TO 1F-15C-34-1-1 BMS

AVIONICS AND NONNUCLEAR WEAPONS DELIVERY FLIGHT MANUAL

F-15C AND F-15D

Ver.: BMS 4.37.3

Date: 24 October 2023

FOREWORD

PURPOSE AND SCOPE

This manual contains data describing relevant aircraft avionics, weapons systems, support equipment and munitions designated for employment of the F-15C and data necessary to execute air-to-air and air-to-ground missions employing nonnuclear munitions.

Please note that the F-15C in BMS is under development process and not finished yet to its desired state. This document will reflect the progression and will be constantly updated.

The following manuals supplement this manual to establish the complete Falcon BMS F-15C series:

- TO-1F-15C-1 BMS (Aircraft systems, Normal procedures, and abnormal procedures).
- TO-1F-15C-1CL BMS (Checklists for normal procedures and abnormal procedures).

These documents are located in the */Docs/02 Aircraft Manuals & Checklists/02 F-15C folder* of your Falcon BMS install.

The default F-15C keyfile “BMS - Full-F15ABCD.key” can be found in */user/config* folder.

TABLE OF CONTENT

1 MISSION DESCRIPTION

1.1 GENERAL

The F-15C, an iconic aircraft in the realm of air superiority, stands as a pinnacle of engineering prowess and combat effectiveness. Distinguished by its robust design and unmatched performance capabilities, the F-15C is a single-seat, twin-engine fighter jet built to dominate the skies. With a length of 63.8 feet and a wingspan of 42.8 feet, this marvel of aeronautics boasts a maximum takeoff weight of 68,000 pounds.

Powered by Pratt & Whitney F100-PW-220 engines, the F-15C can attain speeds exceeding Mach 2.5 and reach altitudes of over 65,000 feet. The aircraft's advanced avionics suite includes radar systems like the AN/APG-63(V)1, providing remarkable target detection and tracking capabilities. Its arsenal comprises a diverse array of Air-to-air weaponry, from AIM-120 AMRAAM and AIM-9 Sidewinder missiles to an M61 Vulcan cannon.

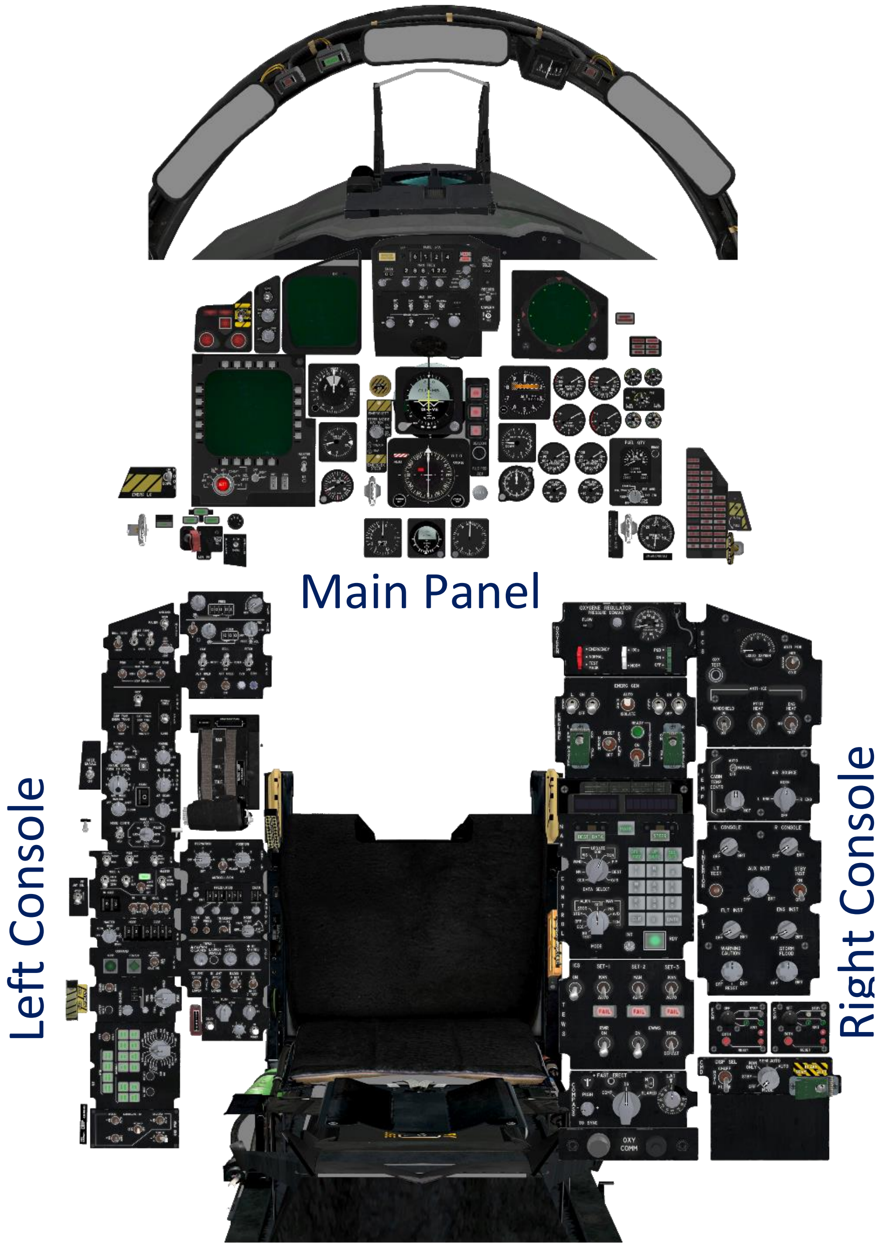
Pilots are enveloped in a cutting-edge cockpit, equipped with multifunction displays and hands-on-throttle-and-stick controls for precise maneuvering. The F-15C's air superiority role is further enhanced by its unmatched agility, allowing for rapid turns and high-g maneuvers.

Maintenance of the F-15C involves intricate systems checks, engine maintenance, and avionics diagnostics, all outlined meticulously in this technical manual. With its exceptional combat record and continuous upgrades, the F-15C remains an integral component of modern air forces, embodying the synergy of engineering excellence and tactical superiority.

2 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.



F-15C Cockpit Layout

2.1.1 COCKPIT CONTROLS AND DISPLAYS

Refer to the TO 1F-15C-1 BMS for a layout and description of the F-15 cockpit and its components.

2.1.2 GENERAL SYSTEMS

2.1.2.1 WEAPONS RELATED AVIONICS

The pilot engages in weapon arming and maintains weapon status across all ordnance using the Programmable Armament Control Set (PACS). The radar system is responsible for identifying and pursuing aerial targets. Data pertinent to weapon targeting and attack guidance is projected onto both the Head-Up Display (HUD) and the Vertical Situation Display (VSD). The aircraft's position and comprehensive Situation Awareness (SA) data are showcased on the situation display interface. Controls for radar functionality and weapon operations, necessitating constant accessibility during attack sequences, are positioned on the control stick and throttles.

2.1.2.1.1 VERY HIGH SPEED INTEGRATED CIRCUIT (VHSIC) CENTRAL COMPUTER

The CC (Central Computer) commands issues directives and collects flight data from the aircraft's sensors. It calculates parameters for attack guidance, tracking, and weapon deployment, overseeing the presentation of these details on both the HUD and VSD. The CC's role within the context of A/A attack modes is extensively elucidated in this manual.

2.1.2.1.2 AIR DATA COMPUTER (ADC)

The Air Data Computer (ADC) is a digital processor that furnishes accurate data such as true airspeed (TAS), air density, and angle of attack (AOA) to the CC. This information is then utilized by the CC to calculate parameters essential for gun mode steering and MRM prelaunch computations.

2.1.2.1.3 RING LASER GYRO (RLG) INERTIAL NAVIGATION SET (INS)

The Ring Laser Gyro Inertial Navigation System (RLG INS) stands as the fundamental origin of attitude, accurate heading, and current position data. It delivers pitch, roll, heading, and inertial velocities to the CC to facilitate weapon launch calculations. Additionally, the radar set benefits from this data for tasks such as antenna stabilization and minimizing ground clutter.

Furthermore, the RLG INS supplies inputs to the CC, specifically for overseeing the reticle control during A/A gun operations when the Lead Computing Optical Sight (LCOS) gun steering mode is active.

2.1.2.1.4 NAVIGATION CONTROL INDICATOR (NCI)

The Navigation Control Interface (NCI) of the INS serves multiple functions, including programming Identification Point (IP) and target data, choosing steering destinations, designating offset targets from IPs, marking targets, and conducting navigation position updates.

2.1.2.1.5 ATTITUDE HEADING REFERENCE SET (AHRS)

The AHRS serves as the main provider of magnetic heading information and acts as a secondary supplier of attitude data to both the CC and radar systems in the event of an INS failure. For more details, please consult section III regarding potential failure modes.

2.1.2.2 MASTER MODE SELECTION AND CONTROL

The airplane's avionics function across four modes: Air-to-Air (A/A), Air-to-Ground (A/G), Visual Identification (VI), and Attitude Director Indicator (ADI). The selection of these modes is controlled by three master mode buttons, labeled A/G, ADI, and VI, functioning as push ON-OFF buttons. The relevant button lights up to indicate the active master mode.

2.1.2.2.1 A/A MODE

To activate the A/A attack HUD display for the currently chosen weapon on the weapon select switch, ensure that all master mode buttons are in the OFF position. If any master mode button is lit up, it will be deselected when you switch to the GUN option on the weapon select switch.

2.1.2.2.2 A/G MODE

To engage the A/G mode, the pilot selects either MRM or SRM on the throttle weapon switch and activates the A/G master mode button. When the A/G master mode button is illuminated, it signifies the activation of the A/G mode. This action not only activates the A/G weapon release circuits but also selects the A/G RNG radar mode. Additionally, the HUD is commanded to display relevant information for the selected delivery mode. Notably, the launch circuit for MRM and SRM is disabled in this mode.

The A/G mode is partially implemented yet and will be improved in the future.

2.1.2.2.3 AIR-TO-AIR (A/A) PRIORITY ENGAGEMENT

This mode is not implemented yet.

2.1.2.2.4 ATTITUDE DIRECTOR INDICATOR (ADI) MODE

This mode is not implemented yet.

2.1.2.2.5 VISUAL IDENTIFICATION (VI) MODE

This mode is not implemented yet.

2.1.2.3 STATION DIAGRAM

AIM-120 Stations:

3, 4, 6, 7 and 2A, 2B, 8A, 8B

AIM-7 Stations:

3, 4, 6, 7

AIM-9 Stations:

2A, 2B, 8A, 8B

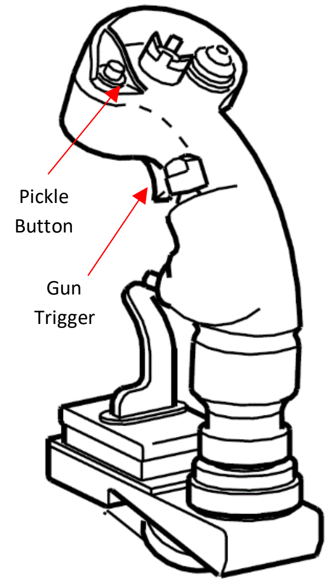
General Purpose Bombs Stations:

2A, 5, 8B

Station Diagram F-15C

2.1.2.4 WEAPON RELEASE (PICKLE) BUTTON

With the master arm switch set to ARM, the weapon release button becomes active. In the A/A master mode, pressing this button initiates the launch of MRM or SRM weaponry while also activating the VTR functionality.



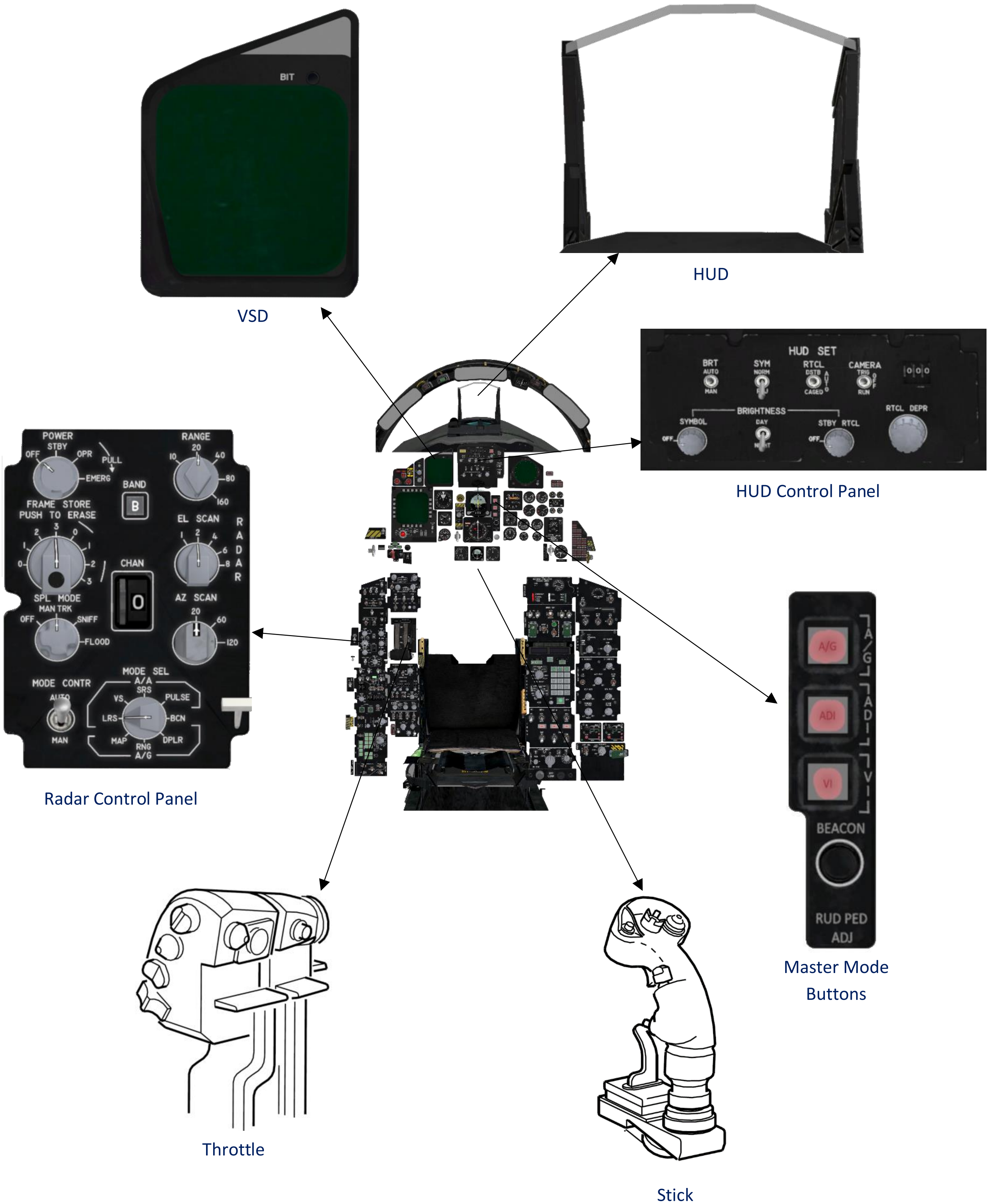
F-15C Stick

2.1.2.5 GUN TRIGGER

Depressing the trigger's initial detent engages the VTR function. Depressing the trigger's second detent, provided the master arm switch is in the ARM position, results in gun firing.

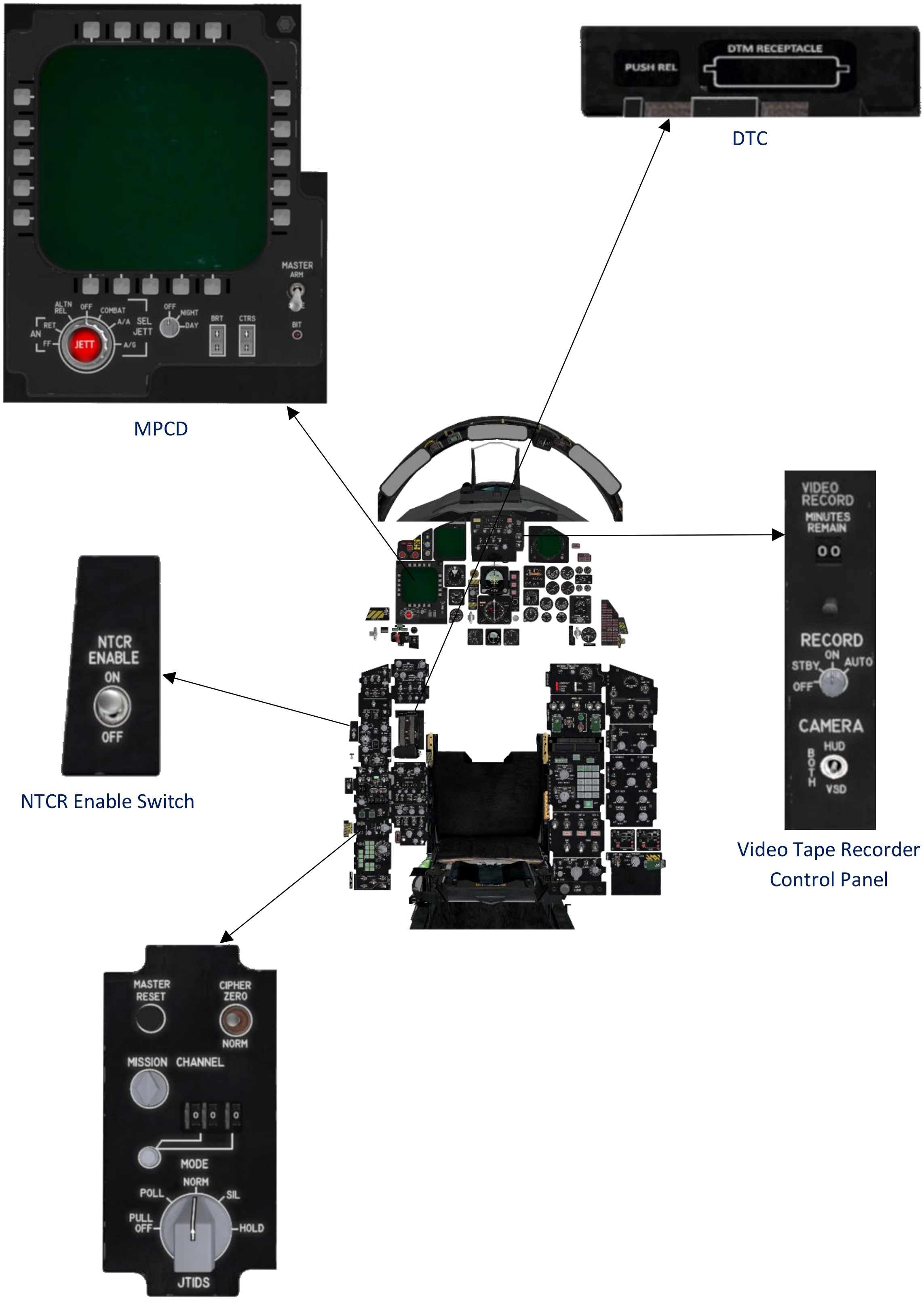
For all information about the stick and throttle, please refer to the F-15 Dash-1.

2.1.2.6 A/A FIRE CONTROL & DISPLAY SYSTEMS



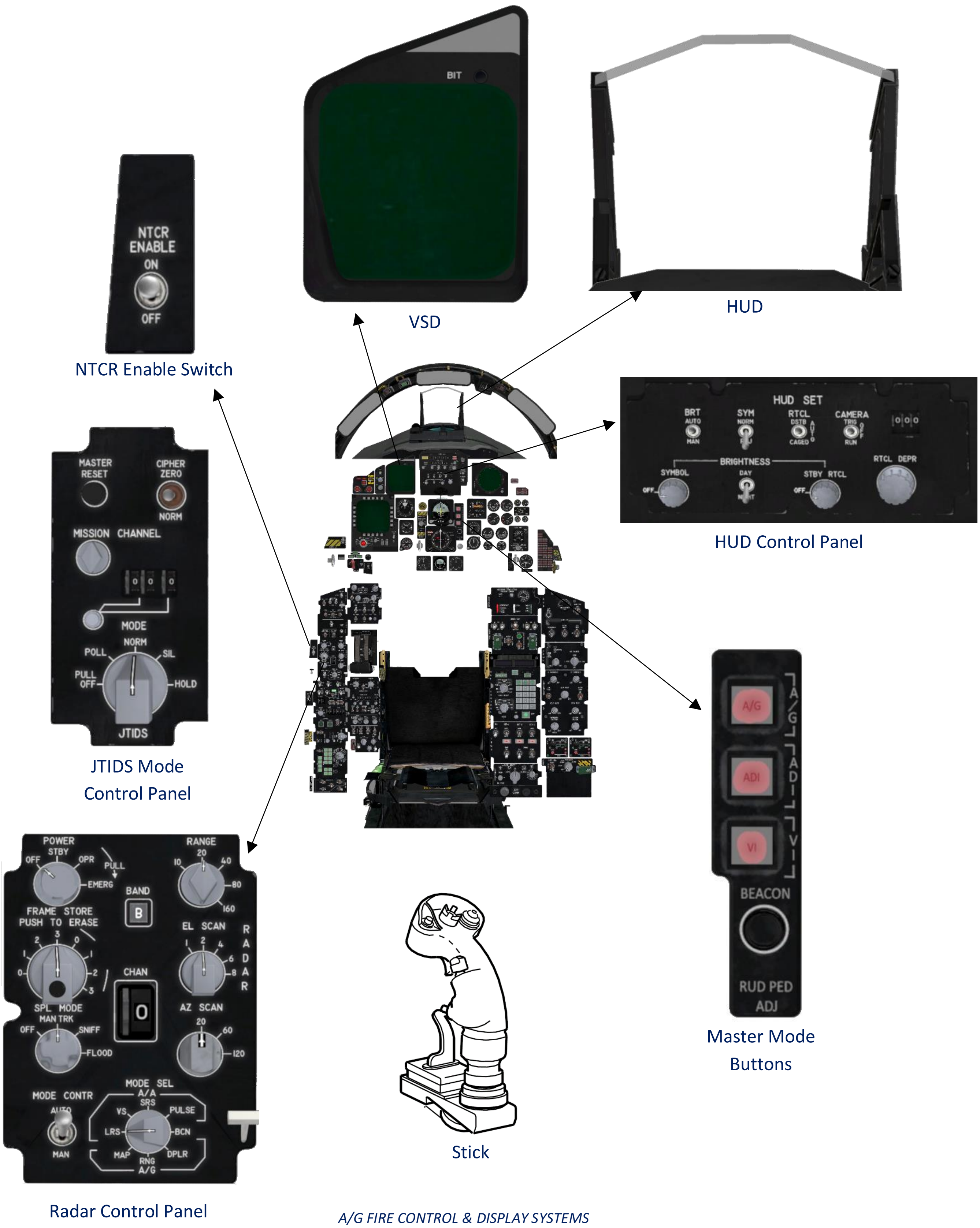
A/A FIRE CONTROL & DISPLAY SYSTEMS

A/A Fire Control & Display Systems (Continued)



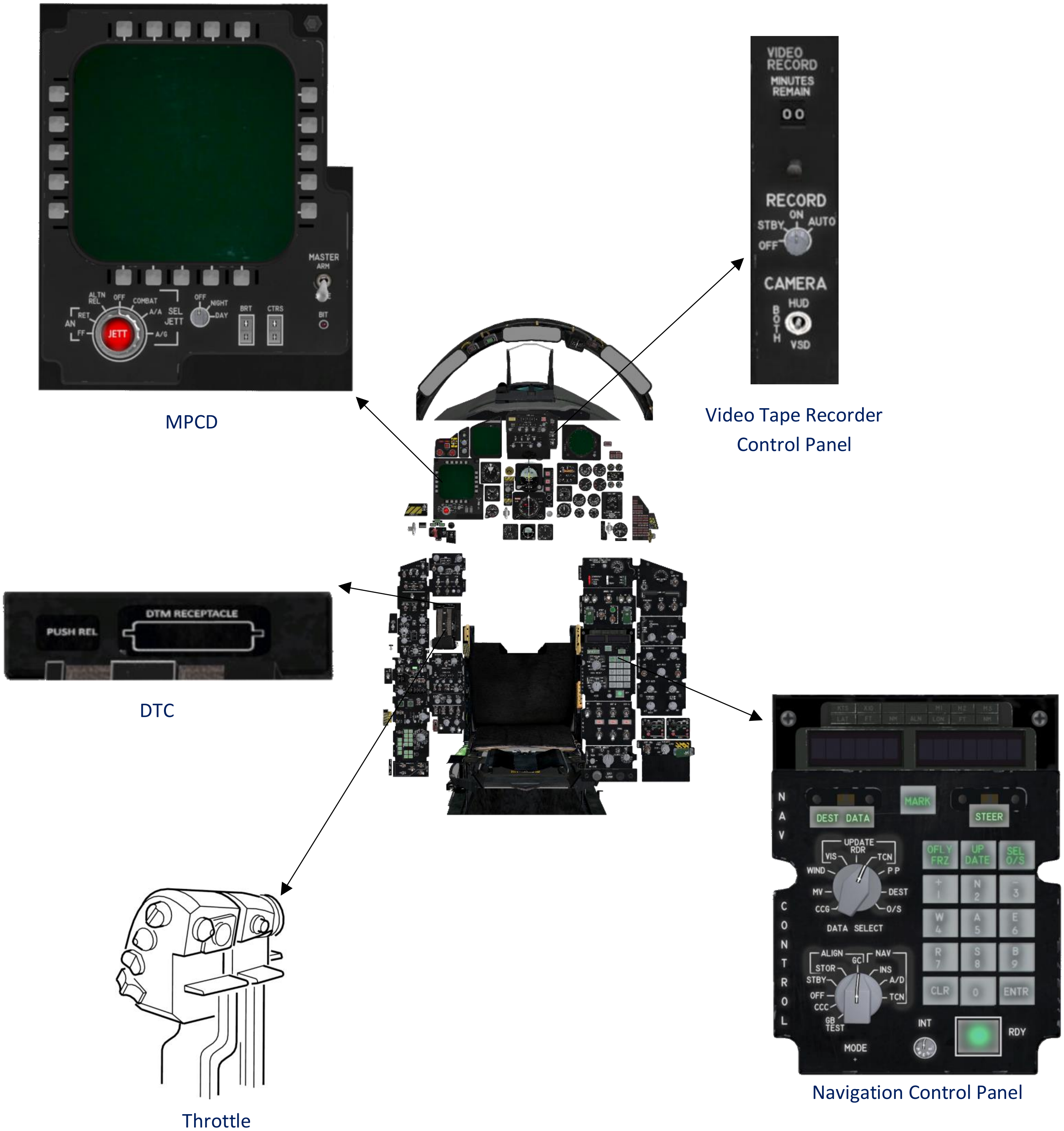
A/A FIRE CONTROL & DISPLAY SYSTEMS

2.1.2.7 A/G FIRE CONTROL & DISPLAY SYSTEMS

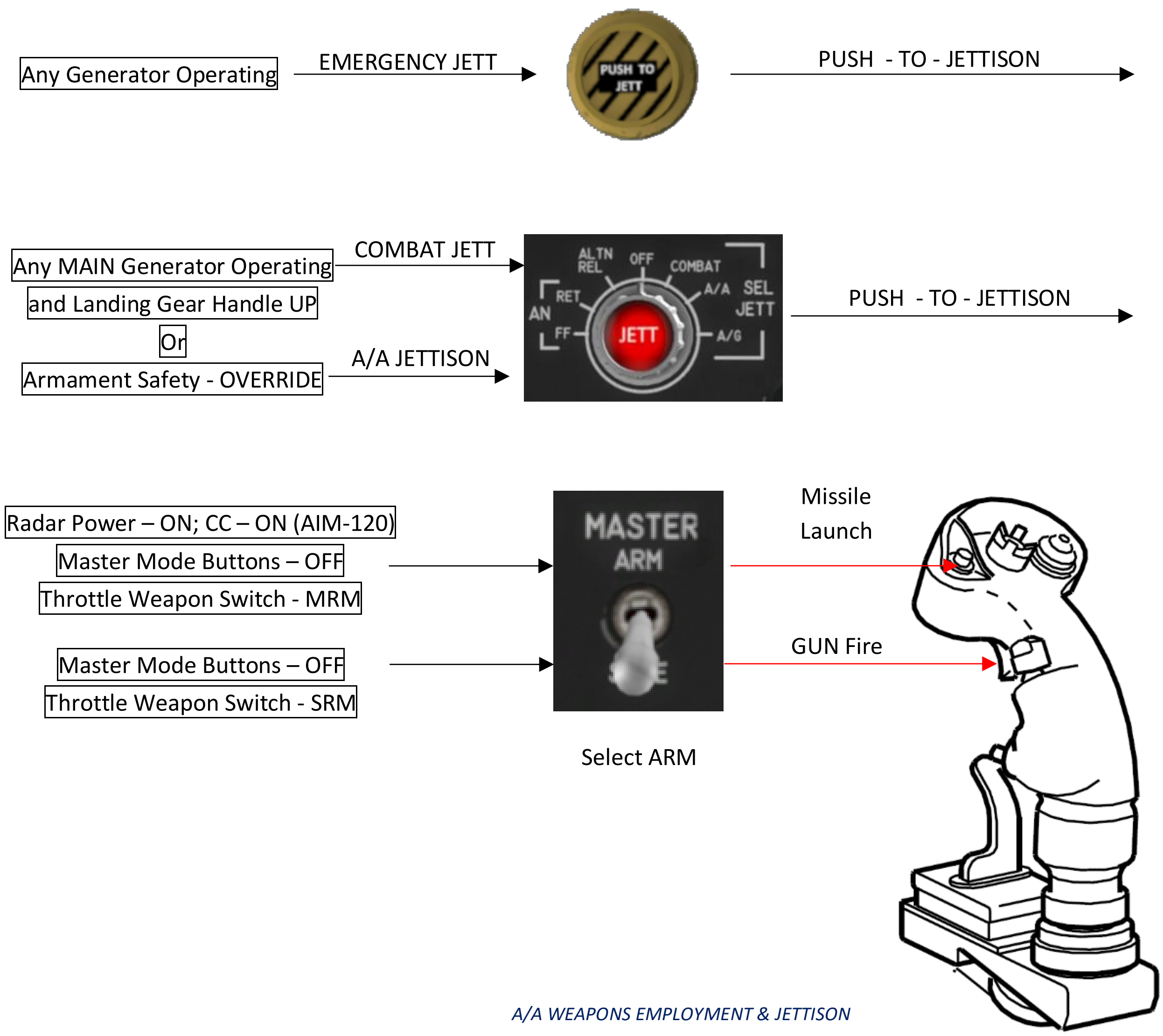


A/G FIRE CONTROL & DISPLAY SYSTEMS

A/G Fire Control & Display Systems (Continued)



2.1.2.8 A/A WEAPONS EMPLOYMENT & JETTISON

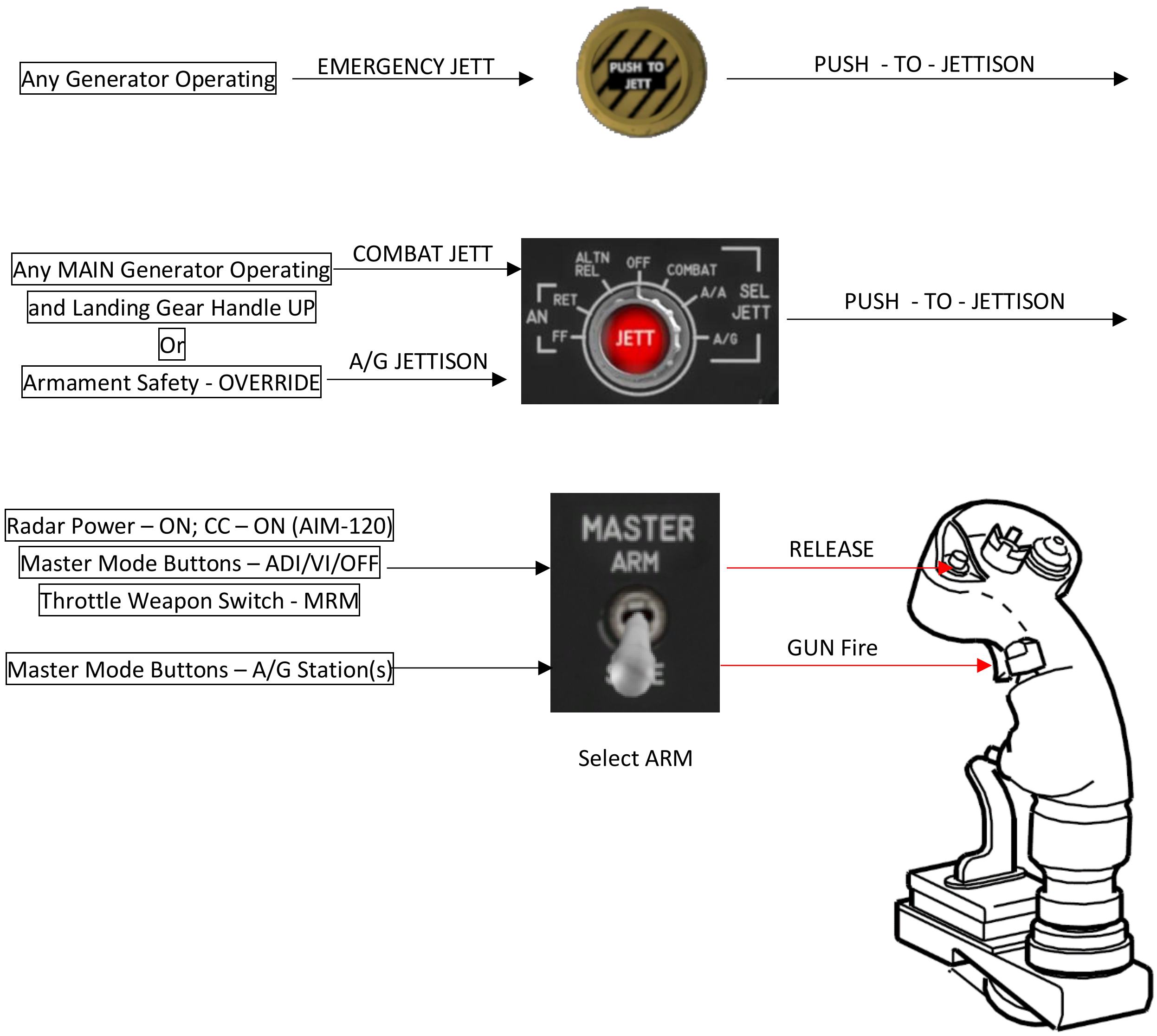


A/A WEAPONS EMPLOYMENT & JETTISON

Please note that the capability of shooting using A/A weapons in ADI and VI has not been completely implemented in this release.

MRM, SRM and GUNs can only be used in the A/A mode so far.

2.1.2.9 A/G WEAPONS EMPLOYMENT & JETTISON



A/G WEAPONS EMPLOYMENT & JETTISON

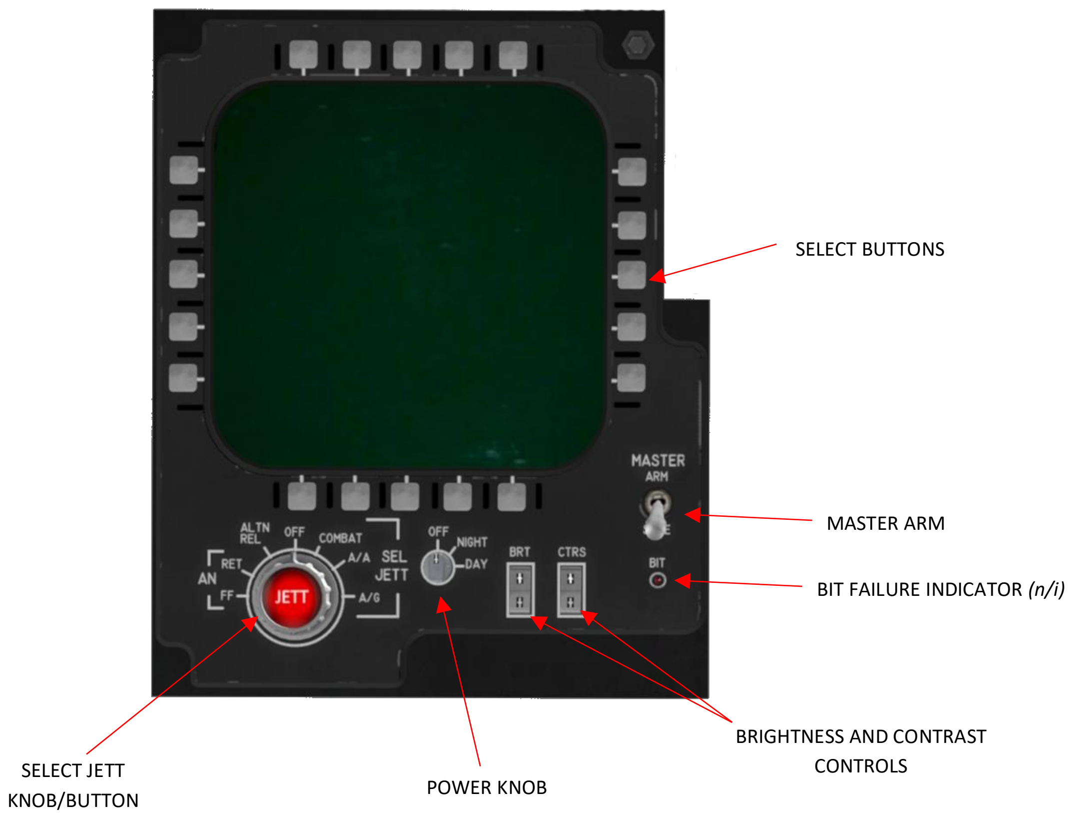
Please note that the A/G functions and systems are partially implemented yet.

2.1.3 PROGRAMMABLE ARMAMENT CONTROL SET (PACS)

The PACS serves as the central hub for all operations related to munitions selection, monitoring, arming, jettisoning, and release sequences. It plays a crucial role as the primary electrical interface connecting the pilot's instructions, the onboard munitions, and the aircraft's avionics systems during weapon attack modes. Additionally, the PACS supplies essential external stores configuration data to the CC to ensure the proper functioning of the OWS.

2.1.3.1 MPCD CONTROL PANEL

The MPCD control panel comprises a color display unit (DU) and a set of controls employed for weapon system management. The DU exhibits information regarding the weapons on board, the currently selected weapon, its quantity, and its status. Surrounding the DU, you will find a cluster of 20 buttons designed for selecting various options, altering the weapon program, and choosing alternative displays.



2.1.3.1.1 SELECTIVE JETTISON KNOB AND SELECTIVE JETTISON BUTTON

Please refer to the Stores Jettison System chapter in this document.

2.1.3.1.2 POWER KNOB

The power knob activates the MPCD.

OFF MPCD is off

Day/Night MPCD is on (no difference yet between day and night setting)

2.1.3.1.3 BIT FAILURE INDICATOR

Not implemented yet.

2.1.3.1.4 MASTER ARM SWITCH

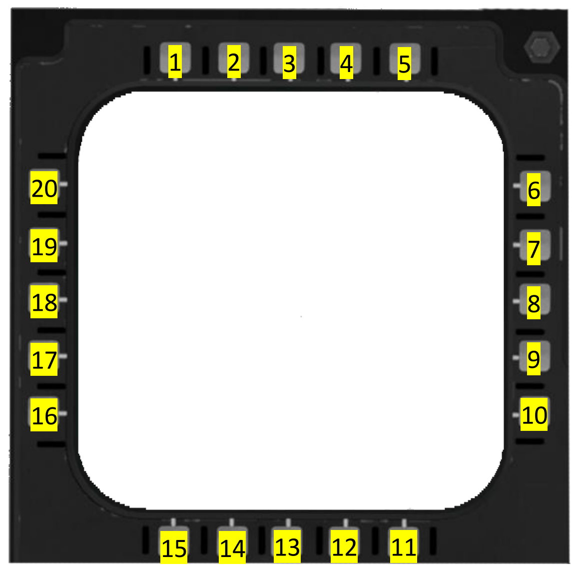
The master arm switch includes a safety lock feature to avoid accidental engagement of the ARM position. To choose the ARM position, the switch must be lifted upwards, moving it out of the detent.

SAFE weapons cannot be utilized.

ARM Either the landing gear handle is UP or the armament safety switch is in OVERRIDE, power is supplied to the master arm switch. This, in turn, activates the capability for weapon release and gun firing. Additionally, the gun cross is displayed on the HUD (Head-Up Display).

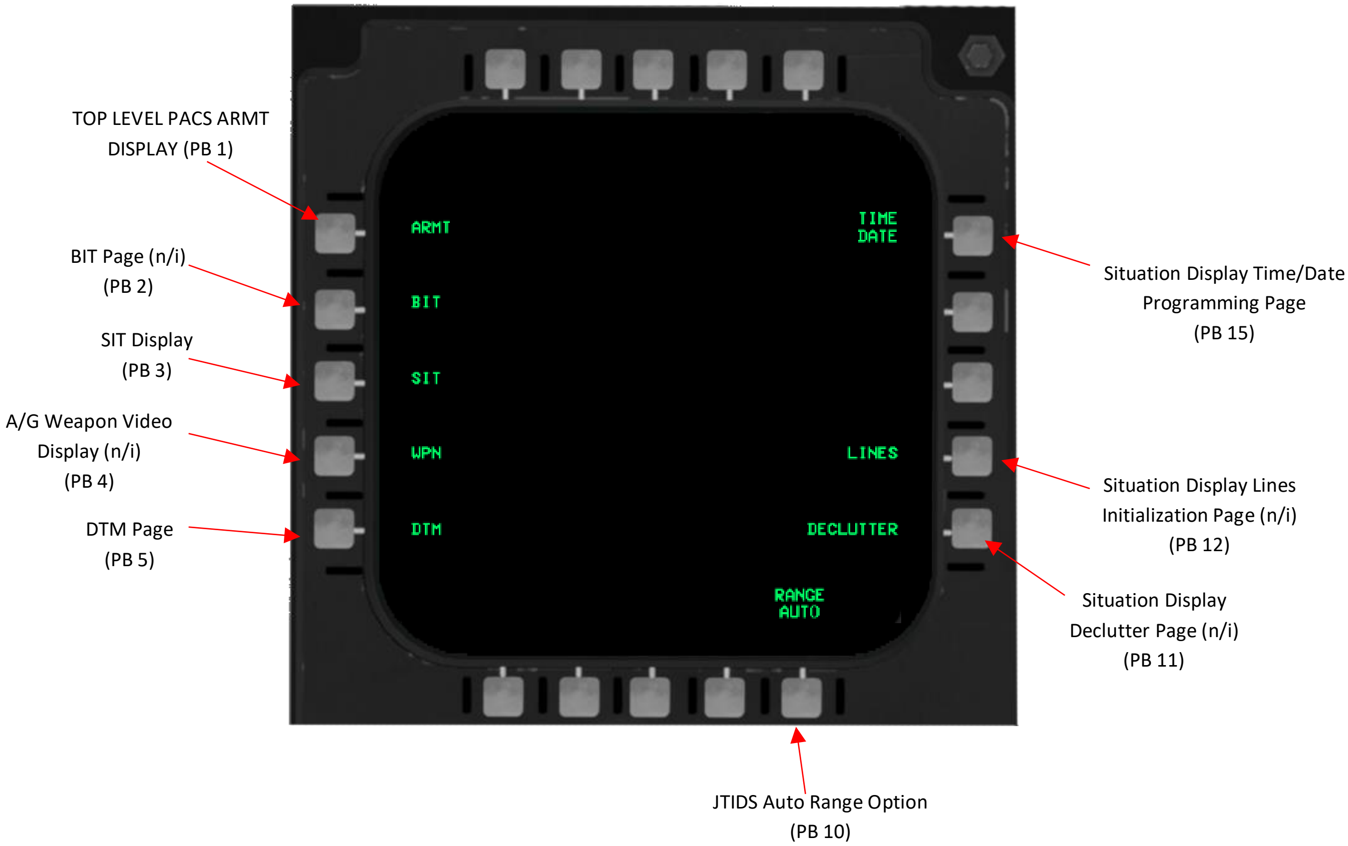
2.1.3.1.5 MPCD SELECT BUTTONS

The Multi-Purpose Color Display (MPCD) features a total of 20 pushbuttons (PBs), evenly distributed with five on each edge of the Display Unit (DU). These buttons serve to select, deselect, or modify the weapon or parameter labels situated next to them. In most instances, the selection is visually denoted by displaying a highlighted box around the label. Any exceptions to this rule are specified where relevant. The highlighted box is removed when deselected, and alterations are indicated by a change in the displayed label each time the button is pressed. To facilitate easy reference to specific buttons, this manual employs PB numbers shown on the right sides.



2.1.3.2 MPCD PAGES

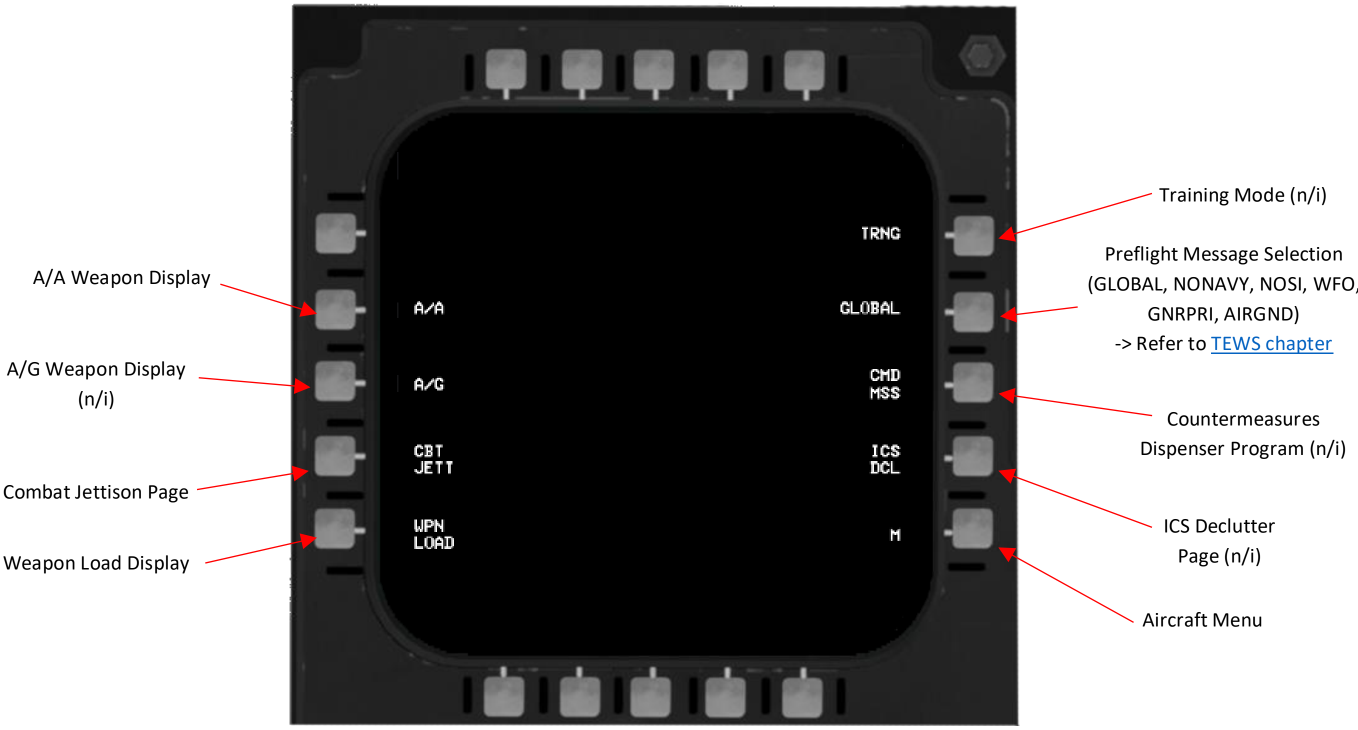
2.1.3.2.1 AIRCRAFT MENU PAGE



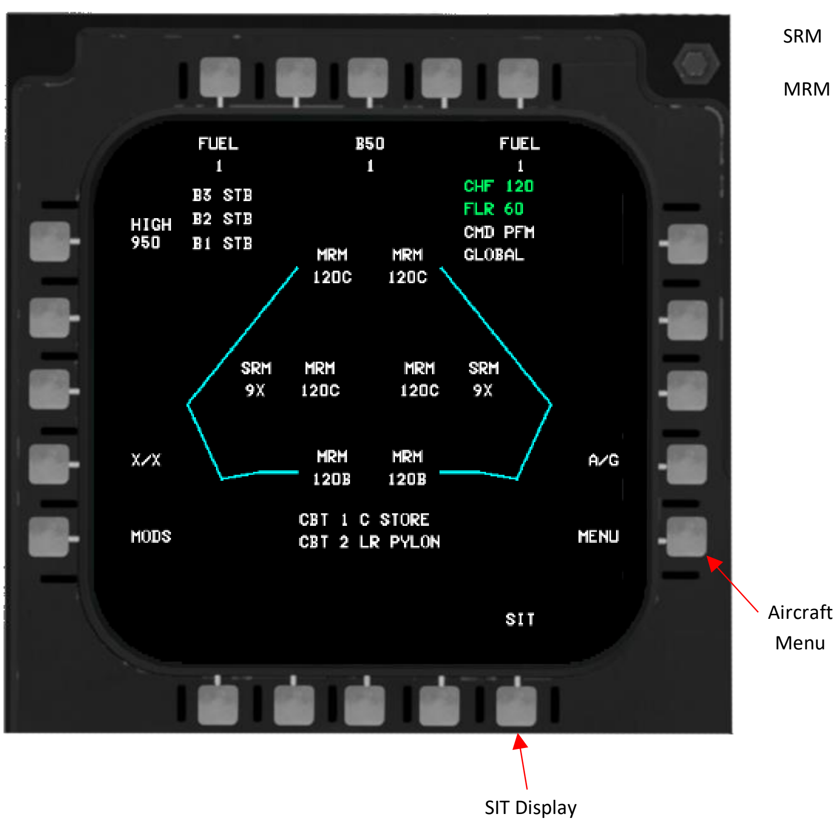
Please refer to the following chapters for more information about all aircraft menu subpages.

Please note that the functionality of all MPCD pages is not fully implemented yet. Only functions implemented will be hightlighted/explained.

2.1.3.2.2 ARMT PAGES

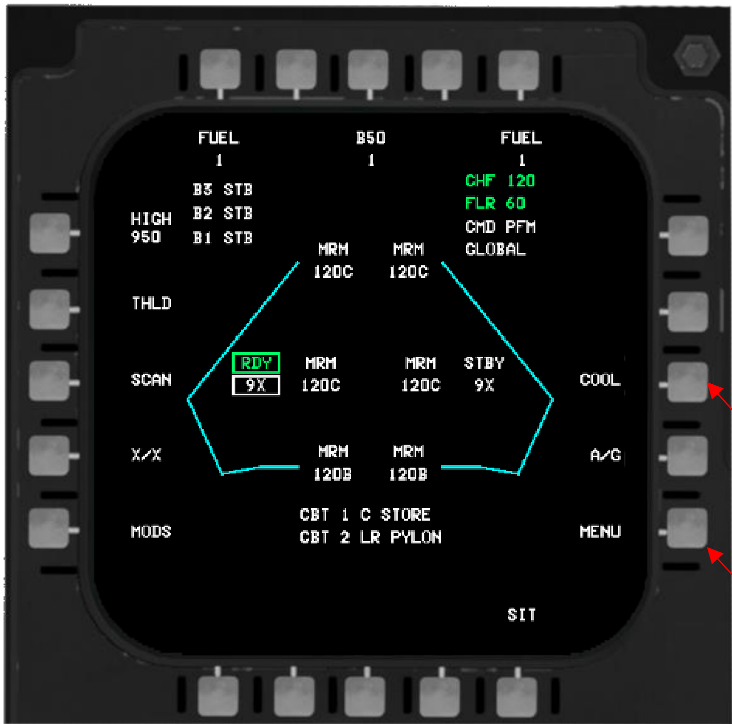


2.1.3.2.2.1 AIR-TO-AIR (A/A) WEAPON DISPLAY PAGE (GUN SELECTED)



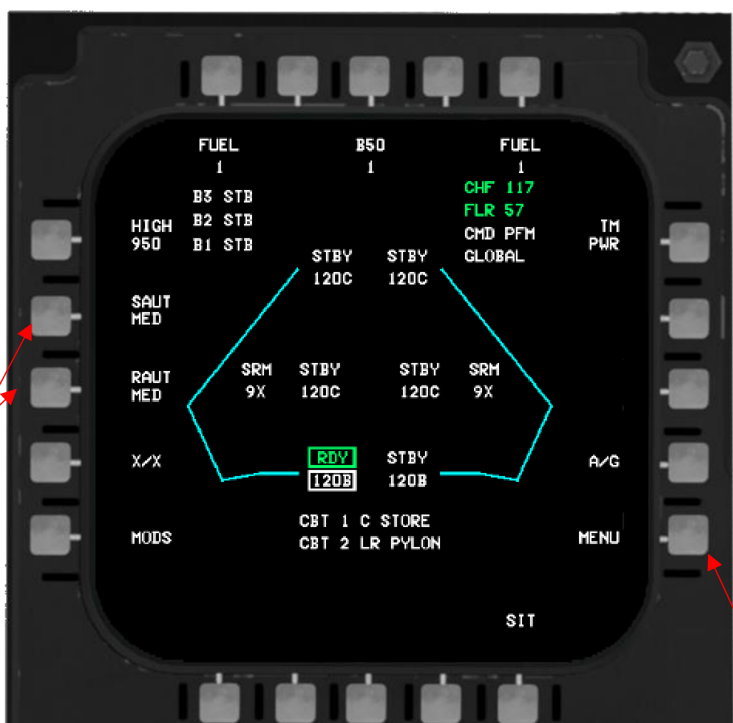
SRM	Weapon type not selected
MRM	Weapon type not selected

2.1.3.2.2.2 AIR-TO-AIR (A/A) WEAPON DISPLAY PAGE (SRM SELECTED)



RDY	Station and Weapon ready (MASTER ARM "ARM")
STBY	Weapon not selected (MASTER ARM "ARM")
9X	Weapon selected
MRM	Weapon type not selected

2.1.3.2.2.3 AIR-TO-AIR (A/A) WEAPON DISPLAY PAGE (MRM SELECTED)



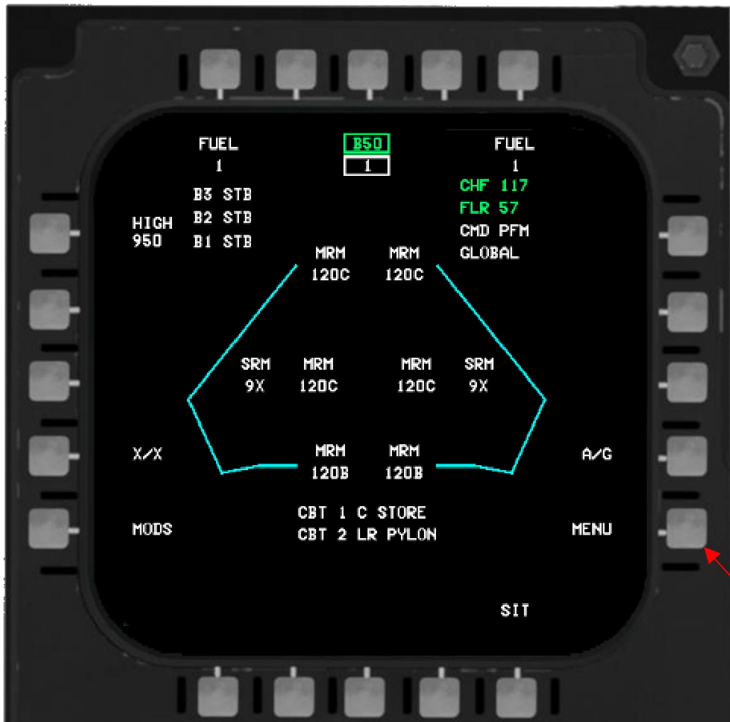
RDY	Station and Weapon ready (MASTER ARM "ARM")
STBY	Weapon not selected (MASTER ARM "ARM")
120B	Weapon selected
SRM	Weapon type not selected

TARGET SIZE

SML	Small
MED	Medium
LRG	Large
UNKN	Unknown

Those options allow the pilot to choose the target size estimate to be provided to AIM-120B/C.

2.1.3.2.2.4 AIR-TO-AIR (A/G) WEAPON DISPLAY PAGE (A/G SELECTED)

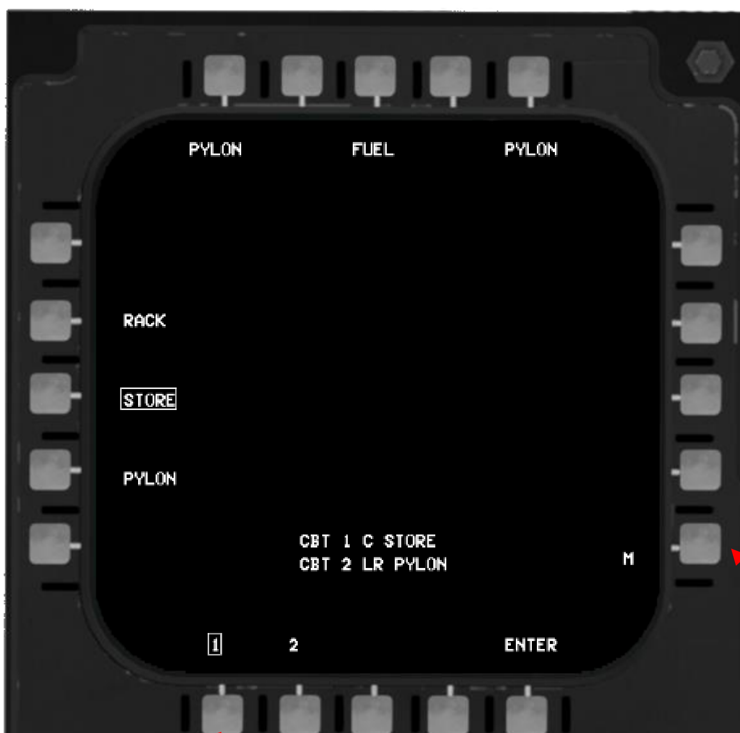


Aircraft Menu

SIT Display

B50	Weapon standby (MASTER ARM “SAFE”)
B50	Station and Weapon ready (MASTER ARM “ARM”)
1	Weapon amount
MRM	Weapon type not selected
SRM	Weapon type not selected

2.1.3.2.2.5 COMBAT JETTISON (CBT JETT) PAGE

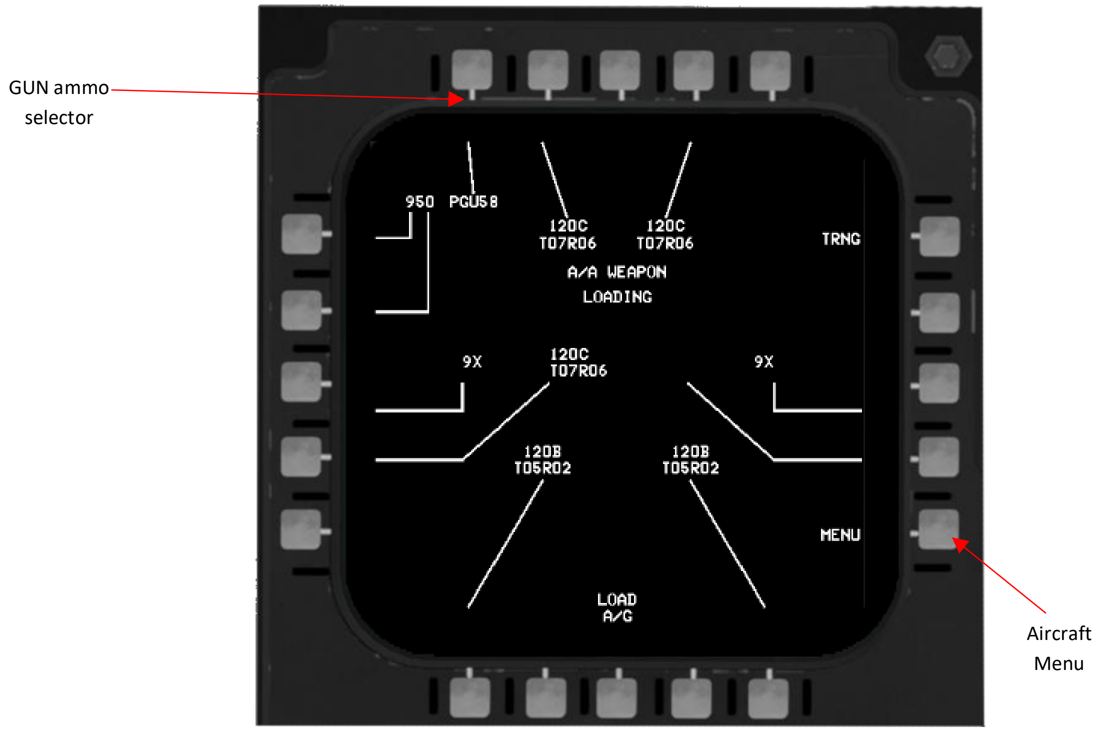


Aircraft Menu

Program 1

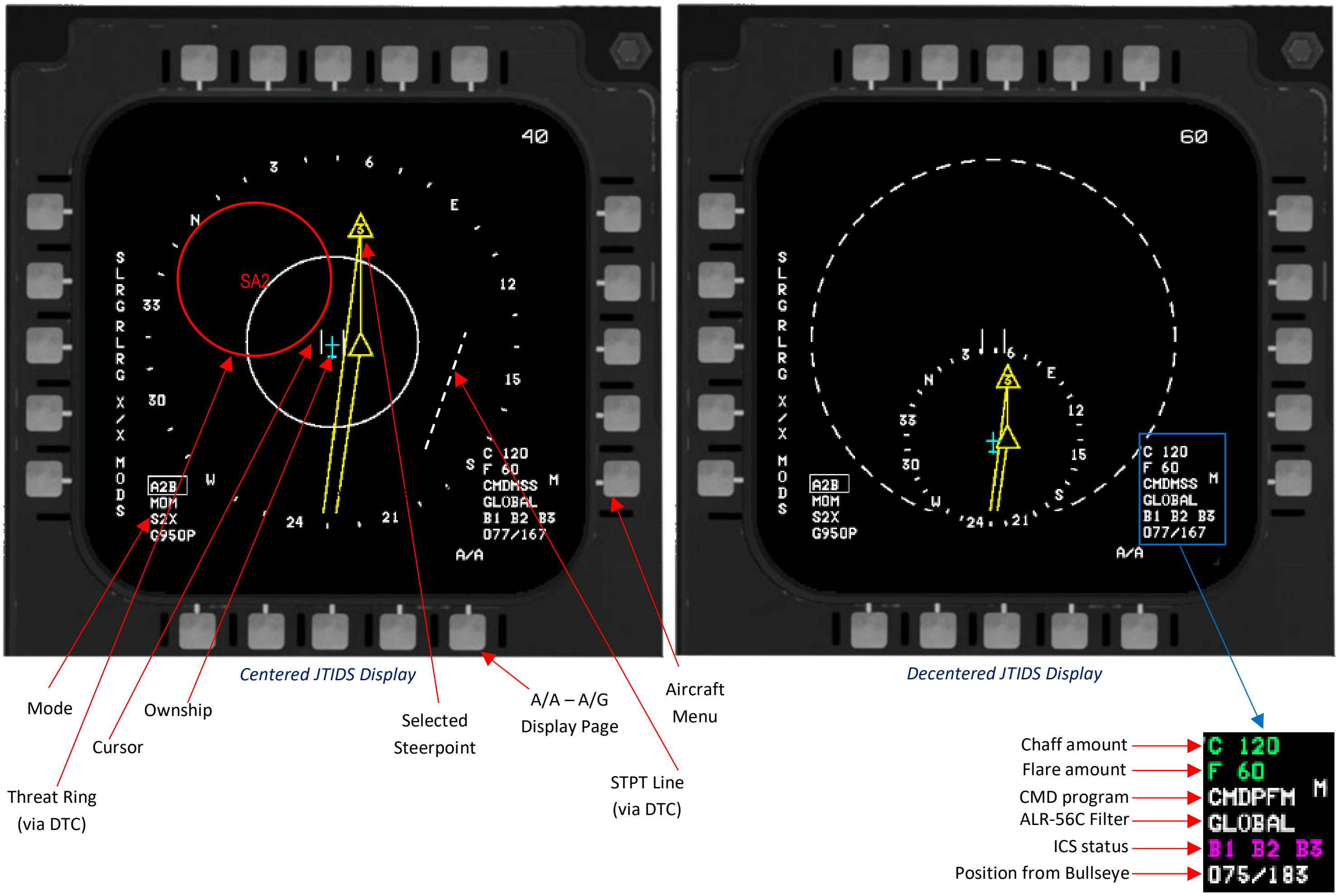
Program 2 (n/i)

2.1.3.2.2.6 WEAPON (WPN) LOAD PAGE



The WPN LOAD page is partially implemented yet.

2.1.3.2.3 SITUATION (SIT) DISPLAY



Centered JTIDS Display *Decentered JTIDS Display*

The CC and radar software come equipped with support for the Joint Tactical Information Distribution System (JTIDS) and Fighter Data Link (FDL). However, achieving full system functionality necessitates the installation of additional hardware components, including the F-15C stick grip, either a JTIDS or FDL terminal, and the mode control panel. In the absence of these hardware components, users can still access a SIT display on the Multi-Purpose Color Display (MPCD). This SIT display, which offers a six-color, comprehensive view, can be selected by pressing the SIT (PB 3) option on the main menu. The SIT display enhances situational awareness by presenting critical information such as ownship status, target data, geographic references, and other data programmed via the Data Transfer Module (DTM).

CASTLE SWITCH

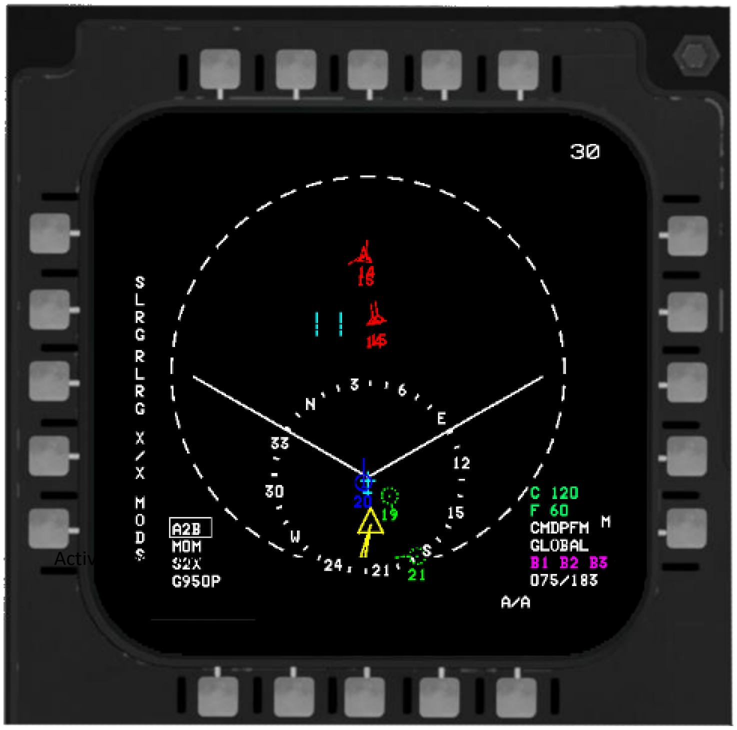
Forward TDC control to VSD display  (Cursor symbol)

Aft ≤ 1sec. TDC control to SIT display  (Cursor symbol)

Right Last SIT display or toggle self-centered/decentered

Left Expand selection

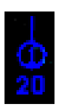
2.1.3.2.3.1 SIT DISPLAY – LINK-16

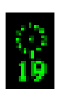


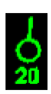
4.37.3 introduces Link-16 (L16) to the F-15C. This version is a very early stage of the L16 and simplified for now. Because the F-15C doesn't have IDM in real life, L16 is necessary to the Eagle to enhance package capabilities and situational awareness for the pilot.

2.1.3.2.3.2 LINK-16 – AIRCRAFT SYMBOLOGY

Up to 30 aircraft are displayed at the same time, prioritized by the closest range to the F-15C. Symbols are:

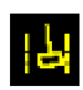
1. Friendly (flight member) 

2. Friendly surveillance air track 

3. Friendly radar target 

4. Unknown radar target 

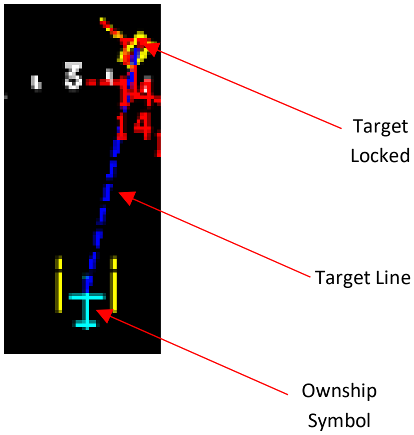
5. Hostile/Bandit radar target 

6. Locked radar target 

Each aircraft symbol contains:

- Heading indication
- Altitude information (in Angels)

2.1.3.2.3.3 LINK-16 – OTHER SYMBOLOGY – PRIMARY DESIGNATED TARGET



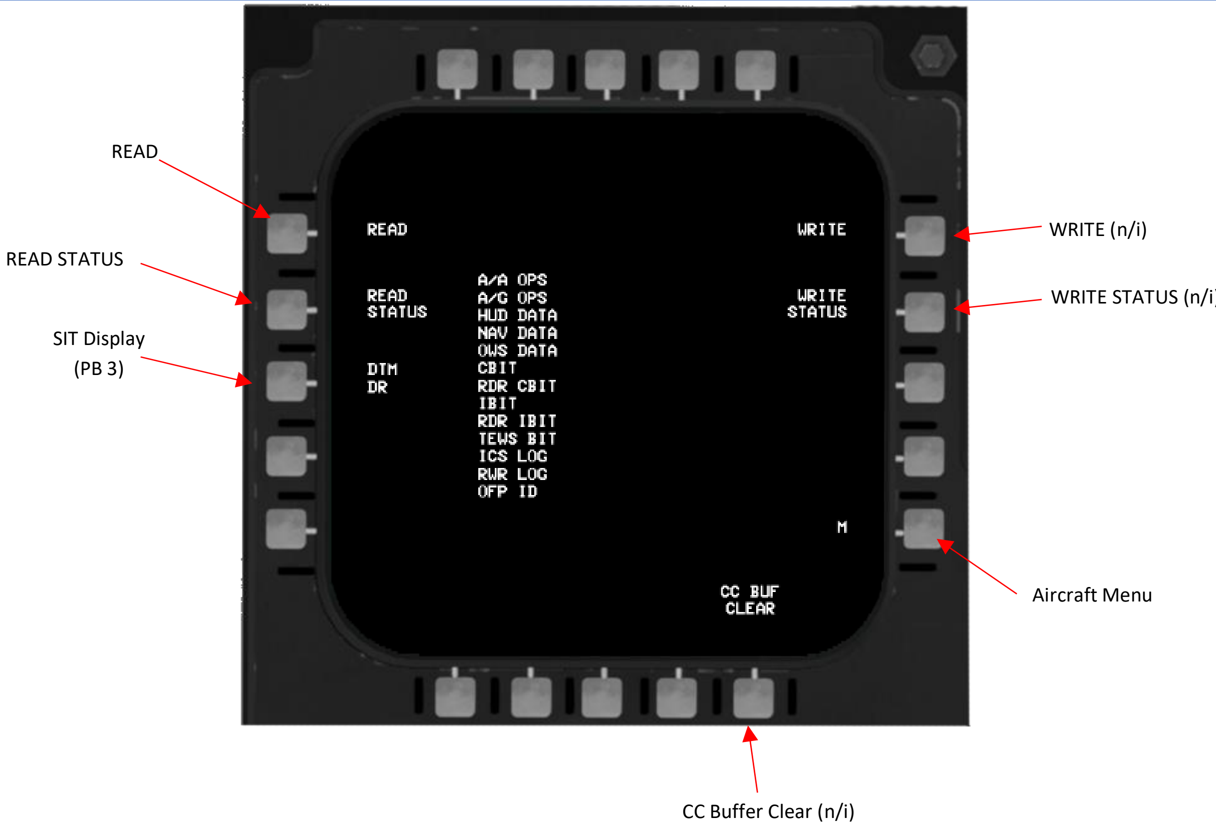
Please note that all designated targets chosen by each member of the flight will be displayed in the SIT as well.

2.1.3.2.3.4 LINK-16 – WORKING CONDITIONS

1. AWACS is on station (Distance to AWACS is no factor for now).

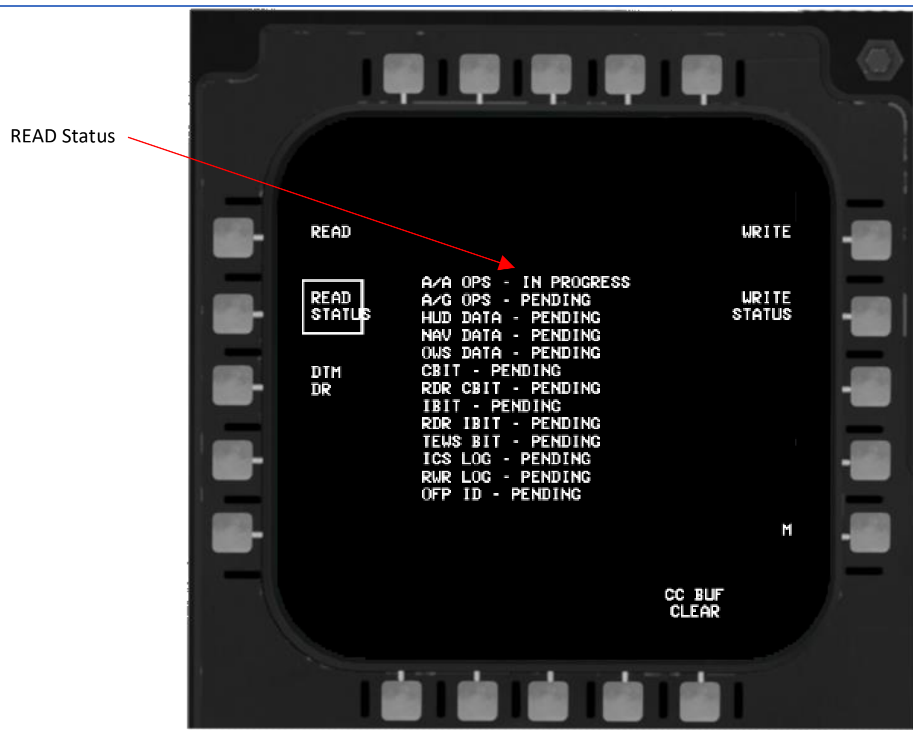
2. Own aircraft is not on the ground.

2.1.3.2.4 DTM PAGE



For more information, please refer to the chapter Data Transfer Module (DTM).

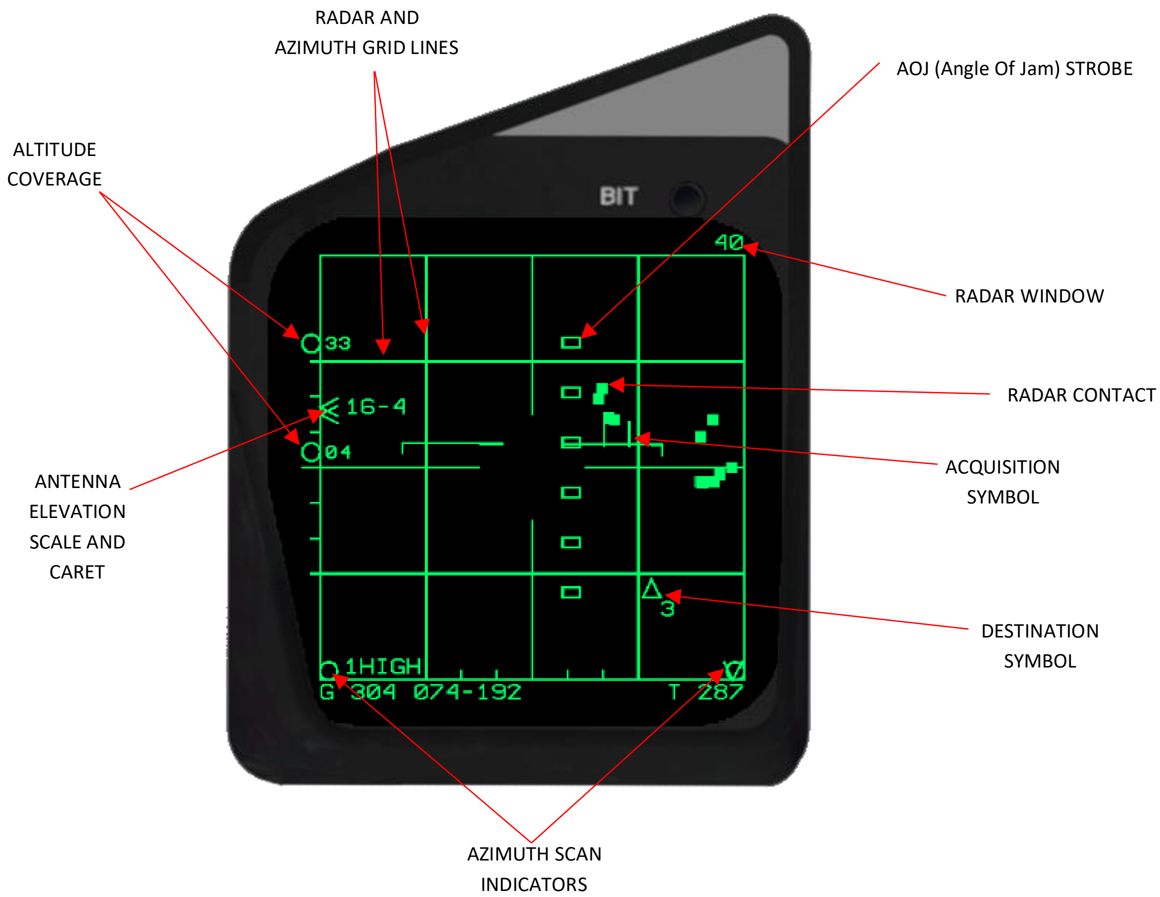
2.1.3.2.4.1 DTM READ DATA PAGE



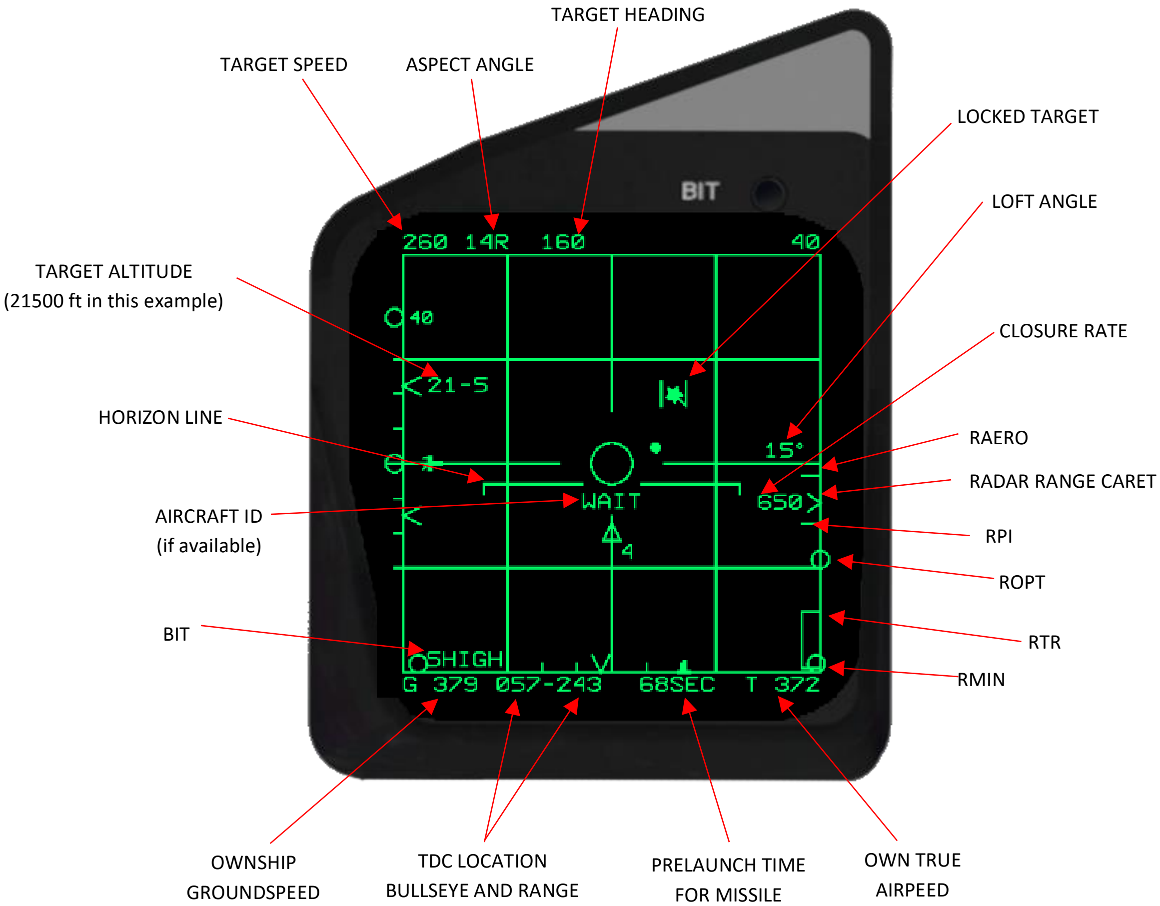
For more information, please refer to the chapter Data Transfer Module (DTM).

2.1.4 VERTICAL SITUATION DISPLAY (VSD)

2.1.4.1 VSD – ALL MODES



2.1.4.2 VSD – A/A – MRM/SRM/GUN MODE



2.1.4.3 VSD – A/G – MODE

Not implemented yet.

2.1.4.4 VSD – RANGE AND AZIMUTH SCAN SELECTION

RANGE Move acquisition symbol up or down over the edge of the VSD.
Available ranges are: 10, 20, 40, 80, 160 NM (Nautical miles).

AZIMUTH Move acquisition symbol left or right over the edge of the VSD.
Available azimuths are: 20, 120 NM (Nautical miles).

2.1.5 DATA TRANSFER MODULE (DTM)

The Data Transfer Module (DTM) serves as a memory module with dual functionalities. It is employed to input mission data into both the CC and PACS through the PSDP and to transfer recorded flight and maintenance events from the CC to the corresponding DTM module.

When an OPS DTM is inserted into the Air Force Mission Support System (AFMSS), the AFMSS automatically configures the DTM by creating a directory structure that designates it as a flight operations (OPS) DTM.

In contrast, DTM modules intended for recording aircraft maintenance events are typically not utilized on the AFMSS. Consequently, maintenance DTM modules do not contain a directory structure. Additionally, if an OPS DTM has been erased, it will no longer possess a directory structure.

The maintenance DTM comes into play during debrief sessions, serving the purpose of transferring data to the Computerized Fault Reporting System (CFRS).

2.1.5.1 DTM READ DATA

During data transfer operations, NCI keyboard inputs are temporarily disabled to ensure the process's integrity. It's important to note that data transfer to the PACS is not possible when the PACS training mode is active. The Data Transfer Module (DTM) facilitates the transfer of various data sets and data types, categorized as follows:

While data transfer is underway, the NCI keyboard becomes temporarily inaccessible. Additionally, it's important to note that data cannot be transferred to the PACS when the PACS training mode is active. The Data Transfer Module (DTM) facilitates the exchange of the following data sets and data types:

CC DATA	**PACS Data (Training and Combat)**
• Waypoint(s), Steer-To/Offset Point Data: ○ a. ID number ○ b. Latitude/Longitude (lat/long) ○ c. Elevation, MSL ○ d. Minimum enroute altitude (MEA) ○ e. Magnetic variation (mag var) ○ f. Offset range north and east ○ g. Offset elevation ○ h. Line type to the next waypoint ○ i. Programmed time of arrival • Tacan Station Data: ○ a. Lat/Long ○ b. Elevation ○ c. Channel # ○ d. Magnetic variation ○ e. Point number • HUD Titling Data: ○ a. Aircraft/wing/mission number ○ b. Local data ○ c. Alert altitude	○ a. A/A Weapon Load (gun rounds/missiles) ○ b. MRM Rmnvr (APG-63 OR APG-70) ○ c. A/G Store Load ○ d. Combat Jettison Program ○ e. AIM-120 Flight Member ID Options ○ f. CBU-87 Spin Rate Selections ○ g. Dispenser Program 1 and 2 **A/G Programs (Training and Combat)** ○ a. Program # ○ b. Release Sequence ○ c. Release Interval/Quantity Option ○ d. Arming Option ○ e. Free Fall/Retard Selection ○ f. Applicable A/G Stations ○ g. Delivery Mode

These data sets and types are integral to various operational and training procedures, ensuring the effective functioning of the systems involved.

2.1.6 STORES JETTISON SYSTEM

2.1.6.1 JETTISON AND RELEASE SAFETY SWITCHES

2.1.6.1.1 LANDING GEAR CONTROL HANDLE

When the landing gear handle is in the lowered position, the PACS jettison controls lose power.

2.1.6.1.2 ARMAMENT SAFETY SWITCH

The OVERRIDE setting on the armament safety switch allows for the bypass of the landing gear handle interlock. To keep the switch in the OVERRIDE position, the aircraft must have power applied to it. It will stay in the OVERRIDE position unless manually switched OFF, power to the aircraft is cut, or the landing gear handle is moved to the UP position. It's important to note that this control does not have any impact on the emergency jettison control circuit.

2.1.6.2 JETTISON CONTROLS

Irrespective of the master arm switch's position, if either the emergency jettison or select jettison button is pressed, all arming solenoids are automatically disengaged prior to the jettison action, ensuring that all stores are released without being armed.

2.1.6.2.1 EMERGENCY JETTISON BUTTON

The emergency jettison button remains active whenever the aircraft is powered, whether internally or externally. When activated, it results in the jettison of MRM missiles and the contents of pylons on stations 2, 5, and 8. It is of utmost importance to exercise extreme caution to prevent unintended ground-level jettison.

2.1.6.2.2 SELECT JETTISON KNOB/BUTTON

When the select jettison button is activated, it releases stores based on the following knob positions:

- OFF: Disconnects power from the selective jettison button.
- COMBAT: The initial press triggers the combat jettison program 1. Program 2 is not implemented yet.
- A/A: Chooses air-to-air selective jettison (not implemented yet).
- A/G: Chooses air-to-ground selective jettison (not implemented yet).
- ALTN REL: This setting is not utilized.
- MAN RET: The implementation for this function is not implemented.
- MAN FF: The implementation for this function is not implemented.

2.1.6.2.3 A/A SELECTIVE JETTISON

Not implemented yet.

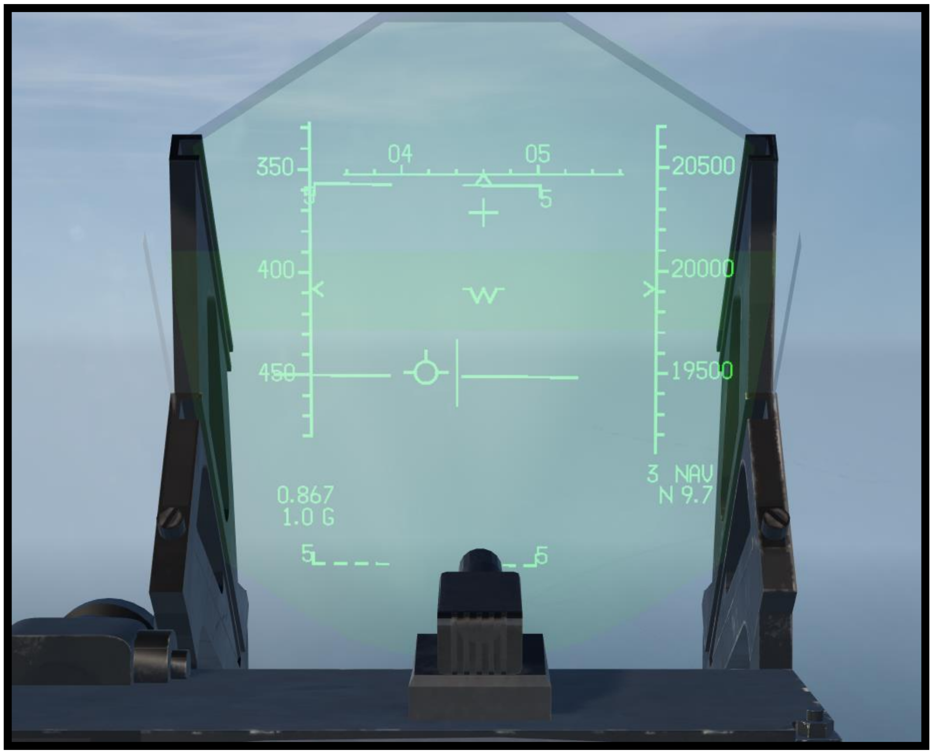
2.1.6.3 PROGRAMMING COMBAT JETTISON

Not implemented yet.

2.1.7 STICK GRIP & THROTTLE CONTROL

Please refer to the TO-1F-15C-1 BMS.

2.1.8 HEAD-UP DISPLAY (HUD) SYSTEM



The Head-Up Display (HUD) presents attack symbology and steering cues for weapon delivery. In case of failures in the CC, ACS, PACS, or HUD symbol generator unit, a standby reticle serves as a contingency display for attack information.

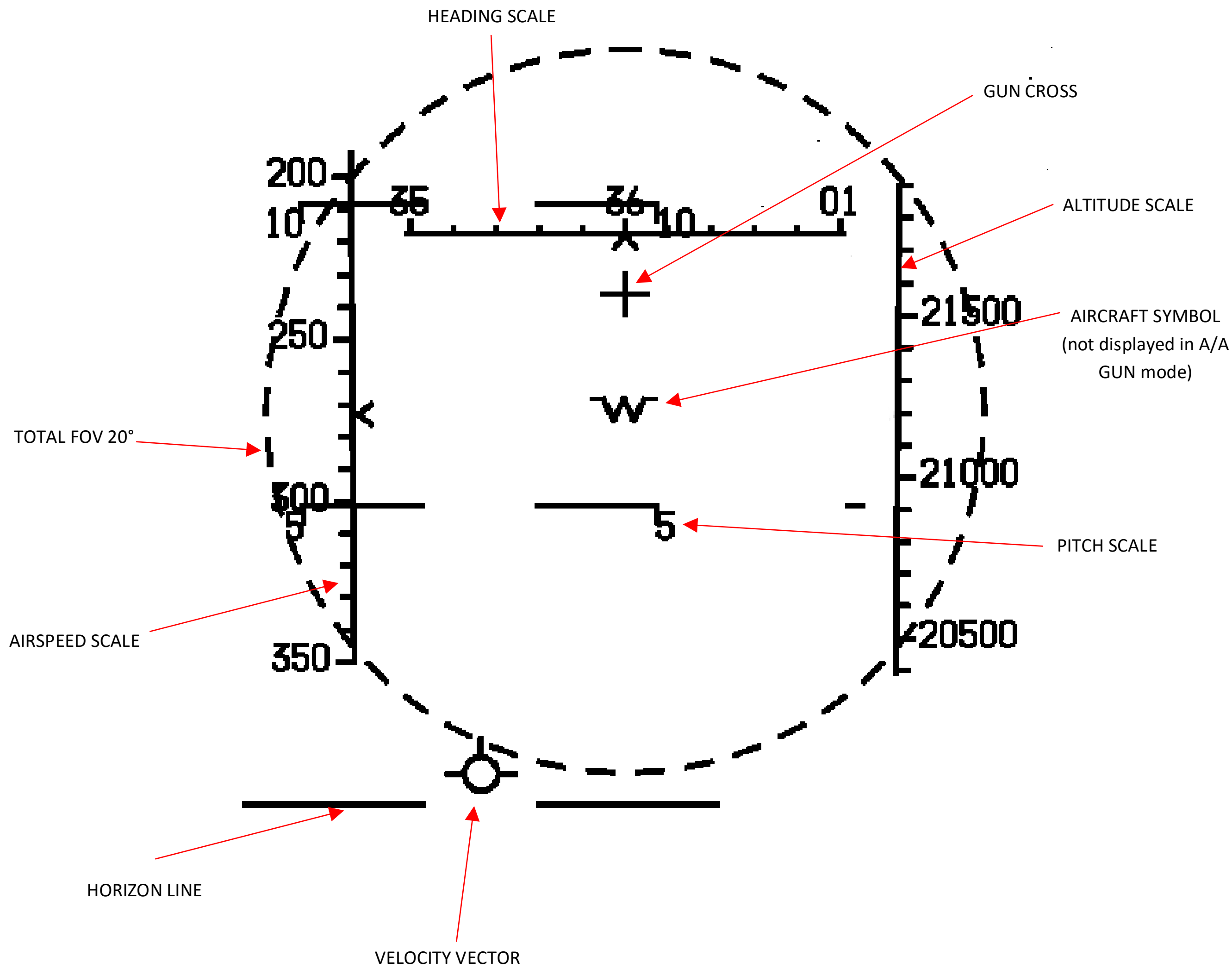
The HUD system, an electro-optical sight system, generates symbolic flight and attack guidance data and projects these symbols directly into the pilot's Field Of View (FOV). The selection of HUD display modes is controlled through the master mode buttons. When in A/A master mode, the display for MRM, SRM, or GUN attacks can be chosen by manipulating the throttle weapon switch.

The complete FOV covered by the HUD is circular, encompassing 20 degrees both in azimuth and elevation. The optical axis, which is the center of the FOV, is positioned 4 degrees below the waterline. The HUD incorporates a depressible standby reticle display featuring a 2-mil diameter aim dot and a 50-mil diameter circle centered around this dot.

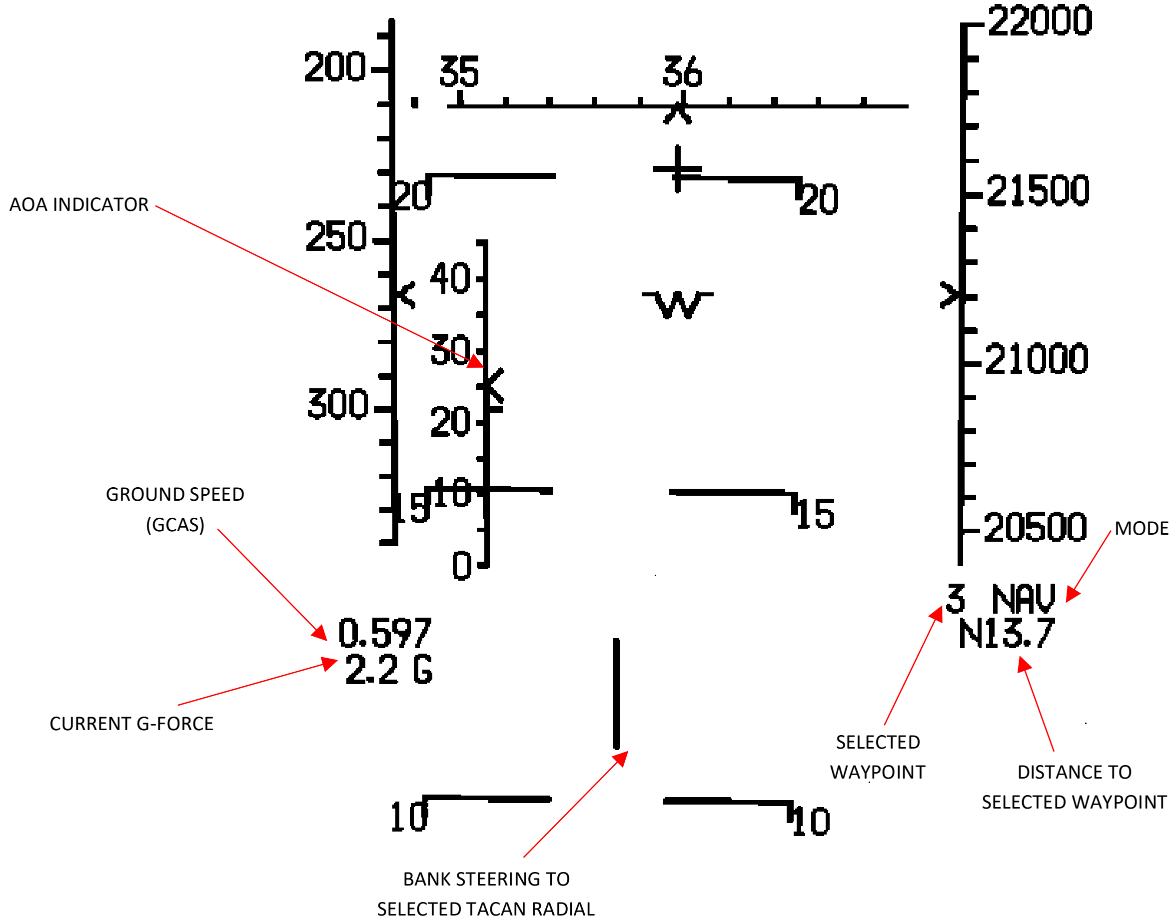
2.1.8.1 HEAD-UP DISPLAY CONTROL PANEL

Please refer to the TO-1F-15C-1 BMS.

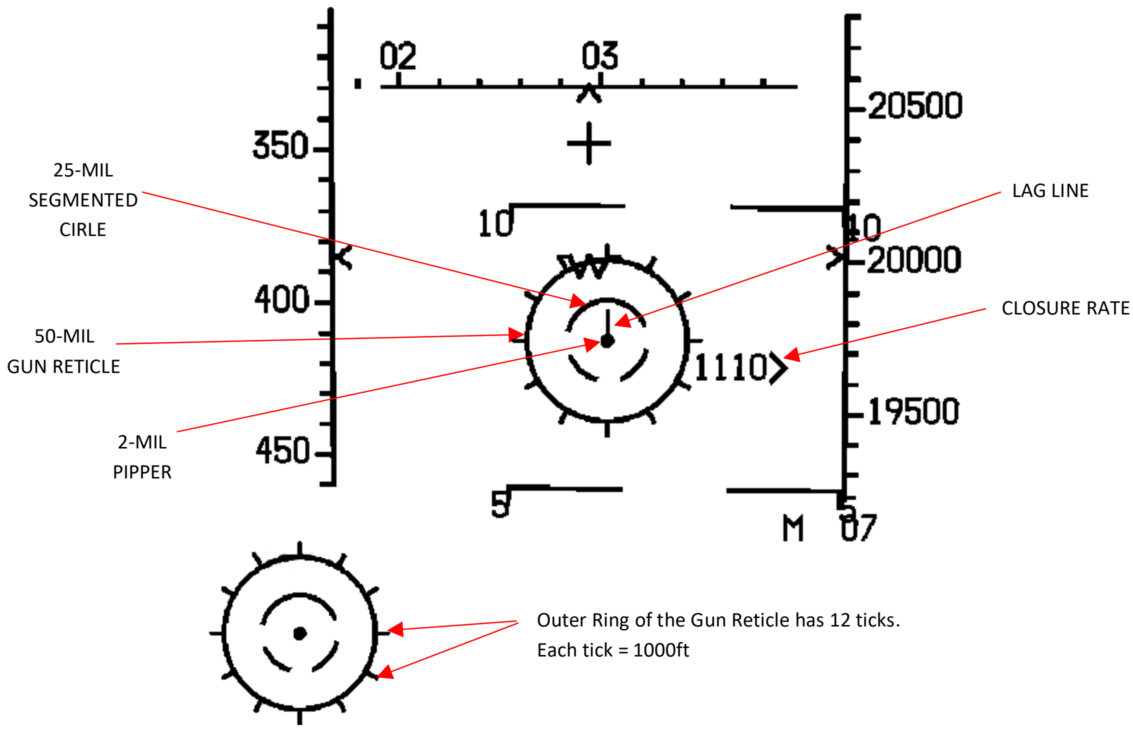
2.1.8.2 HUD SYMBOLS - ALL MODES



2.1.8.3 HUD SYMBOLS - ADI MODE

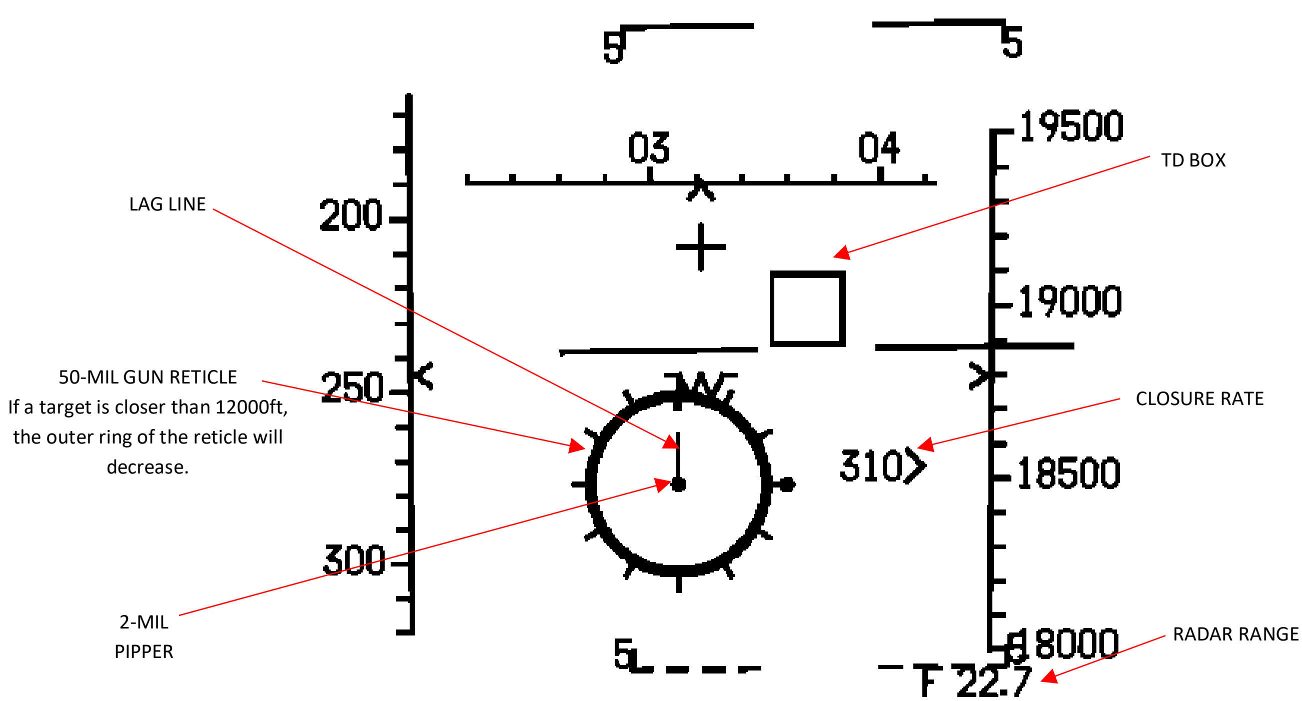


2.1.8.4 HUD SYMBOLS – A/A – GUN MODE – UNLOCK

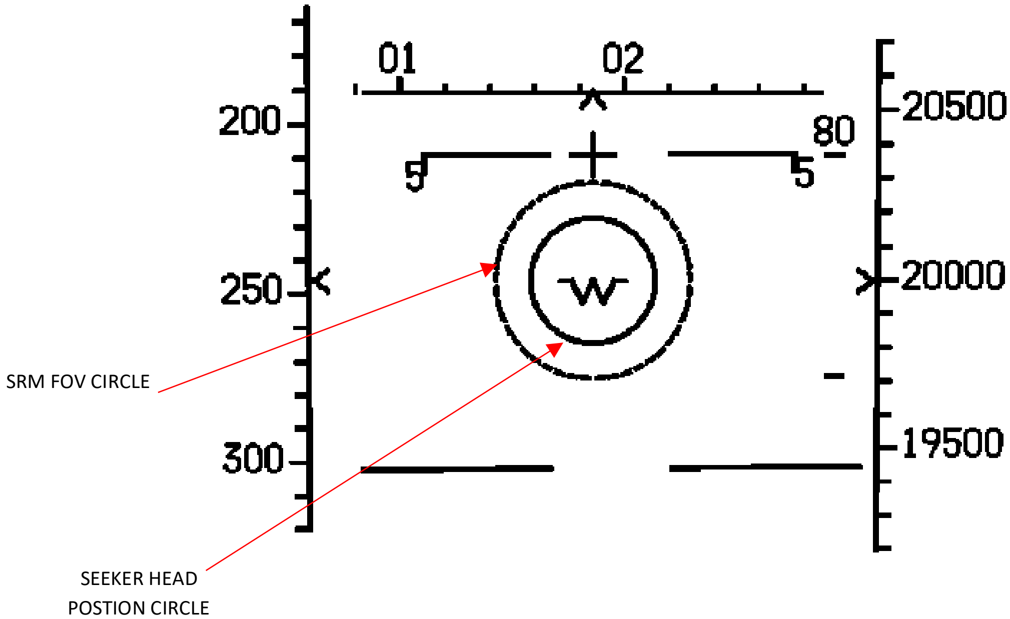


With the weapon select switch in GUN, pressing COOLIE DOWN and holding initiates LCOS reticle stiffen for the LCOS gunsight. Please note that reticle stiffen only works in the UNLOCK status. The gun and HUD gun cross are harmonized at a range of 2250 feet forward of the gun muzzle and 1000 feet if reticle stiffen is selected.

2.1.8.5 HUD SYMBOLS – A/A – GUN MODE – LOCK

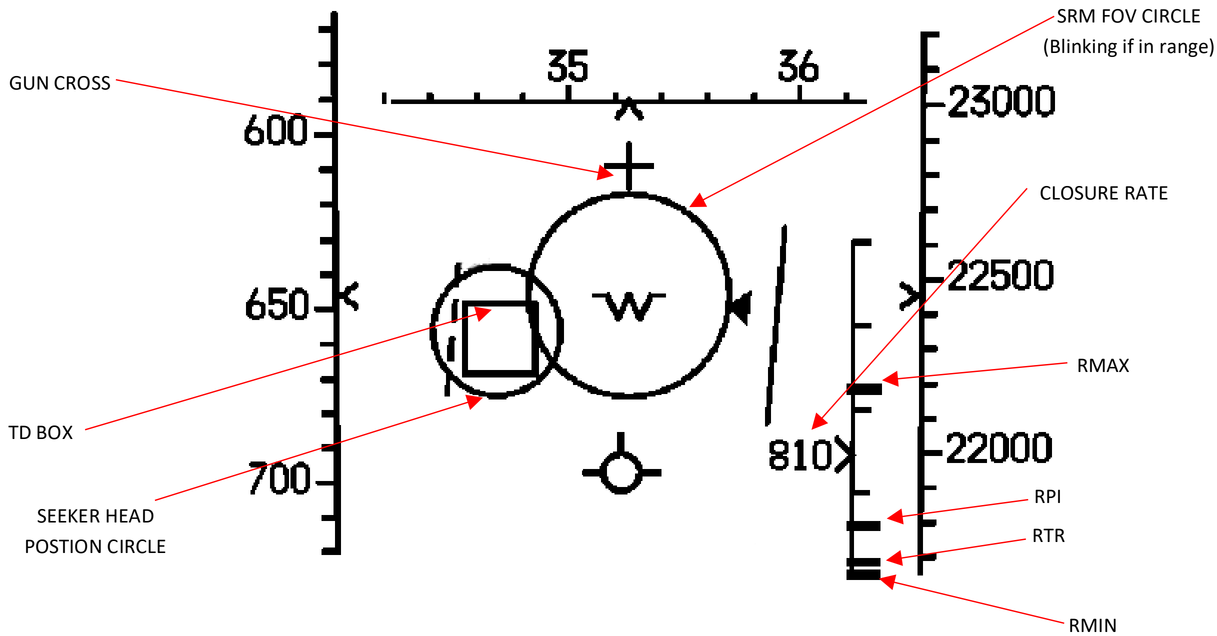


2.1.8.6 HUD SYMBOLS – A/A – SRM MODE (AIM-9) - UNLOCK



This HUD window applies for the AIM-9 L/M/X. The AIM-9P HUD symbology consists of SRM FOV circle only.

2.1.8.7 HUD SYMBOLS – A/A – SRM MODE (AIM-9) - LOCK



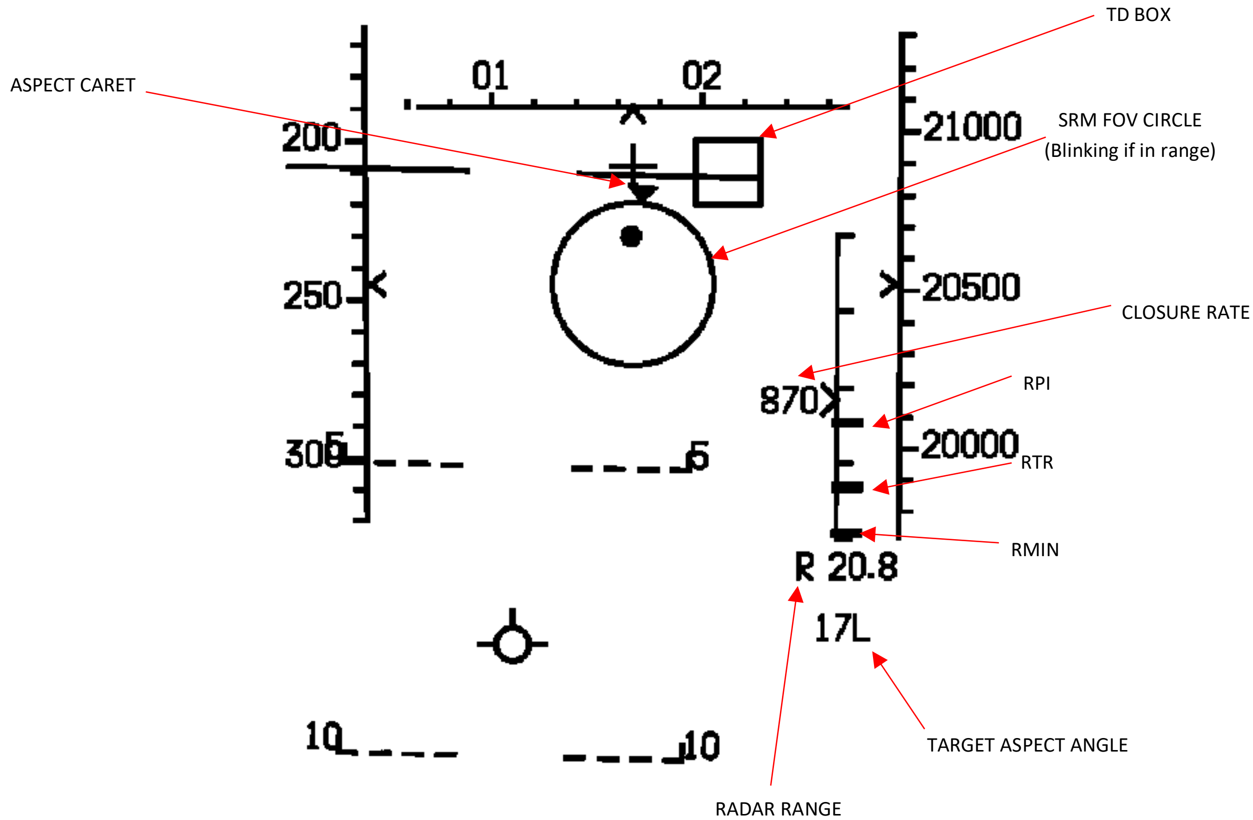
RMAX Rmax represents the maximum launch range necessary to achieve even a marginal probability of success.

RPI RPI represents the maximum launch range achievable with the existing steering setup, ensuring a high probability of success. In this context, it is assumed that the target does not perform any maneuvers; hence, the target's velocity is considered constant with no acceleration. As steering optimization involves aligning the dot precisely within the ASE (Allowable Steering Error) circle, the current steering configuration closely approximates optimal steering. Consequently, Rpi approaches Ropt. When the dot is centered, both Rpi and Ropt are identical.

RTR Rtr signifies the maximum launch range when engaging a target that initiates an evasive turn and run maneuver at launch. This calculation is based on the assumption of the current ownship steering configuration. There is a direct connection between Rtr and Rmin indicated by a vertical line.

RMIN Rmin represents the minimum launch range necessary to achieve even a marginal probability of success. In this calculation, target accelerations are presumed to remain constant for the Time of Flight (TOF) corresponding to Rmin. Additionally, it is assumed that ownship velocity remains constant from the moment of release to separation. A vertical line serves as a connection between Rtr and Rmin.

2.1.8.8 HUD SYMBOLS – A/A – MRM MODE (AIM-120, AIM-7)

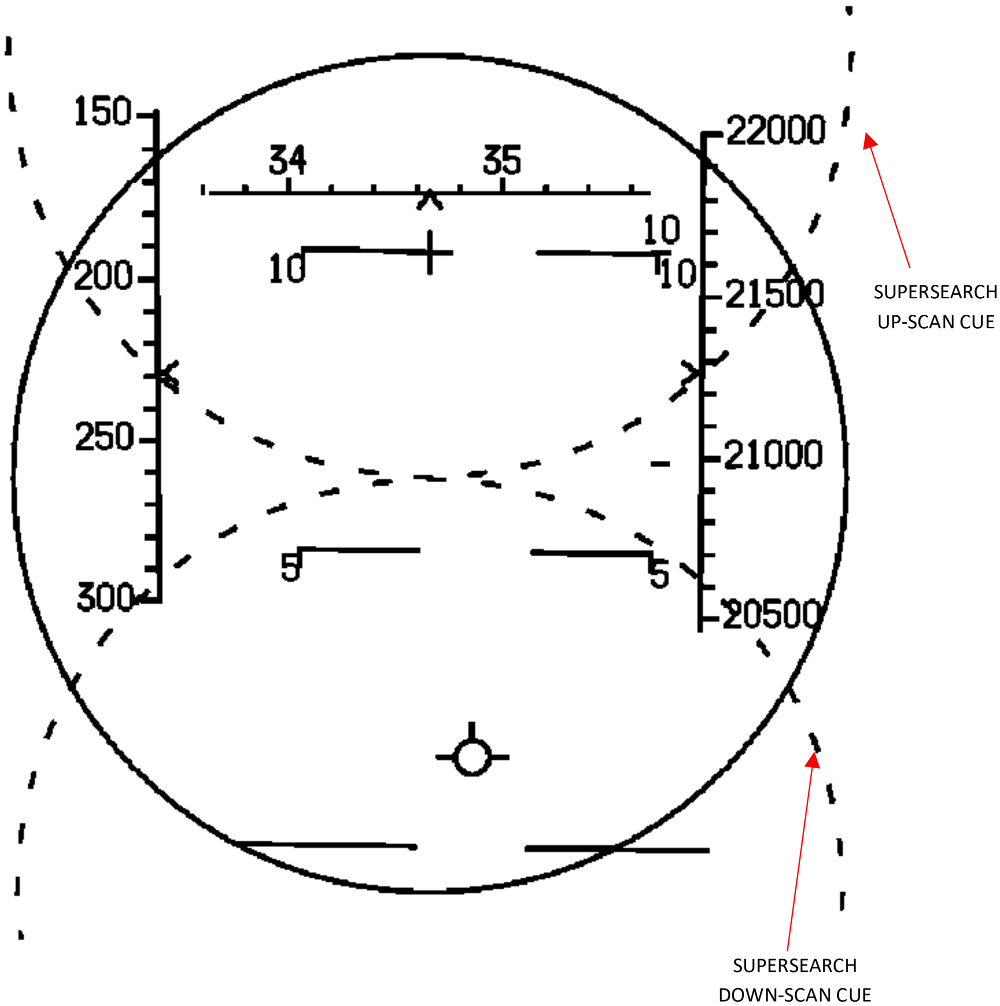


RPI RPI represents the maximum launch range achievable with the existing steering setup, ensuring a high probability of success. In this context, it is assumed that the target does not perform any maneuvers; hence, the target's velocity is considered constant with no acceleration. As steering optimization involves aligning the dot precisely within the ASE (Allowable Steering Error) circle, the current steering configuration closely approximates optimal steering. Consequently, Rpi approaches Ropt. When the dot is centered, both Rpi and Ropt are identical.

RTR Rtr signifies the maximum launch range when engaging a target that initiates an evasive turn and run maneuver at launch. This calculation is based on the assumption of the current ownship steering configuration. There is a direct connection between Rtr and Rmin indicated by a vertical line.

RMIN Rmin represents the minimum launch range necessary to achieve even a marginal probability of success. In this calculation, target accelerations are presumed to remain constant for the Time of Flight (TOF) corresponding to Rmin. Additionally, it is assumed that ownship velocity remains constant from the moment of release to separation. A vertical line serves as a connection between Rtr and Rmin.

2.1.8.9 HUD SYMBOLS – A/A – SUPERSEARCH (SS) MODE (SRM, MRM, GUN)



If Supersearch mode is activated, additional HUD information (Supersearch Down-Scan Cue and Up-Scan Cue) is displayed in each weapon submode (SRM, MRM, GUN).

For more information about the SS mode, please refer to the Supersearch (SS) Mode chapter.

2.1.9 AN/APG-63 RADAR

2.1.9.1 RADAR EQUIPMENT SETS

Doppler (PD) attack radars are primarily designed for air-to-air combat. These radars offer valuable information, such as target range, range rate, antenna angles, and angular rates, which are crucial for computing the necessary parameters for selected weapon attack modes. The radar generates synthetic video data on the Visual Sensor Display (VSD) using digital techniques, presenting targets in symbol form. In air-to-air modes, a B-scan format is employed, showing range (or velocity in the case of the APG-63 radar) versus azimuth scan data. The radar's mode controls are conveniently located on a single panel on the left console, while additional operating controls can be found on the throttles and control stick grip.

These radars consist of multiple Line Replaceable Units (LRUs) and connecting waveguide assemblies. Most of the equipment is housed in the forward left equipment bay. Key distinctions between radar systems lie in their mode capabilities, frequency agility, sensitivity, and Electronic Counter-Countermeasures (ECCM) capabilities. Differences in Line Replaceable Units (LRUs) are outlined below.

The primary antenna receives high-power radio frequency (RF) energy from the transmitter and emits a focused beam for illuminating targets. Radar returns are processed and directed to the receiver for target detection, tracking, and display. In most modes, except for the beacon mode, the radiated beam from the antenna is vertically polarized. However, when the beacon mode is chosen, the antenna roll gimbal rotates 90° to provide the necessary horizontal polarization for beacon operation.

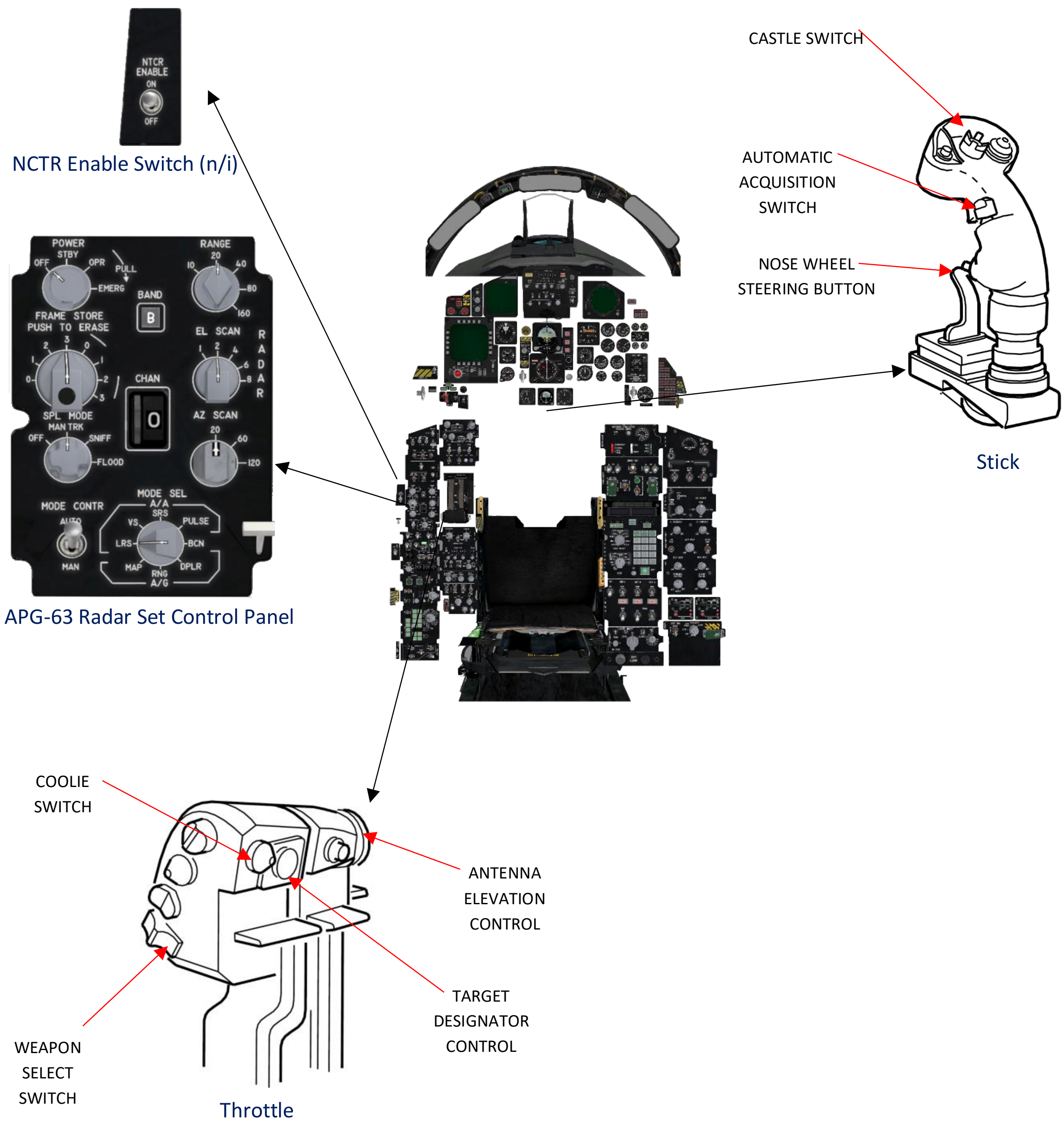
The antenna also includes the null-filling horn and guard horn. The null-filling horn is a small aperture antenna situated on the upper edge of the main antenna, offering broad-angle coverage with vertical polarization. It transmits some RF energy during AIM-7 missile launches to fill in the null region of the main antenna pattern. Both the main antenna and the null horn serve as primary sources of high Pulse Repetition Frequency (PRF) radiation for AIM-7 missile illumination and guidance. An additional source of AIM-7 missile illumination is provided through the flood antenna (refer to Flood Mode). The guard horn, mounted on the lower edge of the main antenna, is designed to receive wide-angle RF side lobe energy. This signal is compared to the main receiver signal to reduce false alarm rates.

2.1.9.2 RADAR BUILT-IN TEST (BIT)

The radar Built-In Test (BIT) system verifies both radar performance and the accuracy of radar parameters entered into the Central Computer (CC). All calculations related to missile launches, including head aiming and English bias adjustments, are executed within the CC. The CC's own BIT routines are responsible for validating its operations and confirming that the CC program, which relies on radar input, is functioning correctly.

Throughout power-up, Operational Readiness Test (ORT), and Initialization BIT (I-BIT) procedures, messages are displayed in the BIT window to provide information about the radar's activities at specific times.

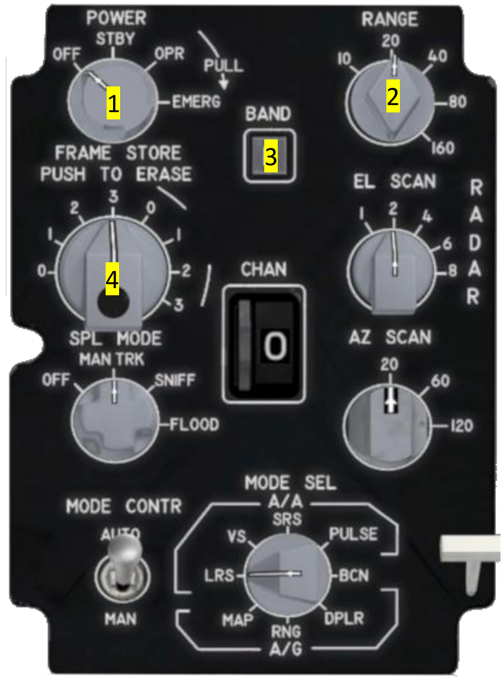
2.1.9.3 RADAR CONTROLS



Radar Controls

2.1.9.3.1 RADAR SET CONTROL (RSC) PANEL

The RSC controls several functions of the APG-63 Radar.



1- **Power Knob**

OFF Radar completely off.

STBY All radar functions are functioning properly, with the exception of the transmitter high voltage and RF transmission circuits. When the "STBY" mode is selected from OFF position, the Built-In Test (BIT) window will sequentially display "PSP LD," followed by "081TST," "042TST" as well as other BIT displays. The BIT is finished after approximately 120 seconds. The knob can be switched to the "OPR" mode.

OPR The radar operates at full capacity unless the aircraft is on the ground and the W-ON-W interlock is engaged. If the OPR mode is selected from the OFF position, the BIT test like described under STBY will executed first before the radar is functional.

EMERG Initiates complete radar operation, bypassing all radar protective interlocks, except for the W-ON-W interlock and the transmitter coolant flow interlock.

2- **Range Knob**

The range knob offers a manual option for choosing the display range scale, with available ranges of 10, 20, 40, 80, or 160 nautical miles (NM).

3- **Frequency Band Selector**

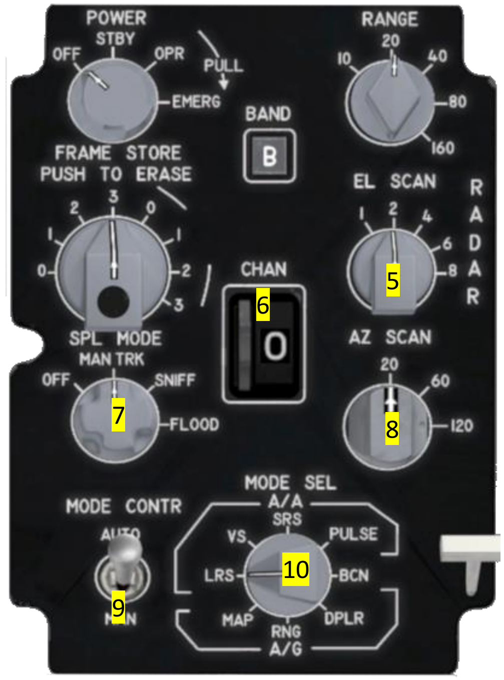
This switch is non-functional yet.

4- **Frames Store knob**

The frame store knob allows for manual adjustment of the duration for which target data is shown on the VSD (Video Situational Display). In this context, one frame corresponds to the time it takes to complete the current bar scan selection. For instance, if a four-bar elevation (EL) scan is chosen, one frame represents the entire cycle of the four-bar scan. The utilization of multiple frame data aging is particularly useful when operating in the Long Range Surveillance (LRS) radar modes. Notably, this feature is also available in the Short Range Surveillance (SRS) mode.

0 Target data is displayed only on the current bar.

1 thru 3 This function allows you to choose the duration for which historical target data is displayed. In this display, the target return within the current bar is shown at its maximum brightness. Furthermore, any stored target data from previous bars or frames is displayed with reduced intensity, indicating the range and azimuth position of the target a specified number of bars or frames ago. When the frame store is configured for one or more frames, Angle Of Jam (AOJ) strobes are eliminated at the second End Of Bar (EOB) after detection.



5- **Elevation Scan Knob**

The elevation (EL) scan knob allows manual selection of elevation scan patterns with options of one, two, four, six, or eight bars. It's important to note that the EL scan knob is non-operational during TWS (Track While Scan) mode.

6- **Channel Selector**

This switch is non-functional yet.

7- **Special Selector**

This switch is non-functional yet.

8- **Azimuth Scan Knob**

The azimuth (AZ) scan knob enables manual selection of three different azimuth antenna scan patterns: 30°, 60°, or 120°. Notably, the physical 20° position on the AZ scan knob corresponds to a 30° azimuth (sort mode) scan pattern, which is further explained in the Sort Mode section of the manual. When in TWS (Track While Scan) mode, the AZ knob provides the flexibility to choose between two options: the two-bar 60° pattern (selected at 120) or the four-bar 30° pattern (selected at either 60 or 20).

9- **Mode Select Knob**

Only AUTO mode is implemented yet.

10- **Mode Selector**

Only LRS mode is functional. See chapter Radar Search Modes for more information.

2.1.9.3.2 RADAR CONTROLS (THROTTLE)

2.1.9.3.2.1 WEAPON SELECT SWITCH

GUNS	Activates 20mm gun submode
SRM	Activates short range missile submode
MRM	Activates medium range missile submode

2.1.9.3.2.2 ANTENNA ELEVATION CONTROL

The antenna elevation control is responsible for positioning the center of the selected bar scan pattern within a range of ±40° in elevation. However, it's important to note that this control output is not utilized in STT (Signal Target Track), DTWS (two-bar scan patterns), or the auto acquisition modes. When the control is rotated to the rear, it moves the antenna upwards in elevation. This elevation change can be observed by checking the elevation caret and scale on the left border of the VSD, as well as by reviewing the VSD altitude coverage data.

The antenna elevation control operates as a spring-loaded rate control device, allowing rotation through approximately ±30° and automatically returning to the central neutral position upon release. Its logic functions similarly to the Target Designator Control (TDC) logic used to control the acquisition symbol. When you apply a fixed deflection to the control, it commands a constant rate of change in the scan center altitude (at the range of the acquisition symbol). Deflection of approximately 3° or less has no impact, but between 3° and roughly 8° of deflection, the commanded rate gradually shifts from 0 to 3000 Feet Per Second (FPS). Between 8° and 23° of deflection, a consistent rate of 3000 FPS for altitude scan center change is commanded. From 23° to around 27° of deflection, the commanded rate linearly increases to the maximum rate of 15,000 FPS.

As the antenna elevation control employs rate control logic rather than position control logic, it can automatically adjust the scan center elevation based on radar operational conditions. For instance, when exiting STT, the search elevation is initialized to the target's elevation instead of beginning at the last commanded value in the search mode. Moreover, elevation angle is reset to zero upon exiting SS (Single Target Search), BST (Bar Scan Track), LR BST (Long Range Bar Scan Track), vertical scan, or auto guns.

When transitioning from an Air-to-Ground (A/G) mode back to Air-to-Air (A/A) search, the elevation scan center is set to an initial position of 0°.

2.1.9.3.2.3 TARGET DESIGNATOR CONTROL (TDC)

The Target Designator Control (TDC) is powered up when the radar's power knob is turned away from the OFF position. The TDC is designed as an isometric positioning device and includes a depressible action switch. It allows you to adjust the position of the VSD acquisition symbol at a rate directly proportional to the amount of force applied to the TDC. A left/right force influences the symbol's azimuth positioning, while an up/down force affects the symbol's range or range rate in a Visual Search mode.

When the TDC is pressed (in the action position), the radar antenna becomes aligned with the azimuth position of the acquisition symbol. Releasing the TDC issues a command for radar lock-on in any Air-to-Air (A/A) search mode.

2.1.9.3.2.3.1 AUTO RANGE SCALE SWITCHING, RANGE BUMP (TDC)

RADAR SEARCH or TWS (Track-While-Scan)

In the MRM or SRM weapon modes, when the TDC is assigned to the VSD, if the pilot moves the acquisition symbol to the top (99%) or bottom (1%) of the VSD, the display automatically switches to the next higher or lower range scale, respectively. Simultaneously, the acquisition symbol relocates to the center of the display. It's important to note that range adjustments are not accessible when dealing with dashed acquisition symbols on the VSD.

STT (Signal Target Track)

When the target's position extends beyond 95% of the currently displayed range (or 99% in a 10-mile range scale), the radar automatically switches to the next higher range scale. Conversely, if the target's position falls below 45% of the displayed range, the radar selects the next lower range scale.

Upon transitioning to STT from either the search or Track While Scan (TWS) modes, there's a brief 3-second delay before the auto range scale decrease takes effect. During this time, the radar can automatically increase the range scale as necessary to maintain STT. However, if TWS or Return-To-Search (RTS) mode is initiated during the 3-second delay, the scale won't be decreased.

When the acquisition symbol is displayed on the Air-to-Air (A/A) radar during STT with MRM selected, you have the option of manual range bumping, as previously described in the Radar Search or TWS modes. After a range scale change resulting from a bump, the acquisition symbol is repositioned to the new midpoint range.

The standard STT auto range bumping logic is paused once a manual range bump occurs, except when increasing the scale if the radar target range exceeds or equals 100% of the current scale. In such cases, the automatic range scale adjustment based on the radar target range is restored. It's worth noting that the range scale cannot be bumped to a scale smaller than the current radar target range.

The regular automatic range scale selection logic is reactivated under the following circumstances:

a. Exiting MRM during STT (removing the acquisition symbol from the display).

b. Exiting STT mode (for instance, returning to search or TWS) and subsequently re-entering STT.

2.1.9.3.2.3.2 AZIMUTH BUMPING (TDC)

In MRM or SRM weapon modes, when the TDC is assigned to the VSD, you have the capability to perform azimuth bumping. This adjustment is based on the azimuth position of the acquisition symbol on the VSD and the deflection of the TDC. However, it's essential to note that azimuth bumping is not an option when dealing with dashed acquisition symbols on the VSD.

When the acquisition symbol reaches either of the extreme azimuth positions on the VSD and the TDC is deflected toward that direction, the azimuth scan selection changes as follows:

SCAN AT AZ BUMP	**SCAN AFTER AZ BUMP**	
	SEARCH	***TWS***
30°	60°	60°
60°	120°	30°
120°	60°	N/A

When the azimuth scan is modified using the azimuth bumping method, the acquisition symbol's azimuth position resets to the center of the VSD. This feature is accessible during TWS, but it's disabled during manual acquisition.

2.1.9.3.2.4 COOLIE SWITCH

UP — When in Search, Coolie Up designates the target and enters highlight mode.

When in TWS, it steps to the next TWS contact.

DOWN — Slave/Bore for SRM.

2.1.9.3.3 RADAR CONTROLS (STICK GRIP)

2.1.9.3.3.1 AUTO ACQUISITION SWITCH

The auto acquisition switch is a four-position switch (FWD, AFT, OFF and DOWN), designed to return to the neutral (OFF) position when released. Below is a list of the switch functions in relation to the radar's operating status.

FWD	When in Highlight mode (~STT), it enters in TWS. When in Search, it enters in Supersearch mode. When in TWS, it steps azimuth.
AFT	If TDC pressed and hold i.e. designate command is true, then enters NDTWS.
DOWN	Goes back to Search Mode, also called Return To Search (RTS). It drops all locked tracks and enters the search mode selected on the Radar Control Panel.

2.1.9.3.3.2 CASTLE SWITCH

When the F-15E stick grip is in use, pushing the castle switch forward or backward results in a clear acquisition symbol on the MPCD or VSD. This symbol informs you which display is currently being influenced by the Target Designator Control (TDC). Conversely, a dashed acquisition symbol indicates that the control does not have authority over that particular display.

Upon powering up or when the radar transitions into any auto acquisition mode, TDC control automatically switches back to the VSD display.

UP	TDC control to VSD display (Cursor symbol)
AFT ≤ 1sec.	TDC control to SIT display (Cursor symbol)
RIGHT	Last SIT display or toggle self-centered/decentered
LEFT	Expand selection

2.1.9.3.3.3 NOSE WHEEL STEERING BUTTON

When in SRM mode, the NWSB button cages/uncages the AIM-9.

2.1.9.3.4 RADAR CONTROLS (MISCELLANEOUS)

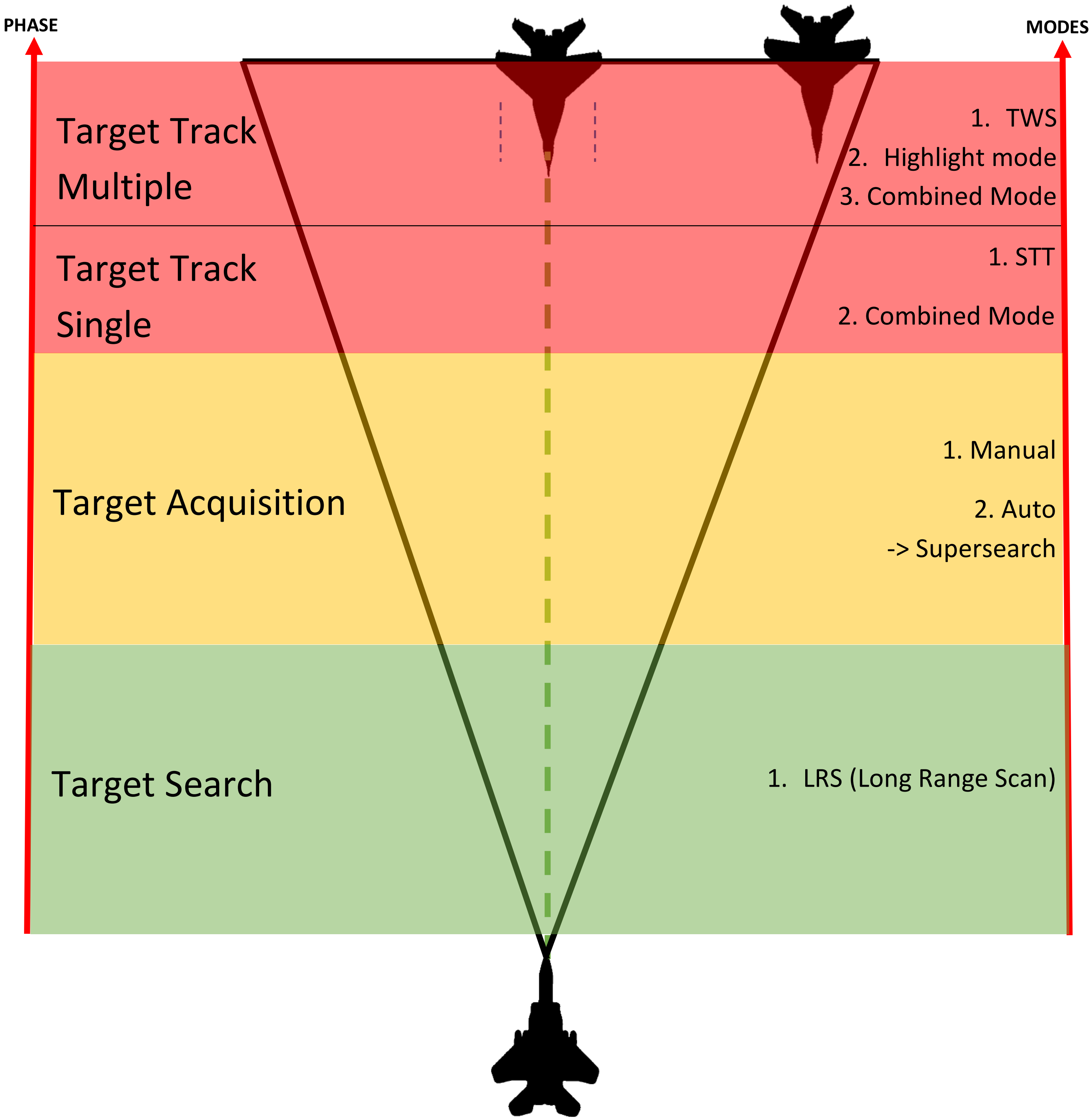
2.1.9.3.4.1 LOCK/SHOOT LIGHTS

Currently not implemented.

2.1.9.4 RADAR MODES

2.1.9.4.1 RADAR MODES – OVERVIEW

The following overview shows the different radar modes currently implemented in BMS and their relation to each other in every phase of an engagement.



RADAR SEARCH MODES A/A	COMPATIBLE WEAPON MODES
LRS (Long Range Scan)	**MRM | SRM | GUN**

RADAR ACQUISITION MODES	COMPATIBLE WEAPON MODE
Manual Acquisition	**MRM | SRM | GUN**
Automatic Acquisition	
➔ Supersearch Mode	**MRM | SRM | GUN**

RADAR TRACKING MODES (Single TGT)	COMPATIBLE WEAPON MODE
STT (Signal Target Track)	**MRM | SRM | GUN**
Combined Mode	**SRM | GUN**

RADAR TRACKING MODES (Multiple TGT)	COMPATIBLE WEAPON MODE
TWS (Track-While-Scan)	**MRM | SRM | GUN**
Combined Mode	**SRM | GUN**
Highlight Search Mode	**MRM | SRM | GUN**

MRM = Medium Range Missile (AIM-120, AIM-7)

SRM = Short Range Missile (AIM-9)

GUN = 20mm Gatling Gun

2.1.9.4.2 RADAR MODE PARAMETERS

Mode Contr AUTO and MANUAL

WEAPON SELECT SWITCH POSITIONED: FROM....TO		RADAR RANGE	AZ SCAN	EL SCAN	TRANSMITTER MODE
SRM	MRM	NO CHANGE	NO CHANGE	A) RSC	INLV H/MPRF
GUN	MRM	40	120°	A) RSC	INLV H/MPRF
MRM	SRM	NO CHANGE (80 MAX)	NO CHANGE	FOUR-BAR (MIN) A) B)	MPRF
GUN	SRM	20	120°	SIX-BAR (2.5° BAR SPACING)	MPRF
SRM or MRM	C) GUN	10	60°	20° (SIX-BAR, 3.4° BAR SPACING)	MPRF AUTO ACQ

INLV Interleaved Pulse Repetition Frequency

LRS Long Range Search

RSC Radar Set Control

SRS Short Range Search (not implemented)

A) If 10 NM or 20 NM range is selected, EL BAR spacing changes from 1° to 2.5°(20 NM) or 3.4°(10 NM).

B) Initializes to RSC if EL selection is greater than four-bar.

C) Search parameters cannot be changed. Scan is positioned in AZ/EL by the TDC. After lockon, bump auto acq available by selecting REJECT.

2.1.9.4.3 RADAR SEARCH MODES

2.1.9.4.3.1 LONG RANGE SEARCH (LRS)

The Long-Range Surveillance (LRS) mode serves as the primary Air-to-Air (A/A) surveillance mode. In LRS, the radar typically operates in an interleaved mode, employing a 50% high pulse repetition frequency (HPRF) and 50% medium pulse repetition frequency (MPRF). This means that the pulse repetition frequency alternates with each bar scan: the first bar uses HPRF, the second uses MPRF, the third uses HPRF, and so on. However, if the 10 nautical mile (NM) range is selected, only MPRF is utilized.

During the search phase, the radar employs an interleaved pulse repetition frequency upon initial entry into the 160 NM range scale. Subsequently, while in the 160 NM scale, the radar adjusts between interleaved and exclusively HPRF in response to alternate range settings.

For the convenience of users, the radar offers a pulse repetition frequency (PRF) selection menu when either interleaved search or interleaved Track While Scan (TWS) is active.

The radar's detection range performance is highly influenced by various factors, including the target's cross-sectional area (a measure of target reflectivity), target Doppler conditions (component of the target ground speed along the radar Line of Sight), ground clutter signal strength (ground reflection coefficient), and specific tactical conditions such as lookdown versus lookup.

The utilization of dual PRF in the LRS mode is designed to maximize the potential for target detection under a wide range of conditions, encompassing both tail and frontal aspects of targets, whether they are positioned above or below the F-15 aircraft.

Other search modes like SRS (Short Range Search) are not implemented yet.

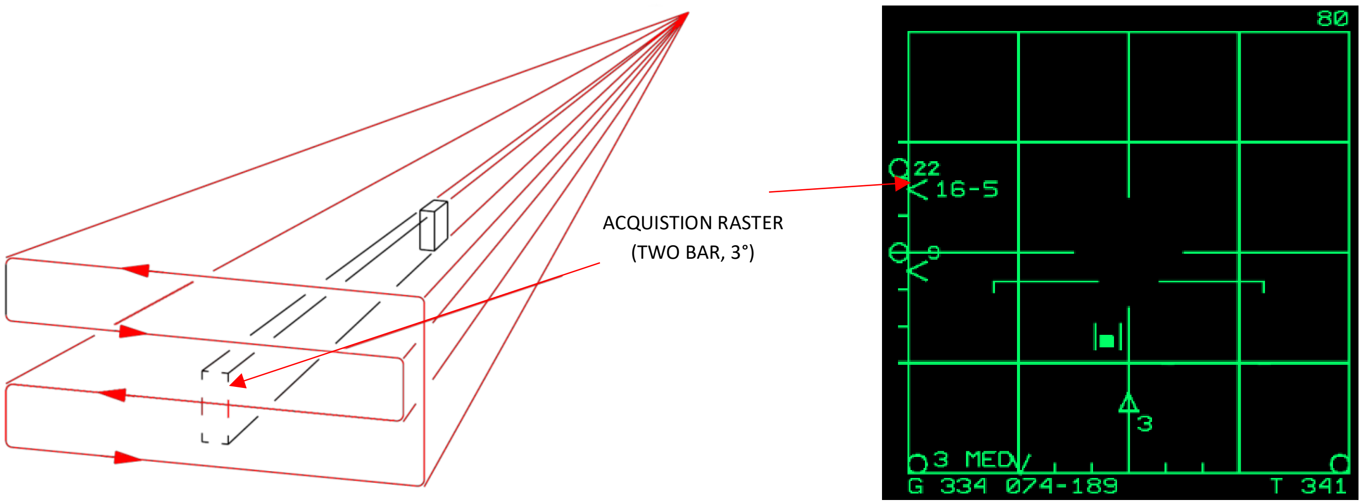
2.1.9.4.4 RADAR ACQUISITION MODES

2.1.9.4.4.1 MANUAL ACQUISITION

Manual target acquisition is carried out using the Target Designator Controller (TDC) while monitoring the acquisition symbol. The pilot aligns the target with the acquisition symbol by applying the appropriate force on the TDC. Pressing the TDC (in the action position) commands the radar to initiate a ±3° azimuth acquisition scan, centered on the acquisition symbol in azimuth, and simultaneously searches within the selected elevation bar pattern.

Releasing the TDC within 1 second commands the radar to lock onto the target. During this time, the radar attempts to correlate any stored target hits within the acquisition symbol for a maximum of 2 seconds. If correlation is successful, the radar automatically selects the Pulse Repetition Frequency (PRF) and bar that were in use at the time of the target detection. It centers a ±3°, two-bar scan at that position for a maximum of 1.5 seconds. Lock-on is achieved upon receiving the second live target hit within the acquisition symbol. If lock-on is not achieved within 1.5 seconds, the scan automatically switches to the number of selected elevation bars and the appropriate PRF interlace.

The typical Low Range Search (LRS) acquisition scan and High/Medium Pulse Repetition Frequency (H/MPRF) interlace is performed frame by frame. If lock-on is still not achieved, the radar remains in the acquisition scan with the lock-on command active. The pilot has the option to adjust the antenna's acquisition scan position using the TDC for azimuth and the elevation (EL) control for elevation positioning to focus on the target. Alternatively, the radar can be returned to the selected search mode by momentarily selecting "Return to Search" (RTS).



2.1.9.4.4.2 AUTOMATIC ACQUISITION

For now, there is one auto acquisition mode available: Supersearch (SS). All auto acquisition modes utilize MPRF.

In all auto acquisition modes, the search range display typically covers a range of 10 nautical miles (NM).

2.1.9.4.4.2.1 SUPERSEARCH (SS) MODE

The Head-Up Display (HUD) operates with a field of view (FOV) of 20° by 20° and utilizes a six-bar scan pattern until a track is established or the Return-To-Search (RTS) option is chosen. The bars are spaced apart by 3.4°. Automatic lock-on occurs, and the radar tracks the first target detected within this scan pattern, provided it falls within a range of 500 feet to 10 nautical miles (NM).

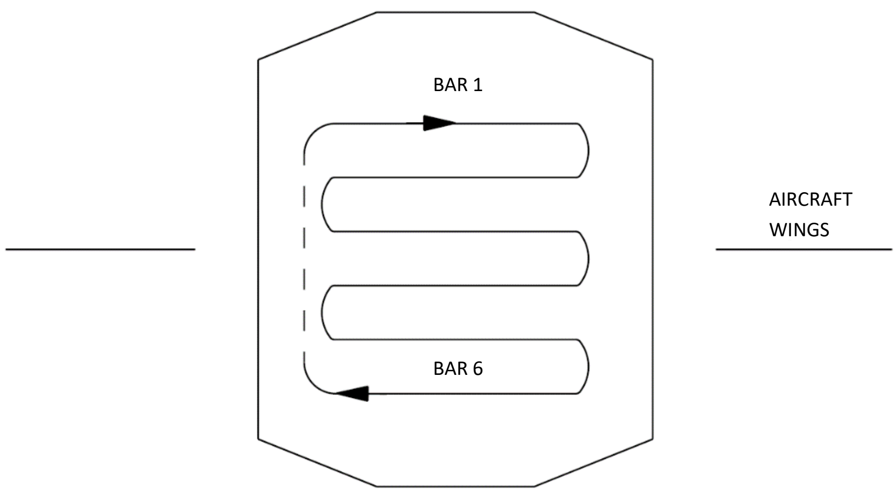
Upon initially selecting the Supersearch (SS) mode, the HUD display presents a 20° reference circle. When angle tracking commences, the display for the selected weapon appears, and the target designator indicates the spatial location of the tracked target. For further auto-acquisition considerations, consult the Radar Employment guidelines.

During the first 40 seconds after takeoff, the bar scan pattern remains parallel to the aircraft's wings, with the scan pattern starting at the top of the HUD FOV. Special detection threshold logic is employed to prevent false lock-ons to the ground. In all other situations and for roll angles less than 45°, the bar scan pattern still remains parallel to the wings, but it initiates from the bottom of the HUD FOV. When roll angles exceed 45°, the bar scan pattern becomes perpendicular to the aircraft's wings, starting from the left side of the HUD FOV. These variations in the scan pattern enhance the capability to establish a lock-on, especially during F-15 or target maneuvering scenarios.

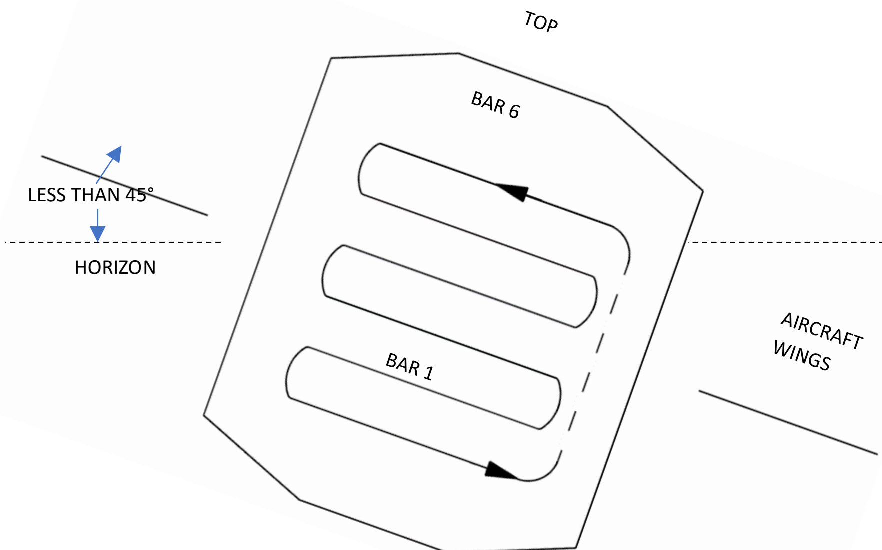
The SS mode can only be entered from Search modes (LRS) with AUTO ACQUISITION SWITCH FORWARD. It will not work from TWS, STT, etc. TWS is considered a special mode as boresight, flood, sniff etc. for the APG-63 family.

When entering the SS, the radar range changes to 10nm and to 20x20°. The HUD will not change

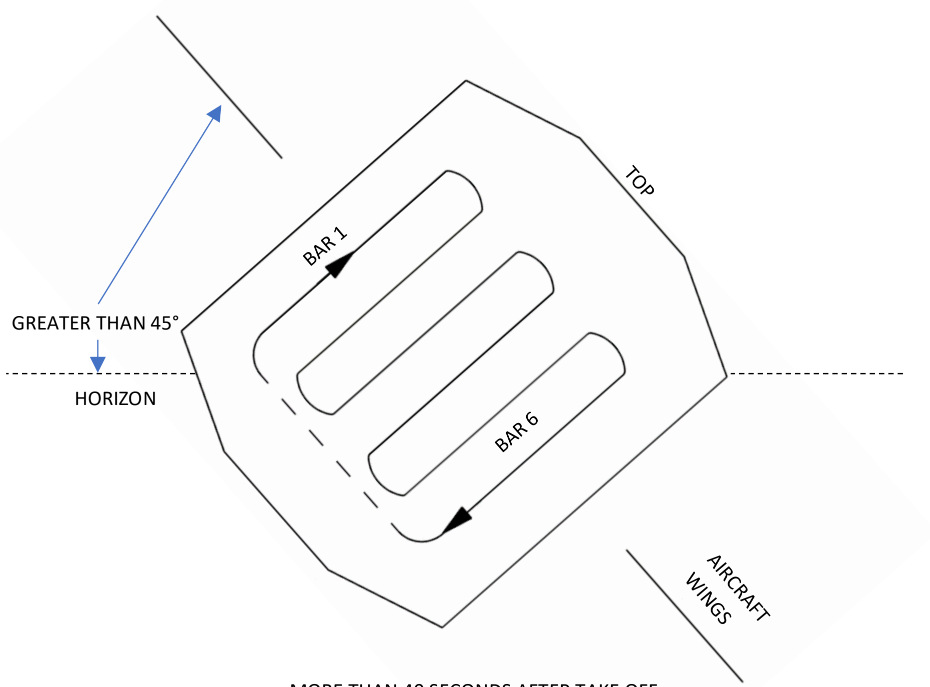
2.1.9.4.4.2.1.1 SUPERSEARCH SCAN PATTERN



FIRST 40 SECONDS AFTER TAKE OFF.
ALL ROLL ANGLES.



MORE THAN 40 SECONDS AFTER TAKE OFF.
ROLL ANGLES LESS THEN 45°



MORE THAN 40 SECONDS AFTER TAKE OFF.
ROLL ANGLES GREATER THEN 45°

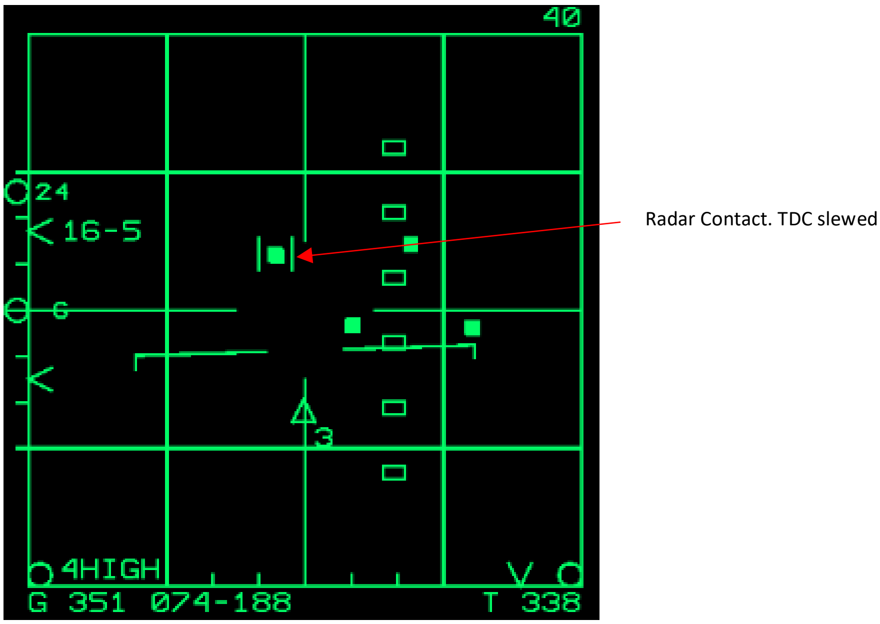
2.1.9.4.5 RADAR TRACKING MODES

2.1.9.4.5.1 SIGNAL TARGET TRACK (STT) MODE

STT is the default track mode when entering A/A master mode. If a target is locked in STT mode, only this target can be tracked and engaged. All other visible targets one the radar will be ignored.

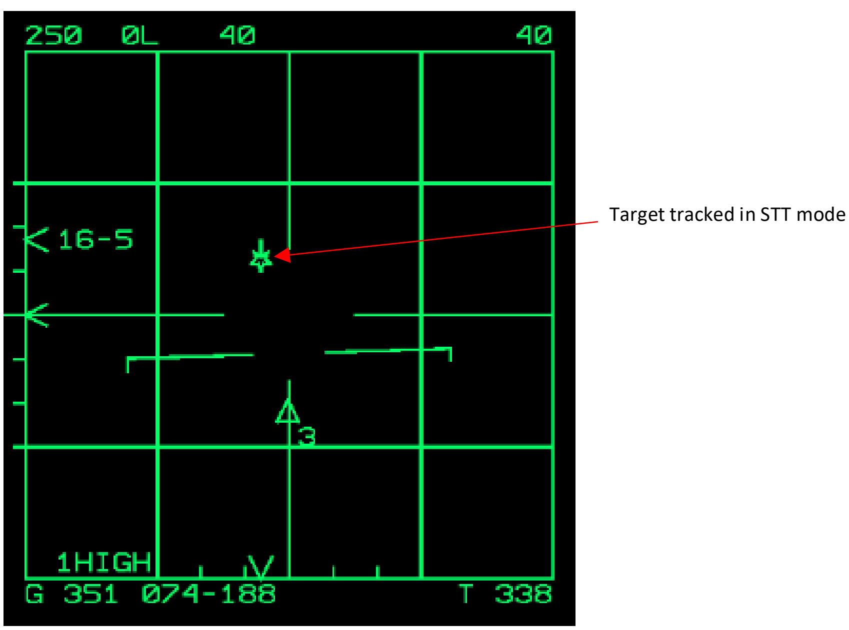
2.1.9.4.5.1.1 STT PROCEDURES

1. Radar identifies multiple contacts. Slew TDC over contact.

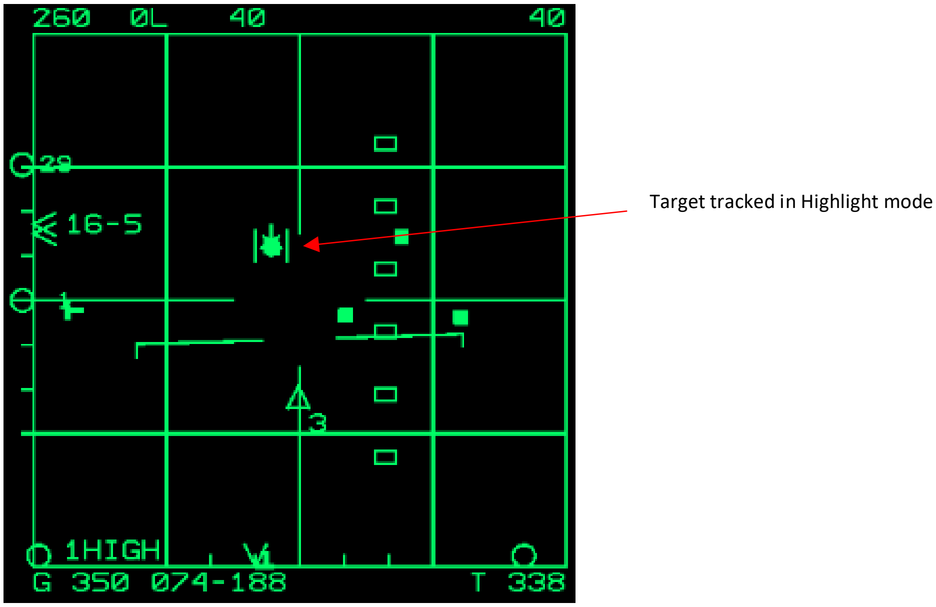


2. Press Target Designator Control Press twice (2x). Target is tracked in STT mode.

Note that all other radar contacts are faded.



3. If a multitrack mode (Highlight/TWS mode) is desired depending on the situation, press “Auto Acquisition Down” which activates the highlight mode without losing track to the target selected in STT.



2.1.9.4.5.2 TRACK-WHILE-SCAN (TWS) MODE

The Track While Scan (TWS) mode offers the ability to detect and track multiple targets within a designated area, providing several benefits for enhancing situational awareness (SA):

a. Swift altitude sampling between targets.

b. Visualization of target formations with heading vectors.

c. Increased confidence in final target sorting.

d. Extensive volume search while preserving targets with heading vectors.

e. Access to TWS track information with a reduced impact on the effectiveness of the Radar Warning Receiver (RWR) equipment.

f. Expedited target updates through High Data Rate TWS (HDTWS).

The capabilities of TWS mode encompass:

a. A target-level turn maneuvering capacity of up to 6 G, enabling effective tracking of targets near the radar's beam without generating false track files.

b. Improved resistance against false track files through enhanced correlation logic and the prevention of data mis-correlation between track files. The logic for building track files is more rigorous, reducing the likelihood of displaying persistent false track files.

c. Enhanced immunity to false target effects caused by Electronic Countermeasures (ECM), along with improved detection of ECM signals and more informative ECM displays for the pilot.

d. Capabilities for tracking course velocities and greater resistance to the impact of Jamming Emitter (JEM) lines.

e. Expanded utilization of Medium Pulse Repetition Frequency (MPRF) in TWS mode to enhance range accuracy for AIM-120 missile cueing and bolster immunity against ECM interference.

2.1.9.4.5.2.1 TWS SCAN PATTERN

TWS mode is capable of tracking up to 10 targets and relaying their track data to the CC and the VSD. It can simultaneously continue detecting and displaying additional targets. When the track files reach their capacity, an additional 18 observation files, represented by symbols at half intensity, can be displayed for one frame. A track file comprises those targets within the radar's scan volume that it can maintain in terms of range (pertaining to skin track), angles, and rates.

To access TWS mode, it can be entered from any air-to-air search mode, or from Single Target Track (STT) mode. TWS modes can only be entered when the weapon select switch is set to Medium Range Missile (MRM) or Short Range Missile (SRM). It's important to note that TWS mode entry is blocked if the GUN mode is selected.

The following TWS scan patterns are available:

a. Medium pattern: four-bar/30° scan -> For general surveillance of widely spaced targets.

b. Wide pattern: two-bar/60° scan -> For co-altitude targets with wide separation in azimuth.

c. Narrow pattern: sixbar/15° scan -> For vertically stacked targets.

d. High data rate scan: two-bar/30° -> For co-altitude maneuvering targets.

2.1.9.4.5.2.2 DTWS ENTRY/EXIT

DTWS can be accessed through various entry points:

1. DTWS is entered from Single Target Track (STT) mode by briefly selecting the auto acquisition (auto acq) switch aft. The radar transitions to DTWS mode with a track file initiated using the target data from STT.

2. It's possible to enter NDTWS from Non-Designated TWS (NDTWS) mode by designating any of the displayed targets using the Target Designator Control (TDC). The designated target becomes the Primary Designated Target (PDT).

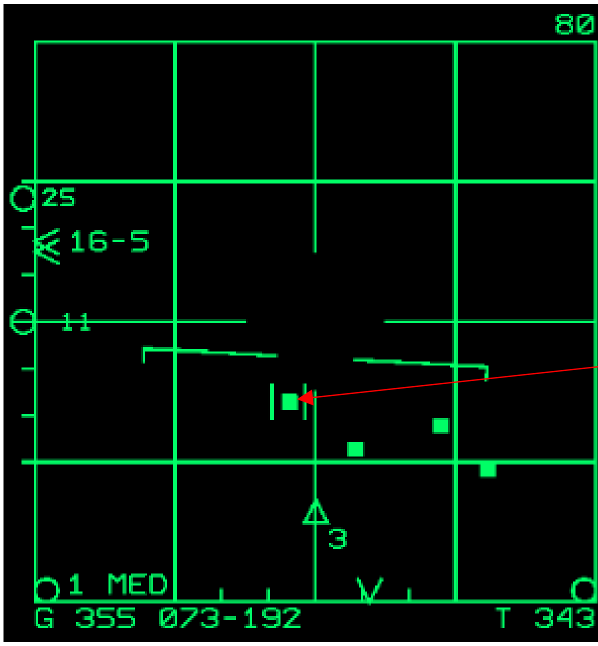
3. In the case of the APG-63 radar system, you can initiate Four-bar 30° DTWS mode from Three-bar High Data Rate DTWS by pressing the auto acq switch forward for less than 1 second. Subsequent brief presses of the auto acq switch cycle between Three-bar HDTWS and Four-bar DTWS.

4. To access Two-bar 60-degree DTWS mode, you can move from Two-bar or Three-bar DTWS by adjusting the azimuth through bumping.

5. If you are using the APG-63 radar system, DTWS may also be entered from NDTWS by momentarily activating the Quick Step feature. The radar's ranked target in DTWS is designated as the PDT in DTWS.

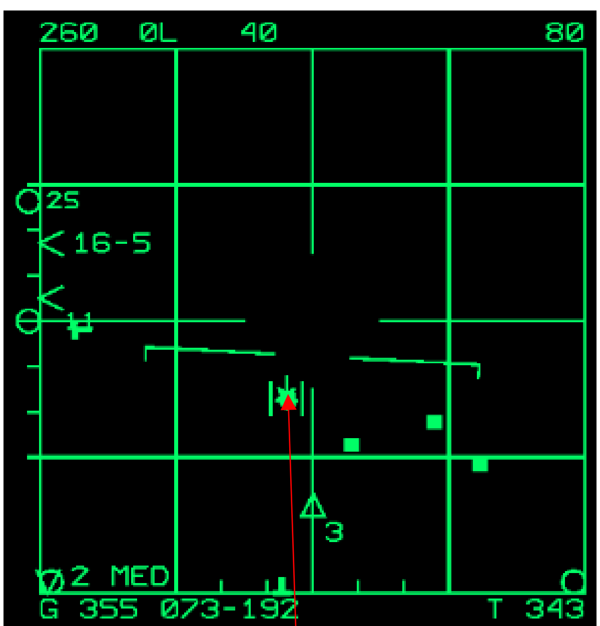
2.1.9.4.5.2.3 TWS PROCEDURES

1. Radar identifies multiple contacts. Slew TDC over contact.



Radar Contact. TDC slewed

2. Lock target with Castle up or “Target Designator Control Press” once. Highlight mode is active.

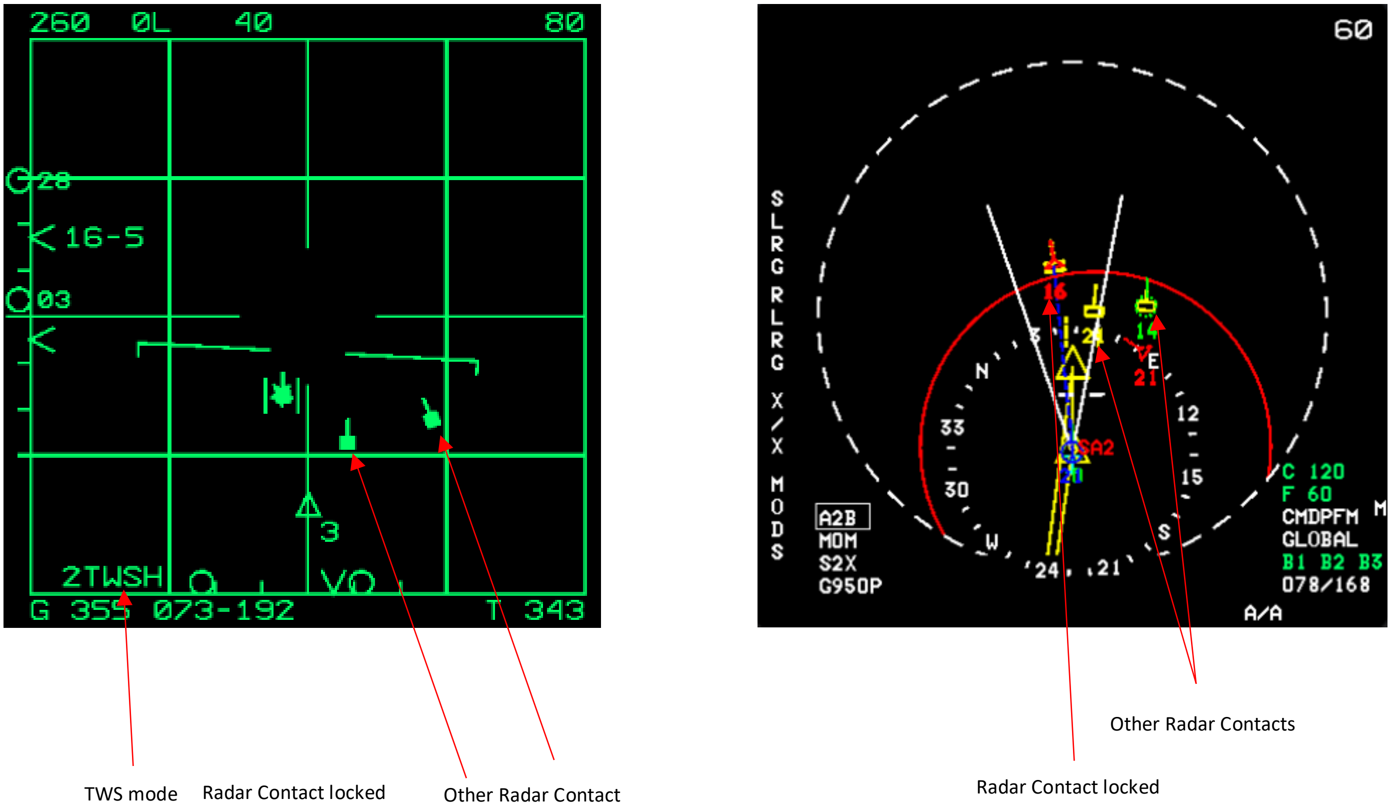


Radar Contact locked

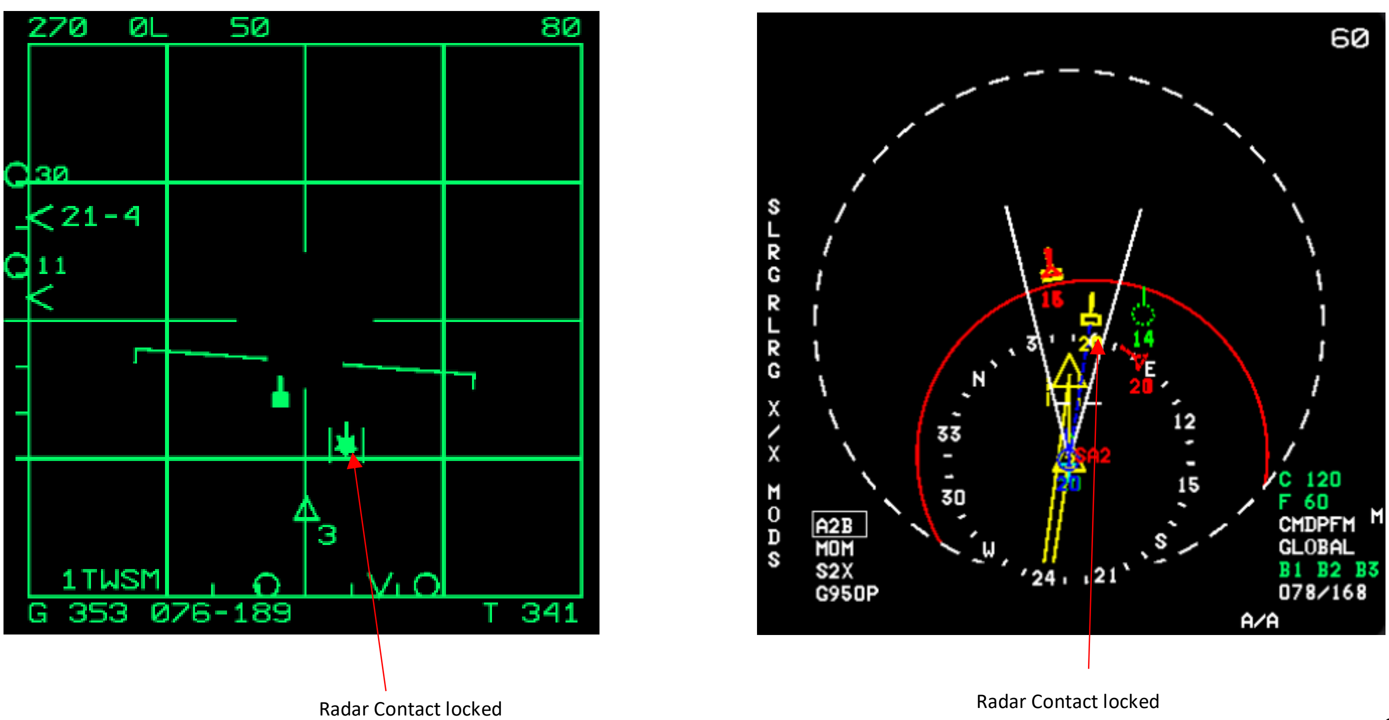
Radar Contact locked

3. Switch to TWS mode via “Auto Acquisition Switch Up”.

First target is tracked and can be engaged when in range while the second target is scanned.



4. With COOLIE UP switch you can select the next target. Note that the friendly contact is faded for the TWS cue.



2.1.9.4.5.3 HIGHLIGHT SEARCH MODE

The highlight search mode allows the pilot to monitor a specific target while still ensuring full radar coverage of the search volume. Additionally, if the chosen target was not previously displayed with upgraded hot/cold symbology, selecting the highlight option prompts the system to carry out the additional processing needed to generate the enhanced hot/cold symbology for that target. While a target is highlighted, the radar scans the selected search volume as usual, with periodic interruptions for mini-raster scans centered on the highlighted target as required. After completing the mini-raster scan, the radar returns to scanning the selected search scan volume.

2.1.9.4.5.3.1.1 HIGHLIGHT SEARCH MODE ENTRY

When the MRM is active and the radar is in LRS, the pilot can engage the highlight search mode by positioning the acquisition symbol over a target, whether it's displayed with normal search symbology. Activating the highlight mode is done by pulling up on the coolie switch. The acquisition symbol then follows the highlighted target until it's manually moved elsewhere. If the radar is already in highlight mode, pulling up on the coolie switch will initiate highlight mode entry at the position of the acquisition symbol.

2.1.9.4.5.4 COMBINED MODE

The integrated mode merges the GUN and SRM modes, prioritizing gun symbology on the HUD while incorporating limited SRM symbology. For alterations affecting both the gun and combined modes, please consult the HUD Gun Mode Symbols. The customary AIM-9 audio tones remain in effect. In the combined mode, the VSD functions as if in SRM mode.

2.1.9.4.5.4.1.1 COMBINED MODE ENTRY

To access the combined mode, simply pull up on the coolie switch for over 1 second while in SRM mode, provided you have bullets available. It's important to note that there's no requirement for SRMs to be available in order to enter the combined mode. You can enter this mode while the radar is operating in the following modes:

- Search
- STT
- SS

The combined mode is entered if all the following conditions are satisfied:

a. The radar is in a mode status other than TWS.

b. The coolie switch up is pulled up for longer than 1 second.

c. The A/A master mode is selected.

d. Weapon select switch is in SRM.

e. Bullets are available.

2.1.9.5 RADAR EMPLOYMENT

During air-to-air engagements, the pilot undergoes three crucial radar operational phases: target detection, acquisition, and tracking. The subsequent process of selecting and launching a weapon depends on the outcomes of the tracking phase.

2.1.9.5.1 TARGET DETECTION PHASE

The High Pulse Repetition Frequency (HPRF) waveform is effective for long-range detection but primarily against targets with a frontal aspect, whether they are positioned above or below the radar. In contrast, the Medium Pulse Repetition Frequency (MPRF) is optimized for detecting targets with either a nose or tail aspect, regardless of whether they are above or below the radar. When the radar is set to a range of 40 or 80 nautical miles (NM), MPRF bars are fine-tuned to be more sensitive in detecting tail aspect targets. However, when you select a range of 10 or 20 NM, MPRF's sensitivity is somewhat compromised, making it equally capable of detecting targets with either a frontal or tail aspect.

Nevertheless, it's important to note that the detection range performance of MPRF, for both frontal and tail aspect targets, is notably less than that of HPRF when it comes to detecting nose aspect targets. Therefore, if a reported target is determined to have a frontal aspect, the pilot can opt for the "HI" mode to benefit from the faster detection rate provided by having HPRF active during all bar scans. These considerations are crucial in situations where changing conditions affect the aspect angle of the target.

2.1.9.5.1.1 RANGE SELECTION

The pilot should choose the shortest possible range based on their knowledge of the actual target distance. This choice provides the finest display range resolution and improves the ability to interpret and respond to displayed information, particularly after establishing a track.

In an interleave mode involving both High Pulse Repetition Frequency (HPRF) and Medium Pulse Repetition Frequency (MPRF), if the pilot selects a 10 NM range, the radar operates exclusively in MPRF. When a range of 160 NM is chosen, and the "HI" mode is selected, the radar deploys HPRF throughout.

When operating within a 10 or 20 NM range, the scan rate increases from 70° to 90° per second. The goal is to minimize the time between radar contacts, especially in close engagements. The slower scan rate is maintained for all HPRF operations to enhance sensitivity, as this mode is primarily intended for small target scenarios.

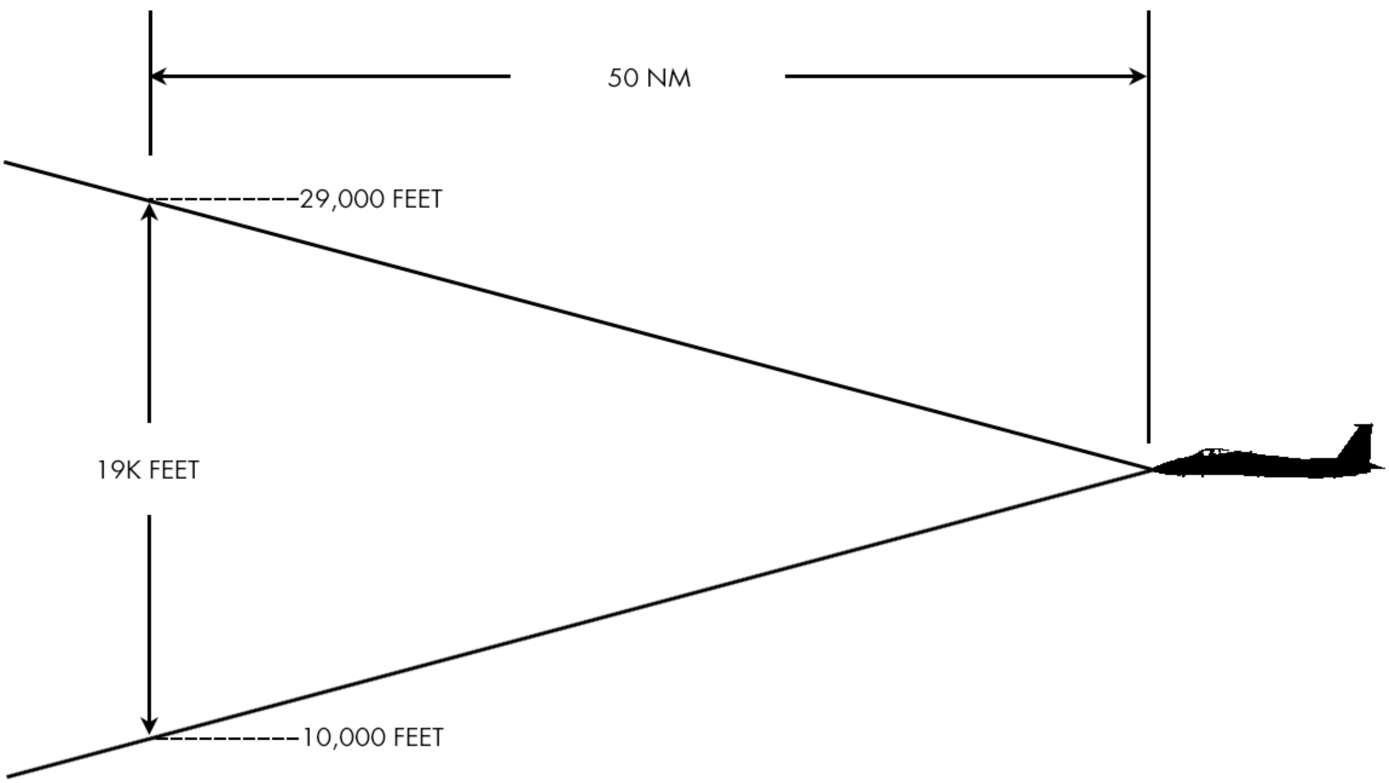
In situations where 10 or 20 NM range scales are chosen, with 3.4° and 2.5° bar spacing and a 90°/second scan rate, MPRF's capability to detect small radar cross-section (RCS) targets may be diminished, especially if the target's altitude places it between two adjacent bars. If small RCS targets pose a threat, it is advisable to maintain a 40 NM range scale to improve MPRF detection. A 70°/second scan rate and 1.0° bar spacing can enhance target detection in such cases. HPRF Real-World Scan (RWS) is minimally effective unless the targets have a very small RCS.

2.1.9.5.1.2 ALTITUDE COVERAGE

EL BAR SCAN *	ANGULAR COVERAGE	APG-63 RADAR BEAM ELEVATION COVERAGE IN FEET						
		10 NM	20 NM	30 NM	40 NM	50 NM	60 NM	80 NM
TWO-BAR SEARCH	3.5°	3700	7400	11100	14800	18500	22300	29700
	5.9°/5.0°	6300	10600					
TWO-BAR TWS	4°	4250	8500	12700	17000	21200	25400	33900
FOUR-BAR SEARCH	5.5°	5800	11700	17500	23300	29200	35000	46800
	12.7°/10.0°	13400	21200					
FOUR-BAR TWS	7°	7400	14800	22200	29600	37000	44400	59200
SIX-BAR SEARCH	7.5°	7900	15900	23800	31700	39700	47700	63600
	19.5°/15.0°	20600	31800					
SIX-BAR TWS	10°	10600	21200	31700	42200	52800	63300	84400

* 3.4 AND 2.5° EL BAR SPACING IS USED IN ALL A/A SEARCH MODES, 10 NM AND 20 NM RANGES RESPECTIVELY.

Example



AT 50 NM, RADAR BEAM COVERAGE OF 2 BAR SCAN IS APPROXIMATELY 19,000 FEET.

2.1.9.5.1.3 ELEVATION SELECTION

Upon receiving a reported target, initiate a search within the target's altitude region by referring to the VSD altitude coverage data. This data provides information about the maximum and minimum beam elevation coverage above Mean Sea Level (MSL) for the currently selected bar/elevation scan and the range indicated by the acquisition symbol on the display.

If necessary, adjust the antenna's elevation control until the VSD altitude coverage encompasses the reported target's altitude. Additionally, consider lowering the bar scan setting, as this enhances the radar's detection capability within the scanned area.

During patrol missions, it's advisable to allocate specific altitude coverage areas among flight members. For instance, the lead aircraft might focus on scanning an altitude range between 25,000 and 50,000 feet, while the wing element scans from 0 to 25,000 feet.

Normally, bar spacing is set at 1° on the 40 NM, 80 NM, and 160 NM range scales. However, for 10 NM and 20 NM range scale selections in all air-to-air search modes except Vertical Scan (VS), and Vector (VCTR), the spacing is typically adjusted to 3.4° and 2.5°, respectively.

2.1.9.5.1.4 AZIMUTH SCAN SELECTION

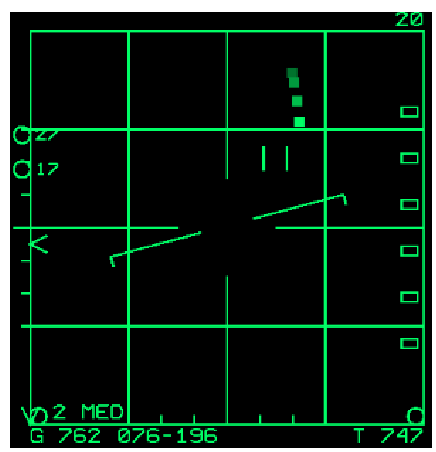
The choice of azimuth scan should be based on the pilot's prior knowledge of the target's position, aiming for the smallest scan range possible. This decision reduces the time it takes for the antenna to complete a full frame rotation and enhances detection capability. In situations where there is no reported target, the default setting is a 120° scan.

If a more focused 30° scan, referred to as "sort mode," is needed, the pilot must manually select it through the TDC (Target Designator Control).

The pilot has the flexibility to "AZ bump" out of the 30° scan (expanding it to 60°) and then alternately switch between 120° and 60° scans. However, it's important to note that you cannot "AZ bump" into a 30° scan. Additionally, temporarily selecting "REJECT" during a sort search will also activate the 60° scan.

During a sort search, the azimuth scan selection is automatically reset to a 60° setting when entering this mode via a rejection from Track While Scan (TWS).

2.1.9.5.1.5 FRAME STORE SELECTION



The choice of target data aging typically depends on the prevailing flight conditions. In situations where the pilot's focus is on instrumentation displays, opting for a lower aging setting helps prevent confusion between older target data and any newly detected targets. On the other hand, in scenarios where the pilot predominantly relies on head-up displays and may not frequently check the Vertical Situation Display (VSD), a higher aging setting may be more advantageous.

When dealing with targets at longer ranges, the increased time gap between detections signifies a higher relative target closing velocity when compared to targets at shorter ranges.

To address these considerations, a Heading Stabilized Display (HSD) and three-frame storage, which includes the option for Ground Moving Target Indication (GMTI), are employed. HSD adjusts the stored targets on the VSD by shifting them in azimuth to compensate for changes in the F-15's heading. This adjustment provides a clear indication of a target's relative position during F-15 maneuvers. The acquisition symbol undergoes a similar stabilization process both during manual acquisition and when employing the sort mode (30° scan).

2.1.9.5.2 TARGET ACQUISITION PHASE

2.1.9.5.2.1 MANUAL ACQUISITION

Manual target acquisition follows a consistent procedure across all modes. During the search phase, all detected and displayed targets are recorded in terms of their target range, azimuth, and the elevation bar on which the detection occurred. This stored data is subsequently used in the following steps:

a. Use the TDC to encompass the target with the acquisition symbol.

b. Press the TDC, directing the radar to execute a ±3° scanning pattern (referred to as a "miniraster") centered on the acquisition symbol, all within the selected bar scan.

c. Release the TDC to initiate lock-on. At this point, the system actively seeks a correlation between the acquisition symbol and the target data stored in memory. Once a correlation is established, the radar antenna swiftly performs a two-bar, ±3° scan on the precise bar/Pulse Repetition Frequency (PRF) where the target was initially detected. Upon receiving a second live hit, tracking of the target is officially established.

If lock-on is not achieved within 1.5 seconds, the radar scan continues in the miniraster pattern within the selected bar scan (never fewer than two bars) until the Return-To-Search (RTS) function is activated.

2.1.9.5.2.2 AUTO ACQUISITION (SUPERSEARCH)

When the standard Supersearch (SS) mode is engaged, the radar automatically scans within the Head-Up Display (HUD) Field of View (FOV) in a range of ±10° in azimuth and 20° in elevation. The pilot's responsibility is to keep the target within the 20° circle displayed on the HUD when this mode is selected. Successful lock-on in SS mode is most dependable when the target maintains a relatively stable position within the HUD FOV.

However, situations involving significant angular rates, a near head-on (beam) aspect condition, or both fighter and target maneuvers can potentially hinder or delay the lock-on process in SS mode. In cases where multiple targets are visible, it may be challenging to determine which target will be acquired first. Once acquisition takes place, the HUD Target Designator (TD) box highlights the target that is currently being tracked.

Depending on the attack geometry, elevated or depressed SS scans can be employed, offering a vertical scan capability while maintaining the broader area coverage of the SS mode.

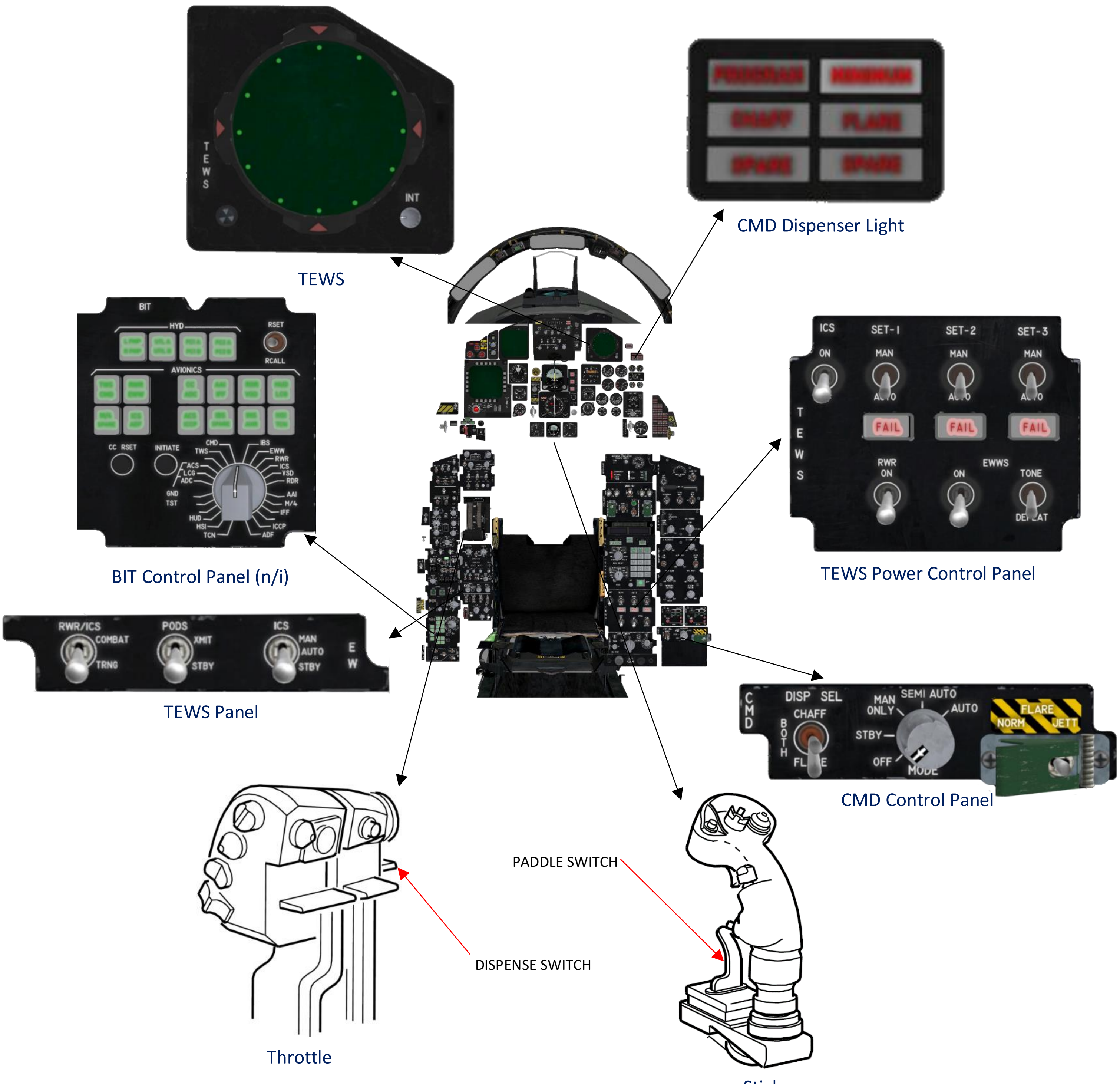
2.1.9.5.2.3 TARGET RETENTION

Following the establishment of a track, search targets can be maintained on the track display at half intensity for the initial 3 seconds, a feature referred to as "target retention." This capability enables search and acquisition targets or Track While Scan (TWS) track records to linger on the track display momentarily after achieving lock-on. It offers the pilot a brief window to confirm whether the intended search or track targets are indeed the same. During this phase, the tracked target symbol aligns with the retained search, acquisition, or TWS track record that's part of the transition. Additionally, when transitioning from a track to another mode, the tracked target symbol remains visible on the display for 3 seconds.

2.1.10 AN/ALE-45 ELECTRONIC COUNTERMEASURES DISPENSER (CMD) SET

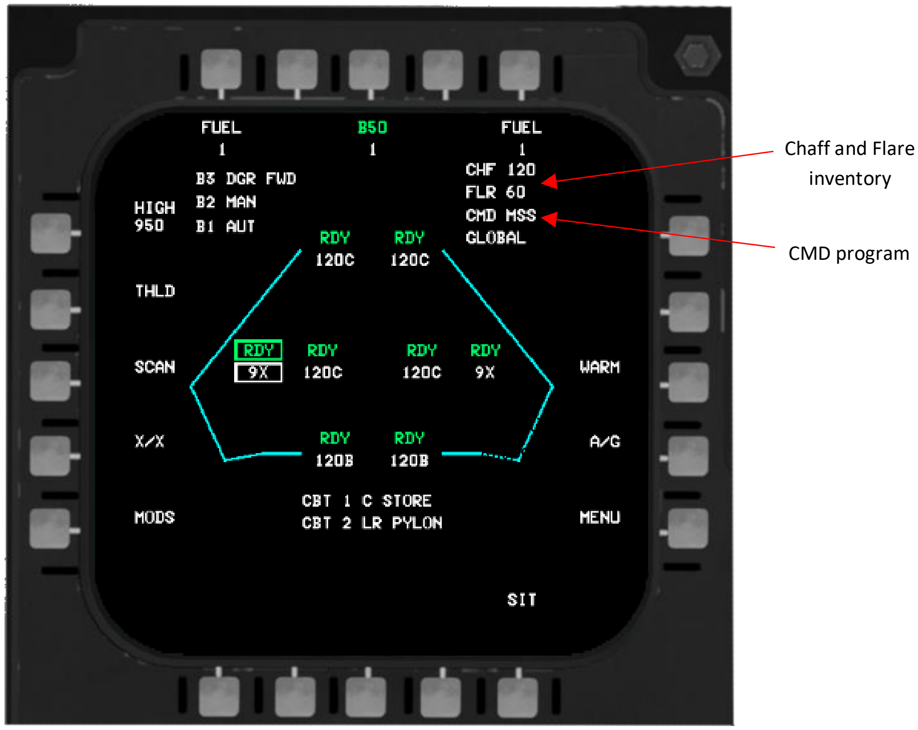
The CMD, or Countermeasures Dispenser, comprises several key components, including the electronic command signal programmer (programmer), the Dispense Control Panel (DCP), and four Dispensing Switch Assemblies (DSAs). The CMD interfaces with various other elements, such as the throttle dispense switch, control stick paddle switch, TEWS telelight panel, BCP, Avionic Status Panel (ASP), and AN/ALR-56C Radar Warning Receiver (RWR) Set. The primary role of the CMD is to effectively dispense and oversee the on-board chaff and flare expendables.

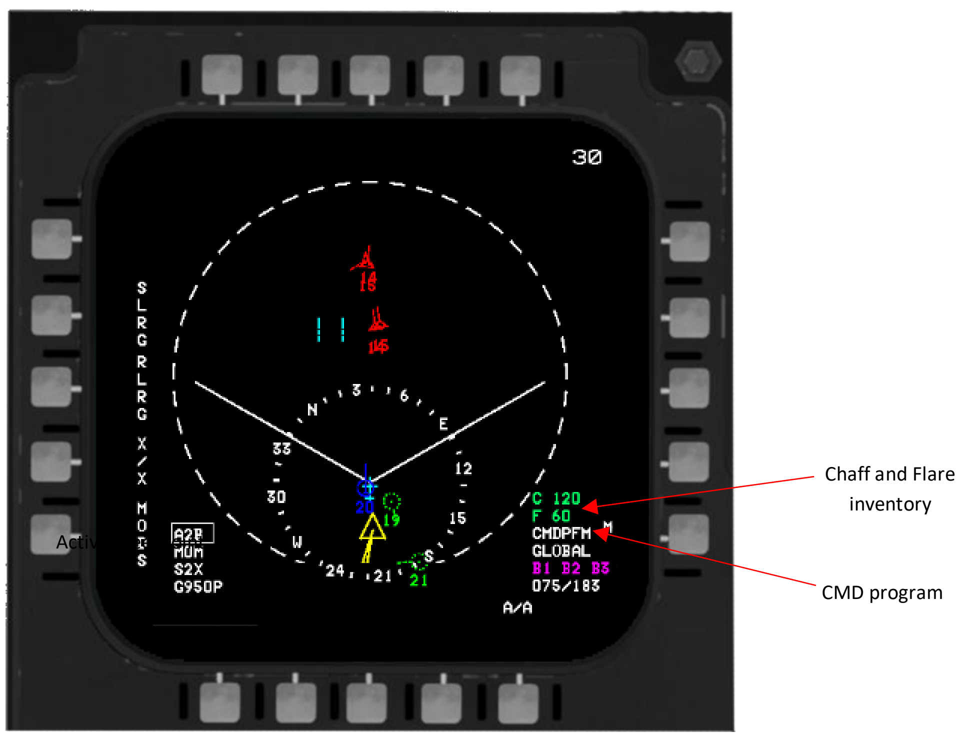
2.1.10.1 CMD CONTROLS, INDICATORS, AND DISPLAYS



CMD Controls & Displays

CMD Controls, Indicators, And Displays (Continued)





CMD Controls & Displays (Continued)

2.1.10.2 TACTICAL ELECTRONIC WARFARE SYSTEM (TEWS)

The ALR-56C uses the basic ALR-56M (RWR for the F-16C in BMS) symbols plus additional options to filter out emitters such as.

Those filters can be enabled on the MPCD, ARMT page, PB 14:

GLOBAL - all symbols

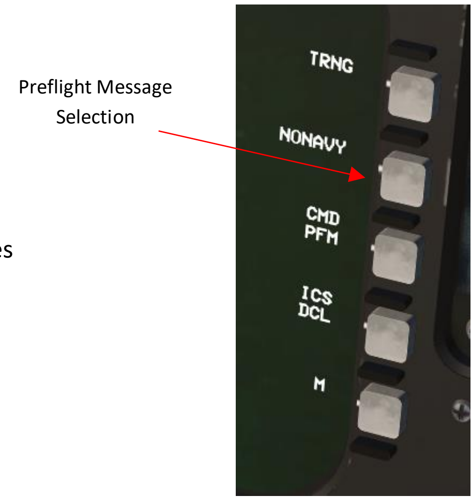
NoNavy - No ships

NOSI - no search radars

WF0 (=Wing Form 0) - Only airplanes

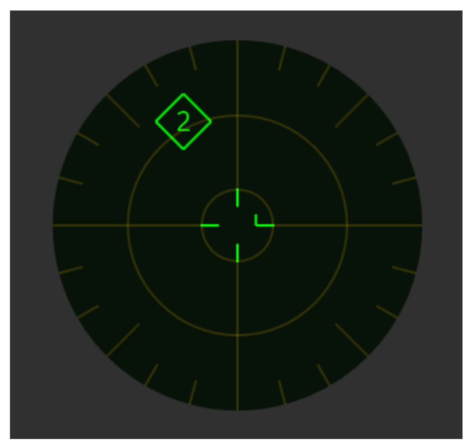
GNDPRI - ground emitters

AIRGND - ground and planes



2.1.10.3 AN/ALR-56C RADAR WARNING RECEIVER (RWR)

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)



2.1.10.4 TEWS POWER CONTROL PANEL

An operational RWR sensor receives command (CMD) input containing threat information, and through consistent updates (via CC), the RWR incorporates velocity and altitude data of the host aircraft to enhance dispensing strategies. Additionally, the RWR interacts with the CMD, continually refreshing the inventory data for the TEWS BIT (Built-In Test) display. Each set (1-3) is responsible for a specific radar band. The current implementation is WIP and will be improved in future versions.

ICS switch Provides power to the Internal Countermeasures Set (ICS) AN/ALQ-135 (V).
Please refer to the AN/ALQ-135(V) chapter for more information.

SET-1/-2/-3 Switches between AUTO and MAN mode for Band 1-3 (all bands are linked together for now)

SET-1/-2 Radar bands for FCR of SAM's (Surface to Air Missiles)

SET-3 Radar bands for FCR of Aircraft's

RWR switch Provides power to the Radar Warning Receiver (RWR) AN/ALQ-56C.

EWWS switches Provides power to the Electronic Warfare Warning System (EWWS).
The Tone/Defeat switch is fixed to DEFEAT for now.

2.1.10.5 CMSD DISPENSER SWITCHES

Paddle Switch Stick (MAN 1) If MAN 1 is pressed and held, the dispensing program will not repeat (the switch must be released and pressed again).

Left Throttle Switch (MAN 2) If MAN 1 is pressed and held, the dispensing program will not repeat (the switch must be released and pressed again).

2.1.10.6 CMD DISPENSER LIGHT

If Chaff/Flare is used, each dispenser light will blink.

If Chaff/Flare is deselected on the CMD control panel, the deselected unit light will be on steady.

Minimum light will be activated if either chaff or flare reaches the minimum value set via data cartridge.

2.1.10.7 CMD CONTROL PANEL

The COUNTERMEASURES DISPENSER CONTROL PANEL purpose is to enable certain modes to the ALE-45 dispenser set.

DISPENSER SELECTOR

CHAFF — Only Chaff will be used

FLARE — Only Flare will be used

BOTH — Chaff and Flare will be used

MODE SELECTOR

OFF — CMD is not operational

STBY — Facilitates both warm-up and complete CMD BIT operations using the Warm-On-the-Way (W-ON-W) method.
While in-flight, there is a restricted capacity for BIT operations. Identification data for Operational Flight Program/Pre-Failure Memory (OFP/PFM) is solely presented by I-BIT when in standby mode, during which dispensing is deactivated.

MAN ONLY — The system receives dispensing commands through either the throttle switch (MAN 2) or the paddle switch (MAN 1). Dispensing patterns are determined using programs such as AN/ALR-56C, PFM, or AFMSS. While on the ground with W-ON-W enabled, dispensing is prevented. Please consult the CMD Dispense Switches section for further information.

SEMI AUTO — This program stands out as the most cost-effective option in terms of material usage. The CMD takes in RWR threat and aircraft parameter data to create the most efficient dispensing plan. When the dispense program is prepared, the green PROGRAM light illuminates. Dispensing is initiated using the MAN 2 throttle switch. If a MAN 1 command or another MAN 2 command is given, the manual program supersedes the RWR-based program.

AUTO — The system processes RWR threat and aircraft parameter inputs to create the most effective dispensing program, which is then automatically activated for dispensing. Should a MAN 1 or MAN 2 command be executed, the manual program takes precedence over the RWR-based program. As of now, the PFM program is in use.

FLARE JETTISON — Not implemented yet.

2.1.10.8 TEWS PANEL

RWR/ICS Only "Combat" is implemented for now.

PODS Not implemented yet.

The current ICS implementation is a hack from the F-16 in BMS.

ICS

STBY	XMIT1 (ECM is in AUTO AVIONICS PRIORITY mode)
AUTO	XMIT2 (ECM is in AUTO ECM PRIORITY mode)
MAN	XMIT3 (ECM is in ACTIVE JAM mode)

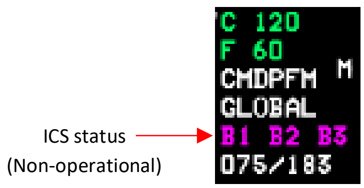
For more information about the ECM implementation, refer to the F-16 Dash-34, chapter 2.7.4.

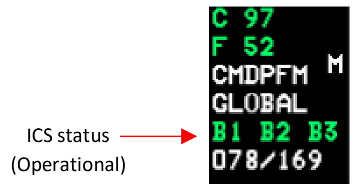
2.1.11 AN/ALQ-135(V) INTERNAL COUNTERMEASURES SET (ICS)

2.1.11.1 ICS STATUS DISPLAYS

SIT Display

The SIT display features a single line displaying three distinct symbols to convey the ICS status. B1 corresponds to band 1, B2 to band 2, and B3 to band 3. The color green signifies that the band is functioning flawlessly, amber indicates that the band is degraded but still operational, and magenta signifies that the band is non-operational.





A/A Display

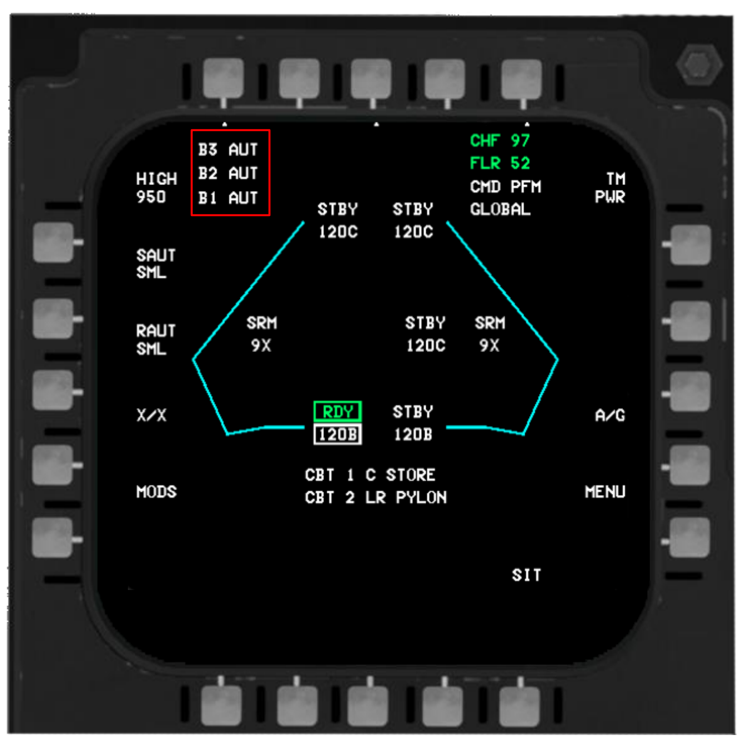
The A/A display presents the ICS status across three separate lines, each dedicated to a specific band. Within each line, the first field designates the band, while the second field depicts the status of the band in order of priority, with the highest priority displayed at the top.

OFF The status "B1 OFF, B2 OFF" indicates that either band 1 or band 2 is currently not establishing communication with the CC through the RWR. Additionally, "B3 OFF" signifies that band 3 is either unable to communicate with the CC or the communication is invalid.

MAN B1, B2 or B3 is in manual mode (Selected via TEWS Power control panel)

AUT B1, B2 or B3 is in auto mode (Selected via TEWS Power control panel)

JAM B1, B2 or B3 is jamming.



GLOSSARY

WIP