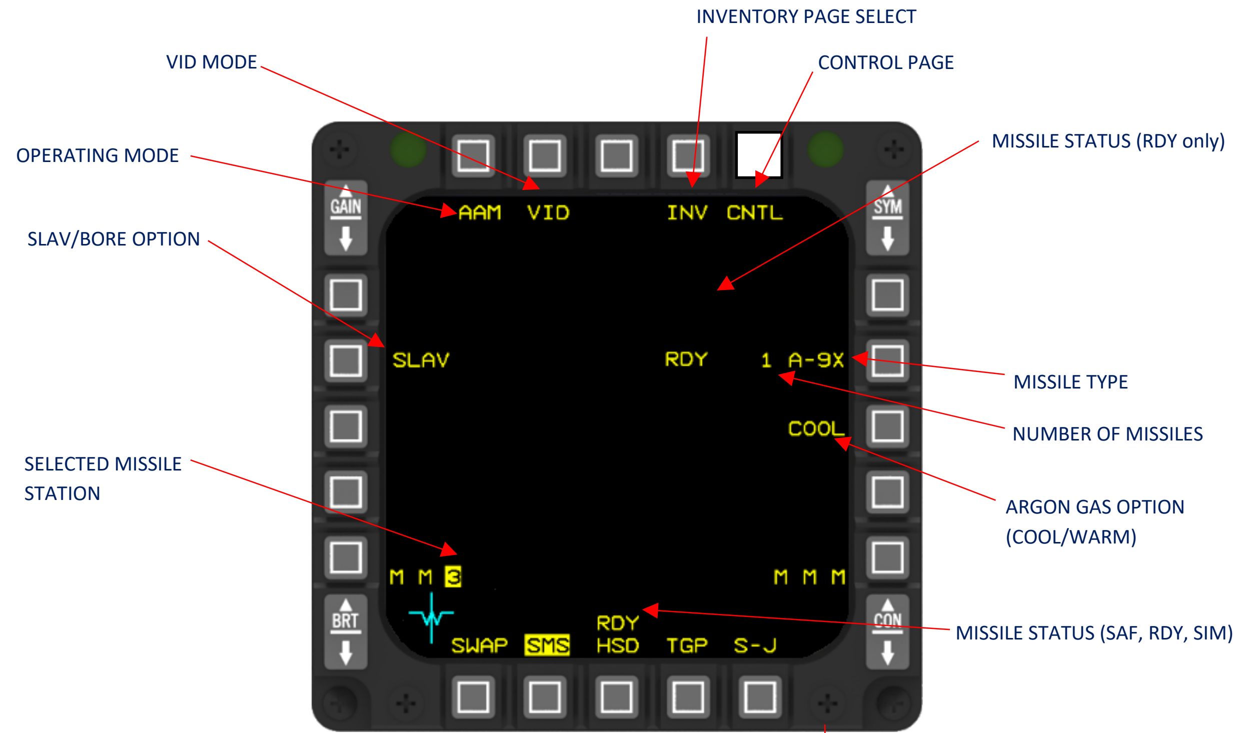
For specific ordnance release parameters and options, please refer to the relevant AIR-TO-AIR chapter.

3.1.1.2.5.1 SMS AIR-TO-AIR GUNNERY PAGE

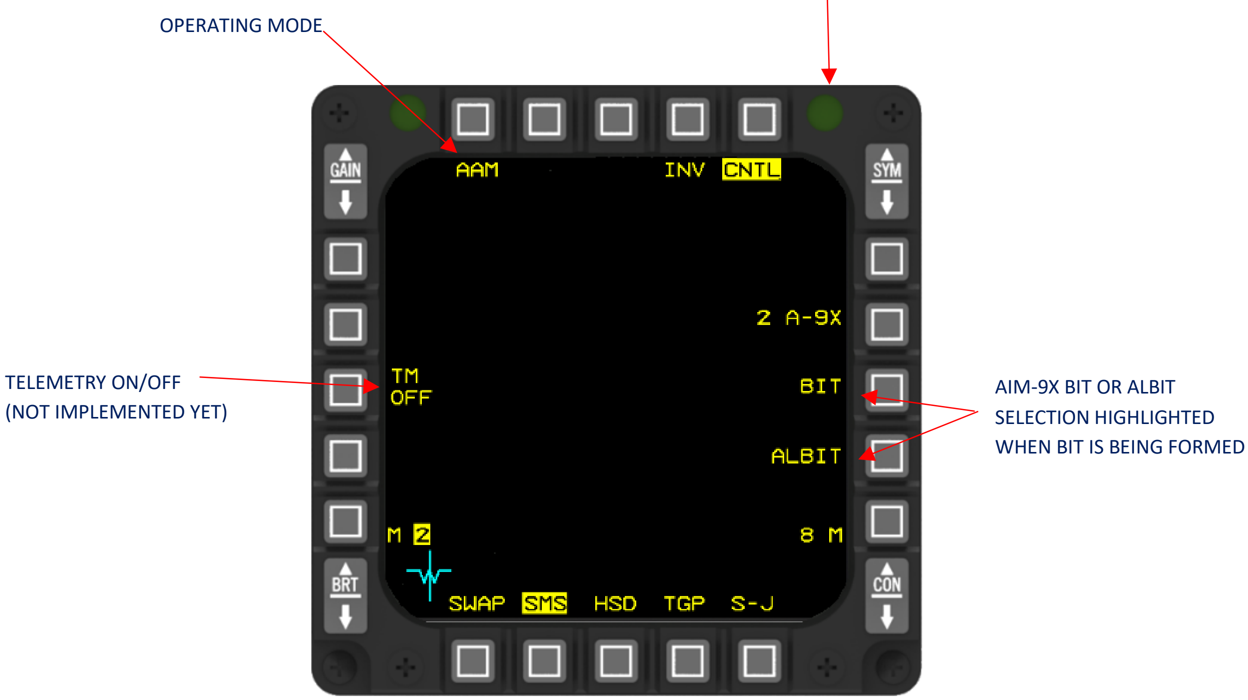


SMS AIR-TO-AIR GUNNERY PAGE

3.1.1.2.5.2 SMS AIR-TO-AIR AIM-9 PAGES

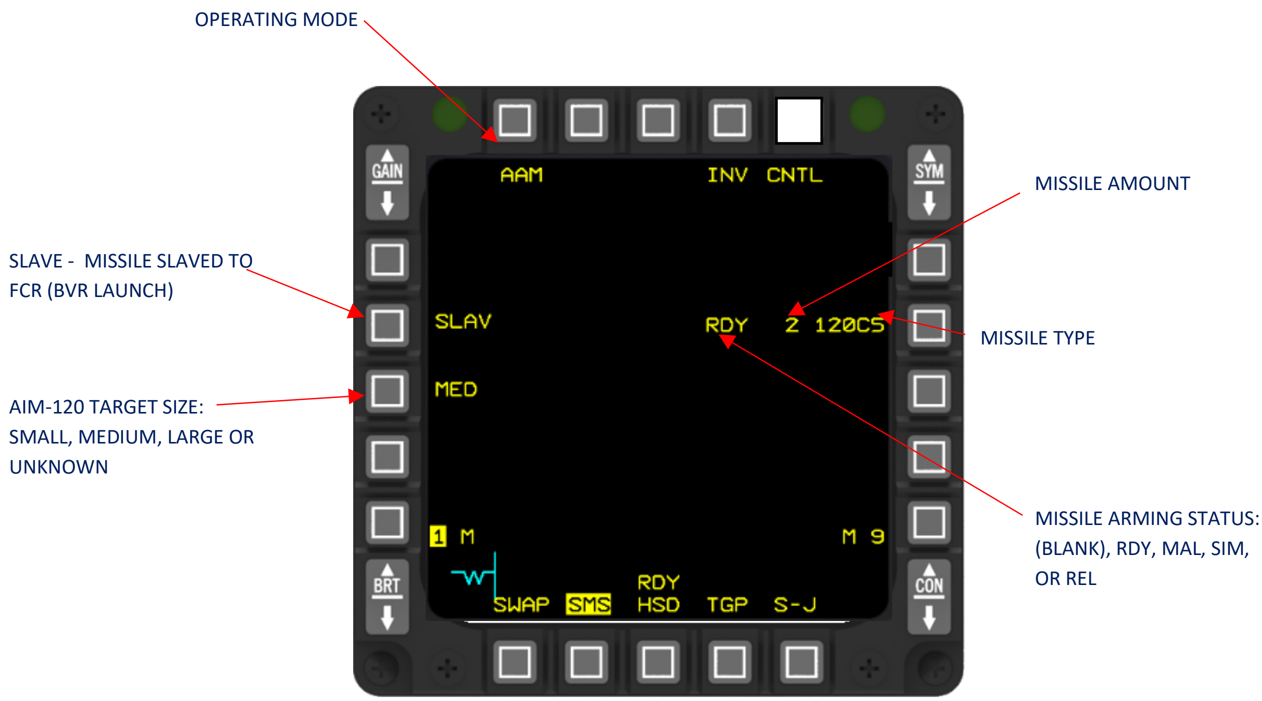


SMS AIR-TO-AIR MISSILE PAGE WITH AIM-9

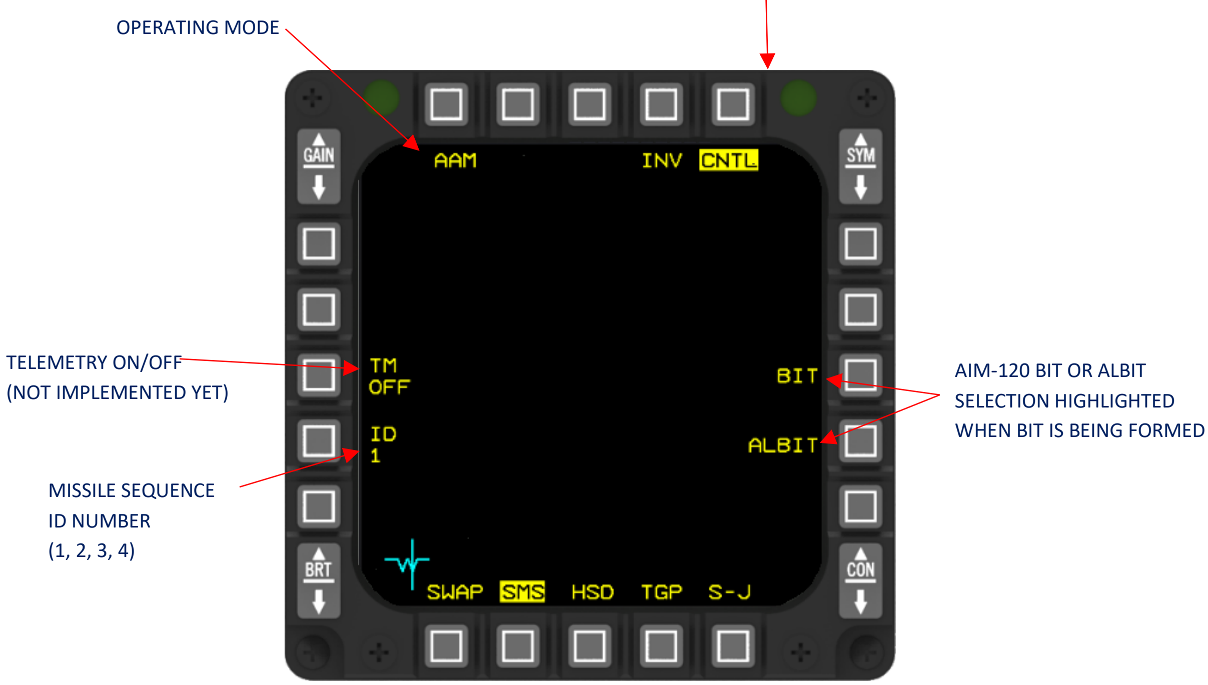


AIM-9X CONTROL PAGE

3.1.1.2.5.3 SMS AIR-TO-AIR AIM-120 PAGES



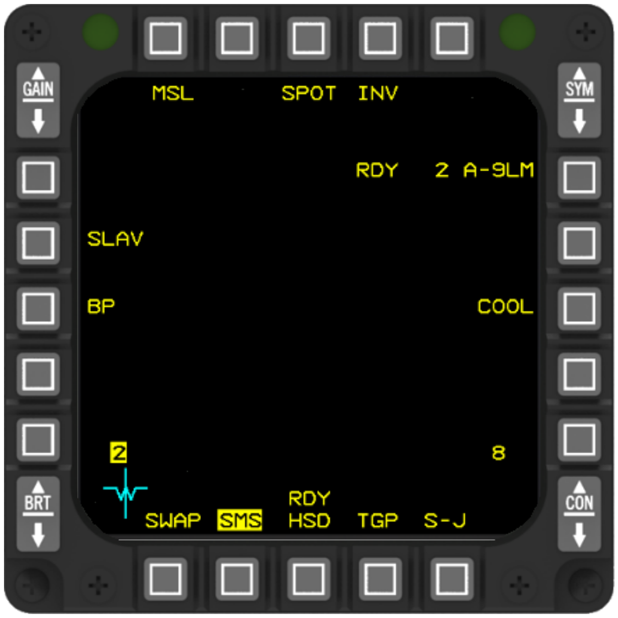
AIM-120B/C WEAPON PAGE



AIM-120 CONTROL PAGE

3.1.1.2.5.4 MISSILE OVERRIDE MODE PAGE

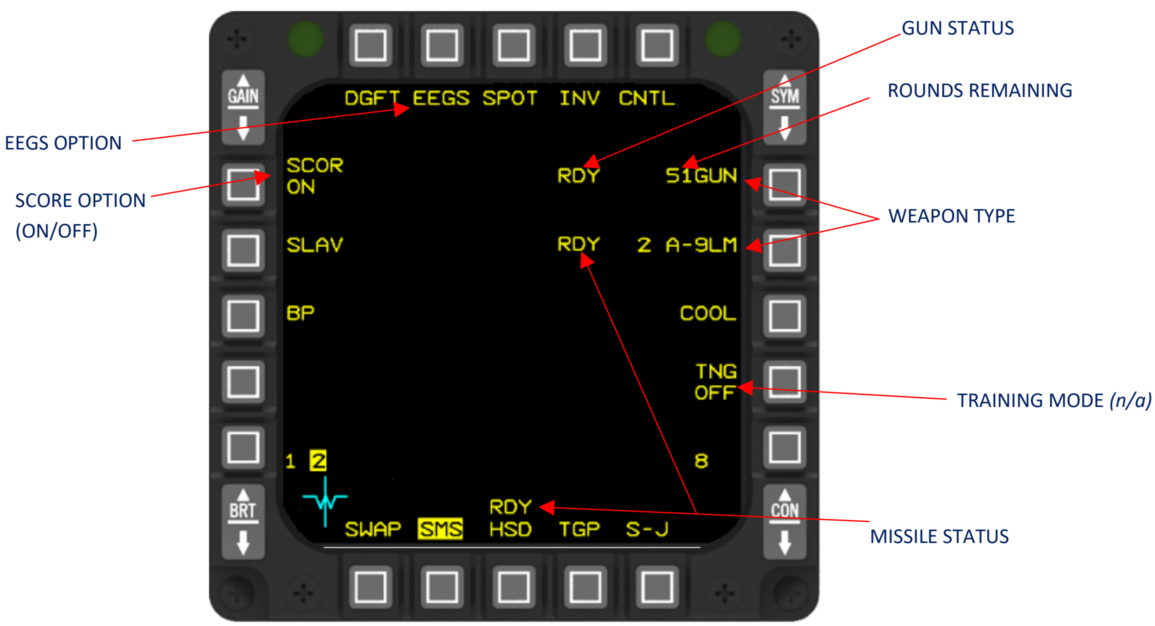
The Missile Override (MSL) page offers identical controls and visuals to the AAM page. However, it is accessed manually by engaging the DOGFIGHT/Missile Override switch located on the throttle.



SMS MISSILE OVERWRITE PAGE

3.1.1.2.5.5 DOGFIGHT (DGFT) MODE PAGE

The DGFT page seamlessly integrates gunnery and air-to-air missile control and display. To access the dogfight mode, simply engage the DOGFIGHT/Missile Override switch on the throttle for hands-on control.



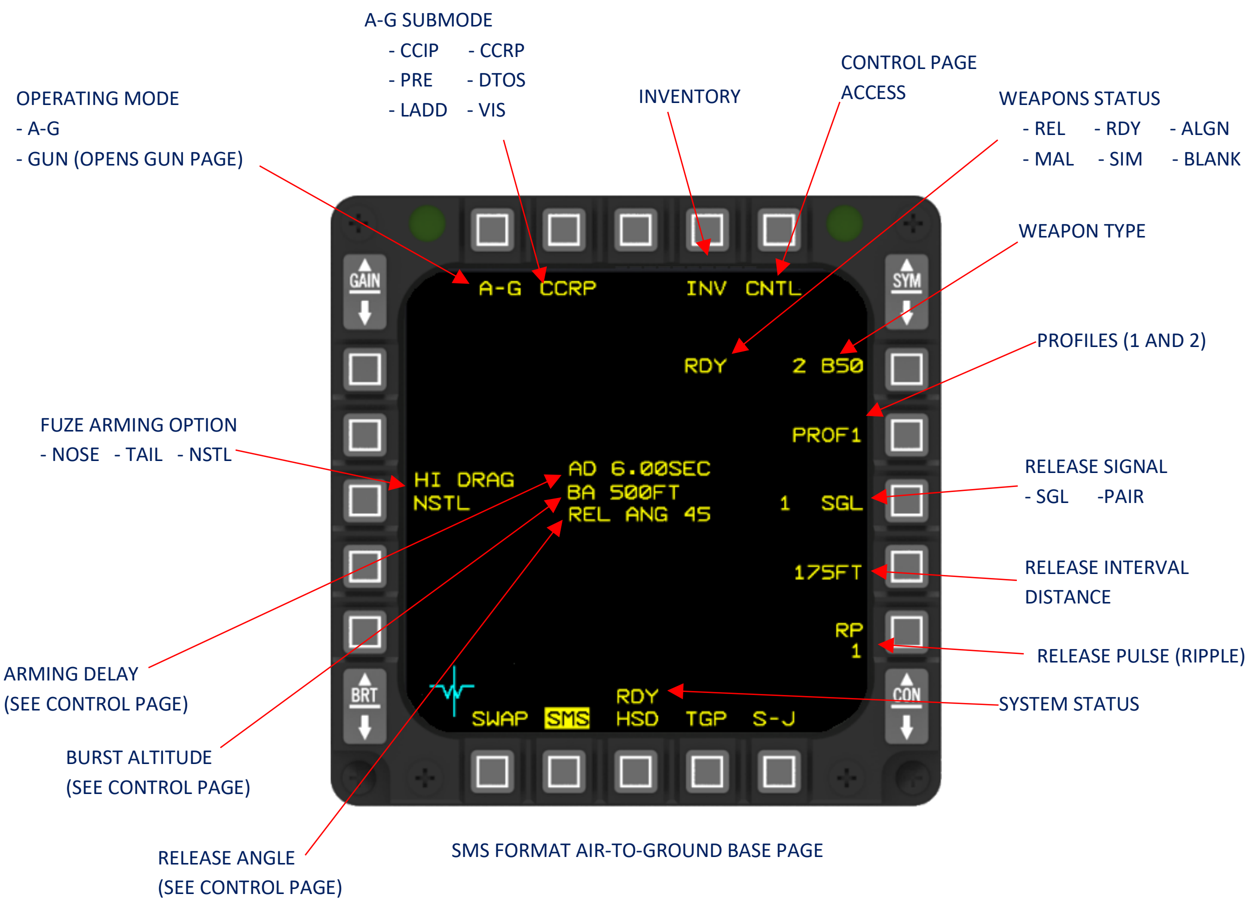
SMS DOGFIGHT MODE PAGE

3.1.1.2.6 AIR-TO-GROUND PAGES

The air-to-ground pages offer comprehensive control and display for air-to-ground weapon delivery and gunnery. All air-to-ground modes can be accessed through the A-G page. To access the GUN page, simply press OSB 1 located next to the A-G mnemonic. For a more detailed description, please refer to the AIR-TO-GROUND section.

The HUNG STORE mnemonic is displayed when appropriate on all SMS A-G pages. On the E-J, S-J, and INV pages, station numbers with hung stores are displayed beneath the HUNG STORE advisory.

3.1.1.2.6.1 SMS AIR-TO-GROUND BASE PAGE



SMS FORMAT AIR-TO-GROUND BASE PAGE

3.1.1.2.6.2 SMS AIR-TO-GROUND CONTROL PAGE

SMS FORMAT AIR-TO-GROUND CONTROL PAGE

The upper and lower OSB lines mirror the main SMS page. However, the left line of OSB buttons (#16 to 20) and OSB #6 on the right provide access to five distinct weapon settings: C1, C2, C3, C4, and LADD.

C1 (OSB #20) pertains to General Purpose or Laser guided weapons, offering two separate arming delay options: one for the NOSE fuse and another for the TAIL fuse. By pressing OSB #20, users can access a subpage where both timings can be configured.

C2 is applicable to Cluster Bomb Units (CBUs) or any weapon that requires a Burst Altitude (BA). Pressing OSB #19 grants entry to an SMS subpage where both the arming delay and burst altitude can be adjusted.

C3 represents an additional setting for CBUs, providing the same options for Arming Delay (AD) and Burst Altitude (BA) as C2.

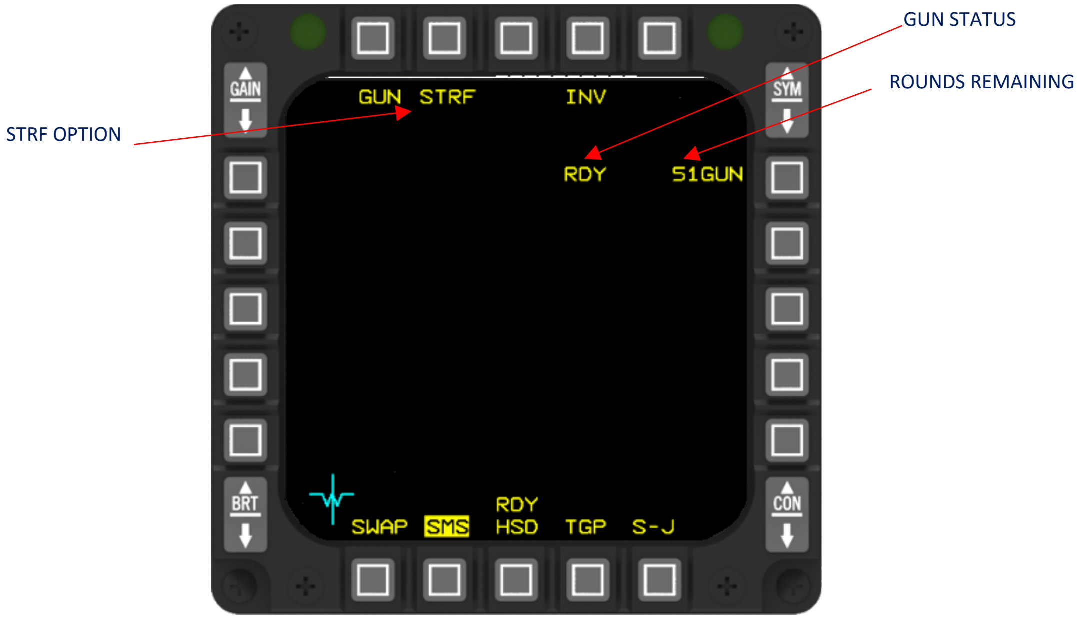
C4 is specifically designed for double fused CBUs. Within this page, users can set AD1, AD2, and BA.

LADD denotes Low Altitude Drogue Delivery, and although OSB #6 features a profile for it, it is not currently implemented in BMS.

OSB #10 allows for the configuration of the planned release angle. This value is necessary for the computer to accurately calculate symbology for DTOS (Digitally Tossed Ordnance System) deliveries.

For specific ordnance release parameters and options, please refer to the relevant AIR-TO-GROUND section.

3.1.1.2.6.3 SMS AIR-TO-GROUND GUN PAGE



For more information about A-G gun usage, please refer to the relevant STRAFE GUNNERY SUBMODE (STRF) section.

PART IV - NON-NUCLEAR WEAPONS (COMBAT)

4.1 SCOPE

In this section, you will find detailed explanations about the various air-to-ground weapons, air-to-ground combat strategies, air-to-air weapons, and air-to-air combat techniques specific to the F-16 aircraft.

4.2 AIR-TO-GROUND

4.2.1 SPI MANAGEMENT

4.2.1.1 INTRODUCTION

To improve air-to-ground (A-G) experience in Falcon BMS, a little more accurate behaviour and interaction of the main A-G sensors has been implemented. SPI is a key factor in the A-G environment, and it is very important to understand how it works. The purpose of this section is to introduce SPI management and its interaction with the main A-G sensors.

Please note that this section is not an entire overview of the relevant sensors, and it does not come as a replacement for reading the more detailed explanations about each sensor.

4.2.1.2 SPI DESCRIPTION

SPI – System Point of Interest, as its name implies, is the point on the ground where (usually) the A-G system is concentrated. The SPI position can be determined (or controlled) by 2 sensors:

- FCR in GM/GMT/SEA while in STP mode.
- Targeting Pod.

Each of these sensors can slave the SPI to where it is pointing according to the avionics and the sensor's mode. The SPI position is then shared between those sensors if conditions fit.

When one of the above sensors is in tracking state (i.e. GM radar in FTT or TGP in non-slave mode) the SPI is slaved to the tracking sensor. If one of the sensors is in tracking state and the pilot is commanding the other sensor to track as well, then the first sensor will break track automatically and update it's position with the SPI (which is slaved to the tracking sensor). It is not possible to have both GM radar and TGP in tracking states at the same time.

If no tracking state exists, slewing the GM radar in STP mode will slew the SPI to the same position shared by the TGP. On the other hand, slewing the TGP in STP mode will also slew the SPI and the GM radar to the same position. If the tracking state exists by either sensor and the other sensor is slewed to a different position, then the slewing is local and has no effect on the SPI position which stays with the tracking sensor.

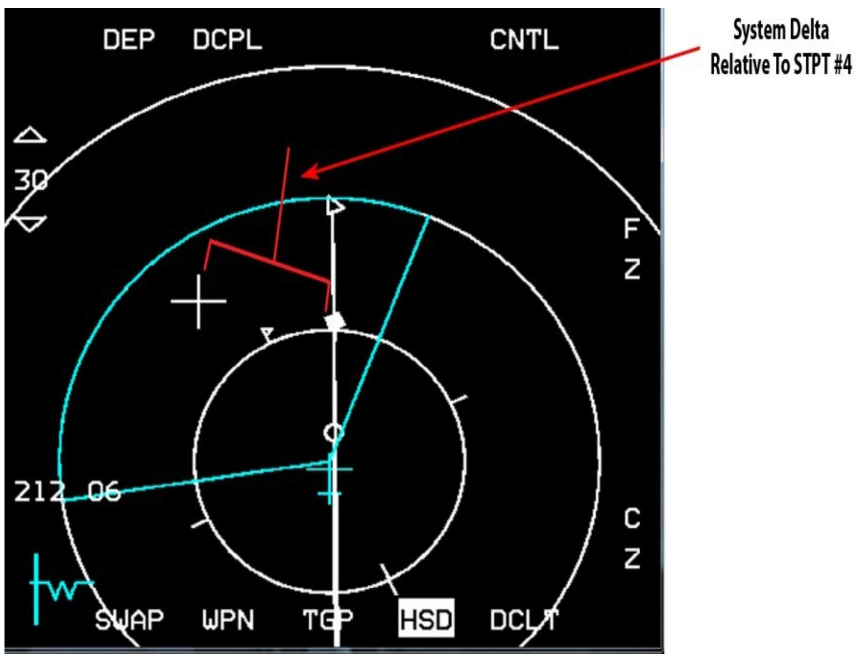
IMPORTANT NOTE: If one of the sensors is in tracking state and the other is slewed it may be perceived as a bug because the TD box will not move with the slewing sensor. This behaviour is correct because the TD box is reflecting the position of the SPI which stays with the tracking sensor.

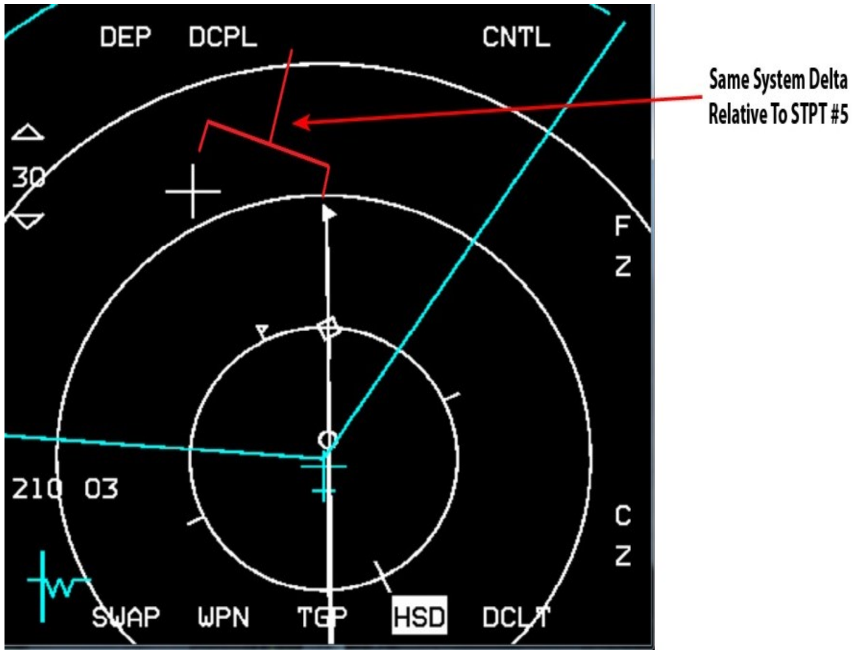
4.2.1.3 SYSTEM DELTA AND ITS EFFECT ON INS/EGI (EMBEDDED GPS/INS)

System deltas are X and Y values which reflect the horizontal difference between the SPI position and the currently selected Steerpoint's original position. The SPI position is initially locked on the STPT position and once SPI is moved (by slewing the FCR or TGP) system delta values change. These delta values are applied to all STPTs, even though the original steerpoint positions (including Bullseye) will still be displayed on the FCR and HSD pages.

This means that when slewing the SPI in A-G mode, your current STPT position is changing too and following the SPI position. You'll see the STPT diamond on the HUD following the SPI position. This change in STPT position affects all navigation STPTs, so even if choosing a different STPT the position will be different than it was originally, as system delta values will have been added to it.

Here is a short example to illustrate how system delta is applied when changing waypoints. On the first image the GM radar cursor and SPI is slewed from its original position on STPT 4, creating a system delta. On the second image the selected STPT is STPT 5 but the system delta is the same and so the SPI/cursor position is adjusted relative to STPT 5.





HUD cues related to STPT position

HUD cues related to STPT position can point towards SPI or towards the original STPT position, depending on the selected master mode. The following table describes where the different HUD cues are pointing for each master mode:

	A-A	NAV	A-G
STPT Diamond	SPI	SPI	SPI
Tadpole Cue	STPT	STPT	SPI
Range	STPT	STPT	SPI
Time To Go	STPT	STPT	SPI

NOTE: As noted in the table above you can easily find yourself switching back to A-A or NAV mode after slewing your SPI in A-G mode and being confused by the fact that your tadpole is no longer pointing to your steerpoint diamond. This is because your STPT diamond is still on the SPI and your tadpole is pointing to the STPT.

Pilots should use the following routine to revert the system solution back to the original navigation solution:

1. **TMS down** (to break any sensor tracking state).
2. **Cursor Zero** (to erase any previously created system deltas - see below).
3. **Wide Field of View** (HOTAS pinky or OSB 3 – to reset FCR to NORM/TGP to WIDE).

This habit should be developed after each cursor slew phase and at each IP if cursor slews have been made.

4.2.1.4 CURSOR ZERO (CZ)

Cursor Zero (CZ) command will erase any previously created system deltas, return all STPTs to their original position and therefore return SPI position to the current STPT position. CZ can be commanded by pressing the corresponding OSB on the A-G FCR, TGP or HSD MFD pages. CZ command is effective only when no sensor tracking state exists, otherwise the SPI position will not change as the tracking sensor will force it back to the same position.

The CZ mnemonic will be highlighted in aircraft with the Nav EGI upgrade if a system delta exists (i.e. SPI slew).

4.2.1.5 SNOWPLOW MODE

Snowplow (SP) mode is toggled by pressing OSB 8 on either A-G radar or TGP MFDs. Toggling SP mode sets both sensors into snowplow (SP label will highlight on both MFDs) and not ground-stabilized position, in front of the aircraft and at half the range of the A-G radar scale. TMS Up can then be used to ground-stabilize and allow slewing of the position. SP mode is always in sync between A-G radar and TGP, so if for some reason the A-G radar SP mode is toggled off by switching radar or master modes then the TGP will also exit SP mode. Slewing one of the sensors when in SP mode will also slew the other sensor to the same position similar to normal how it is working when in normal (STP) mode. The SPI position is not affected when operating in SP mode, meaning that SP mode allows focusing on a position different than the SPI without affecting the SPI.

When snowplow mode is selected and not yet stabilized (whether set by A-G radar or TGP), SOI is defined as being "nowhere," so both A-G radar and TGP will not have the SOI border and NOT SOI will appear on the MFDs. TMS-Up will stabilize SP position and SOI will normally move to the sensor which was SOI before entering SP mode.

4.2.1.6 A-G RADAR AND SPI

When the radar is in STP mode, its position is always in sync with the SPI (the only exception may occur in a case where the SPI is slaved to the TGP because of tracking and the radar is slewed elsewhere). The radar cursor can be slewed freely anywhere with no limitations. Even when slewing the cursor outside of the MFD area, the cursor/SPI will keep slewing although the cursor itself will look as it stays stuck on the MFD bounds. When slewing the radar cursor, the SPI position will update as well (on the HUD the TD box will move and the STPT diamond will follow it if the current selected STPT is a navigation waypoint). When the radar isn't SOI (and not tracking a target—i.e., FTT) and the TGP is the SOI, slewing the TGP will slew the SPI position and the radar cursor position as well so all stay in sync. When the radar is in FTT mode (tracking a target) and STPT is changed, the radar will break track and its position will be synced with the new position of the SPI (STPT position + system deltas).

4.2.1.7 TARGETING POD (TGP) AND SPI

When in STP mode, the TGP position will be in sync with the A-G radar and the SPI position. The exception to this case is if the radar is tracking a target and the TGP becomes SOI and is slewed away from the SPI position, as the SPI stays with the radar track. If the TGP becomes the SOI then the SPI position will move along and update with TGP slews and the radar position will update to the same location as well. If the TGP is tracking and the STPT is changed then the TGP will break track and sync with the SPI position.

4.2.2 WEAPON DELIVERY SUBMODES

The air-to-ground delivery modes enable the avionic system to be configured for specific types of weapons and delivery methods. These modes are categorized as visual, preplanned, mission planned preplanned, and manual. The visual, mission planned preplanned, and preplanned modes allow for automatic release with pilot consent. In the visual modes, HUD symbology is used to designate targets visually. The preplanned delivery options utilize entered coordinates and electro-optical sensor displays for target designation. Prior to the mission, preplanned delivery options require known target coordinates, but an alternate target can be designated by adjusting HUD symbology or using on-board sensors.

The mission planned “preplanned” delivery option is intended for attacking a target planned in the mission and does not permit changes to the targeting data. The manual mode serves as a backup to the visual and preplanned modes and does not provide computed release parameters.

The visual modes include Continuously Computed Impact Point (CCIP), Strafe (STRF), Dive Toss (DTOS), Electro-Optical Visual (EO VIS), and IAM Visual. These modes utilize HUD symbology for visual target designation. In the preplanned delivery modes, known target coordinates are required before the mission. However, an alternate target can be designated by adjusting Sensor Of Interest (SOI) symbology or entering its coordinates during flight. The preplanned delivery modes consist of Continuously Computed Release Point (CCRP), Unified Loft (ULFT), Low Altitude Drogue Delivery (LADD), Electro-Optical Preplanned (EO PRE), Inertially Aided Munitions Preplanned (IAM PRE), Mission Planned Preplanned (MPPRE), and Multiple (UAI). These modes can be supported by a visual reference point (VRP) or visual initial point (VIP), allowing the pilot to have visual or sensor updates on the system's point of interest (SPI).

The manual mode serves as a backup to the visual and preplanned modes, offering manual release without computed release parameters. It requires the pilot's consent for manual release.

VIS – Visual Weapon Delivery Modes

- STRF - Strafe Gunnery
- CCIP - Continuously Computed Impact Point
- DTOS - Dive Toss
- IAM-VIS - IAM Visual Submode
- EO VIS - Electro-Optical Visual

PRE - Preplanned Weapon Delivery Modes

- CCRP - Continuously Computed Release Point
- LADD - Low Altitude Drogue Delivery
- EO PRE - Electro-Optical Preplanned
- EO BORE - Electro-Optical Boresight
- IAM PRE - Inertially Aided Munitions Preplanned (IAMs)

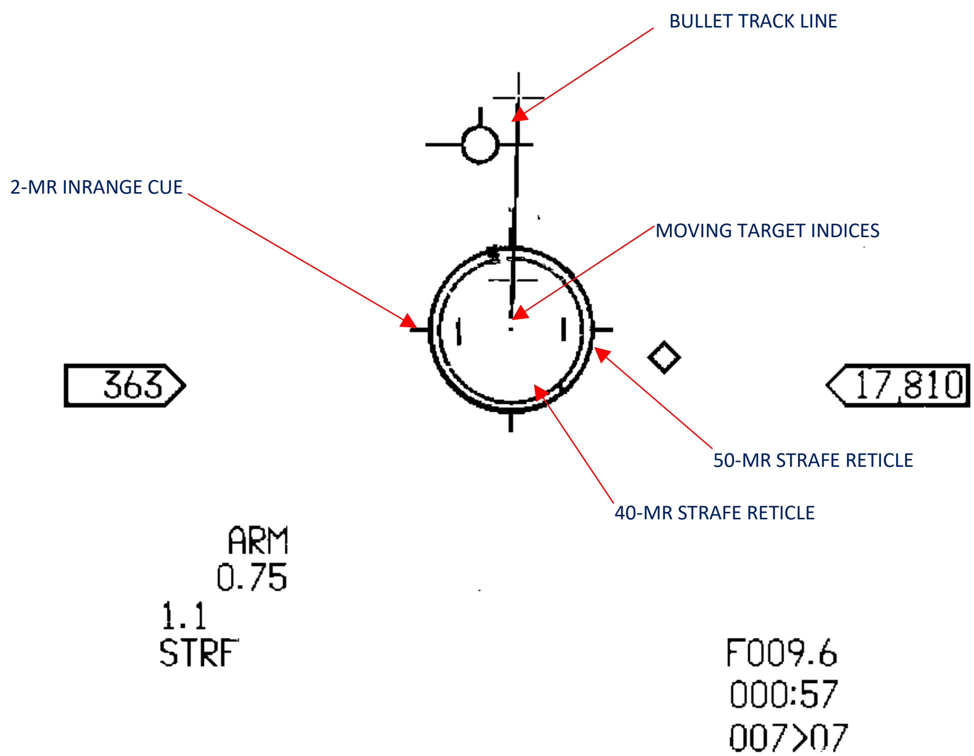
4.2.2.1 VISUAL WEAPON DELIVERY MODES

4.2.2.1.1 STRAFE GUNNERY SUBMODE (STRF)

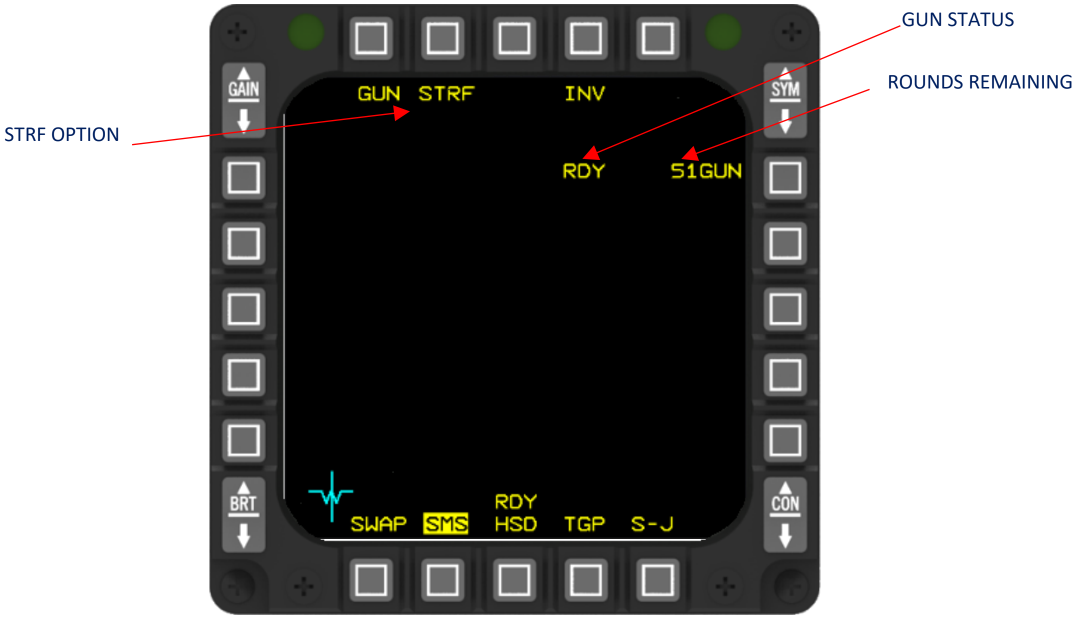
The strafe submode presents a visual representation of the bullet impact point on the HUD. To engage the target accurately, position the pipper on the desired target before firing. The Strafe Reticle includes various components such as a 50 mR circle, a 40 mR partial circle, a 2 mR diameter in-range cue, range tics, moving target indices, a 1 mR pipper, and a bullet track line.

The in-range cue is activated when the slant range to the impact point is equal to or less than the Ammo In-range Value entered in the MFDS or the preloaded DTE In-range Value. The Ammo In-range value can range from 0 feet to 99,990 feet, with a maximum of four digits allowed. The tens digit is automatically displayed as 0.

By default, the in-range cue is shown when the impact point is within 4,000 feet slant range with the M-56 loaded in inventory and 12,000 feet slant range with the PGU-28 loaded in inventory. The Moving Target Indices are displayed to indicate the lead angle for a target moving perpendicular to the line of sight at a speed of 30 knots, using the slant range to the target and bullet "time of fall". The Bullet Track Line starts from the center of the Gun Boresight Cross and extends 5 milliradians from the center of the pipper. The slant range to the target is digitally displayed in the lower right corner of the HUD.



HUD AIR-TO-GROUND GUNNERY SYMBOLOGY



SMS AIR-TO-GROUND GUNNERY PAGE

To engage the submode, press the A-G button on the ICP. Pressing OSB 1 next to the A-G mnemonic on the SMS MFD will display the A-G GUN format. If the MASTER ARM switch is in MASTER ARM and ammunition is loaded, or in SIMULATE mode regardless of ammunition status, strafe symbology will appear on the HUD. However, ammunition must be loaded into the SMS to enable the symbology.

In a computed delivery, the crucial factor is to ensure that the pipper ends up on the target. Trying to steer the pipper directly to the target, particularly in crosswind conditions, can lead to excessive control inputs and subsequent misses. Referring to the boresight cross initially can help minimize these issues. The pilot should roll out to position the boresight cross just slightly upwind of the target, which will result in the CCIP pipper being slightly short of the target. The Flight Path Marker (FPM) will usually be positioned below the pipper. From there, the pilot simply flies the aircraft within the appropriate firing range, making minor adjustments to keep the CCIP pipper smoothly tracking in azimuth towards the target. Since the pipper tends to lag behind flight control inputs, corrections should be gentle and as small as possible.

As the pipper approaches the desired aimpoint, applying slight forward pressure (the amount depending on the dive angle) will halt the forward movement of the pipper. This allows the pilot to accurately track the pinpoint target and prevents a scattered burst. The in-range cue and the pilot's experience help determine the optimal moment to open fire.

4.2.2.1.2 CONTINUOUSLY COMPUTED IMPACT POINT SUBMODE (CCIP)

The CCIP submode is utilized to display the projected impact point of the weapon on the HUD when engaging visually identified targets. To initiate an attack, the aircraft is maneuvered in a manner that aligns the CCIP pipper, representing the impact point, with the target, and then the WPN REL button on the control stick is pressed.

This solution is applicable for both dive and level deliveries. The dive delivery option is typically employed with low-drag bombs, while the level delivery option is commonly used for low-altitude deployment of high-drag weapons or dispensers, as well as medium-altitude release of low-drag weapons. In the case of dive deliveries, if the solution is established, the release occurs instantly. Immediate release also takes place when the weapon impact point is within the field of view (FOV) of the HUD.

In scenarios where the view of the weapon impact point falls below the aircraft's nose, the pipper is positioned approximately 14 degrees downward from the boresight cross, and a time-delay cue is displayed on the bomb-fall line. The time delay is calculated based on the disparity between the pipper position and the actual impact point.

Following the depression of the WPN REL button (post-designate), an azimuth steering line and solution cue are provided to guide the release process. As the time-to-go decreases, the solution cue moves closer to the flight path marker. When the solution cue aligns with the center of the flight path marker, an automatic weapon release occurs. Since the solution is based on automatic ballistics, there is complete freedom in the aircraft's flight path before release. Early release of weapons can be achieved by pulling towards the solution cue. It is crucial that the pipper is on the target at the moment the weapon release button is pressed, and the steering must be neutralized during release.

If laser ranging is desired, there are two options available:

- Pulling the trigger to the first detent activates the laser for as long as the trigger is held.
- Pulling the trigger to the second detent initiates continuous firing of the laser, eliminating the need to hold the trigger.

The laser will continue firing until the weapon is released, the submode is changed, or 30 seconds have elapsed. In either of the above options, the MASTER ARM switch must be set to MASTER ARM or SIMULATE, and LASER ARM must be enabled.

The CCIP pipper consists of a 1 mR dot positioned at the center of a 12 mR circle. When the CCIP pipper reaches the edge of the total FOV, an X-symbol is superimposed over the cue.

4.2.2.1.2.1 CCIP SPECIAL CONSIDERATION

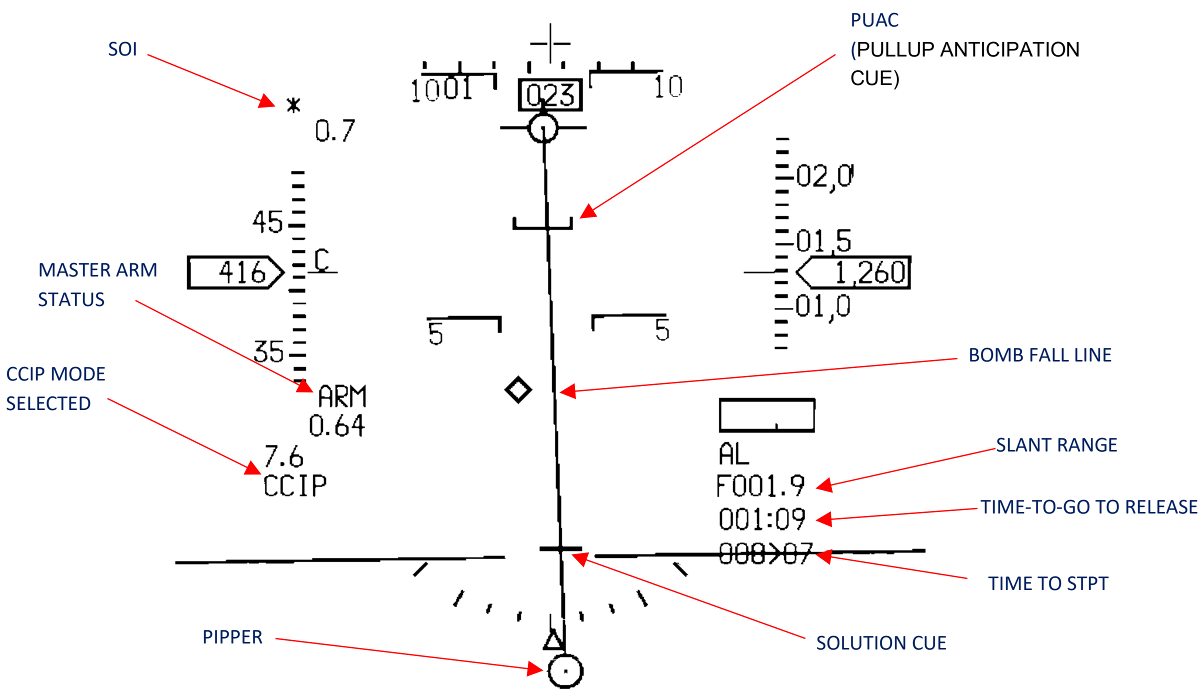
Release Cues

When the MASTER ARM switch is set to MASTER ARM or SIM and a computed release takes place (when the solution cue aligns with the Flight Path Marker), the Flight Path Marker starts flashing and continues to do so as long as the weapon release switch is pressed.

Ripple Releases

In the case of ripple releases, the CCIP symbol is shifted by half of the bomb train distance. This guarantees that the bomb train encompasses the target.

4.2.2.1.2.2 CCIP OPERATIONS - HUD SYMBOLOGY



CCIP OPERATION HUD

4.2.2.1.2.3 CCIP OPERATIONS - MFD SYMBOLOGY

CCIP OPERATION MFD

4.2.2.1.2.4 CCIP-FLIGHT PATH FREEDOM

To ensure precise delivery, it is essential to have the CCIP pipper precisely aligned with the target before depressing the WPN REL button. In the case of delayed release, nullify any steering error by positioning the Flight Path Marker (FPM) on the azimuth steering line during weapons release. This will help achieve accurate delivery. If an earlier release is desired, pull towards the solution cue.

When facing a strong crosswind and a long weapon time of fall, the CCIP pipper may move outside the field of view (FOV) of the HUD. Placing the pipper with an X-symbol over it on the target and initiating the release (pickling) can lead to significant impact errors. To address this situation, the pilot has a few options available, such as realigning the attack axis or releasing the weapon at a shorter slant range to the target.

4.2.2.1.2.5 SOI MOVEMENT

In CCIP mode, it is not possible to switch the Sensor of Interest (SOI) to the Targeting Pod (TGP), and all Advanced Targeting Pods will remain in Laser Spot Track (LST) mode if LST is selected.

When the CCIP mode or CCIP Rockets mode is chosen, the Infrared (IR) pointer is deactivated and cannot be selected.

4.2.2.1.2.6 ACCURATE TARGET COORDINATES

Given that the pipper is initially positioned at the steerpoint elevation and considering that the CCIP process incorporates target coordinates in multiple calculations, it is beneficial to have precise target coordinates whenever possible, despite CCIP being a visual delivery mode.

4.2.2.1.2.7 FAST CHANGING PARAMETERS

Maintaining a stable delivery is crucial to assist the MMC (Modular Mission Computer) calculation process. Delivering with a consistent acceleration of 2 or a maximum of 4 g's on the aircraft is acceptable. However, accelerated deliveries can introduce significant timing errors in the weapon release process. Another issue that may arise from changing parameters is that, in the post-designate state, the height-above-target is not updated. Although the Fire Control Radar (FCR) continues to range, the system does not accept any new inputs.

4.2.2.1.2.8 LACK OF AGR AND NO TGP LASER RANGING

When both the Fire Control Radar (FCR) and Targeting Pod (TGP) are unavailable, a backup sensor is utilized for delivering in CCIP mode. The primary backup sensor, with the highest priority, is the Radar Altimeter (RALT). However, it should be noted that RALT will provide accurate measurements only if the terrain in front of the target is flat and at the same elevation as the target itself.

If the default backup sensor, Barometric Altimeter (BARO), is selected, it calculates the height-above-target by determining the difference between the steerpoint elevation and the system altitude. In this case, the accuracy of the delivery relies on the assumption that the steerpoint elevation matches the actual elevation of the target. If the elevations differ, the delivery will not be precise.

4.2.2.1.2.9 HANDS-ON CCIP SELECTION

To access the CCIP submode without the use of an Inertially Aided Munition (IAM) or Electro-Optical (EO) system, you can utilize the missile step button on the stick. When a bomb is selected, the delivery mode rotary operates in the following sequence:

- CCRP (Continuously Computed Release Point)
- CCIP (Continuously Computed Impact Point)
- DTOS (Dive Toss)

4.2.2.1.2.10 TIME-TO-WEAPON RELEASE

Time-to-weapon release is displayed in CCIP post-designate with a delay cue.

4.2.2.1.2.11 HEIGHT-ABOVE-TARGET COMPUTATION

The CCIP pipper serves as a visual representation of the target impact point. In the pre-designate phase of an air-to-ground attack, if accurate ranging data is available, the height above the target can be calculated. In the CCIP mode during “pre-designated” attacks, the radar continuously provides ranging information. However, during post-designate attacks, specifically delayed deliveries made from under the aircraft's nose, although the radar continues to range, the avionics system disregards this data. This is because the accuracy of the data can be compromised by dynamic maneuvers performed during the delivery.

One of the sensors listed below (in order of priority) is used to obtain ranging data:

• TGP laser.

• AGR (FCR).

• Selected backup bombing sensor (BBS). RALT, BARO or PR (whichever is selected via OSB 6).

The selection of the sensor is based on its availability and validity. In the event that the radar loses its lock or the laser range becomes invalid, the avionics system will preserve the last recorded data for a duration of 3 seconds. Afterward, it will switch to BARO data. If the radar fails to establish a lock within the given 3-second timeframe, the steerpoint elevation will be utilized as the target elevation. In situations where the TGP laser or AGR is unavailable for strafing, and the pilot has chosen either RALT or PR over BARO as the alternative sensor, the radar altimeter (RALT) data or DTS Passive Ranging (PR) data will be employed. The backup sensor can be selected through OSB 6 on the MFDS FCR page.

4.2.2.1.3 DIVE TOSS (DTOS) SUBMODE

The dive toss submode integrates a visual target designation mechanism with a basic automatic ballistic computation to facilitate both dive and toss weapon delivery. In order to engage the target, several conditions must be met: the target designator box must be positioned over the target, the weapon release switch must be pressed, and the pilot must follow the steering cues to reach the release point. If the steering input is neutralized before the time-to-go reaches zero, weapons can be released at any dive or climb angle and at any altitude.

Upon entering the mode, the air-to-ground (A-G) target designator (TD) box is initially located on the flight path marker (FPM). The TD box can be maneuvered onto the target either by adjusting the aircraft's position or by using the CURSOR/ENABLE switch for slewing. The sensors are then directed to point at the same azimuth/elevation (AZ/EL) coordinates as the TD box. The target can be designated by pressing the weapon release (WPN REL) switch or by moving the target management switch (TMS) forward for designation. Designating the target grounds the target designator box, aligning it with or near the target. The box's position can be further refined using the CURSOR/ENABLE switch. Once the target designator box is grounded, the sensors continue ranging through it.

Careful consideration must be given when utilizing pre-designated slews to avoid designating a target that cannot be attacked due to the target's range being shorter than the bomb's range or if the steering error exceeds the aircraft's maneuvering capabilities.

As the aircraft approaches maximum toss range, a maximum toss anticipation cue in the form of a fixed-radius circle (100 mR in diameter) is displayed on the head-up display (HUD). This cue serves as an indication that the F-16 is nearing its maximum toss range (it is only visible in the post-designate scenario). The circle appears on the HUD two seconds before the solution cue emerges. The toss anticipation cue starts flashing when the maximum toss range is reached and continues flashing for an additional two seconds.

4.2.2.1.3.1 DTOS OPERATIONS – HUD SYMBOLOGY

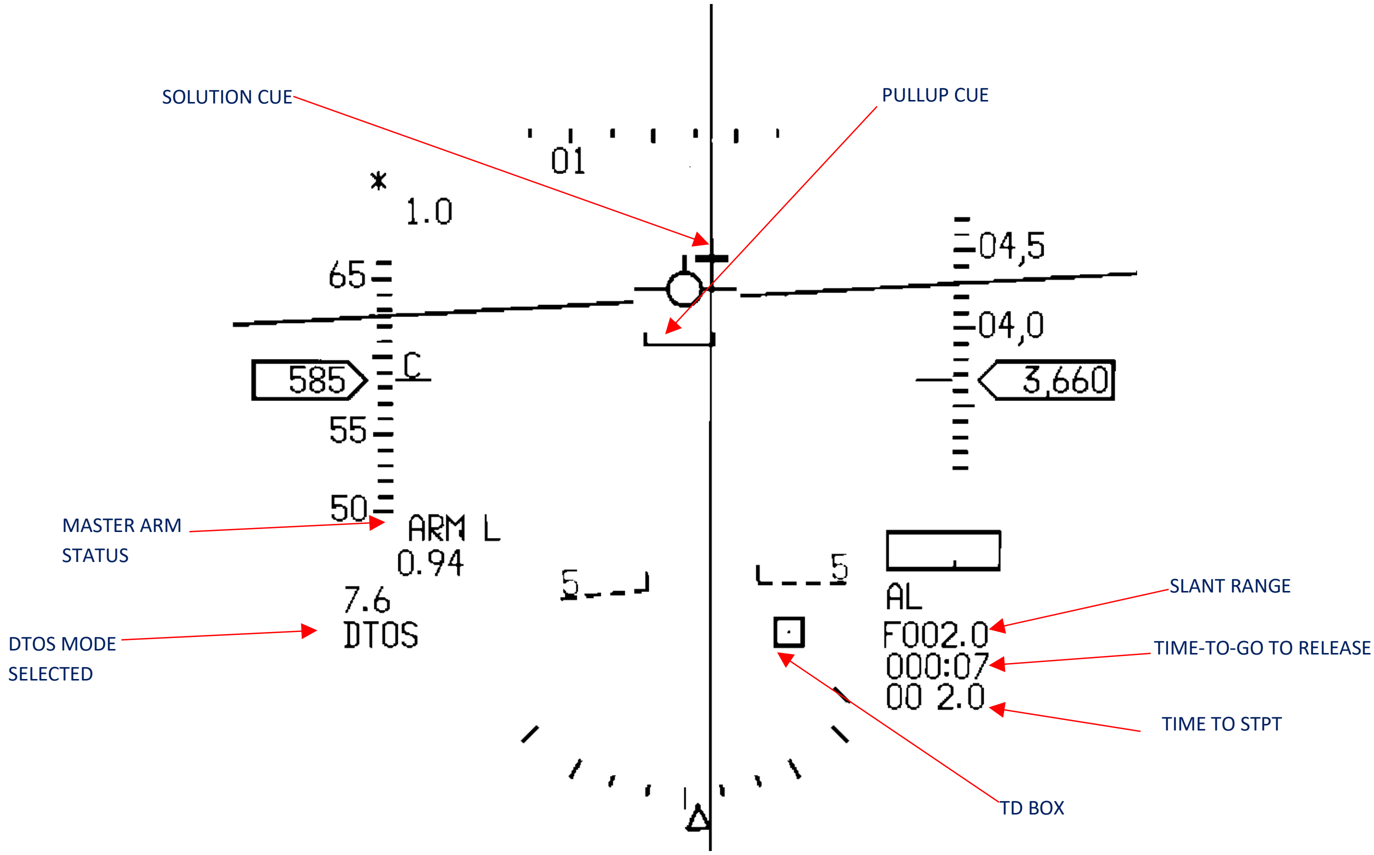
The initial display of the HUD solution cue indicates that a two-second incremental 4g pull-up can be executed to reach a 45-degree climb angle, ensuring a hit on the target at maximum toss range. Both toss and dive deliveries are viable options. As time-to-go approaches zero, the solution cue descends toward the flight path marker. To ensure accurate delivery, the flight path marker must be kept aligned with the azimuth steering line. Pressing and holding the weapon release button authorizes automatic release when the solution cue intersects the center of the flight path marker. In DTOS mode, if the MASTER ARM is set to MASTER ARM or SIM, LASER ARM is ON, and the TGP is in track, pressing the weapon release button activates the laser for DTOS firing.

Once a target has been designated, it can be rejected by utilizing the return-to-search position of the target management switch, cycling the DGFT switch, or selecting a different delivery mode. This action repositions the target designator box onto the flight path marker.

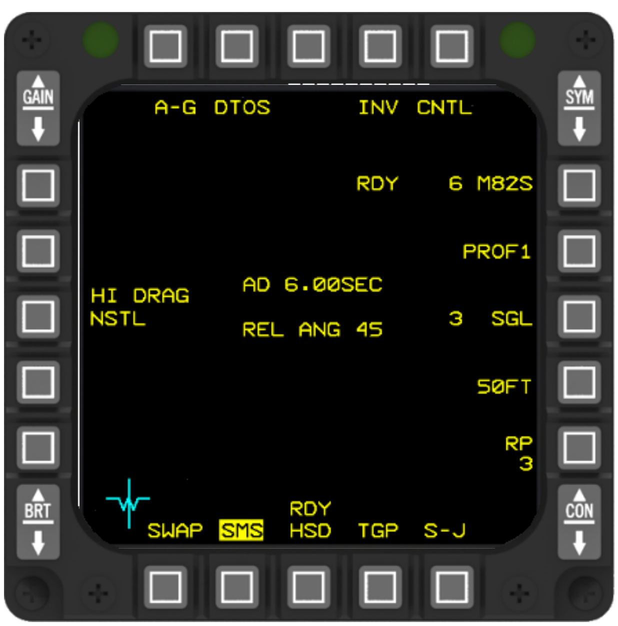
The targeting pod (TGP) can be employed to locate and track a target. Enabling TGP track signifies that the target has been established, transitioning the system into the post-designate state.

The HMCS (Helmet-Mounted Cueing System) allows for target designation and commanding AGR (Air-to-Ground Ranging) on a DTOS target that is located outside the HUD field of view. In DTOS mode, holding the target management switch (TMS) forward for more than 0.5 seconds aligns the TD box with the HMCS line of sight (LOS) at the HMCS Aiming Cue. By adjusting head position, the TD box can be moved over the target and designated for ground stabilization. The TD box position can be further refined using the cursor controller. To reject a DTOS target, pressing TMS Aft causes the TD box to return to the HMCS LOS at the HMCS Aiming Cue. Pressing TMS Aft a second time slaves the TD box to the flight path marker (FPM) in the HUD. Once the target has been designated (TD box ground stabilized), standard DTOS steering cues will appear on the HUD. Align the aircraft's flight path with the target, refine the TD box on the HUD as needed, press the weapon release button, and complete the remainder of the DTOS attack profile in a standard manner.

The utilization of pre-designate and post-designate slews can be advantageous since the calculations made by the MMC (Mission Management Computer) rely solely on the slant range at the moment of target designation (even if AGR is available). The slant range is updated only during slew commands or after re-initialization.



4.2.2.1.3.2 DTOS OPERATIONS – MFD SYMBOLOGY



4.2.2.1.3.3 DTOS – HUD PROCEDURES

Procedures for DTOS using the HUD are as follows:

1. ICP - Depress A-G button.

2. SMS - Select/verify DTOS submode.

3. HUD - Verify DTOS symbology and SOI.

4. MASTER ARM switch - MASTER ARM or SIMULATE.

5. LASER ARM switch - LASER ARM (optional).

6. Target - Designate.

    (a) Maneuver to position HUD TD box over target (as desired).

    (b) Cursor - Slew HUD TD box over target (as desired).

    (c) TMS - Forward to designate target.

7. For TGP sighting (if applicable).

    (a) DMS - SOI to TGP.

    (b) CURSOR/ENABLE control - Slew TGP LOS to target.

    (c) TMS - Forward to establish POINT or AREA track.

8. Trigger - Depress to first detent for Laser ranging (optional).

9. WPN REL button - Depress and hold.

10. Maneuver to maintain FPM on bombfall/steering line until release.

4.2.2.1.4 IAM-VIS – IAM VISUAL SUBMODE

The IAM visual submode combines visual target designation through the HUD with automatic ballistic computation similar to DTOS weapon delivery.

There are two states provided in the IAM visual submode: pre-designate and post-designate. The pre-designate state begins when the pilot selects the VIS weapon delivery option and continues until the weapon release button is pressed or designate is commanded by pushing the target management switch forward on the side stick controller. If the pilot commands a return-to-search by pushing the target management switch aft (down), the pre-designate state is re-entered.

In addition, the HMCS (Helmet-Mounted Cueing System) can be utilized to support IAM VIS delivery. When the HUD is the selected sensor of interest (SOI), and the IAM visual weapon delivery mode is chosen, a TMS forward input for more than 0.5 seconds transfers control to the HMCS. With the HUD as the SOI and the HMCS in control, the pilot designates the target by pushing the target management switch forward on the side stick controller.

4.2.2.1.4.1 IAM-VIS – HUD SYMBOLOGY

In the IAM-VIS delivery submode, the HUD incorporates various symbology for the delivery of IAM weapons. This symbology consists of:

- Azimuth Steering Line: This line provides guidance for aligning the aircraft's azimuth with the target during weapon delivery.

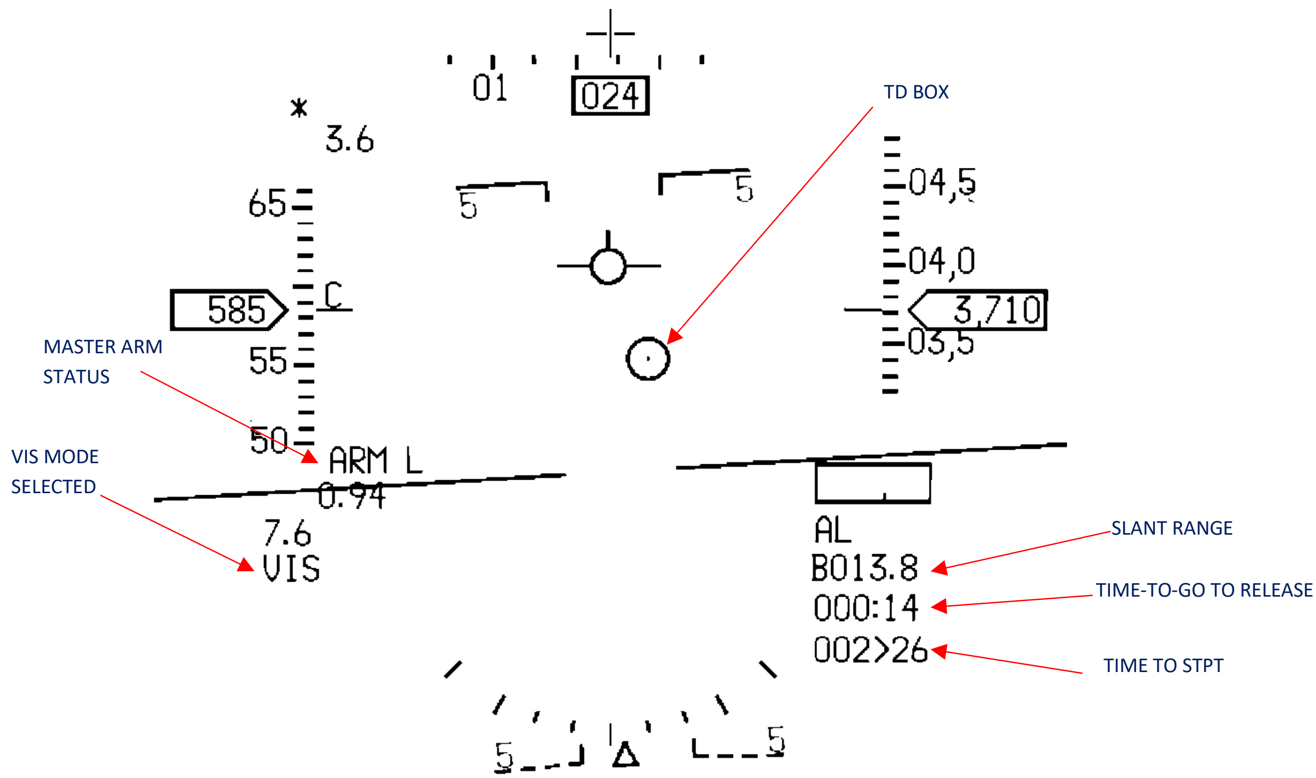
- Extended A-G Solution Cue: The extended cue assists in determining the optimal flight path for accurately delivering the IAM weapon to the target.

- Target Designator Box: The target designator box indicates the location of the designated target on the HUD display.

- IAM Release Scale: This scale includes several elements:
    - Scale Tics: Markings on the scale that provide reference points for weapon release.
    - Target Range Caret: A visual indicator representing the range to the target.
    - Missile Launch Envelope: Depicted on the scale, it indicates the acceptable range of launch parameters for the missile.
    - Required Climb and Turn Angles: Displayed on the scale, they indicate the necessary aircraft maneuvering angles for successful weapon delivery.
    - Predicted Altitude at Weapon Release: This element provides an estimate of the aircraft's altitude at the moment of weapon release.

- Time to RMAX2/Time until Impact: These indications inform the pilot of the time remaining until reaching the maximum range of the weapon (RMAX2) or the estimated time until impact on the target.
- Time over Target: This information shows the estimated time remaining before the aircraft reaches the target.

Together, these HUD symbology elements aid pilots in accurately delivering IAM weapons during the IAM-VIS delivery submode.



4.2.2.1.4.2 ELECTRO-OPTICAL (EO) VISUAL SUBMODE

The electro-optical (EO) visual submode enables dive toss delivery of AGM-65 missiles against visual targets The targeting pod can be utilized to acquire targets and then transfer those targets to imaging infrared AGM-65D/G weapons. In the VIS mode, the operational procedure closely resembles DTOS, where the target designator (TD) box is initially aligned with the flight path marker (FPM) and then ground stabilized using the target management switch (TMS) forward input for designation.

When in the EO visual mode, holding the TMS forward for more than 0.5 seconds directs the TD box to align with the Helmet-Mounted Cueing System (HMCS) line of sight (LOS) at the HMCS Aiming Cue. By adjusting head position, the TD box can be moved over the target and designated for ground stabilization. The same ranging mechanism utilized in DTOS also applies to the VIS mode. The weapon seeker head is synchronized with the TD box.

For more information, refer to the AGM-65 chapter.

4.2.2.2 PREPLANNED WEAPON DELIVERY MODES

4.2.2.2.1 Continuously Computed Release Point (CCRP)

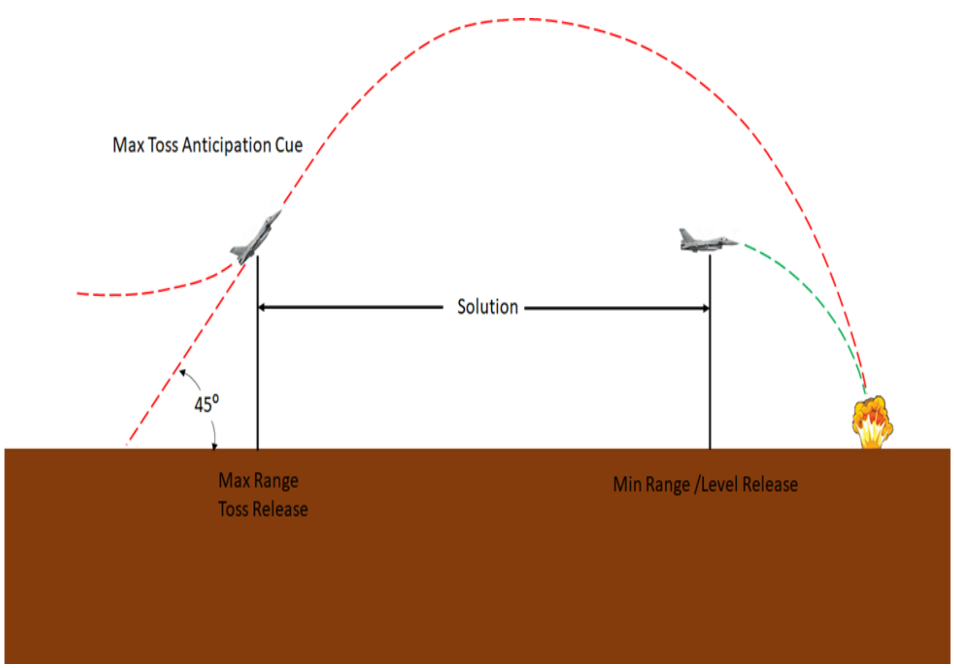
The Continuous Computed Release Point, or CCRP, is the primary delivery submode for attacking preplanned targets. The FCC/MMC uses stored ballistic data, and computes bomb range under dynamic aircraft flight conditions. This weapon release point in relation to the assigned target is the product of the bomb range calculation.

CCRP combines bombing geometry with sensor sighting by using the AG FCR or AG TGP for target acquisition. Visual acquisition can also be used by using the HUD, provided that the target elevation is accurate. CCRP deliveries can also be accomplished by using accurate target coordinates and elevation.

Any of the 99 destinations can be used as direct target steer points. Steer points 1-25 can have 2 offset aimpoints linked to them. The AG FCR or AG TGP targeting cursors are automatically positioned over the selected steer point. Since CCRP uses a steer point as a preplanned target, the release point is the location short of the target equal to bomb range. The system provides aiming symbology for the computed release point.

The release point is constantly updated. Aiming sensor cursor correction slews, along with the aircraft flight conditions, are considered for near-instantaneous bomb range calculations.

The FCC/MMC will also compute maximum toss ranges, allowing low drag munitions to be released at their maximum bomb range by guiding the aircraft for a 45-degree release.



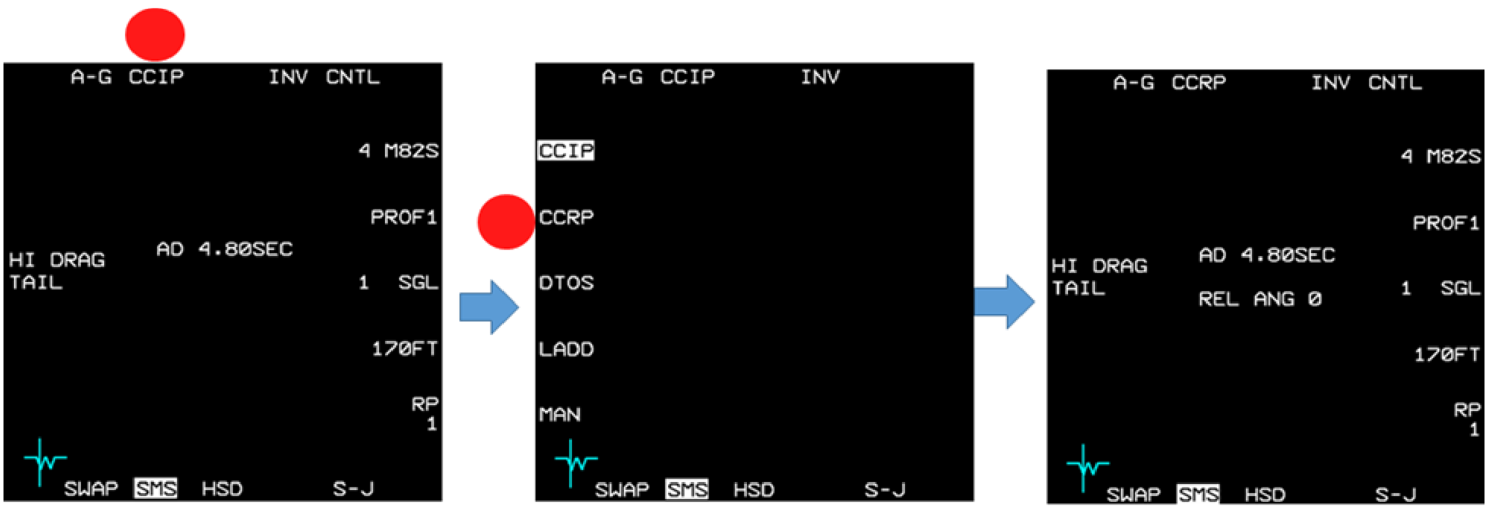
4.2.2.2.1.1 CCRP MODE ACCESS

Press the AG button on the ICP to select AG mode. CCRP is the default submode and will be selected upon AG mode entry.

If another submode is selected, CCRP can be accessed either from the AG SMS page, or selected "hands on" via the MSL STEP button.

On the AG SMS page, the currently selected submode is displayed below OBS 2. To select a different submode, press OSB 2. The AG submode menu appears on the left-side of the MFD, with the currently selected submode highlighted. Select the new submode from the menu, and it will be displayed below OSB 2.

For a "hands on" AG delivery submode selection, press the MSL STEP button on the flight stick.



Press OBS 2

Press OBS 19

MSL STEP rotary

Current mode	**MSL STEP**
CCIP	DTOS→CCRP→CCIP→DTOS
DTOS	CCRP→CCIP→DTOS→CCRP
CCRP	CCIP→DTOS→CCRP→CCIP
LADD/MAN	CCIP→DTOS→CCRP→CCIP

LADD and MAN are not included in the rotary. They must be selected from the AG submenu page.

4.2.2.2.1.2 SIGHTING OPTIONS

Aircraft sensors are pointed along a common line-of-sight (LOS) to a specific point on the ground for air-to-ground sighting known as the System Point-of-Interest (SPI). The following sighting options and cursor position features are available:

STP/TGT –	Steerpoint and Target Direct Aimpoint sighting
OA1/OA2 –	Offset Aimpoint sighting
IP –	Visual Initial Point sighting
RP –	Visual Reference Point sighting
SP –	Snowplow sighting

The STP/TGT, OA1/OA2, IP, and RP sighting options are selected via the sighting point rotary on the MFD GM FCR page (OSB 10). Additionally, the sighting point options are selectable via TMS right. Offset (OA1/OA2), initial point (IP) sighting, and reference point (RP) sighting are used for aim points where positions are known or estimated to be near specified steerpoints. Bearing from true north, range, and elevation data are entered via the upfront controls. *Note: For simplification, entering "0" for elevation places offsets at ground level, regardless of terrain MSL altitude. Thus, pilots should normally enter "0" for altitude.*

4.2.2.2.1.2.1 DIRECT AIMPOINT SIGHTING (STPT/TGT)

Direct sighting can be used in any bombing mode. In direct sighting mode, all sensors are pointed at the selected steerpoint. Slewing the cursor via the cursor control may be required to place the steerpoint position over a desired aim point more precisely. Slew corrections may be zeroed via the cursor zero OSB.

4.2.2.2.1.2.2 OFFSET AIMPOINT SIGHTING (OA1/OA2)

Steerpoints may have up to two offsets, each defined as a true bearing and range from the steerpoint and each with a separate elevation. If an offset aim point has zero range, it is skipped in the sighting point rotary. If OA1 or OA2 are set, all sensors are pointed to the offset position; however, the steerpoint defines the target location. For example, an offset aimpoint can be used to deliver weapons against a target with a poor radar return by locking a nearby radar-significant object and adjusting the offset such that the steerpoint is placed on the desired target. Offset aim point sighting is provided in preplanned submodes (CCRP in this case, since LADD and ULFT are not implemented) only. The OA symbol is an isosceles triangle 12 mr high and 6 mr wide. It is displayed in NAV and A-G mastermodes.

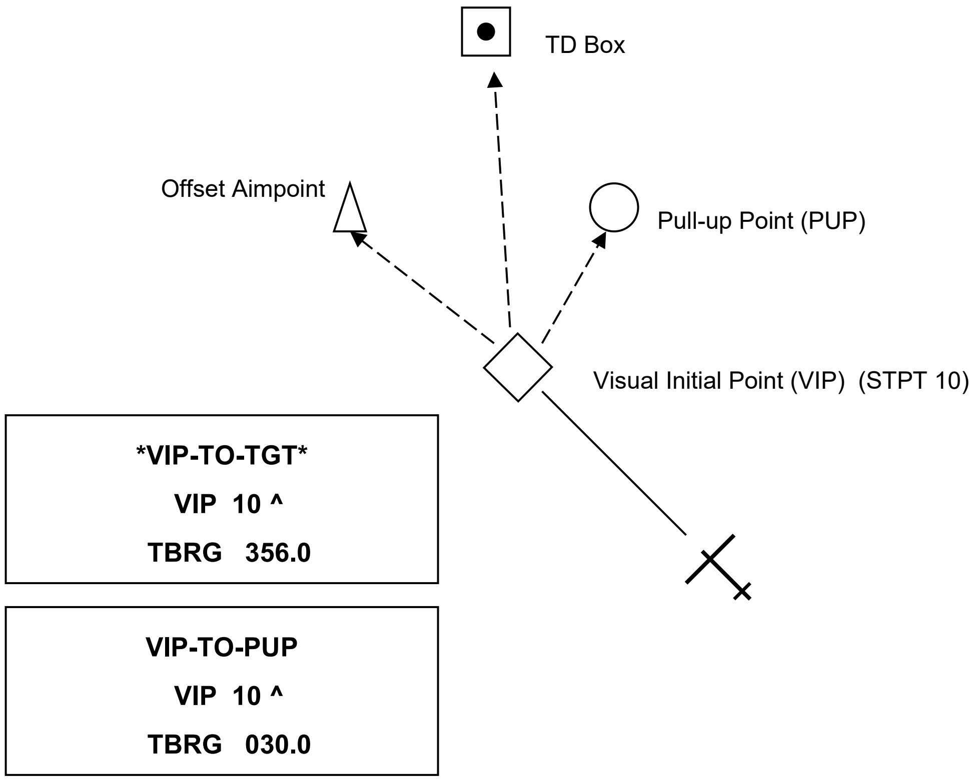
Offset aim point selections are remembered by the system through master mode and steerpoint changes.

4.2.2.2.1.2.3 VISUAL INITIAL POINT SIGHTING (VIP)

Visual initial point (VIP) sighting is used in preplanned submodes to plot a target on the HUD at a true bearing and range from a visually identifiable overfly point.

The VIP sighting mode also allows for an unknown target position to be referenced from a known position (steerpoint) during a mission. By preplanning the IP, bearing, range, and elevation can be entered while airborne to define the target.

While in VIP, navigation steering to the IP is provided via the HSI and the azimuth steering line to the target on the HUD. Cursor zero reverts the system solution back to the original navigation solution if cursor slews are made. Bearing, range and elevation data for the IP may be entered by pressing LIST→3 on the ICP. VIP is mode-selected by placing the scratchpad asterisks on "VIP-TO-TGT" and pressing "0" to mode select. Offset aim points and IP sighting may be used simultaneously.

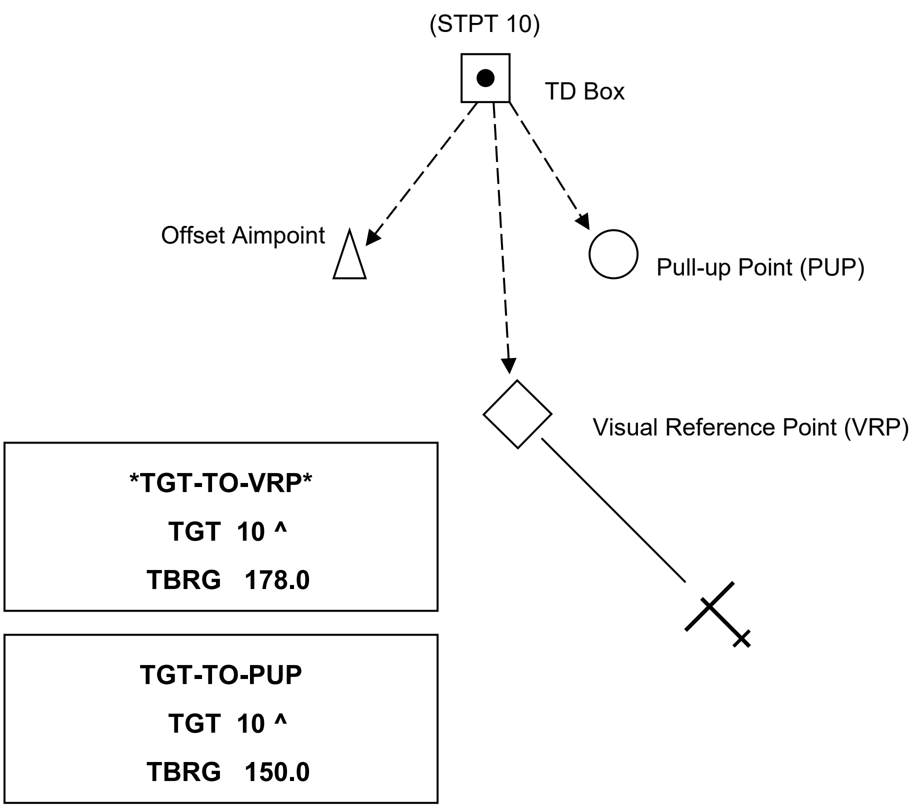


VIP Sighting

4.2.2.2.1.2.4 VISUAL REFERENCE POINT SIGHTING (VRP)

Visual reference point (VRP) sighting mode is used in preplanned submodes to plot a reference point on the HUD as a true bearing and range from the target. This allows the utilization of a known, visually identifiable position, or RP point, to initiate an attack.

While in VRP, navigation steering is provided to the target via the HSI and via the azimuth steering line on the HUD. Initially, the sighting point rotary is on TGT. While in VRP, the steerpoint defines the target and the RP is defined as a bearing and range from the target and an elevation (remember, use “0”). Bearing, range and elevation data for the RP may be entered by pressing LIST→9 on the ICP. VRP is mode-selected by placing the scratchpad asterisks on “TGT-TO-VRP” and pressing “0”. Offset aim point and RP sighting are available simultaneously.



PUP Sighting

Note that since 4.36 the VIP/VRP functions are extended to improve sighting options sighting options in the HUD/HMCS and TGP. You can enable VIP or VRP outside AG-mode or preplanned submode. Overfly updates to the SPI and HUD slews are now implemented.

Furthermore, when VIP or VRP is active and shown, you can slew the TGT/IP/RP/OA geometry around, but the relative distance as defined is maintained. The slews made outside VIP/VRP also apply, since they are calculated relative to the STPT.

Please note that the slews in VIP/VRP are separate from the general slews. Slews in VRP/VIP do not affect 'normal' AG-mode slews.

4.2.2.2.1.2.5 POP-UP POINT (PUP) CUE

The pop-up point (PUP) is entered via the VIP-TO-PUP or VRP-TO-PUP page of the DED. DCS right (SEQ) to select the PUP page from the VIP or VRP pages. When the PUP is limited in the HUD FOV, an X is superimposed over it.

4.2.2.2.1.2.6 FINAL IP AND RP NOTES

Note how aim points and PUPs are defined in both VIP and VRP (they are always off the steerpoint—the VIP is a steerpoint while the VRP is not). Careful study of the geometry of both modes will help the pilot understand which mode is most appropriate for a particular situation. Target type, location, terrain features and delivery methods may also be factors to consider when using one mode or the other. VIP and VRP may not be used simultaneously. Mode-selecting one will de-mode-select the other. It is not advisable to try and use both modes for one steerpoint as OA and PUP geometry will change if one mode is selected but the offsets were intended for (or entered in) the other.

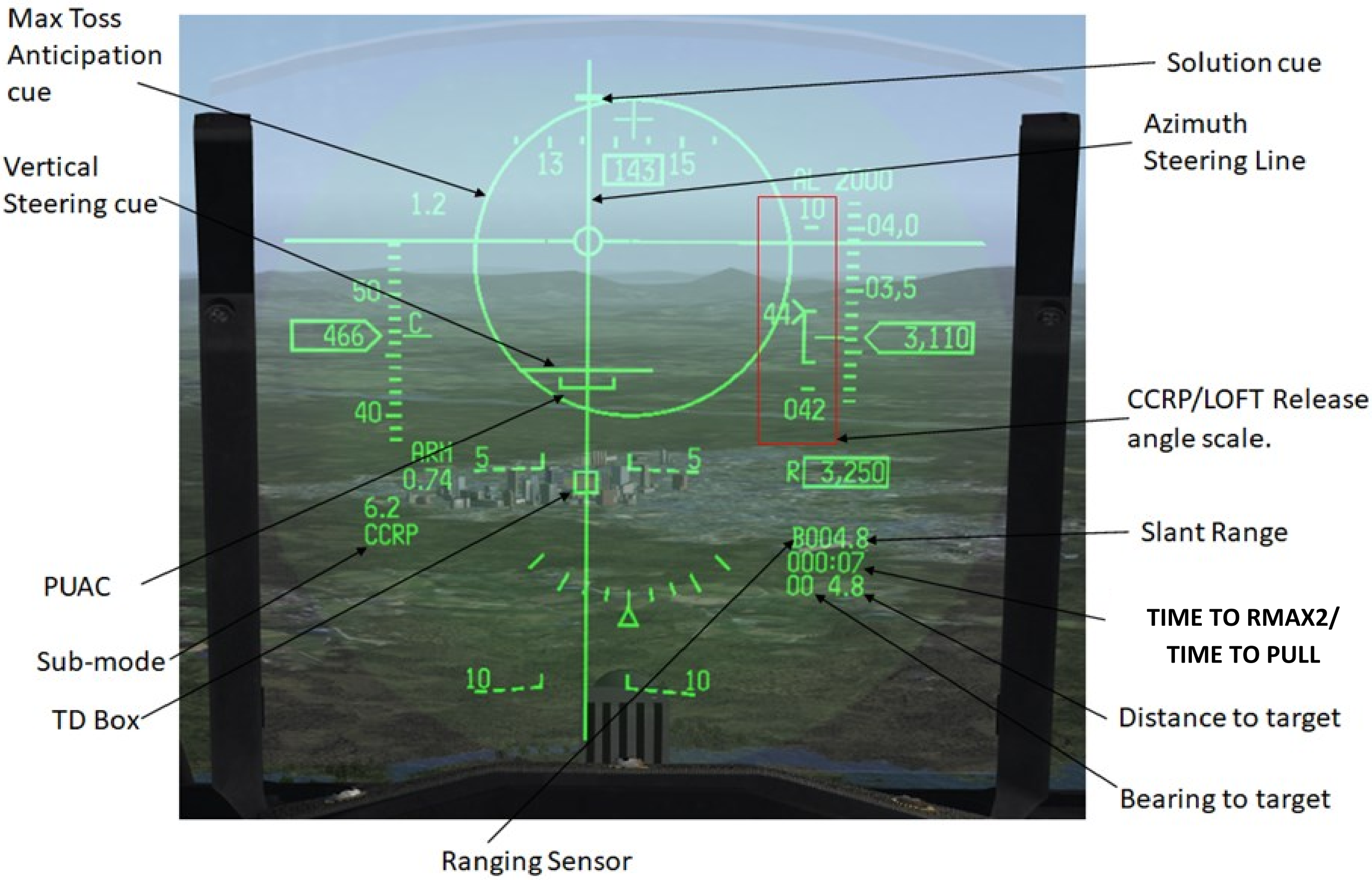
4.2.2.2.1.2.7 SNOWPLOW (SP) SIGHTING

Depress OSB 8 next to the SP mnemonic in GM/GMT to select the snowplow option. The mnemonic highlights indicating that you are in the SP mode. SP sighting directs each sensor line-of-sight straight ahead in azimuth, disregarding any selected steerpoints. In the GM, GMT, and SEA modes, the ground map cursor will be positioned at half the range selected, i.e., the center of the MFD. The cursors remain at this range while the ground map video moves, or "snowplows," across the MFD. At this point, there is no SOI, and the cursors cannot be slewed. Only **after** ground stabilizing the cursor with **TMS forward** can the cursor be slewed.

TMS forward establishes the radar as the SOI and enables cursor slewing. Single target track may be commanded by pressing TMS forward a second time. All cursor slews in SP are zeroed when SP is deselected. After ground stabilizing, the point under the cursors at the time of stabilization effectively becomes your steerpoint. All NAV and weapon delivery steering and symbology, including great circle steering, will be referenced to this "pseudo steerpoint." Displays return to the previously selected sighting point when SP is deselected. For example, SP can be used to accomplish an FCR mark on a point 5 NM in front of your position when the steerpoint selected is 40 NM away. It may often be used with IR Mavericks where target coordinates are not known in advance.

4.2.2.2.1.3 CCRP LOFT DELIVERY

The CCRP submode provides the capability to loft low drag weapons. The HUD provides azimuth steering towards the target, loft cues, time to pull for loft deliveries, and time to release.



4.2.2.2.1.4 AIR TO GROUND TARGET DESIGNATOR BOX (TD BOX)

In air to ground submodes, the TD-box is 10 mR on each side with a 1 mR pipper in the center of the box. When it is outside of the HUD FOV, an X-symbol is superimposed over it, or it is replaced by the target locator line. The TD box represents the LOS to the target and is positioned over the INS representation of the steer point.

4.2.2.2.1.5 AZIMUTH STEERING LINE (ASL)

The ASL provides a guide for optimum lateral steering to the release point.

The displacement of the ASL will indicate the direction needed for the aircraft to turn for the ASL to be positioned on the FPM, to attain precise azimuth steering to the computed weapons release point.

The ASL is blanked from the HUD, when the weapon status is MAL or blank.

4.2.2.2.1.6 MAX TOSS ANTICIPATION CUE

The FCC/MMC continuously computes the maximum bomb range based on aircraft velocity, air density, altitude and weapon ballistics. The maximum range of the weapon equates to a release at 45 degrees of climb.

To alert the pilot of the approaching release point, the max toss anticipation cue appears two seconds prior to the aircraft reaching the max release toss range. The cue consists of a 100-mil circle below the boresight cross at 0° azimuth and -3° elevation. When the aircraft reaches the maximum range, the range caret is coincident with the maximum release range tic and the cue will flash for two more seconds before disappearing from the HUD. An immediate 4.0g pull-up to a 45-degree climb angle will result in a maximum range toss of the weapon.

The maximum toss solution is mechanized with the following assumptions:

• The pilot will initiate a 4.0 G pull-up when the toss cue appears.

• A constant 4.0 G pull-up will be maintained.

• The impact point may be short if the pilot pulls more than 4.0 G.

• Airspeed bleed off is assumed.

• Selection of MIL at initiation of pull-up.

• Smooth transition from 1.0 G to 4.0 G's in 2 seconds

The cue will appear just prior to bomb release for a level delivery with high-drag munition.

4.2.2.2.1.7 VERTICAL STEERING CUE (VSC)

The vertical steering line consists of a large horizontal line displayed on the ASL below the FPM. It initially appears when time to pull is 10 seconds and it is opposed by the solution cue that is displayed above the FPM.

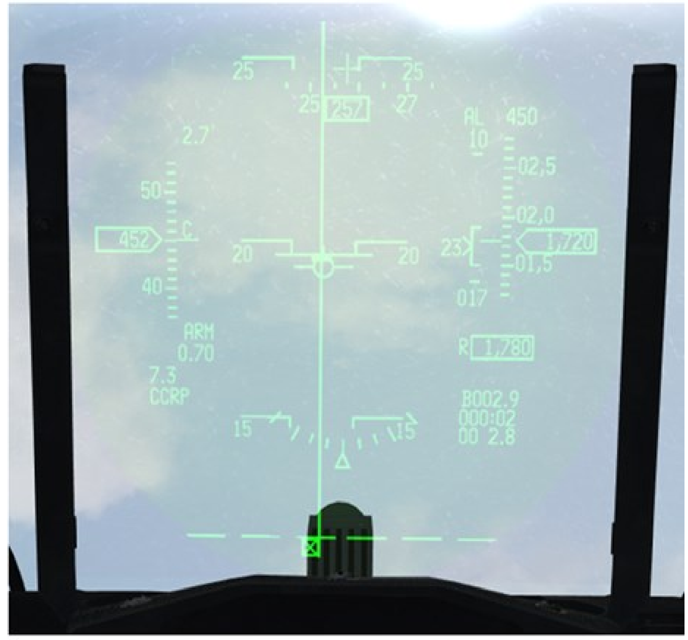
Both cues are equidistant from the FPM and move towards it as time to pull counts down to 000:00.

When both cues coincide over the FPM, they reset. Both cues then will be above the FPM and the VSC will provide guidance for a smooth pull to 4 G's in 2 seconds. This is achieved by keeping the FPM directly below the VSC during the pull.

Time to pull is replaced by time to release, and weapon release is achieved when the solution cue "hits" the FPM, (time to release 000:00).

The VSC is not displayed when the release angle is set to 5 degrees or lower.

Initiate pull and keep FPM on VSC
Timer reset to time to release



2 seconds prior to release

4.2.2.2.1.8 TIME TO PULL

Time to pull is displayed on the HUD and MFD, indicating the time left until the solution cue and the VSC coincides over the FPM. When time to pull is 000:00 it indicates that the weapon will be released at the desired release angle if a 4.0 G pull within 2 seconds is executed.

If Time to pull reaches 000:00 and passes, it is replaced by time to release.

Time to pull is not displayed if the release angle is set at 5 degrees or lower.

Time to pull is not displayed for high drag munitions that are considered non-loftable munitions.

4.2.2.2.1.9 TIME TO RMAX2

Time to RMAX2 is displayed on the HUD and MFD indicating the time left for a weapons release. At 000:00, the solution cue is over the FPM.

Release consent is given by depressing the pickle button prior to the solution cue reaching the FPM and the time to release showing 000:00. The FPM will flash when the FCC/MMC generates a release command.

4.2.2.2.1.10 SLANT RANGE

Slant range is displayed in tenths of nautical miles for ranges greater than 1 nautical mile and hundreds of feet for ranges less than 1nm.

The letter preceding the slant range value indicates the sensor that is being used to calculate the slant range.

B is displayed when the range is calculated using steer point elevation/ barometric data

R is displayed when the radar altimeter is providing range.

F is displayed if the radar is providing range. (This occurs when the ground mapping radar is in fixed target track, or AGR is selected by the means of CCIP, DTOS, VIS and STRF FTT or AGR)

T is displayed when the targeting pod is in AG mode, is the priority sensor and is in a track mode.

L is displayed when the targeting pod is in AG mode, is the priority sensor is in a track mode and the laser is firing.

P is displayed if the range is computed using DTS passive ranging. (N/I).

H is displayed if the HTS is providing range.

BARO, RALT and DTS(N/I), are backup ranging sensors, and will provide ranging when FCR or TGP ranging is unavailable

If ranging data is unavailable, XXX will be displayed.

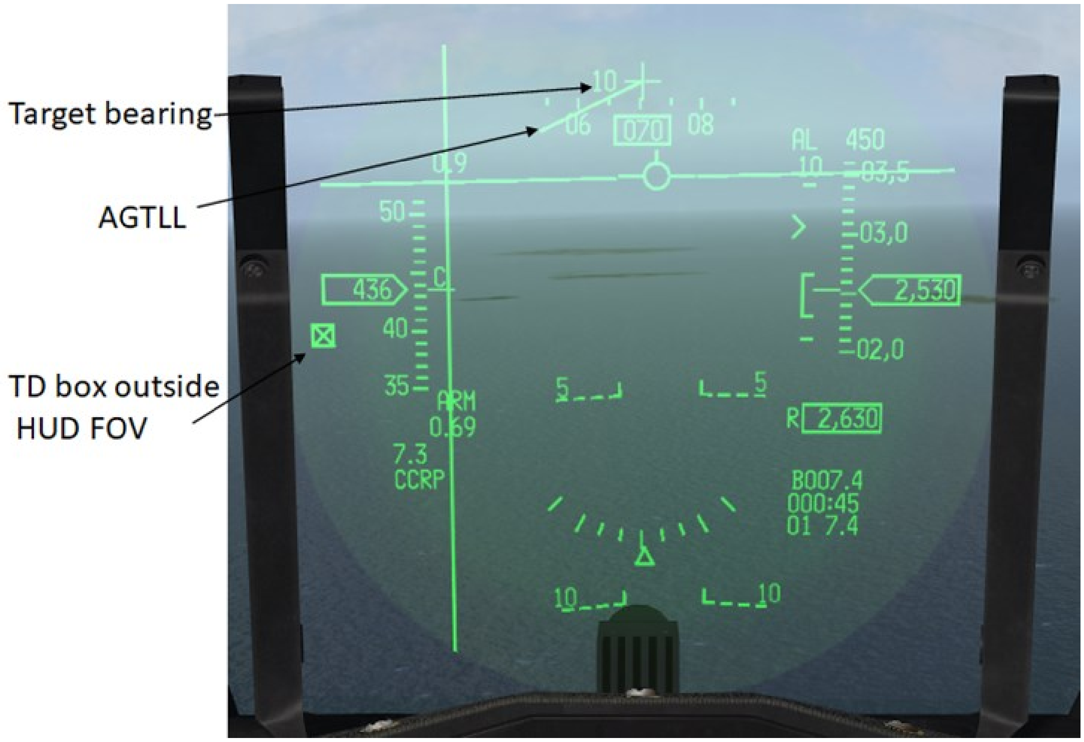
4.2.2.2.1.11 HUD BEARING AND RANGE TO TARGET.

Bearing and range to the target are displayed at the lower right of the HUD. The first two digits are bearing in tens of degrees. The second set of digits is range in nautical miles.

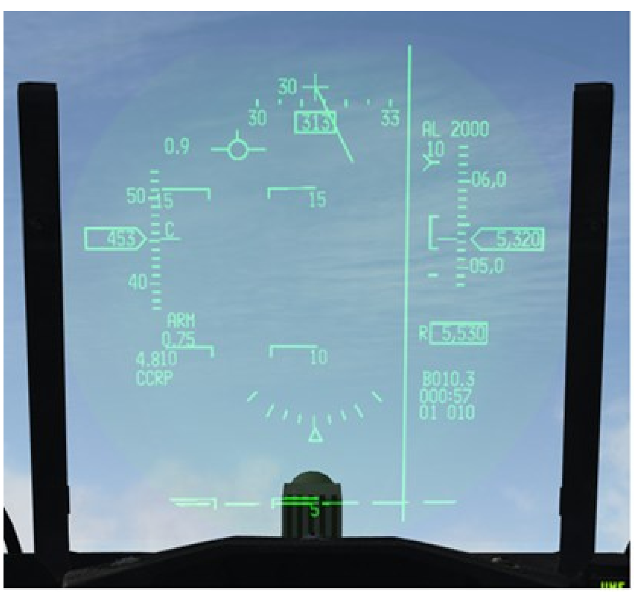
4.2.2.2.1.12 AIR-TO-GROUND TARGET LOCATOR LINE (AGTLL)

In CCRP or DTOS submodes when the target is outside the HUD field of view, the Air-to-Ground Target Locator Line is displayed instead of the target designator box.

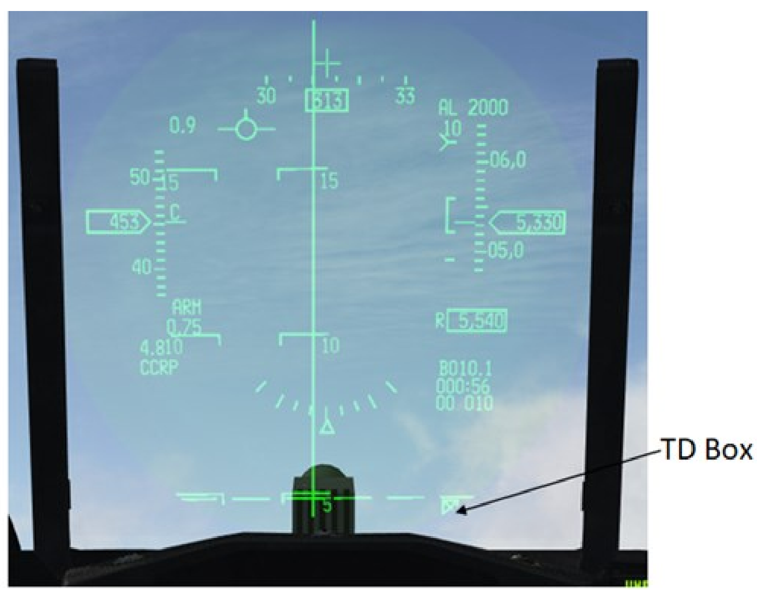
The AGTLL is a 40 mR long line that originates from the gun boresight cross and points towards the target position. The orientation of the 40 mR long line is such that an angle of zero results in the line being displayed vertically up and a positive value of the angle drives the line in a clockwise direction. The target bearing is displayed adjacent to the bore cross.



To avoid confusion with the ASL, the target locator line is not displayed when target position is straight down ±10 degrees. Instead, the target designator box is superimposed by an X symbol at the bottom of the HUD.



AGTLL points towards target



AGTLL not displayed when target is straight down ±10 degrees.

4.2.2.2.1.13 SOLUTION CUE

The solution cue consists of a short horizontal line displayed on the ASL above the FPM.

If the set release angle is above 5 degrees, it will Initially appear for low drag munitions when time to pull is 10 seconds and will move down the ASL towards the FPM as time to pull counts down to zero. When time to pull reaches 000:00, it resets and represents time to release, once again moving down towards the FPM as the aircraft approaches the release point.

If the release angle is less than 5 degrees, the solution cue will initially appear when time to release is 10 seconds and move down the ASL towards the FPM.

For high drag munitions, the solution appears on the ASL, indicating when the aircraft is within a ballistic solution for the munitions that are to be released.

When the solution cue coincides with the FPM, time to release will be 000:00 and the weapon is automatically released if release consent is given by holding down the pickle button.

4.2.2.2.1.14 CCRP/LOFT RELEASE ANGLE SCALE

CCRP/LOFT Release angle scale is displayed in CCRP when:

-Range to target is less than 15nm

-Bearing to target is less than 50 degrees

-The selected weapon is loftable.

When the target range is less than 15nm and above 10nm, the range caret remains pinned, adjacent to the upper tic mark.

The range of the scale is indicated above the upper tic mark. The upper tic mark represents 10nm and the lower tic mark 0 nm. The position of the range caret within the 10 nm scale represents the targets range.

Within the 10nm scale, a bracket similar to the AA DLZ represents the max / min release range. The upper tic mark of the bracket represents the maximum release range which equates to a 45-degree toss. The lower tic mark of the bracket represents the minimum range that equates to a level release.

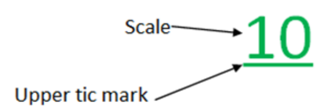
Adjacent to the range caret, the predicted climb angle at weapons release is displayed when the aircraft is at the 45-degree toss range for weapons release. When the range is adjacent or below the level release tic, the predicted release angle disappears

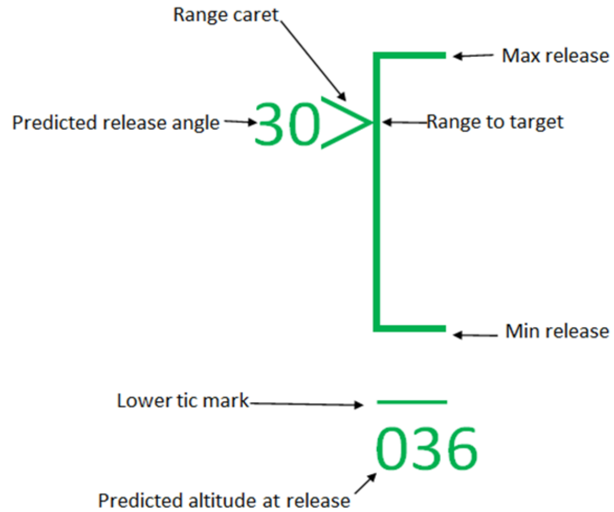
The predicted climb angle indicates the approximate angle of release if the pilot initiated and maintained a 4.0 G pull within 2 seconds. The counter, the PUAC and vertical steering cue VSC (new since 4.36) indicates the time to pull up if you intend to loft the weapon.

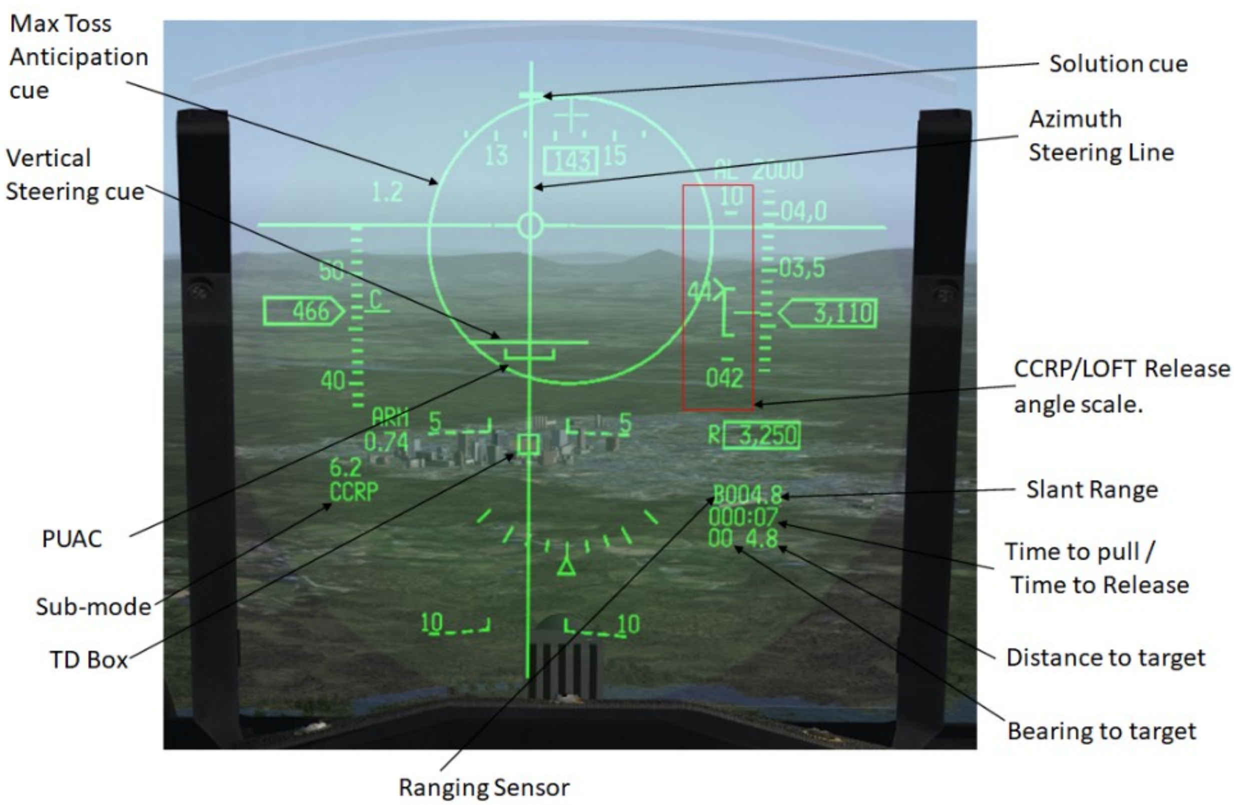
Below the range scale, the predicted altitude at release is displayed in hundreds of feet and is displayed when the aircraft is at the 45-degree toss range for weapon release.

When the range is adjacent or below the level release tic, the predicted altitude disappears.

The range caret may be positioned below the lower bracket of the loft scale during a dive delivery:


Scale
10
Upper tic mark


Range caret
Max release
Predicted release angle
30
Range to target
Min release
Lower tic mark
036
Predicted altitude at release


Max Toss Anticipation cue
Vertical Steering cue
PUAC
Sub-mode
TD Box
Solution cue
Azimuth Steering Line
CCRP/LOFT Release angle scale.
Slant Range
Time to pull / Time to Release
Distance to target
Bearing to target
Ranging Sensor

4.2.2.2.1.15 PUAC

The PUAC appears only in the AG mode in the form of a staple and is used to show either fuse arming or ground clutter.

The PUAC is displayed at its maximum displacement (4 degrees) below the FPM. When both time-to-release and the difference between time-of-fall and time-to-fuze arming for the weapon is 10 seconds or less, the FPM corresponds to the minimum fuze arming point. When time-to-release and the difference between time-of-fall and time-to-fuze arming are both less than 10 seconds, the cue is positioned according to the amount of time remaining between 0 and 10 seconds.

If the aircraft is in a dive, and altitude lost during pull-out is no factor, the PUAC will display fuze arming information based on the entered arming delay and burst altitude (if applicable) on the A-G SMS page. This cue for improper arming appears for all A-G modes except for those modes or weapons where fuze arming information is not applicable, i.e., Rockets, Strafe, EO, and manual deliveries.

The PUAC moves upward toward the FPM as the aircraft dives to indicate that minimum altitude is approaching for dive recovery or weapon release, whichever is more immediate. The cue reaches the flight path marker when the aircraft is at minimum altitude for proper fuze arming. For ripple releases, the PUAC is valid for the bomb with the shortest time for proper fuze arming. For multiple bomb release in a dive delivery, the fuze arming anticipation cue will appear higher relative to the FPM compared to a single bomb release to allow for proper arming for the bomb with the shortest time for fuze arming of that string. The LOW mnemonic is displayed below the FPM when the aircraft is below the minimum altitude for fuze arming and the time-to-release is less than 10 seconds. After reaching the FPM, the pull-up cue resets for the ground avoidance advisory. For ground avoidance in the A-G master mode, the cue reaches the flight path marker when the aircraft is at minimum altitude for dive recovery. A large X symbol flashes at a 5-Hz rate to warn that a pull-up maneuver, consisting of an immediate initiation of a 4.0 G (in 2 seconds) pull-up, is necessary to avoid the ground.

4.2.2.2.1.16 CCRP LEVEL DELIVERIES

The CCRP submode also calculates a level release solution for both high and low frag weapons. The HUD provides azimuth steering towards the target, and time to release (Tim to RMAX2).

When a high drag weapon is selected, it is considered a non loftable munition and the HUD will provide cues only for a level delivery.

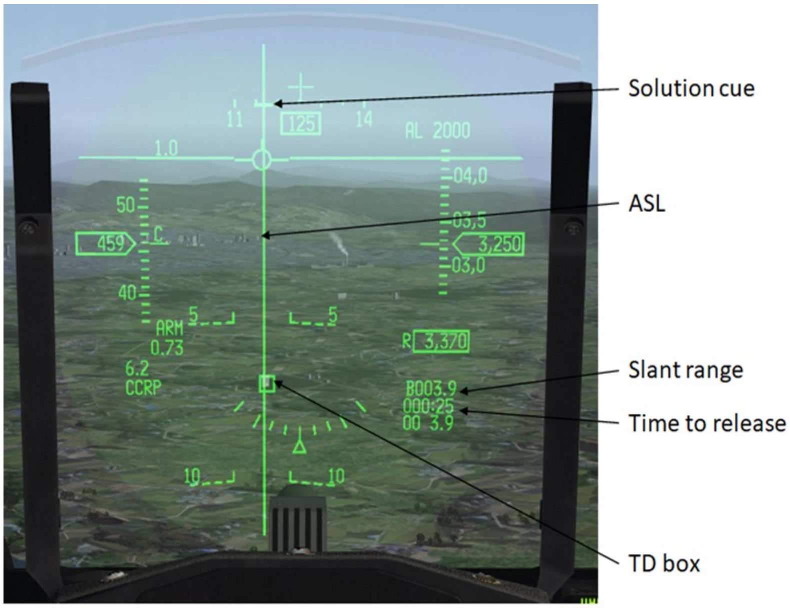
Azimuth steering is provided to the release point, and the time display on the HUD, as well as on the MFD, indicates time to release. Target range and bearing are displayed, and the TD box will be positioned over the target with azimuth and elevation.

The CCRP/LOFT release angle scale and VSC are not displayed.

The solution cue appears on the steering line above the FPM, indicating when the aircraft is within a ballistic solution for the munitions being released.

The maximum toss anticipation cue will appear just prior to bomb release for a level delivery with high-drag munitions.

Consent for release is given by depressing the pickle button prior to and until the solution cue reaches the FPM and the time to release shows 000:00. The FPM flashes when the FCC/MMC generates a release command and weapons are automatically released.



CCRP Level Delivery (HD weapons)

When a low drag weapon is selected and the release angle is set to 5 degrees or less, the displayed time on the HUD and MFD is time to release, and the VSC will not be displayed. The rest of the symbology is identical to a CCRP loft.

Consent for release is given by depressing the pickle button prior to and until the solution cue reaches the FPM and the time to release shows 000:00. The FPM flashes when the FCC/MMC generates a release command and weapons are automatically released.

CCRP level release for LD weapons (Release angle < 5)

If the release angle is set to a value higher than 5 degrees, a level delivery can still be achieved by allowing the time-to-pull to pass. The time displayed will reset to time to release.

4.2.2.2.1.17 CCRP AG SMS SETUP

The SMS can be set up during your ground operations after engine start. Access the control page to enter the fuze arming delay setting for your weapons.

NOSE LO DRAG
TAIL HI DRAG
NSTL HI DRAG

Release angle can be set between 0–45°. A setting of 5° or more will result in CCRP loft cues to be displayed on the HUD to achieve the entered release angle. However, the loft cues will only be displayed if a loftable munition is selected.

4.2.2.2.1.18 FUZING OPTION

If a MK-82S, MK-82SBA, MK-36, BSU-49, BSU-50, or BSU-50B is selected with NOSE as the fuzing option, LO DRAG is displayed along with NOSE adjacent to OSB 18

The munitions will be recognized as a loftable munitions, and loft symbology will be displayed on the HUD.

If any of these weapons are selected with NSTL or TAIL as the fuzing option, HI DRAG will be displayed. The munitions will be recognized non-loftable munitions, and loft symbology will not be displayed on the HUD.

NOSE - Nose lanyard only pulled.

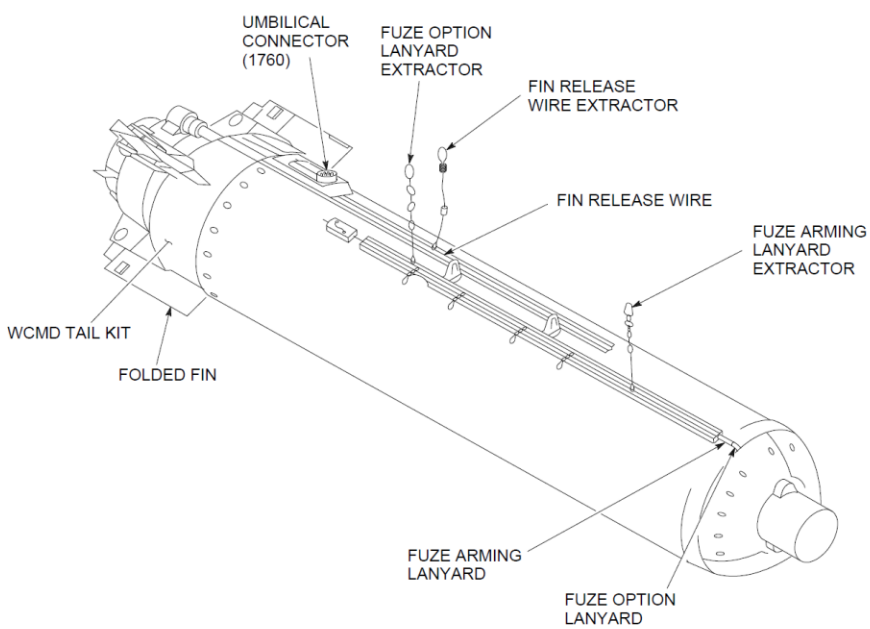
TAIL - Tail lanyard only pulled.

NSTL - Nose and tail lanyards pulled.

MAL - Displayed if fuzing failure occurs.

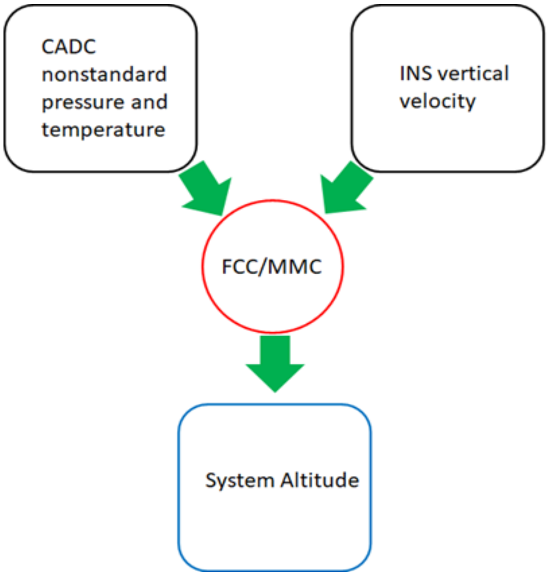
For munitions that are not fitted with a retarding tail assembly, only the fuzing will be displayed.

Fuze settings such as Airburst or Delayed are not implemented yet.



4.2.2.2.1.19 SYSTEM ALTITUDE

The FCC/MCC continuously computes a nonstandard system altitude by adjusting the altitude input from the CADC for current temperature and atmospheric pressure conditions. The FCC/ MMC mixes this adjusted altitude with the integration of INS vertical velocity to obtain a system altitude that reacts rapidly to aircraft vertical movement. System altitude is used for positioning the aiming symbols and cursors in modes that are not using a ranging sensor.

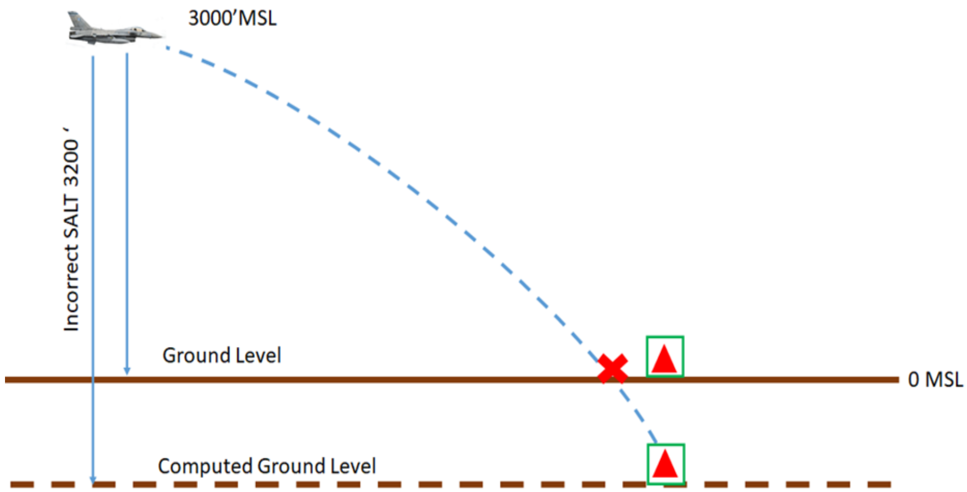


When the AG FCR is in GM, GMT or SEA, the radar is ground-mapping and does not provide air-to-ground ranging unless it is in Fixed Target Track. (FTT)

Preplanned submodes that use the radar ground map in the non-tracking mode, use primarily system altitude to determine the aircraft's height above the target (HAT). This is accomplished by subtracting the entered steer point (target) elevation from the system altitude. If system altitude has no errors and the entered elevation is correct, then an accurate HAT is used for FCC/MMC bomb range calculations. The weapon trajectory is projected through the vertical distance equal to HAT to place impact at the target's elevation.

If there is a system altitude error, or if the entered target elevation is incorrect, bomb range calculations and HAT will be inaccurate. This will cause a long or short miss.

If this error is uncorrected, the weapon will miss the target.

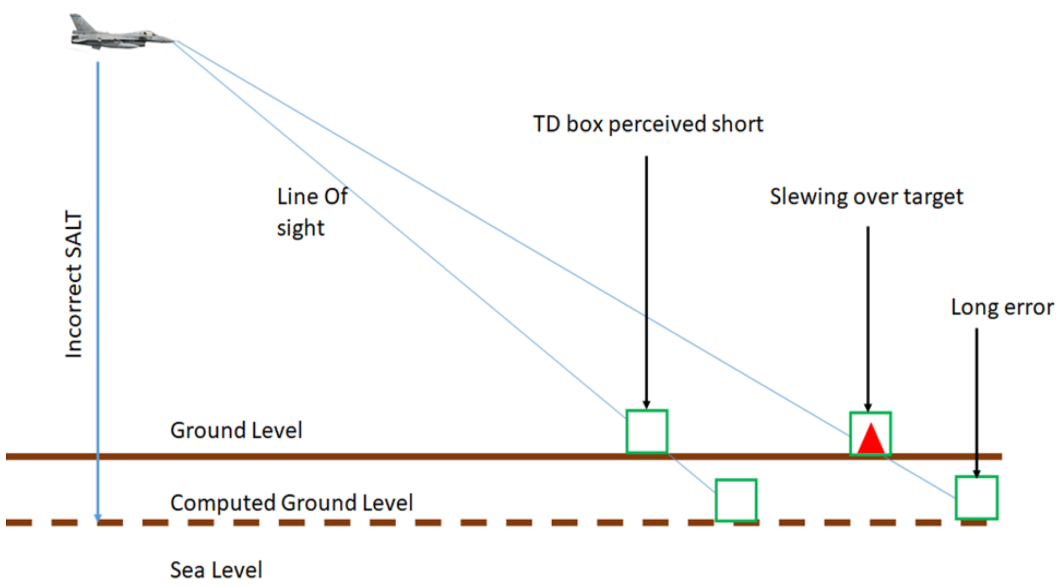


System altitude or target elevation errors can be recognized if the FCR cursors are over the target return of interest, but the TD BOX appears long or short of the target.

The TD box is accurately placed on the correct coordinates, but system altitude or elevation errors will position the TD box on the Z axis either above or below the target.

From the pilot's perspective the TD BOX will appear to be long or short of the target.

If the TD box is perceived to be short, an attempt to correct the error visually by slewing the TD box visually over the target will only result in a shift of the aim point long of the target. Only 3-9 corrections should be made visually by using the HUD as reference.



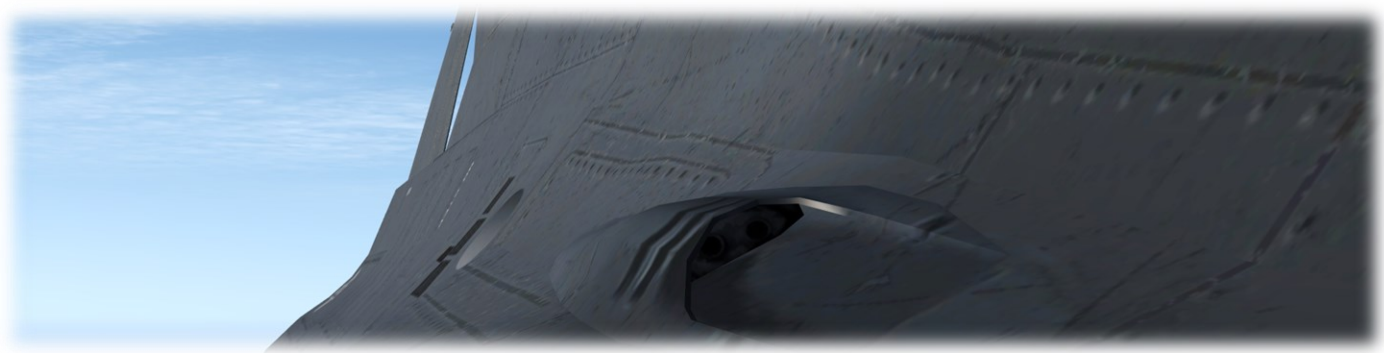
If the target elevation is correct, using FTT, the TGP in a track mode, Laser ranging, AGR, or RALT as the backup bombing sensor, will remove SALT from the FCC/MMC's height above target calculation.

4.2.3 M61A1 20MM GUN SUBSYSTEM

The M61A1 20mm gun subsystem is internally installed within the aircraft's fuselage and the left strake area. This subsystem comprises the M61A1 gun, a hydraulic drive system, and a linkless ammunition handling system. Additionally, a gun purge system and an electrical control system are provided.

The gun controller serves as the electronic unit responsible for regulating the gun's firing. When the trigger is depressed beyond the detent, a voltage is applied to the gun breech area, supplying the necessary fire voltage to the round. Upon releasing the trigger at the end of a burst, the gun undergoes a clearing operation. During this process, five to nine unfired rounds are cycled through the gun without any firing pulses. These rounds are designated as spent and cannot be utilized for the remainder of the flight

The SMS incorporates a “rounds remaining” counting function that tallies each firing pulse from the gun controller and deducts them from the initial number of loaded rounds. However, during the clearing operation, no pulses are generated, making it impossible to accurately determine the exact number of rounds cleared. As a result, the SMS assumes a default value of 7 rounds cleared. Consequently, a disparity can arise between the rounds remaining displayed on the MFD (Multi-Function Display) and the actual remaining rounds available for firing. This discrepancy tends to escalate with an increasing number of clearing operations.



MG61A1 20mm

The rounds remaining feature serves as a convenience for the pilot and does not impact the actual functioning of the gun. It is important to note that the A-G strafe mode cannot be engaged unless there are rounds loaded in the SMS. Despite the absence of indicated remaining rounds on the MFD, the gun can still fire. However, when the last round passes through the gun, a last round switch is triggered, resulting in the shutdown of gun operations.

The gun utilizes electrically primed 20 mm ammunition and has a rapid firing rate of 6000 rounds per minute. It consists of a circular arrangement comprising six individual barrels, each equipped with its own breech bolt. As the gun is fired, the assembly revolves, facilitating the sequential processes of feeding, chambering, firing, extraction, and ejection for each of the six barrels during each revolution. When the barrel aligns with the firing position, firing voltage is applied to the round.

The system incorporates a rotor assembly responsible for supporting the six barrels. This assembly rotates within a stationary housing. Within the rotor assembly, there is a bolt assembly for each barrel, and the entire mechanism is driven by a hydraulic drive system.

During gun operation, ammunition is supplied to the gun transfer unit. This unit removes the ammunition from the conveyor elements, feeds the rounds to the gun, and subsequently replaces the empty cases onto the conveyor elements.

4.2.4 AIR-TO-GROUND MISSILES

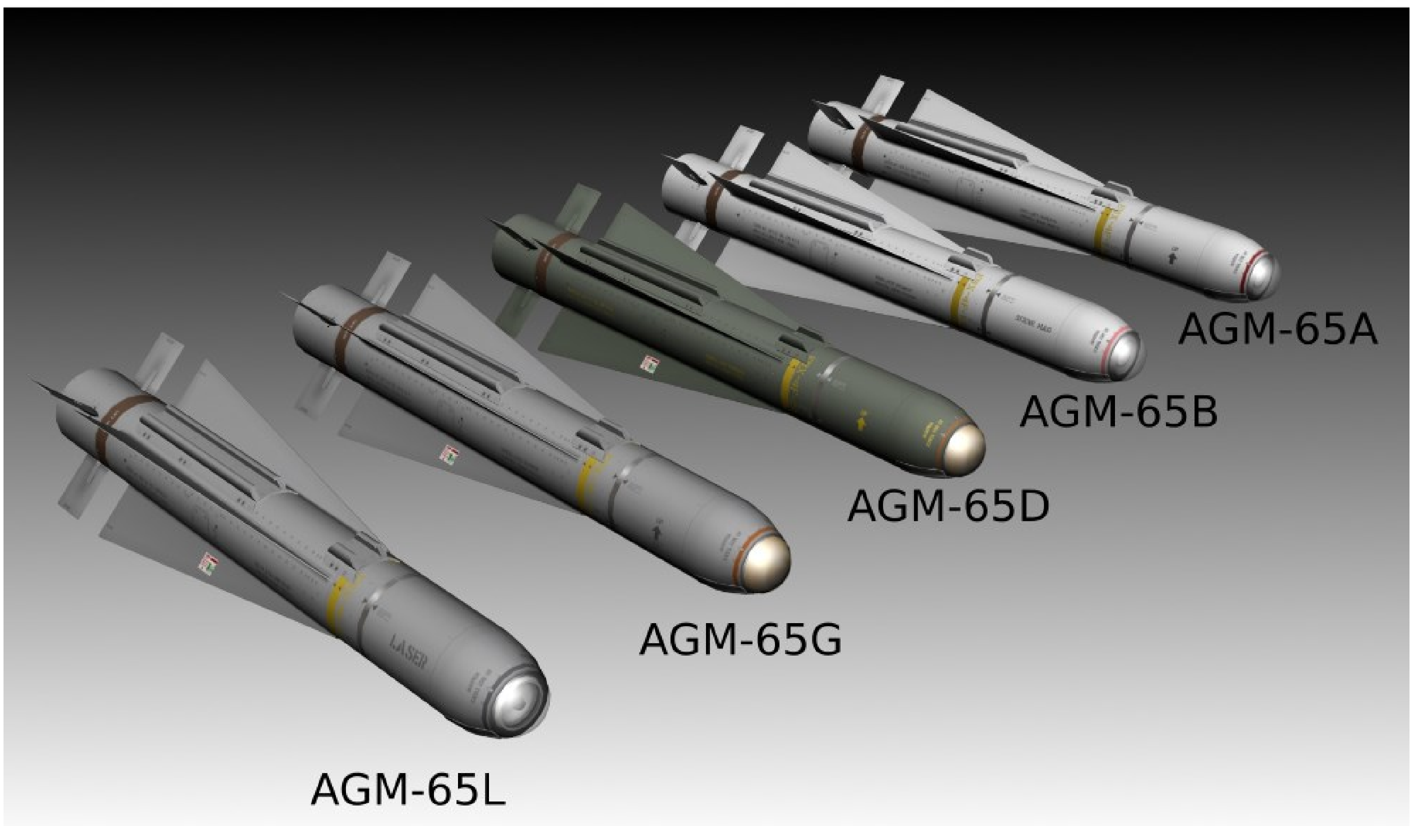
4.2.4.1 AGM-65D/G/L MAVERICK MISSILE

The AGM-65D/G Maverick is an IR, rocket-propelled air-to-ground missile. It is capable of launch-and-leave operations, relying on automatic self-guidance. The AGM-65L Maverick is the Laser guided version.

The AGM-65D uses a shaped charge warhead optimized for use against armored vehicles, bunkers, boats, radar vans and small hard targets.

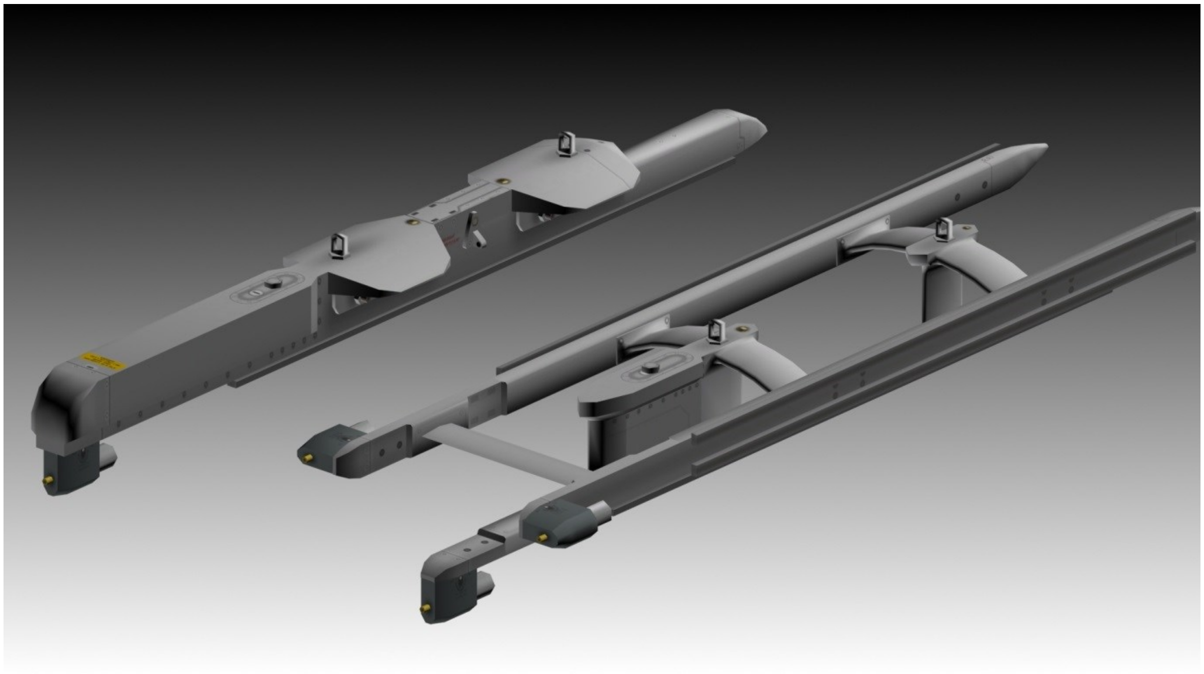
The AGM-65G and L uses a larger kinetic energy penetrator and blast/fragment warhead that is effective against both unusually shaped targets such as hangars, bridges, and ships and against small point targets such as tanks and bunkers.

The AGM-65D utilizes a centroid mode of targeting like the AGM-65A and B. In addition to the centroid mode the AGM-65G can also operate in a force correlate mode of operation for aimpoint selection of large targets.

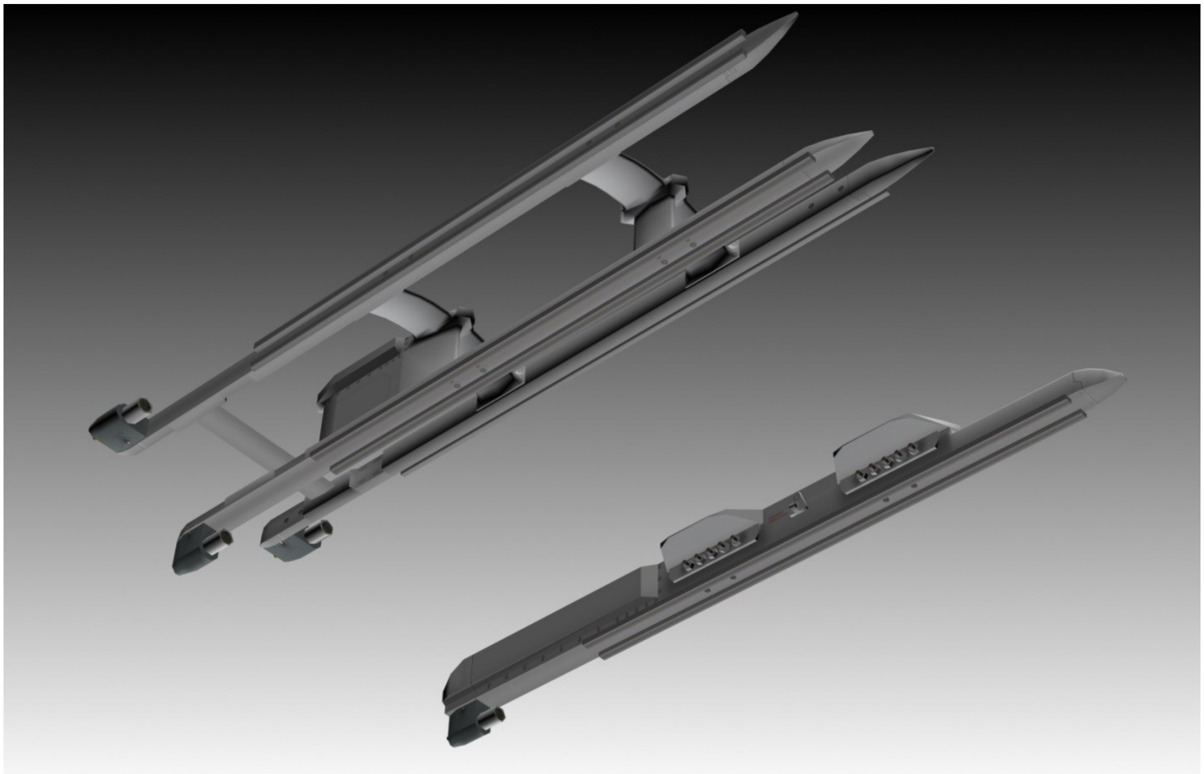


AGM-65 Maverick types in BMS

The AGM-65D is carried on and launched from LAU-88A/A or LAU-117/A launcher. The AGM-65G/L is carried on and launched only from the LAU-117 due to its heavier weight.



LAU-117/A and LAU-88A/A launchers (above)



LAU-88A/A and LAU-117/A launchers (below)

4.2.4.1.1 AGM-65 OPERATIONAL LIMITATIONS

The maximum carriage airspeed with the AGM-65 is 600 KIAS or 0.95 Mach.

The AGM-65 is always HOT, meaning that it will launch when the pickle button is pressed regardless of seeker gimbal limits or a valid lock (steady weapon pointing cross).

During time of lock on or initiating (TMS Up) handoff do not exceed 30° of bank angle. This will result in an invalid track (flashing weapon pointing cross). Once you've initiated the handoff (and HANDOFF IN PROGRESS has repeated) you can exceed 30° bank and once the target enters the weapon FOV the handoff should complete.

Do not launch the AGM-65 missile under conditions which exceed the following limits:

1. Maximum launch speed: Mach 1.2.
2. Maximum gimbal offset angle: AGM-65A = 15°; AGM-65B = 10°; AGM-65D/G = keyhole
3. Maximum dive angle: 60°.
4. Maximum bank angle: 30°.
5. Maximum roll rate: 30°/s.
6. Minimum/maximum load factor: +0.5 g/+3.0 g.

4.2.4.1.2 AGM-65 TIME LIMITATIONS

These missile operational time limits represent missile design capability. As a general rule the missile may be operated for longer time periods if the image presented on the cockpit display is usable.

1. Allow 3 minutes' gyro spin up time before uncaging to prevent damage due to gyro tumble.

2. Power-On (Ready Mode).

Cumulative per mission – 60 minutes maximum (includes 3 minutes gyro spin-up time).

3. Video-On (Full-Power Mode).

(a) Each attack – 30 minutes maximum (AGM-65D and AGM-65G).

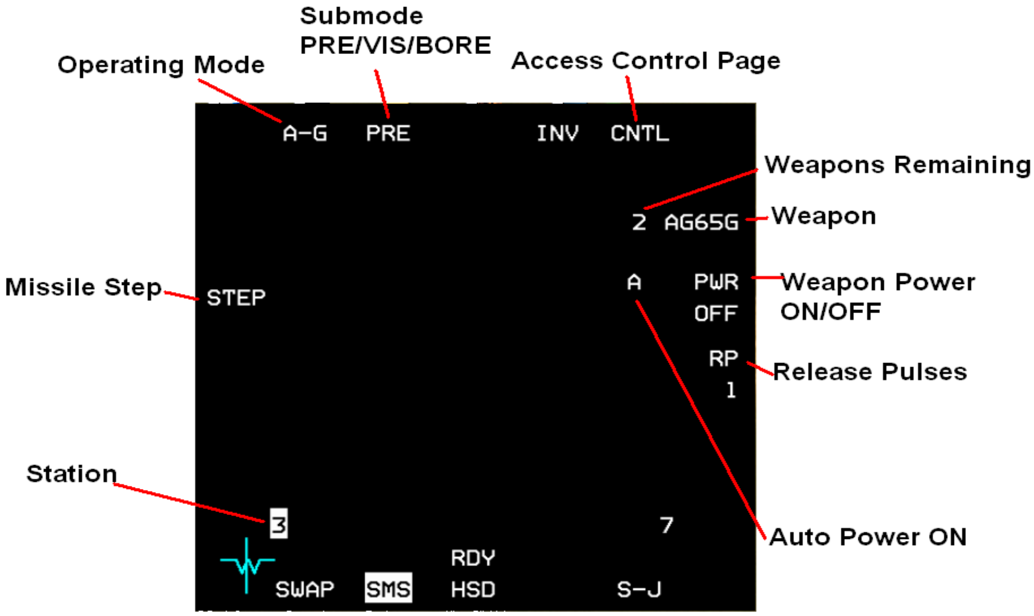
(b) Cumulative per mission – 30 minutes maximum.

4.2.4.1.3 AGM-65 HOTAS FUNCTIONS

Assuming A-G Master Mode, FCR/TGP and WPN page selected.

HOTAS	SOI	Action
MSL STEP		Select next station
CURSOR ENABLE	WPN SOI	Cycle through WPN E-O modes
UNCAGE	WPN SOI	Blow dome cover (AGM-65D)
TMS UP		
	FCR SOI	FCR FTT → WPN SOI→ AGM65 LOS. (2nd TMS UP attempts AGM-65 track)
	WPN SOI (FCR not SOI)	
		PRE MODE: AGM-65 Track
		VIS MODE: Stabilizes the TD BOX/AGM-65 LOS
		BSGT MODE: Stabilizes AGM-65 LOS
	TGP SOI/ WPN PRE	TGP attempts POINT TRACK:
		If POINT TRACK not successful TGP → AREA TRACK
		If POINT TRACK successful → WPN HANDOFF attempt
TMS DOWN		
	WPN SOI	REJECT TARGET
	FCR SOI AND FTT	RETURNS TO GM/GMT/SEA
	TGP SOI	POINT → AREA
TMS RIGHT		
	TGP SOI + POINT TRACK	Rejects HANDOFF target and returns to AREA
	WPN SOI	Force Correlation (AREA)
TMS LEFT		
	TGP SOI	WHOT/BHOT/TV
	WPN SOI	COH/BOH

4.2.4.1.4 AGM-65 BASE PAGE OSB FUNCTIONS



AGM 65 Base Page (SMS EO WPN page)

OSB 1 Operating Mode (A-G/STRF)

OSB 2 E-O sub-modes

- PRE – E-O preplanned delivery.
- VIS – E-O visual delivery.
- BORE – E-O preplanned delivery.

OSB 5 Access to E-O Weapons Control Page

OSB 6 Selected E-O Weapon / Select next available E-O Weapon type

The number of selected weapons remaining and the weapon status are displayed adjacent to the weapon mnemonic. The weapon status mnemonic is also displayed above OSB 13 in descending order of priority as follows:

- REL (release) – Release signal has been issued to weapon.
- RDY (ready) – Weapon is armed and ready for release.
- MAL (malfunction) – Malfunction prohibits release of weapon.
- SIM (simulate) – Weapon is unarmed, but release indications are provided (actual weapon release inhibited).
- Blank – Arming symbology is not displayed on the HUD and release indications are not provided.

NOTE: Weapon status is displayed after EO-WPN page NOT TIMED OUT message disappears.

OSB 7 Manual Power for selected AGM-65 missiles

PWR ON – Power is being supplied to all selected AGM-65s.

PWR OFF – Power is removed from all selected AGM-65s.

When AUTO PWR ON is selected an A is displayed to the left of the PWR mnemonic on the SMS E-O WPN page; when AUTO PWR OFF is selected the A is not present (see AGM-65 Control page).

OSB 8 Release Pulses

If AGM-65 D/Gs are loaded, the number of release pulses requested is controlled via the OSB adjacent to the RP mnemonic and the selected number.

OSB 9-16 Loaded Stations

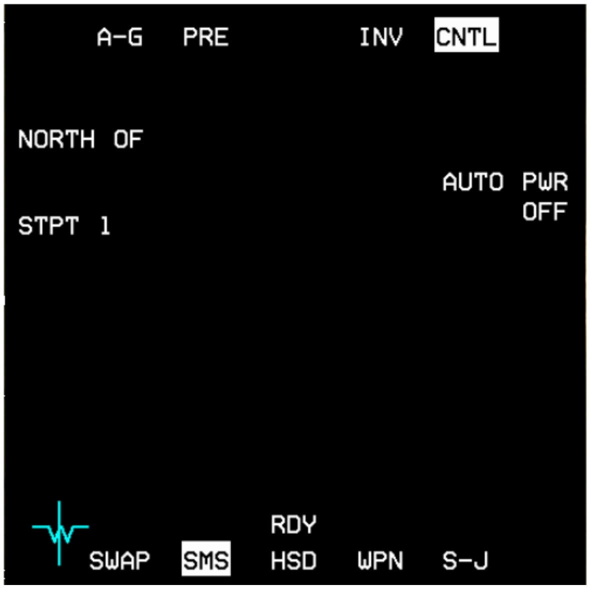
The active station is highlighted. If the selected station has failed, or is degraded, or is hung an F or D or H will replace the station number.

OSB 18 STEP

If the missile is loaded on the LAU-88/A or -88A/A the STEP mnemonic is also displayed. Depressing the STEP OSB should reject the selected missile and step to the next missile on the selected station. It currently changes the station in the same way as the MSL STEP button, or the OSB adjacent to the station number.

4.2.4.1.5 AGM-65 SMS E-O WPN CONTROL/DATA ENTRY PAGES

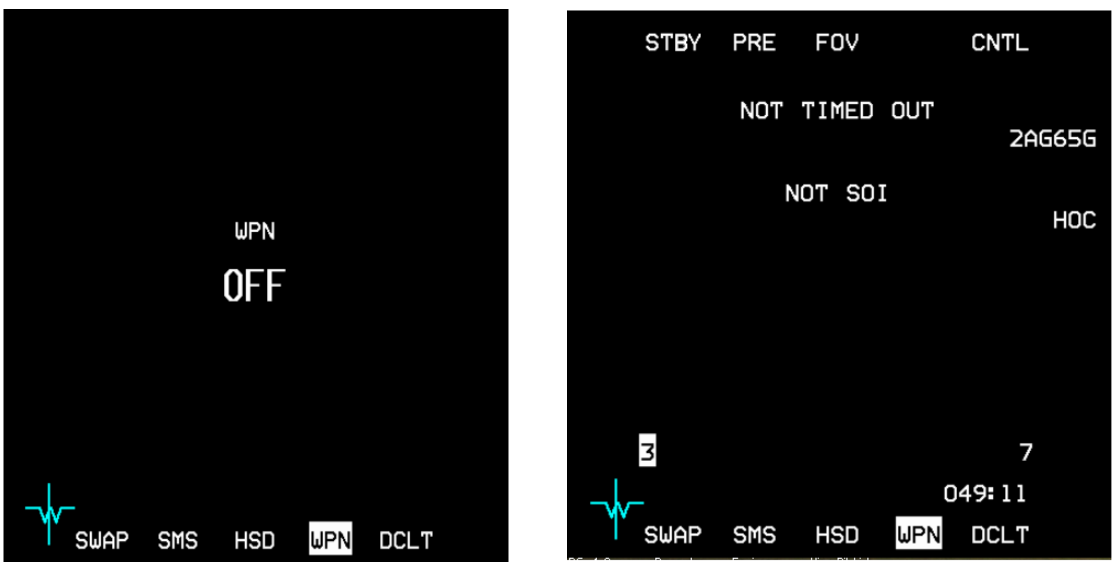
Selecting the CNTL page from the SMS E-O WPN page allows the missiles to be automatically powered up when the aircraft is <2 NM North, East, South or West of a selected steerpoint. The AUTO PWR option is selected/deselected with OSB 7. When AUTO PWR ON is selected an A is displayed to the left of the PWR mnemonic on the SMS EO WPN page; when AUTO PWR OFF is selected the A is not present. The desired steerpoint is changed/selected by depressing OSB 19, accessing the data entry page and keying a valid steerpoint number (1-99). The cardinal position is selected by repeatedly depressing OSB 20 until the desired direction (NORTH, EAST, SOUTH, or WEST) appears.



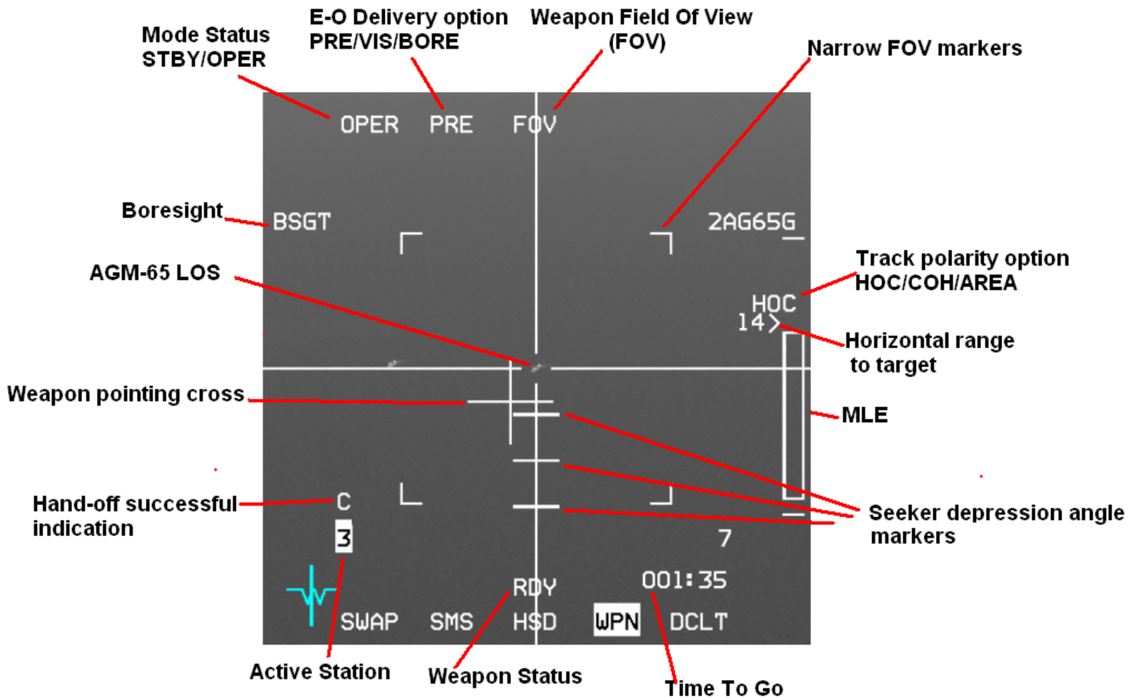
4.2.4.1.6 AGM-65 ELECTRO-OPTICAL WEAPON (E-O WPN) PAGE

The MFD WPN format provides for display of video from AGM-65 missiles. The following E-O states and modes are available:

- OFF – Power to the AGM-65 is not supplied.
- STBY – Power is applied to the AGM-65, but is not fully operational.
- OPER – The AGM-65 is fully operational.
- WPN OFF – Displayed at the center of the WPN page to indicate that the AGM-65 is not powered.
- NOT TIMED OUT – Indicates that the EO timer has been operating for less than 3 minutes.
- BORE – The AGM-65 is pointed to the nominal HUD boresight.
- BOW – Black-on-white polarity contrast option (AGM-65A/B).
- WOB – White-on-black polarity contrast option (AGM-65A/B).
- AUTO – Automatic polarity contrast option (AGM-65A/B).
- HOC – Hot-on-cold polarity contrast option (AGM-65D/G).
- COH – Cold-on-hot polarity contrast option (AGM-65D/G).
- AREA – Forced correlate option (AGM-65G).
- VIS – Visual E-O submode.
- PRE – Preplanned E-O submode.
- BSGT – Boresight correction for SLAVE modes (AGM-65D/G).



Electro-Optical Weapon (E-O WPN) Page



Electro-Optical Weapon (E-O WPN) Page

4.2.4.1.6.1 VIDEO DISPLAY

The video display image is composed of an IR scene video and electronically generated symbols consisting of crosshairs, a pointing cross, seeker depression angle markers and four NFOV markers.

Video display is blank when the MASTER ARM switch is in the OFF position.

NOTE: AGM-65 power is limited to 1 hour without video and to 30 minutes with video on any one flight. After the maximum on-time has been reached the missile must be powered off for a period of 1 hour for AGM-65D/Gs and 2 hours for AGM-65A/Bs.

4.2.4.1.6.2 MODE STATUS

When power is applied to the AGM-65, but it is not fully operational, STBY is displayed below OSB1 along with a NOT TIMED OUT message on the E-O WPN and SMS pages, indicating that the E-O timer has been operating for less than 3 minutes. During STBY the IR image on the weapon page is inhibited.

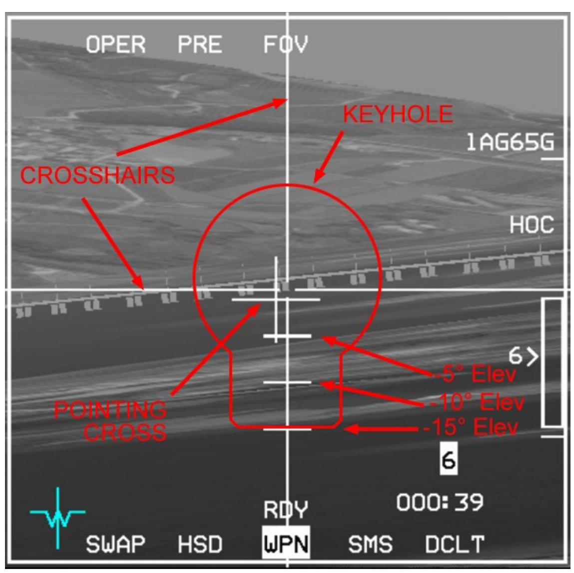
If the F-16 is on the ground (WOW) the mode status will remain in STBY with the IR image off and the NOT TIMED OUT message displayed, regardless of the E-O timer status, unless the GND JETT switch is moved to the ENABLE position while the mode status is in STBY. When the AGM-65 is fully operational, OPER is displayed below OSB1.

When the AGM-65 is not powered WPN OFF will be displayed at the center of the E-O WPN page.

4.2.4.1.6.3 SEEKER DEPRESSION ANGLE MARKERS AND KEYHOLE

The Maverick gimbals are 10° in azimuth and 15° in elevation. The 5, 10 and 15° down elevation limits are displayed as horizontal tick marks in the WPN page (available with the AGM-65D/G only) but the azimuth gimbals are not. The gimbal LOS of the missile is actually shaped like an imaginary keyhole centered on the WPN page crosshairs.

Please note: To ensure a valid missile track after launch, the pointing cross must be within that imaginary keyhole. If it is not, it will most likely flash indicating an invalid track and the missile will almost certainly miss.



AGM-65D/G keyhole

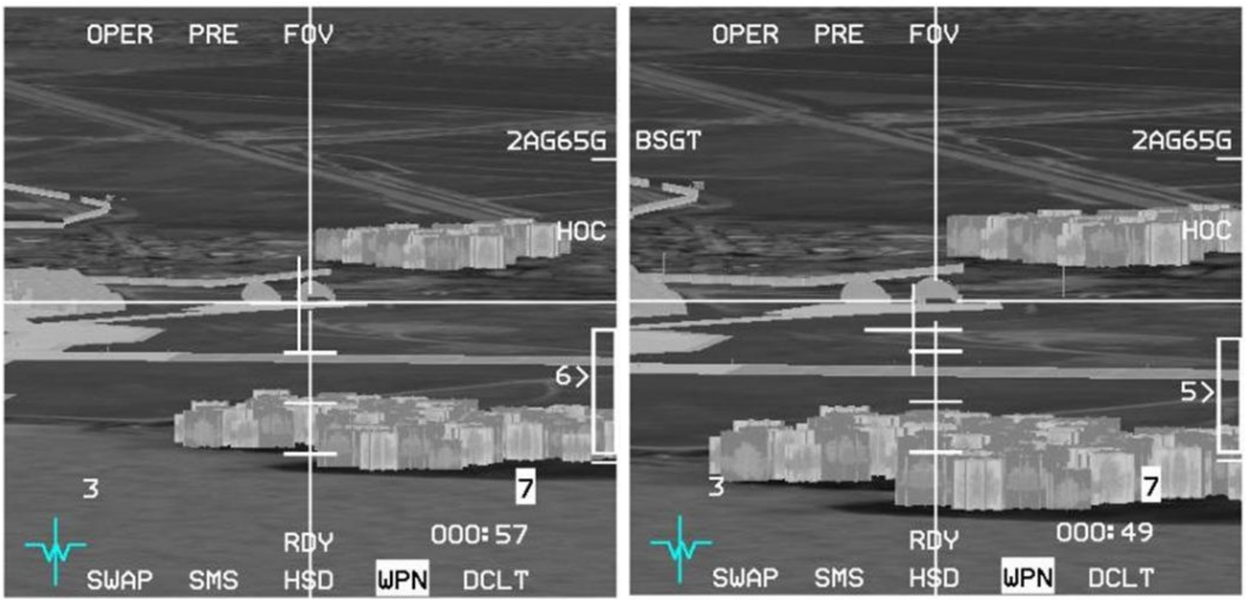
4.2.4.1.6.4 THE POINTING CROSS AND CROSSHAIRS

The displacement of the pointing cross from the center of the display shows the relative bearing between the LOS of the missile seeker and the longitudinal axis of the missile. Any portion of the pointing cross that is coincident with the tracking window is blanked so as not to interfere with target identification. When a lock-on is attempted the pointing cross will flash until a valid lock is obtained. A steady pointing cross on the display indicates a good lock.

NOTE: A flashing pointing cross indicates a high probability of break-lock at launch!

The crosshairs are a set of horizontal and vertical lines extending through the center of the display. The gap at the intersection of the lines delineates the tracking window. Adjustments of the tracker to accommodate larger targets can result in a widening of the crosshair gap.

The figures below show the gap widening to fit the hangar (and BSGT next to OSB 20 indicating a valid track):



AGM-65 crosshair and blanking area

4.2.4.1.6.5 DELIVERY OPTION

- BORE – The AGM-65 is pointed to the nominal HUD boresight.
- PRE – Preplanned E-O submode.
- VIS – Visual E-O submode.

4.2.4.1.6.6 FIELD OF VIEW

Dual-FOV capability with Wide (WFOV) for initial target acquisition and Narrow (NFOV) for improved target identification and tracking. FOV is changed via OSB 3 or the pinky switch. Changing the FOV from WFOV to NFOV will remove the NFOV tracking gates, the FOV mnemonic on OSB 3 doesn't change; if you see the gates you are in WFOV.

There is a significant increase in probability of hit for missiles launched in NFOV over missiles launched in WFOV. Advantages of NFOV are improved target identification and increased launch range. Missiles should be launched in NFOV whenever possible. Launching at WFOV may cause a loss of track after launch.

4.2.4.1.6.7 HANDOFF

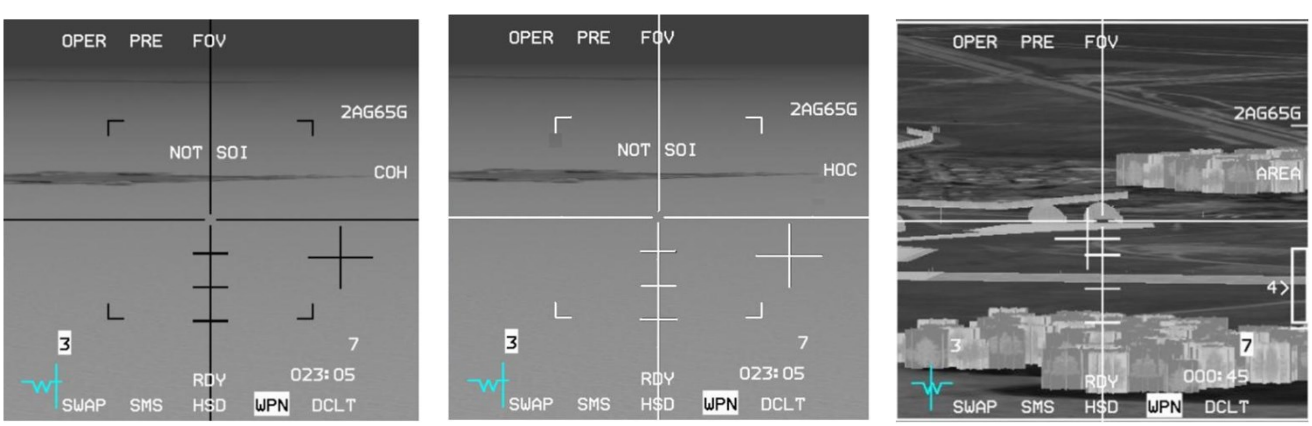
When the Handoff is complete a 'C' is displayed above the selected station (see Targeting Pod E-O Delivery-Handoff).

4.2.4.1.6.8 BSGT

If the lock on is valid BSGT will be displayed adjacent to OSB 20. Depressing OSB 20 momentarily highlights the BSGT mnemonic (see Missile Boresight Procedures).

4.2.4.1.6.9 TRACK POLARITY

- HOC – Hot-on-Cold polarity contrast option.
- COH – Cold-on-Hot polarity contrast option.
- AREA – Forced correlate option (AGM-65G).
- BSGT – Boresight correction for SLAVE modes (AGM-65D/G).



Track Polarity

4.2.4.1.7 AGM-65 E-O DELIVERY

E-O delivery consists of visual (VIS) and preplanned (PRE and BORE) submodes. The E-O delivery submodes provide an option for automatic AGM-65 power up when nearing the target area, automatic video activation with WPN page, automatic SOI switch to WPN page upon target designation and slewing of the AGM-65 LOS without affecting the SPI.

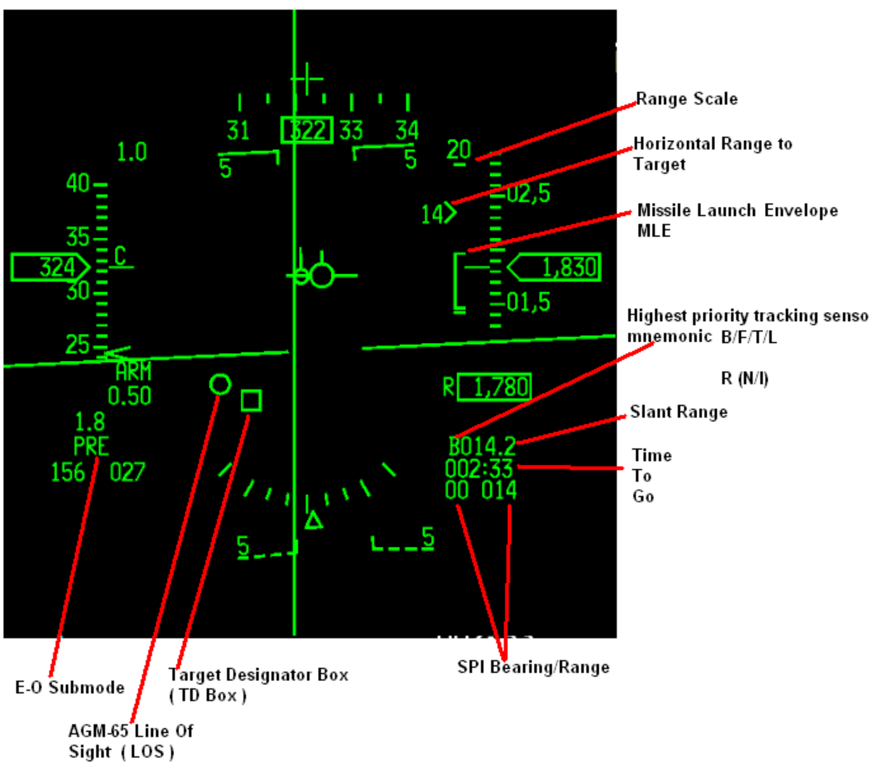
4.2.4.1.7.1 PRE E-O PREPLANNED DELIVERY

The Preplanned (PRE) submode is used for delivery of AGM-65 electro-optical weapons against preplanned targets using CCRP-type sighting with the AGM-65 LOS slaved to the FCR or TGP LOS.

With the FCR as SOI, TMS UP will command a fixed target track (FTT) over a radar return allowing the FCR to provide range and automatically move the SOI to the MFD WPN page and stabilise the AGM-65 LOS.

The SOI can be moved to the MFD WPN page via DMS AFT if a FTT is not desired or for some reason the radar cannot isolate the designated return.

With the WPN page as SOI a TMS UP will stabilize the AGM-65 LOS with range computed using the steerpoint elevation/barometric elevation. If the AGM-65 is stabilised and needs to be rejected, changing the Master Mode will reset the AGM-65 LOS.

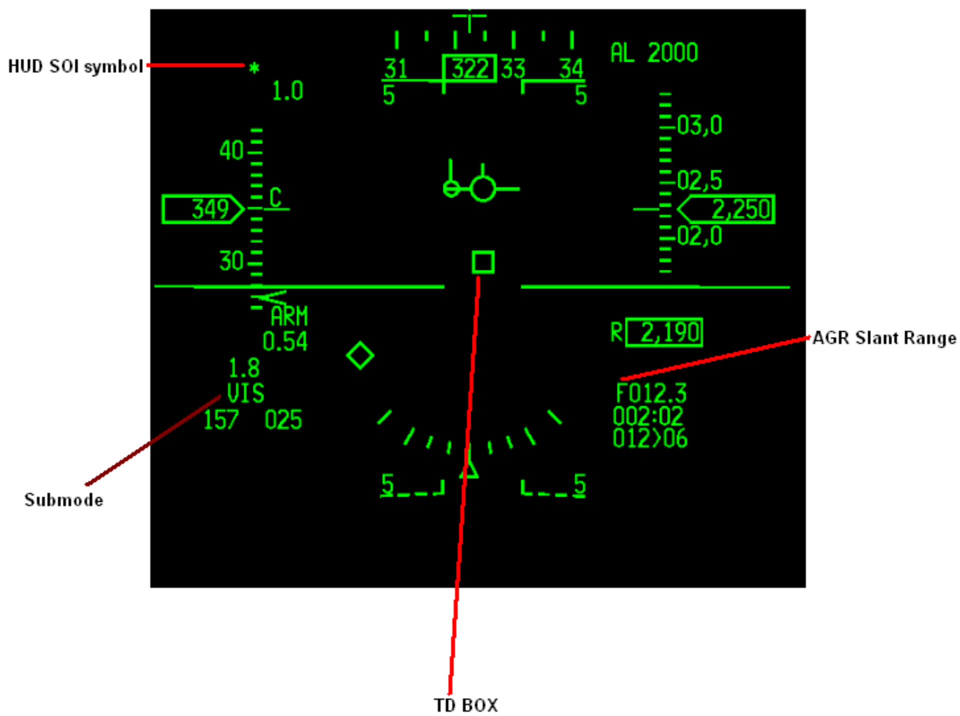


AGM-65 Preplanned Delivery HUD Cues

4.2.4.1.7.2 VISUAL E-O DELIVERY

The visual (VIS) E-O submode is designed for delivery of AGM-65 electro-optical weapons using dive toss (DTOS) type sighting. In VIS submode, the HUD is initialized as the SOI and the weapon seeker head is slaved to the HUD TD box.

Prior to designating a target, the TD box is caged above the FPM. The TD box can be positioned on the target either by maneuvering the aircraft or with the cursor switch. The target is designated by positioning the TMS up. Designating the target ground stabilises the TD box on or near the target and automatically moves the SOI to the TGP or WPN MFD page (TGP has priority if active). Target rejection should be commanded by manually selecting the HUD as the SOI with DMS up and positioning the TMS down.

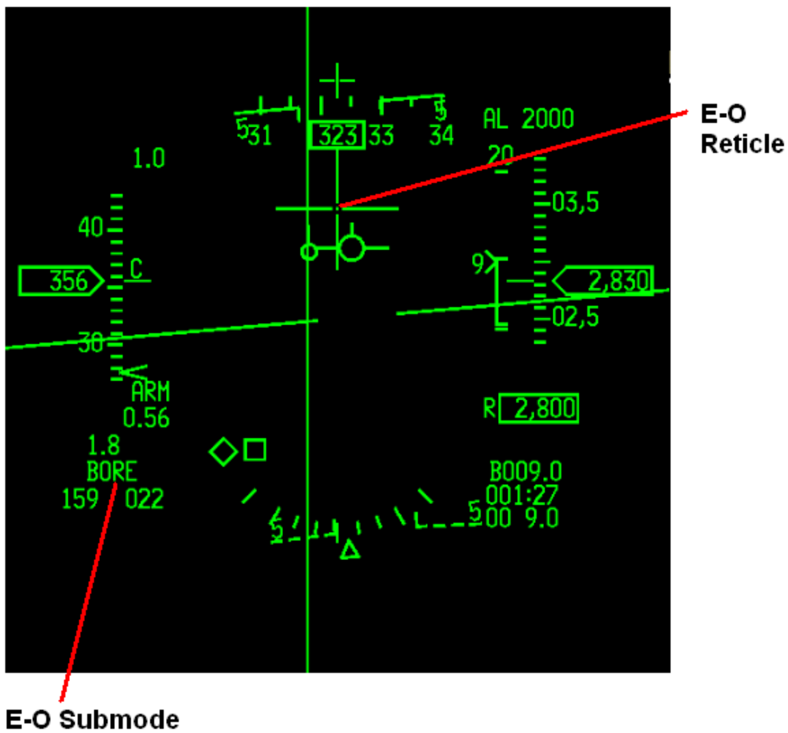


AGM 65 Visual EO Delivery HUD Cues

4.2.4.1.7.3 BORE – E-O DELIVERY

The BORE submode displays are similar to the PRE displays except that the AGM-65 seeker head is pointed to the nominal boresight, which is roughly aligned with the E-O reticle (cross) on the HUD. This allows for firing on targets of opportunity without disturbing the FCR track position. The aircraft is flown to place the HUD E-O reticle on or close to the target. With the WPN format as SOI, the cursor is slewed to refine the AGM-65 target.

The Electro-Optical (E-O) Reticle. The E-O reticle consists of a cross that indicates the E-O weapon is pointed to the armament datum line. For the AGM-65, the E-O reticle is positioned at the armament datum line if the boresight line of sight is selected.



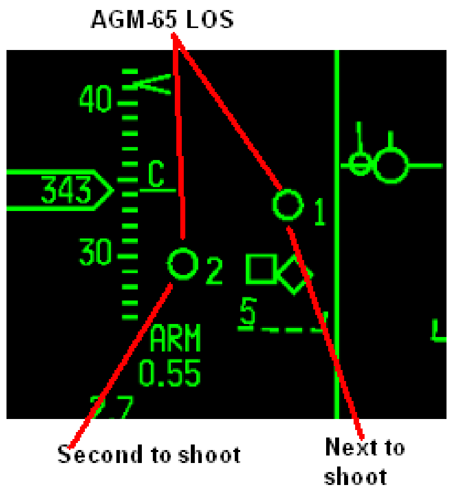
EO Delivery HUD Cues

4.2.4.1.7.4 THE AGM-65 LOS

NOTE: Not applicable to AGM-65L.

The AGM-65 LOS is represented on the HUD as a 10 mr circle. This appears whenever the AGM-65 is slewed or tracking. If the TD box and AGM LOS are both at the same position the TD BOX will be displayed over the AGM-65 LOS as it has display priority.

Two AGM-65 LOS can be stabilised or designated on two different targets prior to launch. Using MSL STEP, select the next station and TMS UP to stabilise the 2nd AGM-65 LOS. Two LOS circles will now exist on the HUD. First to shoot has a '1' next to the circle and the second to shoot has a '2'. MSL STEP will switch between the two LOS circles. Each station can be configured prior to launch.



AGM-65 LOS HUD Cue

4.2.4.1.7.5 BEARING/RANGE TO TGT

Relative bearing is displayed in tens of degrees from the aircraft to the target or SPI. Ranges greater than 10 miles are displayed in nautical miles; ranges of less than 10 miles are displayed in tenths of nautical miles. In VIS mode relative bearing and range to SPI are available only after the AGM-65 LOS is stabilised.

4.2.4.1.7.6 SLANT RANGE

Displays the measured slant range to an air-to-air target or ground sighting point from the highest priority tracking sensor and a mnemonic identifying that sensor. The mnemonics are: F, B, T, L, R (N/I)

- F is displayed when the FCR is providing range.
- R is displayed when the radar altimeter is providing range (N/I).
- B is displayed if the range is computed using steerpoint elevation/barometric elevation.
- T is displayed when the TGP is providing passive range.
- L when the TGP laser is firing and being used.

Slant range is displayed in tenths of nautical miles for ranges greater than 1 nautical mile and hundreds of feet for ranges less than 1 nautical mile.

4.2.4.1.7.7 TIME TO GO (TTG)

In Air-to-Ground weapon delivery modes its function is mode-dependent. In E-O WPN mode, TTG is the calculated time for the aircraft to arrive at the selected SPI TD box.

4.2.4.1.7.8 RANGE SCALE / MLE

A missile launch envelope (MLE) scale is displayed on the HUD and on the MFD WPN page to assist in determining valid range conditions for an AGM-65 launch.

The Range Scale is AGM-65 type dependent:

- AGM-65A/B range scale is fixed at 10nm.
- AGM-65D range scale is fixed at 15nm.
- AGM-65G range scale is fixed at 20nm.

The two fixed tick marks represent the scale boundaries, with the range cue representing the horizontal range to the target. A target range window positioned next to the cue displays the range in nautical miles.

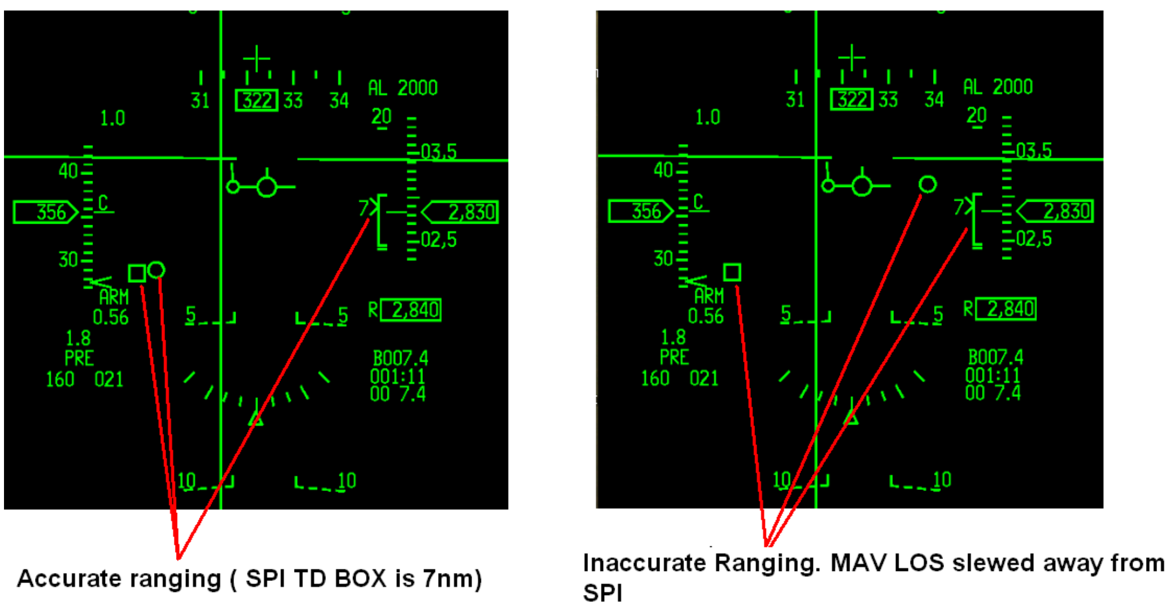
The dynamic open-sided rectangle (DLZ) represents the missile footprint (Rmax and Rmin). On the WPN page the rectangle is solid.

Because the AGM-65 line-of-sight range is not available to the avionic system, the target range cue is positioned using range to the target coordinates (SPI). Furthermore, the bearing/range, slant range and azimuth steering line are also 'tied' to the SPI.

If the AGM-65 LOS circle has been slewed off of the target (seeker head slewed independently of the SPI), the MLE will be somewhat inaccurate. The SPI can be slewed over the MAV LOS after stabilisation or lock on, to assist in a more accurate ranging.

The MLE is available when the following conditions are met:

- SLAVE post-designate entered.
- AGM-65A/B/D/G selected.
- Horizontal range to target less than 15 nm.
- Target within ±30° of the aircraft yaw axis.
- INS data is valid.
- CADC data is valid.



AGM-65 accurate vs. inaccurate ranging

4.2.4.1.7.9 FORCE CORRELATION TRACK (AGM-65G MISSILE ONLY)

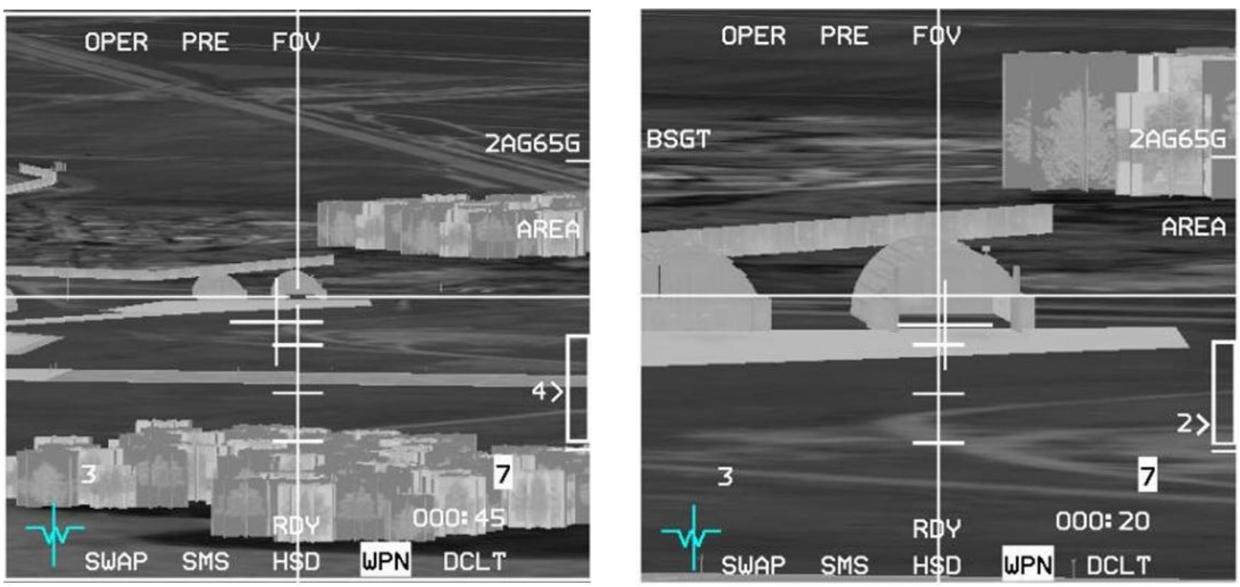
Some large targets may not be suitable for attack with an AGM-65G operating in the centroid track mode. A specific aim point different from the centroid of the target may be the desired impact point (a certain building in an industrial complex, a specific span of a bridge, etc.). The AGM-65G has a feature that allows the tracker to be forced into the correlation track mode prior to launch to track a specific aim point. This action bypasses the centroid track circuitry.

To force the missile into correlation track mode the AREA (OSB 7) position of the aircraft Contrast Select switch is used with the WPN page SOI. Pressing OSB 7 cycles through the options: HOC⟶COH⟶AREA⟶HOC…

SLEW actions are performed normally. Prior to commanding track (lock-on), selection of the AREA position must be made. When TRACK is commanded, target tracking will be accomplished through the correlation tracker circuitry. When lock-on occurs, the crosshairs will close, creating solid crosshairs in both the horizontal and vertical axes on the aim point in the center of the display. The pointing cross will indicate when good-lock logic criteria have been met.

Note: When the AGM-65G is set to Force Correlation Track (AREA) mode, the missile is not compatible with TGP E-O Delivery (Handoff).

Note 2: AREA mode cannot be used with COH polarity so TMS-left will be disabled when in AREA mode.



AGM-65G Force Correlation Track

4.2.4.1.8 AGM-65 TARGETING POD E-O DELIVERY (HANDOFF)

NOTE: This capability is only available when AGM-65D or AGM-65G missiles are loaded, the TGP is operational and the SOI is not on the WPN page.

The TGP is used to detect and track targets for semi-automated AGM-65D/G delivery. The missile boresight correlator (MBC) takes control, selects, configures, and controls missile slew and lock-on of the AGM-65D/G to achieve a tracking missile. This automated mechanization reduces workload by deleting the requirement of interfacing with the WPN page. When in A-G mode with an AGM-65D/G selected and the SOI is the TGP, the MBC is active.

The TGP is operated in POINT track to support the missile. The AGM-65 video is compared to the TGP video and slewed to align with the TGP video; track is then commanded.

Note: If the TGP is SOI and in WIDE FOV, switching to NARO FOV (with pinky switch or OSB 3) will automatically switch the AGM-65 WPN page to NFOV (no tracking gates will be visible).

In POINT track, if an AGM-65 D/G is selected, the TGP attempts to hand-off the target to the missile and the message HANDOFF IN PROGRESS STATION X (where X is the active missile station) is displayed on the WPN page.

If the handoff is successful, a complete indication 'C' is displayed above the weapon station and a small box on the bottom of the AGM-65 LOS circle indicates a successful handoff on the HUD.

If the handoff is incomplete an 'I' is displayed above the weapon station. If the pod is then slewed to a new target and another AGM-65 D/G missile is selected, the TGP attempts to hand-off the new target to the new missile.

Note: there is a bug with a valid lock on when the target is outside the AGM-65 FOV. If handoff is commanded while the bank angle is < 30°, followed immediately by a turn towards the target with a bank angle exceeding 30°, it results in an invalid track. To avoid this wait until after the "HANDOFF IN PROGRESS "message is repeated (flashes) on the WPN page before turning towards the target. The result is a valid track.

TMS-right, with TGP SOI, at any time, causes the last missile to reject the last target.

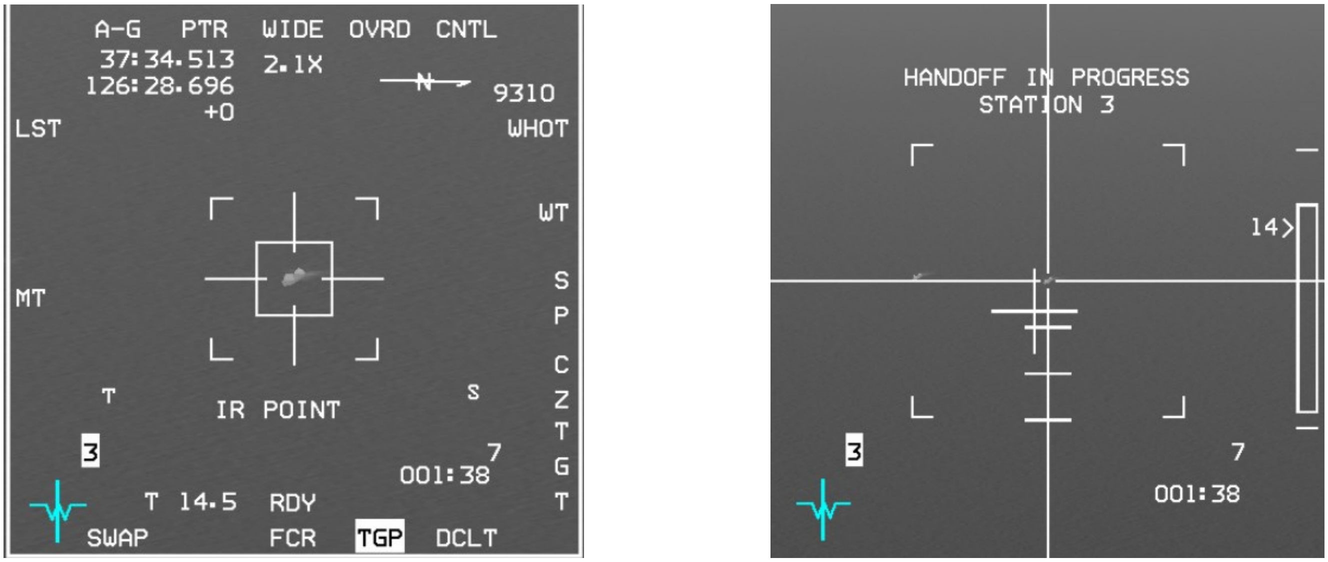
4.2.4.1.8.1 HANDOFF STATUS

Handoff status is displayed above the station numbers on the TGP page.

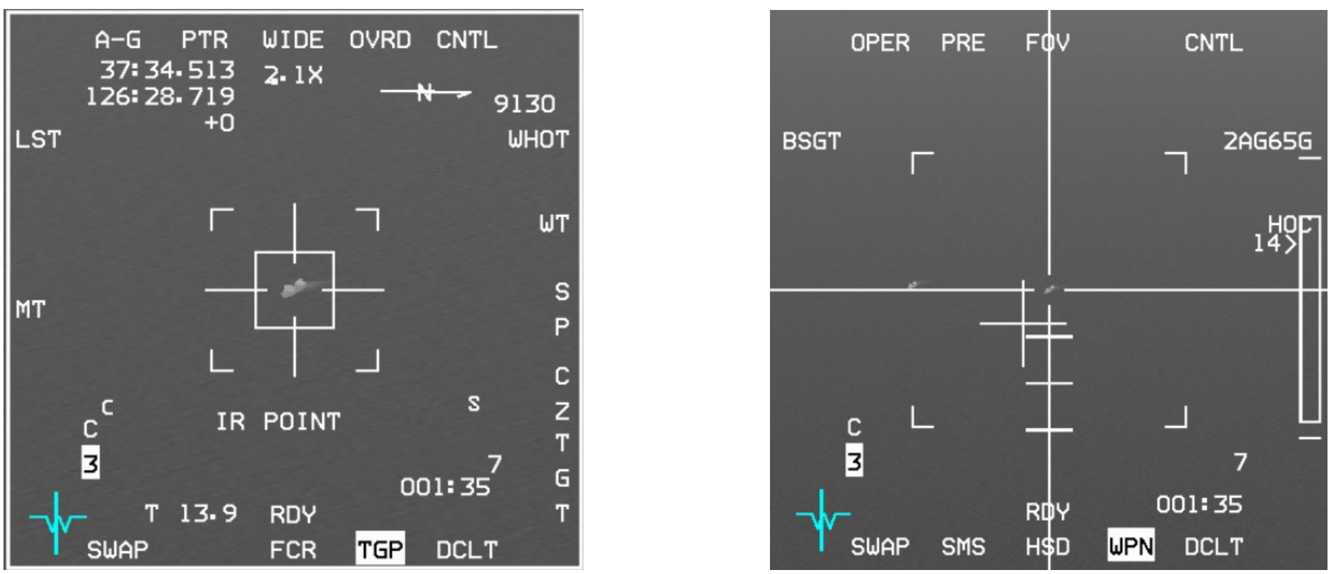
The following summarises status indications:

- **S** – Slave. The missile is slaved to the TGP but not tracking.
- **1** – Slew. The TGP is moving the missile LOS based on comparison of the missile LOS and the TGP LOS.
- **2** – Slew. The TGP is moving the missile LOS based on comparison of the missile and TGP video.
- **T** – Track. The TGP has commanded the missile to track.
- **C** – Complete. Handoff is complete, missile is tracking.
- **I** – Incomplete. Handoff has failed, missile is not tracking.

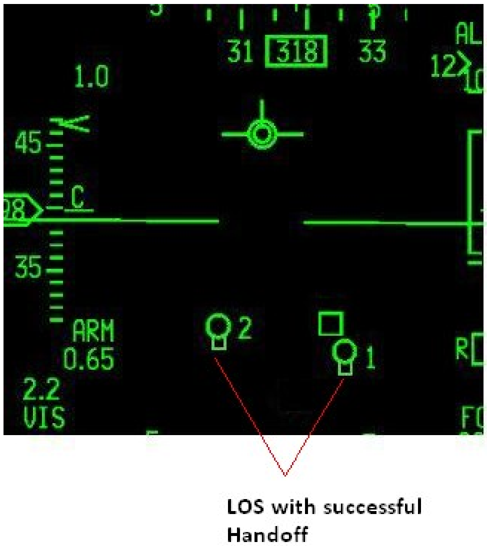
N*ote:* Phase 2 can compensate for a little bit of boresight error. If there is too much, handoff will oscillate between phase 1 and 2. In the 'T' Phase, if the Maverick cannot track, it will keep trying until handoff is aborted or times out.



POINT track - TGP attempts handoff (HANDOFF IN PROGRESS shown on WPN page)



Handoff Complete (also indicated with C above station number on WPN page)



LOS with successful handoff

4.2.4.1.8.2 ALIGNMENT OF AGM-65D/G BORESIGHT TO THE TARGETING POD

The AGM-65 mounting procedure induces an unknown amount of misalignment with the launcher. This misalignment must be removed to improve accuracy and shorten the time required to achieve a handoff. Misalignment is corrected by boresighting the missile LOS to the TGP LOS. The AGM-65 boresight procedure may only be performed on the ground if the missiles do not have dome covers installed. If dome covers are present, the procedure must be done while airborne.

4.2.4.1.9 AGM-65D/G MISSILE BORESIGHT PROCEDURES

AGM-65 boresight should not be attempted on the ground if dome covers are still in place. To accomplish missile boresight, either a LAU-88A/A (AGM-65D), LAU-117/A, LAU-117A(V)1/A, or LAU-117A(V)3/A (AGM-65D and G) launcher is required. The boresighting procedure only needs to be done once per launcher, even if there is more than one AGM-65D missile on that launcher.

When the inventory on any weapon station is changed all AGM-65 missiles will power off. The pilot must power on the missile and wait again for the (up to) 3-minute timeout. If the missile has previously been powered up this timeout may take considerably less time.

AGM-65D/G power is limited to 1 hour without video and to 30 minutes with video on any one flight. If you do not intend to fire your AGM-65s immediately after boresighting you should power them off after completing the procedure and then power them back on at IP.

AGM-65 boresight may be accomplished visually in VIS, *or* with the FCR, *or* with the TGP.

4.2.4.1.9.1 AGM-65D/G MISSILE BORESIGHT PROCEDURES

1. If on ground – GND JETT to ENABLE
2. ICP – Depress A-G button
3. Left MFD – Select desired pages (n/a if boresighting in VIS):
    a. FCR page – Select GM/GMT/SEA submode
    b. TGP page (if TGP available) – Select A-G submode
4. Right MFD – Select desired pages:
    a. SMS page – Depress OSB 7 (PWR OFF) to power up AGM-65's (OSB changes to PWR ON)
    b. WPN page – Confirm PRE submode (if boresighting in VIS – CURSOR ENABLE to change to VIS)
5. HUD – Confirm PRE symbology in lower left corner (or VIS if boresighting in VIS)
6. DMS – Select required sensor (TGP or FCR) as SOI (n/a in VIS – HUD will have * SOI indicator in top left corner)
7. MASTER ARM – ARM or SIM (as desired)
8. WPN page – NOT TIMED OUT disappears after <=3 minutes
9. UNCAGE – (if no video image in WPN page) and switch to NFOV as required
10. MSL STEP – repeat UNCAGE/NFOV for next hardpoint
11. TGP or FCR SOI – TMS Up to ground-stabilize sensor (if necessary)
12. Acquire target and expand FOV as necessary (n/a if boresighting in VIS)
13. TGP or FCR or HUD SOI – TMS Up to designate target. If TGP is SOI then move on to 14. WPN page, else:
    a. After POINT Tracking target WPN page may remain in HANDOFF IN PROGRESS
    b. AVIONICS FAULT lights up, PFLD shows TGP HADF FAIL, MASTER CAUTION light comes on
14. WPN page – Slew AGM-65 gates over the target
15. TMS - Up and release; confirm correct target tracked and that BSGT appears next to OSB 20
16. WPN page – Depress OSB 20 (BSGT)
17. MSL STEP button – Depress to select next hardpoint
18. Repeat steps 14-17 for additional AGM-65D/G launchers
19. (TGP only) – Press F-ACK to clear PFL; 'AV' will remain lit on right side of PFLD status line
20. SMS page – Depress OSB 7 (PWR ON) to power off AGM-65s (unless testing HANDOFF or firing them immediately)
21. If on ground – GND JETT to OFF (unless testing HANDOFF - then delay until after AGM-65s powered down)

Optional steps (TGP only) to test if you can successfully HANDOFF a target after boresighting:

22. Go to DGFT or MISSILE OVERRIDE (any master mode change) to reject all targets then switch back to A-G mode
23. TMS - Up to POINT TRACK desired target; WPN page shows HANDOFF IN PROGRESS
24. 'C' appears over the station number on the WPN (and TGP) page when target successfully handed off
25. AV light in PFL goes off
26. Confirm AGM-65 is tracking the correct target
27. MSL STEP button – Depress to select next hardpoint and repeat step 23 (if desired)
28. SMS page – Depress OSB 7 (PWR ON) to power off AGM-65s (unless using them immediately)

Note: Slewing your ground cursor position (SPI) during the boresighting procedure will effectively slew your current steerpoint by adding a system delta to all steerpoints. All NAV and weapon delivery steering and symbology, including the great circle steering cue (tadpole) will be referenced to the amended steerpoint(s).

The CZ mnemonic will be highlighted in aircraft with the Nav EGI upgrade if a system delta exists (i.e. SPI slew).

Cursor Zero (CZ) will erase any previously created system deltas, returning all STPTs to their original position and SPI to the current STPT position. CZ can be commanded by pressing the OSB marked CZ on the A-G FCR, TGP or HSD MFD pages. A Cursor Zero command is effective only when no sensor tracking state exists, otherwise the SPI position will not change, as the tracking sensor will force it back to the same position.

Note 2: if you carry a TGP and plan to use HANDOFF during your attack you are not limited to boresighting with the TGP; you can boresight in VIS (or with the FCR) as you prefer and then optionally test HANDOFF afterwards before you power down your missiles.

4.2.4.1.10 AGM-65L

The AGM-65L is a laser-guided model of the Maverick air-to-ground missile family.

This model uses a solid state, digital, semi-active laser (SAL) detector as the seeker. The AGM-65L GCS is manufactured from the older AGM-65A or AGM-65B GCS, using core HK circuit cards, the new semi-active laser sensor, specialized signal processing cards and redesigned master interconnect board. The AGM-65L is comprised of the laser detector GCS mated to a heavyweight, penetrating (300-pound), blast/fragmentation warhead CAS and pneumatic actuation system (PAS) for moving the control fins. The missile generates synthetic video cues for displaying laser PRF code, launch constraint circle, presence of properly coded laser energy detection and auto lock-on mode.

The missile can be operated in PRE, VIS and BORE modes. It can detect lasers emitted by ownship TGP or from other aircraft (‘buddy lasing’) as well as JTAC laser painted targets.

Targets must be laser designated for the entire time of flight (TOF) of the missile to the target. Furthermore, the locked laser code programmed into the missile shall match the detected laser. And finally the detected laser position shall be in the synthetic keyhole.

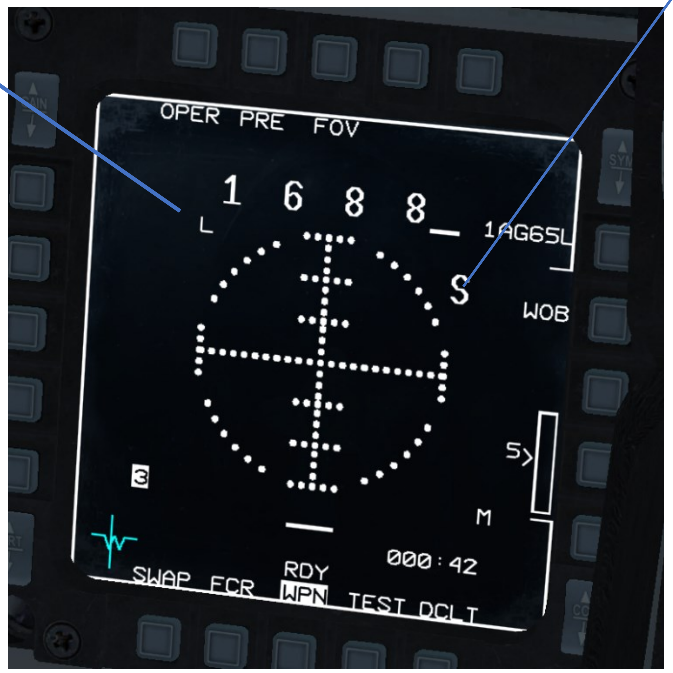
If all conditions are met for a successful launch, the Gimbal Position Indicator (GPI) will show a solid steady square. A flashing X indicates correct laser code definition and detection, but outside the keyhole. A steady X indicates that the missile and detected laser code do not match.

The missile laser code can be changed by unlocking the laser code. Slew the GPI to the laser status symbol “L” and command TMS up short to unlock to code. Using the OSB-7 or TMS left short to toggle the polarity and change the laser code. Another TMS up short at the status symbol “U” will lock the code. If the code is correctly entered, the cursor at the fifth position will remain steady. A flashing cursor indicates an invalid code.

It is recommended to select BORE mode to slew the GPI. Note that in BORE mode, TMS up is required to release the GPI for slewing.

Please note after the L-Maverick is aligned you have to uncage it like all other -65 models (S-Symbol appears on the WPN page).

Before firing the laser:



After firing the laser:

4.2.5 ANTI-RADIATION MISSILES

4.2.5.1 AGM-88 HARM

The AGM-88 High-speed Anti-Radiation Missile (HARM) is a tactical, air-to-surface missile designed to home in on electronic transmissions coming from surface-to-air radar systems. It was originally developed as a replacement for the AGM-45 Shrike and AGM-78 Standard ARM system.

The AGM-88 can detect, attack and destroy a radar antenna or transmitter with minimal aircrew input. The proportional guidance system that homes in on enemy radar emissions has a fixed antenna and seeker head in the missile's nose. A smokeless, solid-propellant, booster-sustainer rocket motor propels the missile at over Mach 2. HARM, a U.S. Navy-led program, was initially integrated onto the A-6E, A-7 and F/A-18 and later onto the EA-6B. RDT&E for use on the F-14 was begun, but not completed. The USAF introduced HARM on the F-4G Wild Weasel and later on specialized F-16s equipped with the HARM Targeting System (HTS).

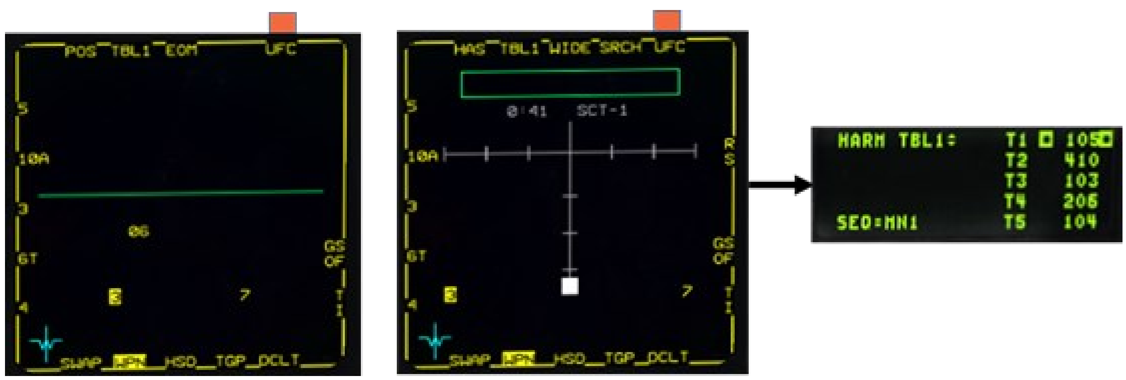
AGM-88 HARM

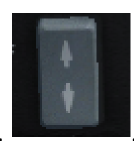
4.2.5.1.1 HARM THREAT TABLES

Initial threat data may be entered via the DTE or, if necessary, the data associated with a given HARM threat table may be accessed on the UFC DED. The three threat tables, (TBL1, TBL2 and TBL3) can be accessed either of two ways:

1) From the UFC DED. In AG master mode, if the HARM is selected in, "HARM" will be displayed adjacent to "0". Press 0 on ICP to access. If a HARM is not the selected weapon, "HARM" will be blanked on the DED MISC page next to label 0 and access to the HARM DED pages is inhibited.

2) From POS or HAS page, by pressing OSB5 "UFC". This will cause the HARM threat table currently displayed on the MFDS to be displayed on the DED.



Threat Tables are cycled from TBL1 to TBL3 using the DED increment/decrement switch. .

Data Control Switch (DCS) is used to position the asterisks to the desired field. .

The HARM threat table page displays and allows changes to the five entries in each of the HARM tables. Each field can accept decimal id's ranging from 0 to 4095. Note that ID's must be unique, two identical Id's cannot be set up in the same page or across pages. To enter a new decimal ID into a table, position the asterisks around the desired threat code and enter a new decimal ID. After the new decimal ID has been typed in, depress "ENTR".

Each entry can be:

1) A SAM system (e.g., 2 for SA2) or

2) A specific radar (e.g., 2T for FAN SONG):

- “T” stands for tracking radar, i.e., FCR radars
- “A” stands for acquisition, i.e., EWR radars

SAM SYSTEM	ALIC CODE	SYMBOL	FCR	ALIC CODE	SYMBOL	EWR	ALIC CODE	SYMBOL
SA2	102	"2"	FAN SONG	202	"2T"	SPOON REST	402	"2A"
SA3	103	"3"	LOW BLOW	203	"3T"	FLATFACE	403	"F"
SA4	104	"4"	PAT HAND	204	"4T"	LONG TRACK	404	"4A"
SA5	105	"5"	SQUARE PAIR	205	"5T"	BARLOCK	405	"5A"
SA6	106	"6"	STRAIGHT FLUSH	206	"6T"			
SA8				608	"8"			
SA9						DOGEAR	609	"D"
SA10	110	"10"	FLAPLID	210	"10T"	BIGBIRD	410	"10A"
SA11	111	"11"	FIREDOME	211	"11T"	SNOWDRIFT	411	"11A"
SA13						DOGEAR	609	"D"
SA15			SCRUMHALF	615	"15"			
SA17	117	"17"	CHAIRBACK	217	"17T"	SNOWDRIFT	417	"17A"
SA19			HOTSHOT	619	"19"			
PATRIOT			AN/MPQ-53	693	"P"			
HAWK	130	"H"	AN/MPQ-46	230	"HT"	AN/MPQ-50	430	"HA"
NIKE				696	"N"			
SKYGUARD				695	"SKY"			
AAA	692	"AAA"						
SEARCH	801	"S"						
UNKNOWN	99	"U"						

4.2.5.1.2 HARM SMS PAGE

Missile power is selected via OSB 7 adjacent to the PWR ON/PWR OFF mnemonic on the SMS base page. When PWR ON is selected, all of the missiles loaded on the aircraft (of the selected type) are simultaneously powered up.

The selection of PWR ON automatically launches a BIT sequence. The BIT sequence lasts approximatively 10 seconds and is identified by the BIT mnemonic being highlighted. Once the BIT sequence is completed and successful, “RDY” is displayed at the bottom of the MFD page. Missiles remain powered up until PWR OFF is selected or a change is made to the current weapon inventory.

Power ON remains displayed until:
1) PWR OFF selected
2) Current Weapon inventory changed

Initiating BIT manually is possible and might clear a faulty missile. OSB 8 can be depressed to initiate a BIT on the HARM missiles. The BIT mnemonic highlights when the BIT is performed, and “RDY” will be displayed when successful.

When an anti-radiation missile is selected, the appropriate mnemonic (AG88) is displayed adjacent to OSB 6 on the SMS base page, along with the total number of missiles loaded in inventory.

OSB2 steps the Tertiary threat tables from TBL0 to TBL3, default TBL1.Tertiary targets corresponding to the selected table will be loaded at Handoff. If TBL0 is selected, no tertiary target will be loaded, Ref.1.4.3.1 Command Destruct (OSB 20) and Burst Height (OSB 19) are not implemented.

4.2.5.1.3 HARM MODES

HARMS in BMS can be used in 3 modes:

- Position (POS) subdivided into 3 submodes: EOM, PB, RUK.
- HARM as Sensor (HAS).
- HARM Attack Display (HAD) (Works only when the HARM Targeting System (HTS) pod is carried). HAD also has three submodes: EOM, PB, RUK.
- DL is not implemented

RF Weapon Delivery Base page   Mode Menu page   HAS page

All HARM's will be handed off with the current steer point. Increase or decrease the STPT number, and all missiles will be updated. MSL STEP button on side stick will step missiles.

It is good practice to set the left MFD as A-A FCR and right MFD as HSD and WPN page.

List of prelaunch parameters:

- HARM Mode
- HARM Submode
- Threat table
- Primary threat.
- Steer point
- Target Isolate
- Geographic Specificity.

The AG FCR is not needed for HARM employment. For maximum SA it is advised to use the AA FCR in conjunction with HARM employment.

4.2.5.1.4 HARM SEEKER OPTIONS

4.2.5.1.4.1 POSITION KNOWN SUBMODES

The following submodes are available in POS and HAD modes.

– Equation of Motion (EOM). EOM is the most restrictive submode. The seeker is activated with a narrow FOV (Field of view), at a certain point from the anticipated threat position. This mode should only be used when the location of the emitter is well known (i.e., collocated to a steer point)

– Pre-Briefed mode (PB). PB is used for long range delivery with high confidence target location. The Seeker will activate at a certain distance from the steer point with a wide FOV.

– Range Unknown (RUK): RUK is used mainly as a defense mode is a degraded EOM mode with high uncertainty about threat range. The seeker is activated at a certain distance from the steer point (i.e., in most cases at launch) with a wide FOV.

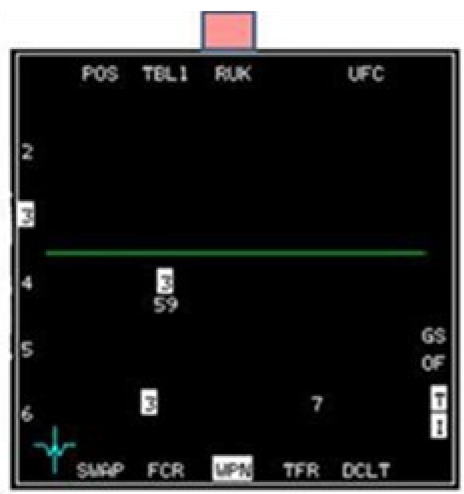
The POS submode is selected via OSB 3 on the FR Weapon Delivery base page in POS, or the EXPAND/FOV button on the side stick.

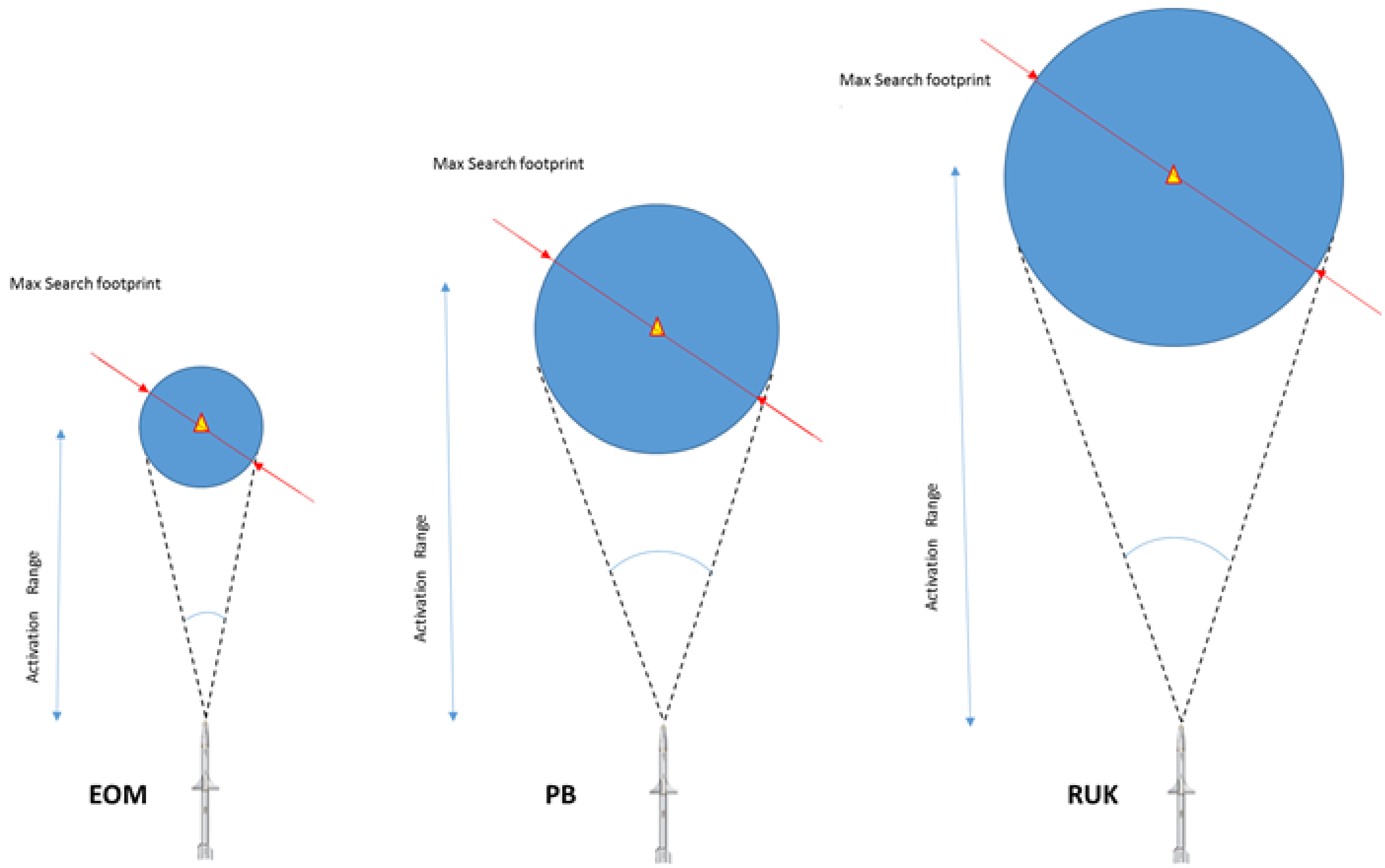
Each submode controls at which point the missile will activate its seeker and what will be the FOV of the seeker.

– Equation of Motion (EOM) is the most restrictive submode. The seeker is activated with a narrow Field of view, at approx. 8NM from the anticipated threat position. This mode should only be used when the location of the emitter is well known (i.e., collocated to a steerpoint)

– Pre-Briefed mode (PB) is used for long range delivery with high confidence target location. The Seeker will activate at approx.. 13NM from the steerpoint with a wider FOV.

– Range Unknown (RUK): used mainly as a defense mode, and is a degraded EOM mode with high uncertainty about threat range. The seeker is activated about approx 30Nm from the steerpoint (i.e., in most cases at launch) with a wide FOV.





4.2.5.1.4.2 GEOGRAPHIC SPECIFICITY (GS) OPTIONS

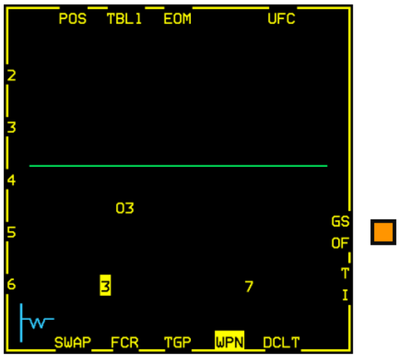
Geographic Specificity options are available in POS and HAD modes

The HARM Geographic Specificity (GS) option allows the option to restrict the HARM seeker within a geographic region defined by a circle centered around the selected steerpoint (POS) or target (HAS).

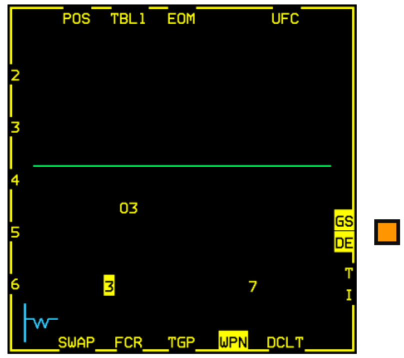
The GS option overrides all other seeker options.

OSB 9 cycles through GS options. The GS mnemonic highlights when GS is selected. The Handoff process is restarted whenever the GS option is selected. The GS option will either be on (highlighted), or GS off.

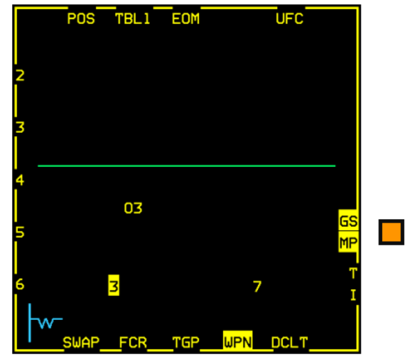
In GS-DE or GS-MP, the Diameter of the area restricted is dependent on the distance at launch. The bigger the distance at launch, the bigger the restricted area. The difference between GS-DE and GS-MP is not implemented.



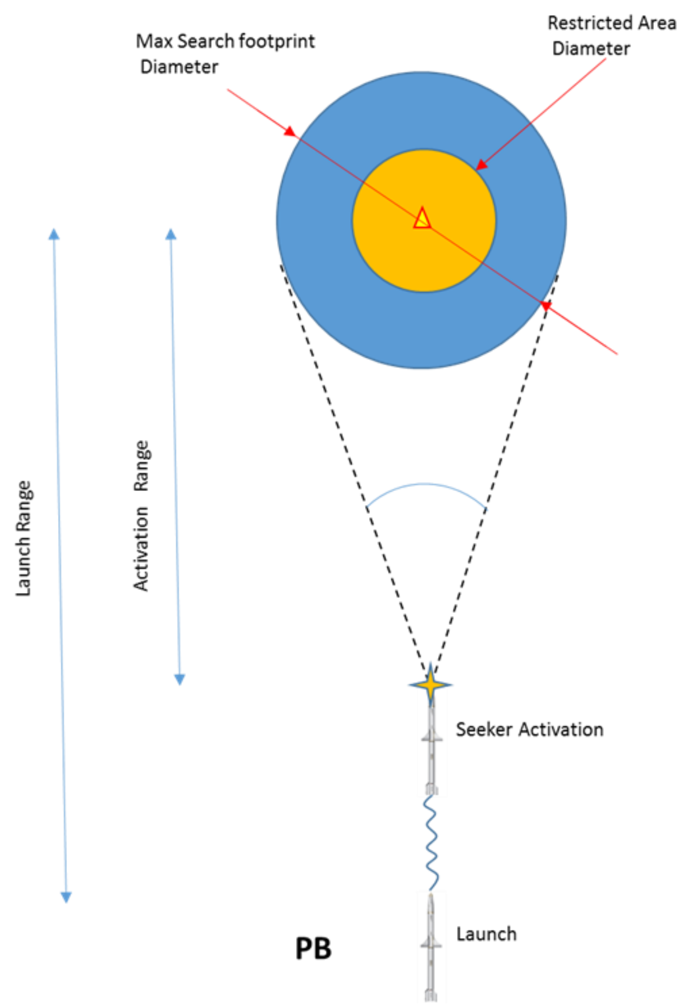
Unrestricted



Geo Restricted



Geo Restricted



4.2.5.1.4.3 TARGET ISOLATE

Target Isolate options are available in POS / HAS and HAD modes

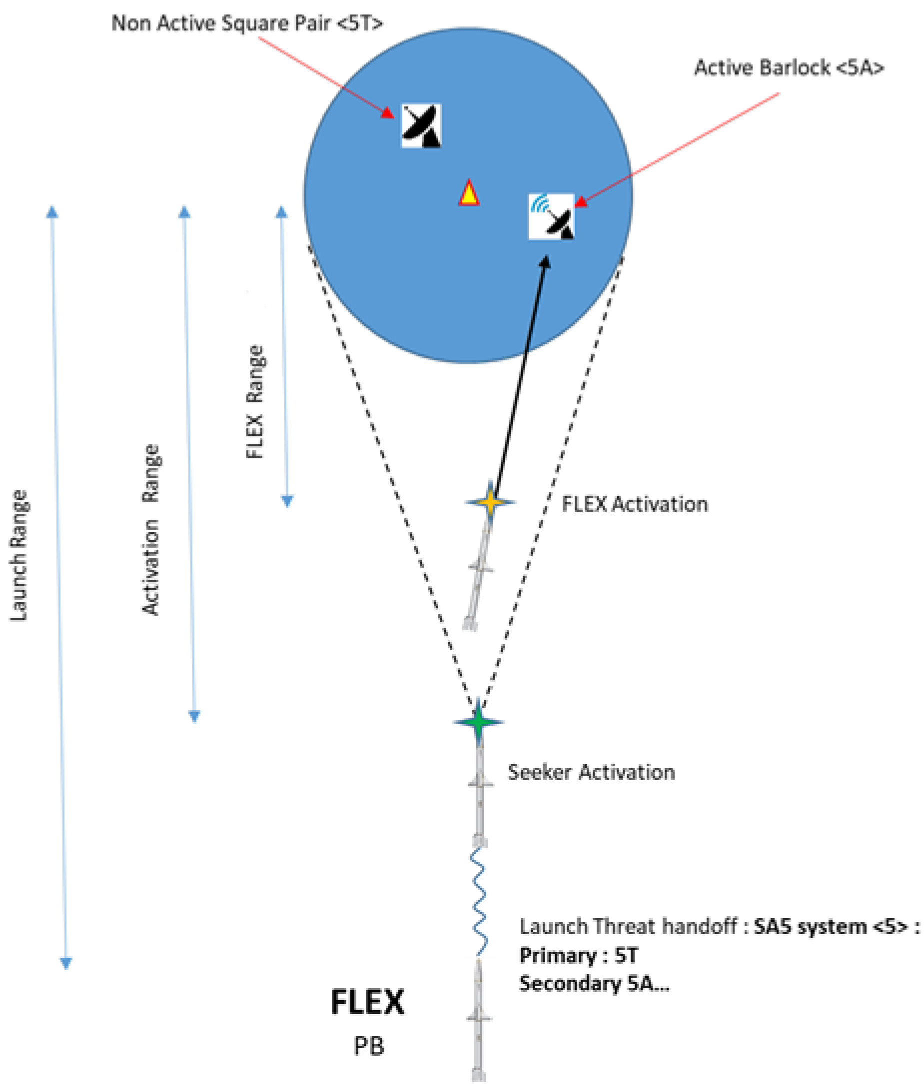
The TI option allows selection of either FLEX or GLIDE.

Target Isolate option allows the pilot to command the HARM to attack only the designated threat type and to control the flex and glide characteristics of the missile.

FLEX means that the HARM will start searching for alternate threat emitter types. A HARM will flex when it has reached the range at which it should have acquired the primary threat type but has not yet acquired it.

Glide means that the HARM will maximize its time aloft to increase its chances of finding a threat.

- The Primary target is the handed off threat, in case of a SAM system it is the most dangerous threat (usually the FCR)
- The Secondary targets are the remaining threats on the active threat table or the priority targets for the HAD mode.
- The Tertiary targets are the threats loaded on the TER selected table. Which table will be loaded as the TER table is defined on the SMS page. If TBL0 is selected as TER table, non-tertiary targets are loaded. If a SAM system is defined as a threat on the threat table, both FCR and EWR are loaded as secondary targets.



4.2.5.1.4.4 GLIDE

Allows the missile to change its flying profile. Glide will maximize its time aloft to increase its chances of finding a threat.

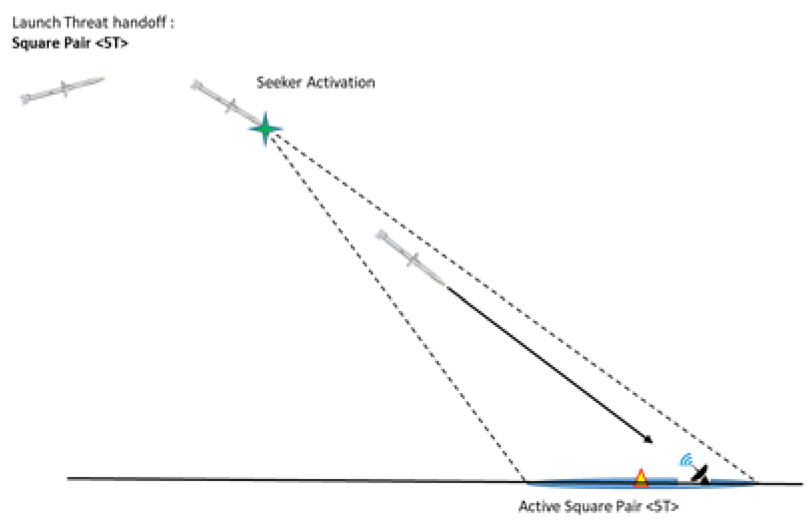
Two glide modes are possible and allow the HARM to be used a SEAD weapon rather than a DEAD weapon

4.2.5.1.4.5 LOTG: LOSS OF TRACK GLIDE

Allows the missile to enter into gliding profile when the primary threat was detected but lost during flight.

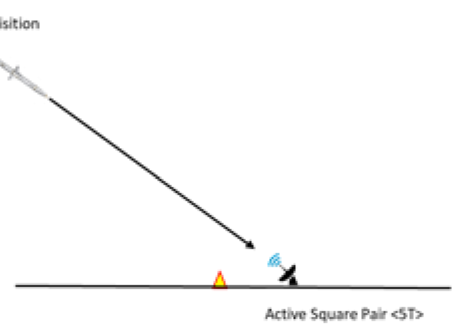
If the missile lost guidance, the INS deviation and limited warhead makes it very unlikely to hit the target in case the missile keeps inertial guidance. Therefore, it can be more efficient to make it glide to maximize its time of flight awaiting the threat to come live again (or any other threat if flex option has been activated).

When entering into LOTG, the HARM seeker is opened wide to maximize the chances to find the threat.



LOTG

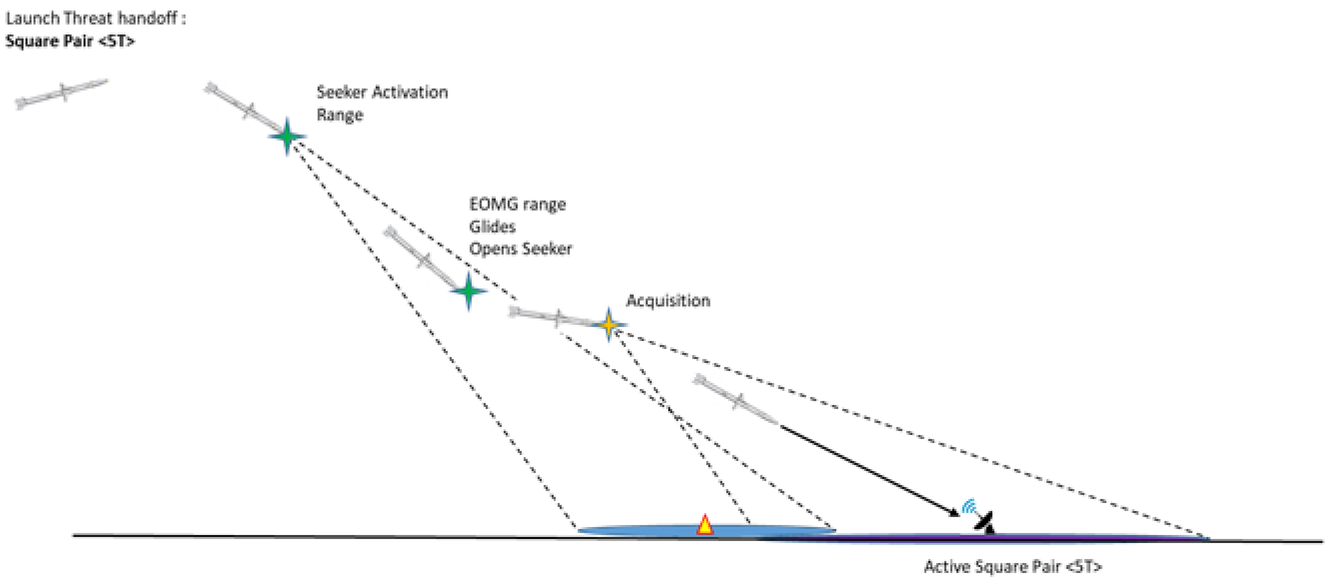
LOTG



LOTG

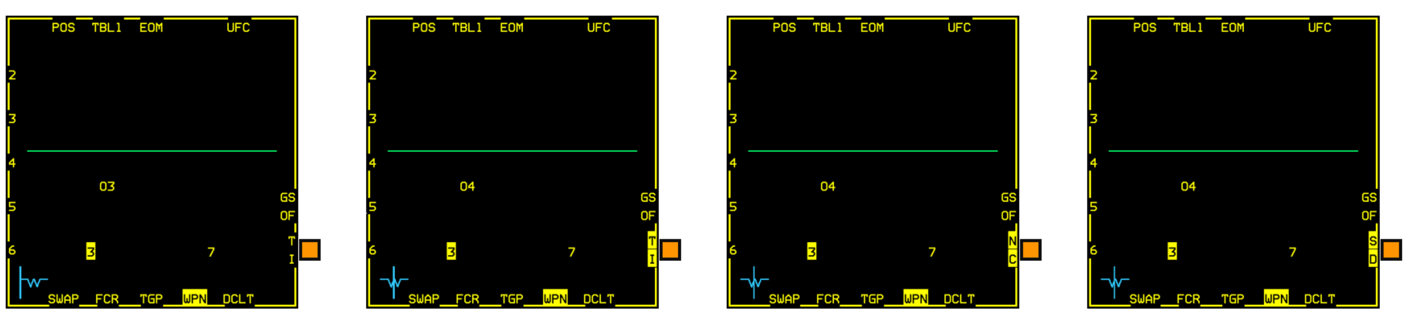
4.2.5.1.4.6 EOMG: EQUATION OF MOTIONS GLIDE

Allows the missile to enter gliding profile in case the primary Threat has not been detected after reaching a certain point. It maximizes its time of flight awaiting the threat to come live (or any other threat if FLEX option has been activated). It allows as well to search for targets in a footprint further away from the initial handed off steer point. When entering EOMG, the HARM seeker is opened wide to maximize the chances to find the threat.



EOMG

OSB 10 cycles through TI options. The TI option may also be toggled by depressing the uncage switch on the throttle.



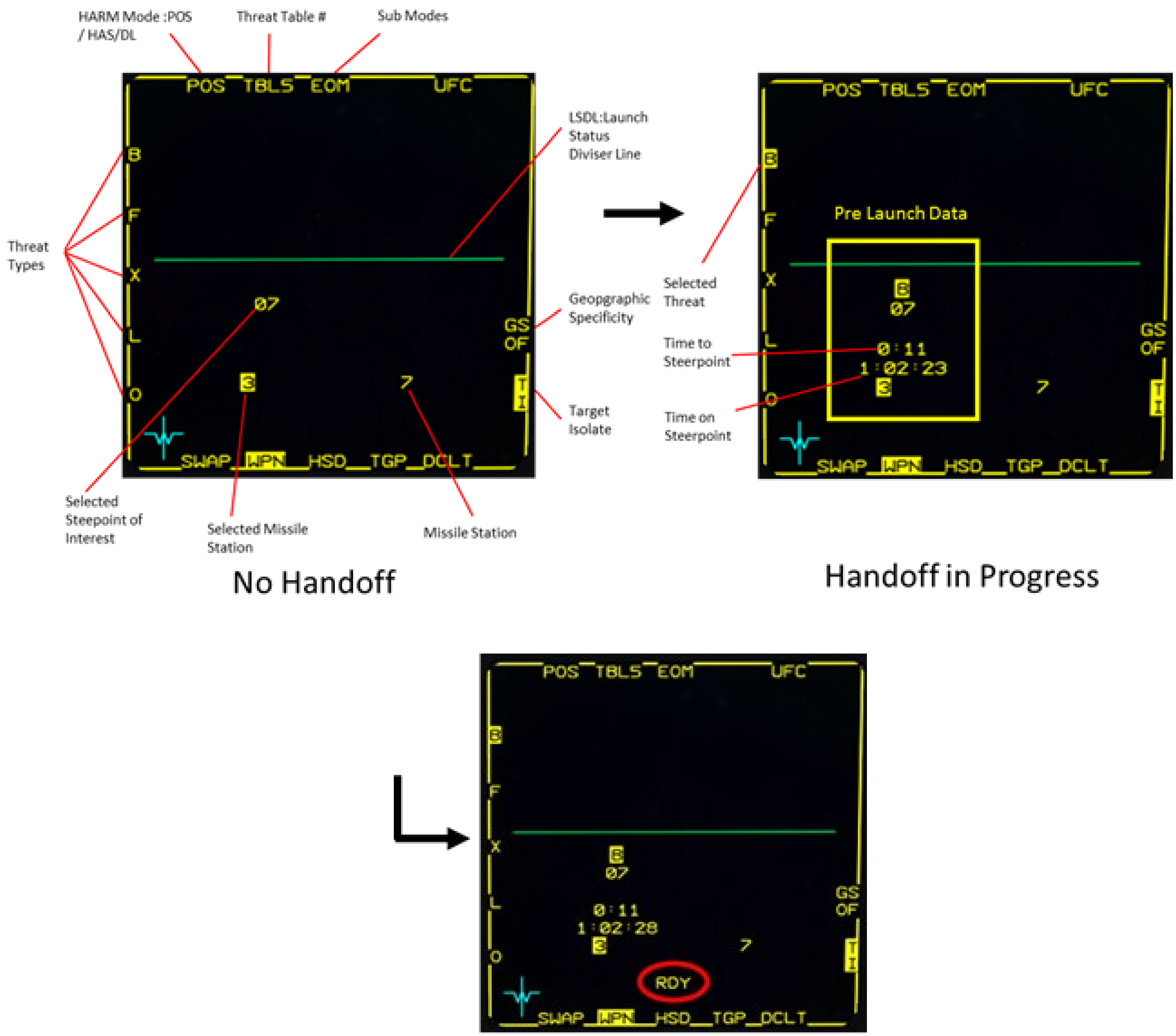
	TARGET ISO-LATE	GLIDE IN-HIBIT	OPERATION	DISPLAY
Default	OFF	OFF	This is the baseline TI - OFF option Missile will glide and flex	T I (no highlight)
1st Depression	ON	OFF	This is the baseline TI - ON option Missile will glide but not flex	T I (highlighted)
2nd Depression	OFF	ON	Missile will not enter LOTG, but may enter EOMG Missile will flex	N C (highlighted)
3rd Depression	ON	ON	Missile will neither glide or flex	S D (highlighted)

4.2.5.1.5 HARM POS MODE

In the POS mode, the aircraft attitude and target position are passed to the HARM. The threat's location is the selected steer point allowing a pre-emptive launch against a silent SAM. After launch the missile will fly toward the selected steer point and to a certain trip point, where (depending on the submode), it will activate its seeker in search of the primary threat (handed off threat). If the primary threat comes online, the missile will guide towards it. If not, depending on the Target Isolate (TI) and the Geographic Specificity (GS) options, the missile will flex/glide for the secondary and tertiary threats. If no target is found, it will miss.

An important point is that the pilot has no clue if the SAM radar is radiating from the MFD WPN page in POS mode. Remember you do not fire at a specific radar, you fire at an area and let the missile make its search depending on POS submode and TI / GS options.

Prior to launch, all parameters: threat, steer point, TI and GS options, must be loaded into the missile. This is called the Handoff process. Each change of one of those parameters requires another Handoff sequence. When the Handoff process is completed, “RDY” is displayed at the bottom of the HUD (“SIM” is displayed in Master Arm SIM). A missile launched without being properly handed off will result in a failure.



No Handoff

Handoff in Progress

Handoff Completed

Threat types within the same TBL are displayed along the left side of the display.

GS and TI options are displayed on the right side of the display.

The center of the POS base page contains missile employment information. It is divided into two sections by the launch status divider line (LSDL - Green line).

Pre-launch information is displayed below the LSDL directly above the selected missile station. Post Launch information is displayed above the LSDL and in reverse order from the station. Threat types within the same TBL are displayed along the left side of the display. The center of the POS base page contains missile employment information. It is divided into two sections by the launch status divider line (LSDL - Green line).

4.2.5.1.5.1 PRE LAUNCH DATA

Selected Threat Type - The currently selected threat type that will be launched against. The threat type will be highlighted after that threat is successfully handed-off. The Threat Type is blank until a threat is selected via OSB or Hands-on (TMS right).

Selected Threat Position - The position of the target that will be attacked. Target position will be a steer point.

Missile Time-of-Flight (TOF) - TOF is based on a current condition launch from the present aircraft location if the aircraft is within launch parameters. If the aircraft is not within launch parameters (e.g., the relative bearing to the target exceeds 5 degrees and the PB flight profile is selected), the TOF is calculated assuming a zero relative bearing to the target. If the aircraft is out of range of the HARM, the TOF is calculated by adding the time-of-flight to bring the aircraft within range with current airspeed and altitude, to the time-of-flight of the missile assuming a launch with current conditions at the edge of the launch envelope and a zero relative bearing to the target. TOF is not displayed until a threat has been handed-off. The TOF data is not available in the RUK flight profile.

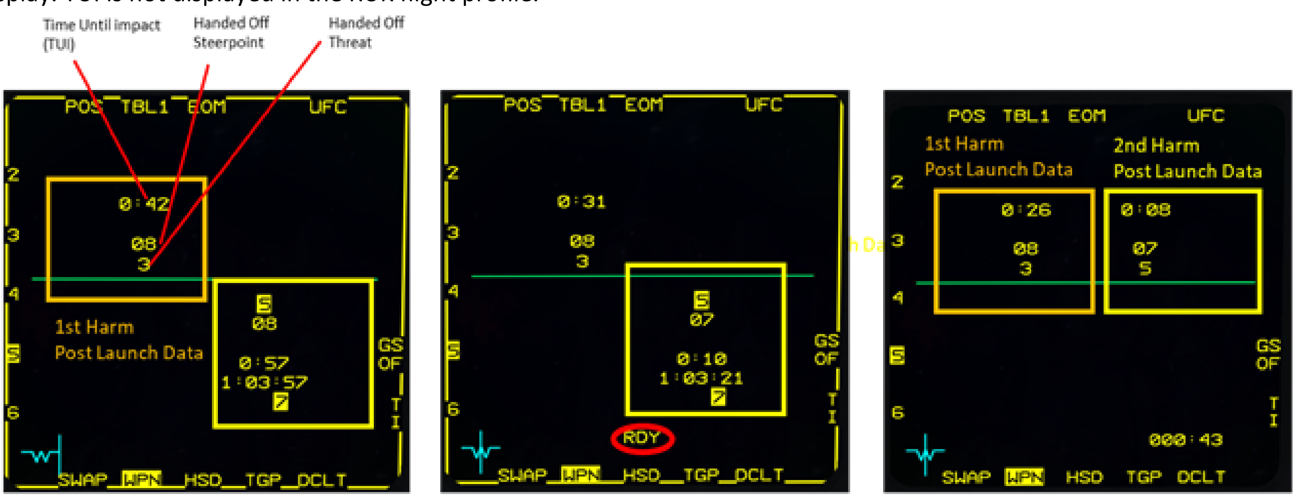
Time-on-Target (TOT) - The real-world TOT will be displayed directly below missile TOF. It will indicate the TOT of the next missile to be launched based on current aircraft position and launch conditions using system time. TOT is not displayed until a threat is selected for hand-off to the HARM. TOT data is not displayed in the RUK flight profile.

HARM loaded stations - The stations on which HARM missiles are loaded will be displayed across the bottom portion of the MFD. The selected station (only one at a time) will be highlighted.

4.2.5.1.5.2 POST LAUNCH DATA

Threat type attacked.

Threat location attacked. Time-until-impact (TUI). The TUI is initialized to the pre-launch TOF counting down from missile launch to the predicted missile impact. When the TUI counts to zero, 0:00 will be displayed for five seconds and then is removed from the display. TUI is not displayed in the RUK flight profile.



Harm station 3 has been launched at Steerpoint 8 with SA3 System handed off

Primary Threat : SA3T
Secondary threats: F - SA4T – SA4A – SA5T – SA5A – SA6T – F – SA2T – SA2A

Tertiary threat s: depending on TER table

Harm station7 has threat SA5 and Steerpoint 7 selected but not handoff yet (not RDY)

New Steerpoint assigned to Harm station 7 via UFC

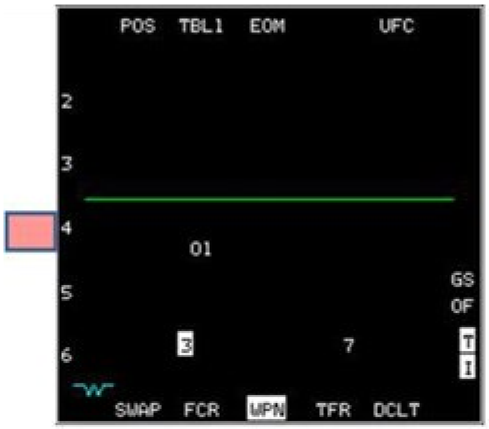
SA5 threat selected

Handoff completed

Both missiles flying

4.2.5.1.5.3 POS MODE THREAT

Three tables are used (each table has 5 entries), for a maximum of 15 radars. Tables are selected from OSB2 on the WPN page or TMS Left. Threats are located on the left edge (OSB 16-20) of the WPN MFD and can be toggled with TMS Right. Once the correct table is selected, you can handoff a threat to the missile. Select first the HARM station and depress threat mnemonic OSB or use TMS Right.



HARM on station 3 is active, no threat is handed off. Press OSB18 to handoff SA-4

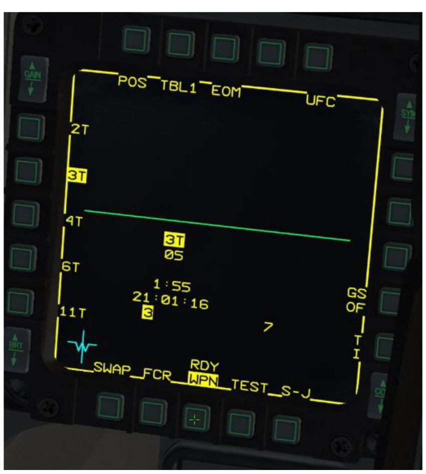
SA-4 is now assigned to HARM on station3. Missile Time of flight and Missile ETA are displayed

You can handoff another threat to another station by switching weapons and repeating the procedure. In fact, you can pre-program each station with a specific threat, POS submode, and HARM mode. The WPN page will remember the handoff threat for each weapon.

4.2.5.1.5.4 POS MODE: TARGET STEER-POINT

In POS mode, the threat position is known. The position of the threat is stored in a STPT or PPT during the planning time or in real time by the use of the aircraft's sensors.

The active steer point will be assigned to the selected HARM after the handoff is complete. After the hand off, the pilot may change the steer point via the UFC. The missile will not keep the first handed off steer point in memory.

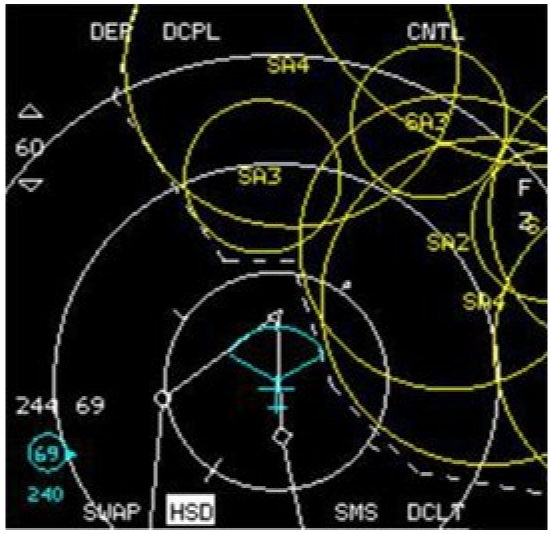


HARM on station 3 has been handed off with a SA-3 threat and the current steer point of interest is STPT 5. Once fired, the missile will fly to STPT 5 and seek a Low Blow (3T) fire control radar in the vicinity of the steer point.

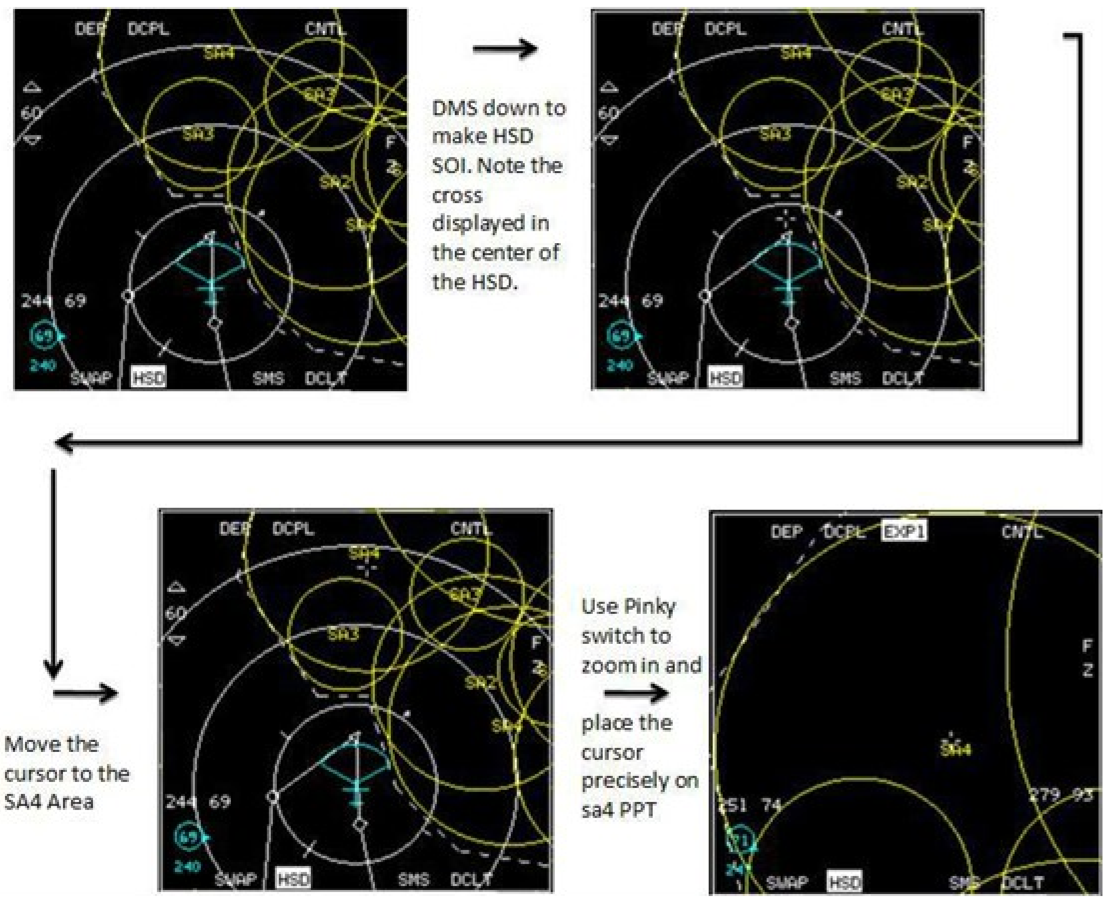
Selecting a steer point can be done with the ICP #4 button (STPT) or by incrementing the STPT with the ICP arrows, but you will more likely fire at a PPT (pre-planned steer point) in this mode instead.

If the briefing was done correctly, you should have a list of PPT numbers with assigned SAMs. You can then simply select the PPT as the Steer point of Interest in the UFC and that location will automatically be assigned to the missile. But the situation can become quickly confusing in flight because the HSD does not give you the PPT number but rather the threat linked to the PPT in the DTC. Similarly, you might have multiple threats of the same type on your HSD and receiving an order to take out a SAM might be hard to resolve without receiving the PPT number.

It might be a good idea to select the Steerpoint of Interest straight from the HSD page rather than from the UFC



Simply make the HSD the SOI with DMS down and move the cursor to the PPT you want to select. Use pinky switch to zoom if required. Once over the PPT, depress TMS up to make that PPT the Steer point of Interest in the system. Confirm in the UFC and in the WPN page that the PPT number is assigned to the HARM.



Depress TMS up to select that steer point as Steer point of interest.

Unzoom (pinky) and check UFC and WPN page to make sure that the Steer point switched to the SA4 PPT.

4.2.5.1.5.5 POS MODE: TIMERS

POS mode is mainly used for pre-emptive launches against known threats.

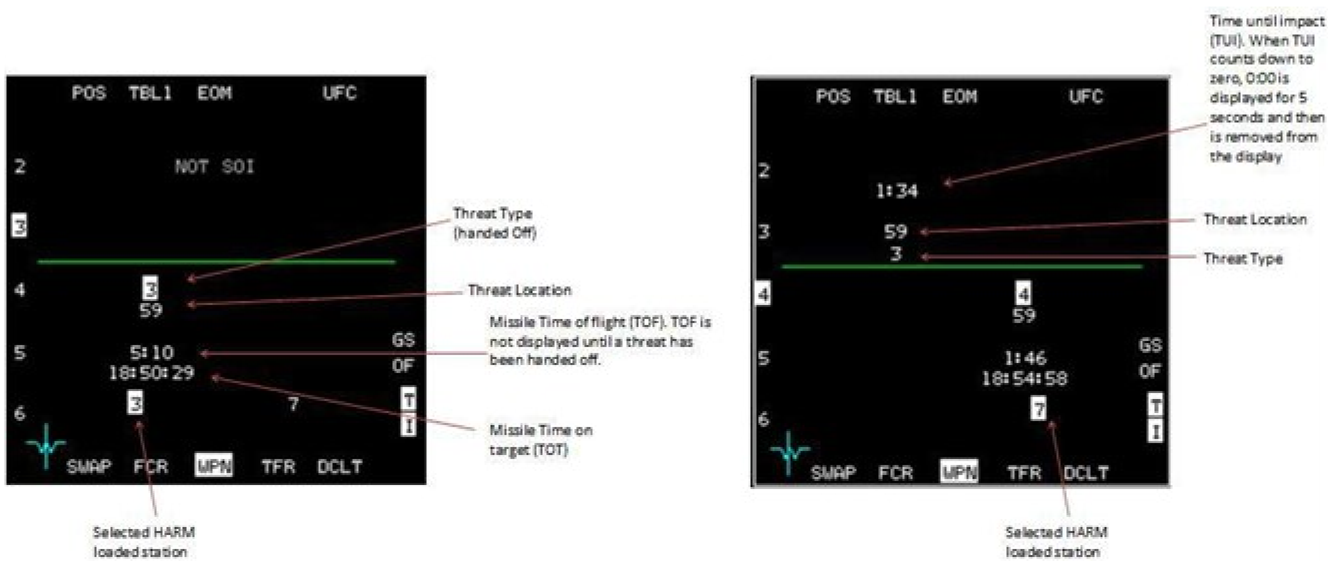
The pre-launch information, which is displayed below the LSDL, can be used for suppression of a SAM system.

The Missile time on target can be used to plan the impact time of the missile to be equal to the time any friendly aircraft enters the SAM's threat envelope.

Prelaunch data: Missile time of flight (TOF) and Missile time of impact the threat (TOT)

Post launch data: Time until impact. (TUI)

Timers are not displayed in RUK submode



4.2.5.1.6 HARM HAS MODE

HAS (HARM as Sensor) mode displays only emitting radars (up to 10). Contrary to POS mode, you do not need to know the threat position; emitting systems are displayed on the MFD. The sensor is the missile; therefore, it is limited to the FOV of the HARM seeker (120°) and once the last missile is fired, the HAS page is no longer accessible.

Only the threats displayed on the left side of the MFD are actively searched. The system is scanning from the first threat and then searches through the rest of the table before returning to the first one.

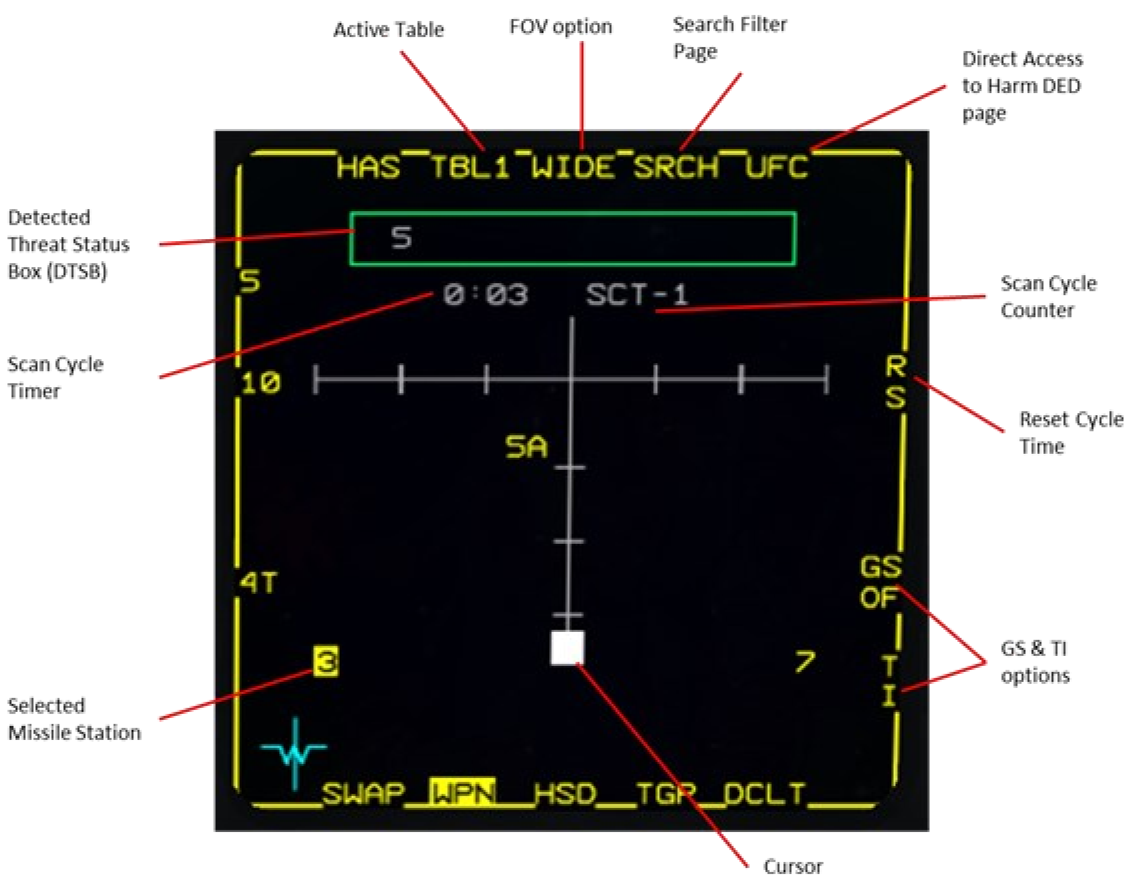
The timer "scan cycle time" indicates the remaining seconds before a whole scan cycle is completed. The scan cycle counter indicates the number of cycles since last reset. The total cycle time depends on the type of threats selected and the FOV option selected.

The contacts in the ALIC are positioned from Elevation and Azimuth of the radar signals that are received by the HARM seeker.

The ALIC display is roll and pitch stabilized.

OSB 1 - changes HARM MODE
OSB2 - toggles tables 1-3: each time a table is changed, the scan cycle timer resets
OSB 3 – access to Search Filter page
OSB 4 – Direct access to DED HARM page
OSB7 - RS resets the scan cycle timer and counter.

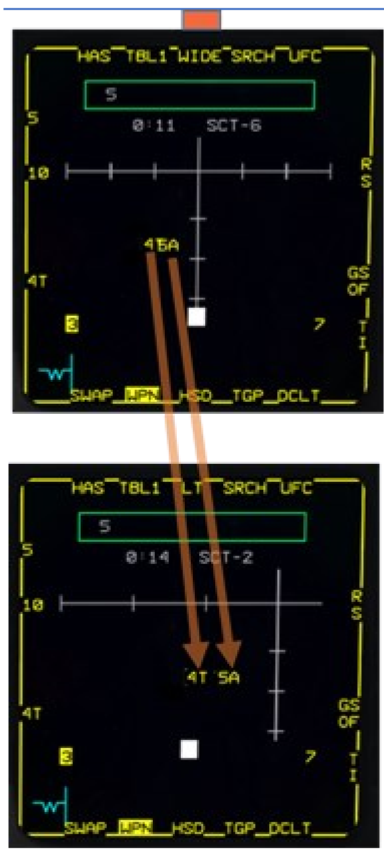
The Detected Threat Status Box indicates what threats corresponding to the threat table are actually detected.



When a threat in the table is a SAM system, the HAS will display its subsystems. If two radars of the same systems are close to each other, the ALIC will display only one threat corresponding to the system symbol.

Illustration: if “5” is selected as a threat in the table, the Bar lock – 5A and the Square Pair – 5T will be merged into a “5” symbol if they are detected close to each other.

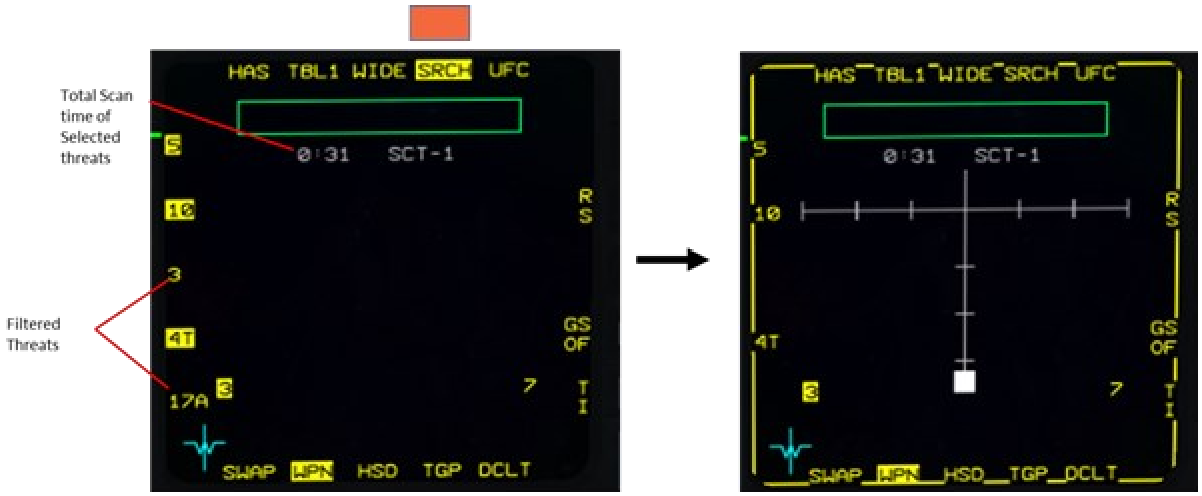
4.2.5.1.6.1 HAS MODE FIELD OF VIEW



OSB3 - HAS Field of WIDE (all direction, long range), CENTER (front only with half the WIDE range), LT (Left only), RT (Right only). Each time the FOV is changed the HAS page resets and threats disappear until detected again. This option acts as a ZOOM and therefore allows declutter of close contacts.

4.2.5.1.6.2 HAS MODE: SEARCH FILTER PAGE

OSB 4 brings you the search filter page, which allows narrowing of the threats from the tables and thus reducing scan total cycle time. Depress OSB2 to toggle between the three tables and depress OSB 16 to 20 to remove a threat from the search. In the Search page, the scan cycle time is static and indicates the total cycle scan time of the selected threat configuration. Depress OSB4 to display the HAS page once set.

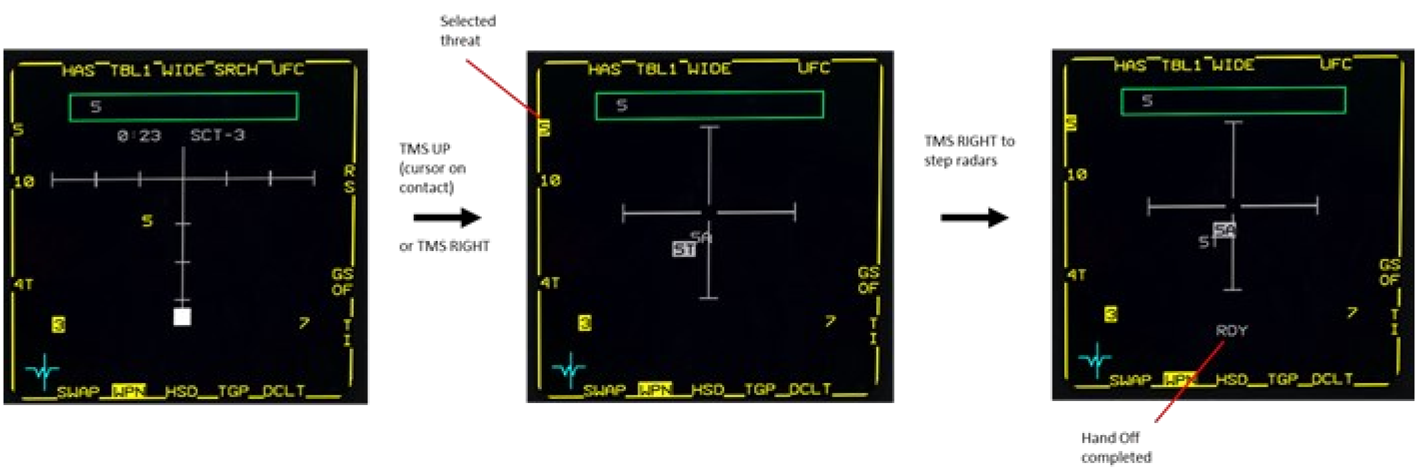


HAS mode: Handoff

To handoff a threat or a system in HAS mode, make the WPN page SOI and move the cursor over the threat. Select it with TMS Up, or TMS right to select the first displayed threat.

The other emitting stations remain displayed in the DTSB for approximatively 6 seconds but not in the display area. If a SAM System has been handed off, all radar contacts of the selected system will be displayed. TMS right allows stepping between different radars to unselect a threat. Use TMS down and the video will revert to the normal scan cycle.

Radars that become outside the FOV of the HARM (or have simply lost contact), will start blinking and system will return to HAS after ten seconds.



Handoff takes about five seconds and is reset each time a new radar is selected. RDY is displayed above OSB 13 when handoff is complete. Missiles fired before the handoff is complete will miss.

4.2.5.1.7 HARM HOTAS CONTROLS SUMMARY

- Cursor enable – Toggles between POS and HAS modes (WPN page needs to be SOI).
- Cursors: Move captain bars in HAS/HAD display.
- TMS Up – Handoff the threat in HAS/HAD.
- TMS Up LONG - POS/HAD: cycles HARM submodes
- TMS down – Deselects the currently selected threat in HAS/HAD.
- TMS Right
  - HAS: Selects first valid threat; a second TMS Right steps to the next threat.
  - POS: Cycles threats from the selected Threat Table
- TMS Left – Toggles between threat tables.
- Pinky Switch
  - POS: Cycles the HARM submodes
  - HAS: Cycles the FOV.

4.2.5.1.8 HARM ATTACK DISPLAY (HAD)

The AN/ASQ-213 HARM Targeting System (HTS) pod can be loaded on USAF F-16C/D Block 40/42 & 50/52 aircraft even if HARMs are not carried as part of the loadout.

The HTS (HARM Targeting System) pod gives pilots the capability to employ the AGM-88 HARM missile in its most effective mode. It can autonomously detect, identify and locate radar guided threats at long ranges and displays the target estimated location to the pilot for HARM designation and firing.

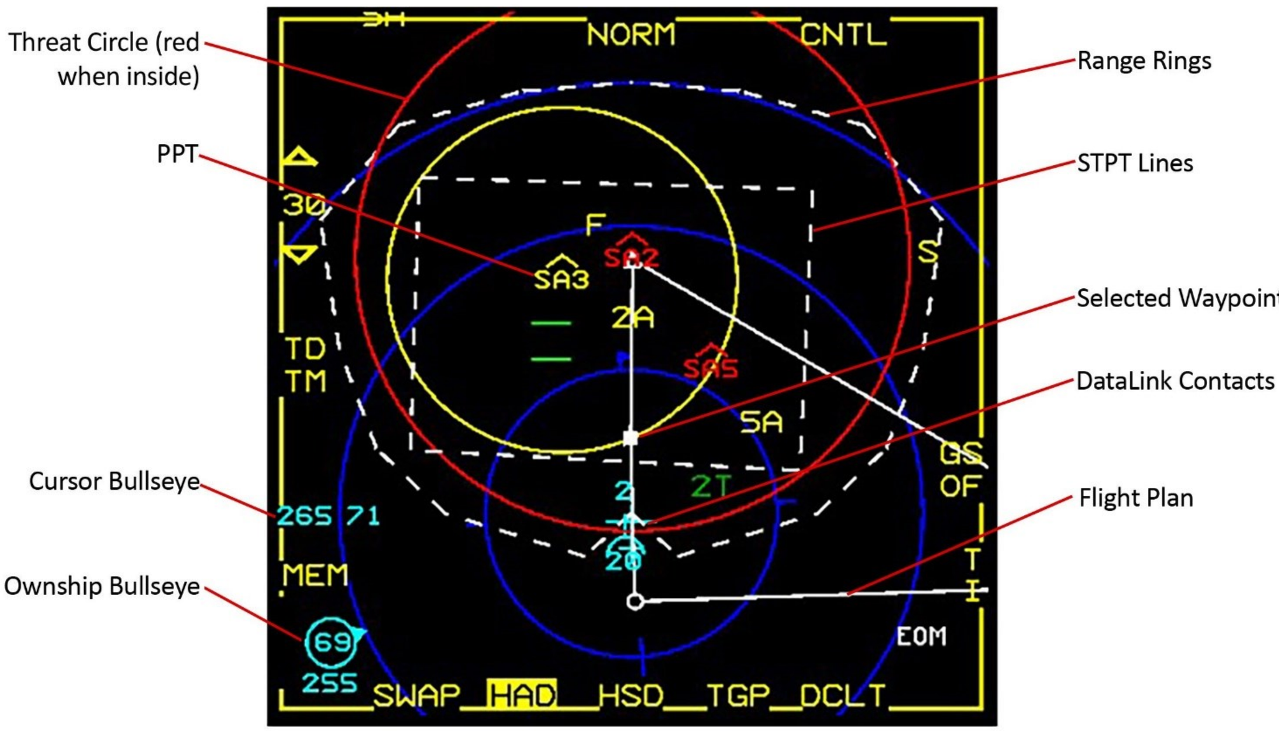
Note: Pods are independently manually selectable from the LOADOUT screen in BMS 4.34. AN/ASQ-213HTS pods will automatically be fitted to the left chin station of compatible USAF F-16C/D Block 40/42 & 50/52 aircraft if selected.

The HAD is selected from the main MFD menu by pressing OSB 2 (HAD label). The HAD may be selected in any master mode but it can only be operated in A-G master mode with HTS and AGM-88s loaded.

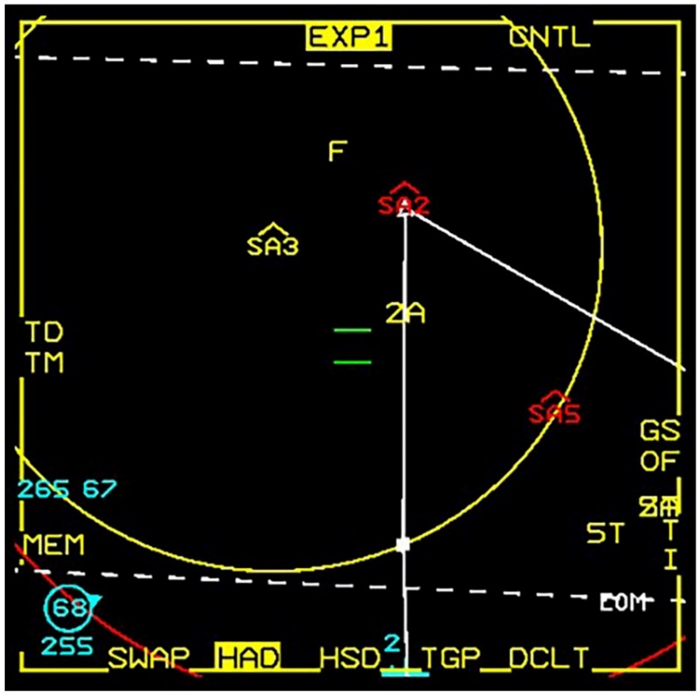
4.2.5.1.8.1 MAIN DISPLAY

The HAD shares all the display features of the HSD including mnemonic:

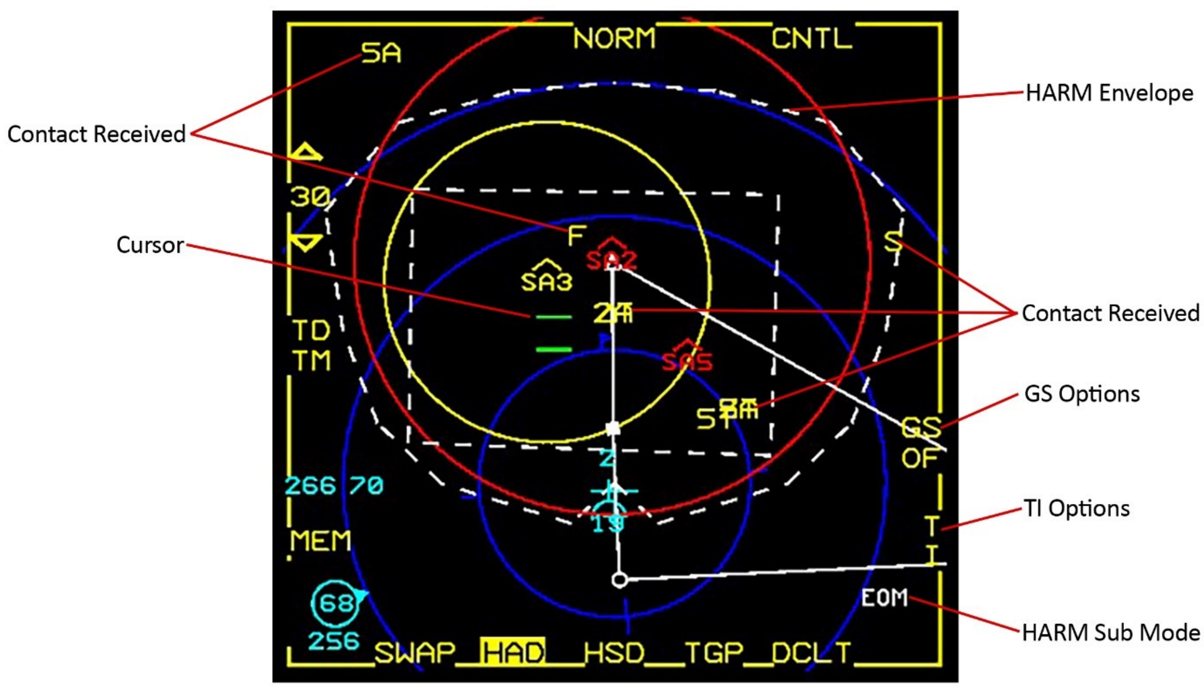
- Waypoints & flight plan
- PPTs and threat circles
- Datalink contacts
- Bulleyes information
- Range Rings
- STPT Lines



HAD cursor movement and expanded FOV (OSB 3 or pinky switch) options are similar to the HSD as well. The pilot may select the HAD range (HAD as the SOI) by slewing the cursors up and down the display to bump the range or by pressing OSBs 19 and 20.



In addition to the standard HSD display, the HAD displays specific information.



4.2.5.1.8.2 HTS PRINCIPLE OF OPERATION

The HTS/HAD is very different from the HAS. Contrary to the HAS, when fired on a HAD locked target, the HARM does not track the target with its own seeker from the start.

The HAD is used to hand off the threat and the estimated position of the target. The HARM is actually fired in POS mode, flying to the estimated handed off position before actually activating its own seeker, exactly like the POS mode.

It is therefore critical that the estimated position of the threat coming from the HTS be computed with the best possible accuracy.

However, the HTS is not an active device, it is a passive device that logs the elevation and azimuth of radar sources. As such, there is no possibility for the HTS to accurately compute the range of the emitter from a single ping. It could be a weak emitter close or a strong emitter far away. On top of this is added the error coming from the HTS antenna resolution.

Therefore, the error on the location of the emitter can be extremely important. We are talking dozens of NM for the HARM, which would totally miss the target area.

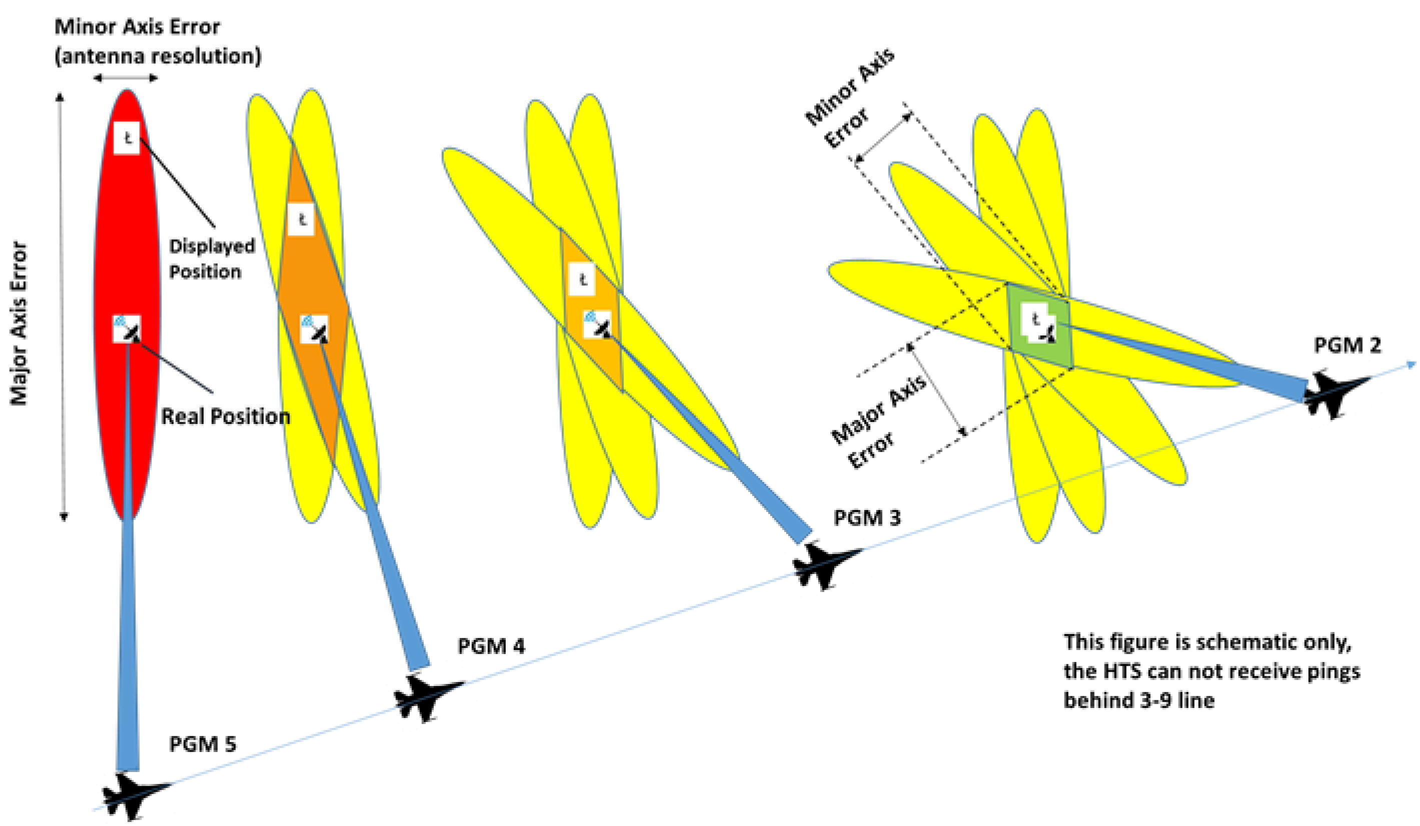
In order to reduce the error in positioning, the HTS keeps track of the contacts and by triangulation of every ping received, reduces the error.

The more azimuth deviation between two pings, the quicker the error is reduced.

The “Major Axis” number represents the size of the longest axis of the error box in NM and in Ft below 1000 ft.

The “Minor Axis” number represents the size of the smallest axis of the error box in NM and in Ft below 1000 ft.

The PGM index represents the level of trust in the accuracy of the contact. Lower index means better accuracy. Firing a HARM with a PGM5 could result in a miss of several miles.



The HTS does not provide any information on the Radar emitter status (searching/ tracking/ guiding).

Detected emitters are colored as follows:

Emitter not active but detected once / Emitter behind 3-9 line

Emitter active

Priority Target

Primary target Selected

Primary target Handed off

The hand off process is automatic after TMS UP and takes a few seconds. Firing a HARM before the handoff process is completed will result in a dead missile.

The HARM WEZ/Footprint is based on Rmax of the AGM-88 and will increase/decrease in size according to your speed and altitude. If the HARM WEZ is greater than the selected display range, the lines will be dashed.

THE HARM WEZ / Footprint is dependent on the HARM submode. The HARM submode is automatically selected between RUK and EOM depending on the PGM index status. Manual override is possible with TMS up Long. As the HARM is actually fired in POS mode, the GS and TI options are available with behavior identical to POS mode.

EOM

PB

RUK

Target lock is possible with the HAD page after all own ship HARMs have been fired. This allows you to direct your AI wingmen to attack based on either a lock on your HAD page or hovering over a threat with the HAD page cursor, provided the HAD page is SOI.

4.2.5.1.8.3 HAD PRIORITY TARGETS

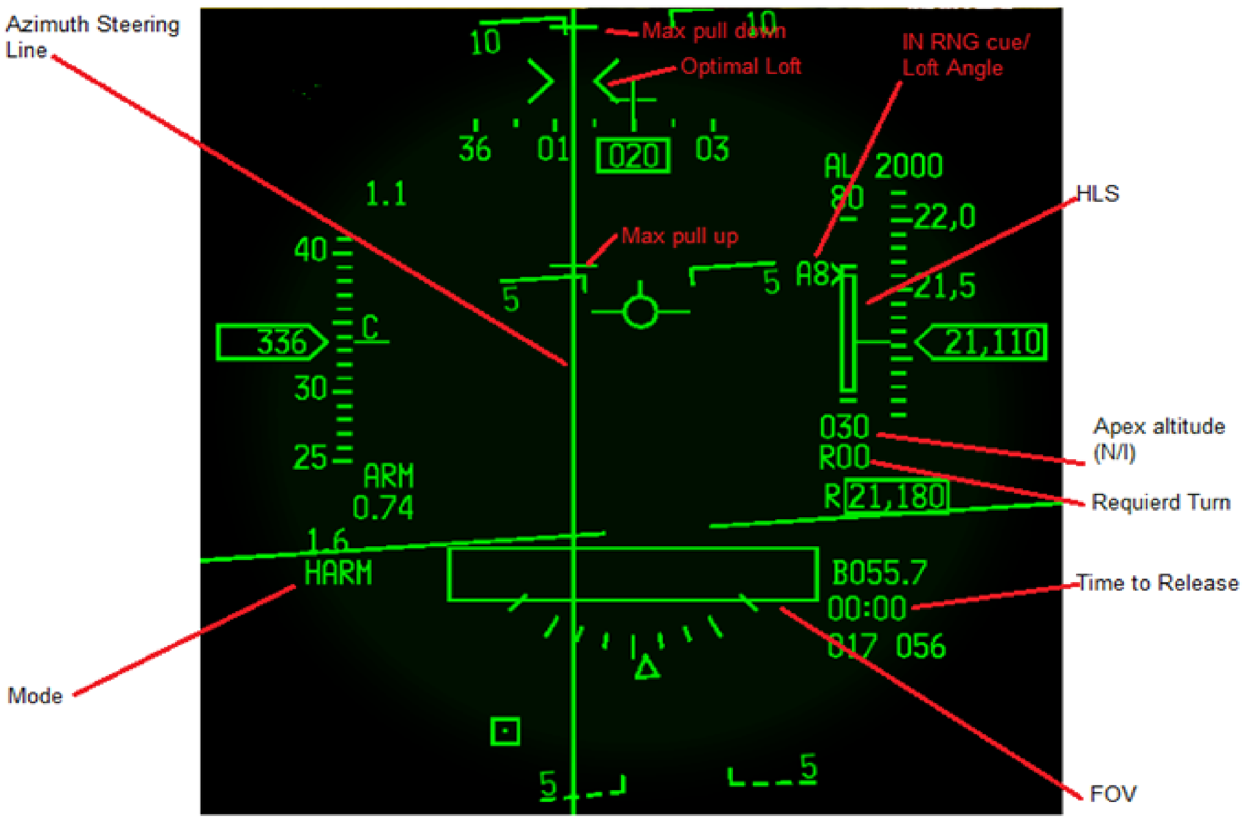
TMS UP designates a contact as a primary target.

If another contact is designated with TMS up, the previous primary target becomes a Priority target. Three priority targets can be set up that way. Once priority targets have been set up, TMS right steps through them (including the designated primary target). Defining priority targets allows speeding up of the designating process and for the firing of several HARM's quickly.

Priority targets are also handed off as secondary targets (see chapter 2.1.5.3): TMS down on a priority target removes the target from the priority list while TMS down in the middle of nothing resets entirely the priority targets and designated primary target.

Please note that HAD SPI capabilities had been improved in 4.36 U1. It is possible now to lock target a SPI in the HAD. This way you can indicate the target in the A-G radar and/or TGP to verify and identify targets more precisely.

4.2.5.1.9 HARM HUD CUES



The HARM FOV box flashes when in range. This is the main cue for firing the missile. HARM FOV is smaller in EOM as the missile Field of view is smaller than in PB and RUK mode.

Azimuth Steering Line (ASL)

Function is similar to ASL in CCRP

Provides steering to direct missile bore sight line at TGT

Is displayed in POS regardless of threat handoff

Loft solution cues

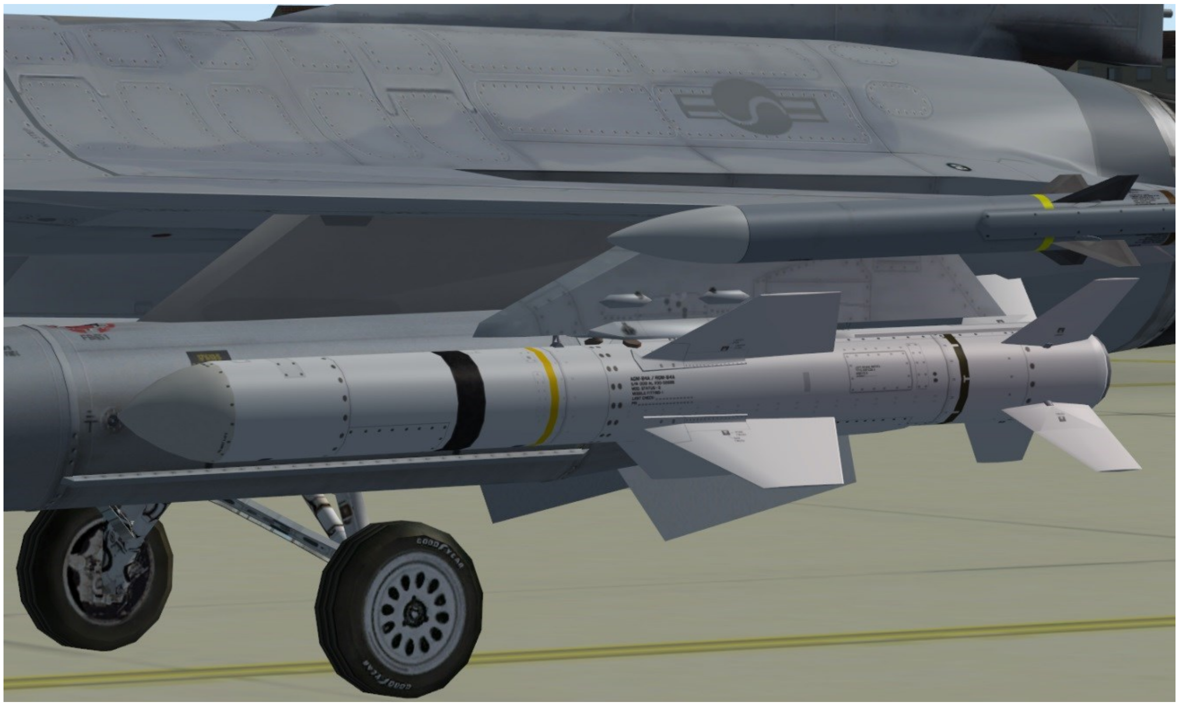
Two loft solution cues are positioned on the Azimuth Steering Line (ASL). A third cue is displayed in PB mode only and is located centrally on the ASL with two carets: It is the Optimal loft cue (see PB mode).

HARM Launch Scale (HLS).

The HLS is displayed on the right side of the HUD. HLS consists of the four ranges (RMAX1/2 and RMIN1/2), two 10mR tics, and an in-range cue. The four ranges defining the Missile Maneuver Zone (MMZ) and the Aircraft Maneuver Zone are not available in RUK mode. The Loft Sngle and Apex Altitude are not implemented.

4.2.6 ANTI-SHIP MISSILES

4.2.6.1 AGM-84 HARPOON



AGM-84A Harpoon

The AGM–84 Harpoon is a sub-sonic, air-to-surface anti-ship missile. It is turbojet propelled and inertially guided with an active radar seeker for target acquisition. The missile is 151 inches long, 13.5-inches in diameter, with a 36-inch span on the control fins and wings. The missile weighs 1145 pounds with JP5 fuel or 1165 pounds with JP10 fuel. A 500-pound blast warhead provides a high degree of effectiveness against ships. The missile's long range (67+ nm) at high subsonic speeds, is achieved by using an air-breathing turbojet sustainer engine.

The Harpoon contains an active radar seeker with frequency agility that affords all-weather hit capability and good performance in an electronic warfare environment. A three axis, strap-down attitude reference system plus a digital computer and a radar altimeter are used for mid-course guidance. The missile flight path is controlled by electromechanically operated fins.

The missile is designed to be fired over water against naval targets. It provides all weather, day or night, anti-ship capability at standoff ranges.

The Harpoon is loaded on a MAU–12 and interfaces with the aircraft using the Harpoon Interface Adapter Kit (HIAK). The HIAK, located in the weapon pylon, converts control data from the pilot and the avionic system into the discrete and serial data format required by the Harpoon. The HIAK reports the weapon status back to the pilot.

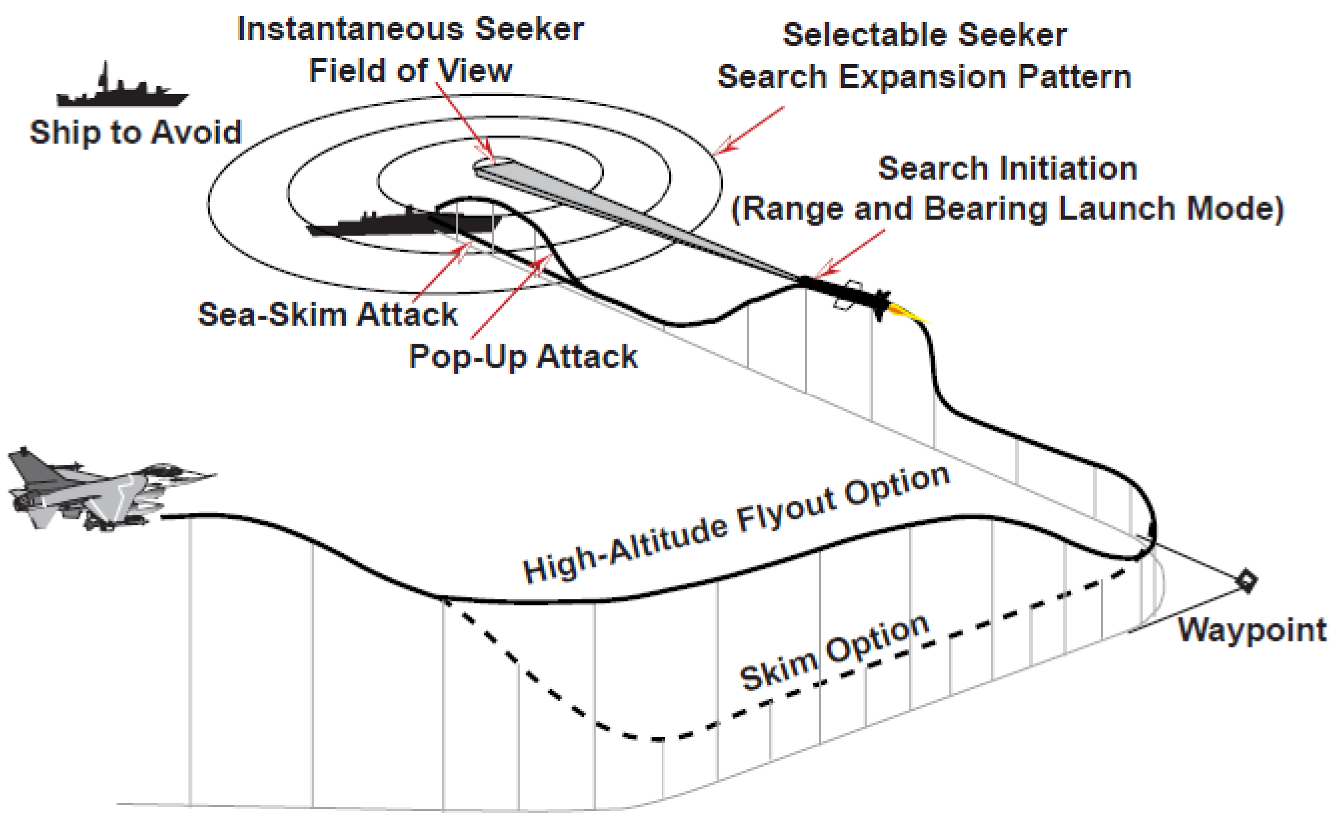
When simulate is selected, the MMC reports it to the HIAK, and the HIAK provides a Harpoon simulation capability. When a Harpoon missile is not loaded, the HIAK simulates the Harpoon interface and responds to launch mode and option changes. The HIAK does not support a simulated launch. If a missile is present with simulate selected, the HIAK continues its normal operation and conditions the missile normally.

The F-16 launch platform controls the launch sequence and provides the missile with initialization and targeting data prior to launch. The missile does not require inputs from the launch platform after launch.

When the missile is ejected from the aircraft, it immediately begins attitude rate damping. Pitch control is initiated shortly thereafter and the Harpoon begins a 30-degree descent to cruise altitude. Next, it turns to the programmed heading enroute to the target or waypoint. During the descent, the radar altimeter is turned on and the sustainer engine is started.

During the mid-course phase of flight, the missile flies at the programmed altitude on the programmed heading to the target. If a waypoint is commanded, the missile flies to the waypoint and then turns toward the target. The midcourse altitude is measured by the radar altimeter. The heading reference is provided by the three-axis attitude reference assembly. At a programmed distance from the target, the radar seeker begins an area search pattern. When target acquisition is achieved, the missile descends to a lower altitude.

A terminal "pop-up" or "skim" maneuver (selectable by the pilot) is initiated when the missile is within a preset distance from the acquired target. The terminal maneuver is designed to counter close-in enemy defences and maximize warhead effectiveness. During the terminal phase, the missile will also turn as required to hit high speed maneuvering targets.



Typical Harpoon Profiles

4.2.6.1.1 HARPOON TARGET AND WAYPOINT DATA LOADING VIA UFC

Target and waypoint data can be loaded through the DTE or entered manually through the UFC. When entering this data through the UFC, the pilot first selects one of the ten Harpoon (HPN) destination DED pages, 90 through 99. The pilot then sequences (SEQ) to the Harpoon waypoint-to-target (WPT- TO-TGT) page for BOL, or target-to-waypoint (TGT-TO-WPT) page for RBL. The following data fields are enterable on the Harpoon steerpoint DED pages:

1. HPN WPT page: Waypoint latitude, longitude, and elevation.
2. WPT-TO-TGT page: True bearing to target.
3. HPN TGT page: Target latitude, longitude, elevation, and time–over–steerpoint
4. TGT-TO-WPT page: True bearing to waypoint and range.

The pilot depresses the data control switch (DCS) up/ down to place the asterisks around the field he desires to change. Then, he keys in the new data via the Integrated Control Panel (ICP), and presses the enter (ENTR) button. Additionally, the pilot can change the range units on the TGT-TO-WPT page. With the asterisks around the range unit, depressing any key 1 through 9 will rotary through nautical miles (NM), displayed to the nearest tenth; kilometers (KM), displayed to the nearest hundredth; and feet (FT), displayed to the nearest foot.

Pressing LIST and then T-ILS 1 on the ICP, the DEST page will appear on the DED. Selecting AGM-84 as the current weapon and switching the selected steerpoint in the DEST page to one of the Harpoon dedicated target steerpoints 90-99 will bring the HPN WPT (BOL) or HPN TGT (RBL) to appear on the DED:

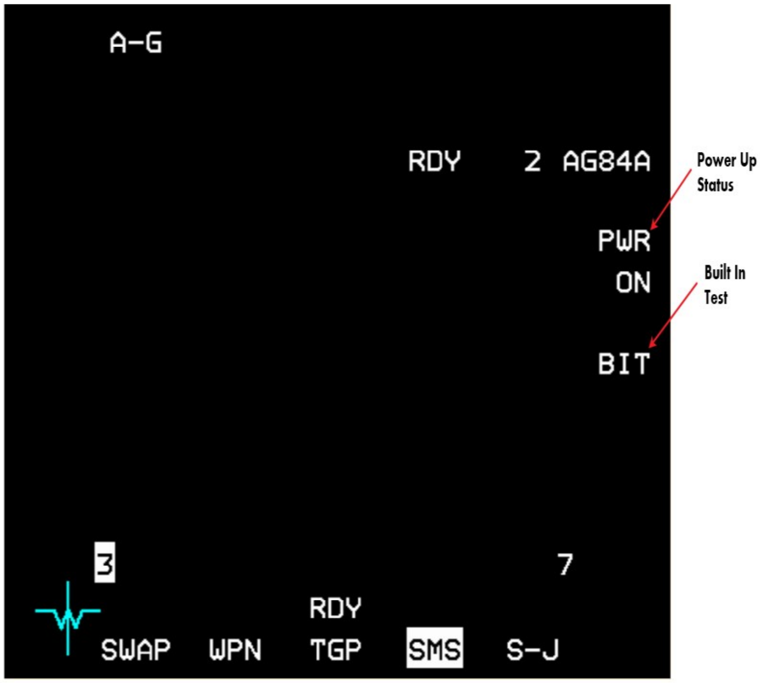
RBL

Harpoon DED TGT page

BOL

Harpoon DED WPT page

4.2.6.1.2 SMS PAGE HARPOON



Harpoon SMS Page

When a Harpoon missile is selected,"AG84" is displayed adjacent to OSB 6 and the total number of Harpoon missiles loaded in inventory is displayed left of the mnemonic.

Missile Power: Missile power is selected via a missile power rotary adjacent to OSB 7. When "PWR ON" is displayed, the selected Harpoon missile will be powered on. Missiles will remain powered up until OSB 7 is depressed, another weapon type is selected, the A–G mode is exited, or a change is made to the current weapon inventory. Missile power does not have to be turned on prior to selecting a station or setting up the missile launch parameters, but must be turned on prior to launching the missile. Selecting missile power on will apply power to the missile on the selected station only. Because of a chance of overheating the missile when power is applied, power should only be applied for 20 minutes or less. The missile takes approximately 15 seconds to come up to full operation once power has been applied.

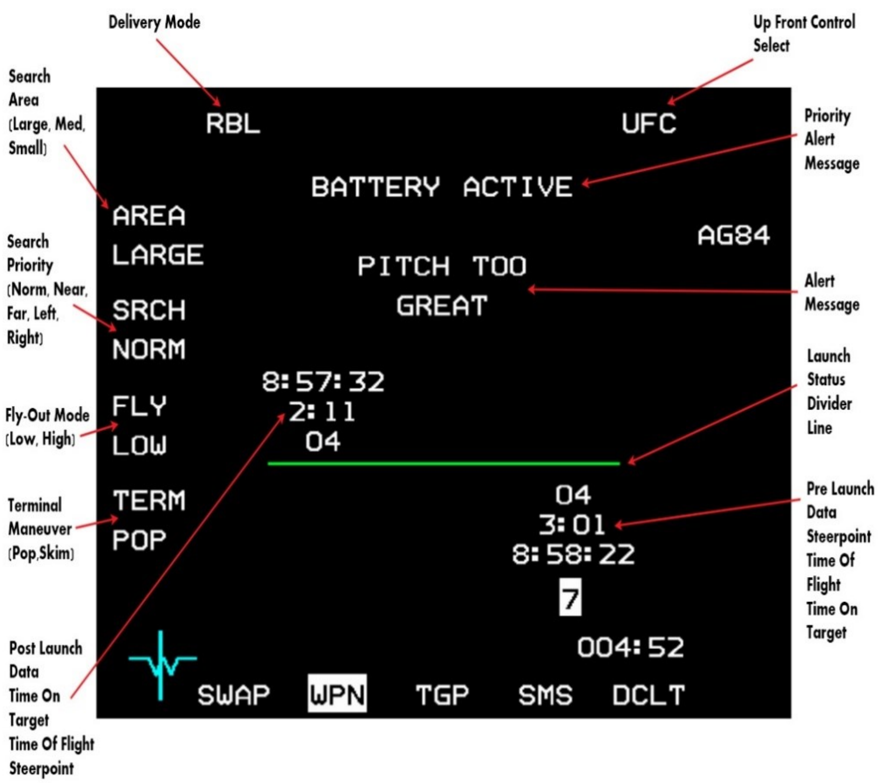
Built In Test: The Harpoon BIT option, available via OSB 8, should be run prior to takeoff to verify the missiles are operational. Selecting OSB 8 commands a BIT to the Harpoon at the selected station. Missile Power must be applied before the BIT mnemonic is displayed. While Harpoon BIT is being performed, the BIT mnemonic will be highlighted. After a Harpoon BIT, the MFD will continue to display the station number for the selected station or replace the station number with an "F" for Harpoons with a failed status.

Hung Store Advisory: When a hung store condition exists, the HUNG STORE advisory message is displayed in the lower center portion of the SMS base page display, and the station number is replaced with an H. Note that also A-A ordnance can now have malfunctions (for example when pulling the release button to early or to long).

4.2.6.1.3 RBL – RANGE AND BEARING LAUNCH MODE

The primary launch mode, RBL, should be used when full targeting information is available. In the RBL mode, the aircraft attitude, altitude, and target position are passed to the Harpoon. In the RBL mode, if the steerpoint is entered as a Harpoon target (steerpoints 90 through 99), the Harpoon also has the capability to accept waypoint position data from the aircraft. After launch, the Harpoon flies to the waypoint position (if selected), turns toward the target and as the target position is approached, activates its seeker. For launch against targets that are not included within the steerpoint range 90 to 99, waypoints are not available.

In the RBL mode, aircraft inertial and target data is processed by the Harpoon Interface Adapter Unit (HIAU - part of the HIAK) to compute direction, altimeter turn on time, engine start time, seeker turn on time, search pattern parameters, and missile destruction time. This data is transmitted to the Harpoon and is used to initialize the missile prior to launch. The seeker turn on time is computed to occur when the missile has reached a predetermined distance from the predicted target location. The destruction time is computed to occur when the missile has flown through the search pattern and the seeker is not locked-on to a target. Three seeker search patterns, small, medium, and large, are selectable by the pilot as a function of target range and mission scenario. The small and medium search patterns are a fixed size as preprogrammed in the HIAU. The size of large search patterns is provided to the missile by the aircraft computer as a function of range to the target at launch. This search pattern is initially positioned over the predicted target location and is small at seeker turn on; however, the search pattern expands to full size as the missile moves toward the target. The small and medium search patterns provide for attack on selected targets in a cluttered environment or restricted waterways.

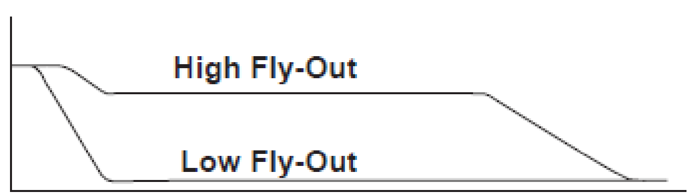


Harpoon WPN Page

Harpoon Search Area Size: The Harpoon search area size is displayed adjacent to OSB 20 when the selected delivery mode is RBL. It is used to communicate the search area size with the missile. Depressing OSB 20 will rotary through the choices of small (SMALL), medium (MED), and large (LARGE). The LARGE size (default) represents an expanding area mode (i.e., at longer ranges, the area to be searched expands). The MED and SMALL sizes are both fixed area modes (i.e., the area is independent of the range). The SMALL and MED search area sizes are more useful when there are numerous ships in the target area or when there is a nearby land mass. There is the potential for a target ship to move out of a smaller target area before the missile reaches it, if the range is very large. INU errors in the aircraft before launch, or in the missile during flight could also contribute to a missed target when using the SMALL or MED search areas.

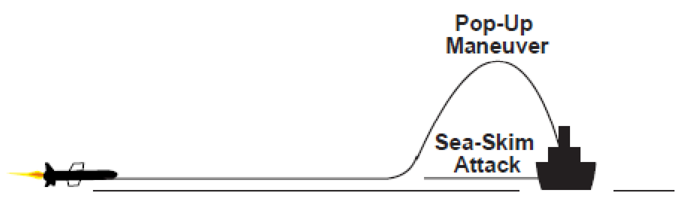
Harpoon Search Priority: The Harpoon search priority is displayed adjacent to OSB 19 when the selected delivery mode is RBL and the Harpoon search area size selection is AREA LARGE. It is used to communicate the missile target area search sequence. The option can be used when the target is one of a cluster. Depressing OSB 19 will rotary through the choices of NORM, NEAR, FAR, LEFT, and RIGHT. The NORM search priority is the default selection and commands the missile to begin its target search in the center of the search area and expand outward in all directions. The NEAR selection commands the missile to begin its target search at the front of the search area and expand its search to the left, right, and back of the search area. The FAR selection commands the missile to begin its search at the back of the search area and expand its search to the left, right, and front of the search area. The LEFT selection commands the missile to begin its search at the left side of the search area and expand the search toward the front, back, and right of the search area. The RIGHT selection commands the missile to begin its search at the right side of the search area and expand the search toward the front, back, and left of the search area. Selecting an option other than NORM is useful when the target is in a cluster and its position within the cluster is not at the center.

Harpoon Fly-Out Mode: The Harpoon fly-out mode is selected via OSB 18. Depressing OSB 18 will rotary through choices of LOW and HIGH fly-out profiles. The missile can either fly to a low level immediately after launch (LOW fly-out-profile) or remain at a higher altitude until it reaches a fixed distance from the launch point. For the HIGH fly-out profile, the missile descends at either 10 nm from launch, the waypoint, or the enable range (BOL mode only), whichever is shorter. The low level mode helps minimize detection, while the high level mode helps avoid obstacles (such as friendly ships) near the launch point.



Harpoon Fly-Out Profiles

Harpoon Terminal Maneuver: The Harpoon terminal maneuver option is displayed adjacent to OSB 17. Depressing OSB 17 will rotary through the choices of POP and SKIM. The terminal maneuver option programs the missile to impact the target from above, or to impact near the water line. POP is the default option that may be more effective against target defences. During the pop-up maneuver, the missile becomes a more dynamic target for enemy defences and, in the case of smaller targets, POP may avoid the missile flying over the target as could occur in SKIM.



Harpoon Terminal Maneuver Profile

Priority Alert Messages: Priority alert messages are common to all launch modes (RBL, BOL, and LOS) and are displayed in the top center portion of the WPN page. There are currently two priority alert messages: “MISSILE OFF” and “BATTERY ACTIVE”. The “MISSILE OFF” message reminds the pilot to return to the SMS page to turn missile power on. The “BATTERY ACTIVE” message is displayed in the case of an interrupted launch sequence. It informs the pilot that the missile is being powered by its internal battery and launch must occur soon to insure enough battery life for the missile to reach the target.

Alert Messages: Harpoon alert messages that apply to all launch modes (RBL, BOL, and LOS) are displayed just below the priority alert message window. The alert messages include information about missile status and aircraft parameters that could prevent or degrade a missile launch. The alert messages that are not launch-mode dependent are shown in the table below.

Alert Mnemonic	Priority	Description And Impact	Corrective Action
INVALID MISSILE TYPE	1	A missile other than an AGM-84D has been loaded onto the wing. The missile will not be powered and cannot be launched.	None
MISSILE ABORTED	2	The missile has been aborted and cannot be launched.	None
MISSILE NOT SAFE	3	There is a failure in missile safety loop and cannot be powered or launched.	None
MISSILE FAIL	4	The missile has failed BIT and cannot be launched.	None
MISSILE COMM FAIL	6	The communications between the A/C and the missile has failed. Only LOS is available.	Select LOS mode
MISSILE NOT READY	7	The gyros in the missile are not up to speed or valid target data has not been sent to the missile. A RDY indication will	Wait for the gyros to spin up or for the missile to be

		not be displayed and missile cannot be launched	initialized.
AIRCRAFT TOO HIGH	10	The A/C is out of the missile launch envelope and the missile could miss the target.	Fly to a lower altitude.
AIRCRAFT TOO LOW	11	The A/C is out of the missile launch envelope and the missile could hit the water and detonate before being able to reach stable flight.	Fly to a higher altitude.
PITCH TOO GREAT	12	The A/C is out of the missile launch envelope by being pitched up or down too far. The missile could miss the target.	Fly the A/C at a more level attitude.
MACH NUMBER OUT OF RANGE	13	The A/C is out of the missile launch envelope because the current mach is too high or too low. The missile could miss the target.	Raise or lower the current A/C mach number as appropriate.
AIRSPEED TOO SLOW	14	The A/C is out of the missile launch envelope. There may not be sufficient speed to start the missile's jet engine.	Speed up.
INITIAL TURN TOO LARGE	15	The initial turn that the missile must make to reach the waypoint or target is too sharp. The missile could miss the target.	Turn the A/C heading closer to the target or waypoint to make the turn smaller.
WPT TOO CLOSE	16	The entered waypoint is too close to the current A/C position. The missile could miss the waypoint and target.	Move the waypoint further from the A/C or vice versa.
WPT TURN TOO LARGE	17	The turn from the waypoint to the target is too large. The missile may not turn sharp enough and miss the target.	Move the waypoint or launch point so that the missile turn is not as long.

Common Harpoon Alert Messages

The alert messages specific to the RBL mode are also displayed just below the priority alert message window and are shown in the table below.

Alert Mnemonic	Priority	Description And Impact	Corrective Action
RBL MODE UNAVAILABLE	8	The RBL Mode is not available due to INS, CADC, or Target data invalidity. The missile can only be launched in the LOS Mode.	Select the LOS Mode.
TGT TO WPT RANGE TOO SMALL	18	The waypoint is too close to the target. The missile may not have time to complete its turn at the waypoint and activate its seeker before passing the target.	Increase the range entered on the TGT-TOWPT DED page (Move the waypoint further away from the target).
OUT OF RANGE	20	The target is beyond the range of the missile given the current A/C parameters. The missile may not reach the target.	Fly closer before launching the missile or modify waypoint position to shorten missile flight path.

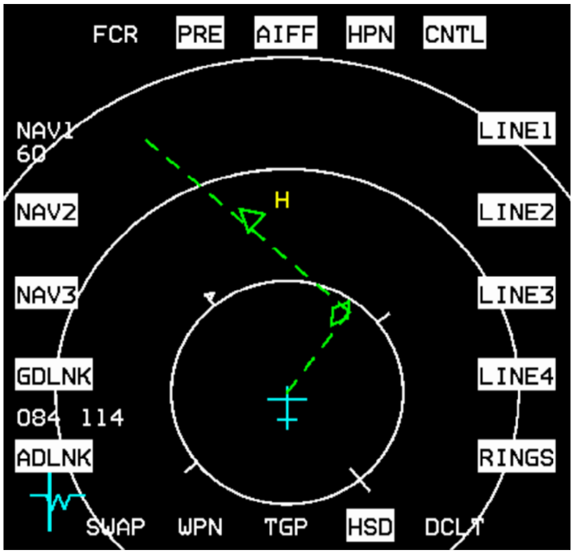
Alert Messages for RBL Mode

Launch Status Divider Line: The Launch Status Divider Line is displayed in the center of the WPN page while in RBL mode. The line is used by the pilot to differentiate between pre–launch and post–launch data. Pre–launch data is displayed below the line and when the launch occurs, the data moves above the line.

Pre And Post Launch Data: Harpoon RBL pre- and post-launch data including the target steerpoint, missile time of flight, and missile time on target are displayed in the center of the WPN page just above the applicable station numbers. The target location is the steerpoint number that the missile will be/has been launched against. The pre-launch data is displayed for the selected station only, while the post-launch data is displayed for all Harpoon loaded stations. The missile time of flight is the time the missile would take to reach the target if launched. The missile time on target is the time of day (system time) that the missile would reach the target. If no missiles have been launched, this data is displayed below the launch status divider line for the selected station only. Once a missile has been launched, the data for that station moves above the line, the station number is removed from the SMS and WPN pages, and the pre–launch data for the newly selected missile will be shown. Upon launch of the last Harpoon missile, the mnemonics adjacent OSB's 1–10 and 16–20 will be cleared. The post-launch timing data (time of flight and time on target) will be removed 5 seconds after the missile time of flight has reached zero.When the last Harpoon missile has been launched and all the times of flight have counted down to zero, the WPN OFF page will be displayed.

Harpoon Launch Mode: The selected Harpoon launch mode is displayed adjacent to OSB 1. Depressing OSB 1 brings up the Harpoon Launch Mode Menu page where the pilot can select one of the three launch modes. Depressing the OSB adjacent to the desired Harpoon launch mode (RBL, BOL, or LOS) will select that mode and return the display to the Harpoon Base page.

HSD Harpoon RBL Symbology: The HSD format supports situational awareness during Harpoon deliveries. On the HSD base and control pages, ownship Harpoon targets are depicted with a yellow letter “H”. The targets represent Harpoon targets in the steerpoint range 90 through 99. The pilot also has the option of displaying the missile fly-out line by selecting HPN on the HSD CNTL page. This figure also shows the Harpoon fly-out line with a waypoint. A diamond is displayed at the waypoint (if selected) and a triangle is displayed at the target. The end of the fly-out line indicates the maximum range of the missile. The Harpoon HSD display aids situational awareness by giving the pilot a visual indication of the waypoint location with respect to the target, aircraft location, and missile maximum range.

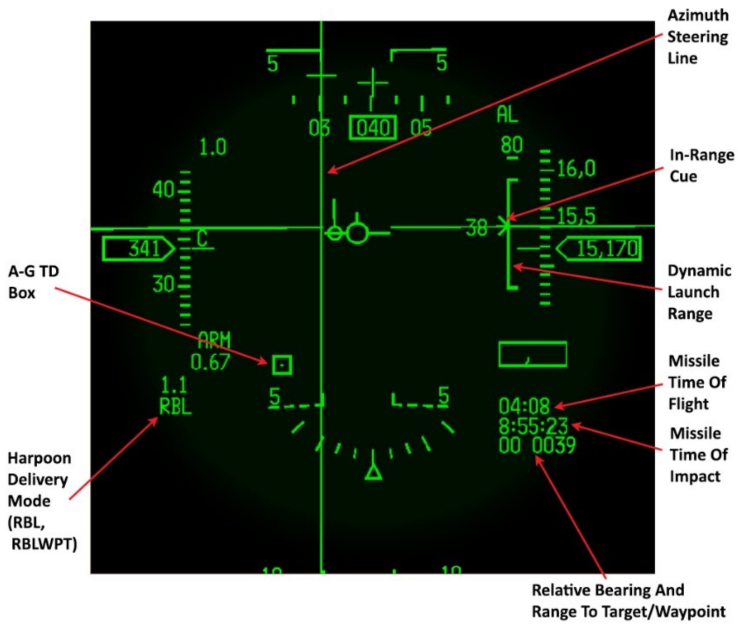


Harpoon Fly-out on HSD

HUD Harpoon RBL Symbology: On the right side of the HUD is a Harpoon dynamic launch zone (DLZ) scale (the DLZ is not displayed in the BOL or LOS modes). The Harpoon launch scale is displayed on the HUD when the missile range to target is 120% or less of the missile maximum range. The scale consists of minimum and maximum range indications. The in–range cue (>) is displayed adjacent to the launch scale. Displayed just left of the in–range cue is the current range to target in nautical miles. The range to target includes the missile flight through the waypoint. When the in–range cue is displayed between the minimum range and maximum range indications, the target is in range.

The bearing and range to the target, or to the waypoint if selected, is displayed in the bottom right corner of the HUD. Above the bearing and range is the estimated time of impact (based on system time). Above the time of impact is the missile time of flight.

The A–G TD Box is displayed on the target and when a waypoint has been selected, a diamond is displayed on the waypoint.



Harpoon RBL HUD Symbology

RBL Launch Sequence: The launch sequence begins with the selection of the Harpoon weapon type. The pilot selects the desired missile flight options and launch mode on the WPN page. Then find a target by entering the target coordinates, slewing the radar or target pod cursors over a target, or using the snowplow mode. Once the SPI is on the target, waypoint bearing and range can be used. In order to use a waypoint, the target number on the TGT-TO-WPT page must be the currently selected steerpoint and the page must be mode selected (like VRP). To prepare the missile for launch, missile power must be turned on from the SMS page and Master Arm must be in the ARM position. The missile can be powered on prior to target acquisition as well. The Harpoon has a maximum power on time of about 20 minutes to avoid overheating. Once missile power is applied, the missile gyros must come up to speed and the missile must be initialized (this takes about 10 seconds). “MISSILE NOT READY” is displayed until the missile is initialized.

To launch the missile, the pilot depresses and holds the weapon release switch. Missile launch should nominally take 1 to 2 seconds but could be as long as 6 seconds. The launch delay is to allow the missile battery squibs to fire and the battery to reach proper voltage. If the pilot does not hold the weapon release button down long enough to complete the release, the missile battery squib will fire but the MMC will inhibit missile release until the weapon release button is depressed again. When the weapon release button is not held long enough for the release to occur, HIAK will provide a “BATTERY ACTIVE” alert on the WPN page when the battery is up to voltage to let the pilot know that the battery squib was fired. If the battery fails to come up to voltage after 6 seconds, the missile will automatically abort and cannot be launched.

Once the release has occurred (i.e., the carts have fired), the flight path marker in the HUD will flash and the station number will be removed from the SMS and Weapon pages. Upon release of the weapon release button, the store quantity will count down, and the next Harpoon station will be selected.

RBL Weapon Delivery Procedure:

1. Verify/Enter A–G via ICP
2. Select SMS format on MFD
3. Select Harpoon missile
4. Power on selected Harpoon station from SMS page
5. Select one MFD format to WPN page and the other MFD as desired
6. Select Missile Options (i.e., search pattern size, search priority, fly-out altitude, terminal maneuver)

   Note - Missile option selections can be made prior to power-on of missile
7. MASTER ARM – ARM or SIMULATE
8. Select appropriate target location (steerpoint) via ICP/DED.
9. (Optional) RBL delivery with a waypoint

   a. Select TGT–TO–WPT page via Destination Direct Page or WPN format on MFD

   b. Verify/select TGT number the same as the currently selected steerpoint

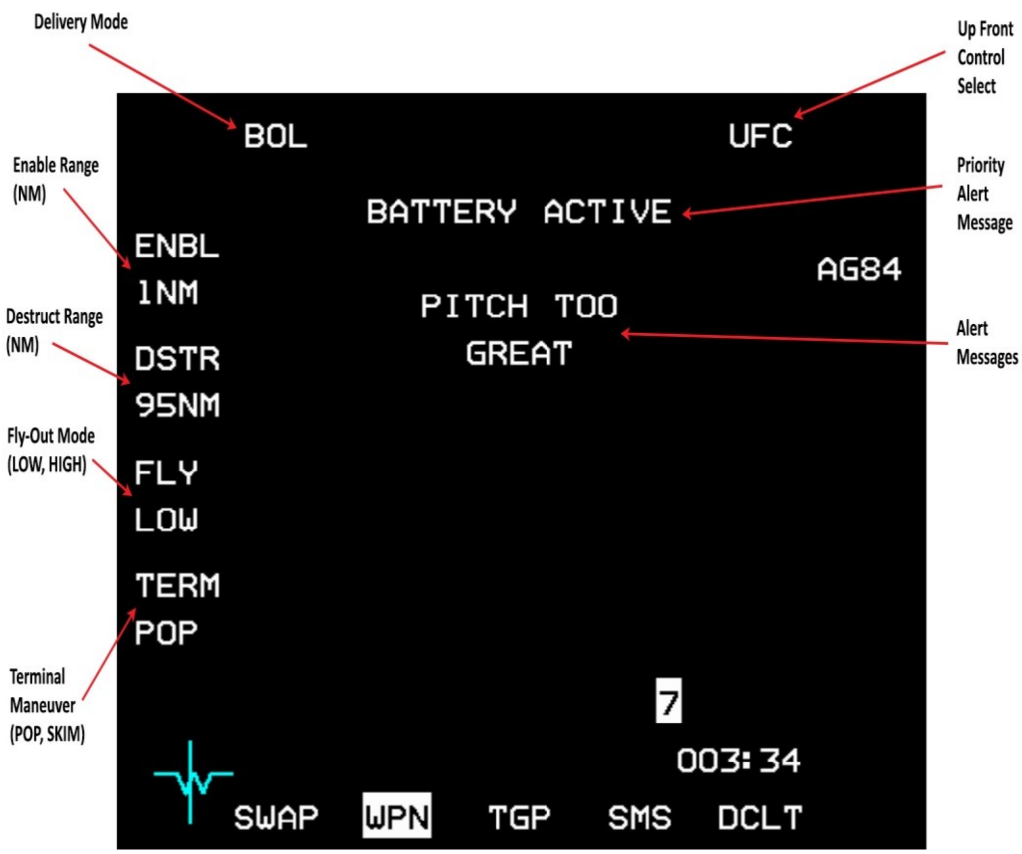
   c. Verify/enter bearing and range to waypoint

   d. Verify/mode select TGT–TO–WPT
10. Verify RBL HUD Symbology
11. Verify RBL HSD Symbology
12. Verify no Alerts on WPN page
13. Position aircraft such that in–range cue is between minimum and maximum ranges
14. Depress and hold weapon release. Verify flight path marker (FPM) flashes, target location number and missile timing data move above the line on the WPN page, and the station number is removed from the SMS and WPN pages. Hold weapon release until missile separation occurs or a missile abort alert is displayed. Nominally, launch takes 1 to 2 seconds, however, the worst case can be as long as 6 seconds.

4.2.6.1.4 BOL – BEARING ONLY LAUNCH MODE

The BOL mode is a slightly degraded mode that is used when actual target range is unknown but bearing to the target is known. In the BOL mode, the seeker turn-on time, search pattern parameters, and missile destruction time computations are performed by the HIAK and do not require target range data. When operating in the BOL mode, there are no search pattern options available. The BOL search pattern is used. The pilot has the option of defining the ranges at which the missile seeker turns on and the missile destructs. This mode is normally used in the event target range is denied or the BOL search pattern is desired. The BOL mode is used when there is not an exact location for the target, but the pilot has a bearing to a target's location. Without a waypoint, the missile flies at the boresight heading at launch. However, a waypoint may also be used, if included within the steerpoint range 90 to 99. The missile will fly to the waypoint and then take up a bearing toward the range-unknown target.

Weapon Base Page: The Harpoon Weapon Page in the BOL mode is very similar to the weapon page in the RBL mode. Differences include the removal of the launch status divider line, target location, and missile timing data. Also search area and priority are replaced with an enable and destruct range. Unique BOL features are discussed in the following sections.



Harpoon WPN Page with BOL Mode

Harpoon Enable Range: The Harpoon enable range (in nautical miles) is displayed adjacent to OSB 20. The enable range is used to tell the missile how far to go before "enabling" (turning on) its radar seeker. The enable range is measured from the launch point if a waypoint has not been selected, or from the waypoint if one has been selected. Depressing OSB 20 brings up the Harpoon Data Entry page. On the Harpoon Data Entry page, the pilot must enter two digits (i.e., 5 nautical miles must be entered as "05"). Once the second digit is entered, the display returns to the Harpoon weapon base page with the new enable range shown. Entry of "00" will return a value of "1." The default value for the enable range is 1 nautical mile.

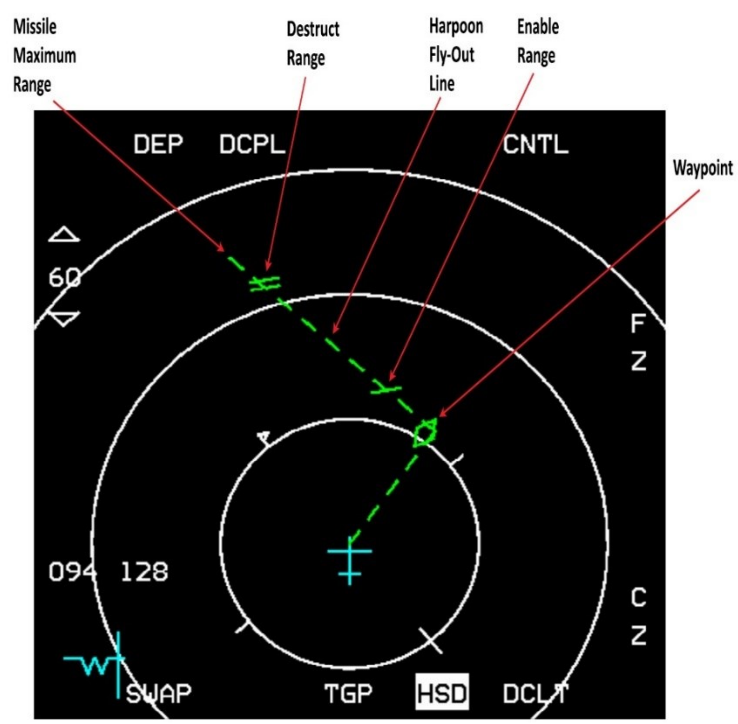
Note: If high fly-out is selected, the missile will only fly at the high fly-out altitude until it reaches the enable range, waypoint (if waypoint selected), or 10 miles, whichever is less.

Harpoon Destruct Range: The Harpoon destruct range (in nautical miles) is displayed adjacent to OSB 19. The destruct range is used to tell the missile how far to go without finding the target before self-destructing. The destruct range is measured from the launch point if a waypoint has not been selected, or from the waypoint if one has been selected. Depressing OSB 19 brings up the Harpoon Data Entry page. The Harpoon Data Entry page for entering the destruct range works the same as for entering the enable range. The default value for the destruct range is 95 miles with a maximum value of 99 nautical miles.

Alert Mnemonic	Priority	Description And Impact	Corrective Action
BOL MODE UNAVAILABLE	9	The BOL Mode is not available due to INS or CADC data invalidity. The missile can only be launched in the LOS Mode.	Select the LOS Mode.
ACTIVE RANGE TOO SMALL	19	The destruct range is too close to the enable range. The missile may not have sufficient time after enabling its seeker to locate the target before selfdestructing.	Increase the space between the enable and destruct range on the WPN page.
DSTR RANGE TOO SMALL	21	The destruct range is too small. The missile may not have time to enable its seeker and locate the target before self-destructing.	Increase the destruct range in the WPN page.

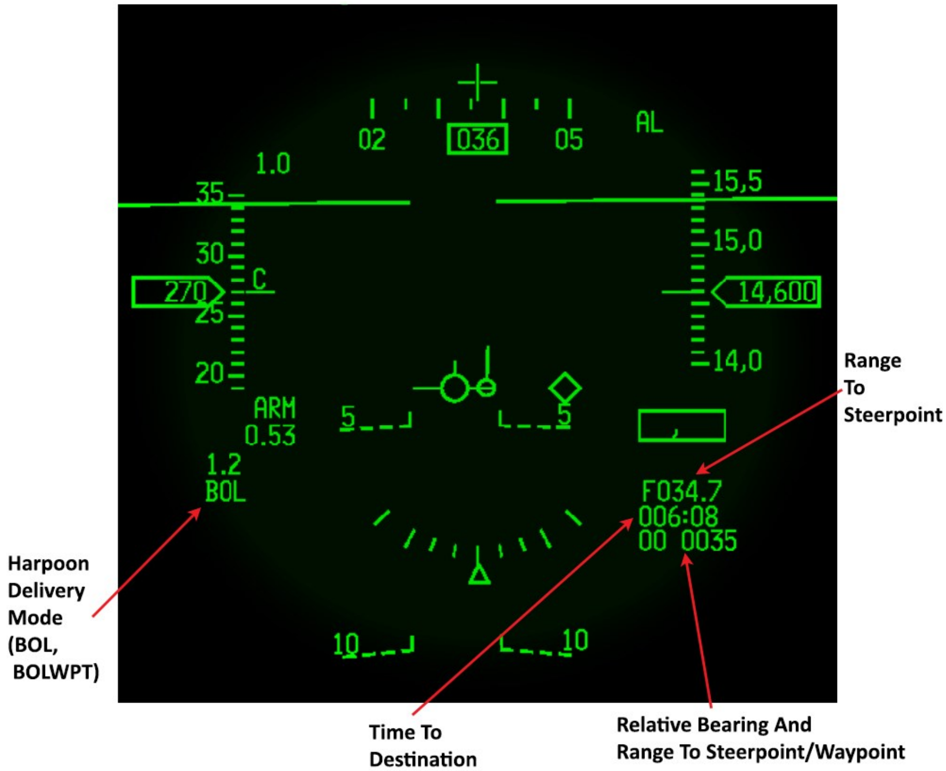
Alert Messages for BOL Mode

HSD Harpoon BOL Symbology: The HSD display in BOL is similar to the display in RBL. The biggest difference is that there is not a defined target point, so the triangle is not displayed. The BOL mode allows for the entry of an enable and destruct range and this information is displayed on the HSD.



Harpoon BOL Display on HSD

<u>HUD Harpoon BOL Symbology:</u> Because there is no known target position, the Harpoon launch scale, missile time of flight, missile time on target, azimuth steering line, and the A–G TD Box are not displayed in the BOL mode. The steerpoint diamond will be displayed on the selected steerpoint (which could also be the selected waypoint). The data displayed in the lower right corner of the HUD (i.e. time to destination and slant range) are the same as would be displayed in the NAV mode. In the very bottom right of the HUD, range and bearing to the selected waypoint will be displayed if a waypoint is selected; otherwise, the range and selected steerpoint number will be displayed.



Harpoon BOL HUD Symbology

<u>BOL Launch Sequence:</u> The actual launch sequence for the BOL mode is the same as for the RBL mode. The biggest difference between the two modes is in setting up the target. A missile in the BOL mode without a waypoint selected will be launched along the current aircraft heading (boresight). With a waypoint selected, the missile will fly to the selected waypoint prior to turning to the entered bearing.

BOL Weapon Delivery Procedure:

1. Verify/Enter A–G via ICP
2. Select SMS page on the MFD
3. Select Harpoon missile
4. Power on selected Harpoon station from SMS page
5. Select one MFD format to WPN page and the other MFD as desired
6. Select Missile Options (i.e., enable range, destruct range, fly-out altitude, terminal maneuver)

   Note - Missile option selections can be made prior to power-on of missile
7. MASTER ARM – ARM or SIMULATE
8. (Optional) BOL Delivery with a waypoint (N/I)

   a. Select WPT–TO–TGT page via Destination Direct Page or WPN page on MFD

   b. Verify/select WPT number the same as selected steerpoint

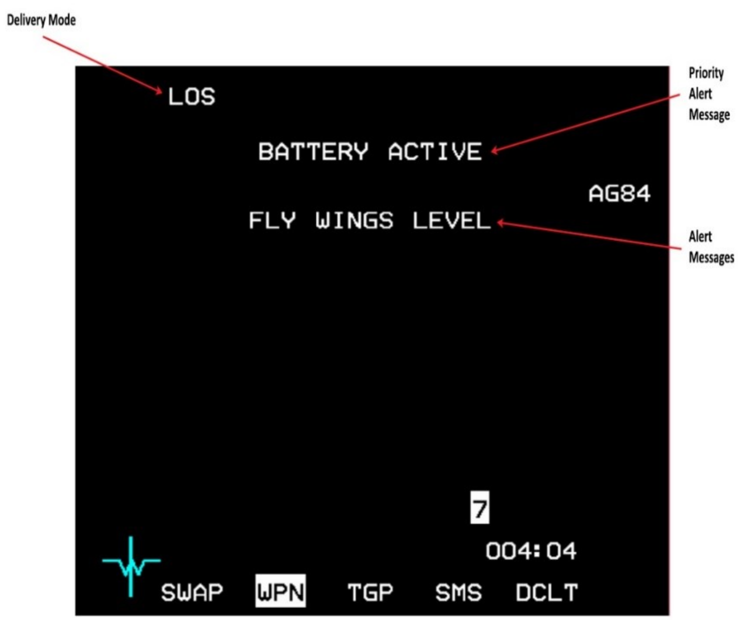
   c. Verify/Enter bearing to target

   d. Verify/Mode select WPT–TO–TGT
9. Verify BOL HUD Symbology
10. Verify BOL HSD Symbology (N/I)
11. Verify no Alerts on WPN format
12. Depress weapon release. Verify FPM flashes and that the station number is removed from the SMS page and the WPN page. Hold Weapon release until missile separation occurs or a missile abort alert is displayed. Nominally, launch takes 1 to 2 seconds however, the worst case can be as long as 6 seconds

4.2.6.1.5 LOS – LINE OF SIGHT LAUNCH MODE

The Line of Sight (LOS) mode is used in the event Harpoon related aircraft avionics malfunctions exist or there is no digital communications between the aircraft and missile. In the LOS mode, the missile's attitude reference is established in a self-level mode, and the bearing to target is established by pointing the aircraft at the target. In the self-level mode, it is necessary to establish straight and level flight toward the target, power up missile, and continue straight and level flight for at least 40 seconds prior to launch. Waypoints are not available for use in the LOS mode, nor is the Harpoon line displayed on the HSD. In the LOS mode, there is no designated target. The missile is launched boresight and shortly after launch activates its radar and looks for a target. The search pattern used in this mode is a preprogrammed BOL search pattern contained in the missile.

Weapon Base Page: In the LOS mode, all of the delivery options are removed. There is a special advisory displayed when in the LOS mode. When the LOS mode is selected and missile power is turned on a "FLY WINGS LEVEL XX SECONDS" advisory is displayed with the "XX" starting at 40 and counting down to 0 (if the digital communications has failed, the count down timer will not be displayed).

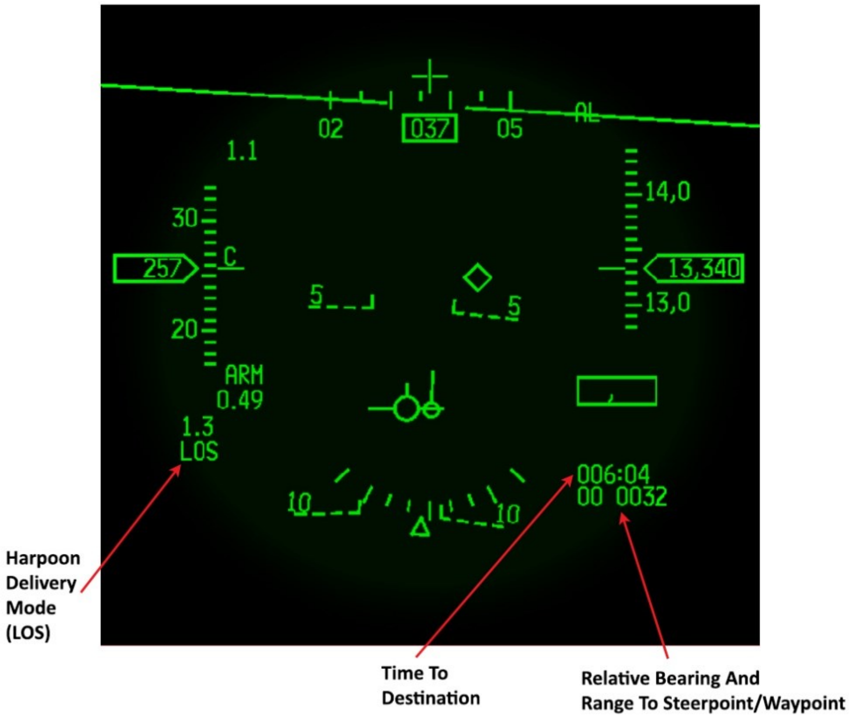


Harpoon WPN Page with LOS Mode

Alert Mnemonic	Priority	Description And Impact	Corrective Action
FLY WINGS LEVEL XX SECONDS	5	The LOS mode has been selected and less than 40 seconds have elapsed since the missile was powered on. The missile should not be launched until the timer reaches 0.	Wait until the timer counts down.
FLY WINGS LEVEL	5	The LOS mode has been selected and more than 40 seconds have elapsed since the missile was powered on.	None

Alert Messages For LOS Mode

HUD Harpoon LOS Symbology: The HUD symbology in LOS mode is just like the symbology in BOL mode without a waypoint selected.



LOS Launch Sequence: The launch sequence for the LOS mode is very simple. The pilot selects the LOS mode on the WPN format. If missile power was on prior to selecting the LOS mode, it will automatically be turned off when the LOS mode is selected. Once the pilot is flying straight and level towards the target, the missile power can be turned on. Once the timer has counted down, the advisory will be "FLY WINGS LEVEL." After continuing to fly straight and level towards the target for 40 seconds, the missile is ready to be launched. At this point, the sequence is just like the RBL and BOL modes. The missile launch is not inhibited prior to the 40 seconds time-out. However, until the timer has counted down, the missile may not fly correctly. The RDY status will be displayed almost instantly after powering up the missile even though the counter has not counted down.

LOS Weapon Delivery Procedure:

1. Verify/Enter A–G via ICP
2. Select SMS page on MFD
3. Select Harpoon missile
4. Select one MFD format to WPN page and the other MFD as desired
5. MASTER ARM – ARM or SIMULATE
6. Verify/Select LOS delivery mode on WPN page
   Note - Missile power for the selected station will be removed, if applied, upon selection of the LOS mode
7. Fly the aircraft straight and level on bearing toward the target
8. Power on selected Harpoon station
9. Continue to fly the aircraft straight and level on bearing toward the target until 40-second timer has counted down
10. Depress and hold weapon release. Verify FPM flashes and that the station number is removed from the SMS page and the WPN page. Nominally, launch takes 1 to 2 seconds; however, the worst case can be as long as 6 seconds.

4.2.7 GENERAL PURPOSE BOMBS

Bombs are commonly classified based on the ratio of explosive weight to total weight, leading to various categories such as General Purpose (GP), demolition, fragmentation, and penetration. In the case of GP Bombs, approximately 50 percent of the total weight is attributed to the explosive content. These bombs typically weigh between 250 to 2000 pounds and deliver significant blast and fragmentation effects. GP bombs are versatile and can be employed against a wide range of targets.

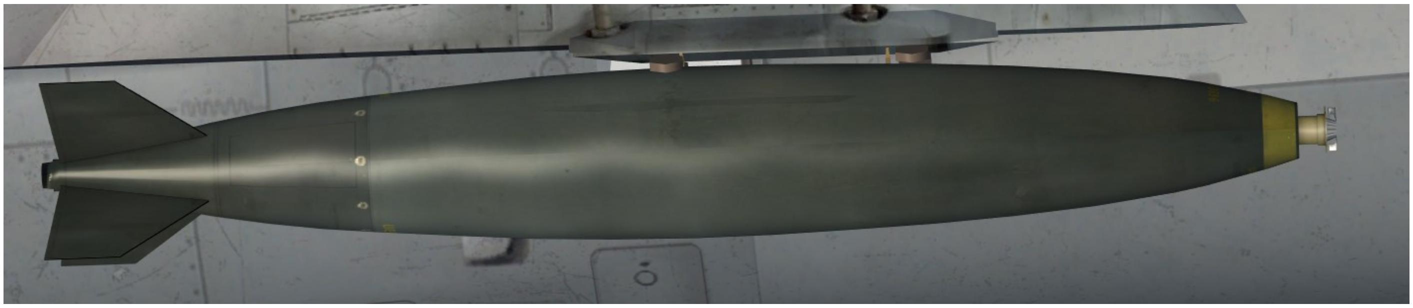
Due to their construction with a body case thickness of around half an inch, GP bombs generate a fragmentation effect upon detonation. Moreover, as the explosive filler constitutes roughly half of the total weight, significant damage can be expected from the blast effect at the target. Additionally, the use of delayed-action fuzes allows for a mining effect. By retaining the original nose closure plug and employing only a tail fuze, GP bombs can be transformed into semi-armor piercing bombs capable of penetrating medium and hard targets. The "GP" designation was given to these bombs to reflect their versatility. Examples of GP bombs include the MK-82 and MK-84 series.

All GP bombs share a cylindrical shape and are equipped with conical fins or retarders for effective external carriage at high speeds. They are designed to accommodate both nose and tail fuzes to ensure reliability and achieve the desired effects, such as blast, cratering, or fragmentation.

The bomb body encompasses the high explosive material, charging well, and suspension lugs. Additional components, including adapter boosters, fin assembly, arming wires, and fuzes, are incorporated to complete the munition.

4.2.7.1 MK-82 AND MK-84 LOW DRAG GENERAL PURPOSE BOMBS (LDGP)

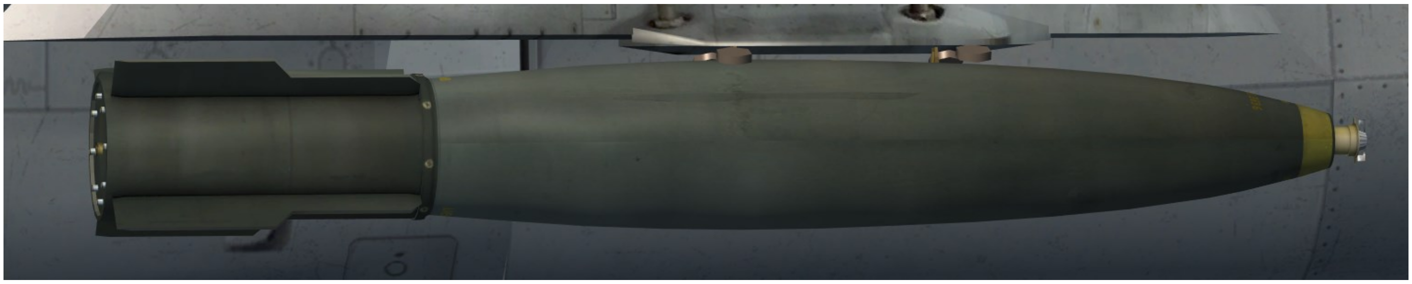
The low drag general purpose (LDGP) bombs, namely the MK-82 (500-pound class) and MK-84 (2000-pound class), share a similar design with differences limited to their size and weight. These bombs feature a sleek cylindrical body with a tapered aft section, to which a conical fin assembly is securely affixed.



MK-82 LDGP

4.2.7.2 MK-82 AIR INFLATABLE RETARDER (AIR) HDGP BOMB

The MK-82 AIR is a modified version of the MK-82 bomb from the 500-pound class. This modification involves attaching a BSU-49/B AIR tail assembly. The AIR variant enables high-speed and low-altitude delivery capabilities by incorporating bomb retardation. This effectively elongates the bomb's trail, minimizing the risk of the aircraft being struck by weapon fragments. Moreover, the increased impact angles help decrease the likelihood of bomb ricochets.



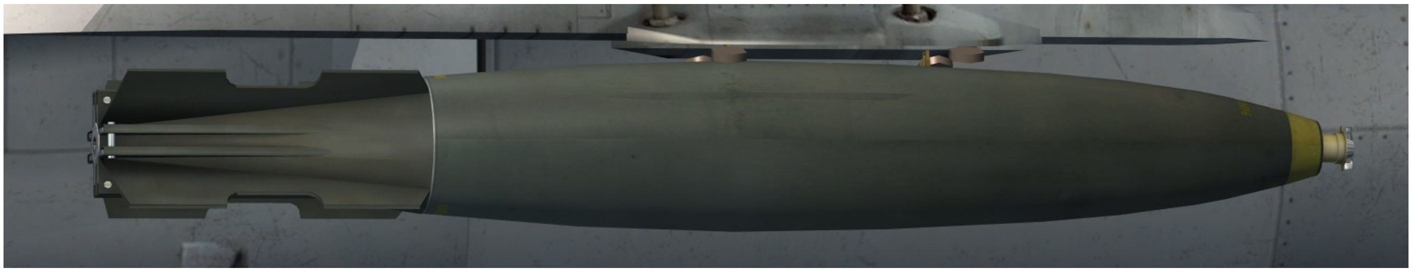
MK-82 AIR

4.2.7.3 MK-82 HIGH DRAG GENERAL PURPOSE (SNAKEYE 1) BOMB

The Snakeye 1, an MK-82 GP bomb from the 500-pound class, falls under the category of high drag general purpose (HDGP) bombs. This variant is achieved by equipping the MK-82 bomb with an MK 15 series retarding tail assembly. With this configuration, the bomb is capable of low-level releases and steeper impact angles.

The retarding tail assembly comprises four MK 15 retarding fins interconnected by a sliding collar, ensuring simultaneous opening of all four fins. In the LD (locked down) configuration, the retarder fins are held closed by a retaining band. This band is kept under a tension of approximately 40 pounds, thanks to leaf springs positioned beneath the fins.

Upon release from the aircraft, the fin release wire or lanyard is fully extracted from the weapon, freeing the retaining band. At that moment, the leaf springs forcefully deploy the retarder fins into the airflow. The aerodynamic forces complete the opening of the fins, extending them nearly perpendicular to the airstream. This extension maximizes drag and stability during the bomb's descent.



MK-82 SNAKEEYE

MK-82 SNAKEYE WITH FINS DEPLOYED

4.2.7.4 MK-84 AIR INFLATABLE RETARDER (AIR) HDGP BOMB

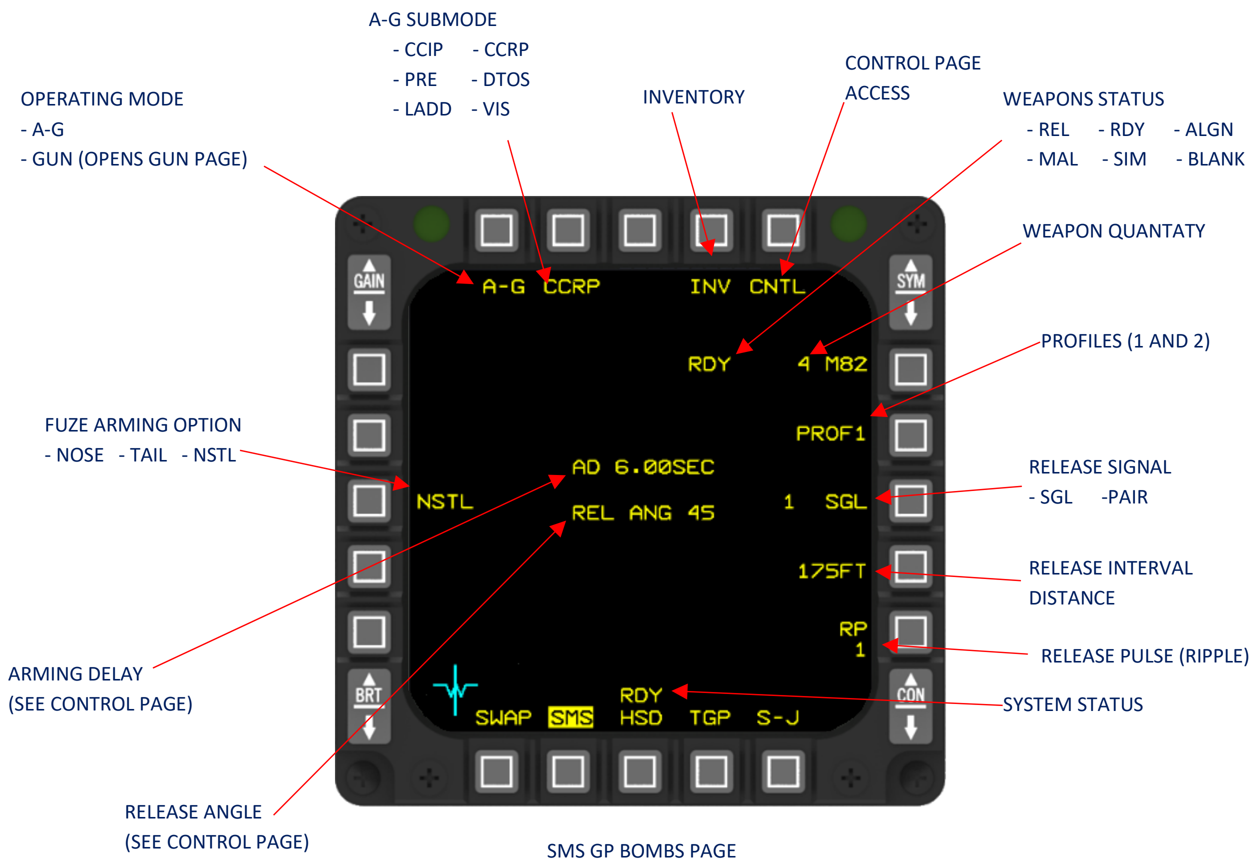
The MK-84 AIR, belonging to the 2000-pound class, is a modified version of the MK-84 bomb achieved by attaching a BSU-50/B AIR tail assembly. Similar to the BSU-49/B AIR assembly, the BSU-50/B assembly comprises an LD stabilizer canister unit, a ballute, and the retarder release lanyard assembly.

The operation of the BSU-50/B is nearly identical to that of the BSU-49/B, except for the absence of the positive high drag arming feature. The specific release configuration is determined by the routing of the arming wire or lanyard, which may be selectable from the cockpit.

MK-84 AIR

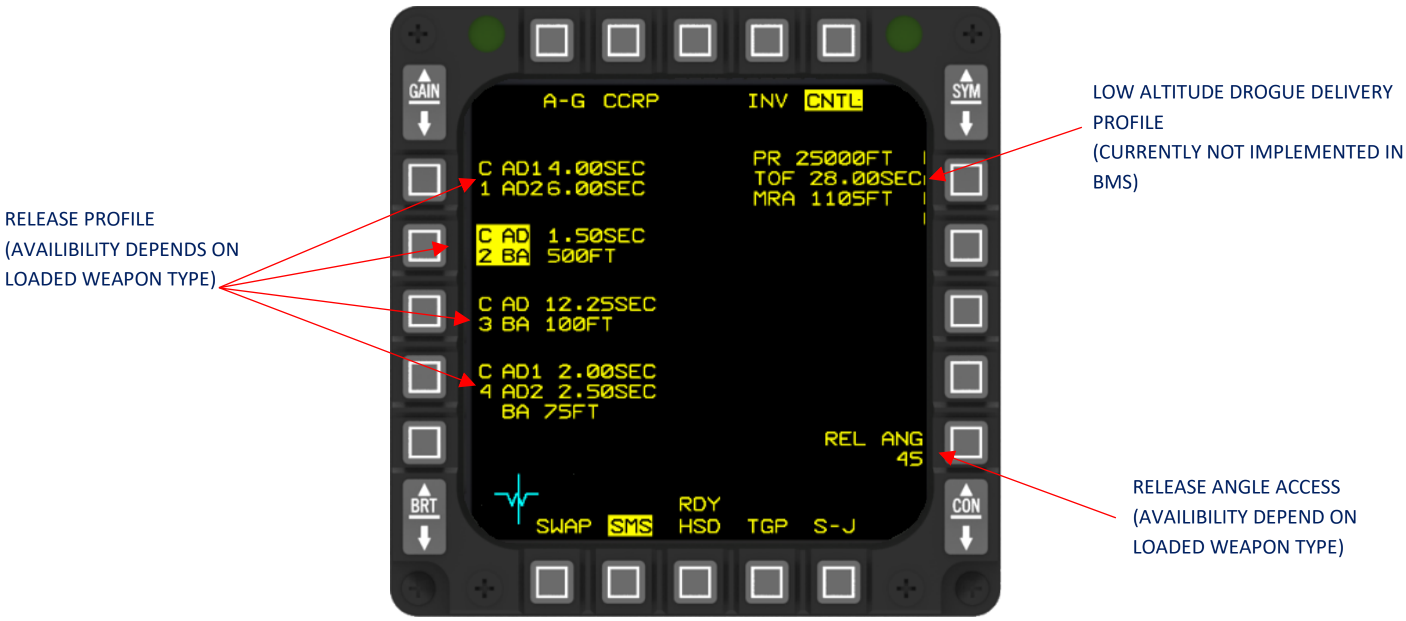
4.2.7.5 GP BOMBS SMS PAGE

The air-to-ground pages serve as a control and display interface for air-to-ground weapon delivery and gunnery operations. All modes related to air-to-ground functions can be accessed through the A-G page. To access the GUN page, simply press OSB 1 located next to the A-G mnemonic.



SMS GP BOMBS PAGE

4.2.7.6 GP BOMBS CNRL PAGE



SMS FORMAT AIR-TO-GROUND CONTROL PAGE

4.2.7.6.1 OPERATING MODE (OSB 1)

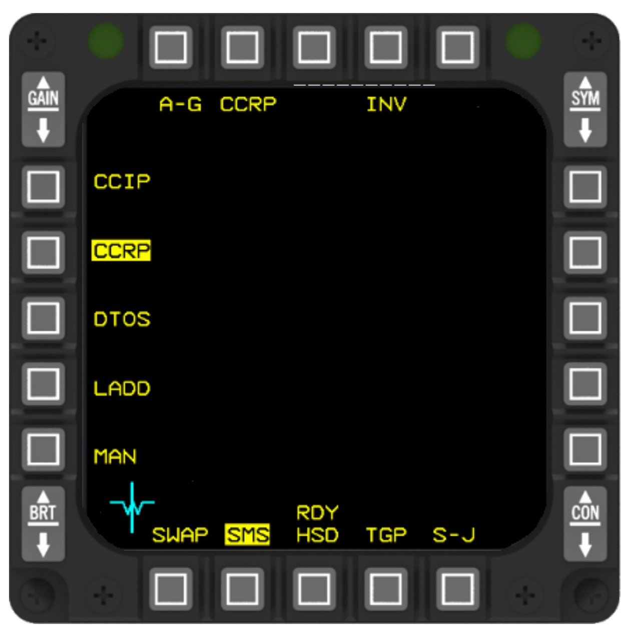
Allows selection of Air-to-Ground page and Gun page. When GUN is selected, the gun page is displayed.

4.2.7.6.2 AIR-TO-GROUND SUBMODE (OSB 2)

When the A-G page is active, pressing OSB 2 located next to the current submode will bring up the menu page that offers various submodes. These submodes include:

- CCIP: Continuously computed impact point.
- CCRP: Continuously computed release point.
- DTOS: Dive toss.
- LADD: Low altitude drogue delivery.
- MAN: Manual.

By selecting one of these submodes from the menu page, you can configure the specific mode for air-to-ground operations.



SMS A-G SUBMODES

4.2.7.6.3 INVENTORY PAGE ACCESS (OSB 4)

D&R accesses the SMS inventory page.

4.2.7.6.4 CONTROL PAGE ACCESS (OSB 5)

D&R accesses the air-to-ground control page.

4.2.7.6.5 WEAPON TYPE AND WEAPON SYSTEM STATUS (OSB 6)

The status of the weapon type and weapon system can be accessed through OSB 6. On the A-G page, the remaining number of selected weapons is shown alongside the corresponding weapon mnemonic. To the left of the weapon mnemonic, the weapon status mnemonic is displayed in descending order of priority, indicating the following:

- REL (release): A release signal has been issued to the weapon.
- RDY (ready): The weapon is armed and prepared for release.
- MAL (malfunction): A malfunction prevents the release of the weapon.
- SIM (simulate): The weapon is unarmed, but release indications are simulated (no actual weapon release occurs).
- Blank: Arming symbology is absent on the HUD, and release indications are not provided.

4.2.7.6.6 PROFILES (OSB 7)

To streamline weapon delivery configuration, profiles are utilized to assign specific setups to each weapon. Two sets of profiles, PROF1 and PROF2, can be accessed via OSB selection at OSB's 7 to 10 and 18. OSB 7 serves as a toggle between PROF1 and PROF2, allowing for the use of a common delivery setup without the need to re-specify each weapon's delivery parameters throughout a mission. The following common profile parameters are employed:

- CCIP, CCRP, DTOS, LADD, ULFT, MAN: Delivery Modes (excluding GBU-24).
- NOSE, TAIL, NSTL: Fuze Arming Options.
- SGL, PAIR: Release Options (excluding GBU-12B, which is limited to single release only).
- FT: Impact Separation in Feet. This value represents the desired distance between impact points for automatic delivery modes (a positive integer ranging from 0 to 999 feet), except for GBU-24 and GBU-12B, as GBU-12B is always restricted to single release.
- RP: Release Pulses Requested (excluding GBU-12B, which is always set to 1).

Additionally, the Release Signal can be accessed via OSB 8.

4.2.7.6.7 RELEASE SIGNAL (OSB 8)

To the left of the SGL or PAIR mnemonic next to OSB 8, the count of release signals sent to the weapon is displayed. Here's what each mnemonic represents:

- SGL: One store is released per station for each requested release signal.
- PAIR: Stores are symmetrically released in pairs, two at a time.

4.2.7.6.8 IMPACT SPACING/RELEASE INTERVAL (OSB 9)

The release interval indicates the time gap between successive weapon releases during a ripple sequence (for release pulses greater than 1), as shown in the table below. The release interval is measured in seconds and ranges from 0.000 to 9.999 seconds, except in manual mode where the range is defined as 0 to 4 seconds. This value is displayed using the SEC mnemonic.

The impact spacing distance, representing the desired distance between impacts for conventional weapons, is displayed with the FT mnemonic. It ranges from 0 to 999 feet. To enter or modify the impact spacing distance, simply press OSB 9 located next to the FT mnemonic, which will take you to the data entry page.

TYPE OF RACK	MINIMUM RELEASE INTERVAL (MS)
MAU-12	60 (0,06sec)
TER-9/A	60 (0,06sec)
SUU-20	200 (0,2sec)

4.2.7.6.9 RELEASE PULSE (OSB 10)

Below the RP mnemonic, adjacent to OSB 10, the number of requested release signals is displayed. To access the data entry page and make changes to the number of release signals, simply press the OSB located next to the RP mnemonic.

4.2.7.6.10 ARMING DELAYS (AD) AND BURST ALTITUDES (BA) (OSB 17)

Pressing OSB 17 will bring up the AD/BA data entry page specifically designed for conventional weapons. The fuze arming data includes arming delays (AD) and burst altitudes (BA), which are associated with different fuze categories. These arming data entries provide visual cues on the HUD for weapon release.

Here are the fuze categories and their corresponding requirements:

- C1: This category includes impact fuze weapons that only require an arming delay (AD1 or AD2). When a category 1 weapon is selected and the fuzing option is set to TAIL or NSTL, AD2 is used. Otherwise, AD1 is used. The arming delay displayed on the A-G WPN page reflects the current arming delay used by the system.

- C2: Category 2 comprises altitude fuze weapons that necessitate both an arming delay and a burst altitude.

- C3: Category 3 consists of time fuze weapons that require an arming delay and a burst altitude.

- C4: Category 4 encompasses rockeye weapons that demand two arming delays and a burst altitude.

4.2.7.6.10.1 GENERIC WEAPON ARMING DELAY

In order to facilitate the swift integration of new weapons during wartime operations, the F-16 provides a convenient method for programming a new weapon. Instead of going through the time-consuming process of creating a new MMC OFP (Onboard Flight Program), the new weapon name and its parameters can be quickly added to the DTC (Data Transfer Cartridge).

It's worth noting that the MFD (Multi-Function Display) Data Entry Page restricts key entry and data fields for arming delay (AD) when a Category 2/3 (proximity) Generic Weapon is selected and NSTL is chosen as the fuzing option. In this scenario, the Mission Planning System (MPS) automatically sets the arming delay value to 6.00 seconds for the Generic weapon when the pilot selects NSTL as the fuzing option.

4.2.7.6.11 FUZE ARMING OPTION (OSB 18)

When selecting a MK-82SE, MK-82LDGB, BSU-49, BSU-50, or BSU-50B with NOSE chosen as the fuzing option, the display adjacent to OSB 18 will show "LO DRAG" along with "NOSE." If any of the mentioned weapons are selected with NSTL or TAIL as the fuzing option, "HI DRAG" will also be displayed.

Here are the fuzing options and their corresponding indications:

- NOSE: Only the nose lanyard is pulled.
- TAIL: Only the tail lanyard is pulled.
- NSTL: Both the nose and tail lanyards are pulled.
- MAL: This indication is displayed if a fuzing failure occurs.

4.2.7.7 LETHALITY EFFECTS

Since BMS 4.37 U3, lethality effects o based on frag trajectory of A-G ordnance is implemented. Fragmentation is a critical aspect of the lethality effects of explosive weapons such as the MK-82 and MK-84 bombs. When these bombs detonate, their casings and surrounding debris are transformed into lethal projectiles known as fragments, which can cause severe damage and casualties over a wide area (including aircraft). Understanding the maximum fragment envelope of these bombs is crucial for assessing their destructive potential.

The MK-82 bomb, weighing 500 pounds, contains a high-explosive filler that produces a substantial blast wave upon detonation. The fragmentation generated by the bomb's casing and other materials is propelled outward by the explosive force, creating a lethal hailstorm of fragments. The maximum fragment envelope of the MK-82 bomb extends to a significant distance from the point of detonation, potentially causing injuries or fatalities to personnel and damage to structures within this range.

LETHALTY EFFECT IN FALCON BMS (Mk-84)

Similarly, the MK-84 bomb, weighing 2,000 pounds, possesses a higher explosive yield compared to the MK-82. As a result, the fragmentation produced by the MK-84 bomb is even more extensive and destructive. The bomb's casing, along with the surrounding materials, is transformed into a large number of lethal fragments, which are propelled outward with tremendous force. The maximum fragment envelope of the MK-84 bomb extends over a substantial radius, inflicting severe damage to infrastructure, vehicles, and personnel within this zone.

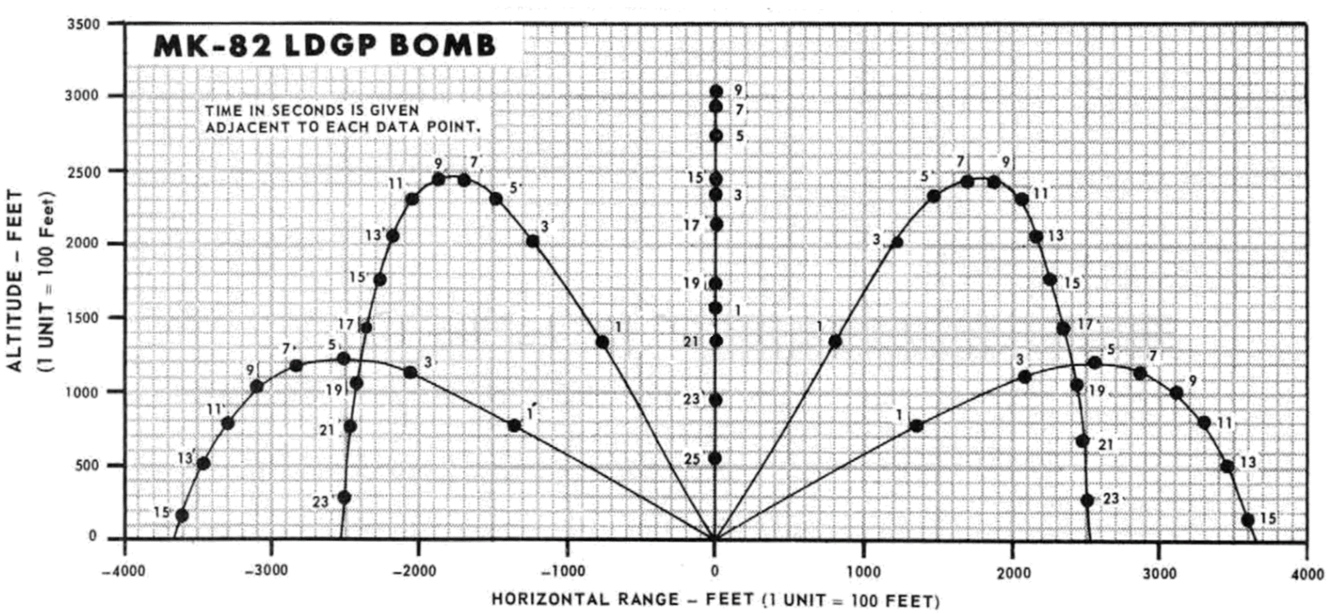
The shape and size of the fragments are determined by the bomb's construction and materials. The casing and other components are designed to fragment into various sizes, ranging from small shrapnel to larger, potentially more lethal fragments. The fragments can have irregular shapes and sharp edges, increasing their ability to penetrate armor, vehicles, and protective structures.

It is important to note that the maximum fragment envelope of the MK-82 and MK-84 bombs is influenced by factors such as the height of burst, angle of impact, and terrain characteristics. These variables can impact the dispersion pattern and distribution of fragments, affecting the overall lethality of the bombs in different scenarios.

4.2.7.7.1 MK-82 LETHALITY EFFECTS

FRAGMENTATION		CRATERING	
Grains	3 to 760m (2500ft)	Diameter	4.6 m to 10.7 m
Velocity	760 m/s to 2440 m/s	Depth	0.76 m to 4.27 m
BLAST		**PENETRATION**	
Pressure at 50 ft (16 m)	17 psi	Steel Armor Plate	32 mm
Pressure at 100 ft (31 m)	5 psi	Concrete 3000 psi (beton)	518 mm

LETHALTY EFFECT Mk-82

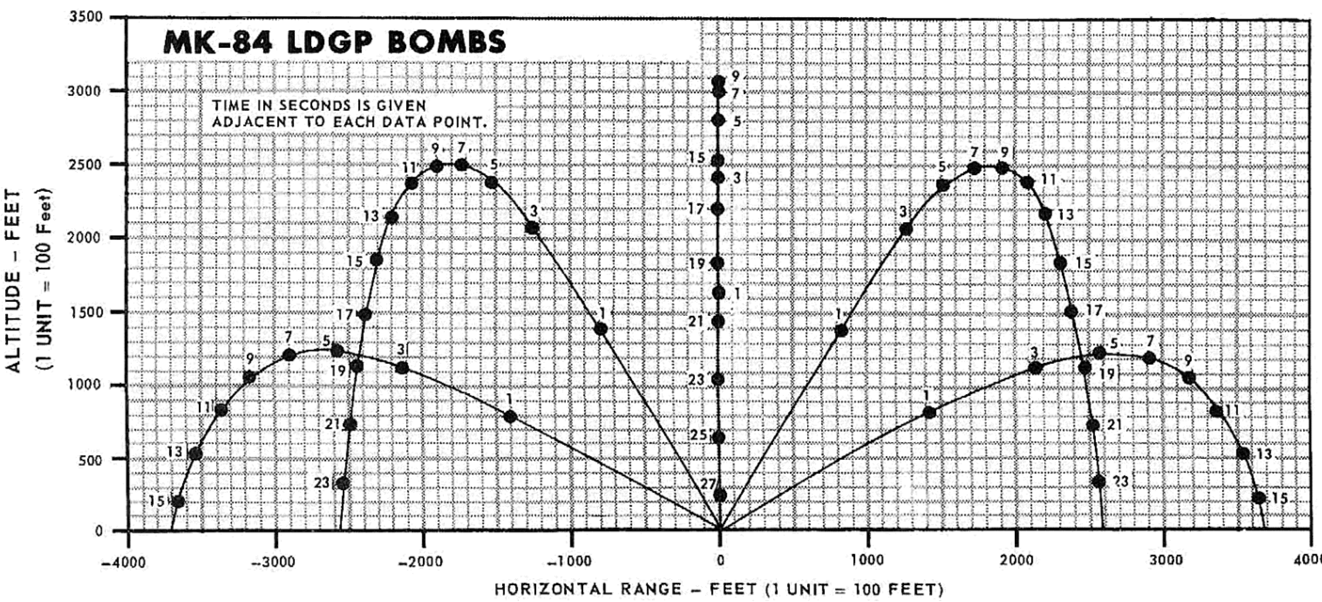


MAXIMUM FRAGMENT ENVELOPE Mk-82

4.2.7.7.2 MK-84 LETHALITY EFFECTS

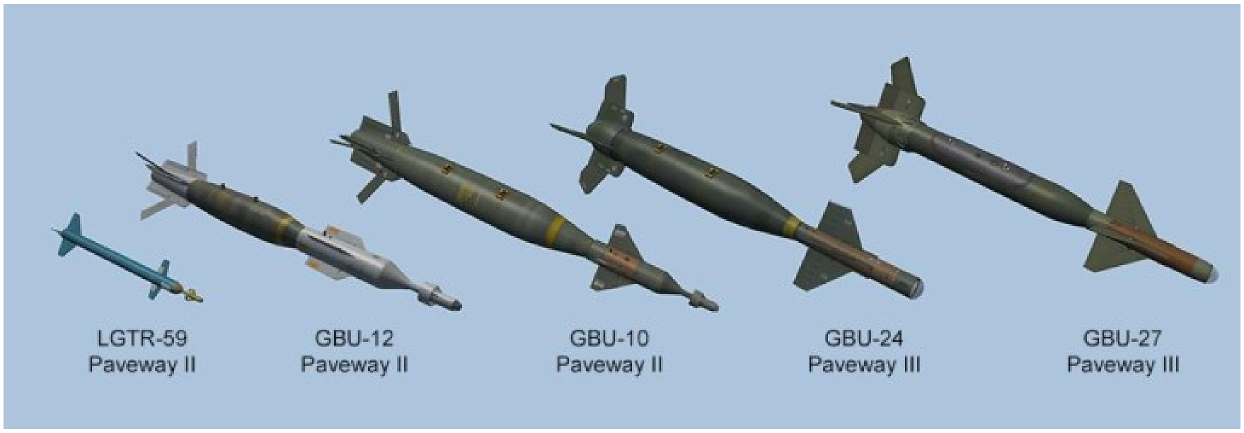
FRAGMENTATION		**CRATERING**	
Grains	4 to 3000	Diameter	7.6 m to 18.3 m
Velocity	610 m/s to 2745 m/s	Depth	1.22 m to 8.84 m
BLAST		**PENETRATION**	
Pressure at 50 ft (16 m)	35 psi	Steel Armor Plate	51 mm
Pressure at 100 ft (31 m)	11.5 psi	Concrete 3000 psi (beton)	884 mm

LETHALTY EFFECT Mk-84



MAXIMUM FRAGMENT ENVELOPE Mk-84

4.2.8 LASER GUIDED BOMB TYPE WEAPONS



Griffin II

A Laser Guided Bomb (LGB) is a manoeuvrable free-fall weapon, attached with a laser guidance kit, which guides to a spot of laser energy reflected off the target. The LGB is delivered like a normal GP bomb, and the laser guidance kit will correct the trajectory errors in order to hit the laser illuminated target.

Since the weapon is tracking a light signature and not the object itself, the target must be illuminated from a separate source. In BMS we have two generations of LGB’s: Paveway II (LGTR-59, GBU-10, GBU-12, Griffin II) and III (GBU-24, GBU-27, LGTR-60). (LGTR-60 is actually a Paveway II but with a better flight profile and should be used to train delivery of Paveway III)

GBU 10 Paveway II

GBU-24 Paveway III

GBU-12 Paveway II

GBU-27 Paveway III

The main difference between the two generations of weapons is the type of control. The newer Paveway III has implemented a proportional control in place of the older "bang-bang" control of the Paveway II (either full deflection of the control fins, or none).

This gives the Paveway III a more efficient flight path, and with the enhancement of the seeker field of view and larger fins, the range of the weapon was increased. In BMS the only difference between the two is the range, for now.

But as a good practice you should start to use the lasing time the correct way:

- Paveway II: lasing should start 12 sec before impact (to minimize the movements of the "bang-bang" control, and consequently the bomb falling short or long)
- Paveway III: 20 sec or more, in BMS it is advised to start lasing manually as soon as the bomb is released

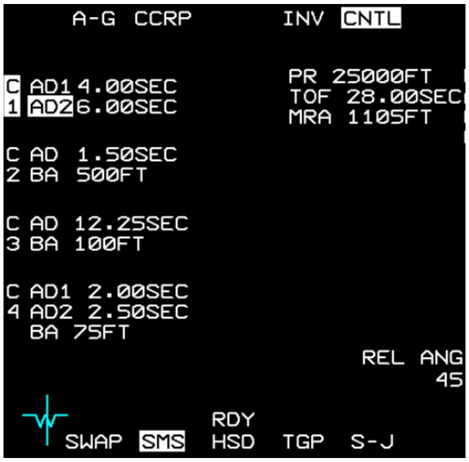
4.2.8.1.1 LGB SMS PAGE

The LGB SMS page is the same as any general purpose bomb.

4.2.8.1.2 LGB CNTL PAGE

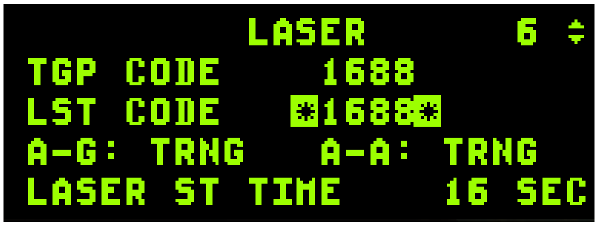
The LGB Control page (accessed by OSB #5 of the SMS page) is the same as any general purpose bomb.

For LGB, C1 should be used and set accordingly as there is no need for Burst parameters. The LADD settings in regard to OSB #6 are not implemented in BMS. The RELease ANGle is the desired pull up angle for LOFT attack but this is still buggy in BMS.



4.2.8.1.3 LASER UFC PAGE

Refer to the chapter LASER DESIGNATOR/RANGER for a complete explanation of the LASER UFC page.



In order for a LGB to guide on a laser beam, their codes must match.

A LGB is set on the ground with a specific laser code, usually by the weapon crew and cross checked by the pilot during it's pre-flight. This is done in BMS at the UI arming screen before flight.

As a pilot you will pre-flight your loaded weapons and you will cross check the bomb code. If you need to change it, you may input another code and confirm the change by pushing the button SET CODE.

Please note, the bomb code cannot be changed after take-off.

The laser illuminating the target must be set to the same LGB code.

This is set in the TGP code of the LASER UFC page.

- If you lase your own bombs with your TGP pod, set your UFC page to reflect your bomb code.
- If you need to lase your wingman's bombs (buddy lasing) you must set the code of your wingman's bombs on your UFC page.

For specific operations and procedures for releasing laser guided bombs, refer to the TGP, UFC, HUD and MFDS chapters in this manual and training manual for Paveway II release procedure training (Training mission #11)

4.2.8.2 LGMS – LASER GUIDED MISSILES

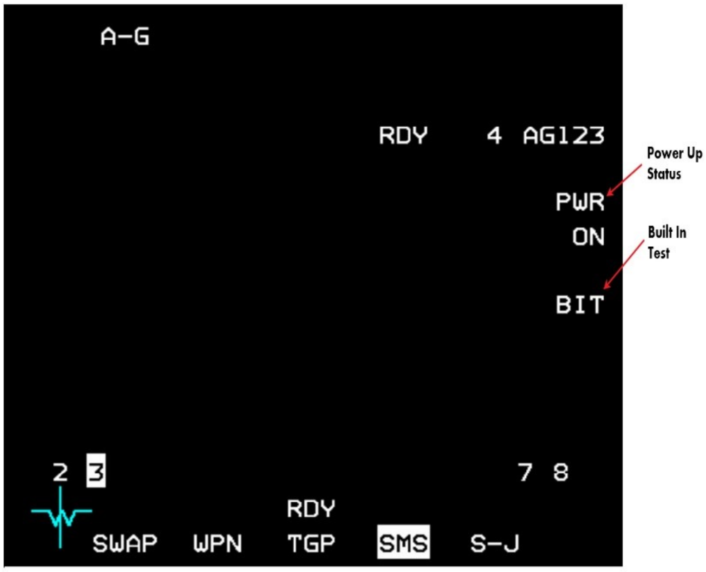
Laser Guided Missiles are missiles that guide on laser energy. An example is the AGM-123 Skipper II.

AGM-123 Skipper II is a short-range laser-guided missile developed by the United States Navy. The Skipper was intended as an anti-ship weapon, capable of disabling the largest vessels with a 1,000-lb (450-kg) impact-fused warhead.

It is composed of a Mark 83 bomb fitted with a Paveway II guidance kit and two Mk 78 solid propellant rockets that fire upon launch. The rockets allow the munition to be dropped further away from the target than free-fall bombs, which helps protect the delivery aircraft from surface-to-air-missiles and anti-aircraft artillery near the target.

AGM-123 Skipper II

4.2.8.2.1 LGM SMS PAGE



LGM SMS page

LGM SMS page contains:

- Power up status – ON/OFF states
- BIT

Power: Once power is applied via OSB 7, all LGMs on all stations will be powered up. Weapons will be ready after a short BIT of a few seconds.

BIT: Built-In test on demand can be applied by pressing OSB 8. The BIT mnemonic will highlight for a few seconds during the BIT. During BIT the missiles cannot be launched.

4.2.8.2.2 LGM RELEASE PROCEDURE

1. Power up the missiles via the SMS page.
2. Fly towards the target until the weapon is in range (DLZ).
3. Make sure there is a stable laser spot on the target (using self or Buddy lasing).
4. Pickle to release the missile.
5. In case of self lasing keep the TGP pointed at the target and keep firing the laser until the missile hits.

4.2.9 INERTIALLY AIDED MUNITIONS (IAM)

This section describes the mechanization functions of the Joint Direct Attack Munition (JDAM), Joint Standoff Weapon (JSOW), Wind-Corrected Munitions Dispenser (WCMD), Small Diameter Bomb (SDB) and Long Range Air-to-Ground Precise Strike Weapon (RAMPAGE) ordnance. Functions include MFDS and HUD control and display features, weapon power-up, initialization, built in test, station and weapon status, weapon type and station selection and weapon targeting. Unique mechanization differences among the weapons are addressed as they arise in the descriptions. Inertially-aided munitions (IAMs) are air-to-ground weapons that include an Inertial Navigation System (INS), or a combination of INS and Global Positioning System (GPS) to precisely guide the weapons to their targets. Each of these weapons provides improved standoff capabilities and relaxed release envelopes. IAMs may be loaded on stations 3 and 7 only. These are the only stations which support the wiring required for the data transfer between the aircraft and weapon.

4.2.9.1 GBU-31 AND GBU-38 JDAM

JDAM weapons are guided by an INS/GPS set contained within the weapon and are designated as Guided Bomb Units (GBUs). The current inventory of JDAM weapons includes the GBU-31(v)1/B, GBU-31(v)3/B (with Penetrator capabilities) and GBU-38/B based on the Mk-84, BLU-109, Mk-83 and Mk-82 bombs, respectively.

GBU-31(v)1/B JDAM

GBU-31(v)3/B JDAM

GBU-38(v)/B JDAM

4.2.9.2 AGM-154 JSOW

JSOW is an unpowered, glide weapon that has deployable wings and is guided by a self-contained INS/GPS set. JSOW comes in two variants, the AGM-154A and the AGM-154C and may be launched from standoff ranges beyond 20 NM at low or high altitudes in day or at night in all weather conditions. The warhead of the AGM-154A consists of 145 BLU-97/B Combined Effects Bomb (CEB) submunitions. These bomblets have a shaped charge for armour defeating capability, a fragmenting case for material destruction and a zirconium ring for incendiary effects. It is most effective against non-moving targets. The AGM-154C uses a penetration warhead and is most efficient against hard targets like runways, bunkers and hardened aircraft shelters. JSOWs can attack pre-planned targets downloaded from the DTE (includes associated waypoints to the target), targets tracked by onboard aircraft sensors, targets provided by datalink, or targets entered by the pilot on the UFC. The JSOW weapon does not require the aircraft to fly directly at the target, but allows release within a launch envelope. JSOWs can be loaded onto the F-15E, F-16 and F-18.

AGM-154A JSOW

4.2.9.3 AGM-158 JASSM

The AGM-158 Joint Air-to-Surface Standoff Missile (JASSM) is a cruise missile designed for long-range precision strikes. It is stealthy, able to avoid enemy air defenses, and operates autonomously once launched. With a range of over 70 nautical miles (93 kilometers) in BMS, the JASSM carries a 1,000-pound (450-kilogram) warhead. Overall, the AGM-158 JASSM provides a safe and accurate standoff capability, contributing to effective long-range precision strikes against high-value targets.

AGM-158 JASSM

4.2.9.4 GBU-39 SDB

SDB is an unpowered, glide weapon that has deployable wings and is guided by a self-contained INS/GPS set. Small diameter bombs may be launched from standoff ranges beyond 30 NM at low or high altitudes in day or at night in all weather conditions. The GBU-39 is most effective against non-moving targets. The GBU-39 uses a high explosive warhead and is most efficient against soft-skinned targets like air defence vehicles, artillery pieces, radars and communications towers, fuel tanks, etc. SDBs can attack pre-planned targets downloaded from the DTC, targets tracked by onboard aircraft sensors, targets provided by datalink, or targets entered by the pilot on the UFC.

The SDB weapon does not require the aircraft to fly directly towards the target, but allows release within a launch envelope. SDBs can be loaded onto the A-10C, F-15E and the F-16.

GBU-39 SDB

4.2.9.5 RAMPAGE

RAMPAGE is a long-range, air-to-ground, seeker-less precision strike weapon and is guided by a self-contained INS/GPS set. RAMPAGE may be launched from standoff ranges beyond 40 NM at low or high altitudes in day or at night in all weather conditions. The Rampage is most effective against non-moving targets. The Rampage uses a high explosive warhead and is most efficient against soft-skinned targets like air defence vehicles, artillery pieces, radars and communications towers, fuel tanks, etc. Rampages can attack pre-planned targets downloaded from the DTE, targets tracked by on board aircraft sensors, targets provided by datalink, or targets entered by the pilot on the UFC. The Rampage weapon does not require the aircraft to fly directly towards the target, but allows release within a launch envelop. Rampages are available for all eSUFA (IAF) versions.

RAMPAGE

4.2.9.6 SPICE BOMB

Spice Bomb

The SPICE (**S**mart, **P**recise **I**mpact, **C**ost **E**ffective) is an advanced EO/GPS guidance kit that was developed by the Israeli company Rafael Advanced Defense Systems. The SPICE can be fed pre-flight via UI Recon/DTC (see training mission 16 in the BMS Training Manual) with the coordinates of ~100 targets which then can be selected in flight and targeted. It does not have the capability of other IAMs to attack targets of opportunity. The SPICE has a relatively long range thanks to twelve advanced control surfaces. SPICE -1000 variants also have deployable wings similar to JSOW and SDB that help to extend the range even further.

4.2.9.6.1 TARGETING INFORMATION SPICE

In order to simulate the pre-planned targets feed for the SPICE bombs, a new set of 100 special "weapon target" STPTs information was added to the UI and to the missions/callsign.ini files. In the UI, WPN TGTs can be assigned for the SPICE bomb in the same way as precision TRG STPTs for other weapons.

Weapon target selection

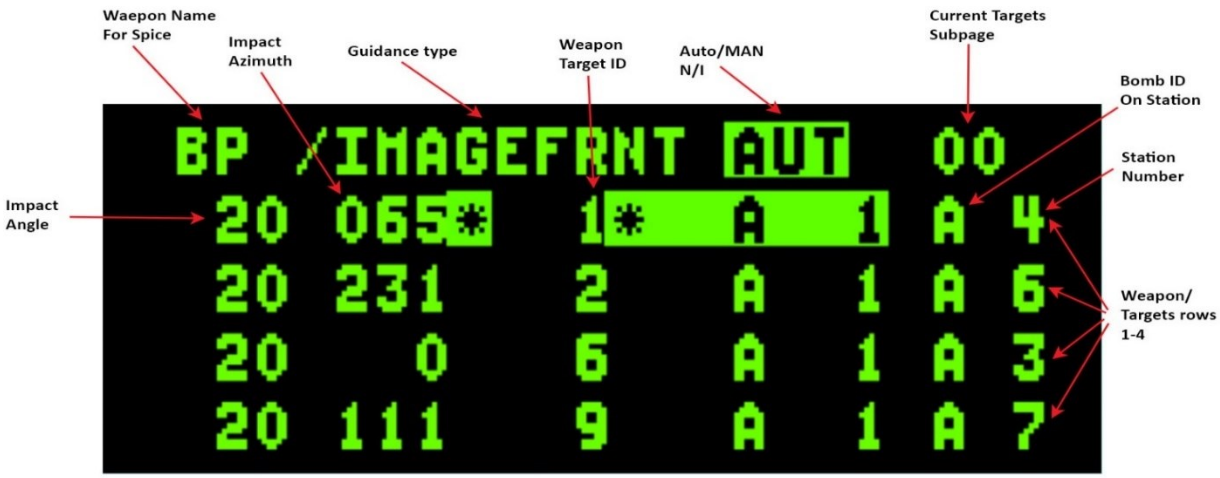
Once weapon targets are selected for the mission (up to 100), each set of targets can be fed to any SPICE bomb that is loaded on the aircraft.

Aircraft in the DB that can use SPICE have a flag in the flight model data file called "CanUseSpice" (can also be found in the avionics configurator). If set to 1, it will allow the special avionics dedicated for the SPICE.

Note: The SPICE in BMS is considered an IAM missile but operates differently.

4.2.9.6.2 DED PAGE SPICE

The SPICE bombs are loaded with targeting data via a dedicated SPICE DED page which is entered by pressing ICP-ENTER in the DED MISC page. This option on the MISC page is available only for ACs that can use SPICE, as mentioned above.



SPICE DED page

The SPICE DED page contains a header row and 4 target rows.

The header row contains the following information:

- Weapon name – BP for SPICE
- Guidance type (specific for bomb)
- Auto mode (specific for bomb) – N/I
- Targets Subpage – There are four target rows in a subpage, one row for each bomb that is loaded. If other subpages exist (dependent on the number of bombs loaded) then they can be toggled by having the asterisks on the top row, sequenced to the subpage number and then press M-SEL 0.

For every Weapon/Target row, the following information appears:

- Guidance type – Appears on the top row but belongs to each weapon separately. The type can be toggled between: “Image front” (default), “Image top” and “GPS”. The GPS option requires the weapon to be GPS aligned like any other IAM, otherwise the weapon will use its image processing technology to find the target.
  Use ICP-SEQ to put the asterisks of the current weapon on the guidance type field and press M-SEL 0.
- Auto mode – appears on the top row for each weapon – N/I
- Impact angle – can be changed but has no real impact.
- Impact Azimuth
- Weapon target ID – this number will reflect the target that is assigned to this weapon from the Weapon targets list (simulating the memory card of the real weapon).
- "A 1" – Appears on every weapon’s row.
- Bomb ID on station – Indicates weapon's position in the station—A for the 1st bomb, B for 2nd and C for 3rd.
- Station ID – The station that this weapon is loaded on.

Note: Every weapon row in the DED page represents a specific SPICE bomb that is loaded on the aircraft and the settings of that row apply specifically to that bomb.

4.2.9.7 IAM WEAPONS DELIVERY SMS PAGES

IAM base pages and their associated control pages are described in figures below. There are several common functions shared by all IAMs as well as unique functions for each weapon.

4.2.9.7.1 POWER

IAMs are powered on by depressing and releasing (D&R) OSB 7 on the JDAM, JSOW, and WCMD SMS weapon base pages. Power is provided to all IAMs and is maintained until launch or manual deselection of power (D&R OSB). Before applying power at any station, IAM weapon power at the selected station should be allowable. IAM weapon power is allowable at a station when a store is present and the station is not hung.

4.2.9.7.2 STATION STATUS REPORTING

The station status indicates the operational status of the IAM loaded at each respective station. Station status is displayed adjacent to OSB 10 (station 7) and OSB 16 (station 3) on the SMS base and control pages. The station number ("7" at OSB 10 or "3" at OSB 16) indicates a "good" weapon status. The station numbers are replaced with D, F, or H for stations having malfunctioning weapons.

- # - Station number indicates a good weapon status
- D - indicates a degraded weapon.
- F - Indicates a failed weapon. This may indicate an MMC communications failure between weapon/station and the MMC or an internal weapon failure.
- H - Indicates that the weapon is a "Hung" store. An "H" would typically be displayed after a weapon release had been unsuccessfully attempted.

4.2.9.7.3 DISPLAY OF IAM WARM-UP AND ALIGNMENT STATUS

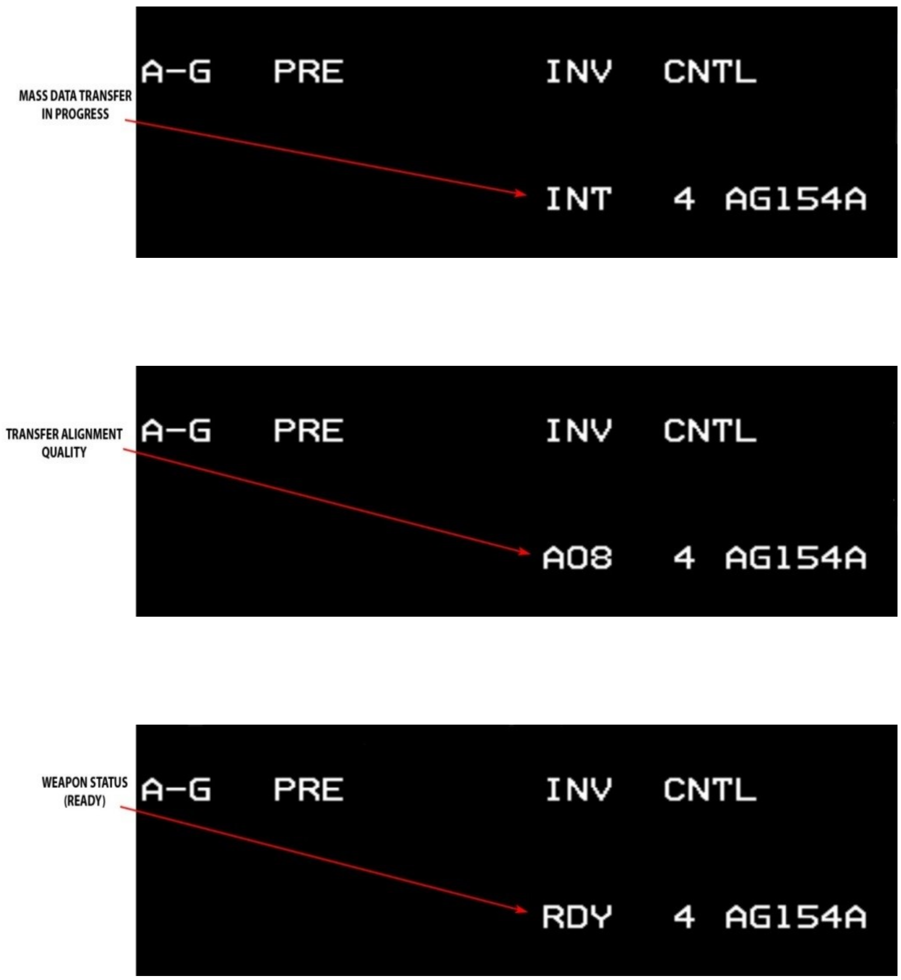
After the automatic BIT on the IAM weapon(s) has been performed, mass data transfer (MDT) occurs for all IAMs (except for the wind corrected munitions dispenser (WCMD) which does not contain a GPS unit). All mission planned weapon data is automatically downloaded from the DTE to the weapon without pilot interaction. The MDT process is performed sequentially for all of the IAM stations that are powered on (a power on command commands power to all IAM loaded stations that meet power on requirements of a positive quantity and a store present). INT status is displayed during MDT.

After initial BIT and MDT, IAM warm-up may take up to three minutes. During this period the weapon navigation solution quality goes from unsatisfactory to marginal and on until the weapon alignment becomes RDY. Status is only provided when a weapon is loaded; no emulation is provided with zero quantity loaded.

After weapon initialization has been completed, the transfer alignment (TXA) quality countdown will begin followed by the alignment status being displayed as ALN, RDY, or SIM above OSB 13. The other alignment statuses are MAL, REL and (Blank) (See the list below):

- REL - Indicates that the MMC has confirmed release consent for the selected station.
- RDY - Nav solution quality is Good, all conditions for launch have been met.
- ALN - Nav solution quality is Marginal, but all conditions for launch have been met.
- MAL- Indicates that some failures exist and the weapon cannot be launched.
- SIM - Nav solution quality is Good for simulated loading (for inventory and training).
- (Blank) - Indicates none of the above statuses apply.

The TXA counts down alignment status (i.e. “A10”, “A08”, “A06”.... where “A10” is the worst alignment status), when minimum transfer alignment is received from the weapon.



TXA counts down alignment status

When the navigation solution quality becomes "good", either "RDY" or "SIM" is displayed both adjacent to OSB 6 and above OSB 13. "RDY" is displayed in both windows if the MASTER ARM switch is in ARM. "SIM" is displayed in both windows if MASTER ARM is in SIM. If MASTER ARM is in the OFF position and navigation solution quality is "good", TXA quality continues to be displayed adjacent to OSB 6, while the window above OSB 13 remains blank. The table below shows the TXA values for the different IAMs:

TXA Quality	JDAM	JSOW	WCMD
10	Unsat	Unsat	Unsat
9	Unsat	Unsat	Unsat
8	Unsat	Marginal	Unsat
7	Unsat	Marginal	Unsat
6	Unsat	Marginal	Unsat
5	Unsat	Marginal	Unsat
4	Unsat	Good	Unsat
3	Marginal	Good	Marginal
2	Good	Good	Good
1	Good	Good	Good

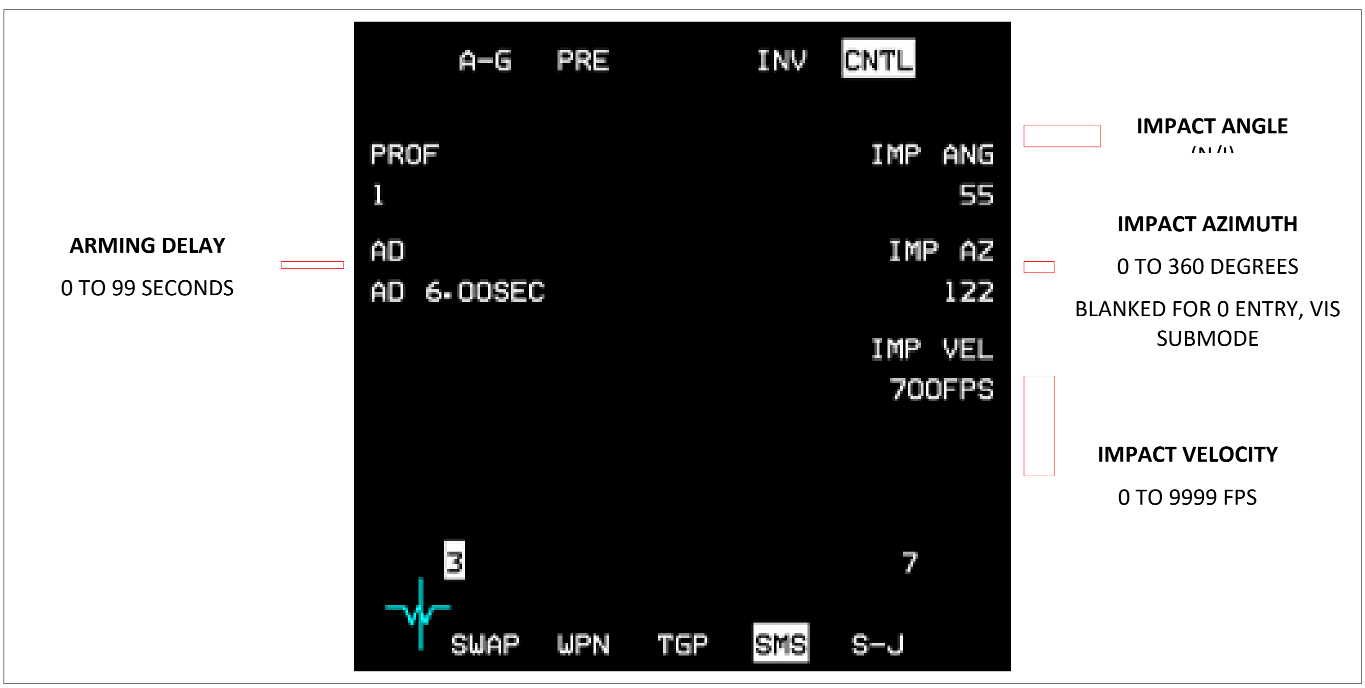
TXA values for the different IAMs

If MASTER ARM is in the OFF position and navigation solution quality is "marginal", the TXA quality continues to be displayed adjacent to OSB 6 and the window above OSB 13 remains blank. With MASTER ARM OFF, a "good" status will have the same indications—blank at OSB 13 and TXA countdown at OSB 6. If a failure occurs during MDT or transfer alignment, "MAL" is displayed in both windows for the selected station. The display of "MAL" will be independent of the position of the MASTER ARM switch.

NOTE: Releasing an IAM when warm-up status is Unsat or Marginal is not recommended and will probably cause the weapon to miss its designated target.

4.2.9.7.4 JDAM SMS PAGE

JDAM SMS base page



JDAM SMS control page

4.2.9.7.4.1 TARGET PROFILE DATA SETS (JDAM)

Four different profiles (one each for up to four individual targets) can be defined based on the individual target characteristics. Target profile data sets may be used with all JDAM variants. The four targeting and weapon parameters below constitute a target profile data set in BMS:

1) Impact Azimuth (see Attack/Impact Azimuth in this Section).
2) Impact Angle (Not currently implemented).
3) Impact Velocity (Not currently implemented).
4) Arming Delay (see Arming Delay in this Section).

The profile numbers have a logical relation to the target desired. As the pilot rotaries through the different profiles (PROF 1 through PROF 4) the parameters change reflecting the different target characteristics. As mentioned in the preceding descriptions, the pilot may select each of the targeting/weapon parameters for change on the JDAM weapon control page. When a parameter is changed on the control page, the data set associated with the PROF number currently being displayed at OSB 20 on the JDAM weapon base and weapon control pages is also changed.

4.2.9.7.4.2 ARMING DELAY (JDAM)

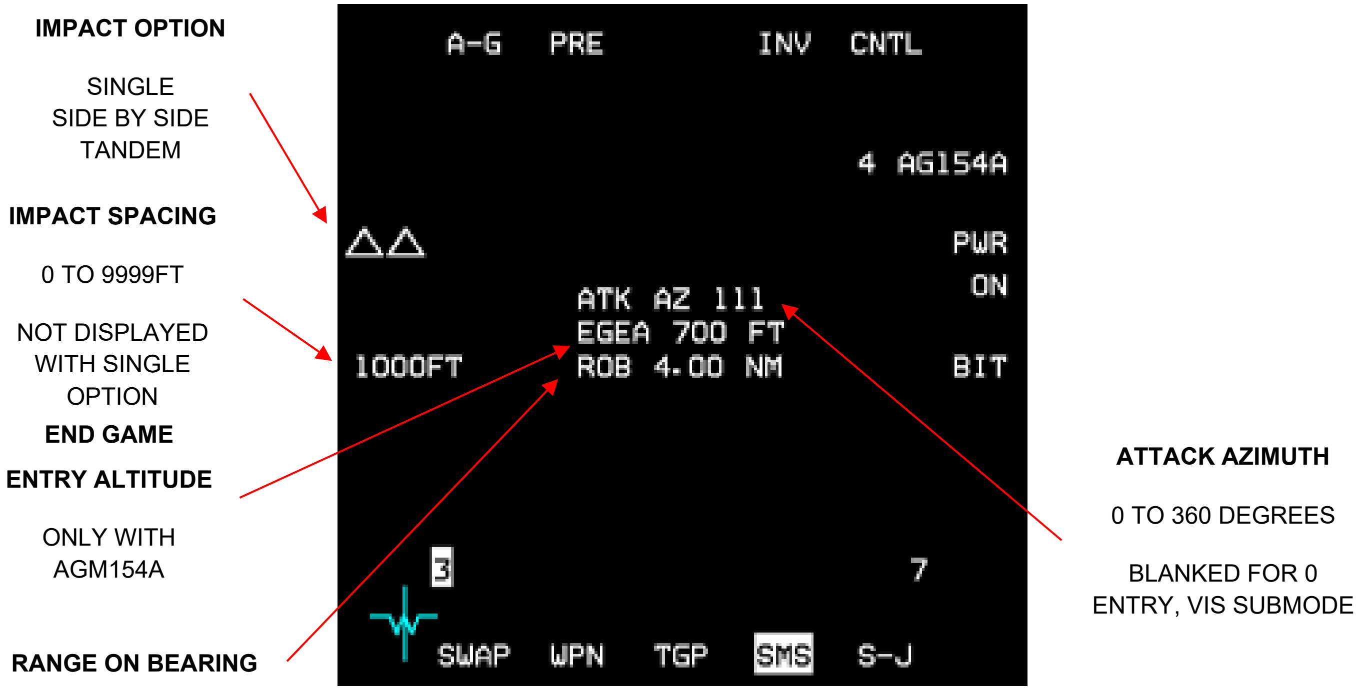
The arming delay is a weapon function that provides a safe separation arm time for JDAM weapons. The arming delay is displayed on the SMS base and control pages. The arming may be changed at OSB 19 on the JDAM control pages. Depressing OSB 19 on the appropriate control page accesses the data entry MFD page for the arming delay value. Any value between 0 and 99.99 seconds may be entered.

4.2.9.7.4.3 ATTACK AZIMUTH (JSOW)/IMPACT AZIMUTH (JDAM)

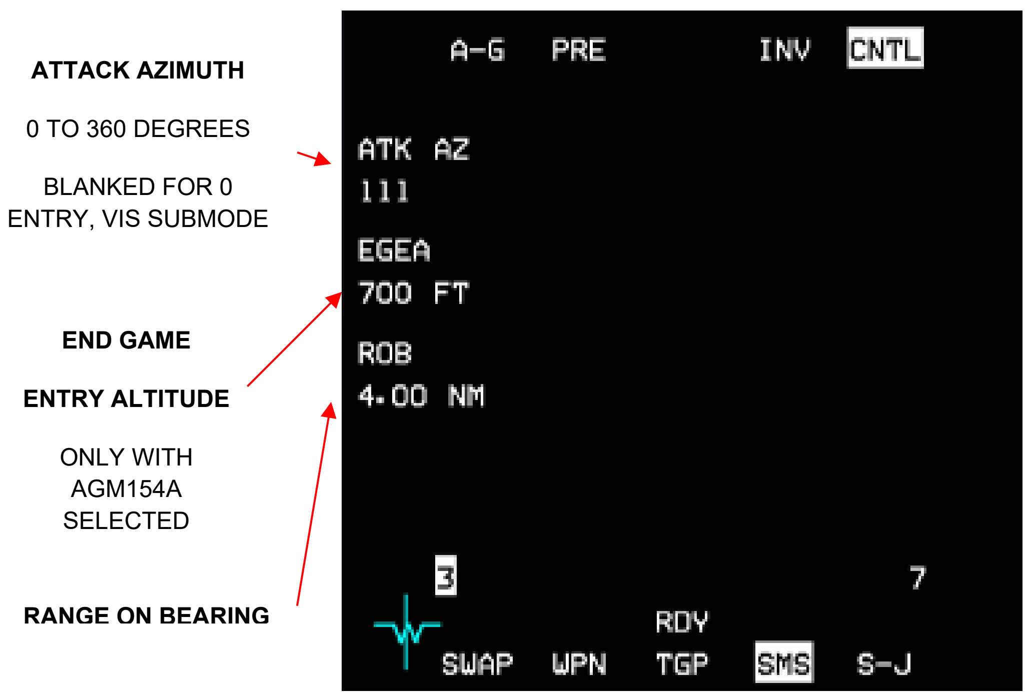
Attack/impact azimuth provides the capability to allow the weapon to attack the target from a specific direction always referenced to North. Attack azimuth is the terminology used for JSOW, while impact azimuth is the terminology used for JDAM. The attack azimuth value is selectable for change for JSOW at OSB 20 on the JSOW and WCMD control pages. Azimuth is entered through the mission planning system or control pages. The JDAM impact azimuth value is selectable for change at OSB 7 on the JDAM control page. Depression of the ATK AZ or IMP AZ OSBs will access the data entry MFD page for attack/impact azimuth. Any value between 0 and 360° may be entered; however, an entry of 0 will be considered invalid to the weapon and will cause the weapon to fly from the release point direct to the target. At release, the bombs will fly from the aircraft direct to the target and the offset sent to the weapon is corrected/adjusted for the Attack Azimuth input.

NOTE: The avionic system will accept manually entered attack/impact azimuth greater than 360°. Attack azimuth inputs greater than 360° will be reduced by 360° or multiples of 360° and sent to the weapon. For example, an entry of 370° results in 10° and an entry of 740° results in 20° being sent to the weapon. In the VIS delivery submode, the avionic system will set the impact/attack azimuth to the aircraft LOS to the target.

4.2.9.7.5 JSOW SMS PAGE



JSOW SMS base page



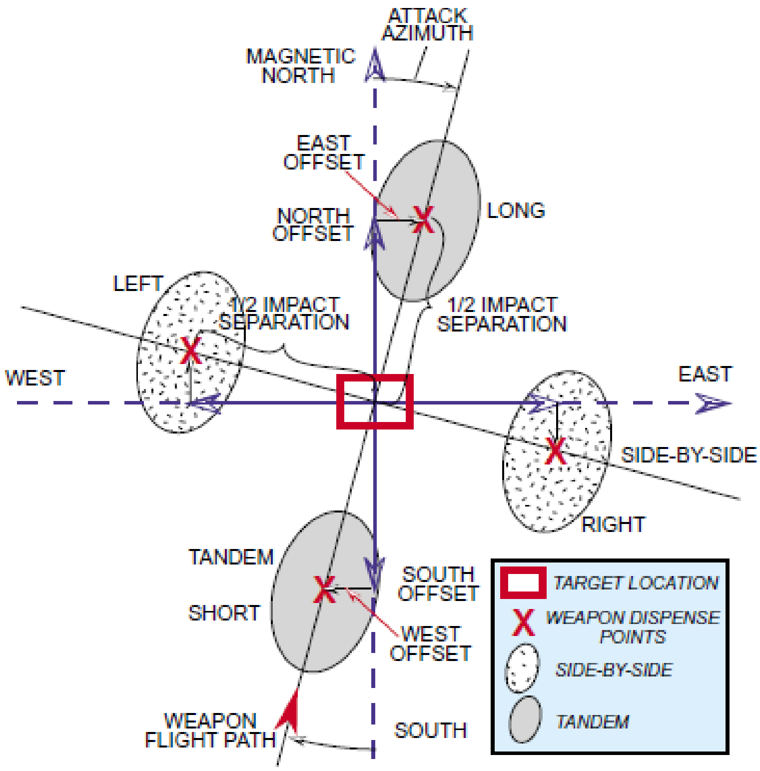
JSOW SMS control page

4.2.9.7.5.1 IMPACT OPTION (JSOW)

Impact option provides the capability to select whether one or two weapons may be released against a target. The option to select whether two weapons may be released against one target is only available for JSOW (PRE and VIS delivery submodes only). The impact option is selectable for change via OSB 19 on the JSOW weapon base pages. The impact option is not displayed on the SMS control pages. Depressing OSB 19 on the base page rotaries though the allowable impact options that are summarized below.

The following are WCMD Impact Geometries:

- Single (One Triangle). One weapon is to be dropped on the target.
- Tandem (Two Triangles Stacked Vertically). Two weapons are to be dropped on the target with impact points along the attack axis. The first weapon in the ripple sequence (currently selected weapon) will be released against the short impact point and the second weapon will be released against the long impact point.
- Side-By-Side - (Two Triangles Abreast) Two weapons are to be dropped on the target with impacts points perpendicular to the attack axis. The station 3 weapon will be released against the left impact point and the station 7 weapon will be released against the right impact point.



JSOW and WCMD impact geometries

NOTE: When the tandem or side-by-side impact option is selected, the avionic system will automatically select the ripple release option. Each weapon receives target latitude, longitude and elevation. In addition, weapon-unique offsets values are sent to each weapon based on the selected impact spacing option, attack azimuth and impact spacing distance. When any of the following conditions occur, the avionic system will automatically default the release option to single and ripple will not be available:

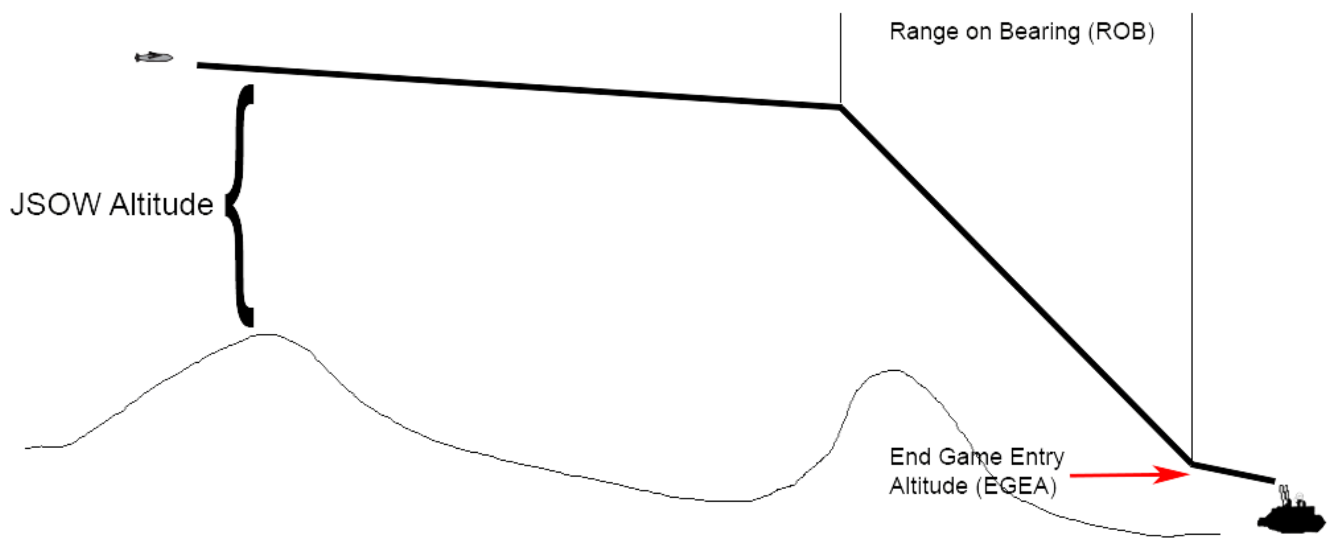
1) Only one IAM station in a pair is loaded in inventory (even quantity zero).
2) MPPRE is the currently selected delivery option. (JSOW only).
3) There is a mix of IAMs actually loaded on the aircraft, or
4) Different weapon IDs have been inadvertently loaded on stations 3 and 7
5) A station is loaded with a failed JSOW or WCMD.

4.2.9.7.5.2 IMPACT SPACING (JSOW)

The impact spacing value determines the distance between the centers of the two submunition dispense patterns during a ripple release (tandem or side-by-side). The pilot defined target location is the center of the combined sub-munitions patterns. The impact spacing can be changed using OSB 18 on the JSOW Weapon base page. Impact spacing is not displayed on the JSOW Weapon control page. Depressing OSB 18 on the base page will access the data entry MFD page for modification of the impact spacing value. If a value of zero is entered, the weapons will have coincident impact points. Although an impact spacing of 9999 feet may be entered, the DLZ is only calculated to the center point. This could lead to one of the weapons being released outside acceptable parameters. The impact spacing value is not displayed on the JSOW Weapon base page when the Single impact option is selected.

4.2.9.7.5.3 EGEA (END GAME ENTRY ALTITUDE) AND ROB (RANGE ON BEARING) FOR JSOW VARIANTS

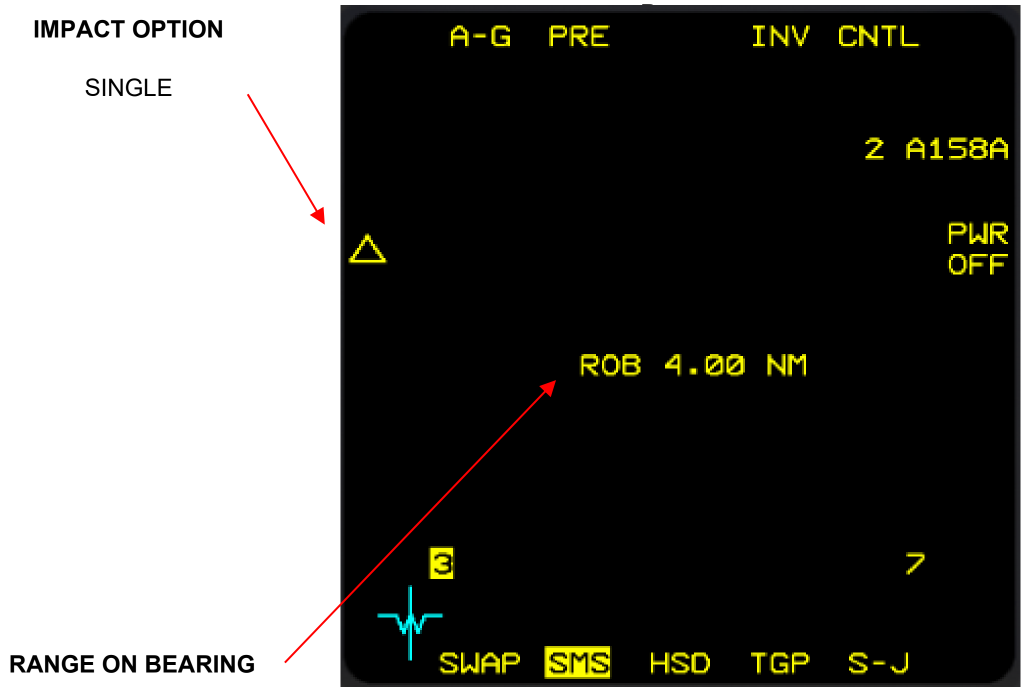
The EGEA and ROB parameters for JSOW in the PRE delivery mode are displayed on the SMS JSOW base and CNTL pages. The pilot may modify these values using the SMS JSOW CNTL page. EGEA defines a minimum altitude relative to the target altitude that the weapon will fly at endgame entry range. This range from the target is where the JSOW will begin its terminal maneuvers. ROB is defined as the minimum range from the target where the weapon's velocity vector will be in line with the planned attack azimuth. ROB has a range of 4 to 9 NM for the A variant and 2.5 to 9 NM for the B (and C) variant. Changing the EGEA will affect the elevation of the JSOW flight path weapon trajectory in order to avoid weapon impact with the terrain prior to arriving at the target. Changing the ROB will change the JSOW flight intercept point with the attack azimuth. JSOW approaches the target along a specified bearing and intercepts that bearing at or beyond the specified ROB from the target. The altitude of the weapon at the ROB intercept point is not specified.



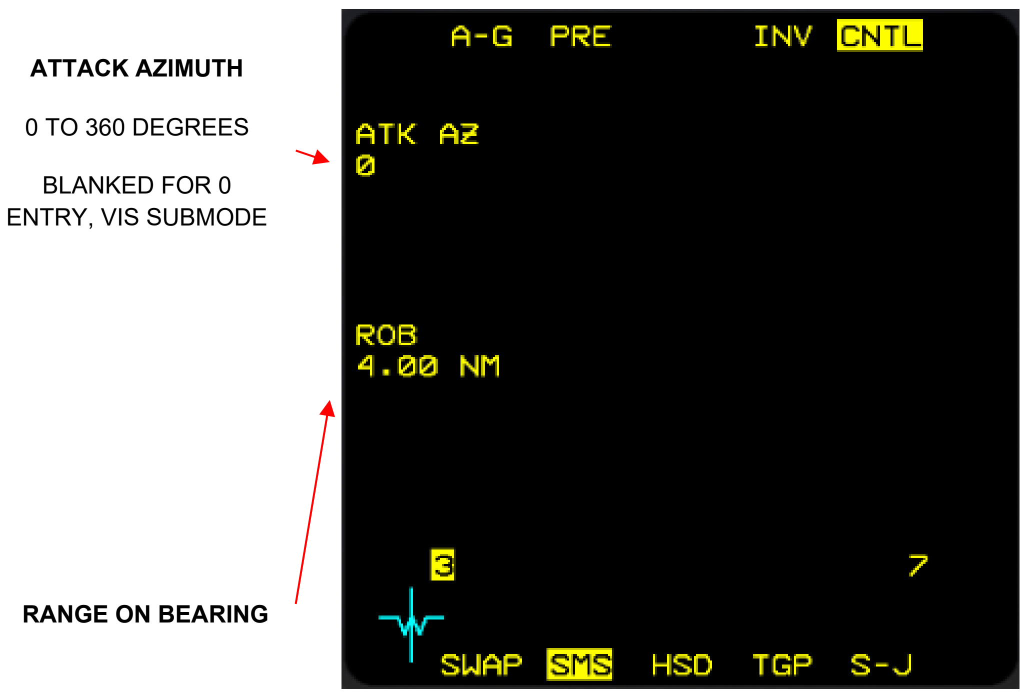
JSOW EGEA and ROB

AGM- 154C does not have EGEA, and thus, EGEA and its value (all modes) are not displayed on the base page. For AGM-154A, the default value for EGEA is 700 feet and the default value for ROB is 4.0 nm. The AGM-154C does not have EGEA capability; the default value for ROB is 2.5 nm. EGEA value is limited between 500 to 2500 feet and ROB is limited between 4.0 and 9.0NM for AGM-154A and between 2.5 and 9.0NM for AGM-154C.

4.2.9.7.6 JASSM SMS PAGE

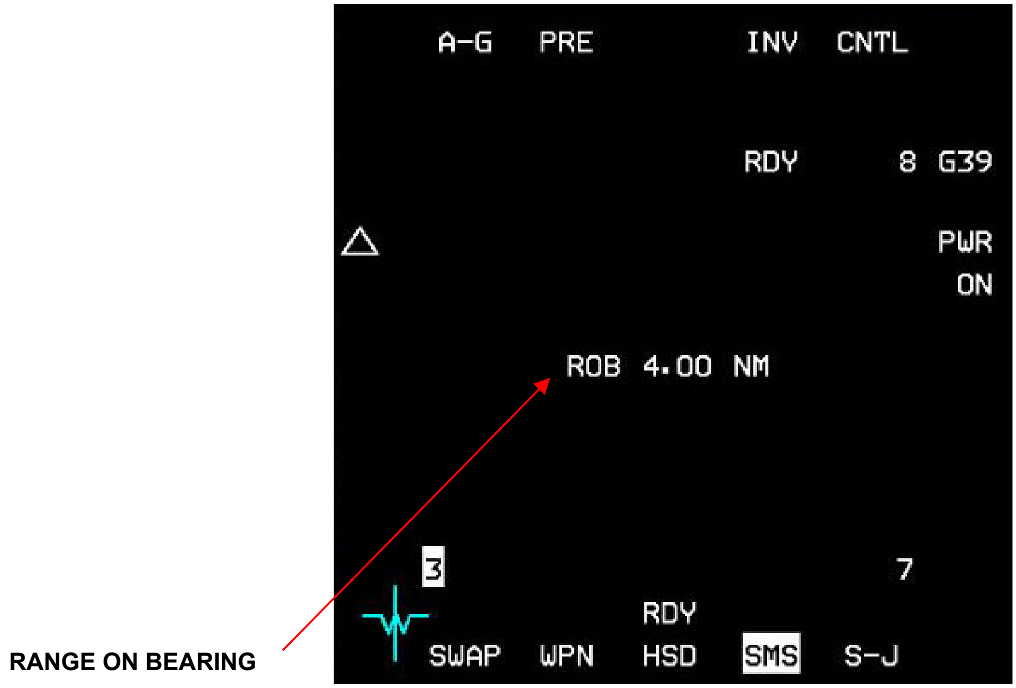


JASSM SMS base page

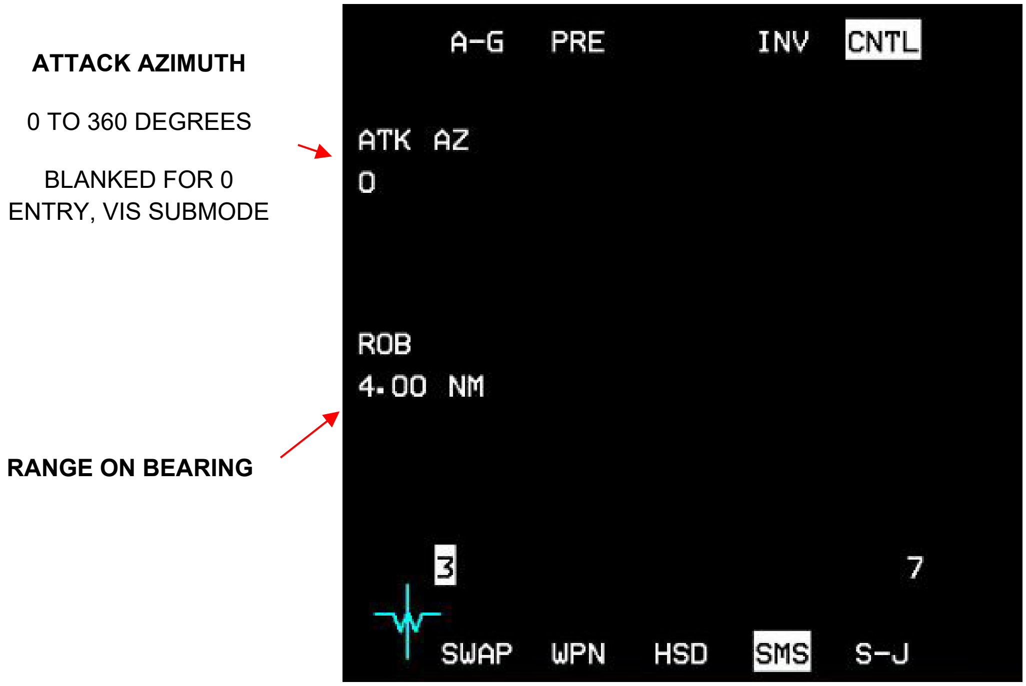


JASSM SMS control page

4.2.9.7.7 SDB SMS PAGE



GBU-39 SDB SMS base page

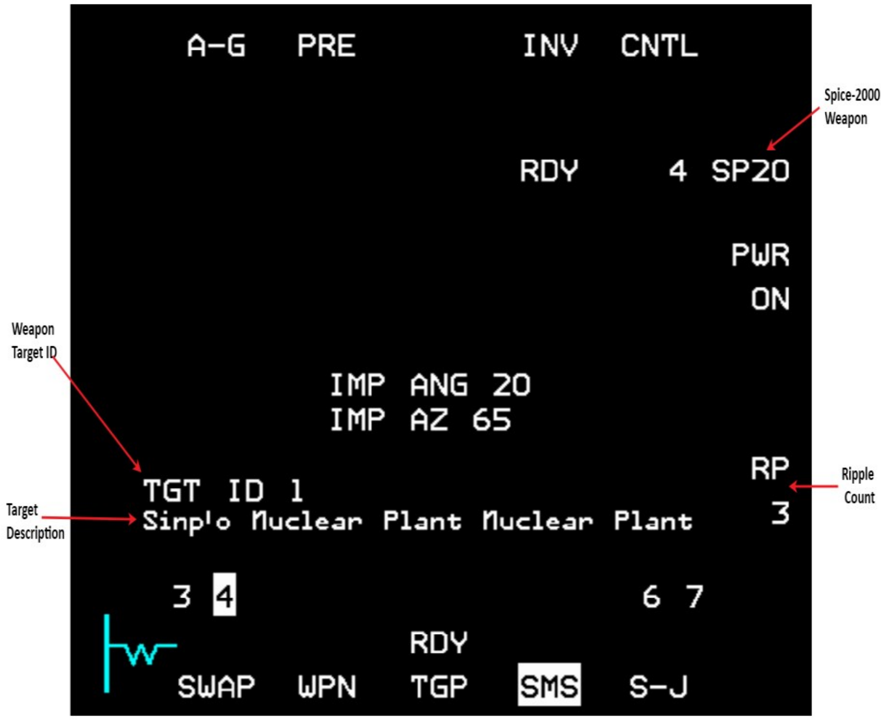


GBU-39 SDB SMS control page

4.2.9.7.8 RAMPAGE SMS PAGE

RAMPAGE SMS control page

4.2.9.7.9 SPICE SMS PAGE



SPICE SMS page

The SPICE SMS page contains same data as JSOWs with the following additional information:

- Ripple count – the number of bombs released when pickle is depressed
- Weapon target ID – the weapon target that is selected for the current weapon
- Target Description – the name of the current target (the name that appears in the UI recon page)

The SPICE bombs release sequence is not dependent on the row that is currently selected in the SPICE DED page but only on the station that is currently selected. HUD cues of the SPICE are identical to the JSOWs cues. In the case of a ripple release, the TD-Box and all other target-based information will correspond to the average position between the selected targets.

Four variants of the SPICE exist in the BMS DB:

1. SPICE 2000 – 2000lb HE bomb
2. SPICE 2000P – 2000lb Penetration bomb
3. SPICE 1000 – 1000lb HE bomb
4. SPICE 1000P – 1000lb penetration bomb

4.2.9.8 IAM WEAPONS DELIVERY HUD SYMBOLOGY

The IAM weapons and the avionic system provide the pilot with information to aid in the weapon delivery. Much of this information is portrayed using the HUD symbology. The symbology includes the HUD Dynamic Launch Zone (DLZ), and other miscellaneous HUD steering and release cues.

4.2.9.8.1 IAM HUD DLZ

The HUD DLZ is displayed when an IAM weapon is selected, valid LAR (Launch Acceptable Region) data for the selected weapon has been downloaded to the MMC, the appropriate delivery submode (MPPRE, PRE, VIS post designate) is selected, the weapon status is REL, RDY, ALN, or SIM, and INS and CADC data are valid.

4.2.9.8.2 IAM HUD DLZ COMPOSITION

1. Upper and lower range scale tics. No range scale value is displayed above the upper range scale tic. For JDAM and WCMD, the DLZ is displayed "normalized" so that the RMAX1 range tic is always displayed at 70% of the selected IAM weapon's kinematic range. The DLZ is normalized to 70% for JSOW PRE and VIS modes.
2. Target range caret (>). The target range caret appears to the left of the kinematic and optimum release zones/staples.
3. RMAX1 / RMIN1 ([). The maximum and minimum weapon kinematic ranges form an outer staple (kinematic release zone) that opens to the right. Releasing the weapon with the target range caret between RMAX1 and RMIN1 (within the kinematic release zone) ensures that the weapon can get to the target. However, the weapon may not arrive with enough energy to meet all end-game parameters such as impact angle, impact azimuth, and minimum impact velocity. With the exception of the JSOW, IAM weapon releases are inhibited until the target range cue is between RMAX1 / RMIN1. The kinematic release zone is based on current aircraft flight conditions.
4. RMAX2 / RMIN2 (]). The maximum and minimum optimum release ranges form an inner staple (optimum release zone) that opens to the left. Releasing the weapon with the target range caret between RMAX2 to RMIN2 ensures that the weapon can get to the target with enough energy to meet all end-game parameters. The optimum release zone is based on current aircraft flight conditions. For JSOW PRE and VIS and for CBU-103 and CBU-104, there is no RMAX2/RMIN2 since there are no end-game parameters to satisfy.
5. JIZ Indication. JSOW In-Zone (JIZ) is sent by the weapon and displayed in HUD adjacent to the range caret, to indicate JSOW in-zone conditions based on selected weapon delivery submode. The DLZ is calculated by the MMC and may not correlate with weapon JIZ indications. The weapon release button is always hot whenever JIZ is displayed. If a non-zero quantity of JSOWs are loaded in inventory, “JIZ” is displayed for JSOW when the weapon is reporting that it is “in-range.”
6. Required turn angle below the DLZ. This window is the direction and magnitude of turn required to position the aircraft in the LAR (for JDAM only and displayed when above 60° offset from target bearing). The depiction consists of one alpha character indicating turn direction left (L) or right (R) followed by two numeric characters indication magnitude in degrees 00-99. For example L05 indicates a left turn of 5°.

NOTE: IAM LAR and DLZ depictions are based on a limited quantity of weapon flight data (truth data) and are the most accurate for medium altitude level releases. LARs and DLZs for low altitude and/or diving releases are typically derived by extrapolation of level release truth data and tend to be less accurate. The DLZ for JDAM and WCMD will be blanked when aircraft speeds are less than 0.5 Mach or greater than 1.5 Mach. In addition, the DLZ will be blanked under any of the following conditions:

- For JDAM, when target bearing exceeds +/- 60°, pitch angle exceeds +/- 60°, impact angle lower than 20° or impact velocity greater than 1200 ft/sec.
- For WCMD, when aircraft altitude is below the fuse function altitude of the weapon or target bearing exceeds +/- 45.

The JIZ depiction is blanked for all JSOW delivery submodes when aircraft speeds are less than 0.6 Mach or greater than 0.95 Mach, aircraft climb/dive angles exceed +/-30°, when target bearing exceeds +/- 60°, or aircraft altitude exceeds 40,000 feet.

4.2.9.8.3 HUD STEERING AND RELEASE CUES

Time to RMAX2. This is displayed until the countdown to the next cue (time to loft, time to RMAX2) reaches zero (then time since RMAX1 until RMAX2 and weapon release actually counts upwards for a few seconds) or a launch has been completed, whereupon it displays predicted time to impact for the last weapon released.

Weapon Time On Target. This indicates the system time at the next cue (as above) based on current flight conditions.

Range and bearing to target. For JDAM, WCMD, or JSOW (PRE and VIS) the bearing and range to the target is displayed in the HUD.

Azimuth steering line (ASL). The ASL provides optimum steering to the weapon release zone. In JDAM, JSOW, and WCMD PRE or VIS, and JSOW MPPRE with no waypoints defined, the ASL provides steering to the target. The ASL is blanked from the HUD, when the weapon status is MAL or blank. The ASL is displayed when weapon status is ALN, RDY, or SIM.

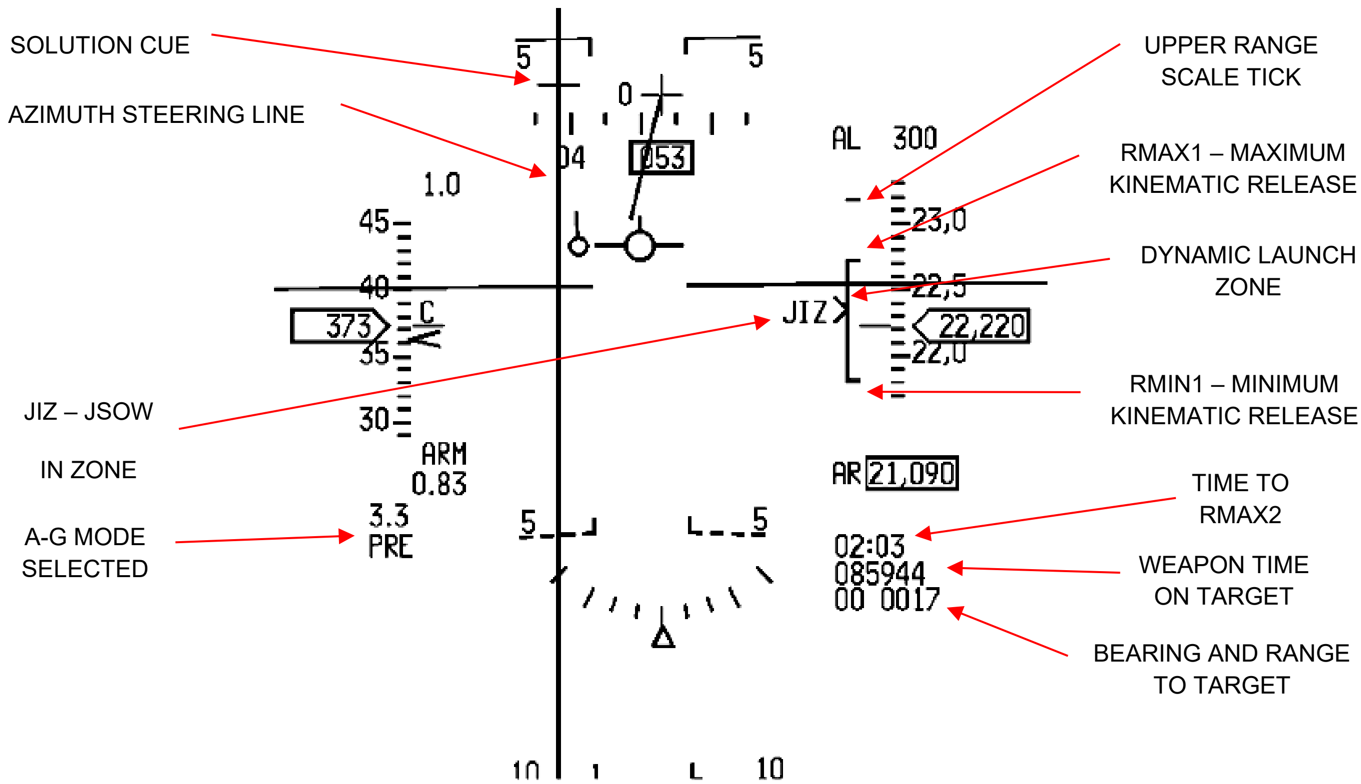
A-G solution cue. The solution cue is displayed when the aircraft approaches the optimal release zone (RMAX2 to RMIN2) or when a change in climb angle can bring the aircraft within the optimal release zone and is centered in azimuth on the azimuth steering line. The cue begins moving down toward the flight-path marker at max loft release range. The cue is coincident with the flight-path marker when the aircraft is within the optimal release zone indicating that the current conditions support a release. When a dive is required to achieve release conditions, the cue will move below the flight-path marker. The solution cue is displayed when weapon status is ALN, RDY, or SIM. Since JSOWs are not meant to be lofted, the solution cue will only be displayed when the aircraft is within the aircraft computed optimal release zone. Thus, the cue should be ignored for JSOW since release determination is based on the weapon computed in-range/in-zone and not the aircraft computed DLZ. The solution cue is blanked when the weapon status is MAL or blank. The pickle button is hot prior to the solution cue being coincident with the FPM.

Target designator (TD) box. The TD box represents line-of-sight to the target. The TD box is blanked when the weapon status is MAL or blank. The TD box is displayed when weapon status is ALN, RDY, or SIM.

Arming Status. The position of the master arm switch (ARM or SIM) is displayed below the HUD airspeed scale.

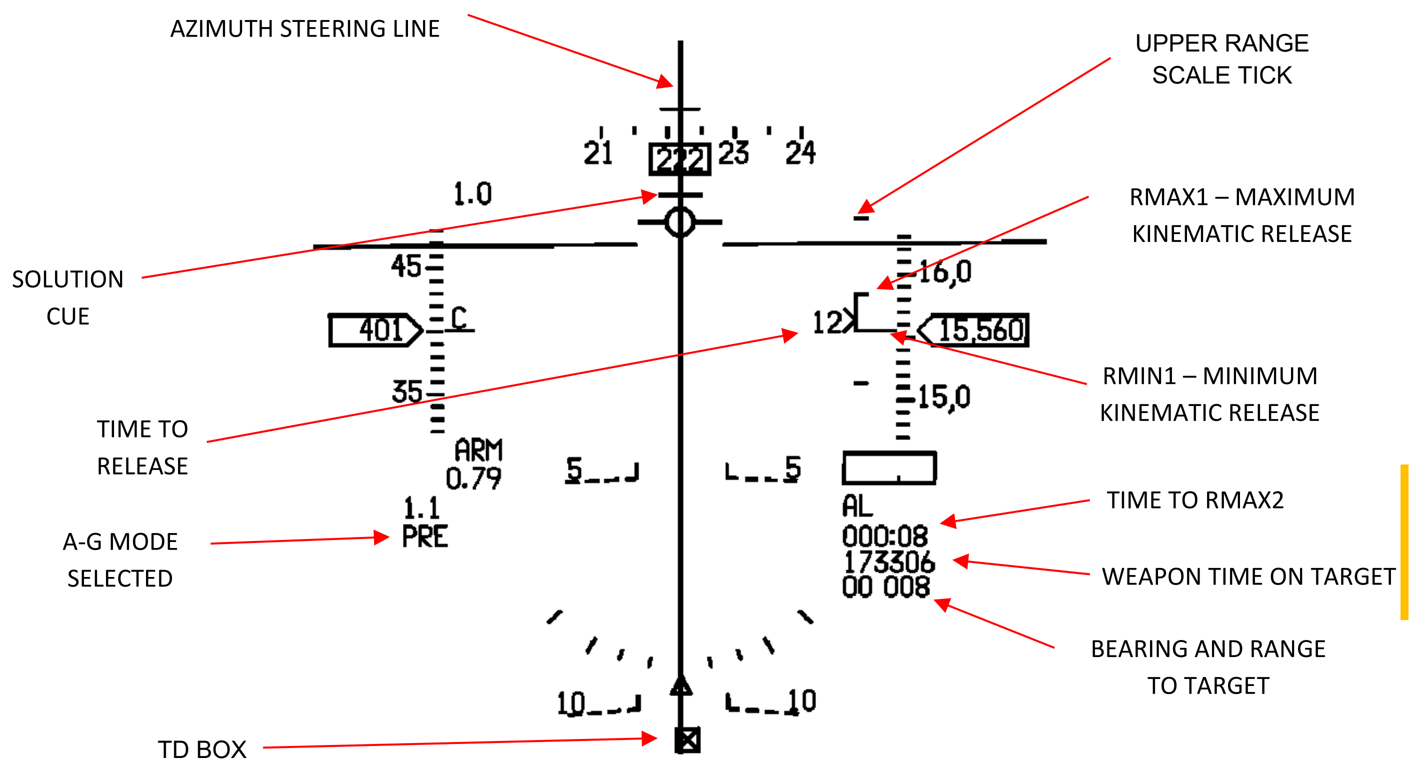
Delivery Mode Indication. The currently selected delivery IAM submode (MPPRE, PRE, or VIS) is displayed at the lower left portion of the HUD.

4.2.9.8.3.1 JSOW STEERING AND RELEASE CUES

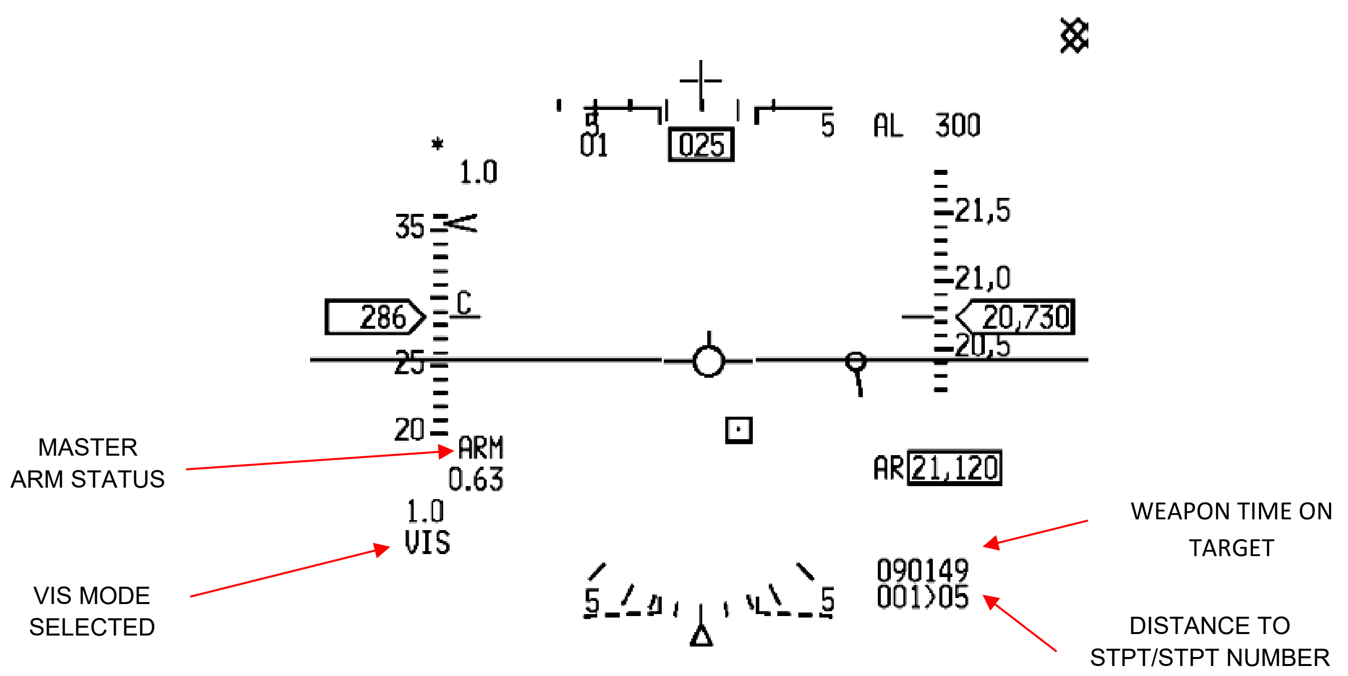


JSOW PRE/VIS-Post-Designate and JSOW MPPRE HUD steering and release cues

4.2.9.8.3.2 JDAM STEERING AND RELEASE CUES

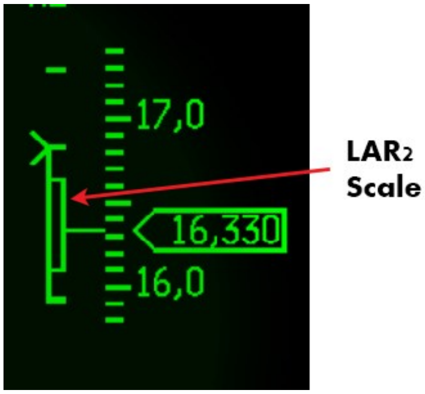


JDAM HUD steering and release cues



Predefined steerpoints location

4.2.9.8.3.3 SPICE STEERING AND RELEASE CUES



SPICE LAR2 Scale

LAR2 Scale: When an attack azimuth is selected for the current SPICE weapon, a LAR2 scale will appear on the LAR scale. The LAR2 scale will indicate if the range is sufficient for the weapon to fly to the target through the selected attack azimuth. If the weapon is released when inside the LAR scale but outside of the LAR2 scale, the weapon will fly directly to the target and not through the attack azimuth.

Note: If the average target is in range then the weapon will be released even if the actual target of that weapon is out of range.

4.2.9.9 JSOW, JASSM, JDAM, SDB, RAMPAGE, PRE WEAPONS DELIVERY PROCEDURES

1. ICP - Select/verify A-G Master Mode.
2. UFC/DED -
    a. Select/verify desired PRE target (steerpoint number).
3. SMS weapon base and control page -
    a. Verify/input correct weapon inventory load.
    b. Verify power ON for each loaded station.
    c. Verify PRE submode selected.
    d. Verify correct weapon stations selected.
    e. Verify weapon status.
4. Cursor Control - Zero cursor, unless cursor corrections required.
5. MASTER ARM switch - ARM.
6. HUD
    a. Use HUD steering cues to manoeuvre until range caret is within launch zone.
    b. Verify JIZ displayed adjacent to range caret (JSOW only).
    c. Verify range caret within RMAX1 / RMIN1 (JDAM/WCMD).
7. WPN REL button - Depress and hold until the FPM flashes (> 1.6 seconds for single, or 3.2 seconds for ripple).

4.2.9.10 JSOW, JASSM, JDAM, RAMPAGE, VIS WEAPONS DELIVERY PROCEDURES

1. ICP - Select/verify A-G master mode.
2. SMS weapon base and control page -
    a. Verify correct weapon stations selected.
    b. Weapon power ON for each loaded station.
    c. Verify weapon status.
3. MASTER ARM switch - ARM
4. HUD -
    a. Select/Verify TD Box is displayed coincident with FPM. Verify vertical position and/or velocity errors (FPM not on horizon in level flight).
    b. Slew or fly TD box over the target and designate. Do not designate the target via the WPN REL button unless no slew refinements are required.
    c. Verify azimuth steering to the TD box is displayed.
    d. Use HUD steering cues to manoeuvre into release parameters.
    e. Verify JIZ displayed adjacent to range caret (JSOW only).
    f. Verify range caret within RMAX1 / RMIN1 (JDAM and WCMD)
5. WPN REL button - Depress and hold until the FPM flashes (> 1.6 seconds for single, 3.2 seconds for ripple).

4.2.9.11 SPICE WEAPONS DELIVERY PROCEDURES

1. Before the mission, set up the necessary weapon targets in the UI.
2. Power up the weapons from the SMS page and note good calibration after warm-up time (RDY label).
3. Open the SPICE DED page.
4. For each SPICE bomb, set the necessary parameters – Target ID, Impact Azimuth, Impact Angle.
5. Set the desired ripple count if ripple is preferred.
6. Verify In-Range on HUD DLZ. If impact azimuth is selected, verify also that the range marker is below the top mark of the LAR 2.
7. Verify that all targets are In-Range in case of ripple release.
8. Pickle – verify not in dive angle in order to avoid undershoots.

4.2.9.12 IAM WEAPON RELEASE CONSIDERATIONS

1. To successfully launch IAM weapons, the weapon release button must be depressed throughout the entire launch sequence. This can take up to 1.6 seconds for a single release and over three seconds for a ripple release. If the pickle button is not held down throughout the launch sequence, the launch will be permanently aborted and subsequent release attempts for that weapon will not be possible (selective or emergency jettison can still be used to jettison the weapon). For either weapon release sequence, if the pilot releases the weapon release button prior to the actual release of that weapon, the aircraft will set the weapon status at the applicable station to "H" (HUNG status).
2. Cursor Zero: To prevent unwanted cursor slews from being applied to the weapon solution, a cursor zero should be commanded prior to weapon release.
3. Weapon Release Button for JDAM: The weapon release button is hot in all applicable delivery submodes whenever the aircraft is within the kinematic release zone (RMAX1 to RMIN1) of the weapon. Weapon release can be initiated in one of two ways: 1) if the aircraft is within RMAX1 to RMIN1, weapon release will be initiated when the pickle button is depressed, 2) if the aircraft is outside of RMAX1 to RMIN1, hold the pickle button depressed and fly the aircraft into the DLZ at which time the release sequence will be initiated. NOTE: When initiating a multiple release sequence close to RMIN, and closing in to the target, the release sequence will continue and the second weapon may miss the target, depending on the conditions.
4. Weapon Release Button for JSOW/SDB: In-range and in-zone are JSOW weapon generated range functions, and the DLZ range data (RMAX1 / RMIN1) are generated from aircraft (core computer) calculations. There are conditions where the weapon-generated functions and DLZ range data will not agree. As a result, DLZ information should be considered to be "rule of thumb" data and the weapon-generated data should be considered the most accurate. The weapon release button will always be hot whenever the weapon reports an in-range condition regardless of weapon delivery submode or DLZ range depictions. However, cockpit indications do not always advise when a JSOW in-range condition has been satisfied. In PRE, VIS, or MPPRE, JIZ is displayed on the HUD and the weapon release button becomes hot when the weapon is indicating in-range regardless of where the DLZ range cue is positioned. For JSOW PRE and MPPRE, JIZ indicates that when released, the weapon will fly direct to the target if no attack azimuth has been defined. Otherwise, the weapon will fly to a target offset point that provides sufficient maneuvering space to turn and hit the target on the specified attack azimuth. The weapon release button becomes hot when the weapon reports an in-range condition. Since there is no cockpit indication that an in-range condition has occurred and that the weapon release button is hot, an inadvertent (in-range) release may be possible.

4.2.9.13 GUIDE ON IAM USAGE

4.2.9.13.1 PRE MODE

In order to use IAMs as pre-planned GPS targeting weapons you need to assign the target you want to a steerpoint. Choosing PRE will automatically set the current steerpoint position set as the weapon target position. If release conditions are met, releasing the IAM will send it to hit the target (steerpoint) position. In PRE mode, any slewing of the currently used sensor (FCR or TGP) will change the target position and send it to the weapon. Releasing a weapon at this stage will send it to the position where the sensor cursors are pointing.

4.2.9.13.2 JDAMS AND SDBS SINGLE PASS – MULTIPLE TARGETS PROCEDURE

The F-16 cannot release JDAMs in ripple mode so in order to release multiple JDAMs in one pass on multiple targets you should follow these steps:

1. During planning in the UI map screen, assign a steerpoint for each target in subsequent order— i.e., 5-6-7-8 for 4 targets.
2. When in range of the targets (assuming they are all in the same area, otherwise this will not work) with the first target steerpoint chosen and cursor-zero (no slewing necessary), releasing the first JDAM/SDB will send it towards the first target.
3. Quickly choose next steerpoint.
4. Release a second JDAM/SDB. Repeat step 3 for the remaining bombs.

Following this procedure (which is real for the F-16) will let you use JDAMs or SDBs as a pre-planned GPS guided weapon and drop many in one pass.

Note that since the LAR is flexible and assuming flight conditions allow, targeting four different targets in one pass by slewing the TGP between drops is possible.

4.2.9.13.3 VIS MODE

Vis mode is similar to the Mavericks visual mode and enables targets to be attached in a fast, visual way. It has two stages—pre- and post-designate. When in pre-designate state the TD box will be attached to the FPM and may be slewed or flown to the target position. A TMS-UP command will stabilize the TD box and cursor slews will fine tune its position. When post-designated, no further action is necessary in order to release a weapon on the target position. Once the post-designate stage is reached, the TD box position has been sent to the weapon and once released the munition will guide to that target position.

4.2.9.13.4 NOTES AND UNIQUE SIMULATION INFORMATION

1) WCMDs are modelled regardless of the wind in the sim and they will hit targets like the JDAMs do.
2) 1.6 seconds pickle delay is implemented for all IAMs and when launch parameters allow (pickle is hot) and pickle button is pressed, you *must* hold it until weapon release, otherwise you'll get a HUNG weapon. If you suffer a HUNG weapon you'll be able to switch stations using the missile step command. JDAMs/WCMDs can switch stations just like missiles.
3) AI will use IAM bombs before they use other bombs (LGBs or dumb). They will release multiple IAM bombs in one pass on different targets. They do that automatically if they are on independent flights and they will do that as wingmen if you direct them to "attack targets." AI will be limited to single IAM bomb drops and to the pickle delay.
4) When firing long range missiles, the player can turn back and the targets should stay deaggregated until the missiles explode. Note this feature might saturate multi-player bandwidth availability. A maximum of four long range missiles (per player) are supported to force target deaggregation in any direction in the theatre.
5) While not directly related to IAMs, FCR/TGP track points will force deaggregation of the targets in the area of the cursors.
6) JSOW MPPRE mode will be allowed only when the current steerpoint is a target.
7) The TGP will be loaded automatically when IAMs are loaded, just as it does for LGBs.
8) IAMs do not require any kind of "locking" of targets. If you are having trouble releasing and hitting targets with IAMs, follow the procedures explained in the "How To" section.
9) While attack azimuth is used for JSOW and affects the flight path, it may not be completely accurate. There may be some undesired differences between the required azimuth and the practical one. Hopefully this will improve in the future.

4.2.9.13.5 SPECIAL JDAM OPTIONS

Note: The following section applies primarily to IAF F-16 C/D and IAF F-16I versions.

To support special JDAM options for all aircraft types, a variable is available in the FM data file. The variable is named *avionicsJDAMAvionicsType* ****** CAUTION! Changing aircraft data may cause multiplayer problems! ******

The valid values are 0-3 and can also be found in the avionics configurator under JDAM option.

The valid values for this variable represent the following:

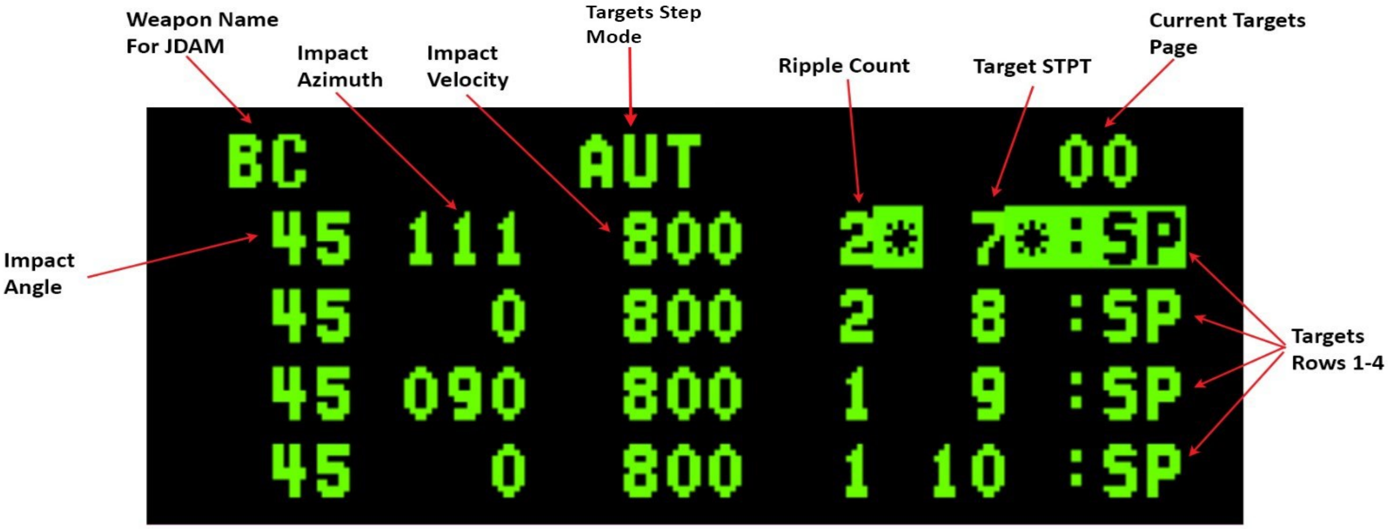
Value 0 – Normal JDAM behaviour as described in section JDAM (default value if not specified in FM).

Value 1 – Allow ripple for JDAMs. Ripple value can be set in the SMS page and the JDAMs will be rippled by the specified amount with every pickle press. Other than that, the avionics and functionality will be same as described in section JDAM.

Values 2 & 3 – This option represents a special JDAM pre-planned targets setting that can be done via a dedicated JDAM’s page on the DED. With this option enabled, the ripple option will appear on the SMS page but it will not necessarily represent the actual ripple number. The value on the SMS page will define a global ripple value, while the actual ripple for every pre-planned target will be defined separately on the DED profile along with other parameters in the default option (Value 0) being defined in the SMS page.

The JDAMs DED page is entered by pressing 0 in the DED MISC page (the option itself will appear on the MISC page only for aircraft that have option 2/3 set for JDAM avionics type).

4.2.9.13.6 DED PAGE



JDAM DED page

The JDAM's DED page contains a header row and 4 target rows.

The header row contains the following information:

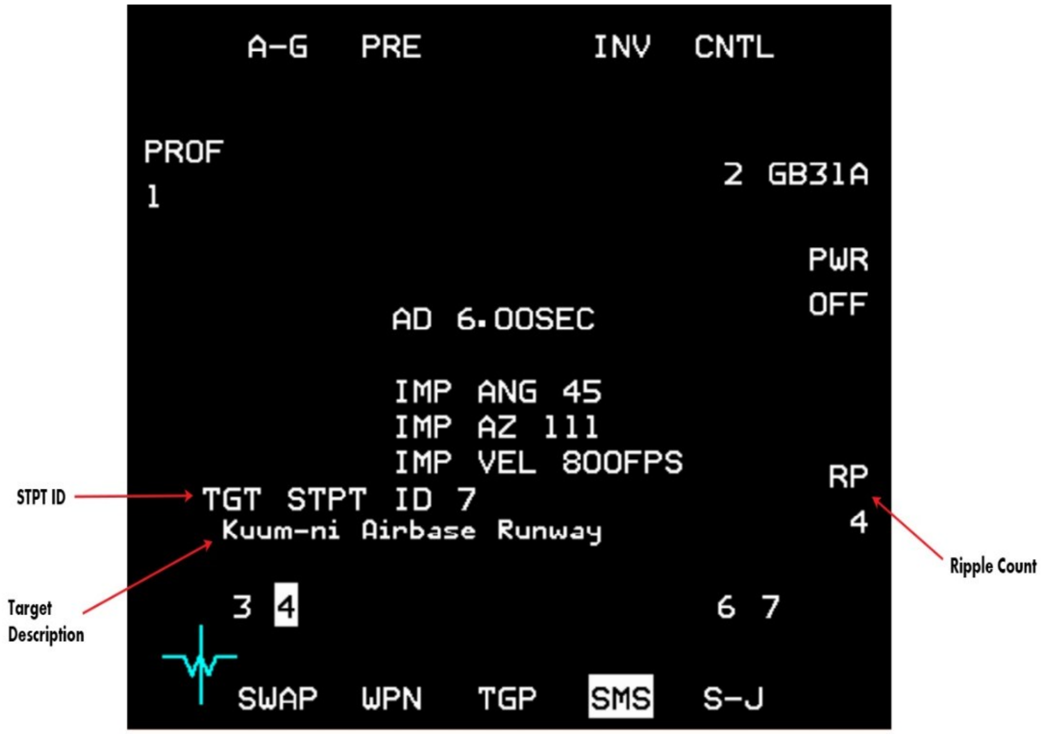
- Weapon name – BC for JDAMs
- Targets step mode – Options are Automatic (AUT) and Manual (MAN). Auto is the default. In Auto mode the system will step to the next target row at pickle release.
- Current targets page—Subpage that is currently shown, counting from 00 up to as many subpages as necessary according to the number of bombs loaded (4 for a subpage). Subpages can be toggled by placing the asterisks on the number and pressing M-SEL on the ICP.

The data in every row contains the following information which is assigned for the specified target (listed from left to right):

- Impact angle
- Impact azimuth
- Impact velocity
- Ripple count
- Target STPT number
- "SP" (STPT)

Note: When exiting the JDAMs DED page (CNI-Reset) the first target will be automatically selected by the system, meaning that the next release will be on the first target in the list.

4.2.9.13.7 SMS PAGE



JDAM SMS page

The SMS page contains the same data as the default type JDAM (Value 0) with the following additional information:

- Ripple count – Global ripple count, meaning that even if the ripple count that was specified in the DED for the current target is greater than this value, or for mode 3 the overall ripple on the targets is greater than this value, the ripple sequence will stop after the number of bombs of this value have been released.
- Target STPT ID – The current target STPT.
- Target Description – The name of the current target (the name that appears in the UI recon page).

4.2.9.13.8 RELEASE CONSIDERATIONS

Multiple targets support with a single pickle press

The difference between options 2 and 3 is that in option 2 there is no multi-targeting support. This means that every pickle press will release bombs on the current target STPT only. If Auto step is specified then the next target row will be selected automatically at release of the pickle. In option 3, multi-targeting is supported and so target step may happen in a single pickle press, for each target at the specified ripple count that was assigned to it. For example, in the profile that is described above (assuming there are 6 JDAM bombs loaded of the same type and the SMS ripple count is set to at least 6) and the target STPTs 7, 8, 9 and 10 are close to each other (so all targets are in-range when pickle is depressed), the FCC will release 2 bombs on STPT target 7, 2 bombs on STPT target 8, and 1 bomb for STPT targets 9 and 10.

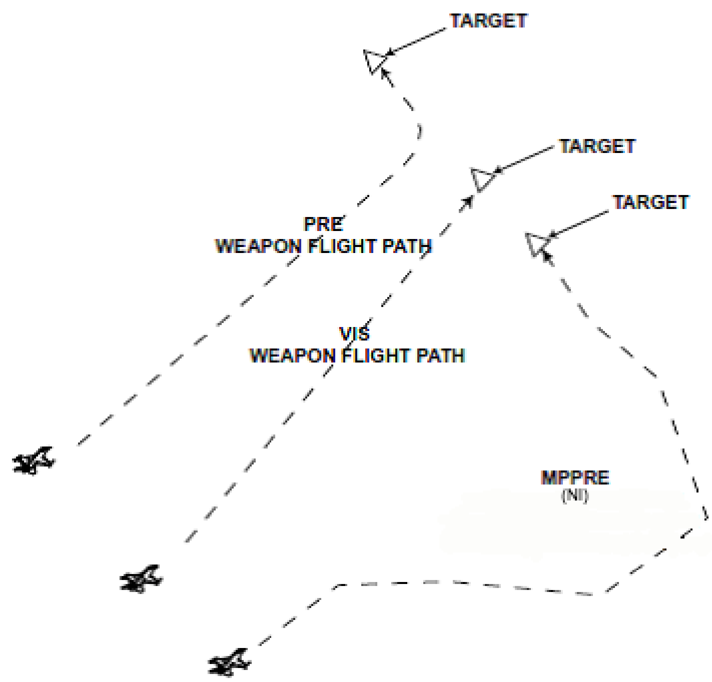
Note: For option 3, in the case that multiple targets are supposed to be targeted, the TD box and other target specific data will correspond to the average position between the targets with the current pickle press. The average information will be shown regardless of if the targets are in-range. It is the pilot’s responsibility to make sure that all targets are in-range at pickle depress, otherwise the sequence will stop when a target is out of range.

JDAM avionics option 2 is assigned by default in the BMS DB to IAF F-16 C/D versions.
JDAM avionics option 3 is assigned by default in the BMS DB to IAF F-16I version.

4.2.9.13.9 MISSION PLANNED PREPLANNED (JSOW)

MPPRE is unique to the JSOW weapon and provides for a single weapon release (no ripple available) against preplanned targets normally having associated waypoints. In MPPRE, the JSOW will fly through up to eight waypoints and then to the target on a final attack azimuth if defined. The weapon will revert to direct targeting along the attack azimuth if it cannot reach the target by flying through all the defined waypoints.

The figure below summarizes IAM delivery submodes and describes the associated weapon flight path profiles:



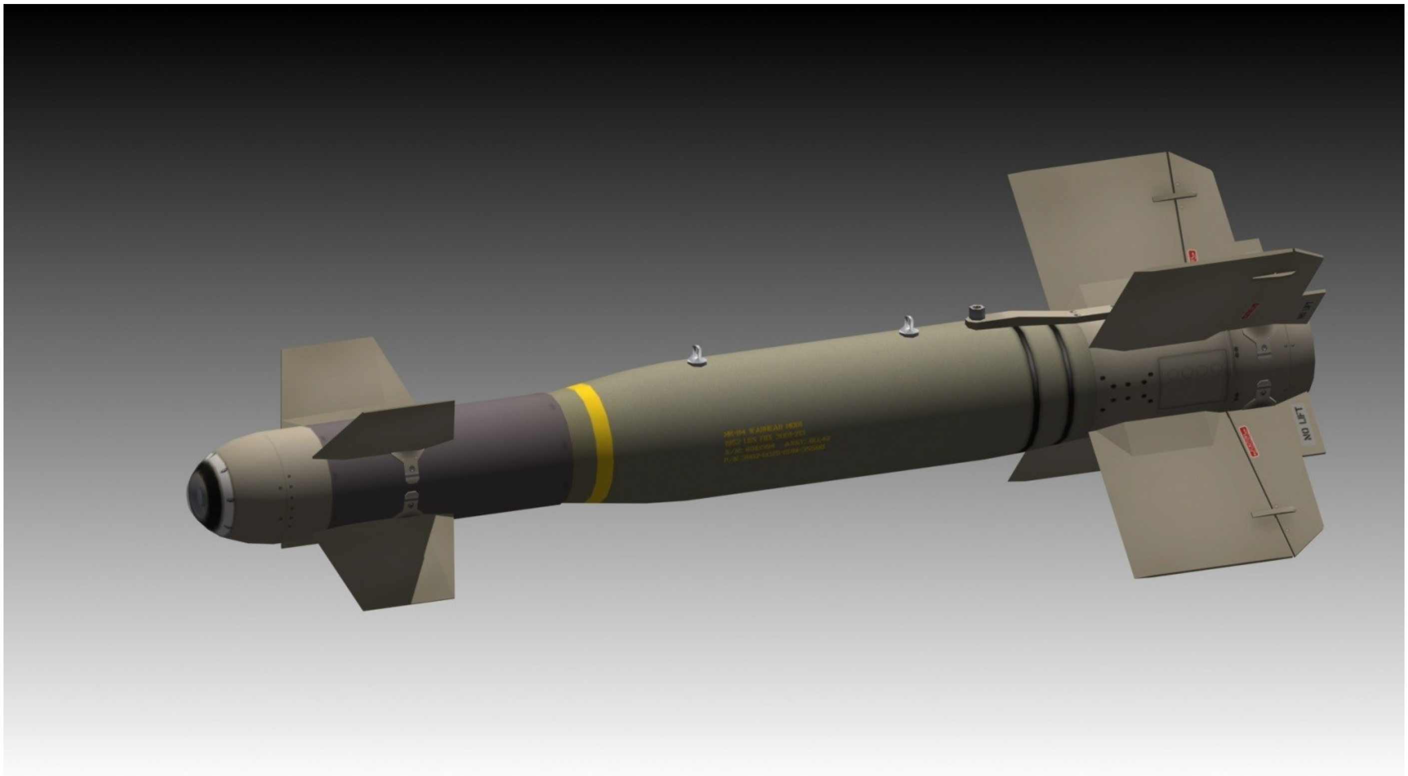
IAM delivery submodes weapon flight path profiles

PLEASE NOTE: *For now, until an appropriate UI DTC feature is implemented to support MPPRE waypoints definitions and management, MPPRE mode will not have waypoints support but only direct targeting or via attack azimuth. MPPRE mode can be selected only when the current STPT is a target STPT. When in MPPRE mode, FCR and TGP slewing will not affect target position and it'll stay permanently on the MPPRE location.*

WEAPON PARAMETERS SPECIAL NOTE: *While for each IAM all the MFD labels and options are implemented, only some of those parameters have a real effect in the simulation environment. For now, the following parameters have no real effect on gameplay although you can set/change their values: JDAM Impact Angle, JDAM Impact Velocity, WCMD Attack Azimuth (while not used for weapon flight it is used for ripple impact option to calculate impact spacing offset), WCMD Target Wind and WCMD Wind Source.*

4.2.10 MAN-IN-THE-LOOP WEAPONS

Man-in-the-Loop weapons are a family of weapons that allows the pilot/WSO to control the weapon after launch via data link. The pilot/WSO can guide the weapon manually to the target by sending the weapon maneuvering commands via data link, while watching the video image that is received from the weapon in real-time.

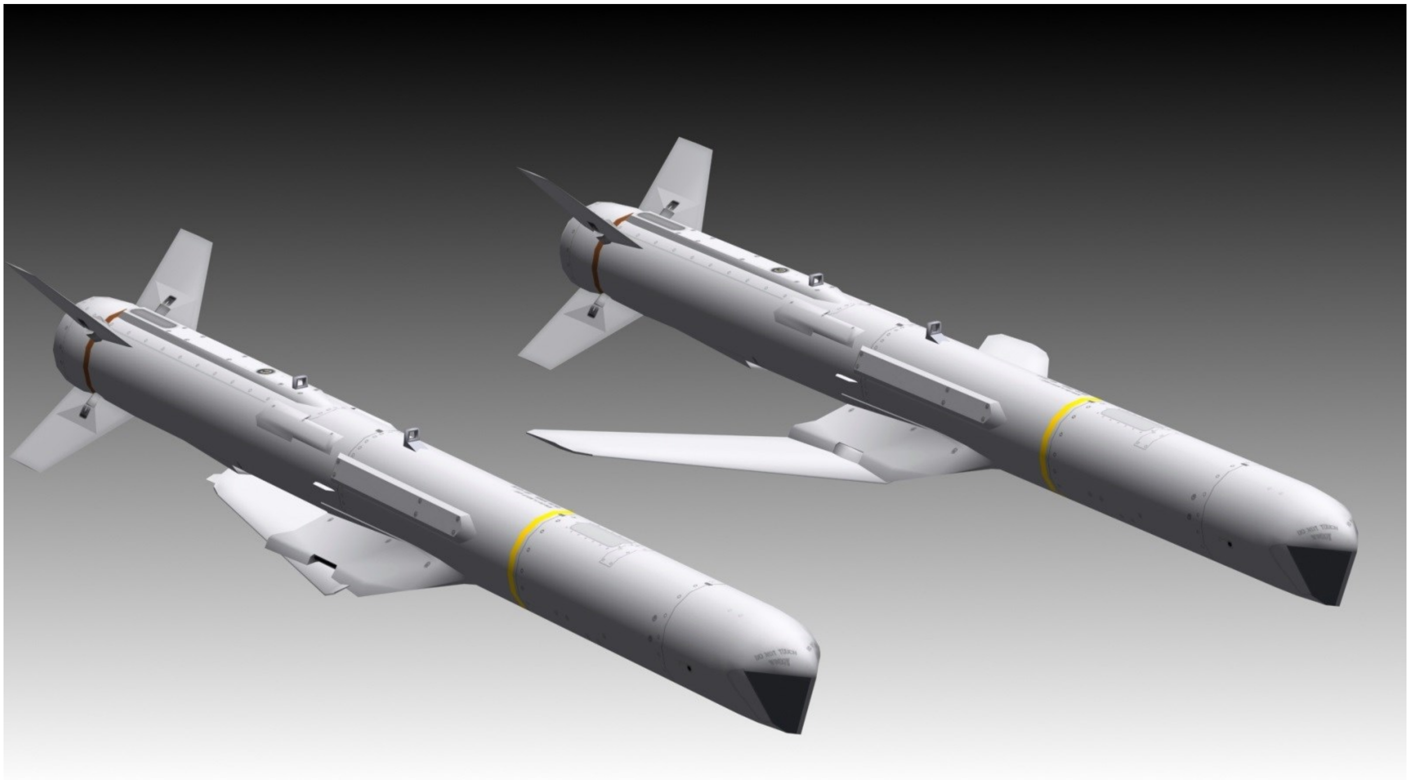


GBU-15

4.2.10.1 GENERAL INFORMATION

Data Link Pod: In order to keep communication with an airborne Man in the Loop weapon, the launching aircraft must carry a data link pod that matches the weapon. Data Link pods will be automatically loaded for AI controlled jets if the loadout decided by the ATO contains a MITL weapon. Human players must load the pod manually if they decide to load a MITL weapon.

Note: At this moment, buddy guidance of weapons is not implemented, so every launching aircraft must carry its own Data Link Pod.



AGM-84H SLAM-ER

The following table contains data for every Man in the Loop weapon that exists in the database and the Data Link Pod it requires. The middle "type" column specifies the value that is expected to be in the weapon's FM file in order to match a given pod:

Data Link Pod	Data Link Pod Type	Supported Weapons	Weapon Platforms
AN/AXQ-14	1	GBU-15 AGM-130	F-16D Block 30 IAF, D40, D40 IAF, F-16I, F-15I, F-4, F-15E
AN/ASW-55	2	AGM-142 Delilah TV	F-15I, F-15C-IAF, F-4 ESK, F-4F
AN/AWW-9 (aka AN/AWW-13)	3	AGM-62-1 AGM-62-2 AGM-84E SLAM AGM-84H SLAM-ER	F/A-18 F/A-18, F-4E IAF F/A-18, AV-8B+, F-15K
APK-9	4	AS-18	MiG-27, Su-30

Data Link Pods and supported MITL weapons

Weapon Generation

There are many variants of Man-in-the-Loop weapons—five different generations exist in BMS:

- 0th Generation – old and primitive Man-in-the-Loop weapons. They have no support for flight stages at all. Maneuvering commands sent to the weapon will be executed directly—meaning that the weapon is actually "flown" by the operator. Careless maneuvering commands may easily lead to loss of control over the weapon due to instability. An example of such a weapon is the AS-18 missile.

- 1st Generation—supports three different flight stages. Commands sent to the weapon move the aiming cross (and the video image) and the weapon executes yaw/pitch corrections accordingly in a direct fashion. There is no stabilized terminal stage. An example of such a weapon is the GBU-15 bomb.

- 2nd Generation—supports three different flight stages. Commands sent to the weapon move the aiming cross (and the video image) and the weapon executes yaw/pitch corrections. Corrections in TRANS mode are done only as soon as the operator stops moving the aiming cross. TERM mode supports a stabilized stage. There is an INS in the weapon so SPI reference position is supported. An example of such a weapon is the AGM-130 missile.

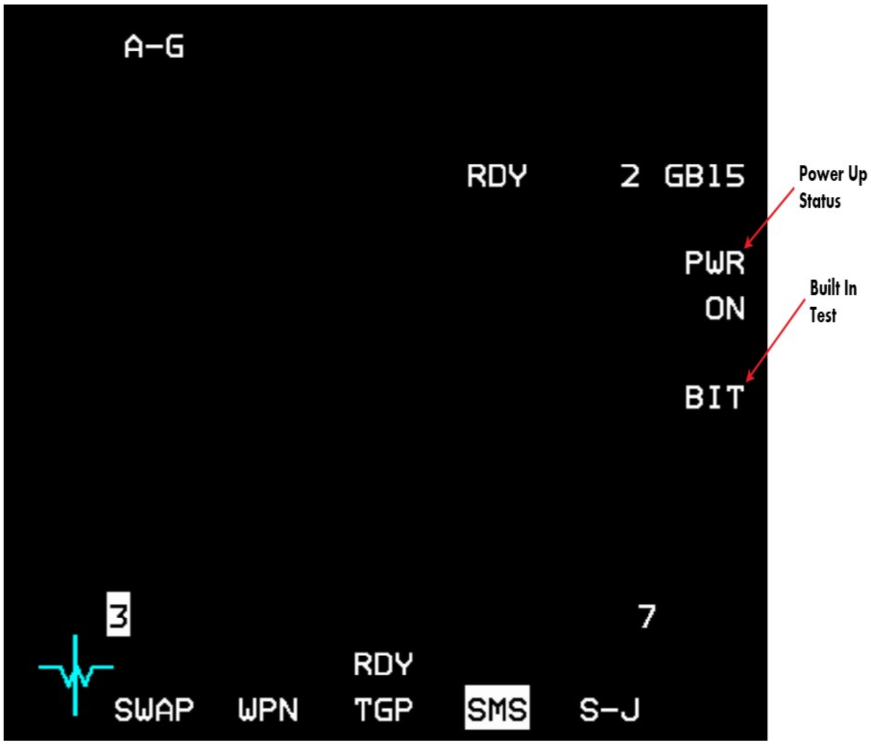
- 3rd Generation – weapons with on board GPS and autopilot capability. 2 flight stages exist, "CRUS" (cruise) and "TERM" (terminal). Relevant flight data relative to the target position will appear on the MFD:
    - Azimuth,
    - Speed,
    - Altitude,
    - Range,
    - Time-to-go,
    - Range to the reference SPI,
    - Bearing relative to the reference SPI.

  Commands sent to the weapon move the aiming cross (and the video image) and the weapon executes yaw/pitch corrections. While in CRUS mode the weapon will keep a pre-defined altitude and execute yaw corrections only when a specific command to do correction comes from the operator. The autopilot will keep the weapon aimed towards the reference SPI when in CRUS mode (in TERM mode the autopilot can be engaged but it has no functionality). TERM mode supports a stabilized stage. An example of such a weapon is the AGM-84E SLAM.

- 4th Generation – same characteristics as 3rd Generation but with an additional ability for a Go-Around function which supports automatic loiter over the target area. An example weapon is the AGM-84H SLAM-ER.

Delilah TV

4.2.10.2 SMS PAGE



Man-in-the-Loop SMS page

The Man-in-the-Loop weapon SMS page contains:

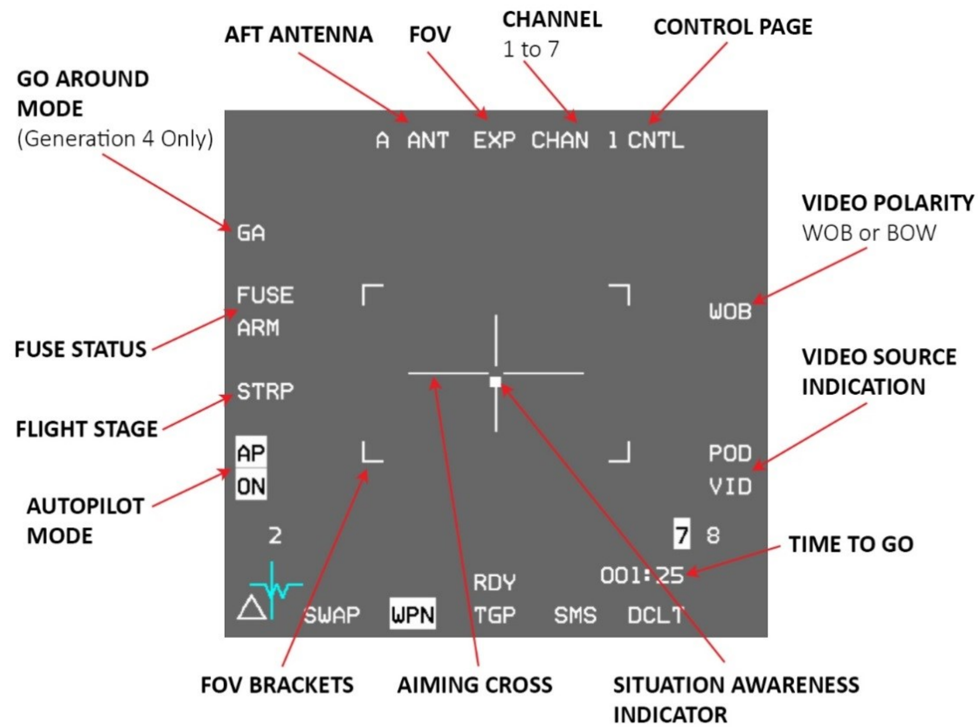
- Power up status – ON/OFF states
- BIT

Power: Once power is applied via OSB 7, all Man-in-the-Loop weapons on all stations will be powered up. A short BIT lasting a few seconds will be executed.

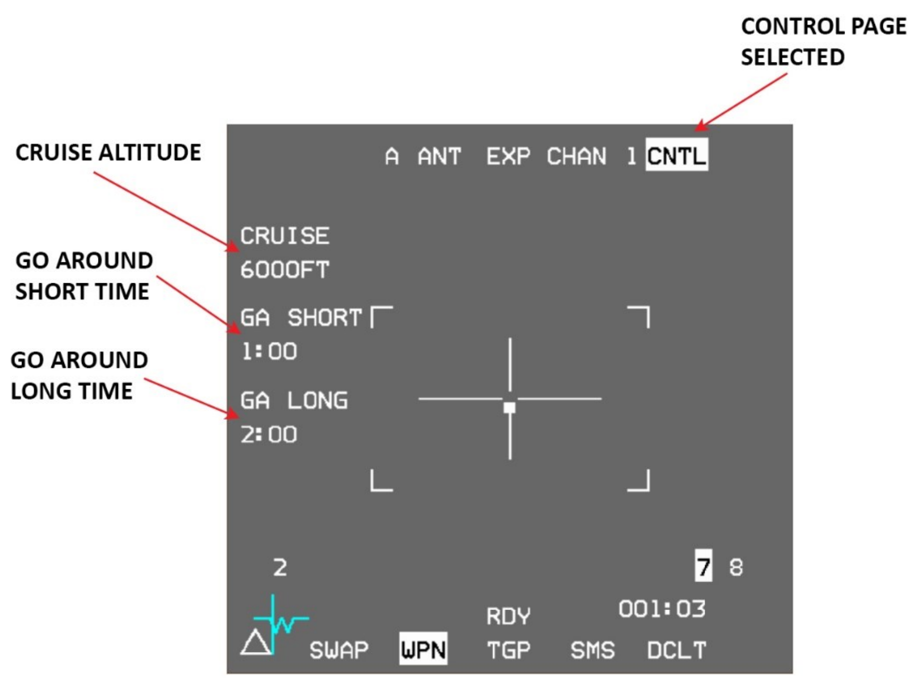
BIT: Built-In test on demand can be applied by pressing OSB 8. The BIT mnemonic will highlight for a few seconds during the BIT. During BIT the weapon cannot be launched.

Warm-up Time: There is a warm up time of three minutes before the weapon's video will be available on the WPN page.
While warm-up is ongoing, a "NOT TIMED OUT" message will appear on the SMS and WPN pages. As soon as the three-minute warm-up period has elapsed, the WPN page will display the video image that comes from the weapon's sensor (IR or TV).

4.2.10.3 WPN PAGE



Man-in-the-Loop WPN page - Strapped



Man-in-the-Loop WPN Control page - Strapped

Video Source: The POD VID label can be highlighted or un-highlighted, which indicates whether the displayed video image is coming through the data link pod or not. When the image is coming through the data link pod it means the weapon is airborne (launched) and it is transmitting the video image through the pod. If the label is not highlighted, the video image is coming from a weapon still strapped to the aircraft.

By pressing OSB 8 when there is a launched weapon airborne the pilot/WSO may switch between managing an airborne weapon or a strapped weapon that is on the aircraft.

Pressing OSB 8 POD VID when there is no airborne weapon to communicate with will result in a "NO SIGNAL" message appearing on the MFD and no video image will be visible.
If no matching Data Link Pod is loaded the POD VID label will be blanked.

Video Polarity: Can be selected between BOW/WOB. The MFD symbology will turn black/white accordingly. Only the symbology is affected; the image will not change polarity and will always be white-hot for IR sensors.

FOV: The EXP label will always appear under OSB 3. Pressing the OSB will switch the FOV between wide and narrow.

Channel: Channels 1-7 are available to control up to seven airborne weapons. Pressing OSB 4 will switch to the next channel. When a weapon is launched the selected channel at the moment of launch will be the channel used to control that weapon after launch. The channel cannot be switched after the missile is launched.

AFT Antenna: The A ANT label highlighted or un-highlighted will indicate if the rear antenna of the data link pod is used to keep data link communication with the weapon. Depending on the position of the weapon and the aspect of the aircraft, the rear antenna may need to be used in order to stay in contact with the weapon.
Signal strength and communication with the weapon depends on the ability of the pod's antenna to receive the signals from the weapon. The angular limitations of the front and AFT antennas are given in the table below:

ANT Mode	Azimuth limits (in degrees)	Elevation limits (in degrees)
Front	+/- 60°	+2° (looking up) -60° (looking down)
AFT	+/- 60° to +/- 165°	+5° (looking up) -90° (looking down)

The pilot must fly the aircraft inside the angular limitations in order to keep data link communication with the weapon. When there is no communication a "NO SIGNAL" message will appear on the WPN MFD instead of the video picture and the weapon will not receive any commands signals.

Weapon Stage:
The Weapon stage appears at OSB 17 and can be changed hands-off by pressing OSB 17 or hands-on via TMS-Up when the WPN page is SOI. For Generation 1 and 2 weapons, once the next stage is selected it is impossible to get back to a previous stage. Generation 3 and 4 weapons can get back from TERM stage to CRUS stage and also get out of ground stabilized TERM mode and back to non-stabilized mode. Generation 0 weapons do not use stages at all and OSB 17 will be blanked when such a weapon is airborne.

There are 4 possible stages:

1. STRP – Strapped – The weapon is still on the aircraft, pre-launch.

2. LOFT – For weapons of generations 1 and 2 only. The weapon in the LOFT stage is airborne and will keep a straight and level flight in order to save energy and not lose altitude.

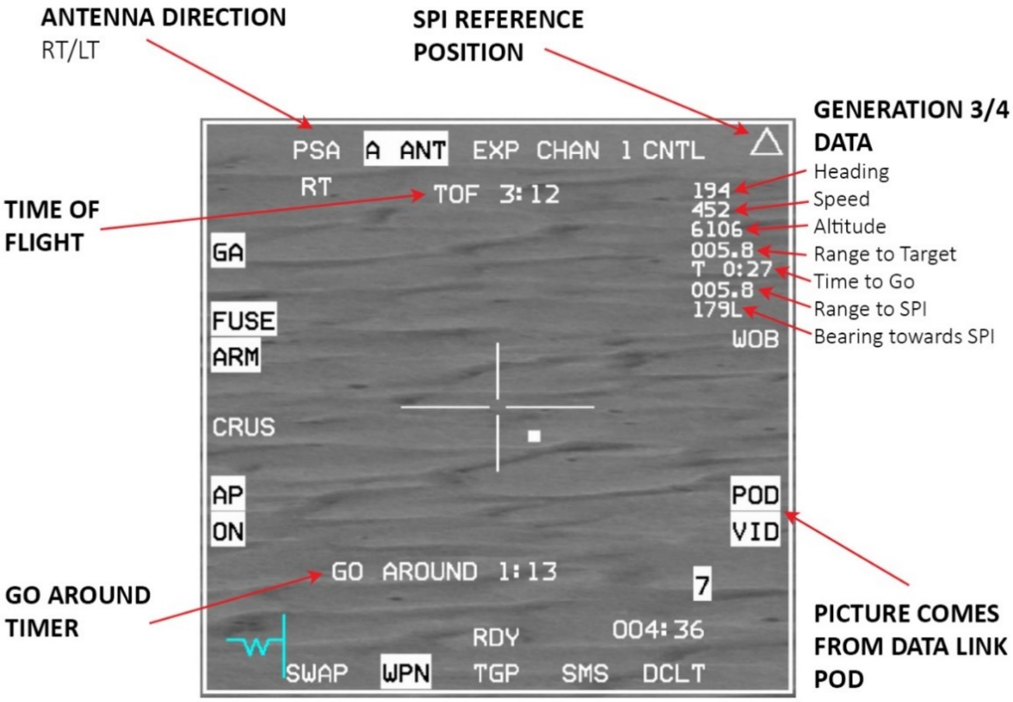
3. TRANS/CRUS:
   TRANS - Transmission – For weapons of generations 1 and 2 only. A weapon in TRANS stage will keep the nose at -3 degrees relative to the horizon. The weapon will correct azimuth according to the operator's aiming cross movements. Weapons of generation 1 will yaw immediately and continuously while weapons of generation 2 will only start yawing when the operator stopped slewing in order to save energy on potentially unnecessary maneuvers.
   CRUS – Cruise – For weapons of generations 3 and 4 only. After launch the weapon will enter CRUS mode and will level off at either launch altitude if cruise altitude was not defined, or at the defined cruise altitude. If autopilot is engaged the weapon will correct its bearing towards the SPI reference and without autopilot the weapon will fly straight ahead and will perform yaw corrections according to the aiming cross position only when the operator sends a command via TMS-Right.
   At TRANS/CRUS stages the weapon will not use its full manoeuvrability, but will only correct yaw gently in order to save energy.

4. TERM – Terminal – The weapon will become fully manoeuvrable and will align its attitude towards the target according to the command coming from the operator. At this stage the situation awareness indicator should be closing on the center of the aiming cross, meaning that the weapon's head is aligning towards the target. For generation 2 weapons and above, terminal stage also has a ground stabilized mode that will be entered once the pilot commands TMS-Up when already in TERM stage. Weapons of generation 3 and 4 can get out of ground stabilized mode via TMS-Down.

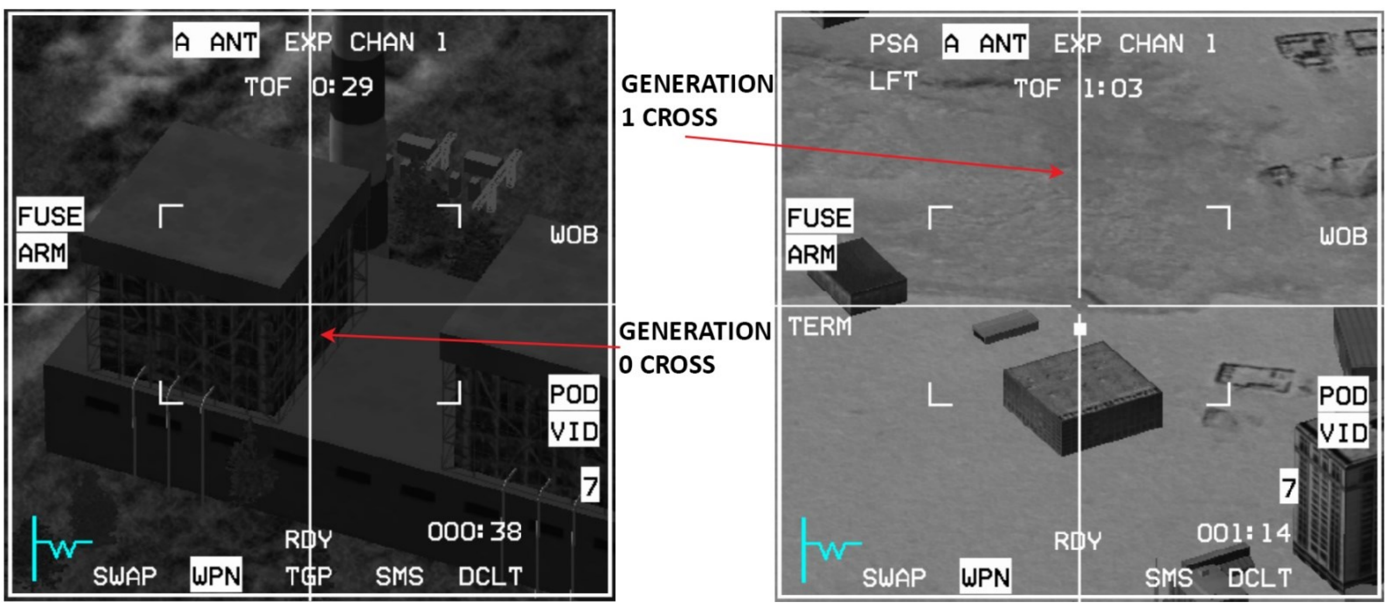
Fuse State: The FUSE ARM mnemonic at OSB 18 will be highlighted if the weapon's fuse is active. The fuse can be armed before the weapon is launched, or while the weapon is airborne. The fuse must be armed for the weapon to detonate when hitting the ground/target.

AP Mode: The Autopilot Mode mnemonic at OSB 16 will appear on the MFD For weapons of generation 3 and 4. The options are ON/OFF and the mnemonic will be highlighted when ON mode is selected. AP ON means that the weapon will align its bearing with the reference SPI position. Autopilot Status may be changed while the weapon is airborne.

4.2.10.3.1 WPN PAGE FOR AIRBORNE WEAPON



Man-in-the-Loop WPN page - Airborne



Generation 0/1 Airborne WPN page

TOF: The TOF indication represents a timer that counts minutes and seconds since the weapon was launched.

PSA Side: The PSA Side indication indicates the direction of the weapon's antenna relative to the position of the target.

SPI Reference Position: For Generation 2 - 4 weapons a Reference SPI position, represented by a triangle, is shown in the display. While the weapon is strapped to the aircraft the triangle will move if the SPI position in the system is moved. After launch the SPI reference position will represent the SPI position of the system at the time of launch. After launch The SPI reference position may be updated by the operator via 2 x TMS-Right < 0.5 seconds and if Autopilot is engaged the weapon will correct heading towards the updated SPI reference position.

Generation 3/4 Data: For Generation 3 and 4 weapons a data set will be displayed in the top-right corner of the video image. The data set will include the following information:

- Heading – The current heading of the weapon.
- Speed – Speed of the weapon in knots.
- Altitude – The altitude of the weapon in feet above sea level.
- Range To Target – The range to the current target (where the aiming cross is pointing) in Nm.
- Time To Go – Time until the weapon will impact on the current target. Format is M:SS for minutes and seconds.
- Range To SPI – Range to the reference SPI in Nm.
- Bearing towards SPI – The bearing relative to the reference SPI. R/L will indicate Right or Left.

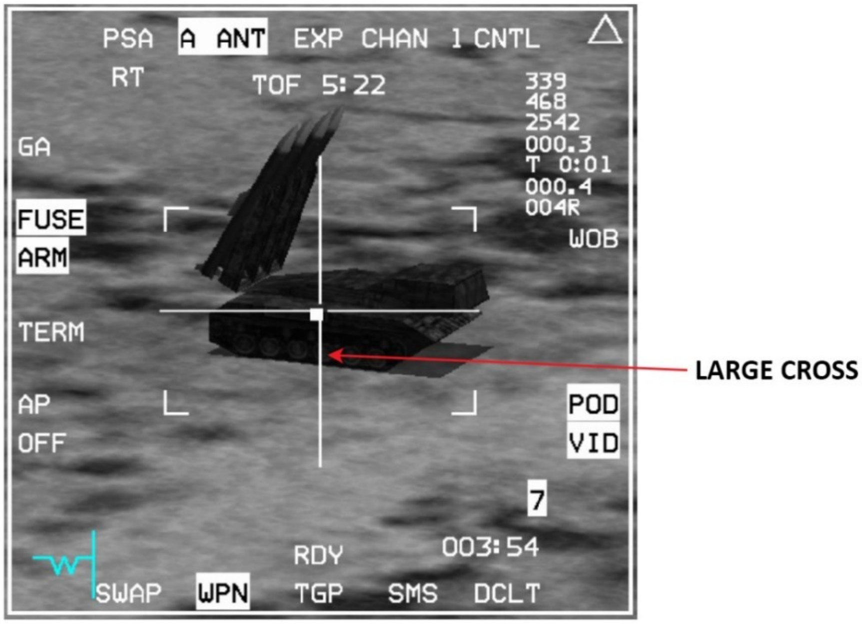
Cruise Altitude: Generation 3 and 4 weapons have an option to set a cruise altitude that the weapon will try to maintain while in CRUS flight stage. The cruise altitude setting is positioned in the WPN Control page near OSB 19. Pressing the OSB will switch the MFD to a cruise altitude data input page. The input must be made of exactly 3 digits which will define the flight level of the cruise altitude. For example in order to set 5000 feet, the input in the data page should be 050.

Go Around Mode: Generation 4 weapons have an option to loiter in the target area without operator involvement. GA mode can be set to SHORT, LONG or OFF. Setting it to SHORT or LONG when the Autopilot is engaged will command the weapon to fly past the SPI reference position without changing heading. The weapon will keep flying away until 1 minute remains on the GA timer when the weapon will start turning back towards the SPI position. The turnaround manoeuvre should take about 1 minute, so the weapon should be aligned towards the target when the timer reaches 0.

If GA mode is set to SHORT or LONG then the GA label at the center bottom part of the MFD will display the GA SHORT/LONG mode if the weapon has not yet passed the SPI position, or the time until the weapon is expected to be aligned with the SPI if the SPI has already been passed. Once The GA timer has started counting it will keep showing updated numbers even if communication with the weapon is lost momentarily; this is useful as the operator can use the time until the weapon comes back from the GA manoeuvre to operate the aircraft.

While in TERM mode, Go Around can be commanded with TMS-Right. The weapon will go back to CRUS flight stage, AP will be engaged and GA mode will be set to SHORT. A second TMS-Right will switch the GA mode to LONG and another TMS-Right will switch GA OFF. The GA SHORT and LONG timers may be set in the Control page via OSBs 18 and 17 accordingly. Pressing one of the other OSBs will switch the WPN page to Go Around Time data input mode; the input must be made of exactly 3 digits which will define minutes and seconds in M:SS format. For example, for entering 1:30 to the timer, the input in the data input page should be 130.

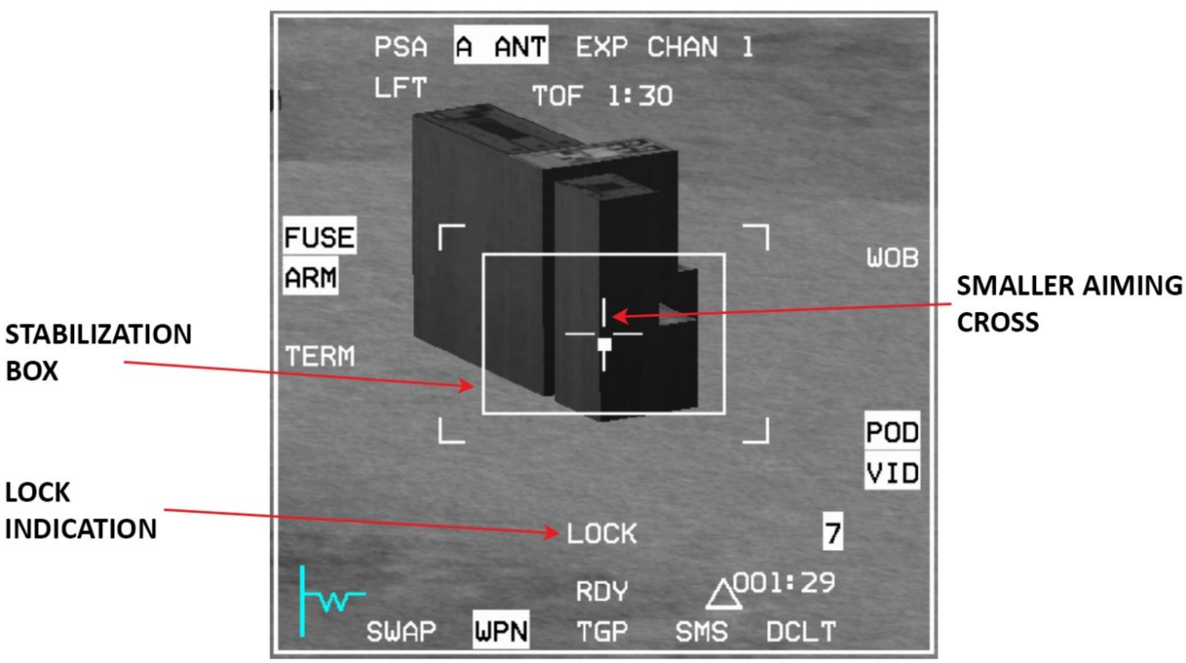
4.2.10.3.2 STABILIZED WPN PAGE FOR AIRBORNE WEAPON



Man-in-the-Loop WPN page – Generation 3/4 – Ground Stabilized

In order to improve aiming in the final moments before reaching the target, generation 2, 3 and 4 weapons can enter ground stabilized mode during the terminal flight stage. Commanding TMS-Up while in TERM will cause the weapon's sensor to attempt to enter ground-stabilized mode. If it succeeds, the video image will become ground stabilized.

- Generation 3/4 weapons in Ground Stabilized mode have a much larger cross than in non-stabilized modes. The cross will move with slew commands, similar to AREA mode in the TGP. The image will be stable and the situational awareness indicator will show the weapon's attitude with relation to the target position.



Man-in-the-Loop WPN page – Generation 2 – Ground Stabilized

Generation 2 Ground Stabilized mode has the following additional information:

- Stabilization Box.
- LOCK mnemonic – To notify that the aimpoint is locked by the weapon.
- The Aimpoint Cross will become smaller.

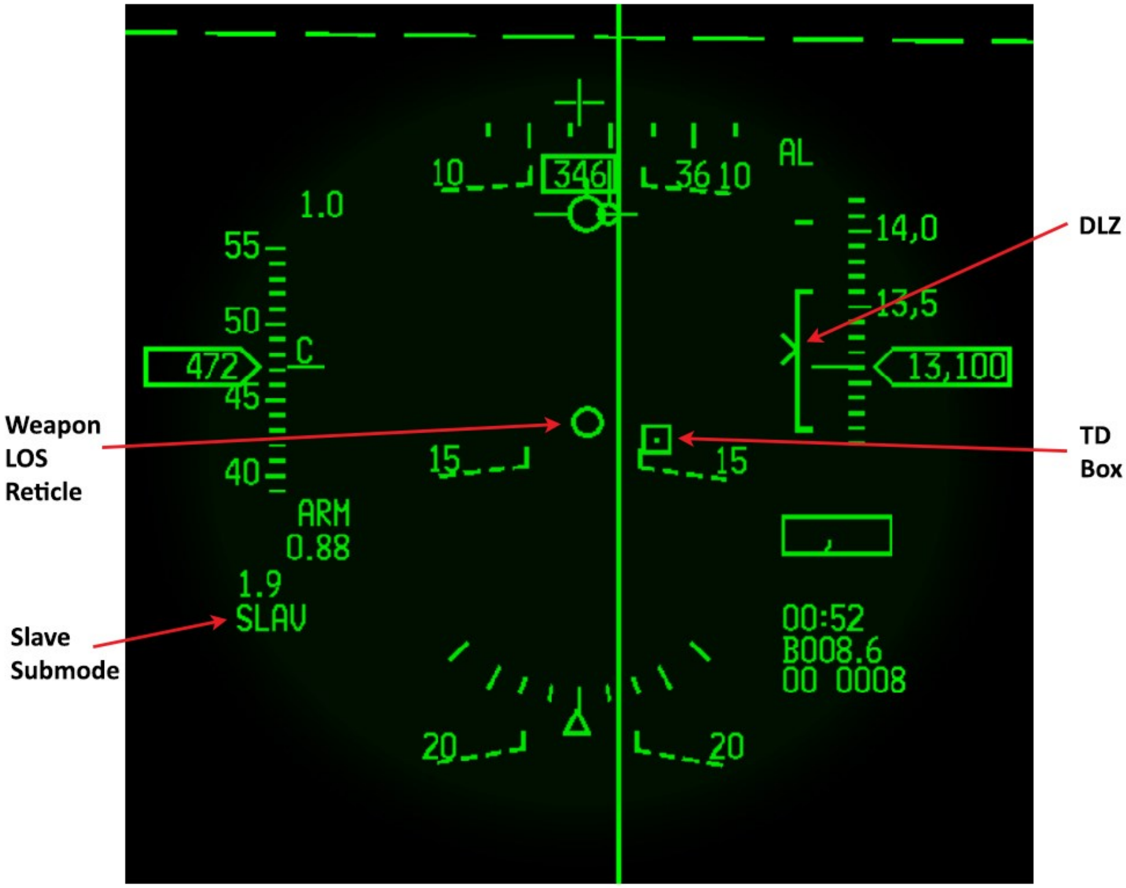
When in ground stabilized mode, the aimpoint of the weapon is controlled by moving the cursor as usual. As the cursor is moved a second cross will appear on the video image and will move away from the current aimpoint towards the new aimpoint. If the operator commands TMS-Up the "LOCK" mnemonic will disappear from the display and the original aiming cross will move towards the new aimpoint and settle there to join the new cross. At this point the "LOCK" mnemonic will reappear to notify that the sensor is now locked on the new aimpoint.

4.2.10.4 MAN IN THE LOOP HANDS-ON CONTROLS

Control	Functionality	Condition
TMS-Up	Toggle Flight Stage/ Enter stabilized Mode	Generations 1-4
TMS-Up Long	Toggle Fuse Arm	
TMS-Right	Command/ Toggle Go Around mode	Generation 4
2xTMS-Right < 0.5 Seconds	Update SPI Reference position to the cross aimpoint position	Generations 2-4
TMS-Right Long	Command weapon to align azimuth with the cross aimpoint	Generations 3-4 in CRUS flight stage
TMS-Left	Toggle Polarity	
2xTMS-Left < 0.5 Seconds	Toggle AFT-Antenna	
TMS-Left Long	Toggle Autopilot	Generations 3-4
TMS-Down	Cancel Ground Stabilized mode	Generations 2-4 in TERM mode
	Switch from TERM mode back to CRUS	Generations 3-4 in TERM mode

Man in the Loop Hands-On Controls

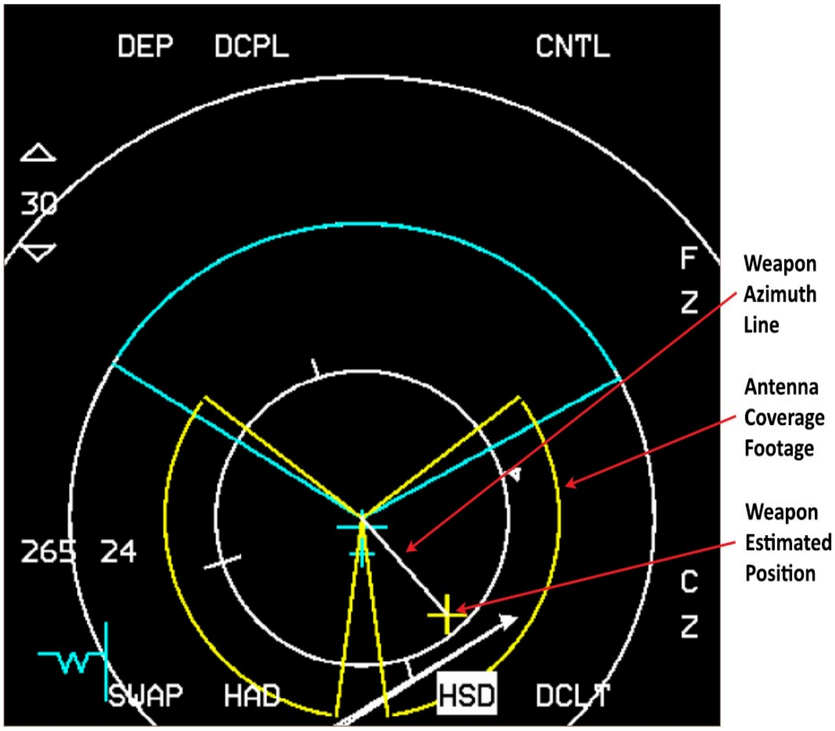
4.2.10.5 HUD



Man-in-the-Loop Weapon HUD

When a Man-in-the-Loop weapon is selected the HUD will be in Slave mode. The TD-Box will be located where the SPI is pointing and a 10 mr LOS reticle will represent the weapon's LOS position. The LOS reticle represents the LOS of the current strapped (next to be launched) weapon only.

4.2.10.6 HSD PAGE



Man-in-the-Loop Weapon HSD

When a Man-in-the-Loop weapon is selected, the HSD will display additional symbology.

Antenna Coverage Footage: This represents the footprint of the antenna mode that is currently selected, relative to the aircraft position. It will be displayed irrespective of the currently selected HSD range.
The antenna footprint will be displayed with or without an airborne weapon.

Weapon Estimated Position: When there is a weapon airborne, the estimated position of that weapon is displayed on the HSD as a yellow cross. If communication with the weapon is lost the cross position will be based on the last known position and estimated movement since.

Weapon Azimuth Line: When there is a weapon airborne, an azimuth line is displayed on the HSD. The line will originate from the aircraft symbol and end at the weapon's estimated position.
When communication with the weapon is lost this azimuth line will be dashed.

Please note that the weapon-dependent symbology is always related to the airborne weapon that is currently being managed according to the selected channel.

4.2.10.7 WEAPON RELEASE PROCEDURE

1. Power up the weapon from the SMS page, early enough for the 3 minutes' warm-up duration.
2. Set the SPI position to the general area of the target (optional).
3. Select the WPN page and make it SOI.
4. Use the cursor and aircraft maneuvers to have the weapon's LOS close to the target position (optional).
5. Set TGP/HSD on the other MFD to aid post-launch operation (optional).
6. When in-range – Pickle to release the weapon.
7. Manoeuvre the aircraft in order to fly away from the target as necessary (optional).
8. Select the appropriate antenna mode and verify that data link communication with the weapon is stable.
9. Watch the weapon course and verify that it is on track to target. If not then move to an appropriate flight stage and correct course as necessary.
10. When close to target, enter terminal stage and arm the fuse.
11. For finer aiming, stabilized mode should be entered (optional).
12. Correct course or target position (stabilized mode) in order to hit the target effectively.

Note: These release procedures may not *all* be relevant for *all* generations of weapons. Generation 0 weapons in particular need to be managed closely right after launch because of the lack of flight stages support.

Note: Man-in-the-Loop weapons are always hot and will be launched whenever the pickle is depressed, even if launch conditions are not satisfied.

4.2.11 DUAL MODE WEAPONS

4.2.11.1 GBU-54 LASER JOINT DIRECT ATTACK MUNITION (JDAM)

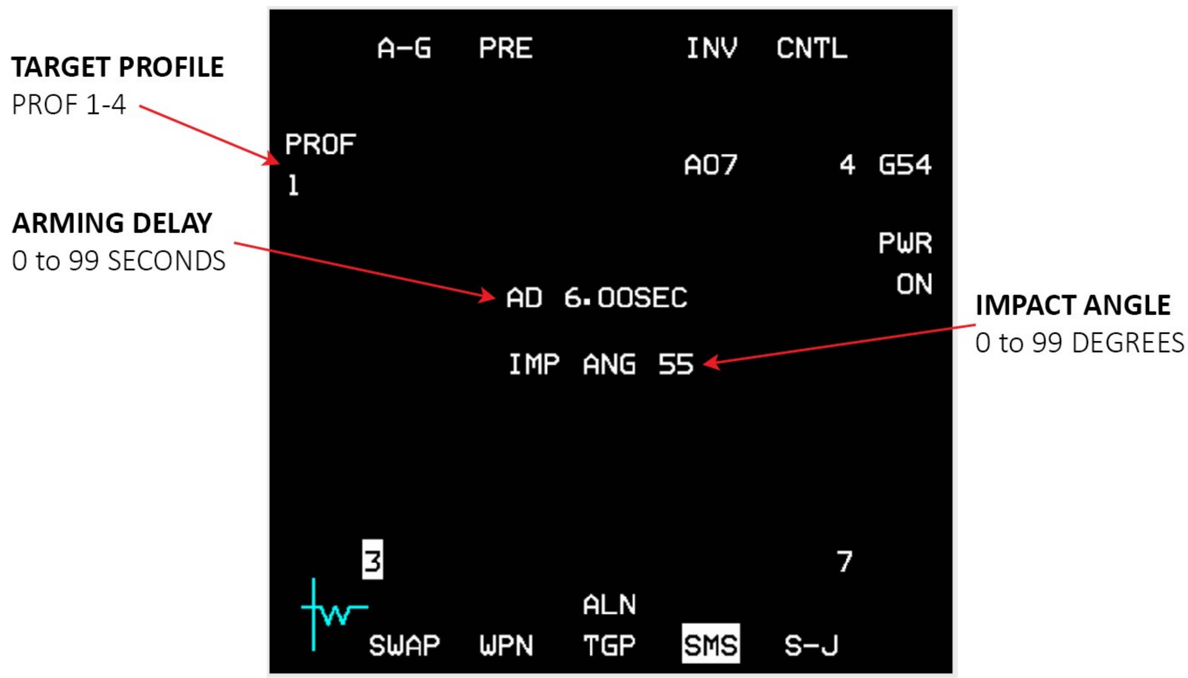
Laser JDAM expands the capabilities of JDAM as it allows dual guidance with a Precision Laser Guidance Set (PLGS) added to JDAM guided bombs. The GBU-54 is based on the Mk-82 500lb GP bomb.

The Laser JDAM either be released to fly independently to the target like a JDAM, or guide to any stationary or moving target by tracking a laser spot like a Laser Guided Bomb. Laser JDAM does not require continuous lasing if the target is stationary, because unlike LGBs, LJDAM extracts coordinates from the laser spot position, so even lasing for a few moments will cause the bomb to change target towards the laser spot position and it will keep heading towards the updated position without the need to lase continuously.

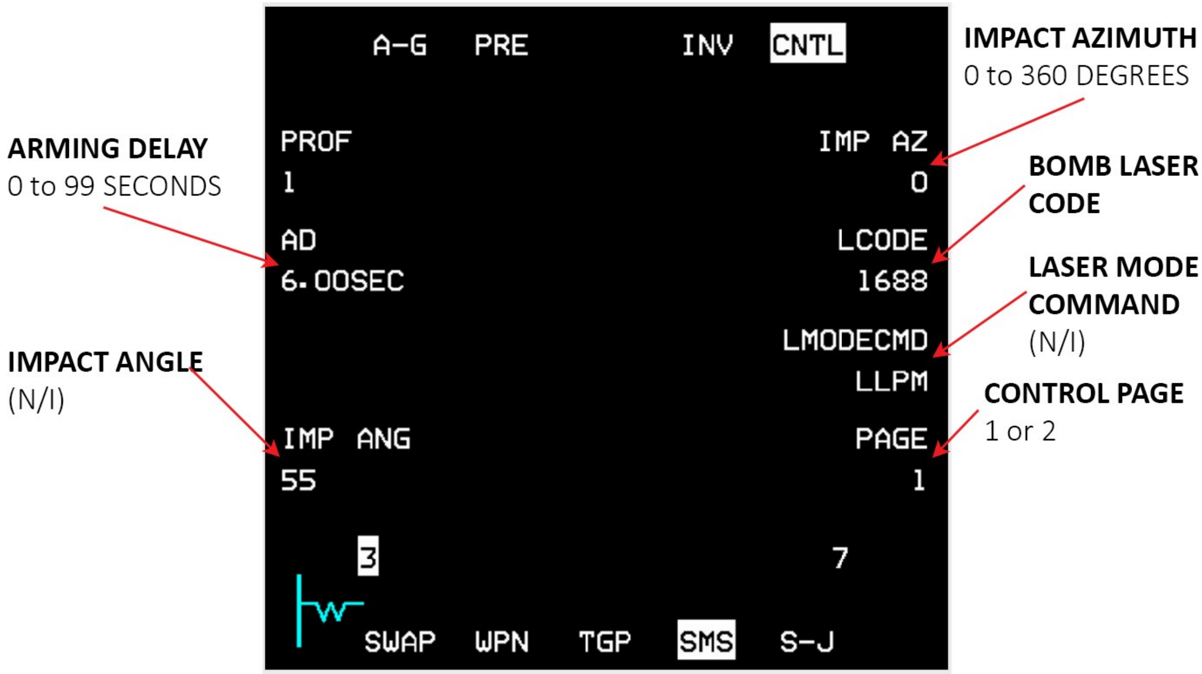
GBU-54 Laser JDAM

Note: the Laser JDAM control page contains 2 subpages. The subpages can be toggled via OSB 9.

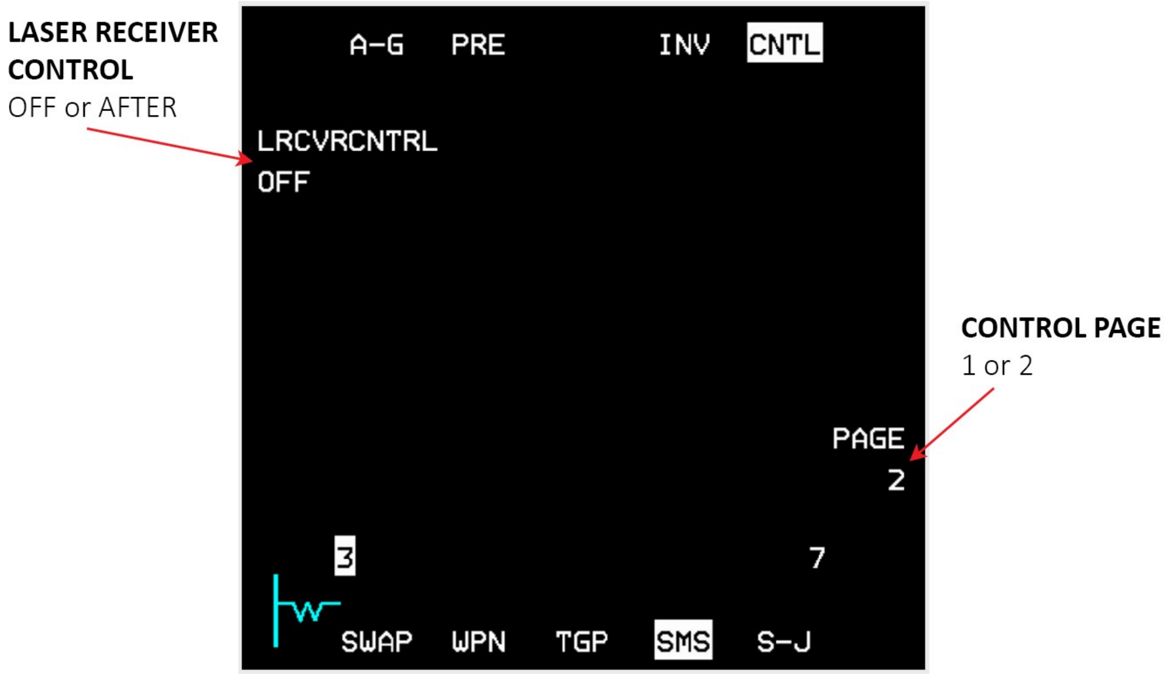
4.2.11.1.1 GBU-54 SMS PAGE



Laser JDAM SMS base page



Laser JDAM SMS control page



Laser JDAM SMS control page 2

4.2.11.1.2 LASER CODE FOR LASER JDAM

The laser code for Laser JDAM can be changed while airborne via OSB 7 in control page 1. Pressing OSB 7 will switch the MFD to input display mode where the new laser code can be entered. Valid values for the laser code are between 1511 and 1788. The laser code is only changed for the selected weapon and doesn't apply to any other Laser JDAMs loaded on the jet; so unless a different laser code (than the default) is necessary, it will still be more efficient to load all the bombs with the required laser code in the LOADOUT screen before the flight.

4.2.11.1.3 LASER RECEIVER MODE FOR LASER JDAM

The laser receiver mode can be found in control page 2 and the valid values are either OFF or AFTER. The receiver mode defines whether the bomb will operate the laser receiver after release. The default value is OFF which means that the laser receiver will not operate after release and the bomb will act as a JDAM only. Switching to AFTER mode before a drop will instruct the bomb to operate its laser receiver; if a laser spot with matching laser code is detected, the bomb will follow the laser spot coordinates. For static targets Laser JDAM doesn't require continuous lasing like LGB's because once a laser spot is detected, the bomb will extract the coordinates from the laser spot and use those coordinates to maneuver to the updated target position.

When impact azimuth is set for Laser JDAMs and the bomb is released within LAR2 range to follow the selected azimuth, the bomb will follow the laser spot only at the end game maneuver towards the target.

If impact azimuth is selected and the laser spot is too far away from the target position that the bomb was released at, the end game maneuver may be too great for the bomb to reach the target.

4.2.12 CLUSTER BOMBS AND DISPENSER MUNITIONS

4.2.12.1 UNGUIDED CLUSTER BOMBS AND DISPENSER MUNITION

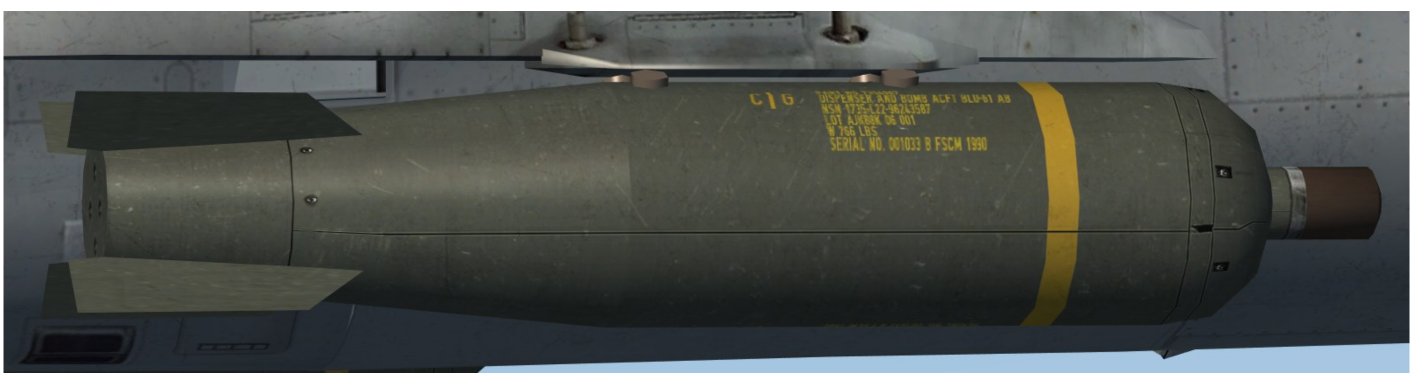
Cluster bombs are devices that contain multiple submunitions and can be either retained on the aircraft or deployed as freefall units. When the dispensers remain attached to the aircraft, the submunitions are dispensed by being ejected through the bottom of the dispenser. On the other hand, dispensers released as freefall units are constructed as clamshells, with either two longitudinal sections (SUU-30) or three longitudinal sections (SUU-64/65).

Upon release, the clamshells of the dispensers disassemble either at a predetermined time or at a specific altitude, allowing the submunitions within to be released. These submunitions are designed as bomblets or mines, intended for engaging various targets such as light materiel, personnel, or armored vehicles.

4.2.12.1.1 MK-20

The Mk-20 can be used in BMS for modern blocks, but it is by default no standard loadout for the F-16 Blk50/52.

4.2.12.1.2 CBU-52/58/71

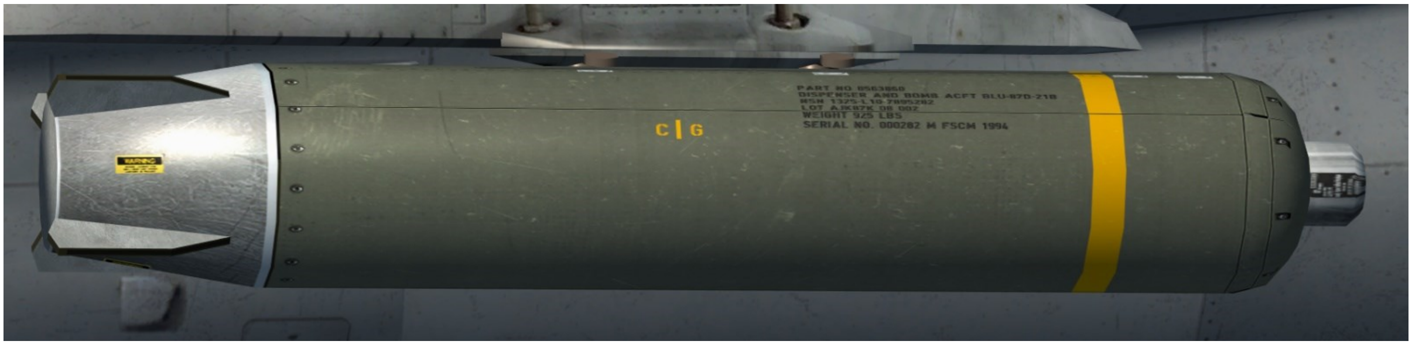


The CBU-52/58/71 can be used in BMS for modern blocks, but it is by default no standard loadout for the F-16 Blk50/52.

4.2.12.1.3 CBU-87/B CLUSTER BOMB COMBINED EFFECTS MUNITION (CEM)

The CBU-87/B combined effects munition (CEM) comprises a SUU-65/B Tactical Munitions Dispenser (TMD) and 202 BLU-97/B bomblets. When using CEM, only two of the available ground-selectable spin rates are utilized: setting 3 (1000 rpm) and setting 5 (2000 rpm).

The BLU-97/B bomblet features a scored steel casing designed to fragment into approximately 300 preformed 30-grain fragments, which effectively counter light armor and personnel threats. It includes a forward-firing shaped-charge liner for armor penetration and a zirconium ring to enhance its incendiary capabilities. To provide drag, orientation, and flight stability for the bomblet, an air inflatable decelerator (AID) or ram-air decelerator (RAD) is securely enclosed within a cap known as a spyder. This ensures proper deployment and control during flight.



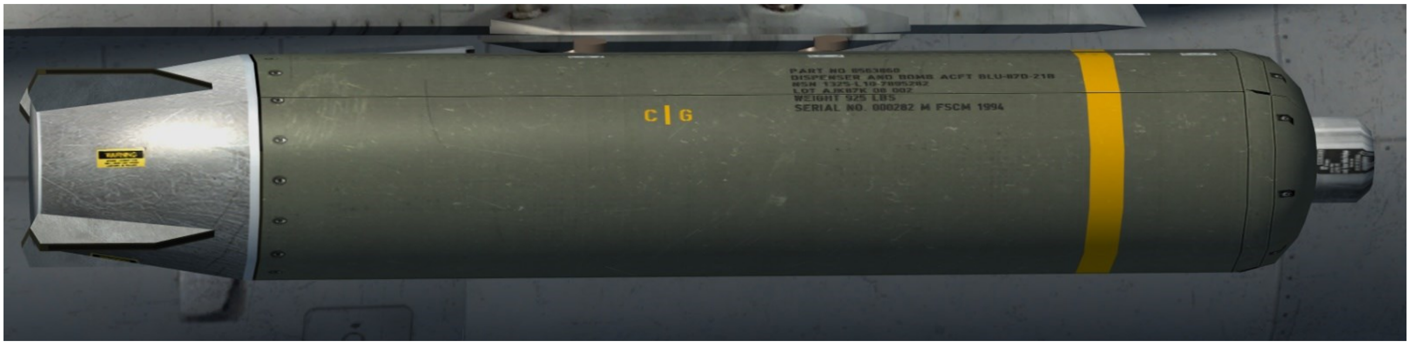
CBU-87 CEM

4.2.12.1.4 CBU-94/B GRAPHITE WEAPON

The CBU-94/B, also known as the "Blackout" cluster bomb, is specifically designed for targeting electrical power infrastructure. It utilizes the BLU-114/B special-purpose munition, which is housed within either the SUU-65/B or SUU-66/B dispenser.

The BLU-114/B, resembling the BLU-97/B in size and shape, contains chemically treated carbon graphite filaments, a small explosive charge, and a parachute-retard system. Packed into a cylindrical casing, it is intended to disrupt and disable electrical power systems.

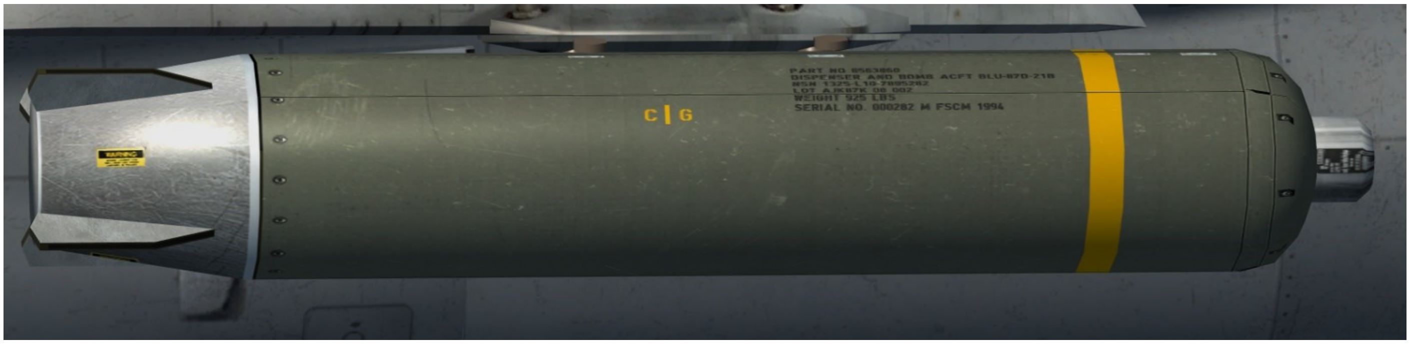
Due to its unique characteristics, the CBU-94/B has earned the nickname "graphite bomb." It is employed to inflict damage on electricity-related infrastructure targets, effectively causing power outages and disrupting enemy operations.



CBU-94/B Graphite

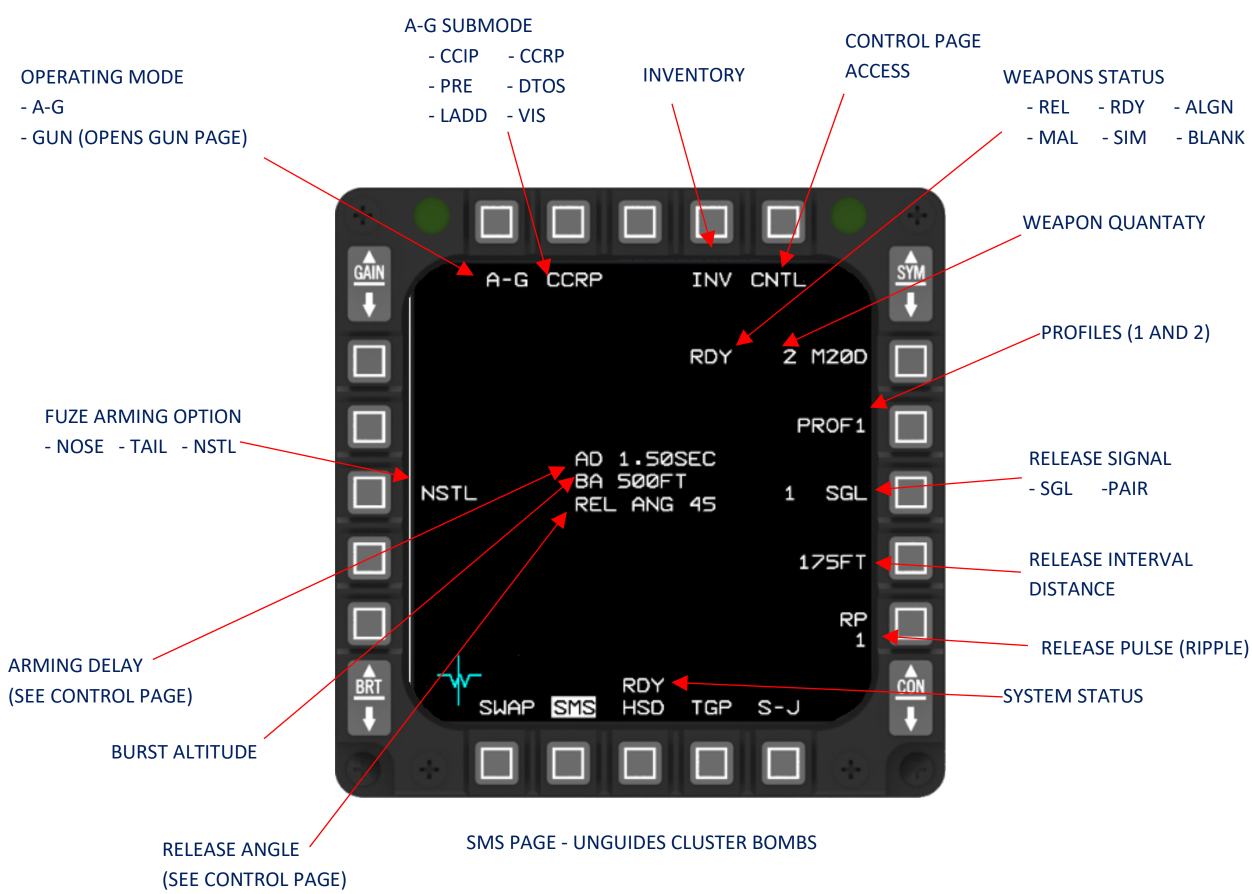
4.2.12.1.5 CBU-97/B SENSOR FUZED WEAPON

The CBU-97/B Sensor Fuzed Weapon (SFW) is comprised of several components, including the SUU-66/B Tactical Munitions Dispenser (TMD), an airbag dispensing system, 10 BLU-108/B submunitions arranged in two bays of five, an integral timer fuze, and the FZU-39/B proximity sensor. The primary objective of the SFW is to offer a capability of multiple kills per pass against a range of targets such as tanks, armored vehicles, artillery, APCs (Armored Personnel Carriers), and support vehicles.



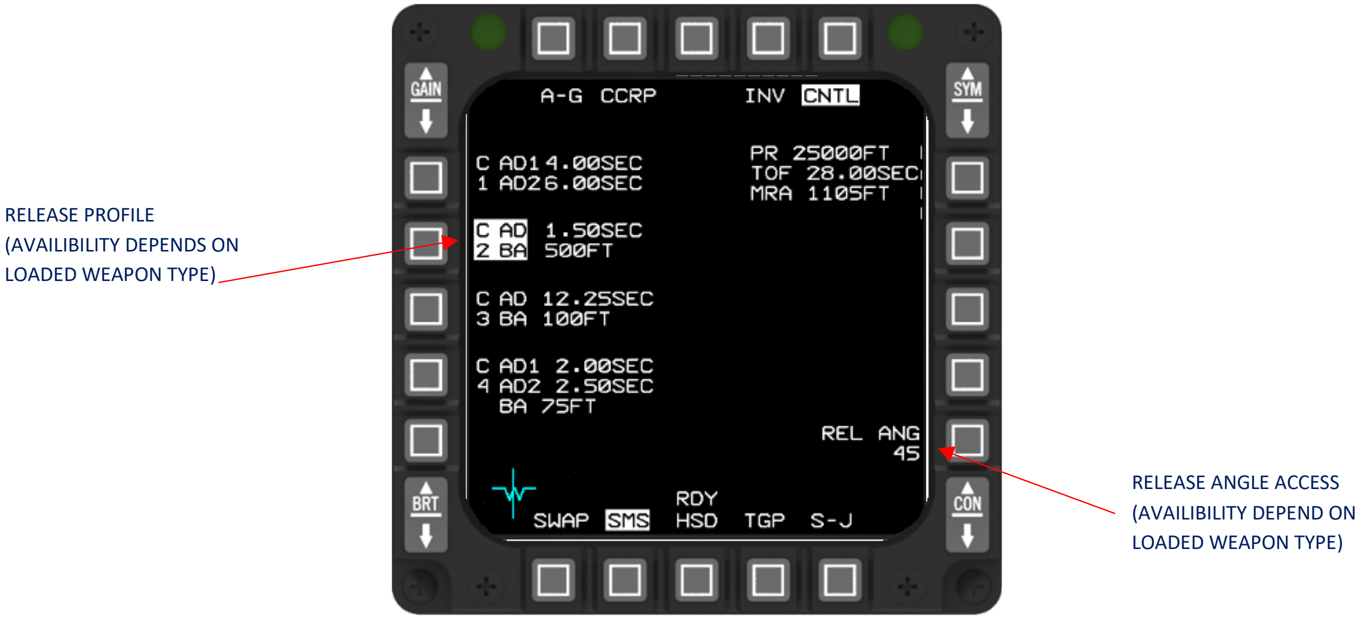
CBU-97/B SFW

4.2.12.1.6 SMS PAGE – UNGUIDED CLUSTER BOMBS

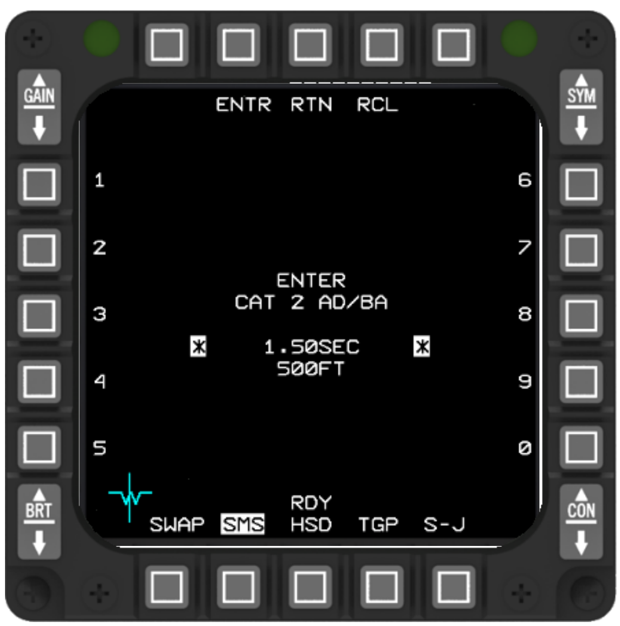


SMS PAGE - UNGUIDES CLUSTER BOMBS

4.2.12.1.7 CNRL PAGE – UNGUIDED CLUSTER BOMBS



CNRL PAGE - UNGUIDES CLUSTER BOMBS



CNRL PAGE – DATA ENTRY FOR ARMING DELAY/BURST ALTITUDE

4.2.12.2 WIND CORRECTED MUNITIONS DISPENSER (WCMD)

4.2.12.2.1 CBU-103/104/105

WCMDs are Cluster Bomb Units (CBUs) that include a tail kit containing an INS that is used to guide the weapon to an upwind dispense position to allow the submunitions to drift over the target (WCMDs do not contain a GPS). WCMD allows release within a launch envelope. With the WCMD tail kit, the CBU-87 Combined Effects Munition (CEM) becomes the CBU-103; the CBU-89 Gator becomes the CBU-104 and the CBU-97 Sensor Fused Weapon (SFW) becomes the CBU-105. WCMDs can be loaded onto the A-10C and the F-16.

CBU-105 SFW

4.2.12.2.2 SMS PAGE WCMD

WCMD SMS base page

4.2.12.2.3 CNRL PAGE WCMD

WCMD SMS control page

4.2.12.2.4 IMPACT OPTION WCMD

Impact option provides the capability to select whether one or two weapons may be released against a target. The option to select whether two weapons may be released against one target is only available for JSOW (PRE and VIS delivery submodes only) and WCMD. The impact option is selectable for change via OSB 19 on the WCMD weapon base pages. The impact option is not displayed on the SMS control pages. Depressing OSB 19 on the base page rotaries though the allowable impact options that are summarized below. The following are WCMD Impact Geometries:

- Single (One Triangle). One weapon is to be dropped on the target.
- Tandem (Two Triangles Stacked Vertically). Two weapons are to be dropped on the target with impact points along the attack axis. The first weapon in the ripple sequence (currently selected weapon) will be released against the short impact point and the second weapon will be released against the long impact point.
- Side-By-Side - (Two Triangles Abreast) Two weapons are to be dropped on the target with impacts points perpendicular to the attack axis. The station 3 weapon will be released against the left impact point and the station 7 weapon will be released against the right impact point.

4.2.12.2.5 IMPACT SPACING WCMD

The impact spacing value determines the distance between the centers of the two submunition dispense patterns during a ripple release (tandem or side-by-side). The pilot defined target location is the center of the combined sub-munitions patterns. The impact spacing can be changed using OSB 18 on the WCMD Weapon base page. Impact spacing is not displayed on the WCMD Weapon control pages. Depressing OSB 18 on the base page will access the data entry MFD page for modification of the impact spacing value. If a value of zero is entered, the weapons will have coincident impact points. Although an impact spacing of 9999 feet may be entered, the DLZ is only calculated to the center point. This could lead to one of the weapons being released outside acceptable parameters. The impact spacing value is not displayed on the WCMD Weapon base pages when the Single impact option is selected.

4.2.12.2.6 BURST ALTITUDE WCMD

Burst altitude is the desired function altitude for WCMD and is displayed on the WCMD SMS base and control pages. Burst altitude may be modified at OSB 18 on the WCMD SMS control page. Depressing OSB 18 accesses the data entry MFD page for modification of the burst altitude value. Burst altitudes are in feet Above Ground Level (AGL).

4.2.12.2.7 ATTACK AZIMUTH WCMD

Attack azimuth provides the capability to allow the weapon to attack the target from a specific direction always referenced to North. Attack azimuth is the terminology used for WCMD. The attack azimuth value is selectable for change for WCMD at OSB 20 on the WCMD control pages. Azimuth is entered through the mission planning system or control page. Depression of the ATK AZ or IMP AZ OSBs will access the data entry MFD page for attack/impact azimuth. Any value between 0 and 360° may be entered; however, an entry of 0 will be considered invalid to the weapon and will cause the weapon to fly from the release point direct to the target. For WCMD in ripple release mode, the avionic system uses the attack azimuth to calculate target offsets for each weapon to achieve at the target. At release, the bombs will fly from the aircraft direct to the target and the offset sent to the weapon is corrected/adjusted for the Attack Azimuth input.

NOTE: The avionic system will accept manually entered attack/impact azimuth greater than 360°. Attack azimuth inputs greater than 360° will be reduced by 360° or multiples of 360° and sent to the weapon. For example, an entry of 370° results in 10° and an entry of 740° results in 20° being sent to the weapon. In the VIS delivery submode, the avionic system will set the impact/attack azimuth to the aircraft LOS to the target.

4.2.12.2.8 ARMING DELAY WCMD

The arming delay is a weapon function that provides a safe separation arm time for WCMD weapons. The arming delay is displayed on the SMS base and control pages. The arming may be changed at OSB 19 on the JDAM control pages. Depressing OSB 19 on the appropriate control page accesses the data entry MFD page for the arming delay value. Any value between 0 and 99.99 seconds may be entered.

4.2.12.3 BURST ALTITUDE FOR CLUSTER BOMBS IN BMS

There are four categories of free fall weapons: C1, C2, C3, and C4, each with distinct characteristics and functions.

C1 refers to surface bombs, such as the Mk 82, designed to impact the target upon release.

C2 represents proximity weapons like the modern CBU-87B and modern Rockeye II, which incorporate sensors to detect and engage targets in close proximity.

C3 encompasses time dispense weapons like the older CBU-87 and CBU-52, which are designed to release submunitions at predetermined time intervals.

C4 is specifically for the old Rockeye II bombs when equipped with primary and secondary timers, allowing for timed detonations.

Regarding cluster bomb units (CBUs), they are predominantly equipped with either timed or radio proximity detonation mechanisms. Although there was a concept of barometric CBU dispense, currently available CBUs are either timed or designed to detect targets through radio proximity.

The abbreviation "BA" has different meanings depending on the weapon category. For C2, "BA" refers to the radio-proximity height of function (HOF), indicating the desired proximity at which the submunitions should engage. For C3 and C4, "BA" represents the desired burst height, indicating the altitude at which the submunitions should disperse. To ensure proper functioning of timed release weapons at the desired altitude, the pilot receives guidance through HUD symbols (PUAC), directing them to release the weapon in a manner that ensures it reaches the desired height after the set time, referred to as the Height Above Target (HAT). Burst altitudes are in feet Above Ground Level (AGL).

4.2.13 DEMOLITION BOMBS

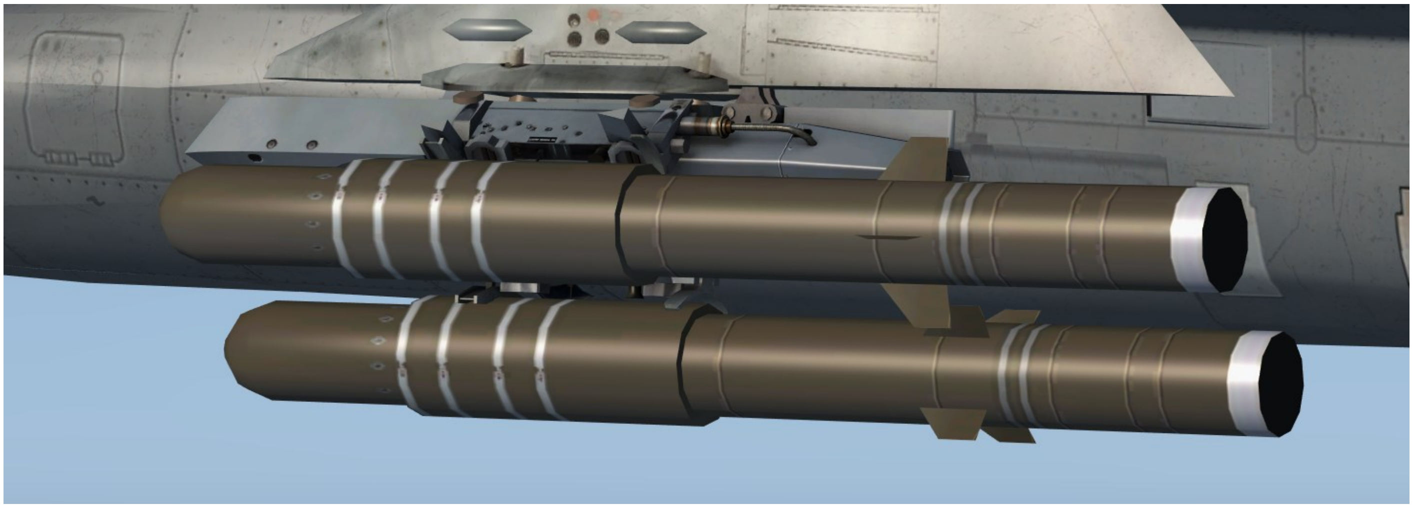
4.2.13.1 BLU-107/B (DURANDAL)

The BLU-107 Durandal is an anti-runway penetration bomb used by various air forces around the world. Originally developed by the French company Matra, the BLU-107 Durandal is designed to disable or destroy enemy runways, rendering them inoperable and hampering enemy aircraft operations.

The BLU-107 Durandal is a relatively small bomb, weighing around 450 kilograms (1,000 pounds). It features a unique design with a long steel casing and a rocket motor at the rear. The bomb is equipped with a mechanism that enables it to penetrate the runway surface upon impact. Once buried, the Durandal deploys its rocket motor, causing a powerful explosion that creates a large crater and displaces significant amounts of soil and debris.

The blast and displacement of the Durandal bomb's explosion can seriously damage or destroy a runway, making it difficult for enemy aircraft to take off or land safely. The rapid creation of a crater and debris further hinders runway repair and recovery efforts, prolonging the disruption caused by the attack.

The BLU-107 Durandal can be deployed from various aircraft, including fighter jets and attack aircraft. It is typically dropped in a high-speed, low-altitude manner to maximize its penetration capabilities. The bomb's small size and unique design allow for multiple Durandals to be carried and deployed simultaneously, enhancing the effectiveness of runway denial operations.

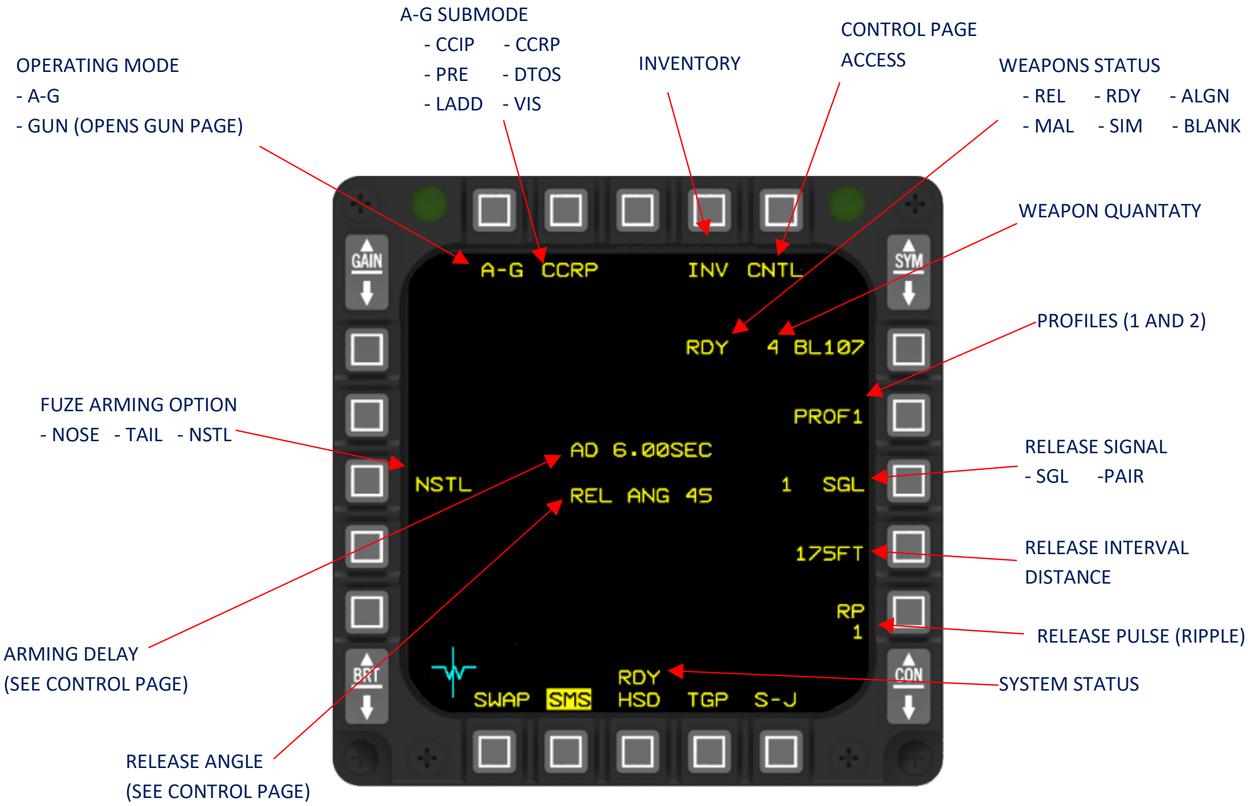


BLU-107 Durandal

Optimal delivery conditions BLU-107

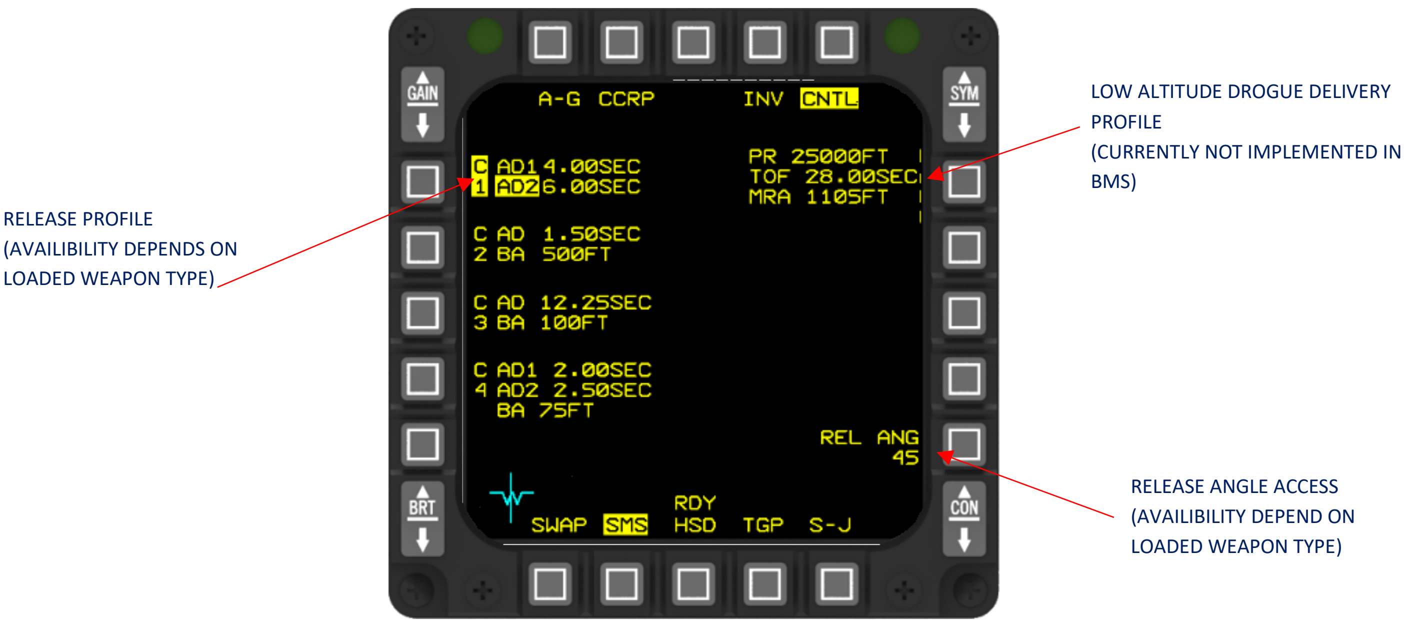
Altitude	200-1000ft (AGL)
Speed	>500kt
Weapon delivery modes	CCIP, CCRP
Arming delay	<1,0sec
Release Interval Distance (CCRP)	As desired

4.2.13.1.1 SMS PAGE - BLU-107



BLU-107 SMS PAGE

4.2.13.1.2 CNRL PAGE - BLU-107



BLU-107 SMS CONTROL PAGE

For low level attacks, arming delays between 0,10sec and 0,80sec are practical.

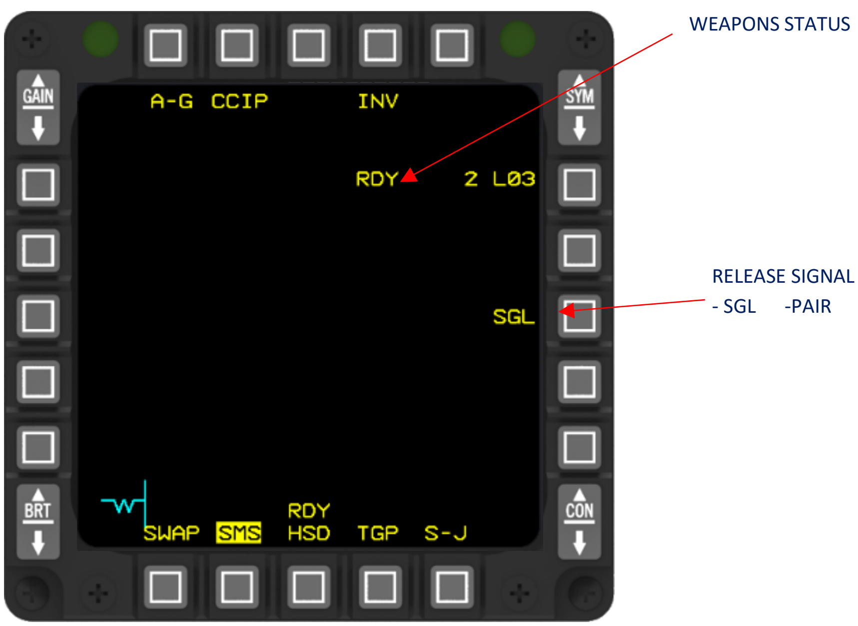
4.2.14 AIR-TO-GROUND ROCKET EQUIPMENT

4.2.14.1 LAU-3/A

The consists a 19-Tube 70 mm (2.75") rocket launcher. The current implementation in BMS is very generic and will be improved in the future.

LAU-3/A Rocket Launcher

4.2.14.1.1 LAU-3/A SMS PAGE



The functionality of the LAU-3/A is not fully implemented in BMS yet. The SMS provide release signal and weapon status options. Be aware that after every weapon release, all 2,75inch rockets from the selected launcher will be fired. This will be improved in the future in BMS.

4.2.15 MINIMUM ACCEPTABLE RELEASE ALTITUDE

Dropping bombs can be done at high altitude and at low altitude. When dropping bombs at low altitude, the closer you are to the ground, the bigger is the exposure to bomb fragments. Therefore, during mission preparation, the pilots need plan for a Minimum Acceptable Release Altitude.

The Minimum Acceptable Release Altitude is found by comparing 3 Minimum Release Altitudes, the one giving you the highest clearance is the one that is going to be chosen to be the Minimum Acceptable Release Altitude for a specific bombing profile (Dive / Level).

In the chapter about General-purpose bombs, there was a mention about the lethality effect of MK-82's and MK-84's. For mission planning purposes, we are using the term of "Fragmentation area". In the fragmentation area, if you find yourself in it at the time of the bomb impact, you are likely going to be hit by bomb fragments. Or if you find yourself in the fragmentation area after the bomb impact but while fragments are still falling back down, you are likely going to be hit by bomb fragments in other words you are going to be fragged.

4.2.15.1 MINIMUM RELEASE ALTITUDE DETERMINED BY THE BOMB'S FRAGMENTATION AREA:

The Fragmentation area is a sphere that represents the area in which bomb fragments represent a risk for the releasing aircraft, both horizontally and vertically. The bomb fragments are projected up in the air to a certain height and take a certain time to fall back down to the ground. This is an important consideration if you plan a multi-ship attack, you want to avoid the second attacking aircraft to fly through that fragmentation area or if he must fly through it, then there needs to be enough time deconfliction to allow for all the bomb fragments to be back on the ground. The fragmentation area only exists for a certain amount of time, which starts at bomb impact.

If you release 1xMK-84, the fragmentation area exists from time of impact of the MK-84 to a determined number of seconds after the impact. If you release 4xMK-84's, the fragmentation area exists from time of impact of the first MK-84 to a determined number of seconds after the impact of the 4th MK-84.

In practice, pilots do plan for frag effects for every attack, even for a simulated pass (Master Arm in SIM). The reason is obvious, you fight like you train.

Note: you will find the term TDA which stands for Target Density Altitude, this is relevant because the thinner the air, the farther the bomb fragment fly, therefore depending on your target's density altitude, the fragmentation area won't be the same as if you accounted for a fragmentation area for a bomb delivery at sea level.

The stay outside of the fragmentation area we establish one Minimum release Altitude.

4.2.15.2 MINIMUM RELEASE ALTITUDE BASED ON THE ALTITUDE LOST DURING THE RECOVERY FROM A DIVE DELIVERY:

For weapons release, specifically for bombs, there are two release profiles:

- Dive delivery, you are diving at a certain dive angle, and you maintain a certain speed.
- Level delivery, you are flying straight and level at certain speed.

In a dive delivery profile, the altitude lost during the recovery from the dive is resulting in the establishment of a Minimum Release Altitude. The altitude lost during the recovery from a diving bombing profile will only be matched with the numbers in the reference table if **for the recovery you pull 5G's, wings level (+/- 30° of Bank) in the span of 2 seconds.** The time it takes you to count from 0 to 2 seconds, if you pull less than 5G's you will not respect the altitude lost found in the reference table during the recovery from your dive. This will result in you flying closer to the ground and potentially in the fragmentation area of your own bombs or preceding aircraft bomb's.

On top of that altitude lost during the dive recovery the desired ground clearance needs to be added on top of it. Look at it as a safety buffer.

That altitude lost will determine your second Minimum Release Altitude.

4.2.15.3 MINIMUM RELEASE ALTITUDE DETERMINED BY THE BOMB'S ARMING DELAY:

There is another factor that needs to be accounted for our third MRA, that is the bomb's arming delay. Let's look into some definitions first.

Fuze: It is the device in the bomb that initiates the detonation of the bomb. There are multiple types of fuzes, which can change the bomb's effect. Two MK-84's, with each one of them having a different type of fuze will have the bomb achieve a different effect.

Arming Delay (AD): Amount of time after which the weapon fuze will be armed. This translates into a vertical distance from the releasing aircraft. An arming delay of 5 seconds will give you 5 seconds of separation time from the F-16 before your bomb's fuze is armed. Those 5 seconds are translated into a vertical distance in feet.

Now, on your SMS page, you can change the AD, the value that you enter on your SMS page, is called an SMS AD, this is because you are going to add 3 values together to have your SMS AD:

AD + fuze arming tolerance + any inherent delay. This addition of time will give you a time buffer which directly translates into a vertical distance from your F-16 after you drop your bomb/bombs.

This will lead you to find the 3rd Minimum release Altitude.

4.2.15.4 DETERMINATION OF THE MINIMUM ACCEPTABLE RELEASE ALTITUDE:

To sum everything up, for the Minimum Acceptable Release Altitude determination we need to consider:

- Dive recovery altitude lost + ground clearance buffer. Therefore, the release altitude needs to be higher than Dive recovery altitude lost + ground clearance buffer, this will give you a minimum release altitude.
- Bomb TOF. The bomb's TOF must be long enough to account for SMS AD. That TOF is translated into a minimum release altitude.
- Fragmentation area. The release altitude needs to be high enough to clear the Fragmentation area. Again, this gives you a minimum release altitude.

Once you have determined all the different minimum release altitudes, you will end up with 3 results. The highest number of those 3 results is going to be your Minimum acceptable release altitude.

4.2.16 SAFE ESCAPE MANEUVER

A safe escape maneuver is a maneuver flown after bomb release for a level delivery and as a recovery from a dive for after a bomb release on a dive delivery profile.

Once the Minimum acceptable release altitude has been determined, you need to apply a safe escape maneuver to enforce it. The Minimum Acceptable Release Altitude is only valid if the proper Safe Escape Maneuver is applied. The safe escape maneuver will provide with a safe escape from bomb fragments, this id valid for bombs with contact fuzes (general purpose bombs) and airburst fuzes (cluster munitions),

Safe escape maneuvers are applied from sea level to 5000 feet density altitude.

4.2.16.1 5 DIFFERENT ESCAPE MANEUVERS:

1. LST – Level Straight Through.
2. CLM – Climbing (for dive bombing profiles, from 0°to 60° dives)
3. Turning Maneuver (for 0°to 20° dive bombing profiles)
4. Level Turning Maneuver (for 0° to 25° dive bombing profiles)
5. Backup escape Maneuver

4.2.16.1.1 LST – Level Straight Through:

After the release the safe escape from frag is ensured by flying straight and level for at least 3 seconds. If it is in the case of a ripple release, the TOF of the last bomb in the ripple is added to the 3 seconds.

4.2.16.1.2 CLM - CLIMBING:

After bomb release, safe escape is based on a pull of 5g's in 2 seconds. Once the nose is approaching the horizon (indicated by the FPM and the artificial horizon line on your HUD) select military power (MIL), maintain the 5G's until reaching 20° flight path angle, relax the G's while continuing to pull up to 30° flight patch angle. The CLM safe escape ends when reaching 30°'s.

4.2.16.1.3 TURNING MANEUVER:

this applies for dive bombing profiles of 0° to 20° of dive-bombing profiles, executed either by the Left or by the Right: Select MIL power, make a roll to 60° to 85 ° bank angle and pull 5G's in 2 seconds. This will give you a controlled dive turn which will reduce the dive angle to 5° approximately. During the turn which is aiming to veer your F-16 60°'s off from the bomb release heading, maintain 5G's. 60° off angle from your bomb release heading is the key for this safe escape maneuver.

4.2.16.1.4 LEVEL TURNING MANEUVER:

this is for 0° to 25° of dive-bombing profiles, after bomb release, select MIL power and at the same time make a wings level pull of 5G's in 2 seconds, as the FPM on your HUD approaches the horizon make a roll either by the Left or the Right and make a level pull of 5G's until your reached a heading that is 60°'s off from your bomb release heading.

4.2.16.1.5 BACKUP SAFE ESCAPE MANEUVER:

if any unforeseen factor hinders you from executing the above planned safe escape maneuvers, such as terrain, weather, threats, this safe escape maneuver can be used as a backup which will result in reasonable safe escape results.

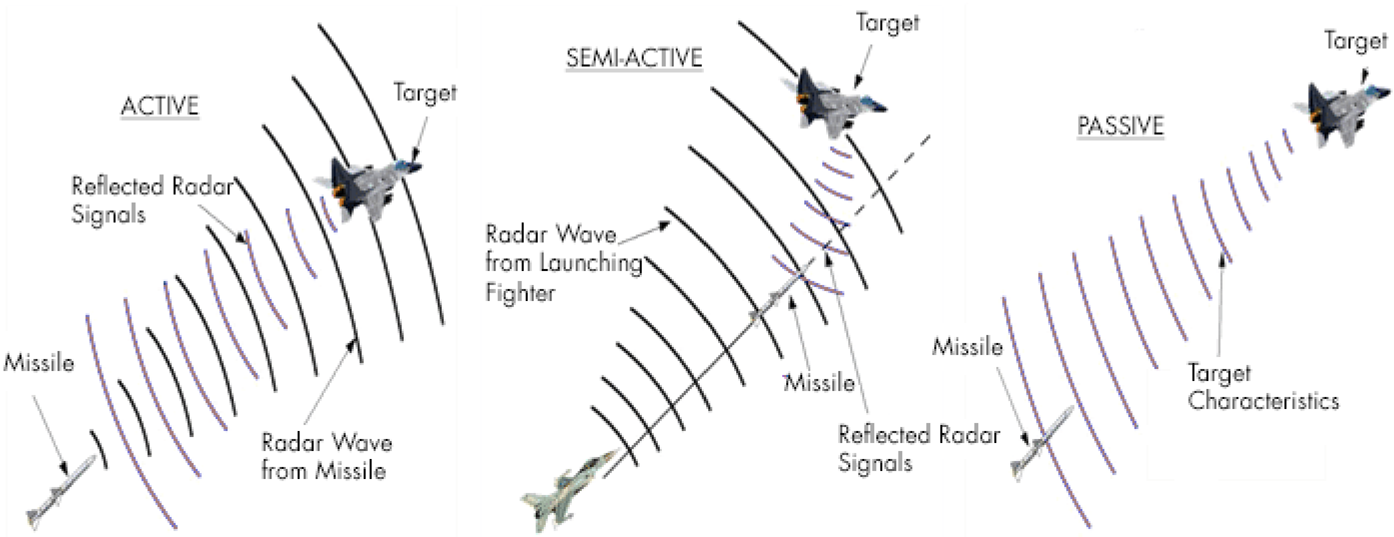
Pull 5G's in 2 seconds, while approaching the horizon with the nose of the aircraft, select MIL power, keep pulling 5G's until reaching 20°'s flight path marker, ease off the G's and keep pulling to 30°'s flight path marker.Or Maintain 5G's until 60°'s of azimuth change has been achieved.

4.3 AIR-TO-AIR

This section describes the Air-to-Air Missile types, Air-to-Air Combat and the related controls and displays.

4.3.1 AIR-TO-AIR MISSILE TYPES AND DESCRIPTION

Missiles can be categorized as either guided or unguided. Unguided missiles follow the laws of motion and travel along a ballistic trajectory. Guided missiles, on the other hand, can either home in on the target or follow a predetermined non-homing path. Non-homing guided missiles are further classified as either inertially guided or preprogrammed. Homing missiles can be classified as active, semi-active, or passive.



ACTIVE

An active missile carries its own radiation source onboard. It emits radiation, which is then directed towards the target. The radiation reflects off the target and returns to the missile, enabling it to self-guide based on this reflected radiation. An example is the AIM-120 missile.

PASSIVE

A passive missile relies on radiation emitted by the target or an external source that is not part of the missile itself. Typically, this radiation is in the infrared (IR) region, as seen in AIM-9 missiles, or in the visible region, as observed in EO AGM-65 missiles. However, passive missiles may also operate in the microwave region, such as anti-radiation missiles.

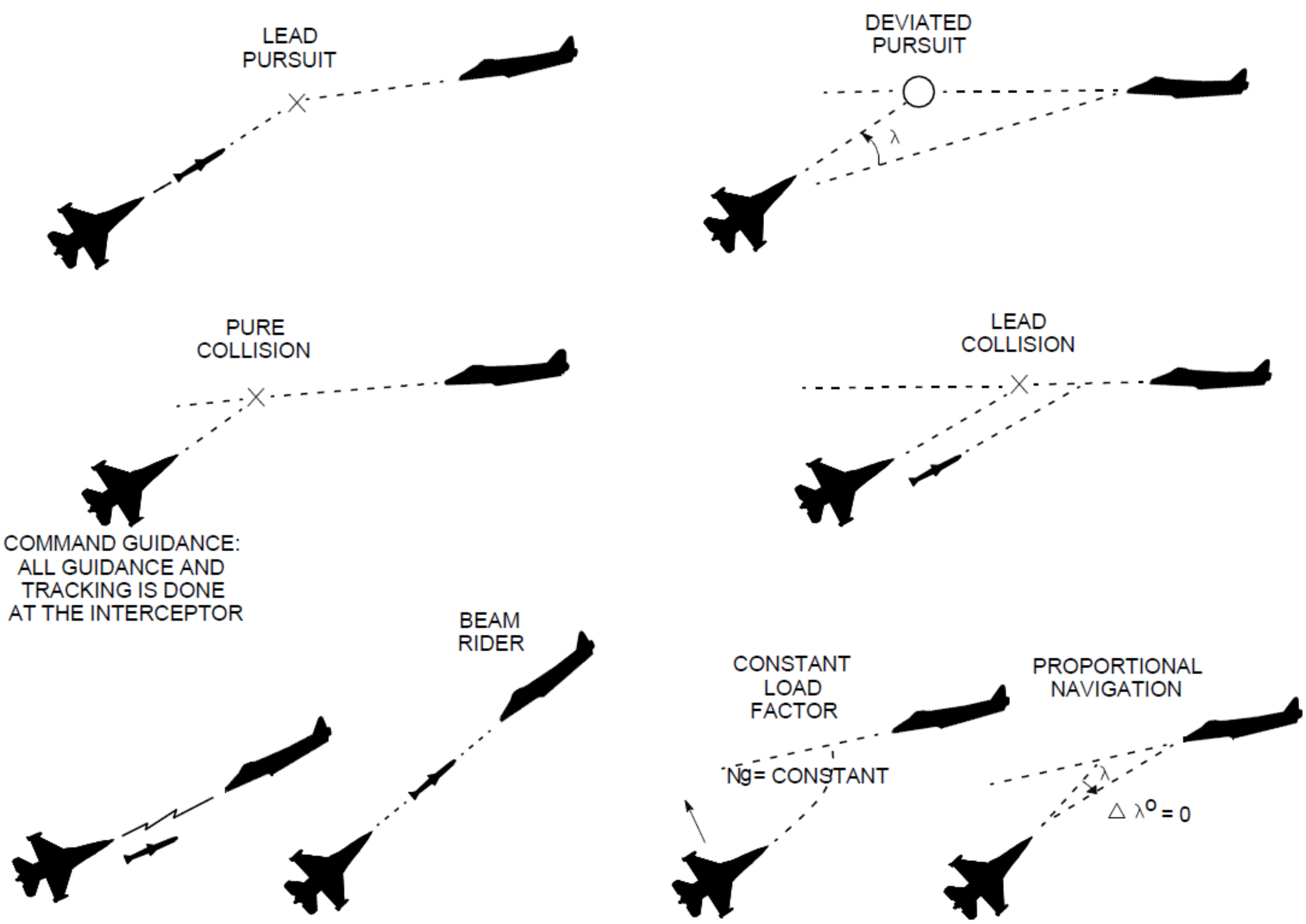
SEMI-ACTIVE

A semi-active missile exhibits characteristics of both active and passive guidance systems. It relies on an external radiation source, usually located at the launch point, to emit energy towards the target. The energy is then reflected back to the missile, which senses the reflected radiation and homes in on it. AIM-7 missiles are an example of semi-active missiles.

4.3.1.1 TYPES OF GUIDANCE

Guidance refers to the method used by a missile to steer towards a target or be steered towards it. This definition encompasses ballistic missiles, which rely on natural forces such as gravity to determine their trajectory. This is commonly known as ballistic guidance. In the case of ballistic missiles, guidance takes place before launch through prelaunch measures aimed at minimizing aiming errors.

On the other hand, guided missiles undergo guidance after launch. By implementing guidance after launch, the impact of prelaunch aiming errors can be reduced. Consequently, the primary objective of postlaunch guidance is to mitigate the requirements imposed during the prelaunch phase, and to adjust for the motion of the target in real time. Postlaunch guidance can be accomplished through various approaches. The subsequent paragraphs outline some of the notable types of guidance.



4.3.1.1.1 LEAD PURSUIT

In lead pursuit, during the launch of missiles or projectiles, the aircraft adjusts its velocity vector to be at an angle relative to the target. This angle ensures that any missile or projectile launched from any position along the flight path will have the potential to hit the target, provided it falls within the effective range of the weapon.

Lead pursuit involves the launch aircraft maneuvering in coordination with the trajectory of the missile or projectile. By adopting lead pursuit, the aircraft maintains a favorable position ahead of the missile's path, aligning itself with the anticipated flight path of the target. This allows for increased accuracy and the potential for a successful impact on the intended target.

4.3.1.1.2 DEVIATED PURSUIT

The missile continuously tracks the target and generates guidance commands to maintain a consistent lead angle (l). When the lead angle is set to zero, it corresponds to a pursuit trajectory known as pure pursuit. However, due to random errors and unintended biases, deviations can occur, leading to a deviated pursuit path. It is not uncommon for the launch aircraft itself to fly on a deviated pursuit course.

4.3.1.1.3 PURE PURSUIT

Pure pursuit refers to a specific type of course followed by a launch aircraft or weapon, in which it travels in a straight line with the sole objective of directly colliding with the target. In this approach, there are no evasive maneuvers or deviations from the path. The launch aircraft or weapon maintains a trajectory that leads directly towards the target, ensuring an inevitable collision. The concept of pure collision emphasizes a deliberate and uncompromising pursuit of impact with the intended target.

4.3.1.1.4 LEAD COLLISION

Lead collision refers to a specific type of course followed by a launch aircraft, where it flies in a straight line to reach a predetermined firing position from which it can take an intercepting shot. The objective of lead collision is to position the launch aircraft in an optimal location relative to the target, allowing for an effective and accurate shot to be taken.

During lead collision, the launch aircraft calculates the necessary lead angle and flight path to ensure that it reaches the desired firing position. This course is carefully planned and executed to achieve the ideal interception point, maximizing the chances of a successful engagement with the target. By flying on a lead collision course, the launch aircraft positions itself strategically to deliver an intercepting shot from the predetermined firing position.

4.3.1.1.5 COMMAND GUIDANCE

The launch aircraft closely monitors the target and the missile during the engagement. A computer system onboard the launch aircraft analyzes the trajectory of the missile and determines whether it is on the correct path to intercept the target. If the computer detects any deviation or misalignment, it generates precise steering commands.

These steering commands are then transmitted from the launch aircraft to the missile before the missile becomes active. The purpose of these commands is to adjust the missile's flight path and align it correctly towards the target. By making these pre-emptive adjustments, the launch aircraft aims to ensure that the missile will effectively intercept the target by the time it becomes active and capable of independent guidance. This coordination between the launch aircraft and the missile's onboard computer allows for real-time corrections and increases the chances of a successful engagement.

4.3.1.1.6 BEAM RIDER

The launch aircraft utilizes a V-shaped radar beam to track the target, with the missile flying along the bottom of this V-shaped beam. This tracking configuration ensures that the missile remains in alignment with the target. In the event that the missile deviates from the bottom of the V-shaped beam, special sensing circuits within the missile come into action.

These sensing circuits detect the deviation and initiate corrective measures to bring the missile back to the correct position within the radar beam. By actively sensing and responding to any positional errors, the missile is guided back on track to maintain alignment with the target.

As long as the launch aircraft continues to track the target accurately, and the missile stays within the radar beam's bottom portion, the missile's trajectory will intersect with the target, leading to a successful interception. This continuous tracking and alignment between the launch aircraft, radar beam, and the missile ensure an effective interception of the target.

4.3.1.1.7 PROPORTIONAL NAVIGATION

This course is designed to adjust the lead angle continuously based on the angular rate (Dl) of the line-of-sight (LOS) to the target. The primary objective is to maintain a zero angular rate (Dl) of the LOS to the target. By doing so, the course aims to keep the target consistently centered within the line of sight.

To achieve this, the lead angle is modified in proportion to the angular rate (Dl) of the LOS. If the LOS deviates or exhibits any angular rate, the lead angle is adjusted accordingly to counteract the deviation and bring the angular rate back to zero. This continuous adjustment of the lead angle ensures that the target remains consistently in the center of the line of sight, minimizing any deviations and maximizing the accuracy of tracking.

The ultimate goal of this course is to achieve precise tracking by maintaining a stable LOS with zero angular rate, allowing for optimal control and engagement with the target.

4.3.2 AIR-TO-AIR COMBAT

The avionics system plays a crucial role in facilitating air-to-air combat by offering various means of control, including head-up, head-down, and hands-on, over essential components such as radar, targeting pod sensors, the M61A1 gun and AIM-9 and AIM-120 missiles. This section comprehensively discusses the diverse modes, sensors, and weapons involved in air-to-air combat, along with their corresponding displays. Whenever applicable, specific procedures and notable considerations pertaining to air-to-air weapon modes are provided to ensure practical implementation and maximize effectiveness.

For every target engaged with an air-to-air weapon, there exists a designated missile of interest (MOI) corresponding to that specific target. Throughout this section, the term "missile of interest" is utilized to describe this concept, as it serves as a reference for various displays and indicators such as time remaining, A/F Pole range, and missile active indications on the MFD target symbols. These displays are directly linked to the status and properties of the missile of interest. It's important to note that if there are no missiles currently in flight against a particular target, there will be no missile of interest associated with that target.

In scenarios where multiple missiles are simultaneously engaged against the same target, a priority scheme is established to determine the missile of interest. This priority scheme consists of three levels, ranked in descending order of preference:

- Weapon type: The type of weapon employed against the target takes precedence in determining the missile of interest.
- Win/lose status: The outcome or status of the engagement, whether it is favorable (winning) or unfavorable (losing), influences the selection of the missile of interest.
- Time remaining: If there are multiple missiles of the same type and win/lose status, the remaining time until impact becomes a determining factor in establishing the missile of interest.

By following this priority scheme, the avionics system ensures that the most relevant and critical missile is identified as the missile of interest for effective monitoring and decision-making during air-to-air engagements.

4.3.2.1 AIR-TO-AIR COMBAT MODES

The avionics system offers three preset air-to-air submodes, each serving a specific purpose in combat engagements. These submodes can be selected individually, allowing for flexible configuration based on the desired weapon combination. The three submodes are as follows:

- DGFT (Dual Gun and Fire Control Track): This submode enables the simultaneous selection of both missiles and the gun. It provides comprehensive control over the weapons system for air-to-air engagements, allowing for a combined approach utilizing missiles and the gun.

- AAM or MSL OVRD (Air-to-Air Missile or Missile Override): In this submode, only air-to-air missiles are selected. It focuses solely on the utilization of missiles for engaging airborne targets. This configuration offers specialized control for air-to-air missile operations.

- GUN (Gun Mode): The GUN submode emphasizes the selection and operation of the gun. It enables hands-off selection of the gun while providing the option for enhanced envelope gunsight (EEGS) gunnery. This submode optimizes the system for gun-based engagements.

Each of these submodes can be customized further by adjusting the radar mode and weapon selection to best suit the specific engagement requirements. By incorporating different master modes, the avionics system facilitates easy switching between configurations tailored for long-range or close-in engagements. The master modes available are as follows:

- A-A (Air-to-Air) Master Mode: This master mode, accessible via the Integrated Control Panel (ICP), serves as the primary air-to-air mode. Within the A-A master mode, the following submodes can be selected:
  - AAM (Air-to-Air Missile Mode): Focuses on air-to-air missile operations.
  - GUN (Gun Mode): Emphasizes the gun with the option of an enhanced envelope gunsight (EEGS) for precise gunnery.

- DGFT (Dogfight) Master Mode: Accessed through the throttle, this master mode is specifically designed for intense dogfight scenarios.

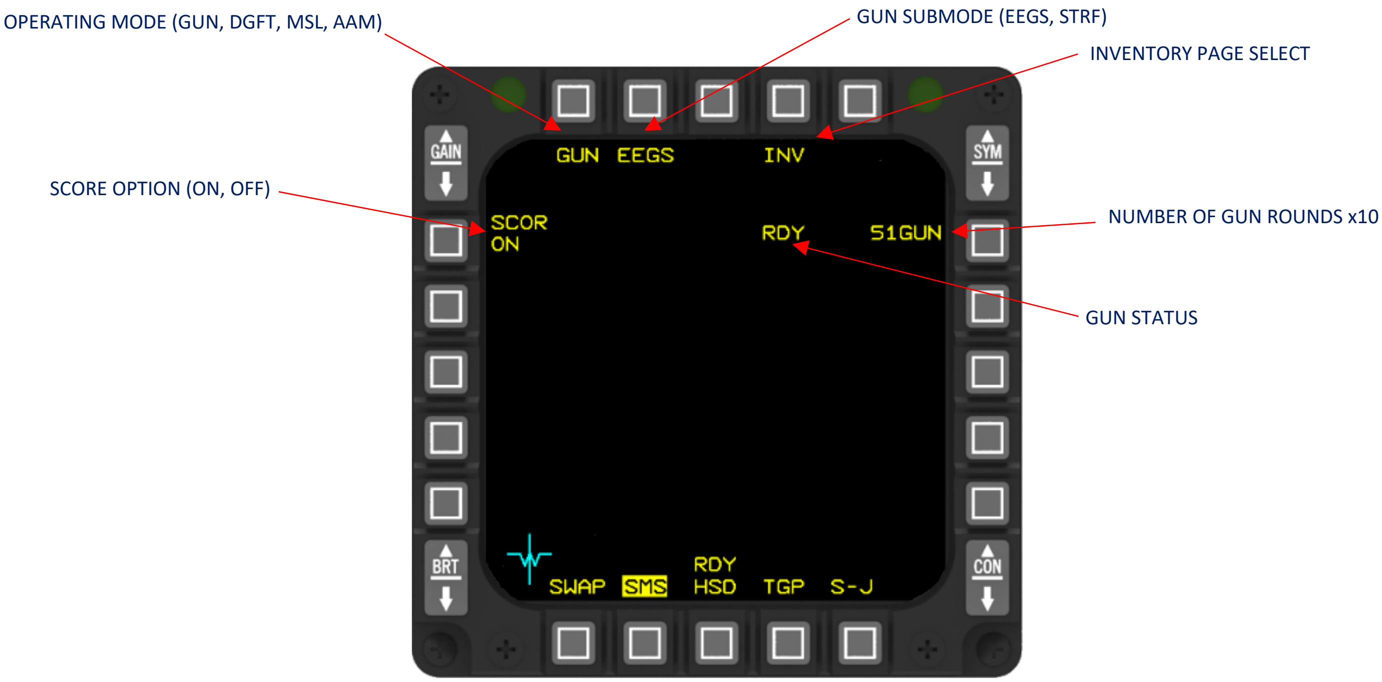
- MSL OVRD (Missile Override) Master Mode: Also selected via the throttle, this master mode provides overriding control specifically for missile operations.

By employing these master modes and submodes, the avionics system offers enhanced versatility and adaptability in air-to-air engagements, ensuring optimal performance based on the specific combat requirements.

4.3.2.1.1 AIR-TO-AIR GUNNERY MODE

The DGFT and GUN modes offer specific symbology and functionality for manual or radar-tracked gun attacks. DGFT can be manually selected using the DGFT/MSL OVRD switch on the throttle, while GUN mode is accessed through the A-A master mode button on the Integrated Control Panel (ICP) and OSB 1 on the SMS AAM page. When in GUN mode, the enhanced envelope gunsight (EEGS) gunnery symbology is activated. This section will provide an overview of the EEGS air-to-air gunnery submode, including its associated displays and controls. To ensure proper gun operations, it is necessary to load the appropriate ammunition type, indicated by the mnemonic PGU28. This can be accomplished either through the MDDE page or via the DTE (Data Transfer Equipment).

4.3.2.1.1.1 GUN PAGE



SMS AIR-TO-AIR GUN PAGE

The gun scoring option can be accessed by selecting OSB 20 located next to the SCOR mnemonic. Once selected, the chosen option will remain active throughout mode transitions and power cycles:

• SCOR ON - Score option selected. Bullets At Target Range (BATR) will be shown.
• SCOR OFF - Score option not selected.
• Blank - Score option available only if dogfight or air-to-air gun mode is selected.

Gunnery status is displayed to the left of the GUN mnemonic adjacent OSB 6 as follows:

• RDY (ready) - Gun is armed and ready.
• SIM (simulated) - Gun is not armed, but simulated cues are displayed.
• Blank - Gun is not available.

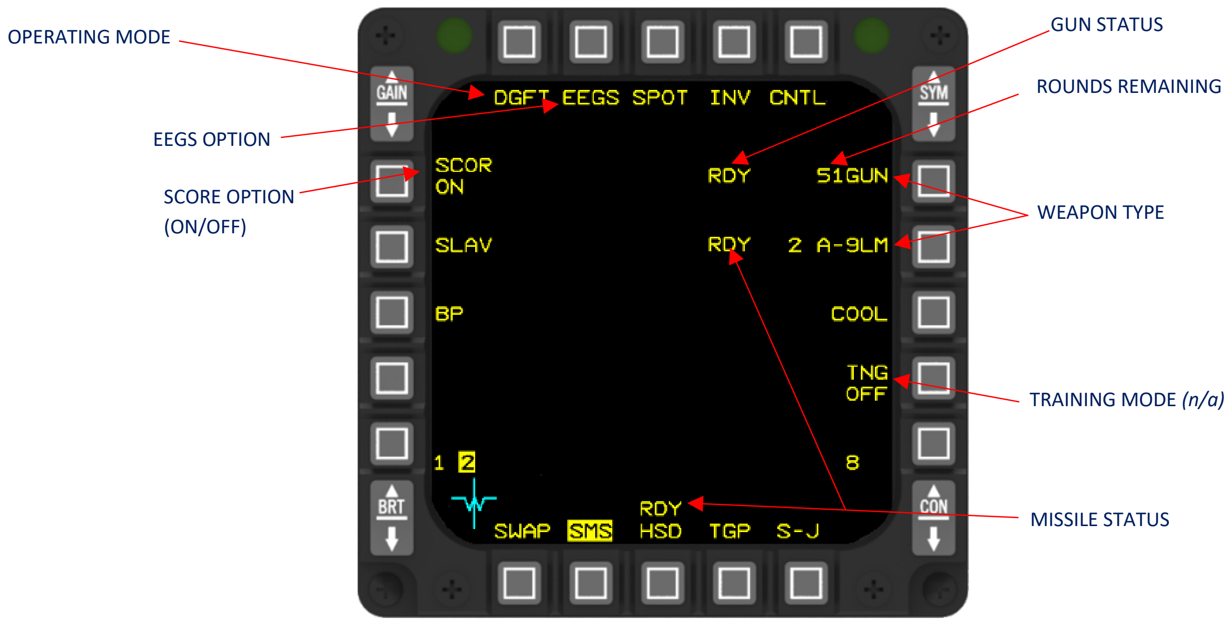
The MFD SMS format displays the number of rounds remaining when the trigger is depressed. When the last round is fired, the last round switch closes and the gun is automatically shut down. At this point, the MFD will display the SAF mnemonic instead of the RDY mnemonic. After the gun is fired, it requires a certain amount of time to clear the ammunition before it can be safely disarmed.

Please note that when no AA missile is loaded on the SMS, the AA gun is selected automatically for AA and DGFT mode. MSL OVRD is locked out since the AA gun cannot be selected in MSL OVRD.

4.3.2.2 DOGFIGHT (DGFT) MODE

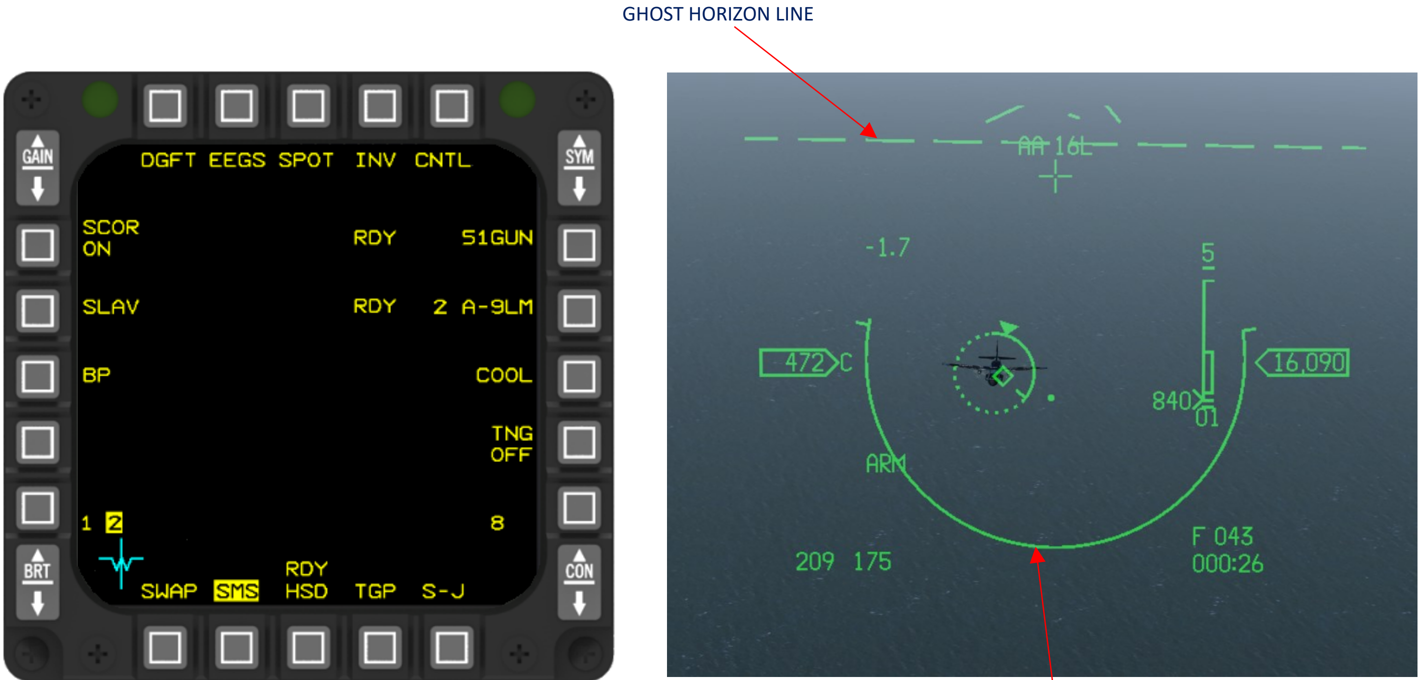
The DGFT mode offers hands-on control and visual representation of both gunnery and missiles using the DOGFIGHT/Missile Override switch located on the throttle. When DGFT mode is selected, it takes precedence over the currently chosen weapon delivery mode. The HUD displays the Enhanced Envelope Gunsight (EEGS) gunnery option and incorporates the Attitude Awareness Arc (AAA) symbology.

4.3.2.2.1 DOGFIGHT (DGFT) MODE PAGE



SMS DOGFIGHT MODE PAGE

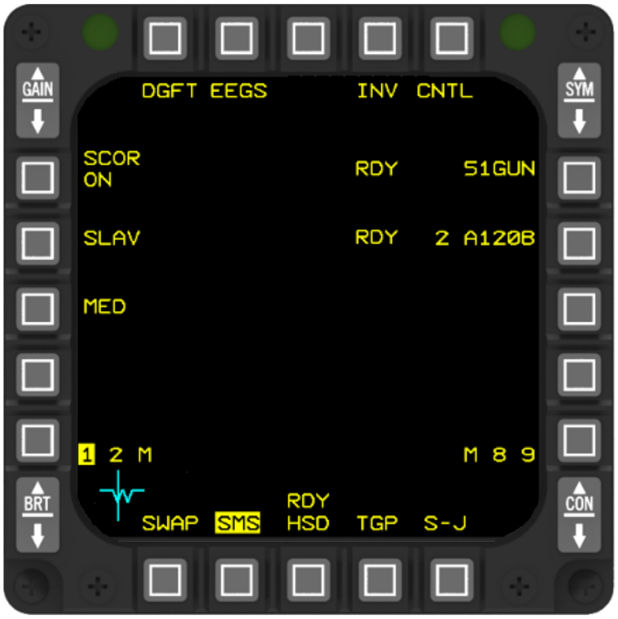
4.3.2.2.2 DOGFIGHT OPERATION WITH SRM



Dogfight Operation with SRM

In the DGFT mode, the HUD presents a different set of missile symbology compared to the AAM or MSL modes. The missile reticle, allowable steering error circle, and attack steering cue are not shown on the HUD. Instead, a fixed set of symbology without any declutter options is displayed. The target designator (TD) box is replaced with the EEGS TD arc. The dynamic launch zone and aspect angle information are automatically displayed. The missile diamond symbol, similar to the air-to-air missile and missile override modes, is available. HUD aiming symbology is only shown if the RDY or SIM mnemonic appears on the MFD, and ARM or SIM is displayed on the HUD. The Attitude Awareness Arc is always shown on the HUD in the DGFT mode, regardless of the position of the MASTER ARM switch.

4.3.2.2.3 DOGFIGHT OPERATION WITH AIM-120



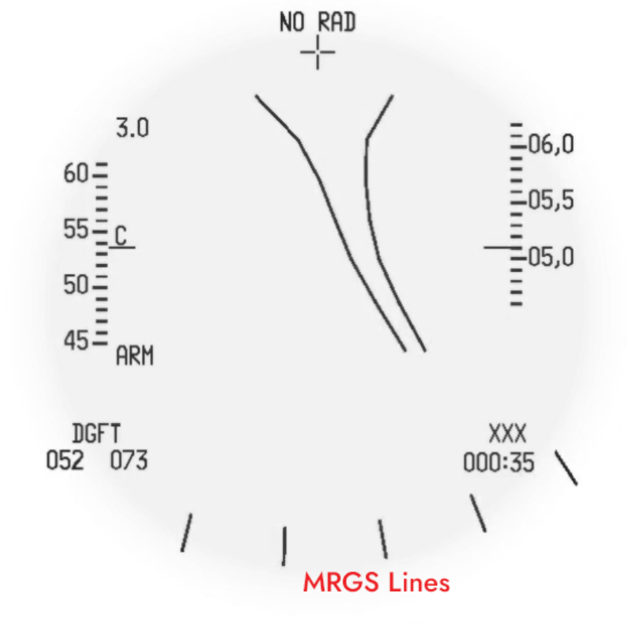
Dogfight Operation with AIM-120

The avionic system in Dogfight mode displays the Attitude Awareness Arc/Ghost Horizon Line (GHL). The Attitude Awareness Arc/GHL remains fixed and is not affected by winds or aircraft yaw. It is roll stabilized around the center of the Heads-up Display (HUD) Total Field-of-View (TFOV). This feature provides the pilot with a visual representation of pitch attitude in the form of an arc.

The arc symbolizes the ground, while an imaginary line connecting the ends of the semicircle represents the horizon. When the aircraft's wings are level (0 degrees pitch), the arc appears as a complete semicircle. In the case of inverted flight, an inverted arc is displayed at the top of the HUD Field-of-View (FOV).

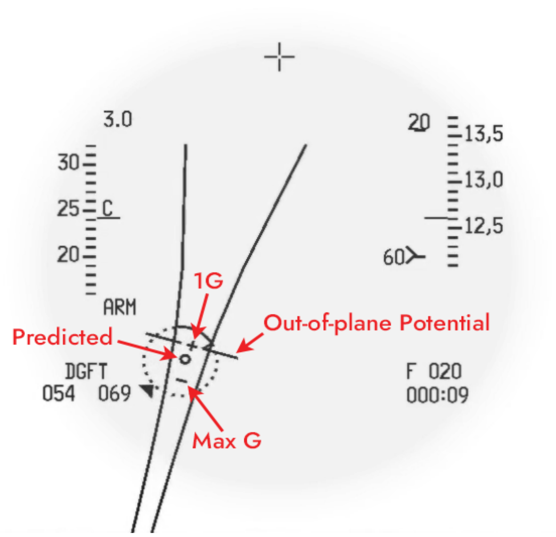
4.3.2.3 ENHANCED ENVELOPE GUNSIGHT (EEGS)

The EEGS submode offers gunnery solutions for visually tracking targets, and it undergoes refinement when radar range, velocity, and acceleration data are accessible. The EEGS algorithm is structured into five distinct levels, each relying on the availability of target data from the radar and a training level. The algorithm is specifically designed to progress through these levels automatically as the target's range, velocity, and acceleration become valid and usable, such as when the filters utilizing the data have settled.



EEGS funnel

Without a radar lock, EEGS displays a funnel and the Multiple Reference Gunsight (MRGS) lines along the bottom of the HUD. The funnel width is based on the target wingspan entered in the LIST 5 page (MAN). For a good firing solution, track the target with the funnel so that its wingtips touch each side. When the trigger is held, the Firing Evaluation Display System (FEDS) shows simulated rounds as dot pairs which move down the sides of the funnel in the same way that tracers would move had they been fired. The MRGS lines help with high LOS rate snapshots. Placing the target on one of the lines should cause it to fly through the gun cross, scoring hits if you start shooting early enough so the target flies through the bullets.

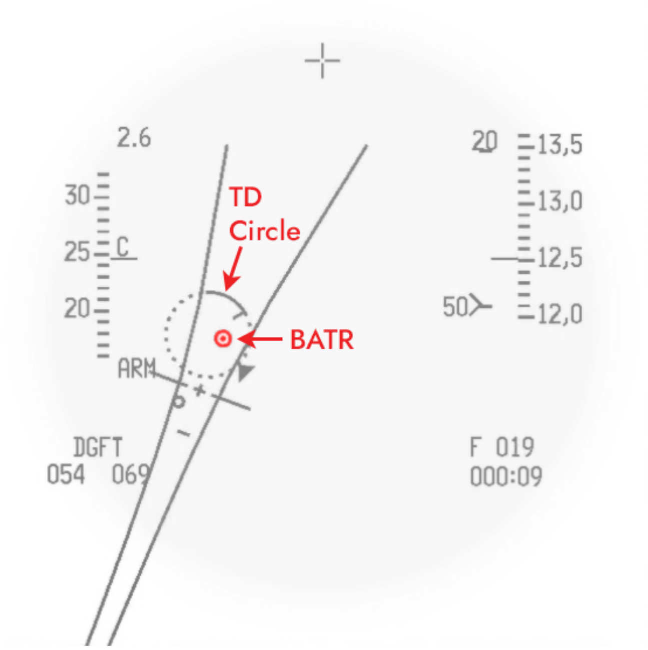


EEGS Targeting Solution

Once a target is locked, a target designator circle appears over it. This circle unwinds counter clockwise to display target range inside 12,000 feet. Shortly after the lock, the radar obtains target velocity and aligns the gun funnel along the target's plane of motion. MRGS lines disappear.

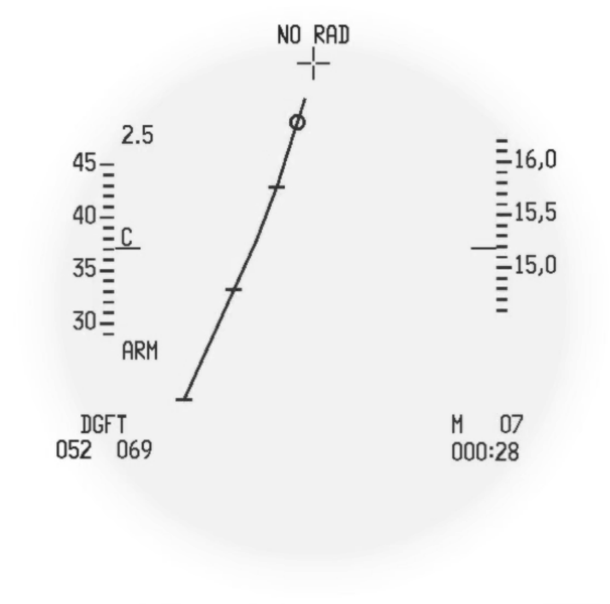
Several other symbols appear. The plus inside the gun funnel is a 1G pipper, which shows the correct lead for a non-maneuvering target. The minus is a Max-G pipper, which shows the correct lead for a target pulling 7.3G directly towards you. On either side of the plus are lines which indicate the target's out-of-plane maneuver potential — the distance they could jink laterally while your bullets are in flight.

Several seconds after lock on, the radar determines target acceleration and, once in range, a 4 mil circle appears this is the correct lead assuming the target maintains their current flight path.



EEGS BATR

After squeezing the trigger, a 6-mil circle shows the location of the bullets as they pass the target. This Bullets at Target Range (BATR) symbol is to help evaluate your shot and is displayed instead of FEDS whenever a target is locked. It disappears as the last bullets from the burst pass the target.



SNAP

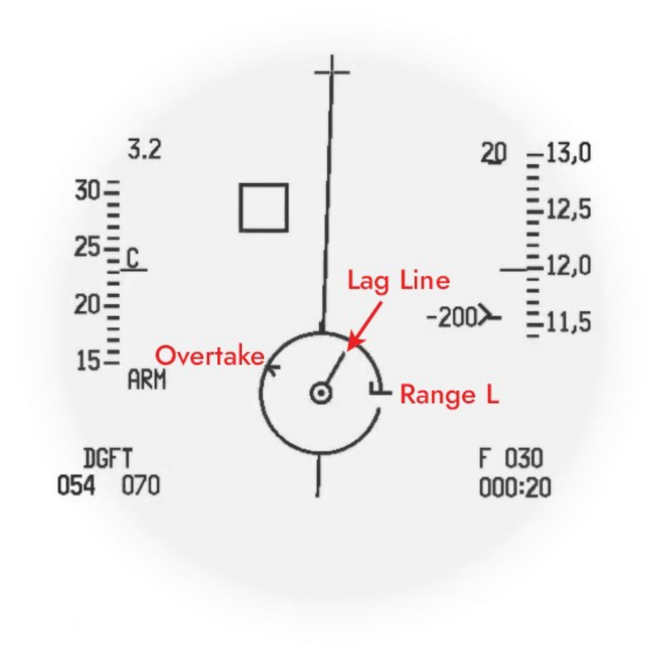
Snapshot (SNAP) gunsight: It displays a gun “snake” which shows the path of bullets fired in the past, like the EEGS funnel does without a lock. Horizontal ticks show where bullets fired ½, 1, and 1½ seconds ago would be.

Without a radar lock, a small circle shows where bullets would be at the set range (700 or 1500 feet, controlled by the manual range knob on the throttle). With a radar lock, the circle shows where bullets would be at target range.

The snapshot sight is the most difficult to use, since it only shows historical data (Where are bullets fired in the past?), not predictive data (Where should I shoot so bullets hit the target when they reach it?). To score hits, you must track the target with the snake for one Bullet Time of Flight (BTOF) or shoot when you think the range circle will pass over the target in one BTOF.

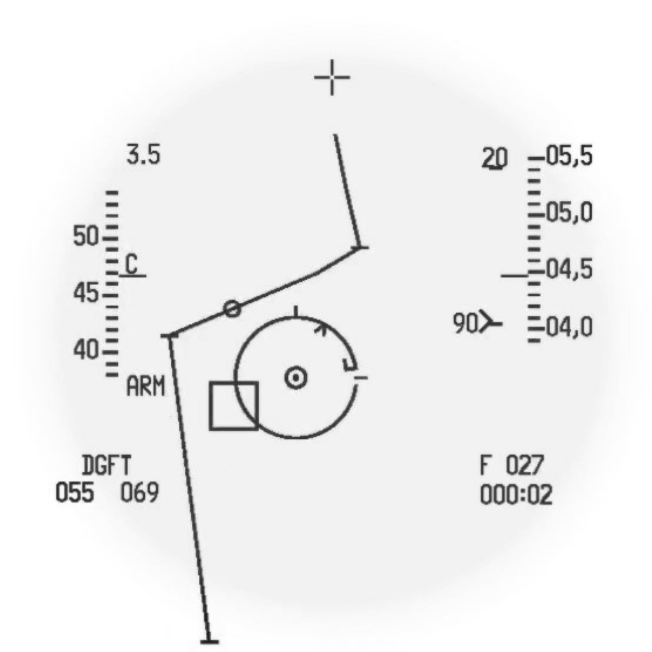
Next is the Lead Computing Optical Sight (LCOS). Without a lock, the pipper size matches the target wingspan at the set range (700 or 1500 feet) and behaves like gyro gunsights in WW2 or Korean War-era fighters. Lead is shown for a target turning in your plane of motion, at the same speed, with the same G. Any differences in these factors will make the pipper inaccurate.

When a target is locked, the pipper briefly jumps back to the gun cross before sliding into position once the radar determines target acceleration. The outer ring of the pipper now shows target range with a “range L” that unwinds just like the EEGS TD circle. An overtake caret also shows closure: The 12 o’clock position represents zero closure, positions to the right indicate positive closure, and positions to the left indicates negative closure. Each o’clock position represents 100 knots, so a caret at the 3 o’clock position indicates 300 knots of closure, and a caret at the 6 o’clock position indicates the target is opening or closing in excess of 600 knots. A lag line extending from the center of the pipper shows the direction the pipper is moving — shooting before it settles is likely to cause a miss.



LCOS

Finally, is the combined Snapshot & LCOS (SSLC) gunsight. This combines the snapshot sight's gun snake with the LCOS pipper (without its lag line). Aim with the LCOS pipper, then evaluate your shot using the snake — the snake should pass over the target as your bullets reach it.



Snapshot & LCOS

4.3.2.3.1.1 GUNSIGHT EMPLOYMENT CONSIDERATIONS

Don’t forget the gun cross! Instead of trying to fly the pipper to the target, concentrate on establishing the gun cross in front of the target, in its plane of motion. From there you should be able to make small adjustments to superimpose the pipper on the target.

To prevent jittering and compensate for radar tracking errors, all pippers have about a ¼ second settling time. This means that to hit the target, you must track it with the pipper ¼ of a second before shooting or start shooting that amount of time before the pipper is on the target.

Aim snapshots with the gun cross, using MRGS lines or the gun snake to line up your shot. The pipper is especially inaccurate in front-quarter shots due to rapidly changing LOS rates.

Gunshot opportunities in combat are rare. Don’t save rounds for other bandits — fire a lethal burst (1–2 seconds) on the one you’re engaged with, then immediately reposition to avoid the resulting fireball. Once separated, assume you’ve been targeted by a new threat. You’ve been very predictable and not checking six while getting your guns kill.

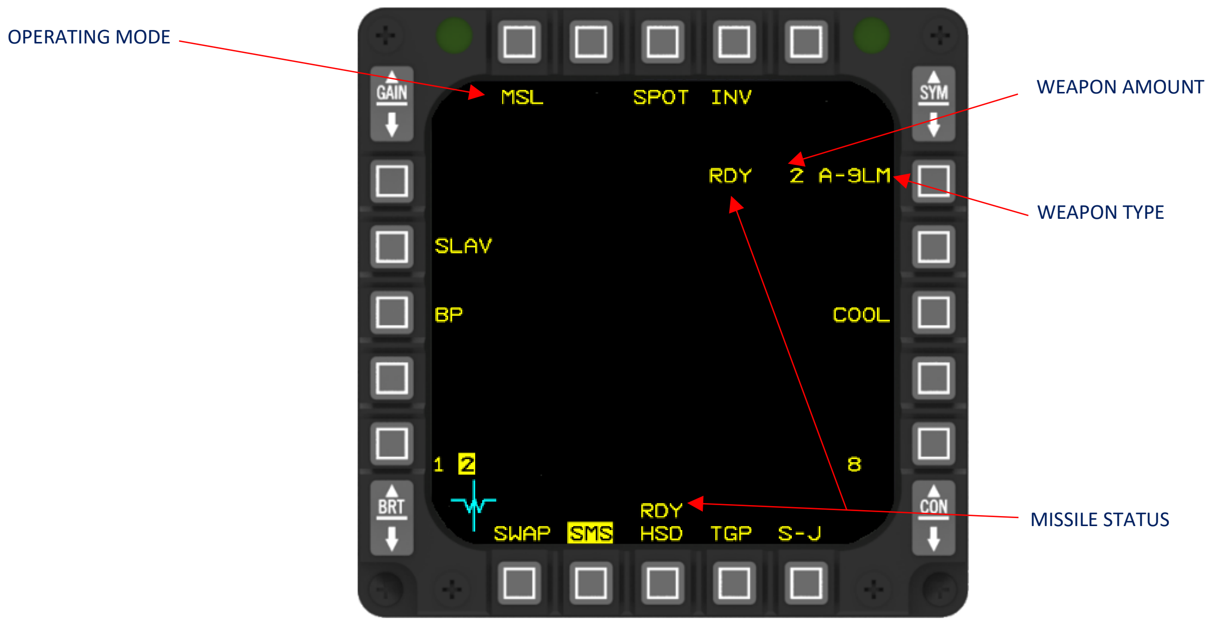
4.3.2.4 AIR-TO-AIR MISSILE AND MISSILE OVERRIDE MODES

The AAM (air-to-air missile) mode and MSL OVRD (missile override) mode provide dynamic targeting symbology and data for launching Short Range Missiles (SRM) such as AIM-9L/M and AIM-9X, as well as Medium Range Missiles (MRM) like AIM-120.

The AAM mode is accessed through the SMS AAM/GUN page on the MFD, while the MSL OVRD mode is activated by using the DOGFIGHT/missile override switch on the throttle. Selecting the MSL OVRD master mode overrides any previously selected weapon delivery mode.

The HUD/HMCS (Heads-Up Display/Helmet-Mounted Cueing System) in missile modes includes essential aiming symbology. It features the target designator box, which frames the target to aid visual identification (or the target locator line and locator angle if the target is outside the HUD/HMCS field of view). The missile diamond symbol represents the line-of-sight (LOS) of the missile, accompanied by the missile reticle and steering cue known as the Collision Antenna Train Angle (CATA). Additionally, the dynamic launch zone (DLZ) is displayed, providing information on the optimal launch conditions for the missile.

4.3.2.4.1 MISSILE OVERRIDE MODE PAGE



SMS MISSILE OVERRIDE MODE PAGE

The missile override (MSL) page provides the same controls and display as the AAM page but is selected hands-on via the DOGFIGHT/Missile Override switch on the throttle.

4.3.2.4.2 SELECTING MISSILES AND STATIONS

When the reported master mode is either Missile Override or Dogfight, or when the submode is Air-to-Air Missile, the MMC (Master Mode Controller) automatically selects an appropriate air-to-air weapon type and the corresponding station that is loaded with that particular weapon type. This selection is made based on the current mode and is remembered on a mode-by-mode basis, such as Air-to-Air Missile, Dogfight, or Missile Override.

For example, let's consider a sequence of events:

- The last time the Air-to-Air Missile mode was selected, an AIM-9M missile loaded on station 9 was the selected weapon type and station.
- The current mode is now Missile Override, and an AIM-9M missile loaded on station 1 is the selected weapon type and station.
- If the reported master mode changes from Missile Override to Air-to-Air Missile, the MMC will automatically switch to the AIM-9M missile loaded on station 1, rather than station 9, as it is the currently selected weapon type and station.

In summary, the MMC keeps track of the selected weapon type and station based on the mode being used, ensuring that the appropriate weapon is consistently chosen, even if the mode changes between Missile Override, Dogfight, or Air-to-Air Missile.

After a release of a selected weapon type, the MMC automatically chooses a new station that is loaded with the same selected weapon type, as long as there are still remaining missiles of that type available. If there are no more missiles of the selected type left, the MMC will check if there is a hung store (a missile that failed to release properly) of the selected weapon type. If a hung store is present, the MMC will select that store as the new station.

Additionally, if all missiles of the previously selected weapon type have been successfully released, the MMC will automatically select a new air-to-air weapon type, if there are any other types of air-to-air missiles available. This ensures that the aircraft always has an appropriate weapon ready for engagement, even after expending all the missiles of a particular type.

In summary, the MMC dynamically selects a new station loaded with the selected weapon type, taking into account the remaining quantities and the presence of hung stores. It also switches to a different air-to-air weapon type if all missiles of the previously selected type have been released.

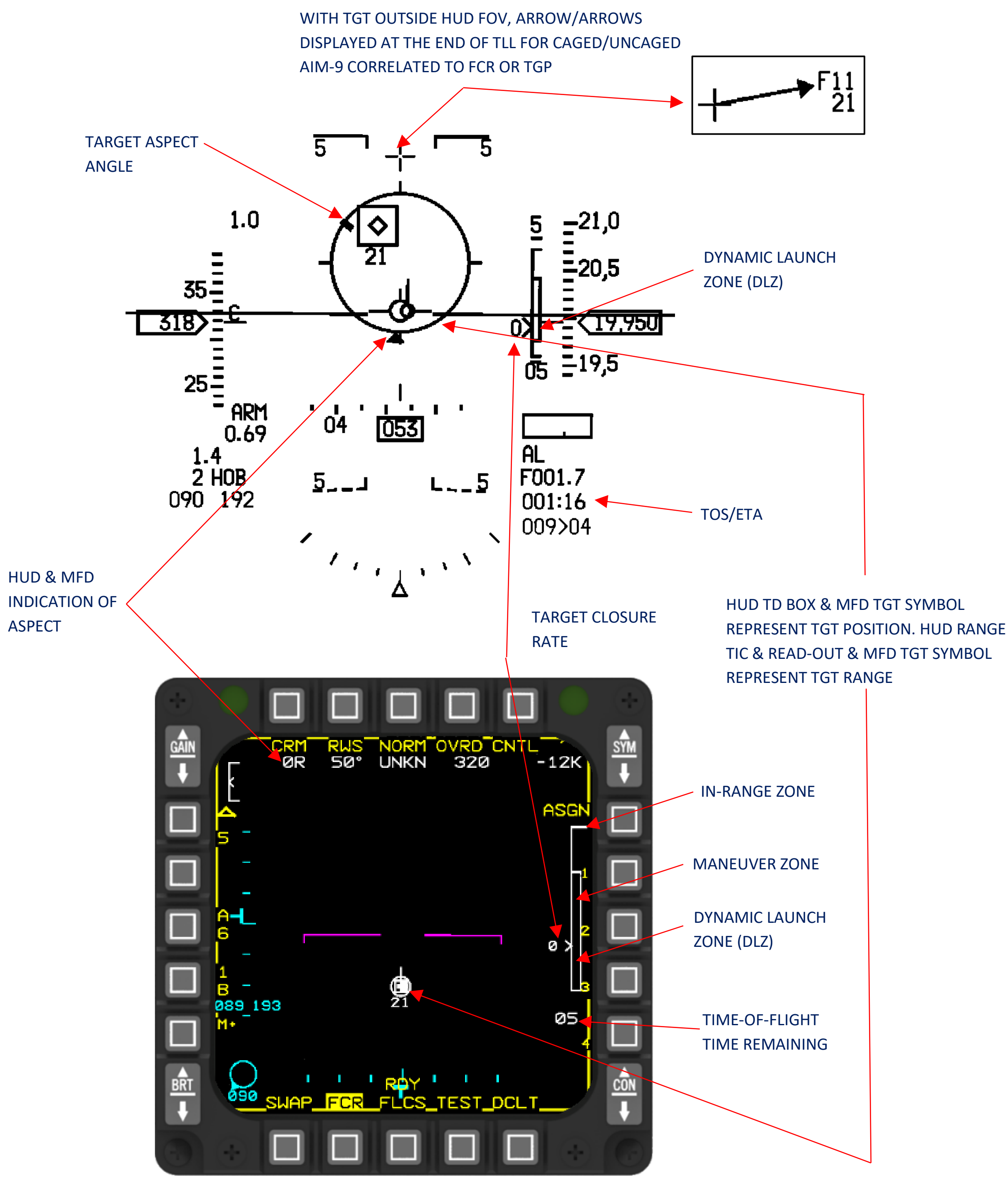
4.3.2.4.2.1 HANDS-ON AIR-TO-AIR WEAPON SELECTION

• While in an Air-to-Air (A-A) master mode, pressing and releasing the MSL STEP button for less than 0.5 seconds will select the next station in the rotary order (3, 7, 2, 8, 1, 9) that is loaded with the currently selected weapon type. The selected station will be highlighted in inverse video on the SMS Base page, and this selection will be retained even through power cycles of the Master Mode Controller (MMC).

• When in an A-A master mode, except when the currently selected sensor of interest (SOI) is for reconnaissance (RECCE), holding down the MSL STEP button for a duration of 0.5 seconds or more will switch to the next category of missile types in the A-A weapon selection rotary. The avionics system will automatically update the displayed weapon mnemonic next to OSB 7 on the SMS Base page to reflect the newly selected missile. If the newly selected missile belongs to a different category, the corresponding missile category will also be updated on the Head-Up Display (HUD).

4.3.2.4.3 SHORT-RANGE MISSILE (SRM) OPERATION

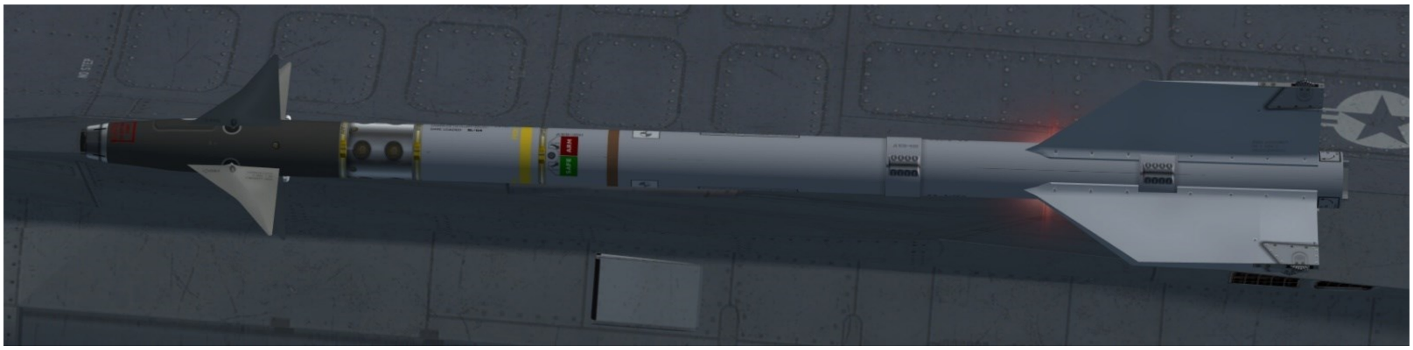
The avionics system facilitates the operation of the Short Range Missile (SRM) by offering essential features such as range determination, line-of-sight (LOS) tracking of the seeker head, field-of-view (FOV) of the seeker, shoot cues, steering guidance, weapon arming, and quantity status information. Various visual cues are provided to assist with FOV, LOS, range, and steering, including the missile reticle, missile diamond, linear missile scale (which incorporates the dynamic launch zone), and Collision Antenna Train Angle (CATA).



COMMON SRM SYMBOLOGY AND DATA

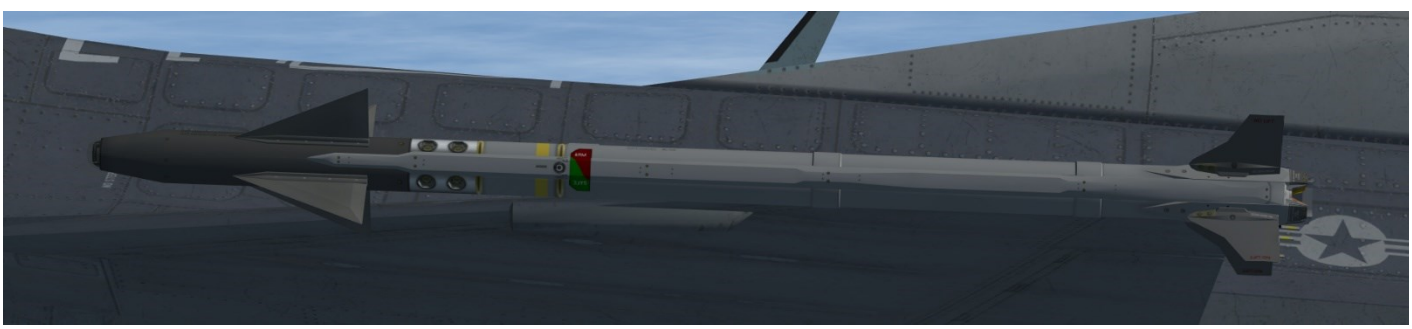
4.3.2.4.3.1 AIM-9 MISSILE DESCRIPTION

The AIM-9 missile is an advanced supersonic air-to-air intercept weapon. It operates as a passive missile, relying on infrared (IR) radiation emitted by the target for guidance. Once launched, the missile does not require further guidance, allowing the pilot to immediately maneuver and evade potential threats. The AIM-9 missile consists of four main sections: the guidance and control section (GCS), warhead, fuze, and missile body (rocket motor). It is connected to the aircraft through an umbilical cable for communication and power supply. The missile's operation can be divided into three phases: captive flight, launch, and free flight. During captive flight, power is provided by the launcher, while thermal batteries within the missile take over power supply during the launch and free flight phases.



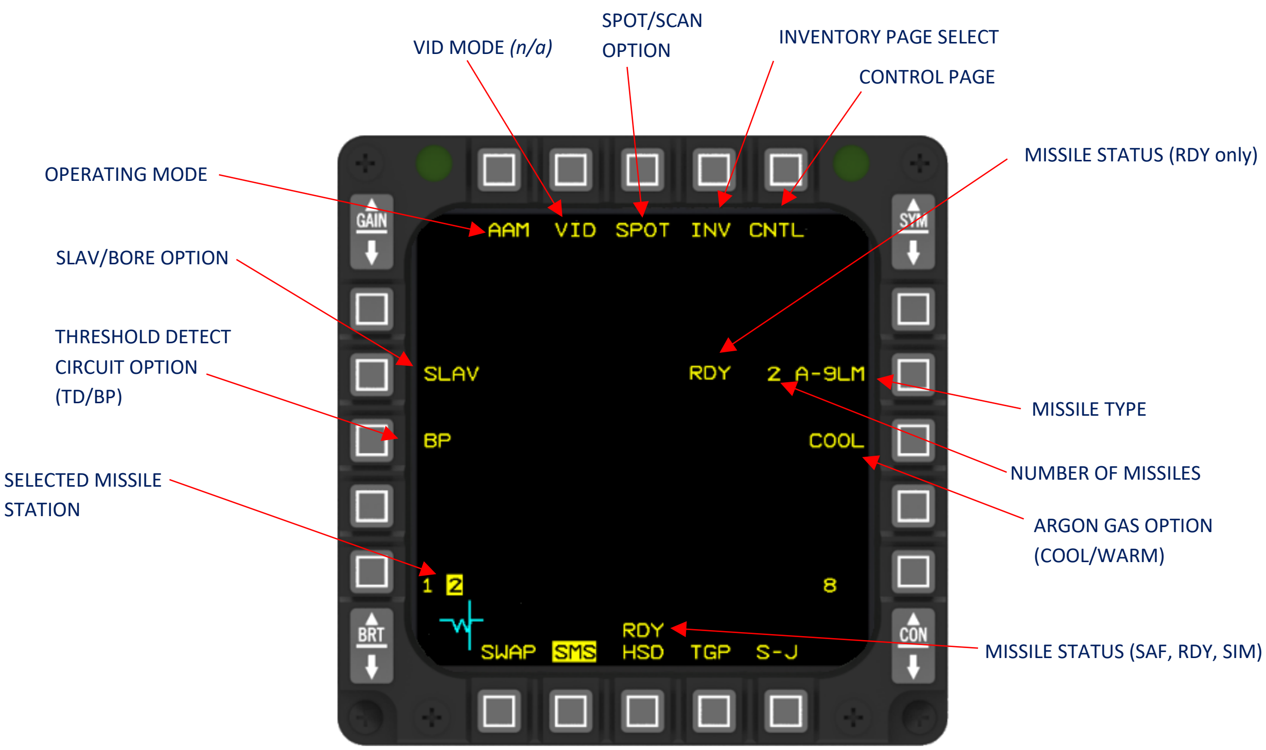
AIM-9M

AIM-9P



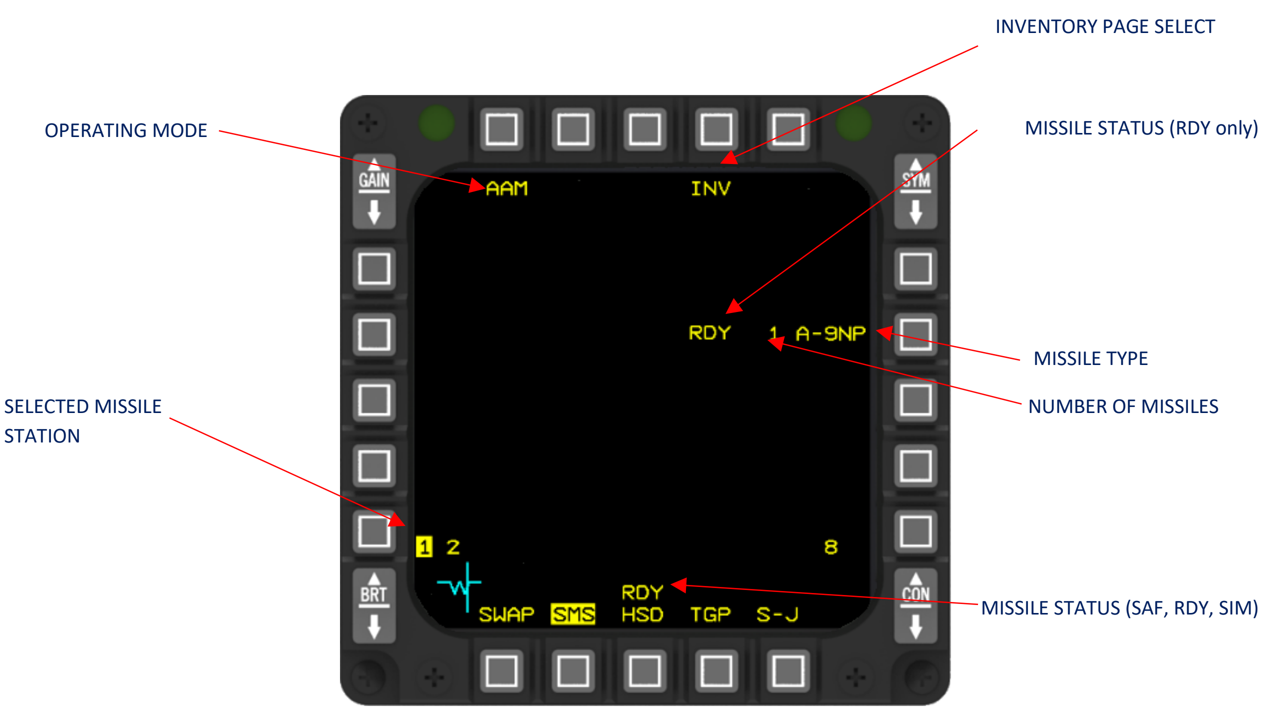
AIM-9X

4.3.2.4.3.2 AIM-9L/M SMS PAGE



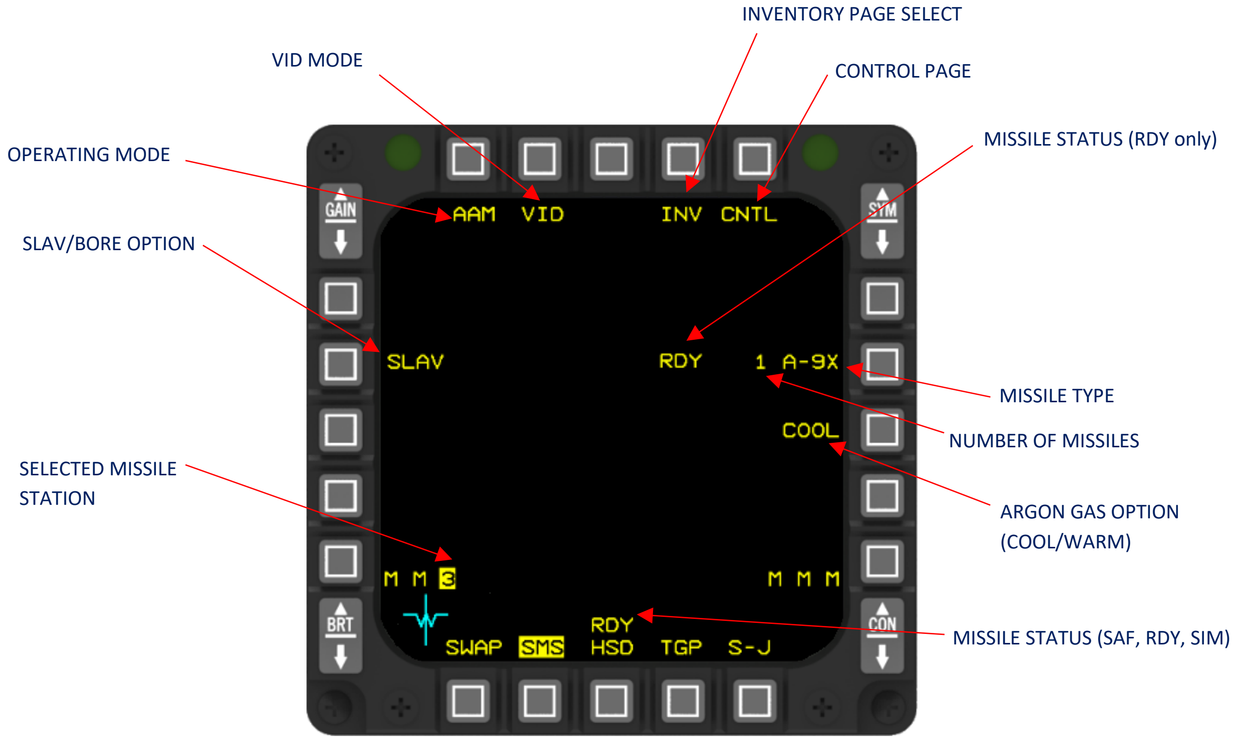
SMS AIR-TO-AIR MISSILE PAGE WITH AIM-9L/M

4.3.2.4.3.3 AIM-9P SMS PAGE



SMS AIR-TO-AIR MISSILE PAGE WITH AIM-9P

4.3.2.4.3.4 AIM-9X SMS PAGE



SMS AIR-TO-AIR MISSILE PAGE WITH AIM-9X

4.3.2.4.3.5 AIM-9 SMS PAGE - OSB FUNCTIONS

Operating Mode (OSB 1)

The operating mode rotary includes three key options: AAM (Air-to-Air Missile), MSL (Missile), and DGFT (Digital Ground Fire Trainer). These modes enable the selection and management of different types of weapons or training systems for air-to-air engagements.

Visual identification mode VID (OSB 2)

The Visual identification mode is used to assist in the visual acquisition of a target. VID mode provides HUD steering cues to aid in positioning the aircraft allowing the ID light, if present, to be used to illuminate the target-of-interest. For now, the VID isn't implemented in BMS yet.

SCAN/SPOT (OSB 3)

he SCAN/SPOT options, accessible via OSB 3 (On-Screen Button 3), can be toggled on the Multi-Function Display (MFD). By default, the first selection is SPOT. When SCAN is chosen, the Head-Up Display (HUD) introduces a 1-degree nutation at a frequency of 1 Cycle Per Second (cps) into the seekerhead gimbals. This nutation expands the Field of View (FOV) of the missile. If audio is active at the time, it will be amplitude modulated at the 1 cps rate. On the other hand, when SPOT is selected, no nutation is applied, and the FOV remains conical, generated around a spot by the offset rotating mirror. The HUD responds accordingly to this command by displaying a larger reticle for SCAN compared to SPOT. Both the Multi-Mode Computer (MMC) and the HUD must be operational for SCAN to take effect.

• SPOT - Missile seeker head does not nutate.

• SCAN - Missile seeker head nutates about directed line of sight.

INV (OSB 4)

D&R accesses the SMS inventory page.

CNTL (OSB 5)

D&R accesses the control page for the selected missile if applicable.

Weapon Type, Quantity and Status (OSB 7)

The number of remaining missiles in the inventory is shown next to the selected missile mnemonic. When the MASTER ARM switch is set to MASTER ARM, the quantity of remaining missiles decreases after each launch. However, when the MASTER ARM switch is in the SIMULATE position, the values do not decrease. By pressing the On-Screen Button (OSB) next to the missile-type mnemonic, you can select one of the following missiles or the test vehicle from the inventory:

MNEMONIC	MISSILE
A-9LM	AIM-9L, -9M
A-9P	AIM-9P
A-9X	AIM-9X

On the AAM (Air-to-Air Missile) page, the missile status mnemonic is presented twice to ensure clarity and prioritization. The first display is positioned to the left of the missile mnemonic (OSB 7), allowing for easy reference. Additionally, the missile status mnemonic is shown above OSB 13 in descending order of priority, with the following meanings associated with each status:

- RDY: This indicates that the missile is armed and ready to be fired. The missile requires proper cooling and communication before the RDY indication is displayed. It is mandatory to have the RDY indication present before launching the missile.
- SIM: This indicates that the missile is not armed, but simulated release indications are provided for training or simulation purposes.
- REL: This signifies that a release signal has been sent to the missile, indicating its readiness for launch.
- MAL: This represents a failure or malfunction that prevents the missile from being fired. Launching the missile is prohibited due to the encountered issue.
- Blank: This indicates that the missile is not armed, and no release indications are provided. It signifies that the missile is not prepared for launch.

By displaying these status mnemonics, pilots can quickly assess the readiness and status of the missiles on the AAM page.

COOL/WARM (OSB 8)

The missile's natural state, with no power supplied, is referred to as "WARM." In DGFT or MSL override mode, when the MASTER ARM switch is in MASTER ARM position and an AIM-9L/M missile is selected for the first time since entering the mode, "COOL" is automatically commanded. In other A-A modes, selecting the OSB adjacent to "WARM" (by D&R) activates the "COOL" mode. To enable cooling of the IR sensing element, power supply is provided to all AIM-9 missiles, which opens a spring-loaded valve. Once the "COOL" command is given, it remains active until "WARM" is commanded or the MMC power is removed with the main landing gear down and locked. When a launch is initiated, an onboard battery in the missile activates and keeps the valve open. It's important to note that the cooling gas exhausts rapidly, leading to a rapid deterioration of IR sensing (and accompanying audio). The "COOL" command removes the "RDY" (ready) inhibit in the MMC; when "WARM" is displayed, achieving the "RDY" state is not possible.

Station Status (OSB 10 & 16)

The SMS AAM page provides an indication of the loaded missile type on each station. The display of this indication is located adjacent to OSB 16 for stations 1 through 3, and adjacent to OSB 10 for stations 7 through 9. When the selected missile type is loaded on a station, the corresponding station number is shown. Additionally, if the displayed station number matches the currently selected station, it is highlighted to provide clear visibility and aid in identifying the selected station. This feature ensures that the pilot can easily recognize the loaded missile type on each station and quickly identify the selected station for precise control.

Missile stations can be selected using the following methods:

- Press the OSB next to the missile station repeatedly until the desired station is highlighted.
- Briefly press the missile step button on the stick for less than 0.5 seconds until the desired station is highlighted.
- Automatic selection occurs upon entering the air-to-air master mode or after performing an air-to-air missile launch.

Once the selected missile type is depleted, the next missile type in the rotary is automatically chosen as the active selection. This automatic selection ensures a smooth transition to the next available missile type, allowing for continued engagement without interruption.

Weapon Status (AIM-9L/M) (OSB 13)

See OSB 7 information. In addition, the status SAF (Master ARM: SAFE) is displayed for OSB 13.

Threshold Detect (AIM-9L/M) (OSB 18)

On the Multi-Function Display (MFD), these options can be selected using OSB toggles. The default option is ByPass (BP), unless modified otherwise. Another option available is Threshold Detect (TD), which involves a threshold detect test within the Advanced Missile Remote Interface Unit (AMRIU). In TD mode, the missile audio must surpass a specified voltage level determined by the AMRIU's threshold detecting circuitry. Only when the audio amplitude exceeds this predetermined level can Uncage (i.e., missile self-track) be commanded. Conversely, selecting BP bypasses this test, and the responsibility for audio discrimination falls on the pilot.

The available options on the MFD are as follows:

- TD: The circuit for threshold detect is engaged.
- BP: The circuit is bypassed, removing the threshold detect test.

Line of Sight (OSB 19) (SLAVE/BORE)

The MFD provides OSB toggles for selecting these options, and they can also be cycled to the opposite option by briefly depressing and releasing the Z-axis of the RDR CURSOR/ENABLE switch. This additional method allows for convenient and quick toggling between the options without the need for extensive menu navigation.

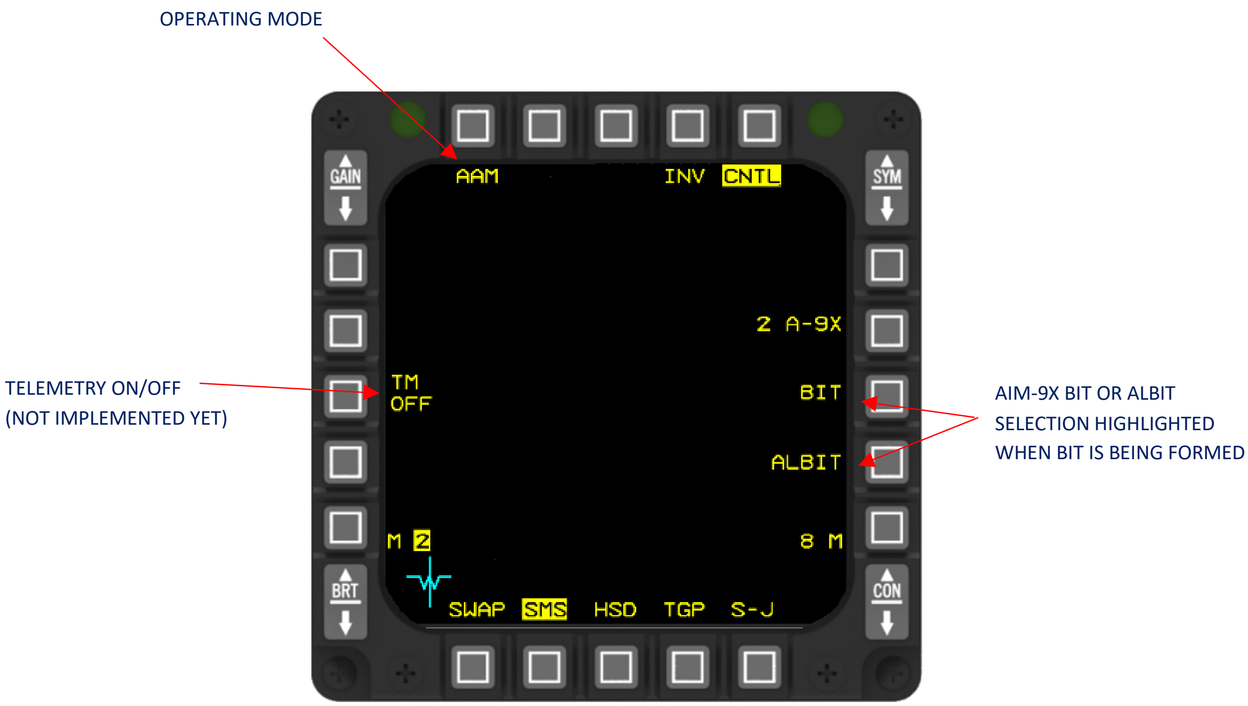
The pilot has the ability to toggle between SLAVE and BORE modes using OSB 19 or the cursor enable (Z-axis) switch. In BORE mode, the AIM-9 missile is synchronized with the line of sight (LOS) of the helmet-mounted cueing system (HMCS), indicated by the aiming cross, as long as a valid HMCS LOS is available. The AIM-9 LOS is directed 3 degrees below the aircraft's boresight in the following scenarios:

- When BORE is selected and there is no valid HMCS LOS.
- When SLAVE is selected and there is no fire control radar (FCR) lock.
- When the targeting pod (TGP) is the Sensor of Interest (SOI) and is not tracking a target.

If SLAVE is chosen and there is no sensor target of interest (TOI), the AIM-9 is commanded to 3 degrees below the Heads-Up Display (HUD) bore-cross. However, if a sensor TOI is established, the missile will be slaved to the tracking sensor. When the FCR is tracking a target, the AIM-9 is directed towards the FCR target LOS. Similarly, if the TGP is the SOI and is tracking a target, the missile is slaved to the TGP LOS. Additionally, if SLAVE is selected, the TGP is the SOI but not tracking a target, and the FCR is tracking a target, the AIM-9 will be slaved to the FCR target until the TGP establishes a track.

To track a target, the AIM-9 missile is commanded via the uncage switch. The AIM-9 remains slaved to the selected LOS (BORE or SLAVE) until seeker track is achieved. Indications of seeker track include the uncage track tone and a double arrowhead on the target locator line (TLL). When the AIM-9 establishes self-track, an audio signal is audible through the pilot's headset. In a scenario where the pilot designates another target using the radar, it is possible for the missile to self-track one target while a Displayed Launch Zone (DLZ) is shown for another target. To reject the AIM-9 target and return the seeker to the selected LOS (BORE or SLAVE), the pilot can press and release the uncage switch.

4.3.2.4.3.5.1 AIM-9X CNTL PAGE - OSB FUNCTIONS



AIM-9X CONTROL PAGE

Weapon Type (OSB 7)

Weapon type (ID) and quantity indicate that AIM-9X is selected. Depressing OSB 7 selects the next available weapon type. All loaded A-A missile types are in the rotary.

Built-in Test (OSB 8)

The AIM-9X missile undergoes a power-up Built-in Test (BIT) when it is initially loaded into inventory. To facilitate operator-controlled BIT, a mnemonic "BIT" is provided next to OSB 8. To initiate a BIT, simply depress the button adjacent to OSB 8. During the BIT process, the "BIT" indicator is highlighted, and it deactivates once the BIT is complete. It's important to note that power-up BITs do not trigger the highlighting of BIT and ALBIT indicators.

To command a BIT, the following conditions must be met:

- AIM-9X is selected as the active weapon.
- Communication is established on the 1553 MUX (Multiplex) interface.
- A specific station has been selected.
- The MASTER ARM is not in the MASTER ARM mode (as a power-up BIT is performed with the MASTER ARM in MASTER ARM mode).

AIM-9X ALBIT (OSB 9)

"ALBIT" option commands BIT on all the loaded AIM-9Xs and functions similar to "BIT."

Station Status (OSB 10 & 16)

Station selection and status are the same as with the base page.

Telemetry Option (OSB 18)

Telemetry Option (OSB 18): The Telemetry (TM) option is accessible when the AIM-9X missile is equipped with a telemetry unit. If the selected weapon is an AIM-9X with a TM unit, four AIM-9X Test Options (pushtiles) will be displayed. It's important to note that these options are intended for flight test purposes only.

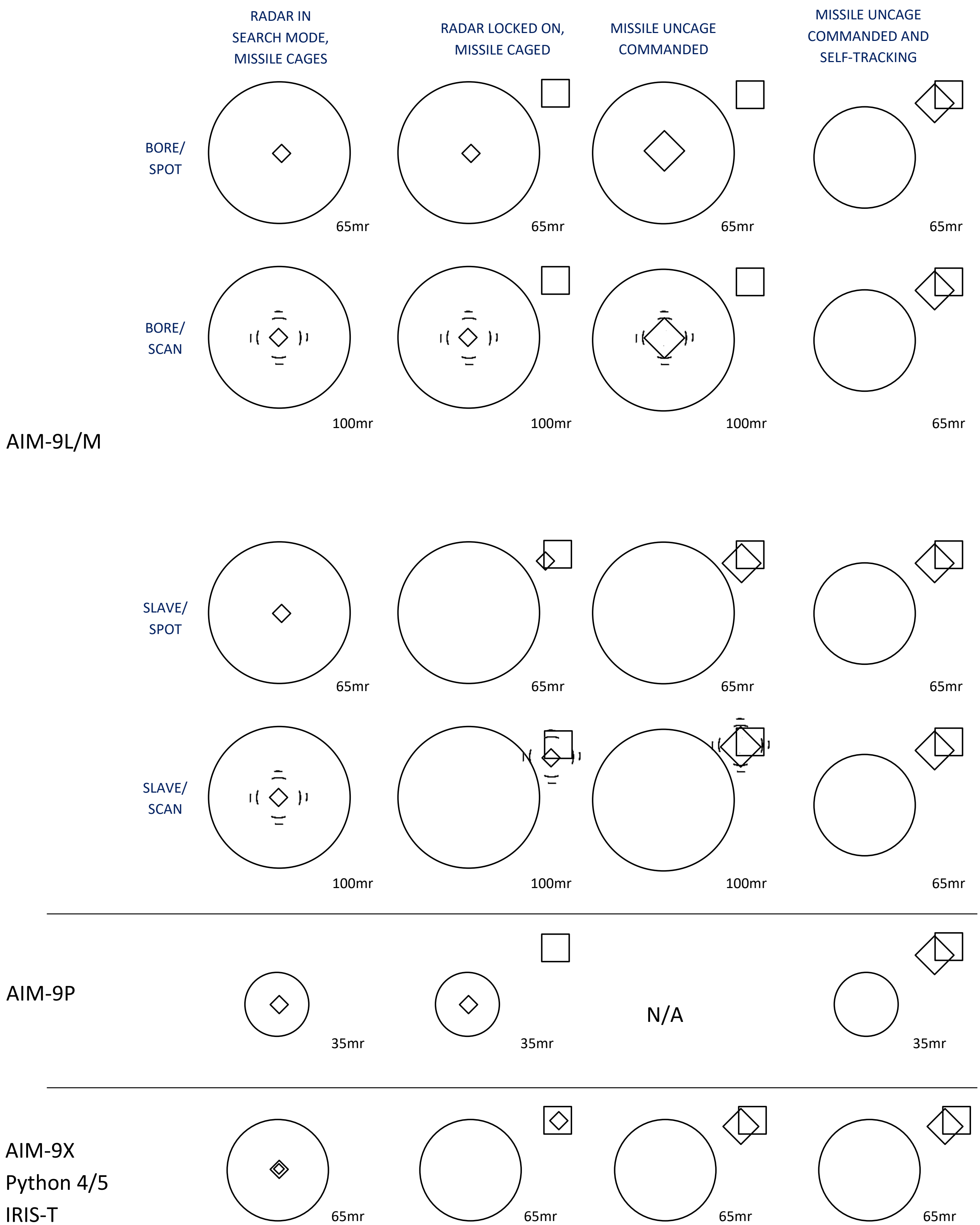
4.3.2.4.3.6 AIM-9/PYTHON 4/5/IRIS-T MISSILE RETICLE

The HUD displays the SRM reticle, which represents the Field of View (FOV) of the missile. The size of the missile reticle is determined by the selected SRM variant and the missile FOV option. When using the AIM-9L/M variant, the reticle diameter is 65 mR when the SPOT FOV option is enabled or when the missile is self-tracking. If the SCAN FOV option is selected, the reticle diameter increases to 100 mR.

The following symbology is shown on the reticle when targeting objects within a slant range of 12,000 feet:

- Reference tics: Four reference tics are positioned at the 3, 6, 9, and 12 o'clock positions.
- Range-to-target cue: This cue consists of a thick tic and range gap. The cue is scaled at 100 feet per clock position, starting clockwise from 0 feet at 12 o'clock.
- Target aspect triangle: When the target velocity is valid, a solid triangle appears on the missile reticle, indicating the angle between the target's longitudinal axis and the line-of-sight to the target. Aspect angles ranging from 0 to 90 degrees indicate a departing target, while angles from 90 to 180 degrees indicate an approaching target.

If the target's slant range exceeds 12,000 feet, the reference tics, range tic, and range gap will not be displayed. During search mode, the reference tics, range tic, range gap, and target aspect angle caret are also not shown. The reticle will flash as an indication that the target is within the maneuver zone.


RADAR IN SEARCH MODE, MISSILE CAGES
RADAR LOCKED ON, MISSILE CAGED
MISSILE UNCAGE COMMANDED
MISSILE UNCAGE COMMANDED AND SELF-TRACKING
BORE/ SPOT
65mr
65mr
65mr
65mr
BORE/ SCAN
100mr
100mr
100mr
65mr
AIM-9L/M
SLAVE/ SPOT
65mr
65mr
65mr
65mr
SLAVE/ SCAN
100mr
100mr
100mr
65mr
AIM-9P
35mr
35mr
N/A
35mr
AIM-9X
Python 4/5
IRIS-T
65mr
65mr
65mr
65mr

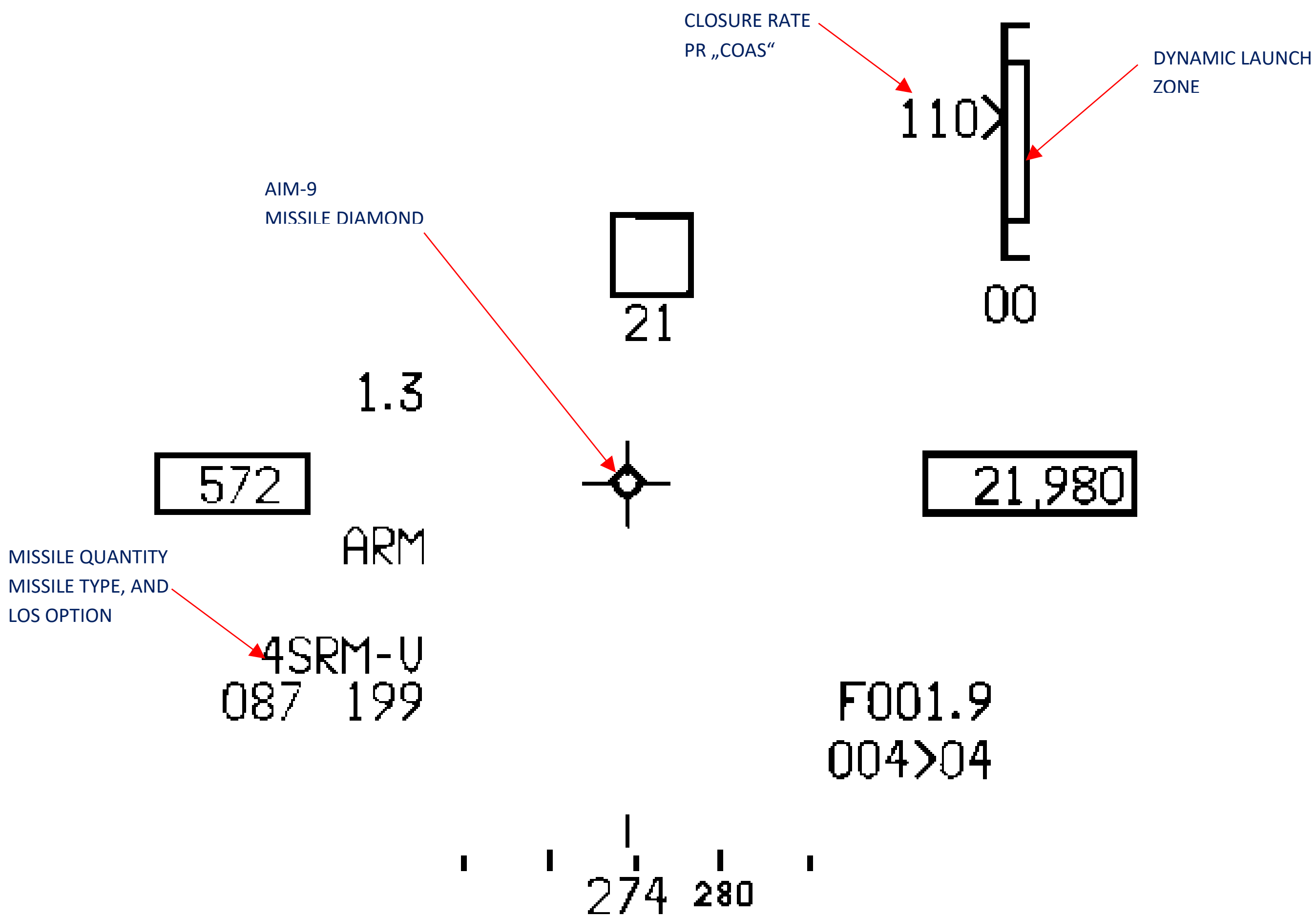
4.3.2.4.3.7 AIM-9 MISSILE DIAMOND

The SRM diamond on the HUD represents the line-of-sight of the missile seeker. In the case of the AIM-9L/M Missile, the diamond is depicted as a square rotated 45 degrees, with each side measuring 6 mR in length.

When the AIM-9L/M missile is slaved, the missile diamond follows the target marked by the FCR/TGP and indicates the position of the SRM seeker head. If the SRM is aligned with the boresight, the missile diamond is centered in azimuth and positioned 3 degrees below the bore-cross.

When the SCAN option is selected for the AIM-9L/M, the diamond precession which means it tracks in a circular motion around the selected line-of-sight, whether in SLAVE or BORE mode.

When the missile is uncaged and attempts to track the target on its own, the missile diamond expands in size to 18 mR. Observing that the large diamond tracks the target, accompanied by the appropriate aural tone, indicates that the missile is functioning properly.



HMCS AIM-9 BORE OPERATION

When the diamond symbol on the HUD or HMCS field-of-view is restricted, an X symbol is overlaid on top of it.

The SLAVE function for the AIM-9L/M, when used with HMCS, synchronizes the missile with the HMCS LOS as long as a sensor target of interest (TOI) exists. If a sensor target is detected, the missile becomes synchronized with the tracking sensor.

The prioritized hierarchy for AIM-9L/M SLAVE is as follows:

- FCR if there is a radar TOI.
- TGP, if the TGP is selected as the SOI and is in air-to-air tracking mode.

It's important not to confuse the missile LOS with the LOS of the system or sensor. Once a track is established, the missile becomes synchronized with the sensor's line-of-sight. Pressing the uncage knob releases the selected SRM from the system's line-of-sight and allows the missile seekerhead to track autonomously, independent of any sensor or system line-of-sight.

The initial missile LOS is determined by the sensor's LOS, which tracks and points towards the target. The LOS can be one of the following:

• The LOS of the FCR target of interest (bugged target).

• The LOS of the TGP.

• The line-of-sight of the aircraft's armament datum line (ADL), which is the longitudinal axis of the pylon surface, angled 3 degrees down from the aircraft's boresight.

• The line of sight provided by the HMCS.

4.3.2.4.3.8 AIM-9 LINEAR MISSILE SCALE

The Linear Missile Scale (LMS) is a visual aid that assists in the delivery of Short-Range Missiles (SRMs). It is displayed on various systems, including:

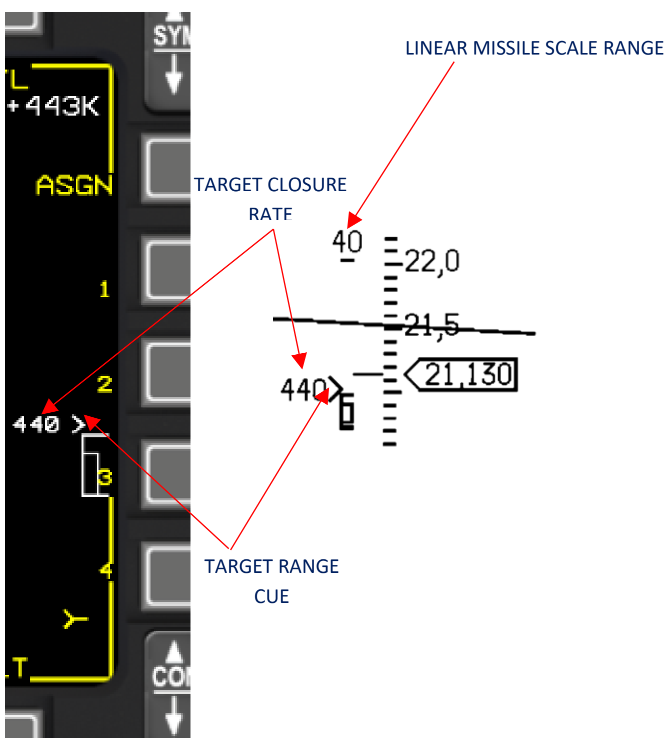
- The HUD (Head-Up Display)
- The HMCS (Helmet-Mounted Cueing System)
- The MFD (Multi-Function Display)

The LMS can still be shown on the HUD and HMCS even if a Dynamic Launch Zone (DLZ) cannot be calculated. However, if a DLZ cannot be computed, it will not be displayed on the MFD.

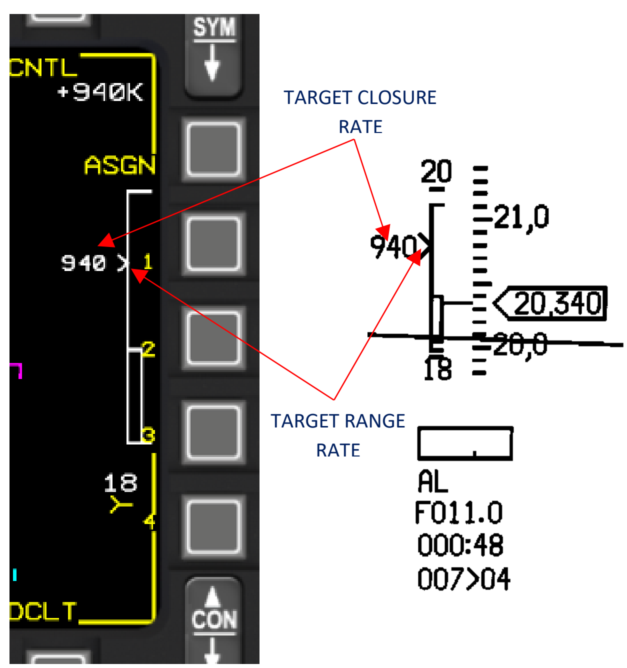
The SRM LMS includes several components, such as:

- Upper and lower range scale tics (HUD only)
- Radar range scale value
- Dynamic launch zone (DLZ)
- Target range caret
- Target closure rate or "COAS" (displayed when the target is in Main Beam Clutter Coast)
- Pre-launch range

The Linear Missile Scale can be displayed in two forms: unexpanded or expanded. The unexpanded LMS is shown when the target range exceeds 110 percent of RMAX1 (maximum range). On the other hand, the expanded LMS is displayed when the target range is equal to or less than 110 percent of RMAX1. The expanded form provides the pilot with a clearer indication of their position within the DLZ.



UNEXPANDED SRM LINEAR MISSILE SCALE.



EXPANDED SRM LINEAR MISSILE SCALE.

4.3.2.4.3.9 SRM DLZ ZONES

The dynamic launch zone (DLZ) is an integral part of the Linear Missile Scale, designed to improve launch accuracy. It consists of an in-range zone and a maneuver zone. When the Short-Range Missile (SRM) is selected as the weapon, the DLZ is displayed on the right side of both the MFD and HUD.

The in-range zone of the DLZ represents the maximum and minimum ranges of the SRM for non-maneuvering targets (RMAX1 and RMIN1). In the unexpanded AIM-9 LMS display, the DLZ parameters are scaled according to the upper tic, which represents the radar range scale value, and the lower tic (located at 25% height for the MFD), representing zero range.

When the expanded AIM-9 LMS is displayed, the DLZ parameters are proportionate to the upper tic, representing 110 percent of RMAX1, and the lower tic (also located at 25% height for the MFD), representing zero range.

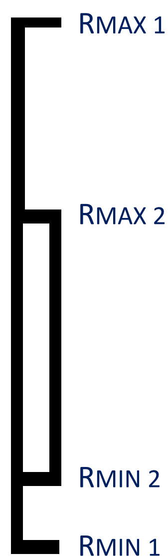
The DLZs for AIM-9L/M and AIM-9X take into account target maneuvers. Here are the different DLZ criteria:

- RMAX1: This criterion applies to non-maneuvering targets and assumes a missile intercept with low termination criteria.

- RMAX2 (RTR - Range Turn and Run): RMAX2 assumes that the target aircraft performs a turn-and-run maneuver upon missile launch. The missile is expected to achieve intercept with high termination criteria. The maneuver consists of an 8g turn (derated for altitude) away from the launch aircraft, followed by constant acceleration. This is the same maneuver assumed for the AIM-120 RTR.

- RMIN2 (RTC - Range Turn to Close): Similar to RMAX2, RMIN2 assumes the same target maneuver criteria, but the target performs a turn towards the launch aircraft. Intercept is expected with high termination criteria.

- RMIN1: RMIN1 assumes that the target maintains its current state without any maneuvers, and the missile intercept occurs with low termination criteria.



SRM DLZ ZONES

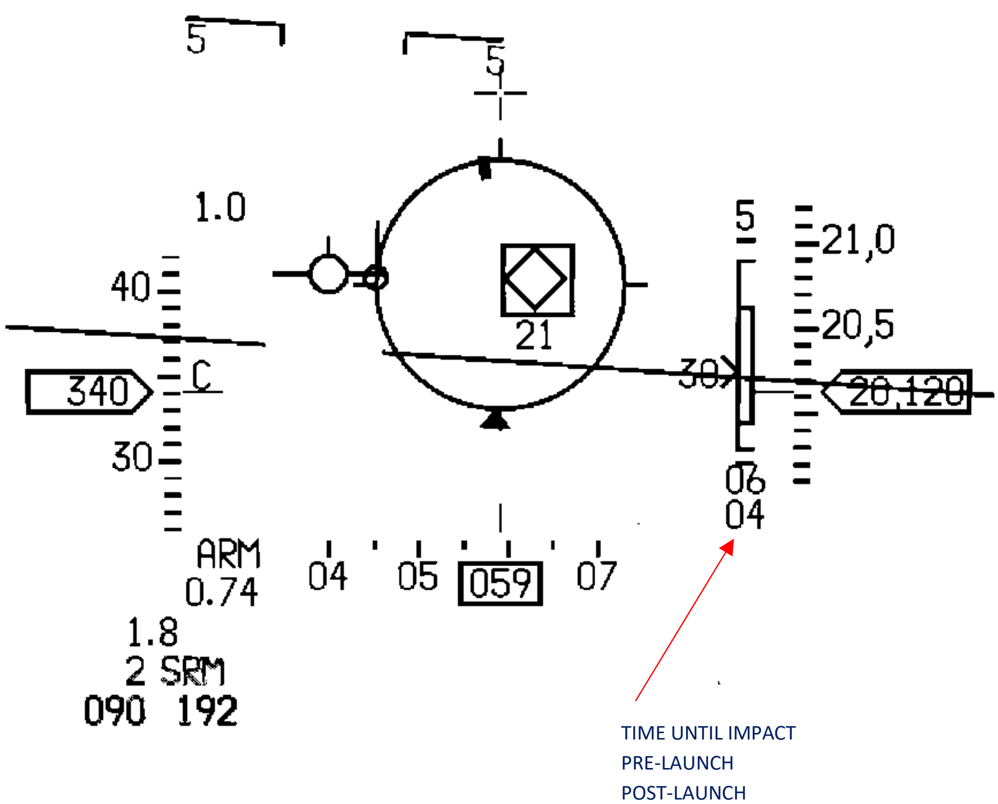
4.3.2.4.3.10 SRM TIME UNTIL IMPACT

The MMC (Mission Management Computer) calculates the Time of Flight for the selected missile in the Dogfight and Missile Override master modes, as well as in the Air-to-Air Missile submode of the Air-to-Air master mode.

In the case of Short-Range Missiles (SRMs), the Time of Flight represents the estimated time until impact. Prior to launch, the display shows the pre-launch computation of the missile time-of-flight based on the Common WEZ (Weapon Engagement Zone) calculation.

Once launched, the Time Until Impact (TUI) for SRMs starts counting down from the pre-launch time-of-flight, taking into consideration target maneuvers. If there is no Target of Interest (TOI) present, but there is at least one missile still in flight (Time Remaining has not expired and reached 0 seconds) against the last TOI, the MMC continues counting down the Time Remaining value based on the passage of time only.

The HMCS (Helmet-Mounted Cueing System) displays the Time Until Impact (TUI) for SRMs.



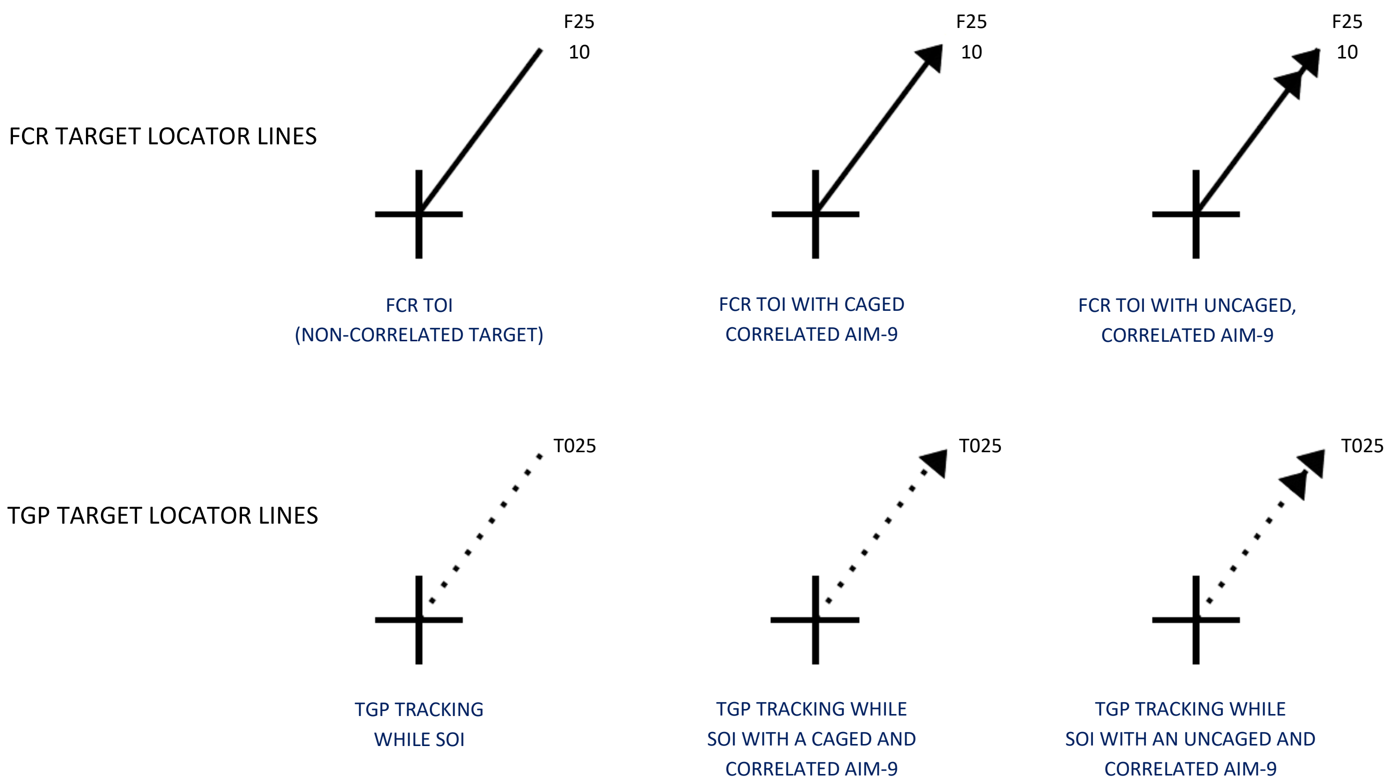
SRM TIME UNTIL IMPACT

4.3.2.4.3.11 SRM CORRELATION SYMBOLOGY

The following SRM correlation indications are shown on the HUD or HMCS through FCR and TGP target locator lines (TLLs):

When an SRM is caged and correlated to a TLL, a single arrowhead is displayed at the end of the associated FCR or TGP TLL on both the HMCS and HUD.

When an SRM is uncaged and correlated to a TLL, a double arrowhead is displayed at the end of the associated FCR or TGP TLL on both the HMCS and HUD.



TARGET LOCATOR LINES

NOTE
TARGET LOCATOR ANGLE DATA AT THE END OF THE TARGET LOCATOR LINE IS ONLY DISPLAYED ON THE HUD, NOT THE HMCS

4.3.2.4.3.12 SRM PROCEDURES

1. MFD - Select/verify AAM, ACM or MSL OVRD.

2. HUD/HMCS - Verify air-to-air missile symbology.

RADAR MODE

3. Select radar mode.

   (a) For CRM/TWS, CRM/ULS, CRM/RWS, CRM/VSR, or ACM - Acquire target; obtain lock-on if desired.

   (b) For CRM/TWS - Verify target bugged.

TARGETING POD

4. TGP air-to-air mode selected.

   (a) With TGP as SOI, TMS - Forward and release to command POINT track.

   (b) Slew TGP cursor over target and verify TGP is in POINT track on target.

5. SMS - Verify desired missile.

6. For AIM-9 missile:

   (a) MASTER ARM switch - MASTER ARM or SIMULATE.

   (b) HUD/HMCS/MFD - Verify RDY/SIM and aiming symbology.

   (c) Maneuver until target in launch zone/missile diamond on target.

   (d) MAN RNG/UNCAGE control - Depress to uncage missile track (if desired).

   (e) Verify missile tone/diamond on target.

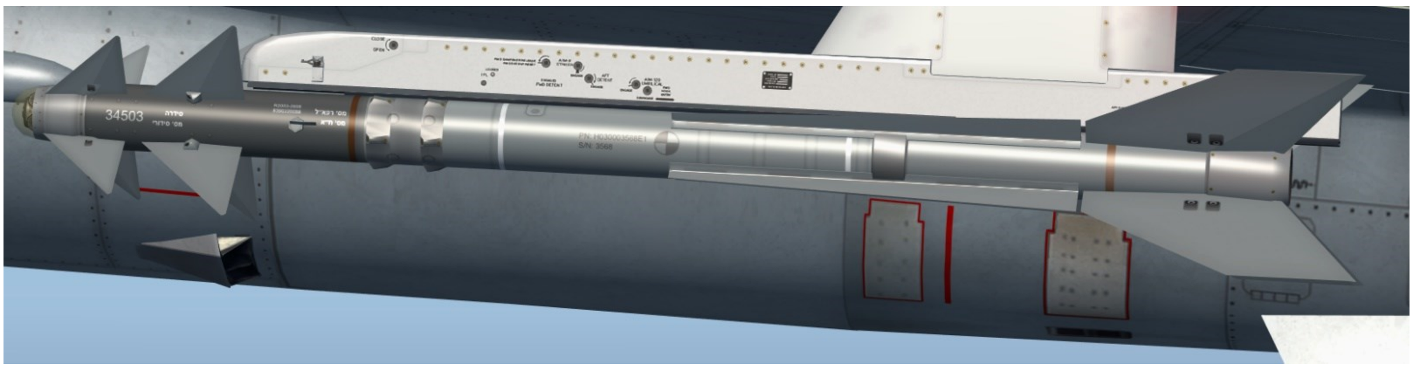
   (f) WPN REL button - Depress and hold until missile launch.

4.3.2.4.3.13 PYTHON 4/5

The Python missile series has been widely used by various air forces around the world. The Python-4, also known as the "Python 4th Generation," is a highly agile and advanced missile designed to engage aerial targets. It incorporates advanced technologies such as imaging infrared seekers, high manoeuvrability, and countermeasures resistance. The Python-5, also referred to as the "Python 5th Generation," is an upgraded version with enhanced performance, including extended range and improved target acquisition capabilities.

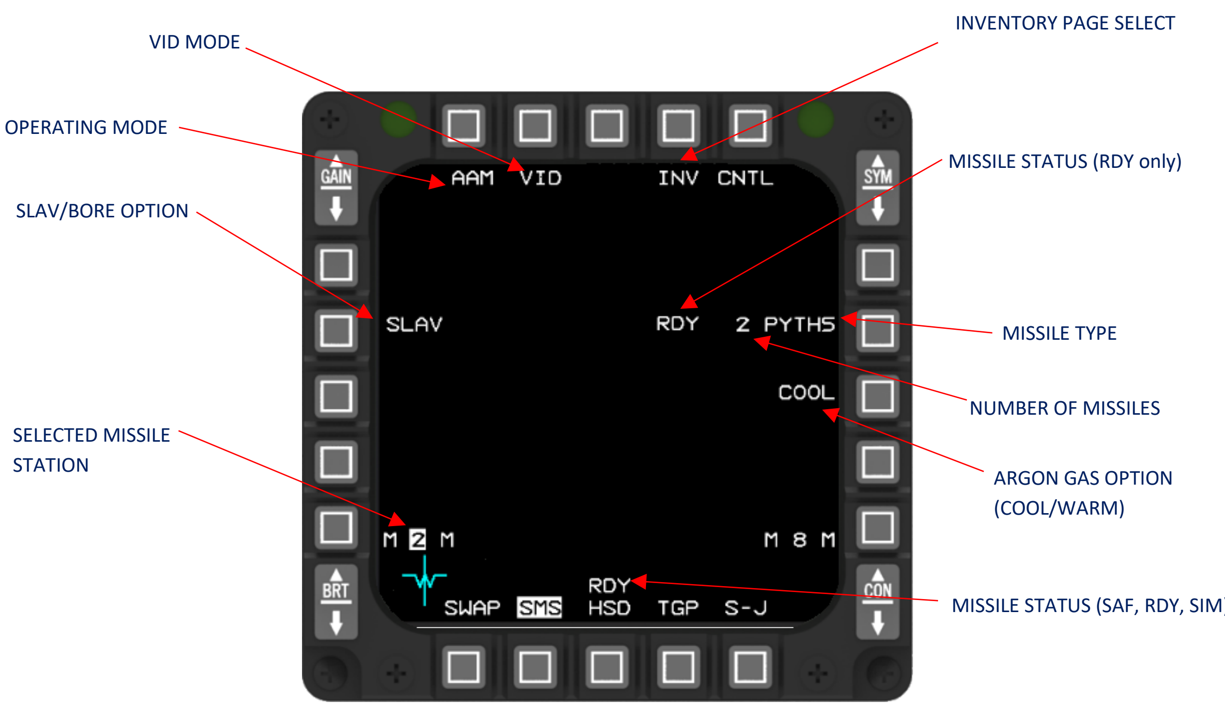
These missiles are primarily used for air combat and are often integrated with fighter aircraft, providing a significant advantage in aerial engagements. They have been deployed on numerous platforms, including fighter jets like the F-15, F-16 (Israel), and F-35.

In BMS, the Python 4 and 5 functionalities are equal to the handling of the AIM-9. For SRM usage in BMS and MFD symbology refer to chapter 4.3.2.4.2.



PYTHON-5

4.3.2.4.3.13.1 PYTHON 4/5 SMS PAGE



PYTHON5 SMS AIR-TO-AIR MISSILE PAGE

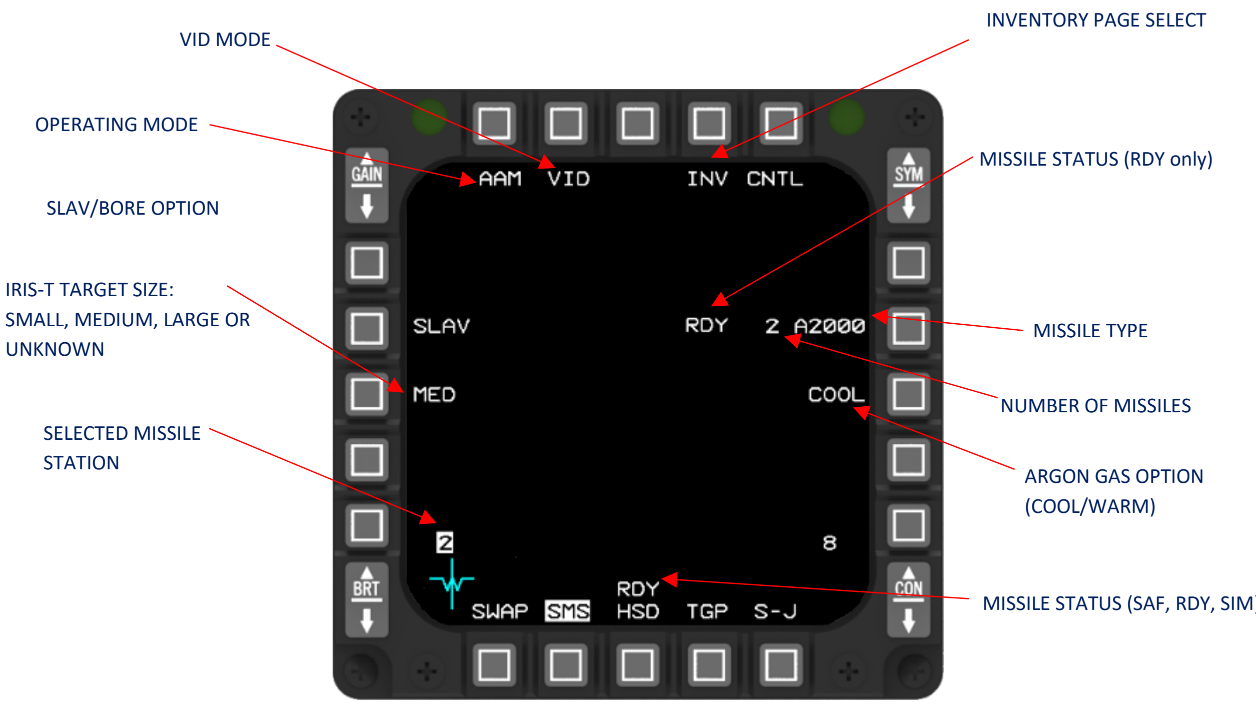
4.3.2.4.3.14 IRIS-T

The IRIS-T (Infra-Red Imaging System Tail/Thrust Vector-Controlled) is a cutting-edge short-range air-to-air missile designed for dogfight scenarios. With infrared homing and high maneuverability, the IRIS-T ensures precise target tracking and engagement.

In BMS, greece F-16 Block 50/52/52+ versions are capable using the IRIS-T.

IRIS-T

4.3.2.4.3.14.1 IRIS-T SMS PAGE



IRIS-T SMS AIR-TO-AIR MISSILE PAGE

4.3.2.4.4 MEDIUM RANGE MISSILES (MRM) OPERATION

4.3.2.4.4.1 AIM-120 MISSILE DESCRIPTION

The AIM-120 Series missile is a versatile air-to-air missile designed for all weather conditions and beyond-visual-range engagements. It utilizes radar guidance and is capable of launch and leave operations, with options for rail or ejection launch. The missile's guidance system offers four modes:

- Active radar with the ability to home in on targets even in the presence of jamming throughout all flight phases.
- Command updates for long-range engagements, coupled with active terminal guidance.
- Inertial guidance combined with active terminal guidance when command updates are unavailable.
- Active terminal guidance that operates independently from aircraft fire control systems, effective within the seeker acquisition range.

The AIM-120 Series missile is equipped with a solid fuel, reduced smoke rocket motor for propulsion. The AIM-120B variant allows for reprogramming through the missile umbilical, while the AIM-120C variant offers both reprogrammability and a compressed carriage configuration. These missile designs follow the block upgrade concept, enabling continuous enhancements. Within this framework, the missile configurations are denoted as AIM-120C and C-5, with the latter incorporating the "Plus 5" rocket motor and a shortened control section.

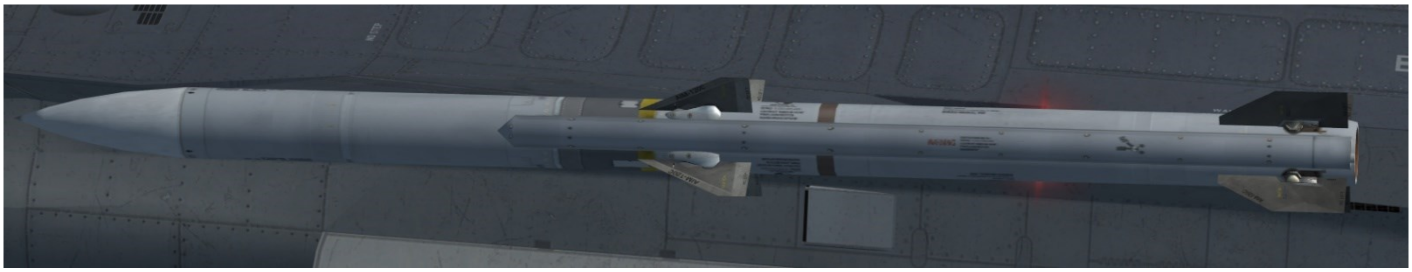
Before delving into the intricacies of avionics and tactical strategies, let's provide a concise overview of the operational theory behind the AMRAAM and active missiles in general.

The AMRAAM is classified as an active missile renowned for its "fire and forget" capabilities, although this description requires some clarification. The AIM-120 possesses its own radar system, albeit smaller in size compared to the aircraft from which it is launched. Consequently, the missile's range for target detection and lock-on is limited compared to the radar detection range of the launching aircraft. However, the missile can still be launched from distances beyond its detection range. In such cases, the launching aircraft must relay pertinent information to the AMRAAM via a datalink or provide support, including details about the target's position, aspect angle, and speed, until the aircraft's own radar can detect it (thus activating the missile). Once the missile becomes active, it truly embodies the "fire and forget" principle. However, even at this stage, a guaranteed kill is not assured. While the AMRAAM relentlessly strives for a successful hit, the absence of the aircraft's radar assistance diminishes the probability of kill (Pk), preventing it from reaching a perfect score of 100% (or 1.0). It is essential to remember the adage that "two radars are always better than one!" Therefore, maintaining lock for as long as possible is highly advisable.

The AIM-120 operates in two active states: HPRF (High Pulse Repetition Frequency) and MPRF (Medium Pulse Repetition Frequency). These states will be examined in greater detail later, but for now, it is crucial to understand that HPRF is utilized at longer distances than MPRF, albeit with less accuracy in pinpointing the target's location. Consequently, it is recommended to break lock once the missile enters the HPRF active state or to continue maintaining lock until the MPRF active state is reached. The choice between these options depends on the specific threat and will be explored further in subsequent discussions. A sound technique is to consistently attack from the flanks or the "6 o'clock" position (or alternatively, the "3-9 hemisphere").

The objective when deciding to fire an AIM-120 missile is to effectively conserve range while maximizing the probability of a successful hit. Achieving this goal requires utilizing all available resources and employing logical reasoning. These resources include the AMRAAM Dynamic Launch Zone (DLZ) and the Head-Up Display (HUD) symbology, which are accurately modelled in BMS.

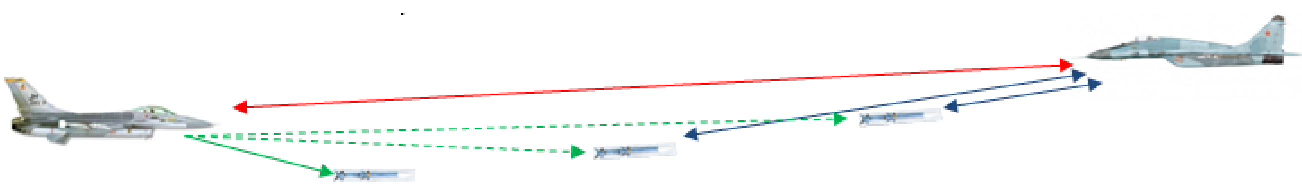
AIM-120B



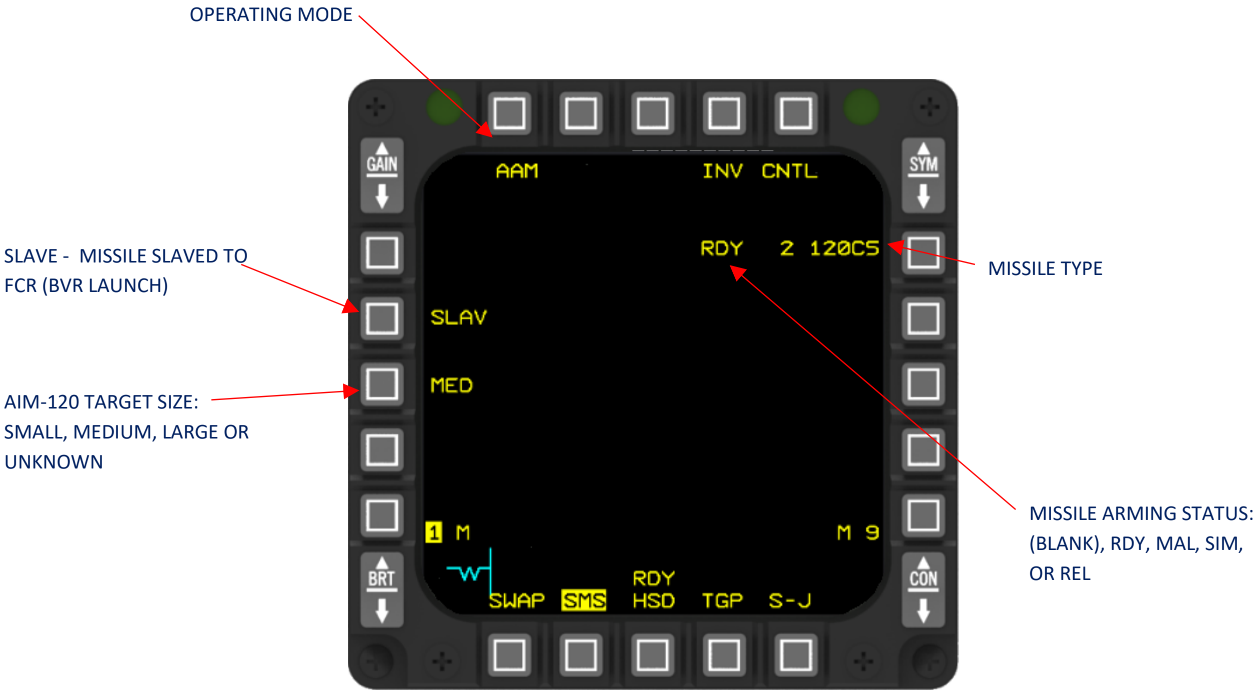
AIM-120C

When an AIM-120 missile is launched, it can be subject to two different termination criteria. Termination criteria refers to the parameters that determine the kinetic energy and maneuverability potential of the missile to successfully intercept and destroy or damage the target. These criteria can be categorized as High Termination Criteria or Nominal Termination Criteria. The latter signifies that the missile possesses less energy and maneuverability, resulting in a reduced probability of hitting the target.

In certain situations, it may be necessary to employ a lofting technique to enhance the missile's effectiveness. Lofting involves executing a pitch-up maneuver, typically around 30 to 40 degrees, analogous to throwing a stone at an elevated angle.



4.3.2.4.4.2 AIM-120 SMS MENU PAGE



AIM-120B/C WEAPON PAGE

Operating Mode (OSB 1)

Operating mode rotary in the SMS air-to-air mode includes: AAM, MSL and DGFT.

INV (OSB 4)

Accesses the SMS inventory page.

Control Page (OSB 5)

Accesses the AIM-120 control page.

Weapon Type, Quantity and Status (OSB 7)

The selected missile mnemonic is accompanied by the display of the remaining quantity of missiles in inventory for that specific missile type. When the MASTER ARM switch is set to MASTER ARM, the value of remaining missiles decreases after each launch. However, when the MASTER ARM switch is in the SIMULATE position, the values do not decrease. To select a specific missile or the test vehicle from the inventory, you can press the OSB located next to the corresponding missile-type mnemonic.

MNEMONIC	MISSILE
A120B	AIM-120B
A120B	AIM-120C
120C5	AIM-120C5

Weapon System Status (OSB 7 and 13)

The following AIM-120 weapon system status indications are displayed:

• RDY - Missile is armed and ready to fire. Communications with the missile must be present before a RDY indication is

displayed. A RDY indication is required to launch the missile.

• SIM - Missile is not armed but simulated release indications are provided.

• REL - A release signal has been issued to the missile.

Station Status (OSB 10 & 16)

The selected station can be changed via OSB 10 and 16. The station status indicates the operational status of the AIM-120 loaded at a station as follows:

• F Failed status - The AIM-120 has failed BIT and cannot be launched.

• H Hung status - indicates a hung store at that station.

• M - indicates stations loaded with unselected missile types.

Physical Size (OSB 18, AIM-120B/C)

Physical target size and radar cross section for the AIM-120B/C missile are controlled via OSB 18 and 8 respectively on the AIM-120B/C weapon page. The AIM-120B/C missiles can accept both physical size and radar cross section information. The missile receives fuzing information based on the options selected. These options will remain through power cycles in the air. UNKN is selected if power is cycled on the ground. If a threat type is known, the option must be set manually.

• SHORT

• MEDIUM

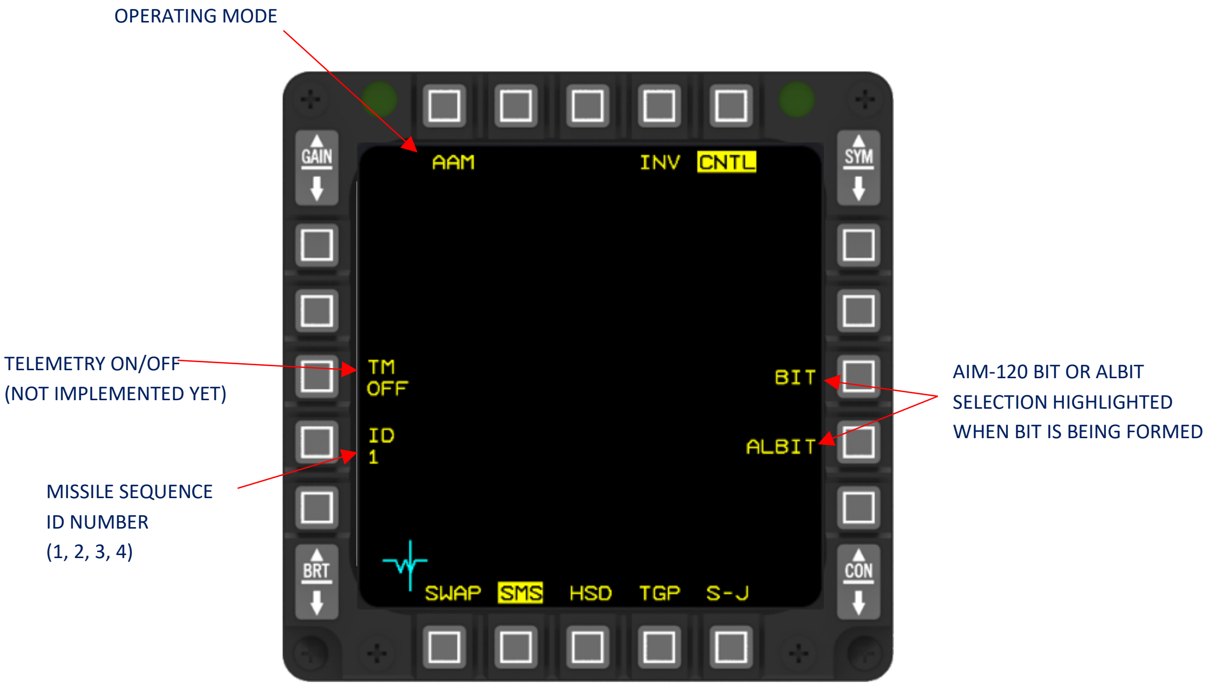
• LONG

• UNKN

Line of Sight (OSB 19)

Pressing OSB 19 and selecting the SLAVE option prepares the chosen AIM-120 missile for launch against the designated target. This is indicated by positioning the HUD missile diamond at the center of the TD (Target Designator) box. On the other hand, selecting the BORE option centers the missile diamond on the HUD horizontally and positions it 6 degrees below the boresight cross. In this mode, the selected missile is primed for active launch and aligned with the boresight direction indicated by the missile diamond. It's important to note that the selected option remains in effect during mode transitions and MMC (Mission Management Computer) power cycles as long as the weapon is chosen.

4.3.2.4.4.3 AIM-120 SMS CNTL PAGE



AIM-120 CONTROL PAGE

Built-in Test (OSB 8)

The "BIT" mnemonic is positioned next to OSB 8, enabling the operator to initiate a Built-In Test (BIT) when necessary. To execute a BIT, simply press the button located adjacent to OSB 8. It's important to note that neither BIT nor ALBIT (Alternate BIT) will be highlighted during power-up BITs. Please note that the functionality of the AIM-120 BIT is not fully implemented yet.

AIM-120 ALBIT (OSB 9)

The "ALBIT" option allows for the execution of the Built-In Test (BIT) on all loaded AIM-120 missiles. It conducts the test sequentially on each missile of the selected weapon type and operates similarly to the "BIT" function. By pressing OSB 9 adjacent to the ALBIT mnemonic, the ALBIT function is initiated, and the mnemonic is highlighted. The self-test process takes approximately 4 seconds for each missile in the inventory. During the self-test of each station, the corresponding station number is highlighted on the MFD (Multi-Function Display). Once the test is completed, the highlight is removed from the ALBIT mnemonic, and any failure indications are displayed as described earlier for individual built-in tests.Please note that the functionality of the AIM-120 ALBIT is not fully implemented yet.

Sequence ID (OSB 17)

The assigned missile ID for an AIM-120 missile determines the specific frequencies utilized by its onboard radar for target acquisition and tracking post-launch. The missile ID serves an additional purpose as a synchronization and identification pattern within the data link system. This enables an AIM-120 in flight to distinguish its own data link messages from those intended for other missiles.

Telemetry Option (OSB 18)

The Telemetry (TM) option is accessible when the AIM-120 is equipped with a TM unit. These options are specifically intended for flight testing purposes.

• TM OFF - Disables power to the telemetry unit. The telemetry status is set to OFF when there is a change in inventory at a station where a missile is loaded.

• TM ON - Activates power to the telemetry unit.

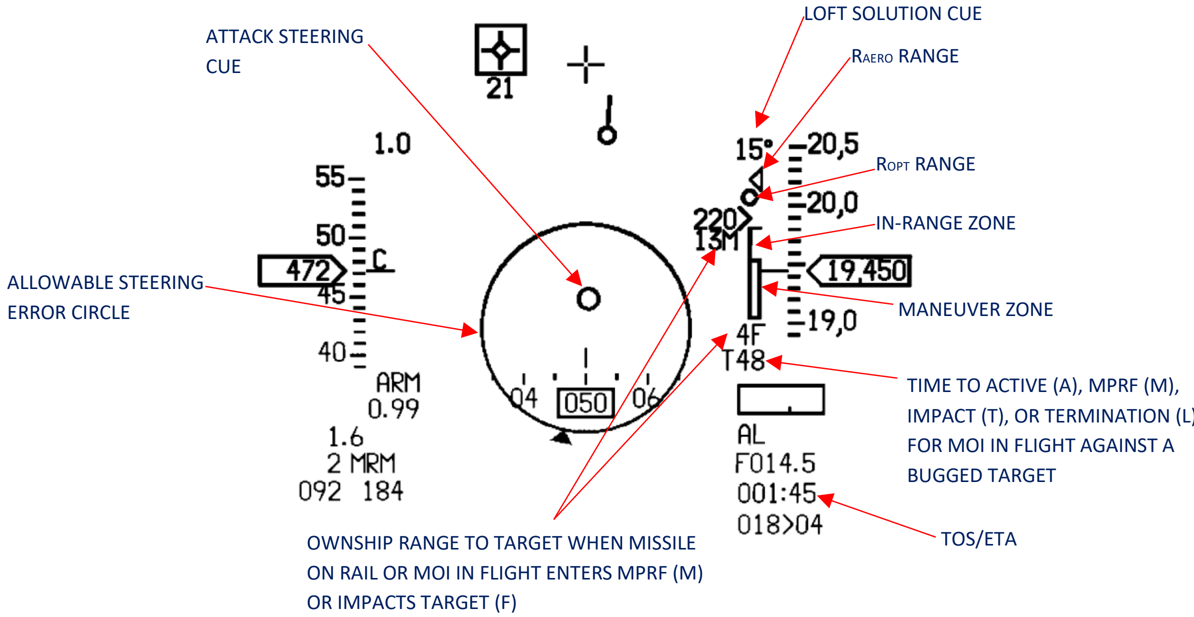
Please note that the functionality of the TM is not fully implemented yet.

4.3.2.4.4.4 AIM-120 MISSILE OPERATION

The avionics system plays a crucial role in supporting the AIM-120 missile by offering various essential functions. These functions include providing in-range indications, seeker head line-of-sight (LOS) information, missile shoot cues, steering guidance, weapon arming capabilities, and quantity status updates. Additionally, cues such as the missile diamond, attack steering cue, allowable steering error circle, and dynamic launch zone contribute to providing guidance for LOS, steering, and range parameters.

4.3.2.4.4.5 AIM-120 MISSILE DIAMOND

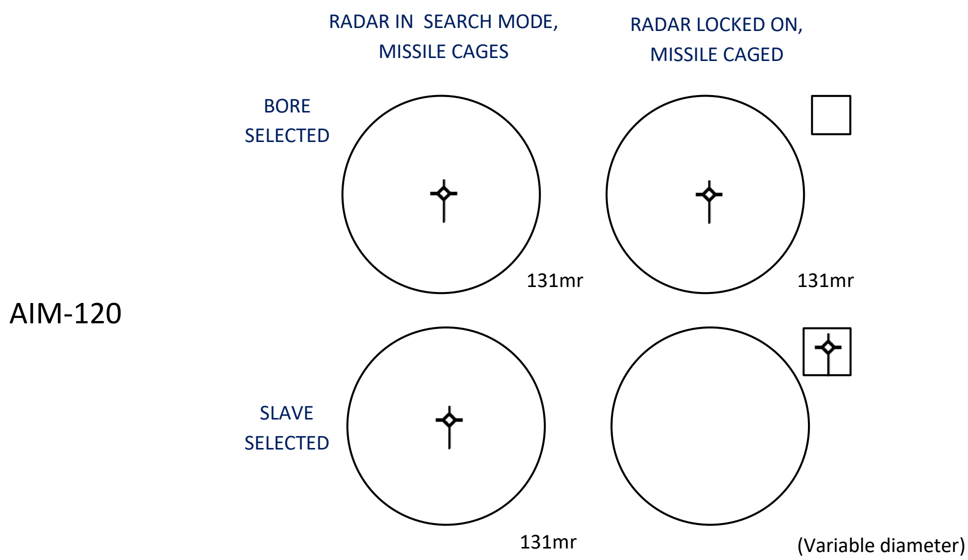
The AIM-120 missile diamond is the same as for a caged SRM with four tics on it to distinguish between the missiles. This diamond, also known as the "hairy diamond," represents the line-of-sight of the missile at the time of launch. When the AIM-120 is linked to a radar-targeted designation, the missile diamond is positioned at the center of the target designator box. In boresight mode, where the boresight reticle encompasses the HUD field-of-view (with a diameter of 262 mR), the missile diamond is positioned at the center of the steering error circle, approximately 6 degrees below the borecross. If the target falls outside the HUD FOV, a limit X symbol is placed on the diamond at the edge of the HUD field-of-view. Finally, the missile diamond flashes to indicate that the target is within range, specifically when the slant range is within the DLZ ranges R_{PI} and R_{MIN}.



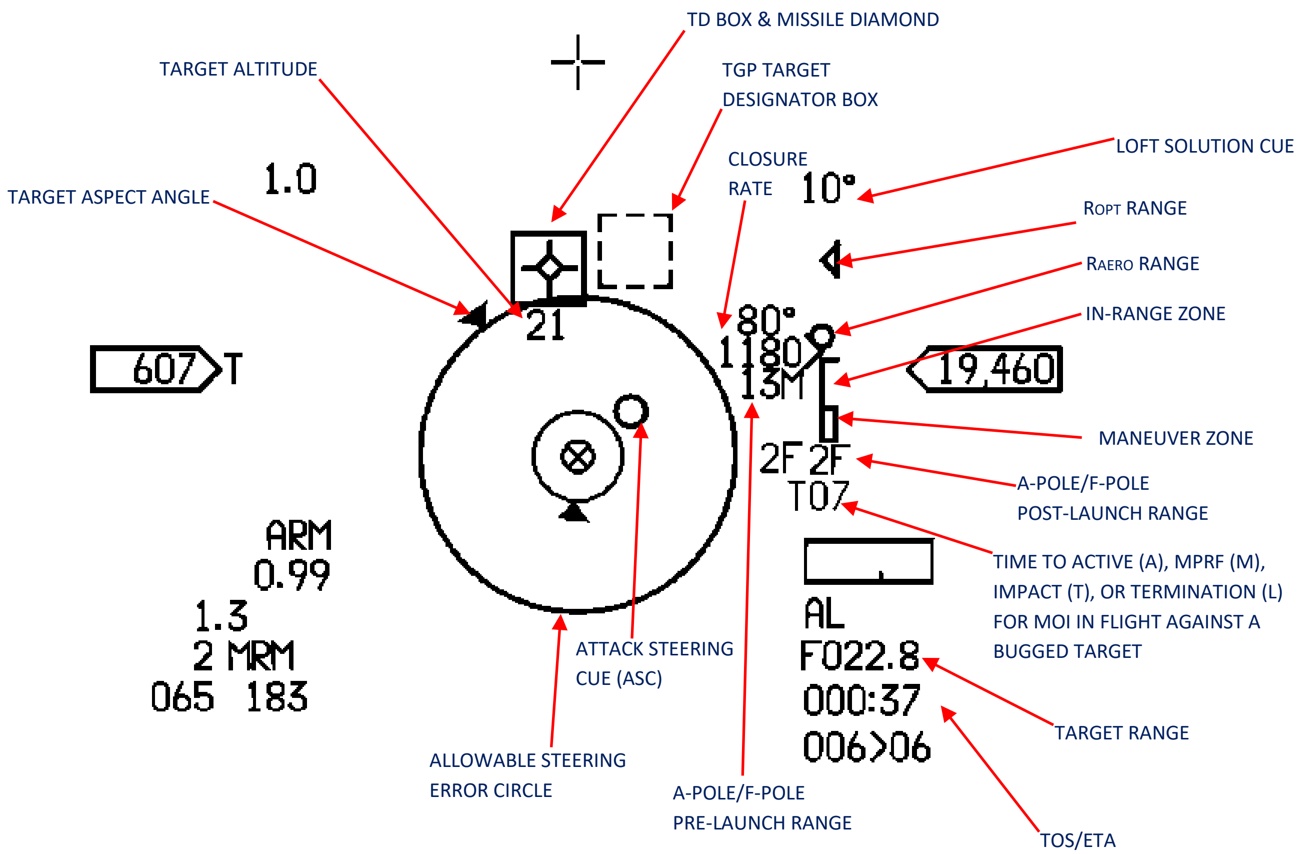
COMMON AIM-120 SYMBOLOGY AND DATA

4.3.2.4.4.6 AIM-120 RETICLE

If the AIM-120 sighting option is set to Bore, or if the sighting option is Slave without a designated target and the weapon system status is RDY or SIM, the AIM-120 boresight reticle, represented by a circle with a diameter of 262 mR, is shown on the HUD (the Bore reticle is not visible on the MFD).



AIM-120 MISSILE RETICLE AND DIAMOND.



SLAVE AIM-120 HUD

4.3.2.5 AIM-120 MODES OF OPERATION

The AIM-120 can be operated in 2 modes: SLAV and BORE. Switching between the two modes can be done either on the SMS page, or with the CURSOR/ENABLE button. CURSOR/ENABLE can switch between SLAV and BORE either momentarily for as long as it is pressed, or as a toggle, depending on the particular aircraft avionics.

SLAV mode: SLAV[E] is the standard mode of operation for the AIM-120. In SLAV mode, the missile is slaved to the FCR. When a track is bugged on the FCR (SAM, TTS/DTT or STT), the missile will be fired at the bugged track. As long as the target remains bugged on the FCR, the missile will receive updates on target position in-flight via the AIM-120's datalink up to the point when it is close enough to activate its own seeker. With a bugged target in SLAV, the missile can be fired with a long press of the Pickle button.

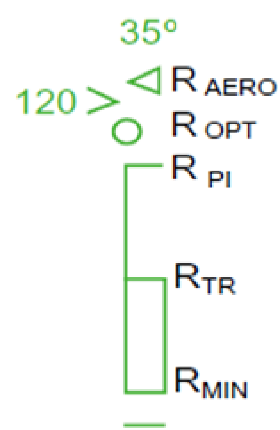
SLAV mode without a bugged target: A missile can also be fired in SLAV without a bugged target, by a long simultaneous press of UNCAGE and Pickle.

BORE mode: BORE allows you to fire a missile relying solely on the missile seeker to find a target. In BORE launch, the missile seeker goes active directly after launch and targets the first aircraft it 'sees'. This mode should only be used for self-defence with extreme caution, as the missile seeker will not discriminate friend or foe (the brevity for such a launch is *MADDOG* for good reason). In BORE mode, missile fire is done by a simultaneous long press of UNCAGE and Pickle. In BORE mode, the missile will ignore any bugged target on the FCR.

NOTE: This mode is well suited in dogfights when a Sidewinder (or other AA IR missile) is not an option.

4.3.2.5.1.1 DYNAMIC LAUNCH ZONE (DLZ)

R_{AERO} (Range Aerodynamic): Represents the maximum kinematic range of the missile, thus the longest range shot having a chance to hit the target. This is assuming the target does not manoeuvre, the pilot performs optimal loft/steering and the missile will result in *Nominal Termination Criteria*.



R_{OPT} (Range Optimal): Basically the same as R_{AERO} but with *High Termination Criteria* this time.

R_{PI} (Range Probability of Intercept): Same as R_{OPT} but without having to loft or make azimuth changes. We still assume the target is non-maneuvering.

R_{TR} (Range Turn and Run): Represents the maximum range shot, assuming the target turns away from your aircraft to tail aspect at launch.

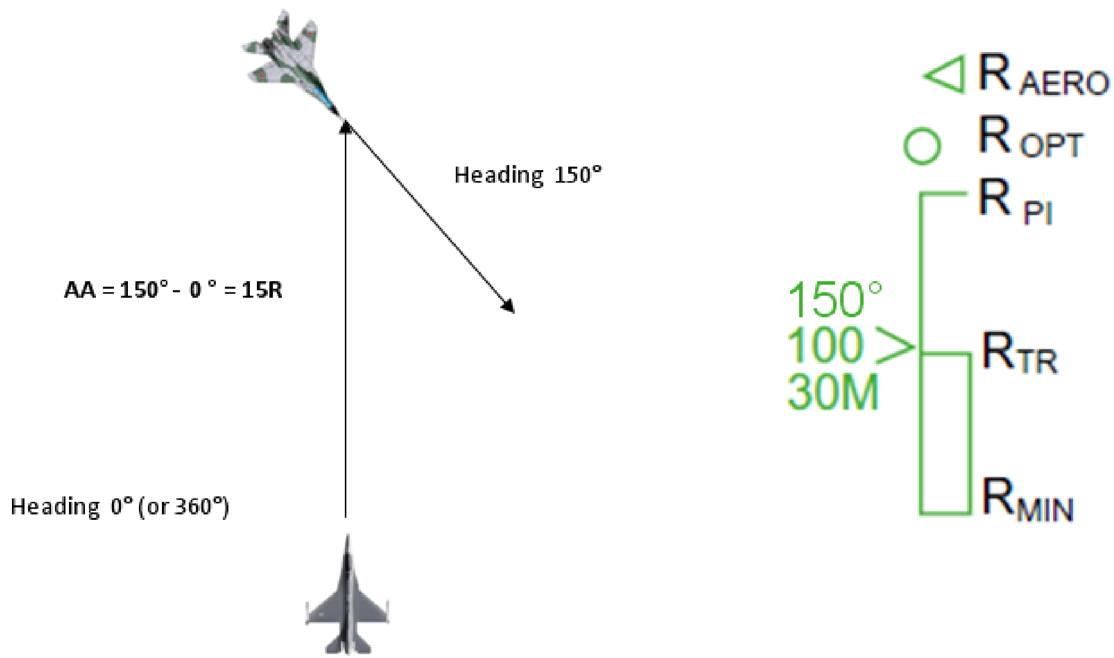
R_{MIN} (Range Minimum): Self-explanatory!

A-POLE: Range from your aircraft to the target when the missile will go active (MPRF).

F-POLE: Range from your aircraft to the target when the missile will impact the target.

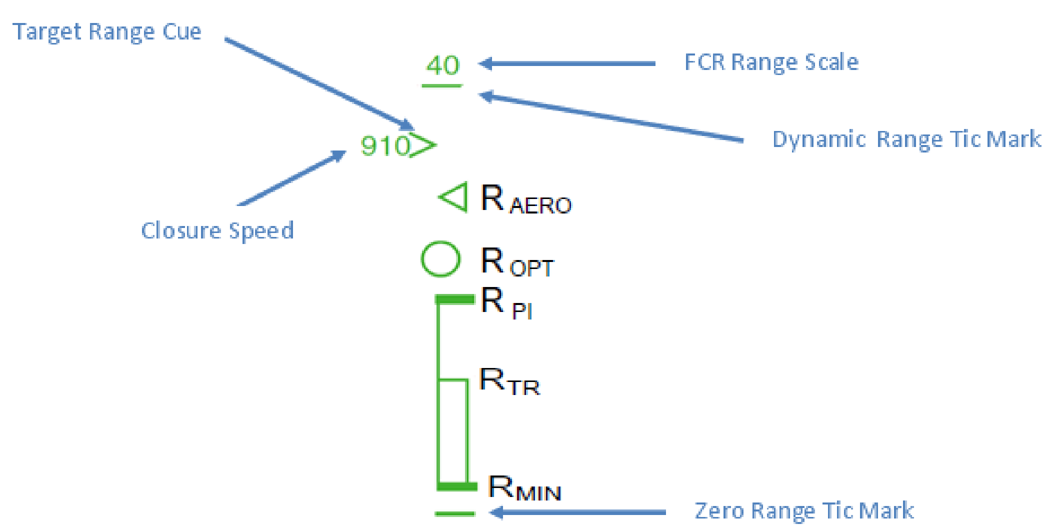
DMC (Digital Maneuvering Cue): Represents the heading change the target has to make to degrade the AMRAAM from high termination criteria to nominal. This value will never exceed the AA (Aspect Angle) and the R_{TR} cue will grow up to this value.

For example:

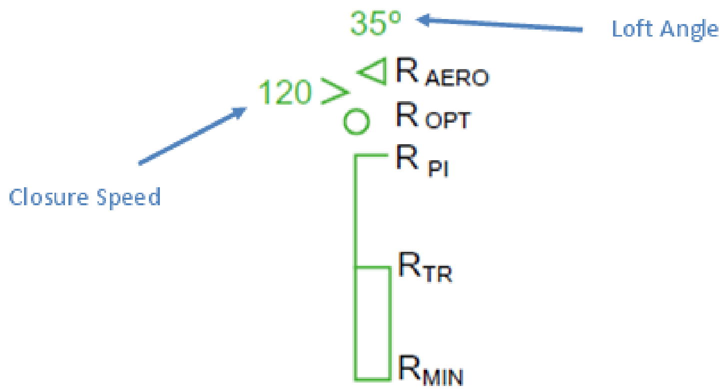


Let's see all the possibilities we can encounter in flight:

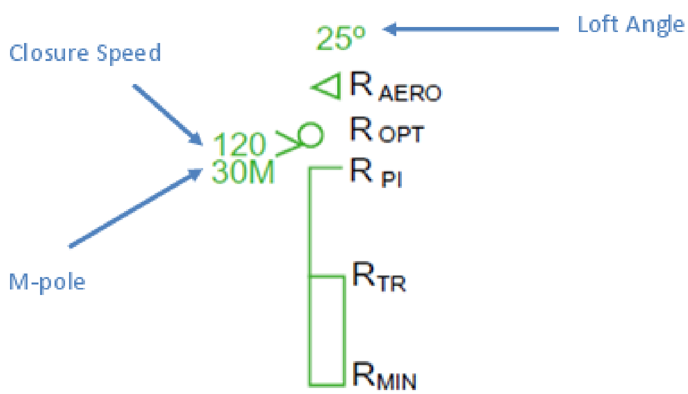
- When the target is beyond 125% of R_{AERO} (unexpanded DLZ)



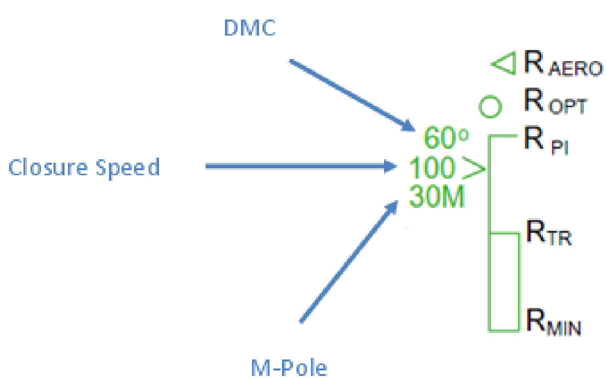
- When the target is within 125% of R_{AERO} (expanded DLZ : R_{AERO} grows up to the former tick mark)



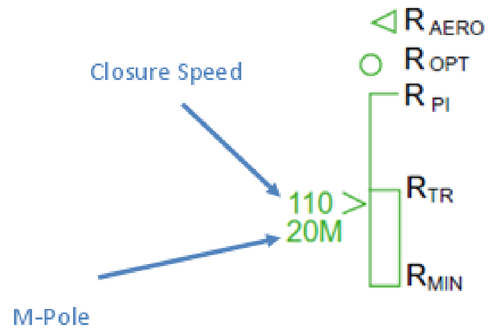
- When the target is within R_{OPT}



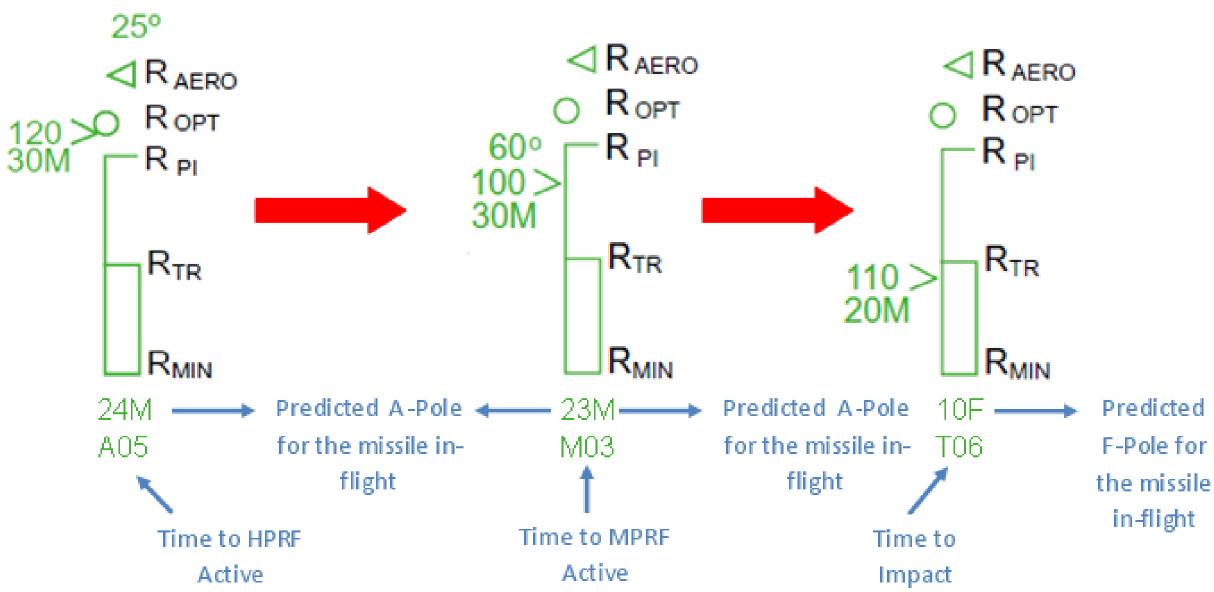
- When the target is within high termination criteria of the AMRAAM (R_{PI})



- When the target is within the no-escape zone of the AMRAAM (R_{TR})



Once launching a missile, the A-pole or F-pole of the missile in-flight (depending if the missile is already MPRF active or not) as well as the Time to HPRF active or Time to MPRF active or Time to Impact will appear below the DLZ. This is a dynamic countdown that will be updated if the target or your aircraft maneuvers. Consider a shot taken at R_{OPT} then you fly straight ahead to the (maneuvering) target.



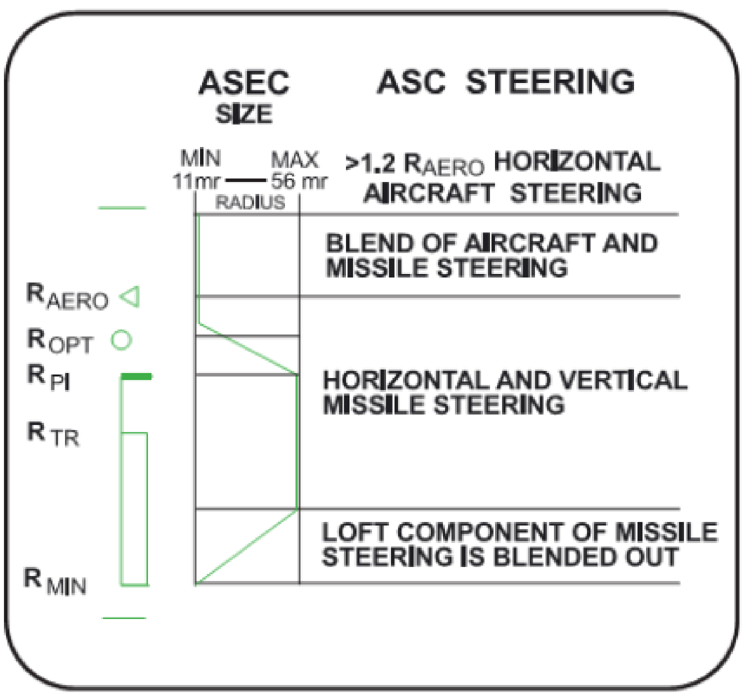
4.3.2.5.1.2 ALLOWABLE STEERING ERROR CIRCLE (ASEC)

The ASEC is a variable diameter circle displayed on the HUD and MFD when an AIM-120 is the selected weapon, sighting option is Slave, and a bugged target exists. The weapon status must be RDY or SIM (Master ARM in ARM or SIM) in order for the ASEC/ASC and DLZ to appear. If there is no bugged target, the AIM-120 Boresight reticle will be displayed. The ASEC is an aid for positioning the attack steering cue in order to take the best shot possible based on the steering. At target ranges from outside R_{AERO} to R_{OPT}, the ASEC is its smallest size, 11mr radius. At R_{OPT}, the ASEC begins to grow in size until target range reaches R_{PI} where it reaches its maximum size (the ASEC represents 45° of allowable steering error at R_{PI}). From R_{PI} to midpoint R_{TR}, the ASEC remains its largest size, at which point it begins to shrink again until it reaches minimum size at R_{MIN}. The ASEC flashes when the target range is within the manoeuvre zone. The ASEC's variable radius varies from 11mr to 56mr with a slaved target. For a bore shot, the radius is static at 131mr (262mr diameter). The ASEC on the MFD is identical in function.

4.3.2.5.1.3 ATTACK STEERING CUE (ASC)

The ASC (8 mr diameter circle in the HUD, 10-pixel radius circle on the MFD) provides several types of steering: horizontal aircraft steering, a blend of aircraft and missile steering, optimal missile steering (with horizontal and vertical missile steering), or R_{MIN} steering (shortest LOS to the target). The type of steering provided is a function of range to the target. Horizontal aircraft steering is provided against targets beyond 1.2 x R_{AERO} (where R_{AERO} is the maximum kinematic range of the missile) and is based on the limits of the ASEC and a 45 degress LOS to target limit. Blended aircraft and missile steering is provided for target ranges between 1.2 R_{AERO} and R_{AERO}. Inside R_{AERO}, the steering provides optimal horizontal and vertical missile steering. Once inside mid-point R_{TR} (half-way in the manoeuvre zone), the ASC provides R_{MIN} steering. The pilot follows the ASC cue by rolling until the cue is on the HUD centerline above the center position of the ASEC and then pulls the aircraft (if commanded) to put the ASC in the center of the ASEC. When the target range is greater than R_{AERO}, a limit cross (X) is displayed inside the ASC to indicate that an AIM-120 shot does not exist even if the pilot performed a loft manoeuvre. The limit cross will also be displayed when the required lead angle exceeds 60°, even if the target is nominally in range. Neither the ASEC nor ASC are displayed on the HUD in DGFT mode.

The following diagram sums ASC/ASEC relationship to the DLZ and the type of steering provided:



4.3.2.5.1.4 LOFT SOLUTION CUE

When the target range reaches the value of R_{AERO}, an AIM-120 Linear Missile Scale will display a loft solution cue. This cue represents a digital readout of the aircraft's pitch, indicating the required pitch adjustment to align the R_{PI} (Range of Planned Intercept) with the R_{OPT} (Range of Planned Termination). By executing the necessary loft solution maneuver between the R_{AERO} and R_{OPT} distances, the R_{PI} will align with the R_{OPT}, allowing the pilot to take a shot from R_{AERO} with a chance of hitting the target, assuming the target remains stationary. As the target gets closer to the R_{OPT}, the missile will have more energy when it reaches the target area.

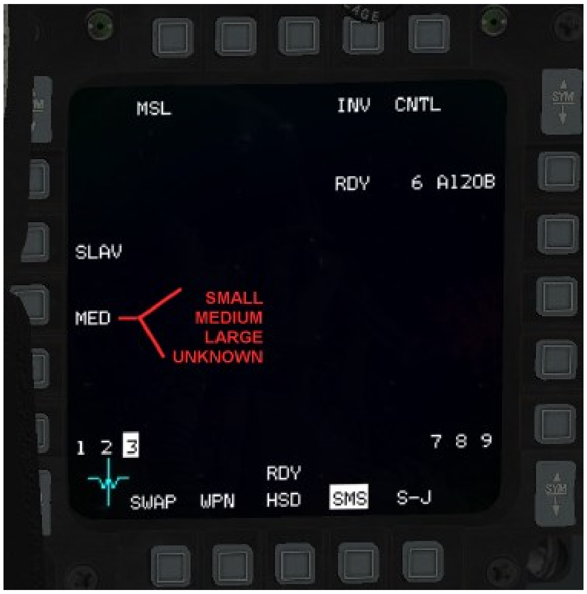
If the pilot performs the required loft solution between the R_{OPT} and R_{PI} distances, the R_{PI} will align with the R_{OPT}. In this case, the pilot can take an R_{OPT} shot and have a chance of hitting the target, provided the target does not maneuver. Once the target range falls within the R_{PI}, the loft solution is no longer displayed, as no further vertical or horizontal steering adjustments are necessary to achieve an accurate shot.

4.3.2.5.1.5 LOFT ANGLE DISPLAY

The loft angle is indicated with a degree symbol to enhance its clarity and user-friendliness. It's important to note that when a DMC (Desired Missile Course) solution is available, the display of the loft solution is not shown as these two functions are mutually exclusive. The provided image below showcases typical HUD and MFD DLZs (Dynamic Launch Zones) when the target range exceeds 125 percent of R_{AERO}. Additionally, it is worth mentioning that the HMCS (Helmet-Mounted Cueing System) does not present the loft angle on its display.

4.3.2.5.1.6 HPRF VS. MPRF, A/F-POLE CUES AND MISSILE DATALINK

BMS incorporates advanced features of the AMRAAM (Advanced Medium-Range Air-to-Air Missile) DLZ (Desired Launch Zone) A/F-pole cues and associated range and timing readouts. The HUD, HMCS and FCR displays have all been updated to include enhanced A/F-pole cues. Notably, the AMRAAM loft cue has been repositioned (above the R_{AERO} caret) to accommodate the new Digital Manoeuvring Cue (DMC) (shown above the target closure value by the range indicator >). The radar model for AMRAAM includes HPRF (High Pulse Repetition Frequency) mode for favourable target geometries. This mode enables the missile to activate the seeker well before the normal MPRF (Medium Pulse Repetition Frequency) range and attempt to track the target. HPRF is particularly effective for tracking high aspect targets with high closing range rates. Datalink guidance remains active up to MPRF unless the pilot commands a snip (drops the radar track) before that point. During HPRF with host aircraft Datalink guidance, the missile will utilize the most optimal tracking solution available, either the seeker or host Datalink guidance. Activation of HPRF and MPRF modes is now solely based on the range to the target, as opposed to the previous time-to-run-based approach.



A notable enhancement allows the pilot to select the Radar Cross Section size on the AMRAAM's SMS page. The available options are small, medium, large, or unknown. However, it is important to note that selecting "SMALL" in the SMS page might not be practical in Falcon BMS, as it is primarily intended for targeting small RCS targets, though it could be useful against helicopters. Opting for the "SMALL" RCS size results in reduced MPRF ranges by approximately one-third compared to the "MED" size.

Regarding the HUD A/F pole cues, they are now provided for both pre-launch and post-launch scenarios. Post-launch cues are relative to the selected Missile-Of-Interest (MOI) for the current bugged target. Changing the MOI in Target Tracking System (TTS) or Track While Scan (TWS) modes will provide A/F pole cues for the MOI for each missile that is in flight to the respective targets. Time remaining cues are also available for the MOI of the current bugged target, showing the time to HPRF, MPRF, time to intercept, or time to termination (essentially the remaining missile time of flight). The timer is more persistent than before and behaves dynamically for the bugged target and a effective MOI. For a effective missile where tracking has been lost or intentionally snipped, the timer functions as a simple stop watch. However, it is important to note that the timer may not count down in a linear fashion for a bugged target with an active Datalink missile due to dynamic calculations that take target maneuvers into account.

The Missile Datalink is able to support up to six missiles in flight. AMRAAMs can be fired on up to two targets in TTS mode or up to six targets in TWS mode. A/F pole and time remaining data are now accessible for all six missiles if they are in flight, and their intended targets are still present as track files on the FCR.

4.3.2.5.2 ACTIVE RADAR HOMING MISSILE

BMS 4.36 brought some significant changes to the Aim-120. The active radar homing missile are modelled with 3 phases:

A) Mid- course: From Launch to Acquisition phase

B) Acquisition with two sub-phases:

- HPRF (optional)
- MPRF

C) Terminal phase: From acquisition to hit

4.3.2.5.2.1.1.1 MID-COURSE PHASE

During the mid-course phase, the missile relies on Datalink (DL) messages that are transmitted from the Launcher aircraft, and that contains information about the target detected by the FCR.

The accuracy of the estimated position, course and speed of the target heavily depends on the Radar submode, with STT being the most accurate, TWS being the least.

Should the Datalink be lost before the acquisition phase, the missile uses the last information received about position, course and speed and will fly using its own INS to this predicted target position. The missile is therefore not completely lost. But a hit is very unlikely.

4.3.2.5.2.1.1.2 ACQUISITION PHASE

Contrary to BMS 4.35 and any version of Falcon before, the missiles does not get a pre designated target during Mid-Course Phase, but will have to detect and track by its own radar the target during acquisition phase.

The acquisition is done with the seeker using physical calculation Signal to Noise Ratio (SNR), based on seeker's radar power and frequency (HPRF or MPRF), antenna scan capabilities, targets RCS and EM environment.

At activation, the missile automatically chooses the most appropriate acquisition phase (HPRF or MPRF) to scan a certain volume around the estimated target position.

The parameters / information about the status of the missile (time to "Husky" or "Pitbull", ranges, poles) displayed in the cockpit essentially depend only on the RCS selected in the SMS Page. These displays are only based on calculations of the avionics, because the real status of the rocket is not known due to the missing backward data link.

4.3.2.5.2.1.1.3 TWO ACQUISITION PHASES

Most of ARH missiles have a very small radar, which is characterized by a relatively small range detection capability but also limited beam width and angle.

The typical beam width of the ARH seeker is in the range of 10 to 20 deg half Angle; while the missile has the capability to turn their antenna in AZ and EL toward the estimated target, they are unable to scan the area with their antenna like as FCR does in search mode.

Therefore, in order to be able to scan the largest part of the area around the estimated target, the seeker should be activated as early as possible.

Due to the small antenna and limited power available, the MPRF cannot be efficient at a long range. However, the HPRF allows for the activation of the seeker at the longest range possible allowing for the maximum scan volume.

4.3.2.5.2.1.1.3.1 HPRF

HPRF stands for High Pulse Repetition Frequency. In HPRF mode, the seeker is able to detect and track targets based on their closure rate (similar to VS mode for FCR), therefore it cannot detect or track targets if closure rate is not higher than a certain gate threshold.

When the estimated target is within HPRF range and above threshold, the missile enters into HPRF acquisition phase. If not, it will continue flying on DL (if available) or INS to the MPRF acquisition phase.

The missile will orient its seeker to the target estimated position and will consider targets in its range, azimuth and elevation that are above velocity gate and select one of them.

As soon as a HPRF target is selected, the DL Target is rejected. However, the DL is not terminated. Therefore, in case no targets are detected during that phase or HPRF target lost, the missile will continue flying taking into consideration DL received.

Due to the very nature of the HPRF that is detecting targets based on their closure Rate, HPRF tracking is vulnerable to notch maneuvers.

If a target is selected by the missile seeker, the target is transferred from HPRF to MPRF at MPRF acquisition range without another MPRF acquisition phase.

4.3.2.5.2.1.1.3.2 MPRF

MPRF stands for Medium Pulse Repetition Frequency. MPRF activates when the estimated target is within MPRF range, (or when a HPRF target is within MPRF range). If the HPRF target has not been selected, the Seeker will search for targets within range, azimuth and elevation and select the closest from the target estimated position.

As soon as a MPRF target is selected, the DL Target is rejected. However, the DL is not terminated. Therefore, in case no targets are detected during that phase or MPRF target lost, the missile will continue flying taking into consideration DL received.

The new modelling of ARH guidance opens a wide variety of tactical situations where the missile can fail to acquire the right target or even fail to track at all. This is heavily dependent on the FCR submode of the launcher and the evasive / maneuvers of the target.

4.3.2.5.2.1.1.3.3 MADDOG

When fired in BORE mode, the ARH will fly to a virtual target estimated in front on its own position, enters into MPRF search immediately after launch and will seek for a target within its seeker range, azimuth and elevation. Extreme caution must be taken when firing in this mode as the missile will not distinguish between friendly or enemy targets, hence the launch brevity term "Maddog". The selection of target will be the first one it will find this will not be necessarily the closest.

If the seeker does not find any target, the missile will continue flying until battery exhaustion and continue searching in MPRF within its seeker range and azimuth

4.3.2.5.2.1.1.3.4 CLEAR AVENUE OF FIRE

Considering the very high possibility to track the wrong target, including friendlies, CAF (Clear Avenue of Fire) prevents in order to teach AI to avoid frat kills. Depending on the tactical situation, the AI will decide to engage or not, even if ordered. So, do not expect AI to engage targets with ARH when a friendly is in the vicinity of the targeted aircraft

The clear avenue of fire for AI is also implemented for IR seekers (such as AIM-9).

PART V - NONNUCLEAR TRAINING WEAPONS AND EQUIPMENT

5.1 TRAINING WEAPONS

Conventional training weapons in the MMC stores inventory are:

- TGM-65G
- CATM-88D
- BDU-33
- BDU-59
- BDU-60
- GBU-38/B INERT
- AIM-120
- AIM-9M

For training stores loaded as conventional training weapons, the avionic system displays the same parameters as a conventional weapon. For training stores loaded as nuclear training weapons, the avionic system displays the same parameters as a nuclear weapon.

The TGM-65G training missile automatically produces a video image on the WPN format after activation, via the selection of the weapon format (provided the selected weapon is timed out) or by manually depressing the MAN RNG/ UNCAGE control prior to the completion of the timer sequence.

IsCATM 0 or no definition is a usual missile that can shoot at MASTER ARM: ARM and kill things.

IsCATM 1 and 2 are CATMs that can only shoot at MASTER ARM: SIM. Set it to 1 does not kill things that are for PVP AA training, set it to 2 will kill things. 2 is for CATM-88D for SEAD training missions.

CATM will not reduce ammo count even if you simulated "shooting" it but will be visible in the Tacview file.

PART VI - F-16 VARIANTS - OVERVIEW

6.1 COCKPIT

Model	Block	Notes	Seats	MFDs	JHMCS	RWR
F-16C	Block 30	18th AS	1	Color	Yes	AN/ALR-69(V)
F-16C	Block 32	64th AS	1	Color	Yes	AN/ALR-69(V)
F-16AM	Block 15	BAF	1	Color	Yes	TASC
F-16AM	Block 15	RDAF	1	Color	Yes	AN/ALR-69(V)
F-16AM	Block 15	RJAF	1	Color	Yes	AN/ALR-69(V)
F-16AM	Block 15	RNLAF	1	Color	Yes	AN/ALR-69(V)
F-16AM	Block 15	RNoAF	1	Color	Yes	AN/ALR-69(V)
F-16CM	Block 50	USAF Thunderbirds	1	Color	Yes	AN/ALR-56M
F-16A	Block 15		1	Green	No	AN/ALR-69(V)
F-16B	Block 15		2	Green	No	AN/ALR-69(V)
F-16C	Block 25		1	Green	No	AN/ALR-69(V)
F-16C	Block 30		1	Color	No	AN/ALR-69(V)
F-16C	Block 32		1	Color	No	AN/ALR-69(V)
F-16CM	Block 40		1	Color	Yes	AN/ALR-56M
F-16DM	Block 40		2	Color	Yes	AN/ALR-56M
F-16CM	Block 42		1	Color	Yes	AN/ALR-56M
F-16CM	Block 50		1	Color	Yes	AN/ALR-56M
F-16CM	Block 52		1	Color	Yes	AN/ALR-56M
F-16DM	Block 52		2	Color	Yes	AN/ALR-56M
F-16C	Block 50 PXII	HAF	1	Color	Yes	AN/ALR-93(V)1
F-16C	Block 52+ PXIII	HAF	1	Color	Yes	AN/ALR-93(V)1
F-16C	Block 52+ PXIV Advanced	HAF CFT	1	Color	Yes	AN/ALR-93(V)1
KF-16C	Block 32	ROK	1	Color	No	AN/ALR-69(V)
KF-16C	Block 52	ROK	1	Color	Yes	AN/ALR-56M
F-16A	Block 15	Netz - IDF/AF	1	Green	No	Not Defined
F-16B	Block 15	Netz - IDF/AF	2	Green	No	Not Defined
F-16C	Block 30	Barak I - IDF/AF	1	Color	Yes	SPS-1000V-5
F-16D	Block 30	Barak I - IDF/AF	2	Color	Yes	SPS-1000V-5
F-16C	Block 40	Barak II - IDF/AF	1	Color	Yes	SPS-1000V-5
F-16D	Block 40	Barak II - IDF/AF	2	Color	Yes	SPS-1000V-5
F-16I	Block 52+	Sufa - IDF/AF	2	Color	Yes	SPS-1000V-5
F-16I	Block 52+	Sufa CFT - IDF/AF	2	Color	Yes	SPS-1000V-5
F-16C	Block 32	EAF	1	Green	No	AN/ALR-69(V)
F-16C	Block 40	EAF	1	Color	No	AN/ALR-56M
F-16C	Block 52+	EAF	1	Color	No	AN/ALR-69(V)
F-16D	Block 52+	RSAF	1	Color	Yes	AN/ALR-93(V)1

Cockpit - Air-to-Air Combat

6.2 ENGINE AND FUEL

Model	Block	Notes	Engine	Center Fuel Bag	Wing Fuel Bags	Conformal Fuel Tank (CFT)
F-16C	Block 30	18th AS	F110-GE-100	300 Gal	370 Gal	None
F-16C	Block 32	64th AS	F110-PW-220	300 Gal	370 Gal	None
F-16AM	Block 15	BAF	F100-PW-220	300 Gal	370 Gal or 600 Gal	None
F-16AM	Block 15	RDAF	F100-PW-220	300 Gal	370 Gal	None
F-16AM	Block 15	RJAF	F100-PW-220	300 Gal	370 Gal	None
F-16AM	Block 15	RNoAF	F100-PW-220	300 Gal	370 Gal	None
F-16CM	Block 50	USAF Thunderbirds	F100-PW-229	300 Gal	370 Gal or 600 Gal	None
F-16A	Block 15		F100-PW-200	300 Gal	370 Gal	None
F-16B	Block 15		F100-PW-200	300 Gal	370 Gal	None
F-16C	Block 25		F100-PW-220/220	300 Gal	370 Gal	None
F-16C	Block 30		F110-GE-100	300 Gal	370 Gal	None
F-16C	Block 32		F100-PW-220	300 Gal	370 Gal	None
F-16CM	Block 40		F110-GE-100	300 Gal	370 Gal or 600 Gal	None
F-16DM	Block 40		F110-GE-100	300 Gal	370 Gal or 600 Gal	None
F-16CM	Block 42		F100-PW-220	300 Gal	370 Gal or 600 Gal	None
F-16CM	Block 50		F110-GE-129	300 Gal	370 Gal or 600 Gal	None
F-16CM	Block 52		F100-PW-229	300 Gal	370 Gal or 600 Gal	None
F-16DM	Block 52		F100-PW-229	300 Gal	370 Gal or 600 Gal	None
F-16C	Block 50 PXII	HAF	F110-GE-129	300 Gal	370 Gal or 600 Gal	None
F-16C	Block 52+ PXIII	HAF	F100-PW-229	300 Gal	370 Gal or 600 Gal	None
F-16C	Block 52+ PXIV Advanced	HAF CFT	F100-PW-229	300 Gal	370 Gal or 600 Gal	440 Gal
KF-16C	Block 32	ROK	F100-PW-220	300 Gal	370 Gal	None
KF-16C	Block 52	ROK	F110-GE-129	300 Gal	370 Gal	None
F-16A	Block 15	Netz - IDF/AF	F100-PW-200	300 Gal	370 Gal	None
F-16B	Block 15	Netz - IDF/AF	F100-PW-200	300 Gal	370 Gal	None
F-16C	Block 30	Barak I - IDF/AF	F110-GE-100	300 Gal	370 Gal or 600 Gal	None
F-16D	Block 30	Barak I - IDF/AF	F110-GE-100	300 Gal	370 Gal or 600 Gal	None
F-16C	Block 40	Barak II - IDF/AF	F110-GE-100	300 Gal	370 Gal or 600 Gal	None
F-16D	Block 40	Barak II - IDF/AF	F110-GE-100	300 Gal	370 Gal or 600 Gal	None
F-16I	Block 52+	Sufa - IDF/AF	F100-PW-229	300 Gal	370 Gal or 600 Gal	None
F-16I	Block 52+	Sufa CFT - IDF/AF	F100-PW-229	300 Gal	370 Gal or 600 Gal	440 Gal
F-16C	Block 32	EAF	F100-PW-220E	300 Gal	370 Gal	None
F-16C	Block 40	EAF	F110-GE-100	300 Gal	370 Gal	None
F-16C	Block 52+	EAF	F100-PW-229	300 Gal	370 Gal	None
F-16D	Block 52+	RSAF	F100-PW-229	300 Gal	370 Gal	None

6.3 AVIONICS

Model	Block	Notes	INU	Advanced JDAM Mode	TGP to Mav Handoff	Radar
F-16C	Block 30	18th AS	Gyro	None	No	AN/APG-66
F-16C	Block 32	64th AS	Gyro	None	No	AN/APG-68
F-16AM	Block 15	BAF	EGI	None	Yes	AN/APG-66(V)2A
F-16AM	Block 15	RDAF	EGI	None	Yes	AN/APG-66(V)2A
F-16AM	Block 15	RJAF	EGI	None	Yes	AN/APG-66(V)2A
F-16AM	Block 15	RNoAF	EGI	None	Yes	AN/APG-66(V)2A
F-16CM	Block 50	USAF Thunderbirds	EGI	Type 1	Yes	AN/APG-68(V)
F-16A	Block 15		Gyro	None	No	AN/APG-66
F-16B	Block 15		Gyro	None	No	AN/APG-66
F-16C	Block 25		Gyro	None	No	AN/APG-66
F-16C	Block 30		Gyro	None	No	AN/APG-66
F-16C	Block 32		Gyro	None	No	AN/APG-68
F-16CM	Block 40		EGI	None	Yes	AN/APG-68
F-16DM	Block 40		EGI	None	Yes	AN/APG-68(V)
F-16CM	Block 42		EGI	None	Yes	AN/APG-68(V)
F-16CM	Block 50		EGI	Type 1	Yes	AN/APG-68(V)
F-16CM	Block 52		EGI	Type 1	Yes	AN/APG-68(V)
F-16DM	Block 52		EGI	None	Yes	AN/APG-68(V5)
F-16C	Block 50 PXII	HAF	Gyro	None	Yes	AN/APG-68(V)
F-16C	Block 52+ PXIII	HAF	EGI	None	Yes	AN/APG-68(V)XM
F-16C	Block 52+ PXIV Advanced	HAF CFT	EGI	None	Yes	AN/APG-68(V)XM
KF-16C	Block 32	ROK	Gyro	None	Yes	AN/APG-68
KF-16C	Block 52	ROK	EGI	None	Yes	AN/APG-68(V)
F-16A	Block 15	Netz - IDF/AF	Gyro	None	No	AN/APG-66
F-16B	Block 15	Netz - IDF/AF	Gyro	None	No	AN/APG-66
F-16C	Block 30	Barak I - IDF/AF	Gyro	Type 2	Yes	AN/APG-66
F-16D	Block 30	Barak I - IDF/AF	Gyro	Type 2	Yes	AN/APG-66
F-16C	Block 40	Barak II - IDF/AF	EGI	Type 2	Yes	AN/APG-68
F-16D	Block 40	Barak II - IDF/AF	EGI	Type 2	Yes	AN/APG-68
F-16I	Block 52+	Sufa - IDF/AF	EGI	Type 3	Yes	AN/APG-68(V)9
F-16I	Block 52+	Sufa CFT - IDF/AF	EGI	Type 3	Yes	AN/APG-68(V)9
F-16C	Block 32	EAF	Gyro	None	No	AN/APG-68
F-16C	Block 40	EAF	Gyro	None	Yes	AN/APG-68
F-16C	Block 52+	EAF	EGI	None	Yes	AN/APG-68
F-16D	Block 52+	RSAF	EGI	None	Yes	AN/APG-68(V)

c

6.4 AIR-TO-AIR

Model	Block	Notes	Sidewinder	Sparrow	AMRAAM	Other AAM
F-16C	Block 30	18th AS	AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16C	Block 32	64th AS	AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16AM	Block 15	BAF	AIM-9M,9P,9X	None	AIM-120B	None
F-16AM	Block 15	RDAF	AIM-9M,9P,9X	AIM-7M	AIM-120B	None
F-16AM	Block 15	RJAF	AIM-9M,9P,9X	AIM-7M	AIM-120B	None
F-16AM	Block 15	RNoAF	AIM-9M,9P,9X	AIM-7M	AIM-120B	IRIS-T
F-16CM	Block 50	USAF Thunderbirds	AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16A	Block 15		AIM-9M,9P	AIM-7M	AIM-120B	None
F-16B	Block 15		AIM-9M,9P	AIM-7M	AIM-120B	None
F-16C	Block 25		AIM-9M,9P	AIM-7M	AIM-120B	None
F-16C	Block 30		AIM-9M,9P	AIM-7M	AIM-120B	None
F-16C	Block 32		AIM-9M,9P	AIM-7M	AIM-120B	None
F-16CM	Block 40		AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16DM	Block 40		AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16CM	Block 42		AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16CM	Block 50		AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16CM	Block 52		AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16DM	Block 52		AIM-9M,9P,9X	AIM-7M	AIM-120B,C	None
F-16C	Block 50 PXII	HAF	AIM-9M,9P	None	AIM-120B,C	IRIS-T
F-16C	Block 52+ PXIII	HAF	AIM-9M,9P	None	AIM-120B,C	IRIS-T
F-16C	Block 52+ PXIV Advanced	HAF CFT	AIM-9M,9P	None	AIM-120B,C	IRIS-T
KF-16C	Block 32	ROK	AIM-9M,9P	AIM-7M	AIM-120B	None
KF-16C	Block 52	ROK	AIM-9M,9P	AIM-7M	AIM-120B,C	None
F-16A	Block 15	Netz - IDF/AF	AIM-9M,9P	None	None	None
F-16B	Block 15	Netz - IDF/AF	AIM-9M,9P	None	None	None
F-16C	Block 30	Barak I - IDF/AF	AIM-9M,9P	None	None	Python-4,5
F-16D	Block 30	Barak I - IDF/AF	AIM-9M,9P	None	None	Python-4,5
F-16C	Block 40	Barak II - IDF/AF	AIM-9M,9P	None	None	Python-4,5
F-16D	Block 40	Barak II - IDF/AF	AIM-9M,9P	None	None	Python-4,5
F-16I	Block 52+	Sufa - IDF/AF	AIM-9M,9P	None	AIM-120B,C	Python-4,5
F-16I	Block 52+	Sufa CFT - IDF/AF	AIM-9M,9P	None	AIM-120B,C	Python-4,5
F-16C	Block 32	EAF	AIM-9M,9P	AIM-7M	None	None
F-16C	Block 40	EAF	AIM-9M,9P	AIM-7M	None	None
F-16C	Block 52+	EAF	AIM-9M,9P	AIM-7M	None	None
F-16D	Block 52+	RSAF	AIM-9M,9P, 9X	None	AIM-120B,C	Python-4,5

6.5 AIR-TO-GROUND

Model	Block	Notes	General Purpose Bombs	Laser Guided Bombs	Maverick	Anti-Radiation
F-16C	Block 30	18th AS	None	None	None	None
F-16C	Block 32	64th AS	None	None	None	None
F-16AM	Block 15	BAF	Various	GBU-10,12,24	None	None
F-16AM	Block 15	RDAF	Various	GBU-10,12,24	AGM-65D,G,L	None
F-16AM	Block 15	RJAF	Various	GBU-10,12,24	AGM-65D,G,L	None
F-16AM	Block 15	RNoAF	Various	GBU-10,12,24	AGM-65G,L	None
F-16CM	Block 50	USAF Thunderbirds	Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-88
F-16A	Block 15		Various	None	AGM-65A,B,D,G,L	None
F-16B	Block 15		Various	None	AGM-65A,B,D,G,L	None
F-16C	Block 25		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-45,88
F-16C	Block 30		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-45,88
F-16C	Block 32		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-45,88
F-16CM	Block 40		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-88
F-16DM	Block 40		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-88
F-16CM	Block 42		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-88
F-16CM	Block 50		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-88
F-16CM	Block 52		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-88
F-16DM	Block 52		Various	GBU-10,12,24,27	AGM-65A,B,D,G,L	AGM-88
F-16C	Block 50 PXII	HAF	Various	GBU-10,12,24	AGM-65A,B,D,G,L	AGM-88
F-16C	Block 52+ PXIII	HAF	Various	GBU-10,12,24	AGM-65A,B,D,G,L	AGM-88
F-16C	Block 52+ PXIV Advanced	HAF CFT	Various	GBU-10,12,24	AGM-65A,B,D,G,L	AGM-88
KF-16C	Block 32	ROK	Various	None	AGM-65D,G,L	None
KF-16C	Block 52	ROK	Various	GBU-10,12,24	AGM-65D,G,L	AGM-88
F-16A	Block 15	Netz - IDF/AF	Various	None	None	None
F-16B	Block 15	Netz - IDF/AF	Various	None	None	None
F-16C	Block 30	Barak I - IDF/AF	Various	GBU-10,12,24,27, Griffin II	None	None
F-16D	Block 30	Barak I - IDF/AF	Various	GBU-10,12,24,27, Griffin II	None	None
F-16C	Block 40	Barak II - IDF/AF	Various	GBU-10,12,24,27, Griffin II	None	None
F-16D	Block 40	Barak II - IDF/AF	Various	GBU-10,12,24,27, Griffin II	None	None
F-16I	Block 52+	Sufa - IDF/AF	Various	GBU-10,12,24,27, Griffin II	None	None
F-16I	Block 52+	Sufa CFT - IDF/AF	Various	GBU-10,12,24,27, Griffin II	None	None
F-16C	Block 32	EAF	Various	None	AGM-65A,B,D,G	None
F-16C	Block 40	EAF	Various	GBU-10,12	AGM-65A,B,D,G	None
F-16C	Block 52+	EAF	Various	GBU-10,12	AGM-65A,B,D,G	None
F-16D	Block 52+	RSAF	Various	GBU-10,12,24,27	AGM-65G,L	None

Model	Block	Notes	Small Diameter Bombs	Man In The Loop	Standoff Land Attack Missile	JDAM
F-16C	Block 30	18th AS	None	None	None	None
F-16C	Block 32	64th AS	None	None	None	None
F-16AM	Block 15	BAF	GBU-39	None	None	GBU-31,38,54
F-16AM	Block 15	RDAF	None	None	None	GBU-31,38,54
F-16AM	Block 15	RNLAF	GBU-39	None	None	GBU-31,38,54
F-16AM	Block 15	RNoAF	GBU-39	None	AGM-119	GBU-31,38,54
F-16CM	Block 50	USAF Thunderbirds	GBU-39	None	AGM-154,158	GBU-31,38,54
F-16A	Block 15		None	None	None	None
F-16B	Block 15		None	None	None	None
F-16C	Block 25		None	None	None	None
F-16C	Block 30		None	None	None	None
F-16C	Block 32		None	None	None	None
F-16CM	Block 40		GBU-39	None	AGM-154,158	GBU-31,38,54
F-16DM	Block 40		GBU-39	GBU-15	AGM-154,158	GBU-31,32,38,54
F-16CM	Block 42		GBU-39	None	AGM-154,158	GBU-31,38,54
F-16CM	Block 50		GBU-39	None	AGM-154,158	GBU-31,38,54
F-16CM	Block 52		GBU-39	None	AGM-154,158	GBU-31,38,54
F-16DM	Block 52		GBU-39	None	AGM-154,158	GBU-31,38,54
F-16C	Block 50 PXII	HAF	None	None	AGM-154	GBU-31
F-16C	Block 52+ PXIII	HAF	None	None	AGM-154	GBU-31
F-16C	Block 52+ PXIV Advanced	HAF CFT	None	None	AGM-154	GBU-31
KF-16C	Block 32	ROK	None	None	None	None
KF-16C	Block 52	ROK	None	None	Spice 1000/P,2000/P	GBU-31,32,38,54
F-16A	Block 15	Netz - IDF/AF	None	None	None	None
F-16B	Block 15	Netz - IDF/AF	None	None	None	None
F-16C	Block 30	Barak I - IDF/AF	None	None	Spice 1000/P,2000/P Rampage	GBU-31,38,54
F-16D	Block 30	Barak I - IDF/AF	None	GBU-15, Delilah	Spice 1000/P,2000/P Rampage	GBU-31,38,54
F-16C	Block 40	Barak II - IDF/AF	None	None	Spice 1000/P,2000/P Rampage	GBU-31,38,54
F-16D	Block 40	Barak II - IDF/AF	None	GBU-15, Delilah	Spice 1000/P,2000/P Rampage	GBU-31,38,54
F-16I	Block 52+	Sufa - IDF/AF	GBU-39	GBU-15, Delilah	Spice 1000/P,2000/P Rampage	GBU-31,38,54
F-16I	Block 52+	Sufa CFT - IDF/AF	GBU-39	GBU-15, Delilah	Spice 1000/P,2000/P Rampage	GBU-31,38,54
F-16C	Block 32	EAF	None	None	None	None
F-16C	Block 40	EAF	None	None	None	None
F-16C	Block 52+	EAF	None	None	None	None
F-16D	Block 52+	RSAF	GBU-53	None	None	GBU-31,38,54

Model	Block	Notes	Cluster Munition	WCMD	Anti-Ship Missiles	Rockets
F-16C	Block 30	18th AS	Mk-20, CBU-52,58,71,87,97	None	None	LAU-3A
F-16C	Block 32	64th AS	Mk-20, CBU-52,58,71,87,97	None	None	LAU-3A
					None	None
F-16AM	Block 15	BAF	Mk-20, CBU-52,58,71,87	None	None	LAU-3A
F-16AM	Block 15	RDAF	Mk-20, CBU-52,58,71,87	None	None	LAU-3A
F-16AM	Block 15	RJAF	Mk-20, CBU-52,58,71,87	None	None	LAU-3A
F-16AM	Block 15	RNLAF	Mk-20, CBU-52,58,71,87	None	None	LAU-3A
F-16AM	Block 15	RNoAF	Mk-20, CBU-52,58,71,87	None	None	LAU-3A
F-16CM	Block 50	USAF Thunderbirds	Mk-20, CBU-52,58,71,87,97	CBU-103,104,105	None	LAU-3A
					None	None
F-16A	Block 15		Mk-20, CBU-52,58,71,87,97	None	None	LAU-3A
F-16B	Block 15		Mk-20, CBU-52,58,71,87,97	None	None	LAU-3A
F-16C	Block 25		Mk-20, CBU-52,58,71,87,97	None	None	LAU-3A
F-16C	Block 30		Mk-20, CBU-52,58,71,87,97	None	None	LAU-3A
F-16C	Block 32		Mk-20, CBU-52,58,71,87,97	None	None	LAU-3A
					None	None
F-16CM	Block 40		Mk-20, CBU-52,58,71,87,97	CBU-103,104,105	None	LAU-3A
F-16DM	Block 40		Mk-20, CBU-52,58,71,87,97	CBU-103,104,105	AGM-84A	LAU-3A
F-16CM	Block 42		Mk-20, CBU-52,58,71,87,97	CBU-103,104,105	None	LAU-3A
F-16CM	Block 50		Mk-20, CBU-52,58,71,87,97	CBU-103,104,105	None	LAU-3A
F-16CM	Block 52		Mk-20, CBU-52,58,71,87,97	CBU-103,104,105	None	LAU-3A
F-16DM	Block 52		Mk-20, CBU-52,58,71,87,97	CBU-103,104,105	None	LAU-3A
					None	None
F-16C	Block 50 PXII	HAF	Mk-20, CBU-52,58,71,87,94	CBU-103	None	None
F-16C	Block 52+ PXIII	HAF CFT	Mk-20, CBU-52,58,71,87	CBU-103	None	None
F-16C	Block 52+ PXIV Advanced	HAF CFT	Mk-20, CBU-52,58,71,87	CBU-103	None	None
					None	None
KF-16C	Block 32	ROK	Mk-20	CBU-105	None	None
KF-16C	Block 52	ROK	Mk-20	CBU-105	AGM-84A	None
					None	None
F-16A	Block 15	Netz - IDF/AF	Mk-20, CBU-52,58,71,87,94	None	None	None
F-16B	Block 15	Netz - IDF/AF	Mk-20, CBU-52,58,71,87,94	None	None	None
F-16C	Block 30	Barak I - IDF/AF	Mk-20,CBU-52,58,71,87,94,97	None	None	None
F-16D	Block 30	Barak I - IDF/AF	Mk-20,CBU-52,58,71,87,94,97	None	None	None
F-16C	Block 40	Barak II - IDF/AF	Mk-20,CBU-52,58,71,87,94,97	None	None	None
F-16D	Block 40	Barak II - IDF/AF	Mk-20,CBU-52,58,71,87,94,97	None	None	None
					None	None
F-16I	Block 52+	Sufa - IDF/AF	Mk-20,CBU-52,58,71,87,94,97	None	None	None
F-16I	Block 52+	Sufa CFT - IDF/AF	Mk-20,CBU-52,58,71,87,94,97	None	None	None
					None	None
F-16C	Block 32	EAF	Mk-20	None	None	LAU-3A
F-16C	Block 40	EAF	Mk-20	None	AGM-84A	LAU-3A
F-16C	Block 52+	EAF	Mk-20	None	AGM-84A	LAU-3A
						None
F-16D	Block 52+	RSAF	Mk-20,CBU-52,58,71,87,94,97	None	AGM-84A	None

6.6 ATTACHABLE PODS

Model	Block	Notes	HTS	LANTIRN	FLIR	SNIPER XR
F-16C	Block 30	18th AS	No	No	No	No
F-16C	Block 32	64th AS	No	No	No	No
F-16AM	Block 15	BAF	No	Yes	No	Yes
F-16AM	Block 15	RDAF	No	Yes	No	Yes
F-16AM	Block 15	RJAF	No	Yes	No	Yes
F-16AM	Block 15	RNoAF	No	Yes	No	Yes
F-16CM	Block 50	USAF Thunderbirds	Yes	Yes	No	Yes
F-16A	Block 15		No	No	No	No
F-16B	Block 15		No	No	No	No
F-16C	Block 25		No	No	No	No
F-16C	Block 30		No	Yes	Yes	No
F-16C	Block 32		No	Yes	Yes	No
F-16CM	Block 40		Yes	Yes	Yes	Yes
F-16DM	Block 40		Yes	Yes	Yes	Yes
F-16CM	Block 42		Yes	Yes	Yes	Yes
F-16CM	Block 50		Yes	Yes	Yes	Yes
F-16CM	Block 52		Yes	Yes	Yes	Yes
F-16DM	Block 52		Yes	Yes	Yes	Yes
F-16C	Block 50	HAF PXII	No	Yes	Yes	No
F-16C	Block 52+	HAF CFT PXIII	No	Yes	Yes	No
F-16C	Block 52+ Advanced	HAF CFT PXIV	No	Yes	Yes	No
KF-16C	Block 32	ROK	No	Yes	Yes	No
KF-16C	Block 52	ROK	No	Yes	Yes	No
F-16A	Block 15	Netz - IDF/AF	No	No	No	No
F-16B	Block 15	Netz - IDF/AF	No	No	No	No
F-16C	Block 30	Barak I - IDF/AF	No	No	No	No
F-16D	Block 30	Barak I - IDF/AF	Yes	No	No	Yes
F-16C	Block 40	Barak II - IDF/AF	No	No	No	No
F-16D	Block 40	Barak II - IDF/AF	Yes	No	No	Yes
F-16I	Block 52+	Sufa - IDF/AF	No	Yes	Yes	No
F-16I	Block 52+	Sufa CFT - IDF/AF	No	Yes	Yes	No
F-16C	Block 32	EAF	No	Yes	Yes	No
F-16C	Block 40	EAF	No	Yes	Yes	No
F-16C	Block 52+	EAF	No	Yes	Yes	Yes
F-16D	Block 52+	RSAF	No	Yes	Yes	Yes

Attachable Pods - Air-to-Air Combat

Model	Block	Notes	ECM	Low Alt Camera	Datalink Pod	Other *MRP: Modular Recon Pod FRP: Flight Profile Recorder"*
F-16C	Block 30	18th AS	AN/ALQ131(v), 184	No	None	
F-16C	Block 32	64th AS	AN/ALQ131(v), 184	No	None	
F-16AM	Block 15	BAF	AN/ALQ131(v)	No	None	FRP and MRP
F-16AM	Block 15	RDAF	AN/ALQ131(v)	No	None	MRP
F-16AM	Block 15	RNLAF	AN/ALQ131(v)	No	None	
F-16AM	Block 15	RNoAF	AN/ALQ131(v)	No	None	FRP
F-16CM	Block 50	USAF Thunderbirds	AN/ALQ131(v), 184	Yes	None	
F-16A	Block 15		AN/ALQ131(v)	Yes	None	
F-16B	Block 15		AN/ALQ131(v)	Yes	None	
F-16C	Block 25		AN/ALQ131(v), 184	Yes	None	
F-16C	Block 30		AN/ALQ131(v), 184	Yes	None	
F-16C	Block 32		AN/ALQ131(v), 184	Yes	None	
F-16CM	Block 40		AN/ALQ131(v), 184	Yes	AN/AXQ-14	
F-16DM	Block 40		AN/ALQ131(v), 184	Yes	AN/AXQ-14	
F-16CM	Block 42		AN/ALQ131(v), 184	Yes	None	
F-16CM	Block 50		AN/ALQ131(v), 184	Yes	None	
F-16CM	Block 52		AN/ALQ131(v), 184	Yes	None	
F-16DM	Block 52		AN/ALQ131(v), 184	Yes	None	
F-16C	Block 50	HAF PXII	Internal	Yes	None	FRP
F-16C	Block 52+	HAF CFT PXIII	Internal	Yes	None	FRP
F-16C	Block 52+ Advanced	HAF CFT PXIV	Internal	Yes	None	FRP
KF-16C	Block 32	ROK	AN/ALQ131(v)	Yes	None	
KF-16C	Block 52	ROK	Internal	Yes	None	
F-16A	Block 15	Netz - IDF/AF	AN/ALQ184	Yes	None	
F-16B	Block 15	Netz - IDF/AF	AN/ALQ184	Yes	None	
F-16C	Block 30	Barak I - IDF/AF	Internal	Yes	None	
F-16D	Block 30	Barak I - IDF/AF	Internal	Yes	AN/AXQ-14	
F-16C	Block 40	Barak II - IDF/AF	Internal	Yes	None	
F-16D	Block 40	Barak II - IDF/AF	Internal	Yes	AN/AXQ-14	
F-16I	Block 52+	Sufa - IDF/AF	Internal	Yes	AN/AXQ-14	
F-16I	Block 52+	Sufa CFT - IDF/AF	Internal	Yes	AN/AXQ-14	
F-16C	Block 32	EAF	AN/ALQ131(v)	Yes	None	
F-16C	Block 40	EAF	AN/ALQ131(v)	Yes	None	
F-16C	Block 52+	EAF	AN/ALQ131(v)	Yes	None	
F-16D	Block 52+	RSAF	Internal	Yes	None	

6.7 IDM / LINK 16 (STN)

Model	Block	Notes	IDM	MIDS/L16 - Flight STN	MIDS/L16 - Team STN	MIDS/L16 - Donor STN
F-16C	Block 30	18th AS	Yes	No	No	No
F-16C	Block 32	64th AS	Yes	No	No	No
F-16AM	Block 15	BAF	Yes	1-4	1-4	1-8
F-16AM	Block 15	RDAF	Yes	1-4	1-4	1-8
F-16AM	Block 15	RNLAF	Yes	1-4	1-4	1-8
F-16AM	Block 15	RNoAF	Yes	1-4	1-4	1-8
F-16CM	Block 50	USAF Thunderbirds	Yes	1-4	1-4	1-8
F-16A	Block 15		No	No	No	No
F-16B	Block 15		No	No	No	No
F-16C	Block 25		Yes	No	No	No
F-16C	Block 30		Yes	No	No	No
F-16C	Block 32		Yes	No	No	No
F-16CM	Block 40		Yes	1-4	1-4	1-8
F-16DM	Block 40		Yes	1-4	1-4	1-8
F-16CM	Block 42		Yes	1-4	1-4	1-8
F-16CM	Block 50		Yes	1-4	1-4	1-8
F-16CM	Block 52		Yes	1-4	1-4	1-8
F-16DM	Block 52		Yes	1-4	1-4	1-8
F-16C	Block 50	HAF PXII	Yes	No	No	No
F-16C	Block 52+	HAF CFT PXIII	Yes	No	No	No
F-16C	Block 52+ Advanced	HAF CFT PXIV	Yes	1-4	1-4	1-4
KF-16C	Block 32	ROK	Yes	No	No	No
KF-16C	Block 52	ROK	Yes	1-4	1-4	1-4
F-16A	Block 15	Netz - IDF/AF	Yes	No	No	No
F-16B	Block 15	Netz - IDF/AF	No	No	No	No
F-16C	Block 30	Barak I - IDF/AF	Yes	1-4	1-4	1-8
F-16D	Block 30	Barak I - IDF/AF	Yes	1-4	1-4	1-8
F-16C	Block 40	Barak II - IDF/AF	Yes	1-4	1-4	1-8
F-16D	Block 40	Barak II - IDF/AF	Yes	1-4	1-4	1-8
F-16I	Block 52+	Sufa - IDF/AF	Yes	1-4	1-4	1-8
F-16I	Block 52+	Sufa CFT - IDF/AF	Yes	1-4	1-4	1-8
F-16C	Block 32	EAF	Yes	No	No	No
F-16C	Block 40	EAF	Yes	No	No	No
F-16C	Block 52+	EAF	Yes	1-4	1-4	1-4
F-16D	Block 52+	RSAF	Yes	1-4	1-4	1-4

All non-F-16 aircraft types in BMS and their IDM/Link 16 capabilities are explained in the BMS User Manual chapter 5.1.8.3.

6.8 LINK 16 (HUD/HMCS/MFDS)

Model	Block	Notes	HUD symbology	HMCS symbology	FCR symbology	HSD symbology
F-16C	Block 30	18th AS	-	-	-	-
F-16C	Block 32	64th AS	-	-	-	-
F-16AM	Block 15	BAF	All	All	All	All
F-16AM	Block 15	RDAF	All	All	All	All
F-16AM	Block 15	RNLAF	All	All	All	All
F-16AM	Block 15	RNoAF	All	All	All	All
F-16CM	Block 50	USAF Thunderbirds	All	All	All	All
F-16A	Block 15		-	-	-	-
F-16B	Block 15		-	-	-	-
F-16C	Block 25		-	-	-	-
F-16C	Block 30		-	-	-	-
F-16C	Block 32		-	-	-	-
F-16CM	Block 40		All	All	All	All
F-16DM	Block 40		All	All	All	All
F-16CM	Block 42		All	All	All	All
F-16CM	Block 50		All	All	All	All
F-16CM	Block 52		All	All	All	All
F-16DM	Block 52		All	All	All	All
F-16C	Block 50	HAF PXII	-	-	-	-
F-16C	Block 52+	HAF CFT PXIII	-	-	-	-
F-16C	Block 52+ Advanced	HAF CFT PXIV	PDLT (No range)	PDLT (No range)	EXP.Data: No line 2	EXP.Data: No line 2
KF-16C	Block 32	ROK	-	-	-	-
KF-16C	Block 52	ROK	PDLT (No range)	PDLT (No range)	EXP.Data: No line 2	EXP.Data: No line 2
F-16A	Block 15	Netz - IDF/AF	-	-	-	-
F-16B	Block 15	Netz - IDF/AF	-	-	-	-
F-16C	Block 30	Barak I - IDF/AF	All	All	All	All
F-16D	Block 30	Barak I - IDF/AF	All	All	All	All
F-16C	Block 40	Barak II - IDF/AF	All	All	All	All
F-16D	Block 40	Barak II - IDF/AF	All	All	All	All
F-16I	Block 52+	Sufa - IDF/AF	All	All	All	All
F-16I	Block 52+	Sufa CFT - IDF/AF	All	All	All	All
F-16C	Block 32	EAF	-	-	-	-
F-16C	Block 40	EAF	-	-	-	-
F-16C	Block 52+	EAF	PDLT (No range)	PDLT (No range)	EXP.Data: No line 2	EXP.Data: No line 2
F-16D	Block 52+	RSAF	PDLT (No range)	PDLT (No range)	EXP.Data: No line 2	EXP.Data: No line 2

All non-F-16 aircraft types in BMS and their IDM/Link 16 capabilities are explained in the BMS User Manual chapter 5.1.8.3.

PART VII – ABNORMAL AIRCREW PROCEDURES

7.1 ABNORMAL PROCEDURES

This section described aircrew procedures and information on Malfunction Analysis, Maintenance Fault List (MFL), Pilot's Fault List (PFL) and Built-In Tests (BIT).

7.1.1 MALFUNCTION ANALYSIS

All faults forwarded to the Federal Communications Commission (FCC) are transmitted through the Maintenance Fault List (MFL) and are accessible via the TEST page on the MFD. Subsequently, all MFL-recorded faults are logged in the DTC file for post-flight access and review. See dtc_last_flight_faults.txt in your *User**Logs* folder.

The fault reporting system employs two distinct schemes: the Maintenance Fault List (MFL), encompassing comprehensive details for all reported faults, and the Pilot's Fault List (PFL), which contains equivalent information exclusively for faults relevant to the pilot. Notably, the PFL is a subset of the MFL.

Faults necessitating pilot intervention or impairing mission capabilities are documented on the Pilot's Fault List (PFL) and exhibited on the Pilot's Fault List Display (PFLD). The activation of the MASTER CAUTION light and caution panel lights for avionics, engine, and Flight Control System (FLCS) faults serves as an indication of pilot-centric faults, with these faults automatically showcased on the PFLD.

The MFL plays a crucial role in pinpointing faults to specific subsystems, identified by the Test number, which may not be imperative during the flight but proves valuable for maintenance post-flight. In our context, it serves the purpose of scrutinizing the faults occurring during a flight to assess the appropriateness of pilot actions.

7.1.2 MAINTENANCE FAULT LIST (MFL)

The Maintenance Fault List is accessed from the MFD TEST page (see chapter 2.1.6.14). The page displays a maximum of 17 faults with the following format:

FAULTY subsystem - TEST number - Number of occurrences (up to 9) - Time of first occurrence.

FLCS	036	1	1:19

The initial column, denoted as PFL message, serves to identify the subsystem where the fault originated, constituting the first grouping of the corresponding PFL message.

The second column features a test number that specifically identifies the subsystem experiencing the failure. This TEST number is cross-referenced below in this manual and the emergency checklists.

In the third column, the number of occurrences of the failure since FCC power-up is recorded. The maximum count for a single failure is nine.

The last column displays the time of the first occurrence of the fault since FCC power-up. The Maintenance Fault List (MFL) can accommodate up to 17 entries, inclusive of two key events: take-off and landing. These two events segment the entries into three significant phases of the mission.

In instances where more than 17 malfunctions, including take-off and landing, transpire, the most recent one is systematically replaced with a new entry.

All faults are retained in the Diagnostic Trouble Code (DTC), as elucidated in the subsequent section on DTC Faults recording. A take-off (TOF) flag is logged when the airspeed reaches 120 knots and the landing gear is raised. Conversely, a landing (LAND) flag is recorded when the landing gear is down, and airspeed falls below 80 knots.

7.1.2.1 MAINTENANCE FAULT LIST (MFL) - MNEMONICS

The subsystems are denoted by specific mnemonics, each corresponding to a distinct system:

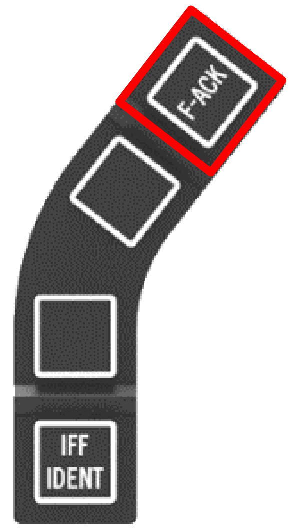
- AMUX: A-multiplex bus
- BLKR: Interference blanker unit
- BMUX: B-multiplex bus
- CADC: Central air data computer
- CMDS: Countermeasures dispensing set
- DLNK: Data modem
- DMUX: D-multiplex bus
- EGI: Embedded Global Positioning System / Inertial Navigation Set
- ENG: Engine
- FCC: Fire control computer
- FCR: Fire control radar
- FDR: Crash survivable flight data recorder
- FLCS: Digital flight control system (DFLCS)
- FMS: Fuel measurement system
- GPS: Global positioning system
- HUD: Head-Up display
- L16: Link-16
- IFF: Advanced identification friend or foe
- IDM: Improved Data Modem
- INS: Inertial navigation set
- MC04, MC13, MMC: Modular Mission Computer
- MFDS: Multifunction display set
- MIDS: Multifunction Information Distribution System
- MSL: Missile slaving loop
- NVP: Navigation Pod
- RALT: Radar altimeter
- RWR: Radar warning receiver
- SMS: Stores management set
- TCDS: Threat Adaptive Countermeasures Dispensing Set
- TCN: TACAN
- TGP: Targeting Pod
- UFC: Upfront control set
- TOF: Pseudo fault recording the take-off time.
- LAND: Pseudo fault recording landing time.

When a fault occurs, the Pilot's Fault List (PFL) is presented on the TEST page, and the corresponding three-digit test number is displayed in the second column. This test number serves as the key to identify the subsystem that encountered the failure. For a comprehensive list of test numbers, refer to section 7.1.5, and they are also outlined in the emergency checklists.

In specific scenarios, the PFL may be identical, and only the differing test number provides additional insights into the precise cause of the malfunction. For example, a NVP COMM FAIL may have two distinct causes: test number 14 signifies a failure of the NVP due to INS, while test number 15 indicates an NVP failure stemming from a radar altimeter problem. In such cases, the pilot, armed with the exact cause information, can swiftly address the issue by examining the relevant system.

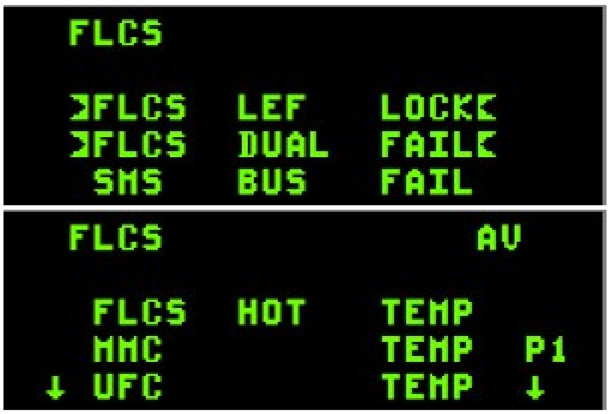
7.1.3 PILOT'S FAULT LIST (PFL)

BMS incorporates a fully implemented Pilot Fault List (PFL) that categorizes faults relevant to the Flight Control System (FLCS), Engine, and Avionics based on priority. These faults are then displayed on the Pilot Fault List Display (PFLD), also known as the Pilot Fault Display (PFD), situated on the right auxiliary console. Faults are acknowledged (though not necessarily resolved) by pressing the F-ACK (Fault-Acknowledge) button on the left glareshield.



The PFLD features one status line and a maximum of three fault lines.

Faults presented on the PFLD are categorized and prioritized into four levels (listed by priority):



- FLCS warning level faults – FLCS mnemonic displayed on the left side of the status line. Warning level PFLs are displayed within >symbols<
- FLCS caution level faults – FLCS mnemonic displayed on the left side of the status line.
- Engine faults – ENG mnemonic displayed in the center of the status line.
- Avionics faults – AV mnemonic displayed on the right side of the status line.

A blank PFLD indicates a normal situation with no reported faults. When the system reports faults, the PFLD displays the fault category and the type of malfunction. If the malfunction is acknowledged with the F-ACK button but the fault persists, the PFLD becomes blank, except for the fault category mnemonic in the status line at the top. Upon clearing the fault (resolving the problem), the PFLD returns to a fully blank display.

Below the status line, the PFLD provides space to exhibit three faults, structured as follows:

Affected subsystem (FLCS) – Affected function (LEF) – Severity of fault (LOCK)

Warning level PFLs are presented within >symbols<, as illustrated in the first two faults below.

In cases where more than three failures occur, consecutive faults are displayed on subsequent pages of the PFLD. In such instances, page numbers and arrows pointing down indicate the existence of additional faults. Navigation to the next page is facilitated by pressing the F-ACK button.

7.1.4 TABLE OF POSSIBLE FAULTS (PFL & MFL)

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
FLCS WARNING	>STBY GAIN<	14	Dual Air Data failure	FLCS in Standby Gains	FLCS RESET - Land ASAP
	>FLCS DUAL FAIL<	21	FLCS electronics, sensor or power failure	None	Not yet implemented
	>FLCS LEF LOCK<	43	LEFs locked or damaged	Possible asymmetry	Check FLCS panel LEF switch - FLCS reset
	>FLCS AP FAIL<	50	Autopilot has failed	Autopilot unavailable	Do not use Autopilot
	>FLCS BIT FAIL<	55	Failed FLCS BIT	Fault only on ground	Not resettable through FLCS reset - rerun FLCS BIT again
	>SWIM ATTD FAIL<	75	INS attitude estimator failure	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM SCP FAIL<	79		TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM NVP FAIL<	76	Navigation pod self-mode failure	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM RALT FAIL<	80	SDC monitor failure or CARA data bad	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	PFL NAME		**CAUSE**	**SYMPTOMS**	**CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS**
FLCS CAUTION	FLCS ADC FAIL	13	Air data input signal failure	Second ADC fail triggers STBY GAINS and latches ADC fail against FLCS RESET attempt	FLCS RESET - Land ASAP
	ISA RUD FAIL	34	Rudder servo actuators malfunction	Rudder problems	FLCS RESET - Land ASAP
	ISA ALL FAIL	36	Controls servo actuators malfunction	Flight control problems	FLCS RESET - Land ASAP
	FLCS HOT TEMP	48	Excess temperature in FLCS branches	None	Not yet implemented
	FLCS SNGL FAIL	49	Single electronic or sensor failure in FLCS	Only on Ground	FLCS RESET
	FLCS BIT PASS		Bit passed (not real caution)		None
	FLCS FLUP OFF	54	FLCS auto fly-up is inhibited	No fly-up in manual TF	Discontinue TFR ops
	FLCS MUX DEGR	71	FLCS BIT detected degradation of FLCC MUX interface when attempting FLCS BIT without FCC/MMC power	None - fault only on ground	Not resettable through FLCS reset - rerun FLCS BIT again
ENGINE	ENG AI FAIL	15	Engine anti-ice valve failed (GE129)	None	Avoid areas of suspected icing conditions
	ENG A/B FAIL	18	Afterburner system failure (GE129)	Afterburner not available	Go SEC mode. Land asap
	ENG AI TEMP	84	Possible engine damage (PW229)	Rough engine	Land asap
	ENG AI FAIL	85	Engine anti-ice valve failed (PW229)	None	Avoid areas of suspected icing conditions
	ENG A/B FAIL	87	Afterburner system failure (PW229)	Afterburner not available	Go SEC Mode. Land asap

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
FLCS WARNING	>STBY GAIN<	14	Dual Air Data failure	FLCS in Standby Gains	FLCS RESET - Land ASAP
	>FLCS DUAL FAIL<	21	FLCS electronics, sensor or power failure	None	Not yet implemented
	>FLCS LEF LOCK<	43	LEFs locked or damaged	Possible asymmetry	Check FLCS panel LEF switch - FLCS reset
	>FLCS AP FAIL<	50	Autopilot has failed	Autopilot unavailable	Do not use Autopilot
	>FLCS BIT FAIL<	55	Failed FLCS BIT	Fault only on ground	Not resettable through FLCS reset - rerun FLCS BIT again
	>SWIM ATTD FAIL<	75	INS attitude estimator failure	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM SCP FAIL<	79		TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM NVP FAIL<	76	Navigation pod self-mode failure	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM RALT FAIL<	80	SDC monitor failure or CARA data bad	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	PFL NAME		**CAUSE**	**SYMPTOMS**	**CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS**
FLCS CAUTION	FLCS ADC FAIL	13	Air data input signal failure	Second ADC fail triggers STBY GAINS and latches ADC fail against FLCS RESET attempt	FLCS RESET - Land ASAP
	ISA RUD FAIL	34	Rudder servo actuators malfunction	Rudder problems	FLCS RESET - Land ASAP
	ISA ALL FAIL	36	Controls servo actuators malfunction	Flight control problems	FLCS RESET - Land ASAP
	FLCS HOT TEMP	48	Excess temperature in FLCS branches	None	Not yet implemented
	FLCS SNGL FAIL	49	Single electronic or sensor failure in FLCS	Only on Ground	FLCS RESET
	FLCS BIT PASS		Bit passed (not real caution)		None
	FLCS FLUP OFF	54	FLCS auto fly-up is inhibited	No fly-up in manual TF	Discontinue TFR ops
	FLCS MUX DEGR	71	FLCS BIT detected degradation of FLCC MUX interface when attempting FLCS BIT without FCC/MMC power	None - fault only on ground	Not resettable through FLCS reset - rerun FLCS BIT again
ENGINE	ENG AI FAIL	15	Engine anti-ice valve failed (GE129)	None	Avoid areas of suspected icing conditions
	ENG A/B FAIL	18	Afterburner system failure (GE129)	Afterburner not available	Go SEC mode. Land asap
	ENG AI TEMP	84	Possible engine damage (PW229)	Rough engine	Land asap
	ENG AI FAIL	85	Engine anti-ice valve failed (PW229)	None	Avoid areas of suspected icing conditions
	ENG A/B FAIL	87	Afterburner system failure (PW229)	Afterburner not available	Go SEC Mode. Land asap

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
AVIONICS FAULTS	FLCS BUS FAIL	3	FLCS System failure	Illuminates AVIONICS FAULT light instead of FLCS FAULT light	Can't use PFLD to review FLCS fault; use MFD TEST page
	FMS FAIL	4	Fuel Management system failure	Fuel bingo capability degraded	Monitor Fuel situation closely
	HUD BUS FAIL	3	HUD system failure	No HUD	RTB
	HMCS LBUS FAIL	3	Left Bus HMCS failure	Loss of HMCS	Pilot discretion
	HMCS RBUS FAIL	6	Right Bus HMCS failure	Loss of HMCS	Pilot discretion
	HMCS TEMP FAIL	20	Overheat of the HMCS system	HMCS will shutdown	Pilot discretion
	RALT BUS FAIL	3	Radar Altitude system failure	No Radar Altimeter	Pilot discretion
	FCC FAIL	4	FCC Failure	Fire Control Computer non-operational	Discontinue offensive operations
	FCC TEMP	132	Overheat of the FCC system	Possible damage if not shut off	Shut off FCC, check AIR SOURCE knob position
	FCR BUS FAIL	3	FCR Failure	FCR non-operational	Discontinue offensive operations
	FCR XMTR FAIL	94	FCR transmit operation failure	FCR not emitting	Discontinue offensive operations
	BLKR BUS FAIL	3	RWR system failure	RWR is blind	Discontinue offensive operations
	DLNK FAIL	5	Datalink system failure	Datalink non-operational	Pilot discretion
	UFC BUS FAIL	3	UFC system failure	DED and PFLD non-operational	Reset UFC
	UFC TEMP	42	Overheat of the UFC system	Possible damage if not shut off	Shut off FCC, check AIR SOURCE knob position
	AMUX BUS FAIL	3	AMUX BUS failure	FCC is forced to NAV	Discontinue offensive operations
	BMUX BUS FAIL	3	BMUX BUS failure	FCC is forced to NAV	Discontinue offensive operations
	DMUX BUS FAIL	3	DMUX BUS failure	HUD, HMS, MFDs non-operational	Pilot discretion
	CADC BUS FAIL	3	Loss of CADC parameters to avionics system	No Airdata Available	Pilot discretion
	EPOD SLNT DEGR	60	ECM system failure	ECM non-operational	Discontinue offensive operations
	CMDS BUS FAIL	3	CMDS bus failure	CMDS non-operational	Discontinue offensive operations
	CMDS DSPN DEGR	4	CMDS failure with chaffs	Chaff release non-operational	Pilot discretion
	CMDS INV DEGR	6	CMDS failure with flares	Flare release non-operational	Pilot discretion
	RWR BUS FAIL	3	RWR BUS failure	RWR non-operational.	Reset RWR - Pilot discretion
	RWR DEGR	21	Problem in the RWR system	All RWR quadrants inoperable	Reset RWR - Pilot discretion
	RWR DEGR (135)	6	Problem in the front left RWR (09-12)	Front left RWR quadrant inoperable	Reset RWR - Pilot discretion
	RWR DEGR (135)	7	Problem in the front right RWR (12-03)	Front right RWR quadrant inoperable	Reset RWR - Pilot discretion
	RWR DEGR (225)	8	Problem in the aft left RWR (06-09)	Aft left RWR quadrant inoperable	Reset RWR - Pilot discretion
	RWR DEGR (225)	9	Problem in the aft right RWR (03-06)	Aft right RWR quadrant inoperable	Reset RWR - Pilot discretion
	MMC TEMP	5	Overheat in the MMC system	Possible damage if not shut off	Shut off MCC, check AIR SOURCE knob position
	MMC DEGR		Mission Modular computer problem	MMC non-operational	Pilot discretion

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
AVIONICS FAULTS (CONTINUED)	MC04	326	Mission Modular computer problem	MMC restart	None
	MC04 DEGR	300	Mission Modular computer problem	MMC restart	None
	MC13	326	Mission Modular computer problem	MMC restart	None
	MC13 DEGR	300	Mission Modular computer problem	MMC restart	None
	TCN FAIL	4	TACAN system failure	TACAN non-operational	Use INS steerpoints
	IFF BUS FAIL	3	IFF system failure	IFF non-operational	Pilot discretion
	IFF INM4 FAIL	30	IFF mode4 failure	Degraded AIFF. Mode 4 not available	Pilot discretion
	XP NO KEYS	131	Keys zeroized	Degraded AIFF. Mode 4 not available	Pilot discretion
	INT NO KEYS	46	Keys zeroized	Degraded AIFF. Mode 4 not available	Pilot discretion
	LINK 16 INIT REQD	74	MIDS sync fail	No MIDS information	Press OSB 8 in the DTE page
	MSL SLAV FAIL	4	Missile Slave failure	Missile seeker will not follow radar line of sight	Use boresight mode
	MFDS LFWD FAIL	168	MFD LEFT failure	Left MFD non-operational	Pilot discretion
	MFDS RFWD FAIL	177	MFD RIGHT failure	Right MFD non-operational	Pilot discretion
	GPS BUS FAIL	3	GPS failure	GPS non-operational	INS will drift without GPS backup
	IDM BUS FAIL	3	IDM failure	Loss of IDM	Pilot discretion
	INS BUS FAIL	3	INS failure	INS non-operational	Go backup system (CNI)
	EGI AR FAIL	9	EGI Failure	No GPS data available	Go backup system (CNI)
	EGI NAV FAIL	13	EGI failure	GPS/INS non-operational	Go backup system (CNI)
	NVP COMM FAIL	13	Invalid Air Data	CADC fault (Not implemented)	Not implemented
	NVP COMM FAIL	14	INS invalid data	Terrain following FAIL and AUTO fly-up	Check INS/EGI/GPS
	NVP COMM FAIL	15	Invalid RALT	Terrain following FAIL and AUTO fly-up	Check RALT switch position & RALT BIT not running
	NVP FLIR ALIGN	12	FLIR alignment failure	FLIR video misaligned	Reset FLIR, discontinue FLIR operations
	NVP FLIR FAIL	9	FLIR failure	FLIR inoperative	Discontinue TFR/FLIR operations
	NVP FAIL	10	Navigation pod failure	Navigation pod inoperative	Discontinue TFR operations
	NVP TFR FAIL	24	TFR failure	TFR inoperative	Discontinue TFR operations
	SMS BUS FAIL	3	SMS BUS failure	All functions lost except EJ, SJ	RTB at pilot discretion
	SMS TEMP	19	Overheat in the SMS system	None	Shut off SMS, check AIR SOURCE knob position
	SMS STA1 DEGR	103	Station 1 Remote interface degraded	Command not executed correctly	Left wingtip pylon malfunction, pilot discretion
	SMS STA1 FAIL	87	Station 1 Remote interface failed	Station operation inhibited	Left wingtip pylon malfunction, pilot discretion
	SMS STA2 DEGR	104	Station 2 Remote interface degraded	Command not executed correctly	Pilot discretion
	SMS STA2 FAIL	88	Station 2 Remote interface failed	Station operation inhibited	Pilot discretion
	SMS STA3 DEGR	105	Station 3 Remote interface degraded	Command not executed correctly	Discontinue offensive operations

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
AVIONICS FAULTS (CONTINUED)	SMS STA3 FAIL	89	Station 3 Remote interface failed	Station operation inhibited	Discontinue offensive operations
	SMS STA4 DEGR	106	Station 4 Remote interface degraded	Command not executed correctly	Left wing tank pylon - monitor fuel
	SMS STA4 FAIL	90	Station 4 Remote interface failed	Station operation inhibited	Left wing tank pylon - monitor fuel
	SMS STA5 DEGR	107	Station 5 Remote interface degraded	Command not executed correctly	Centreline - monitor fuel
	SMS STA5 FAIL	91	Station 5 Remote interface failed	Station operation inhibited	Centreline - monitor fuel
	SMS STA6 DEGR	108	Station 6 Remote interface degraded	Command not executed correctly	Right wing tank pylon - monitor fuel
	SMS STA6 FAIL	92	Station 6 Remote interface failed	Station operation inhibited	Right wing tank pylon - monitor fuel
	SMS STA7 DEGR	109	Station 7 Remote interface degraded	Command not executed correctly	Discontinue offensive operations
	SMS STA7 FAIL	93	Station 7 Remote interface failed	Station operation inhibited	Discontinue offensive operations
	SMS STA8 DEGR	110	Station 8 Remote interface degraded	Command not executed correctly	Pilot discretion
	SMS STA8 FAIL	94	Station 8 Remote interface failed	Station operation inhibited	Pilot discretion
	SMS STA9 DEGR	111	Station 9 Remote interface degraded	Command not executed correctly	Right wingtip pylon malfunction, pilot discretion
	SMS STA9 FAIL	95	Station 9 Remote interface failed	Station operation inhibited	Right wingtip pylon malfunction, pilot discretion
	TGP BUS FAIL	3	TGP system failure	Total loss of TGP function	Discontinue TGP operations
	TGP HADF FAIL	9	Maverick Controller fail	No AGM-65 hand-off at Boresight	Reattempt boresight procedure or use VIS mode
	TGP HADF FAIL	10	Maverick Controller out of tolerance	Boresight error	Reattempt boresight procedure or use VIS mode
	TGP HADF FAIL	18	Missile Boresight Correlator fail	No AGM-65 hand-off	Cancel sensor lock and reattempt handoff or use VIS mode
	TGP HADF FAIL	19	Negligible Missile Boresight Correlator capability degradation	Hand-off error	Cancel sensor lock and reattempt handoff or use VIS mode
	BRK PWR DEGR		Single FLCS Electronic Fail	One FLCC branch not powered	Check which branch and set brake channel accordingly

GLOSSARY

A	
A-A	Air-to-Air
AA	Aspect Angle
AAA	Attitude Awareness Arc
AAF	Attitude Advisory Function
AAM	Air-to-Air Missile
AATLL	Air-to-Air Target Locator Line
ABC	Automatic Brightness Control
AC	Aircraft Configuration
ACAL	Altitude Calibration
ACCTVS	Advanced Color Cockpit Television Sensor
ACM	Air Combat Mode
ACMDS	Advanced Countermeasures Dispenser System
ACMI	Air Combat Maneuvering Instrumentation
ACQ	Acquisition
ACRIU	Advanced Conventional Remote Interface Unit
A-D	Analog-to-Digital
AD	Arming Delay
ADDL	Additional
ADI	Attitude Direction Indicator
ADL	Armament Datum Line
A DLNK	Air Data link
ADS	Avionics Display Set
ADTC	Advanced Data Transfer Cartridge
ADTE	Advanced Data Transfer Equipment
ADTU	Advanced Data Transfer Unit
AEW	Airborne Early Warning (AWACS)
A-G	Air-to-Ground
AGC	Automatic Gain Control
AGL	Altitude Above Ground Level
AGM	Air-to-Ground Missile
AGR	Air-to-Ground Ranging
AGTD	Air-to-Ground Target Designator
AGTLL	Air-to-Ground Target Locator Line
AI	Airborne Intercept/Azimuth Indicator/ Artificial Intelligence
A IDM	IDM Air Tracks
AIFF	Advanced Identification Friend or Foe
AIM	Air Intercept Missile
Aimpoint	The preplanned point on or near target that is used to align pipper
ALBIT	All Station Built-In-Test
ALIC	Aircraft Launcher Interface Computer
ALIGN	Alignment (INS)
ALN	Transfer Alignment (IAM)
ALOW	Altitude Low
ALT	Altitude
ALT CAL	Altitude Calibration (switch position)
ALT REL	Alternate Release
ALT TRK	Altitude Line Tracker/Blanker
AM	Amplitude Modulation, Altitude Match (ATP)
AMRAAM	Advanced Medium Range Air-to-Air Missile
AMRIU	Advanced Missile Remote Interface Unit
AMUX	Avionics Multiplex
AMZ	Aircraft Maneuver Zone

A/N	Alphanumeric
ANT	Antenna
ANT ELEV	Antenna Elevation
AOA	Angle Of Attack (Arrival)
AOR	Areas of Responsibility
APC	Aircraft Parking Chart
ARH	Anti-Radiation Homing
ARMT	Armament
ARWR	Advanced Radar Warning Receiver
ASE	Allowable Steering Error
ASEC	Allowable Steering Error Circle
ASC	Attack Steering Cue
ASCII	American Standard Code for Information Interchange
ASGN	Assign
ASL	Azimuth Steering Line
A TGTS	Air-to-Air Targets
ATC	Attack Target Complex (a type of Mission Assignment) , Air Traffic Controller
ATD	Advanced Threat Display
ATF	Automatic Terrain Following
ATK AZ	Attack Azimuth
ATO	Air Tasking Order
ATP	Advanced Targeting Pod
ATT, ATTD	Attitude
ATT/FPM	Attitude Bars and Horizon Line/Flight Path Marker
Attack Profile	Weapon deliver options stored in SMS that are anticipated to be used in specific instances
ATT	EGI Attitude Mode
AUTO	Automatic
AUTO BRT	Automatic Brightness control to maintain, contrast ration between the symbols and background
AWACS	Airborne Early Warning and Control System
AV	Avoid
AVTR	Airborne Video Tape Recorder
AZ/AZI	Azimuth

B			
BA	Burst Altitude	CDEEU	Common Data Entry Electronics Unit
BAL	Ballistics	CDI	Course Deviation Indicator
BAI	Bank Angle Indicator	CEM	Combined Effects Munitions
BAR	Elevation Bar	CEN	Centered
BARO	Barometric	CENT	Map center
BATR	Bullets at Target Range	CFIT	Controlled Flight Into Terrain
BATT	Battery	CFOV	Center Field Of View
BBS	Backup Bombing Sensor	CG	Center of Gravity
BCN	Beacon	CH	Chaff
BCN DLY	Beacon Delay	CH/CHAN	Channel
BDA	Battle Damage Assessment	CHNG	Change
BDU	Bomb Dummy Unit	CHNL	Channel
BGO	Bingo	CIT	Combined Interrogator and Transponder
BHOT	Black Hot	CIV/MIL	Civilian/Military
Bingo Fuel	A threshold fuel value that the pilot enters in MMC memory	CJ/R	Center Jettison/Release
		CKPT BLNK	Cockpit Blanking (HMCS)
BIT	Built-In Test	CLM	Climbing
BKUP	Backup	CLR	Clear
Blind Bombing	Air-to-Ground weapon delivery modes that utilize radar ground map features rather than indicators to locate the target	CM	Countermeasures
		CMBT	Combat (LASER)
		CMDS	Countermeasures Dispenser System
BLOS	Beyond Line of Sight	CMFD	Color Multifunction Display
BLU	Bomb Live Unit	CMS	Countermeasures Management Switch
BNGO	Bingo	CMSC	Countermeasures Set Control
BOC	Bomb On Coordinate	CNI	Communication/Navigation/IFF
BORE	Boresight	CNTL	Control
BOT	Bomb On Target	C/A	Coarse Acquisition
BP	Bypass	C/O	Cutout (HUD function)
BR	Bearing	COH	Cold on Hot (Maverick Sensor Mode)
BRG	Bearing and Range	COLR	Color
BRT	Bright, Brightness	COM1	Communications Radio 1
BRU	Bomb Rack Unit	COM2	Communications Radio 2
BSGT	Boresight	COMM	Communication
BSU	Bomb Stabilization Unit	CONT	Contrast, Continuous
BTH	Both (Laser-Pointer)	CONV	Conventional
BUP	Backup	CORR	Canopy/Camera Corrections
BUS	Electrical connection and distribution point	CPL	Couple
B/R	Bearing/Range	CRIU	Conventional Remote Interface Unit
B-W	Black-on-White	CRM	Combined radar mode
		CRM	Combined Radar Mode
C		CRS	Course
		CRSE	Course
CA	Cartridge	CRUS	Cruise
CADC	Central Air Data Computer	CRU/EM	Cruise Energy Management
CAL, Cal	Calibration	CS	Carriage System, Control Section
Canned Value	Data stored in permanent memory	CSFDR	Crash-Survivable Flight Data Recorder
		CTFOV	Center Total Field Of View
CARA	Combined Altitude Radar Altimeter	CTVS	Cockpit Television Video System
CAS	Calibrated Airspeed, Close Air Support	CU	Cockpit Unit
CAT	Category	CW	Continuous Wave Illumination
CATA	Collision Antenna Train Angle	C/Z, CZ	Cursor Zero
CATM	Captive Air Training Missile		
CBU	Cluster Bomb Unit		
CCIP	Continuously Computed Impact Point		
CCMFD	Common Color Multifunction Display		
CCRP	Continuously Computed Release Point		
CCTVS	Color Cockpit Television Sensor		
CDE	Circular Distance Estimates		

D		**E**	
D	Degraded, Data Link	DU	Display Unit
D&R	Depress And Release	DVR	Digital Video Recorder
DAY	Day position allows control of brightness from off to full intensity	Dynamic Launch Zone	The zone in which a missile would strike a maneuvering target
DBS	Doppler Beam Sharpening		
DBU	Digital Backup Unit	DWAT	Descent Warning After Takeoff
DCLT	The removal of display data from the HUD/ MFD/HMCS (Declutter)		East
		E	
DCPL	Decouple	ECM	Electronic Countermeasures
DCS	Data Control Switch	ECS	Environmental Control System
DDR	Digital Data Recorder	DER	Endurance
DE	Default	EEGS	Enhanced Envelope Gunsight
DEAD	Destruction of Enemy Air Defense	EGEA	End Game Entry Altitude
DED	Data Entry Display, Dedicated Channel Mode	EGI	Embedded GPS/INS
DEG	Degree(s)	EGR	Embedded GPS Receiver
DEGR	Degraded	EHL	Extended Horizon Line
Delta	An increment of a variable	EHSI	Electronic Horizontal Situation Indicator
DEP	Depressed	EHSIM	Electronic Horizontal Situation Indicator Master
DEPR	Depression		
DEPR RET	Depressible Reticle	EHSIS	Electronic Horizontal Situation Indicator Slave
DES	Desired		
DESIG	Designate	E-J, EJ	Emergency Jettison
DEST	Destination	EL	Elevation
DF	Direction Finder	ELEC	Electrical
DFLCS	Digital Flight Control System	ELEV	Elevation
DGFT	Dogfight	ELINT	Electronic Intelligence
DGPS	Differential Global Positioning System	EM	Energy Management (HUD display)
DIR	Direct, Direct-In Range	EMER	Emergency
DISP	Dispense Command (switch position)	EMTY	Empty
DL	Data Link	ENABL	Enable
DL/DLNK	Data Link	ENG	Engine
DLAY/DLY	Delay	ENT, ENTR	Enter
DLZ	Dynamic Launch Zone	E-O/EO	Electro-Optical
DMC	Digital Maneuvering Cue	EOM, E	Equations of Motion
DMD	Demand	EOMG	Equations of Motion Glide
DME	Distance Measuring Equipment	EON	Engagement Order Number
DMS	Display Management Switch	EPU	Emergency Power Unit
DMUX	Display Multiplex Data Bus	ERR	Error
DNR	Donor	ESD	Enhanced Search Display
DPL	Deploy	ETA	Estimated Time of Arrival
DRIFT C/O	Flight path marker with drift cutout	ETR	External Time Reference
DRNG	Delta Range	EU	Electronics Unit
DS	Dispenser Station	EXP	Expanded
D/S	Wind Direction and Speed		
DTC	Data Transfer Cartridge		
DTE	Data Transfer Equipment		
DTED	Digital Terrain Elevation Data		
DTOS	Dive-Toss		
DTS	Digital Terrain System		
DTT	Dual Target Track		
DTU	Data Transfer Unit		

F			
F, FAIL	Failed	GM	Ground Map
F-ACK	Fault Acknowledge	GMT	Ground Moving Target, Greenwich Mean
FC	Flight Channel	GMTT	Time
FCC	Fire Control Computer	GND	Ground Moving Target Track
FCR	Fire Control Radar	GND SPD	Ground
FD	Function delay	GP Bomb	Ground speed
FDR	Standard Flight Data Recorder	GPS	General Purpose Bomb
FEBA	Forward Edge of the Battle Area	G/S	Global Positioning System
FEDS	Firing Evaluation Display Set	GS	Ground Speed
FI	Free Inertial		Ground Stabilized, Glide slope, Geographic
FINS	Forward Imaging Navigation Sensor	GT	Specificity
FIX	Fixtaking	G TGTS	Gyro Test
FL	Flare	G/T	Ground targets
FL ON	Flight On	GW	Ground Track
FLCS	Flight Control System		General Weight
FLIR	Forward Looking Infrared		
FLT	Flight	**H**	
FM	Frequency-Modulated		
FMCW	Frequency-Modulated Continuous Wave	HAD	
FOG	Fiber Optic Gyro	HARM	HARM Attack Display
FOV	Field of View	HARTS	High-Speed Anti-Radiation Missile
FPM	Flight Path Marker	HAS	Horn Awareness and Recovery Training
FPS	Frames Per Second/Feet Per Second	HAT	Series
FR ON/OFF	Friendly Declutter	HD	HARM-As-a-Sensor Mode
FRAG	Fragmentation	HDG	Height Above Target
FRQ	Frequency	HDGP	Head
FRZ	Freeze	HDPT	Heading
FS	Front Section, or Fuselage Station	HE	High Drag General Purpose
FT	Feet	HEX	Hardpoint
FTIT	Fan Turbine Inlet Temperature Gauge	HI, HOT	High Explosive
Fps	Feet per second	HLS	Hexadecimal
FTT	Fixed Target Track	HOBO	Hot Integration (LITENING)
Fuze	A device used to initiate weapon detonation	HOC	HARM Launch Scale
FWD	Forward	HOM	Hands-On Black-Out
FZ	Freeze	HMCS	Hands On Controls
		HMPT	Home
G		HOS	Helmet Mounted Cueing System
		HOTAS	Home Point
g	Gravitational (acceleration)	HOT	Hostile
G	Gravity		Hands-On Throttle And Stick
g available	The maximum number of g's allowed by the flight	Hr	Jettison mode ready indication (Weapons
	controls	HSD	selected released unarmed)
g	The maximum number of g's that can be pulled	I	Hour
sustainable	without losing current specific gravity	HTFOV	Horizontal Situation Display
GAAF	Ground Avoidance Advisory Function	HTS	Horizontal Situation Indicator
GBU	Guided Bomb Unit, conventional bomb with self-	HUD	HUD Total Field-Of-View
	contained guidance system	HYD	HARM Targeting System
G/C	Great Circle Steering	Hz	Head Up Display
GC	Gyrocompass		Hydraulic
GCAS	Ground Collision Avoidance System		Hertz
GCS	Guidance and Control Section		
GD	Guard		
G DLNK	Ground data link		
GE	General Electrics		
GEM	GPS Embedded Module		
GEO	Geo-Location		
G FRND	Ground Friendlies		
GHL	Ghost Horizon Line		
G LIM	G Limit		

I		**L**	
I/O	Input/Output	L	Left
IAM	Inertially Aided Munition	LADD	Low Altitude Drogue Delivery
IAS	Indicated Airspeed	LANTIRN	Low Altitude Navigation Targeting Infrared
IBIT	Initiated Built-in Test		For Night
ICP	Integrated Control Panel	LAR	Launch Acceptability Region
ID	Identification	LASR	Laser
IDL	Intraflight Data Link, Initialization Data Load	LAT, Lat	Latitude
IDM	Improved Data Modem	LAU	Launcher Armament Unit
IFA	Inflight Alignment	Lb, Lbs	Pound
IFF	Identification Friend or Foe	LCD	Liquid Crystal Display
IFOV	Instantaneous Field Of View	LCODE	Laser Code
IKP	Integrated Keyboard Panel	LD	Low Drag, Lead
ILS	Instrument Landing System	LDETECT	LST Detect
IMP ANG	Impact Angle	LDG	Landing
IMP AZ	Impact Azimuth	LDGP	Low Drag General Purpose
INC	Increase	LDR	Laser Designator
IND LTS	Indicator Lights	LED	Light Emitting Diode
INIT	Initialization	LEV	Level
INR	Inertial Rates	LFT	Left
INS	Inertial Navigation System	LG	Large, Landing Gear
INSM	Inertial Navigation System Memory	LGB	Laser-Guided Bomb
INT	Intensity, Transfer of Initialization Data , Internal	LIS	Line-In-the-Sky
INTRG	Interrogator	LIT	LITENING Targeting Pod
INU	Inertial Navigation Unit	LJDAM	Laser Joint Direct Attack Munition
INV	Inventory	LJ/R	Left Jettison/Release
IP	Initial Point	L/L/E	Latitude/Longitude/Elevation
IP-TO-TGT	Initial Point to Target	LLLGB	Low Level, Laser-Guided Bomb
IP-TO-PUP	Initial Point to Pull-up Point	LM	Laser Marker (IR Pointer)
IR	Infrared, In Range	LMODECMD	Laser Mode Command
IRC	In-Line Release Connector	LMS	Linear Missile Scale
		LMZ	Laser Mask Zone
		LNCH	Launch, Launcher
		LNCHW	Missile Launcher With Track Adapter
J		LNG	Longitude
		LOB	Line of Bearing
JASSM	Joint Air-to-Surface Standoff Weapon	LONG/LNG	Longitude, Long Calibration (LIT)
J/R	Jettison and Release	LOS	Line-of-Sight
JDAM/JDM/	Joint Direct Attack Munition	LOTG	Loss Of Track Glide
JD		LPI	Low Probability of Intercept
JDN	Joint Data Network	LPRF	Low Power Radio Frequency
JETT/JTSN	Jettison	L/R	Loader Reader
JFS	Jet Fuel Starter	LRCVRCNTL	Laser Receiver Control
JHMCS	Joint Helmet Mounted Cueing System	LRG	Large
JIR	JSOW In Range	LRM	Line Replaceable Module
JIZ	JSOW/JASSM In Zone	LRR	Laser Range Receiver
JMR	Jammer	LRU	Line-Replaceable Unit
JSOW/JSW	Joint Standoff Weapon	LSCD	Laser Spot Search Code
JTAC	Joint Terminal Attack Controller	LSDL	Launch Status Divider Line
JTSN	Jettison	LSL	Laser Spot Locator
		LSR	Laser Designator
K		LSRCH	LST Search
		LSS	Laser Spot Search
KF	Kalman filter	LST	Laser Spot Tracker, Land Specific Type
KL	Wind correction constant due to altitude gain	LT	Left
KCAS	Knots Calibrated Airspeed	LTE	Launch To Eject
KIAS	Knots Indicated Airspeed	LTF	Left
kpbs	Kilobits Per Second	LTIP	Laser Target Imaging Sensor
KT	Knot	LT HPT	Left Hardpoint
Kts or KTS	Knots	LUU	Illumination Unit, Flare
KYBD	Keyboard	LVL	Level

M	
m	Meter
m/s	Meters per second
M	Mode, Multiple, Mask, Master, Mass Model, Meters, Mission Store
MA	MASTER ARM switch, Matrix Assembly, Medium
MAG	Altitude, Mission Assignment
MAG VAR/	Magazine
MAGVR	Magnetic Variation Maintenance
MAL	Malfunction
MAN	Manual
MAU	Miscellaneous Armament Unit
MAX, Max	Maximum
MBAL	Manual Ballistics
MBC	Missile Boresight Correlator
MC	Mission Channel, Mission Commander
MDDE	Menu Driven Data Entry
MDS	Minimum Detectable Signal, Mission Data Set
MDT	Mass Data Transfer, Mission Data Table
MER	Multiple Ejector Rack
MFD	Multifunction Display (Unit)
MFDS	Multifunction Display Set
MFL	Maintenance Fault List
MGC	Manual Gain Control
MHz	Megahertz
MIDS	Multifunctional Information Distribution System
MIF	Missile-Inflight
MIL-STD	Military Standard
MISC	Miscellaneous
MIZ	Missile Impact Zone
MK	Mark, a designation preceding model numbers
MK INT	Marker Intensity
MKPT	Markpoint
ML	Missile Launch
MLE	Missile Launch Envelope
MLG	Main Landing Gear
MLNCH	Missile Launcher
MM/mm	Millimeter
MMC	Modular Mission Computer
MNEMONIC	Code/display relating to memory
MMZ	Missile Maneuver Zone
MNL	Manual
MOD	Modification
MON	Monitor
MP	Monitor Program/Mission Planned
MPCTR	HSD Map Center
MPD	Mission Planning Data
MPL	Maneuver Potential Line
MPPRE	Mission Planned Preplanned
MPO	Manual Pitch Overwrite
MPS	Mission Planning Station
mR	Milliradians (see MILS)
MRA	Minimum Release Altitude
MRGS	Multiple Reference Gun Sight
MRIU	Missile Remote Interface Unit
MRM	Medium Range Missile
MRU	Magnetic Receiver Unit
ms, msec	Millisecond, 1 ms = 0.001 second
MSEC	Millisecond, 1 msec = 0.001 second
M-SEL	Mode Select
MSL	Mean Sea Level
MSL	Missile, Missile Override
MSMD	Master Mode
MSN DUR	Mission Duration
MSN RT	Mission Route
MT	Multi Track
MTR	Moving Target Reject
MTT	Moving Target Track/Multi Target Track
MULT	Multiple or Multi Mode
MUX	Multiplex
N	
N	North
N/A	Not Applicable
N/M	North Pointer/Meterstick
NARF	Navigation Alignment Refining Feature
NARO	Narrow
NAV	Navigation
NAV DB	Navigation Database
NC	Non-Cooperative
NCTR	Non-cooperative Target Recognition
NFOV	Narrow Field-of-View
NM	Nautical Miles
NOGO	Cannot Comply
NO RAD	No Radiation
NOM	Nominal
NORM	Normal
NOZ	Nozzle
NPG	Network Participation Group
NSTL	Nose-Tail
NRM	Normal
ns, nsec	nanosecond
NT	Neutral Track
NTR	Network Time Reference
NTO	Not Timed Out
NVIS	Night Vision Imaging System
NVM	Nonvolatile Memory
NVP	Navigation Pod
NWS	Nose Wheel Steering
NXT	Next
O	
O2	Oxygen
OA1	Offset Aimpoint 1
OA2	Offset Aimpoint 2
OAP	Offset Aimpoint
OBST	Obstacle
OCT	Octal
OFLY	Overfly
OFTRK	Offset Track
OOB	Out Of Bounds
OPER	Operate, Operational
OPS	Operation
OPT	Option
OSB	Option Select Button
OVL	Overlay
OVRD	Override
OVRFLY	Overfly

P			
PDLT	Primary Data Link Track	RDR ALT	Radar Altimeter
PDU	Pre-Briefed Submode, Playback	RDRCP	Radar Coupled
PFL	Pilot Display Unit	RDRDE	Radar Decoupled
PFLD	Pilot Fault List	RDY	Ready
PGM	Pilot Fault List Display	REC	Receive
Pickle	Program, Precision Guided Munition	REL	Release
	The act of depressing weapon release button	REL ANG	Release Angle
Pipper	Optical sight aim dot	REP	Release Pulse
PM	Power Management	RET	Reticle
PNL	Panel	RET DEPR	Reticle Depression
POI	Point-of-Interest	RF	Radio Frequency
POS	Position Known Mode, Position	RIU	Remote Interface Unit
PPS	Precise Positioning Service	RKT	Rocket
PPLI	Precise Participant Location and Identification	RM	Receiver Module
PR	Pull-up Range	RMAX	Maximum Range
PRA	Planned Release Angle	RMIN	Minimum Range
Pressure	Altitude measured from standard sea level	RMLG	Right Main Landing Gear
Altitude	pressure. Altitude 29.92 inches of mercury (1013Mbar)	RNAV	Area Navigation
PRE	Preplanned	RNG	Range
PRF	Pulse Repetition Frequency	ROB	Range On Bearing
PRGM	Program	Ropt	Optimum Steering
PRI	Primary	RP	Reference Point, Release Point,
PROF	Profile		Release Pulse
PSI	Pounds Per Square Inch	RPM	Revolutions Per Minute
PT	Precision Targeting (HTS)	RST	Reset
PTR	Pointer (Laser Marker)	R/T	Receiver/Transmitter
PUAC	Pull Up Anticipation Cue	RTAM	Reset Transfer Alignment Message
Pull-up	An air-to-ground indication/cue, displayed on HUD that	RT HPT	Right Hardpoint
	requires immediate action to avoid ground clobber	RTN	Return
PUP	Pop-Up Point	RTS	Return-to-Search
PW	Paveway , Pratt & Witney	RTT	Round Trip Timing
PWR	Power	RUK	Range Unknown Submode
		RWR	Radar Warning Receiver
Q		RWS	Range While Search
		RWY	Runway
QFE	Atmospheric pressure at airfield elevation	RX	Receiver
QNH	Air pressure (Sea Level)		
QTY	Quantity	**S**	
R		S	South
		S#	Set number
R	Right	SA	Situation Awareness, Selective Availability
RA	Release Altitude	SAASM	Selective Availability Anti-Spoofing Module
RACK	Mnemonic for loading rack store number and	SAD	Search Altitude Display
	quantities	SAI	Situation Awareness Indicator
RAD	Radius	SALT	System Altitude
Radar Mile	A radar mile is the time required for one pulse of	SAM	Surface-to-Air Missile
	energy to be transmitted 6000 feet and reflected	SBC	Symbology Brightness Control
	back to the receiver (12.4 microseconds)	SBIT	Startup BIT
Raero	Maximum Kinematic Flight Range	SC	Scan Cycle, Special Channel
RALT	Radar Altimeter	SCP	Signal Control Processor
RAM	Random Access Memory	SD	Shutdown
Raster	Horizontal scan of the electron beam in a fixed TV	SDB	Small Diameter Bomb
	format	SDC	Signal Data Converter
R/B	Range/Bearing	SDP	Signal Data Processor
RCCE,	Reconnaissance	SEA	Sea State Clutter Reduction Mode
RECCE		SEC	Secondary Mode
RCL	Recall	SEAD	Suppression of Enemy Air Defenses targets
RCVR	Receiver	SEL	Selective Emergency Jettison
RDR	Fire Control Radar	SEL JETT	Selective Jettison

S		T	
SEQ	Sequence	T	Training, track, TGP
SFW	Sensor Fuzed Weapon	T/R	Transmit/Receive
SGL	Single	TA	Threat Area, Transfer Alignment
SH	Stored Heading	TAA	Target Aspect Angle, Threat Area
SIM	Simulate		Avoidance
SJ or S-J	Selective Jettison	TAC	Tactical
SLAV, SLV	Slave	Target	Height of target above mean sea level
SLNT	Silent	Elevation	True Airspeed, Tail Actuator Subsystem
SMS	Stores Management System	TCN/TACAN	Tactical Air Navigation
SMTH	Smooth ride option (TFR)	TD	Target Designator, Time Delay
SNAP	Snapshoot gunnery (display)	TD	Threshold Detect (AIM-9L/M), Target
SNGL	Single	TDMA	Time Division Multiple Access Detector
SNSR	Sensor	TE	Tactical Engagement
SOI	Sensor of Interest	TEF	Trailing Edge Flaps
Solution	In air-to-ground modes, a symbol that indicates	TER	Triple Ejector Rack
Cue	when bombs should be released to hit the target	TF	Terrain Following
SOP	Standard Operational Procedure	TF or Tf	Time of Flight or Time of Fall
SP	Snowplow	TFOV	Total Field-of-View
SPD	Speed	TFR	Terrain Following Radar
SPI	System Point of Interest	TGM	Training Guided Missile
SQL	Squelch	TGP	Targeting Pod
SR	Smart Rack	TGT	Target
SRCH	Search	THDG	True Heading
SRM	Short Range Missile	THLD	Threshold
SS	Snapshoot	Threat	A passive system which detects and
STA	Station	Warning	identifies threat radar signals
STAT	Status	System	
STBY	Standby	TI	Target Isolate
STOR	Stored	TISL	Target Identification Set, Laser
STOR HDG	Stored Heading	TL	Tail
Store	Identifier for weapons/racks (SMS)	TLA	Target Locator Angle
Number		TLL	Target Locator Line
STP/STPT	Steerpoint	TM	Track Mode, Telemetry
STRF	Strafe	TMD	Tactical Munitions Dispenser
STRG	Steering	TMP	Temperature
ST SAM	Single Target SAM	TMS	Target Management Switch
STN	Source Track Number, Station	T/O	Takeoff
STT	Single Target Track	TOF	Time of Flight
SW	Software	TOI	Target Of Interest
SY	System Computed, System Measured (WCMD)	TOS	Time Over Steerpoint, Time On Station
SYM	Symbology	TOT	Time on Target
SYNC	Synchronization status	TPNDR	Transponder
		TQ	Track Quality, Time Quality
		T/R	Transmit/Receive
		T-R	Threat Rings
		TR	Training
		Track	To lock on a target with the radar and continue following its position.
		TRK	Track
		TRNG	Training (LASER)
		TUI	Time Until Impact, Time Until Intercept
		TV	Television
		TWA	Threat Warning Aux
		TWP	Threat Warning Prime
		TWS	Track While Scan
		TX	Transmitter
		TXA	Transfer Alignment

U		**X**	
UAI	Universal Armament Interface	XMIT/XMT	Transmit
UFC	Upfront Controls	XMTR	Transmitter
UHF	Ultra High Frequency	XR	Extended ran
UI	User Interface		
ULFT	Unified Loft	**Y**	
ULS	Up-look Search		
UNK	Unknown	**Z**	
UNLK	Unlock		
UTC	Universal Time Coordinated		
UTM	Universal Transverse Mercator		
UV	Ultraviolet		
V			
V	Velocity, Volts		
VAH	Velocity, Altitude, Heading (HUD)		
VEL	Velocity		
VG	Aircraft Groundspeed		
VHF	Very High Frequency		
VID	Visual Identification		
VIP	Visual Initial Point		
VIPCRP	VIP/CCRP Combination		
VIS	Visual		
VMS	Voice Messaging System		
VMU	Voice Message Unit		
VOL	Volume		
VOR	VHF Omnidirectional Range		
VRP	Visual Reference Point		
VRPCRP	VIP/CCRP Combination		
VS	Velocity Search		
VSR	Velocity Search with Ranging		
VV	Vertical Velocity		
VVI	Vertical Velocity Indicator		
VX	X-Axis Velocity		
VY	Y-Axis Velocity		
VZ	Z-Axis Velocity		
W			
W	West		
WAC	Wide Angle Conventional		
WAR	Wide Angle Raster		
WAT	Along track winds at run-in altitude		
WCMD	Wind Corrected Munitions Dispenser		
WD	Wide, Wind		
WEZ	Weapon Engagement Zone		
WHOT	White Hot		
WL	Waterline, a plane of horizontal reference on an aircraft		
WLCO	Will Comply		
WOB	White on Black		
WOW	Weight-On-Wheels		
WP/WPT	Waypoint		
WPN	Weapon		
W/SPAN	Wingspan		
WUP	Warm-up		
WVR	Within Visual Range		
WX	Weather		

Abnormal Procedures - Table of possible faults (PFL & MFL)