THE FIGHTER COLLECTION

EAGLE DYNAMICS

DCS SERIES

DCS: F-16C Viper

Early Access Guide

Updated 11 July 2023

DIGITAL COMBAT SIMULATOR

INTRODUCTION

Thank you for your purchase of DCS: F-16C Viper!

DCS: F-16C Viper brings to Digital Combat Simulator one of the most successful lightweight multirole fighters in modern history. This module features the most realistic PC simulation of the F-16C, which includes accurately simulated flight dynamics, avionics, sensors, and weapon systems. Although the F-16C has existed in many variants and configurations in its history, this module simulates the F-16C Block 50 as it existed in United States Air Force and Air National Guard service circa 2007.

The F-16C was the first operational U.S. fighter aircraft to utilize fly-by-wire controls; and designed for sustained 9G turn performance in close-range "dogfight" maneuvers. The F-16 has been in continuous production for over four decades, with well over 4,000 airframes produced, and continues to serve in the air forces of over 20 nations around the world. Known for its maneuverability and acceleration in close-range air-to-air combat, pilot-friendly cockpit design, and mission versatility, the F-16C Block 50 has also become one of the most successful SEAD (Suppression of Enemy Air Defenses) platforms in the United States Air Force, also known as "Wild Weasel".

As a Wild Weasel, the F-16 pilot uses a combination of sophisticated electronic sensors and clever tactics – and a little bit of crazy – to locate and attack hostile air defense batteries. This is often done while deliberately exposing themselves to engagement by those very same air defense weapons.

Be the first in, and the last out!

Key features:

- Detailed, fully-clickable, 6DOF cockpit along with a highly detailed external model.
- APG-68 Fire Control Radar (with air-to-air and air-to-ground modes), HARM Targeting System, Litening II targeting pod, and Joint Helmet Mounted Cueing System (JHMCS).
- Air-to-air weapons include the M61 20mm Vulcan cannon, AIM-9 Sidewinder heat-seeking missiles, and AIM-120 AMRAAM active radar-homing missiles.
- A large assortment of air-to-ground munitions, including (but not limited to) AGM-88 HARM anti-radar missiles, AGM-65 IR- and TV-guided Maverick anti-armor missiles, AGM-154 JSOW glide bombs, JDAM and WCMD inertially aided munitions, and Paveway laser-guided bombs.
- DL16 datalink, providing a high degree of situational awareness and teamwork between wingmen.
- ALR-56M radar warning receiver, ALE-47 countermeasure dispensers, and ALQ-131/184 jamming pods.
- Fly missions in the Black Sea region or one of the many DLC maps like the Persian Gulf, Syria, and more.
- Multiplayer cooperative and head-to-head gameplay.
- Feature-rich Mission and Campaign editors facilitate user-created content.
- Huge array of land, air, and sea units to fight alongside and against.

Sincerely,
The DCS: F-16C Viper Team
2 October 2019

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LATEST CHANGES

Significant changes to the guide will be noted on this page.

15 Oct 2019 – Added IFF Interrogation procedure to radar section.

20 Oct 2019 – Updated AIM-9 diamond and uncage behavior description in AIM-9M/X Employment sections.

22 Oct 2019 – Added Track While Scan radar sub-mode description.

25 Oct 2019 – Added INS alignment procedures.

28 Oct 2019 – Added section on SMS MFD page and Selective Jettison.

05 Nov 2019 – Added Air Refueling procedures.

08 Nov 2019 – Added DL16 Datalink information.

15 Nov 2019 – Added additional CMDS DED Page descriptions.

24 Nov 2019 – Added information on the radar display's Expand Feature.

21 Jan 2020 – Added EEGS Level V gunsight information.

28 Jan 2020 – Added information on filtering FCR display datalink tracks.

11 Feb 2020 – Added slave/bore HOTAS functionality to AIM-9 employment section.

25 Feb 2020 – Updated TACAN band change procedure in the TACAN Navigation section.

15 Mar 2020 – Added M61A1 Gun dispersion information to the Gun Employment section.

31 Mar 2020 – Added TIME and ALOW DED page descriptions to the UFC section.

26 Aug 2020 – Substantially revised Targeting Pod section to add new functionality. Added Stored Heading and Inflight INS alignment procedures.

27 Aug 2020 – Added procedures for kneeboard usage to the Bomb Seeker Laser Code section. Added radar display missile DLZ to AIM-120 Employment section. Added details on Dogfight and Missile Override modes.

28 Aug 2020 – Added new section describing Autopilot functions. Substantially revised section describing DED Pages with emendations and many additional pages.

31 Oct 2020 – Added AGM-88 HARM section with HAS mode procedures.

3 Nov 2020 – Added AGM-65 Maverick section.

6 Dec 2020 – Added VIP/VRP/PUP section, and POS mode (RUK profile) to AGM-88 HARM section.

15 Dec 2020 – Added a section on System Point of Interest (SPI) and Cursor Zero mechanics. Added section on TGP track modes.

14 Feb 2021 – Added Aircraft History and F-16C Stores sections.

20 Mar 2021 – Updated AGM-88 HARM with POS/EOM and POS/PB delivery modes.

16 May 2021 – Added JDAM section.

11 Jul 2021 – Added JSOW section.

1 Aug 2022 – Full review of existing manual initiated.

30 Nov 2022 – Revisions performed as necessary for accuracy and correct formatting; revised/updated DCS: World Fundamentals, Weapons & Munitions, Cockpit Overview, Hands-On Controls, Heads-Up Display, Upfront Controls, Radio Communications (work-in-progress), Joint Helmet Mounted Cueing System, Defensive Systems, and ALIC Code Appendix. Added Tactical Systems chapter (work-in-progress), HARM Targeting System chapter, Electronic Countermeasures, Appendix C – HAD/HAS Threat Tables, Appendix E – Glossary of Terms, and Appendix F – Formulas.

10 May 2023 – Revised/updated Procedures chapter. Updated Hands-On Controls section and added a consolidated HOTAS function table at the end. Updated Radar Warning Receiver section for new functionality and controls. Updated Appendix A with checklists from Procedures chapter. Updated Appendix B and Appendix C with latest ALIC codes and symbols. Added Appendix D – HOTAS Quick References. Corrected various typos.

NOTE: The Navigation, Radio Communications, and Tactical Systems chapters are still works-in-progress. These chapters have received some changes but will receive further revisions of existing content, and additional new content, in follow-on manual updates. These revisions are already in progress but were not ready at the date of publishing. In addition, the FCR, DL16, Targeting Pod, Air-to-Air Employment, and Air-to-Ground Employment chapters will also receive revisions/updates in the future.

DCS: WORLD FUNDAMENTALS

USAF Photo
by SrA Daniel Snider

HEALTH WARNING!

Please read before using this computer game or allowing your children to use it.

A very small proportion of people may experience a seizure or loss of consciousness when exposed to certain visual images, including flashing lights or light patterns that can occur in computer games. This may happen even with people who have no medical history of seizures, epilepsy, or "photosensitive epileptic seizures" while playing computer games.

These seizures have a variety of symptoms, including light-headedness, dizziness, disorientation, blurred vision, eye or face twitching, loss of consciousness or awareness even if momentarily.

Immediately stop playing and consult your doctor if you or your children experience any of the above symptoms.

The risk of seizures can be reduced if the following precautions are taken, (as well as a general health advice for playing computer games):

Do not play when you are drowsy or tired.

Play in a well-lit room.

Rest for at least 10 minutes per hour when playing the computer game.

INSTALLATION AND LAUNCH

To install DCS World and the DCS: F-16C Viper module, you will need to be logged into Windows with Administrator rights.

DCS World is the PC simulation environment that the DCS: F-16C Viper simulation operates within. When DCS World is launched, you in turn launch DCS: F-16C Viper.

As part of DCS World, a map of the Caucasus region, the Su-25T "Frogfoot" attack aircraft, and TF-51 training aircraft are also included for free.

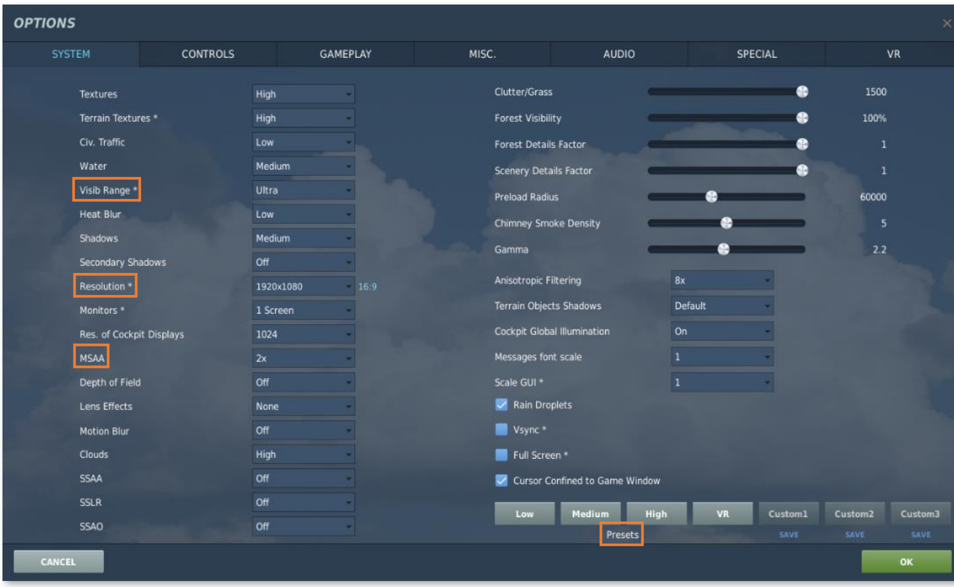
After purchasing DCS: F-16C Viper from our e-Shop, start DCS World by executing the icon on your desktop. Upon initialization, the DCS World Main Menu page is opened. From the Main Menu, you can read DCS news, change your wallpaper by selecting any of the icons at the bottom of the page, or select any of the options along the right side of the page.

Select the Module Manager icon at the top of the Main Menu. Upon initial entry into the Module Manager, a pop-up window titled Install Modules should automatically display, listing any DCS products that you have purchased and have yet to install. Ensure DCS F-16C Viper is checked, and then click OK. Alternatively, you can select the Modules tab, scroll down until you locate the DCS: F-16C Viper entry, and click Install. In either case, DCS World will close and automatically proceed with an update to download and install the necessary files. After the download and installation is complete, DCS World will automatically restart.

To get started quickly, you can select Instant Action and play any of the missions listed for the F-16C Viper.

Configure Your Game

Before jumping into the cockpit, the first thing we suggest is to configure your game. To do so, select the Options button at the top of the Main Menu screen. You can read a detailed description of all Options in the DCS User Manual. For this Early Access Guide, we will just cover the basics.



SYSTEM Tab. This tab allows you to configure your graphics options to best balance aesthetics with performance.

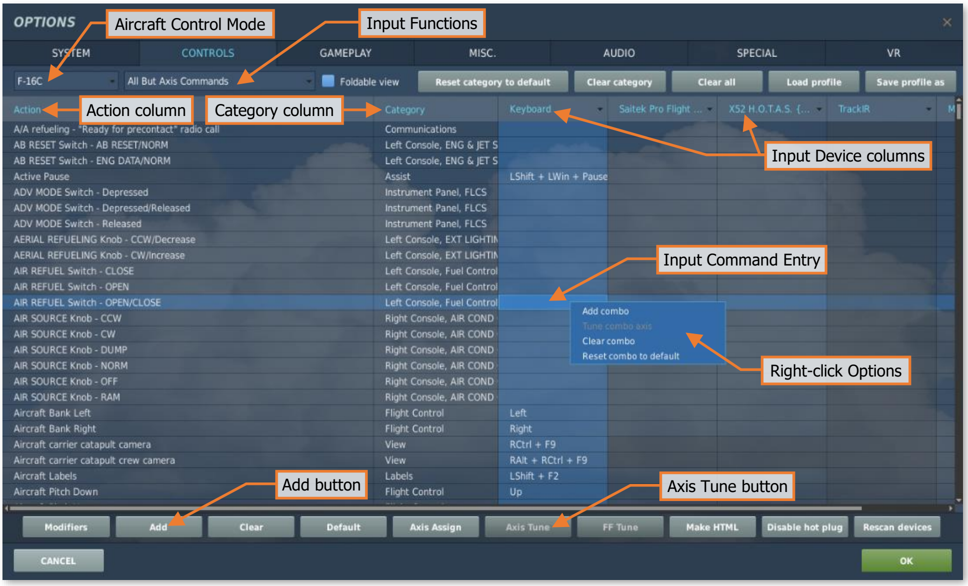
There are Presets options along the bottom of the page, but you can further adjust your graphics settings to best suit your computer. If you have lower performance, we suggest selecting the "Low" button and then increase graphics options to find your best balance.

Items that most affect performance include Visibility Range, Resolution, and MSAA. If you wish to improve performance, you may wish to first adjust these system options.

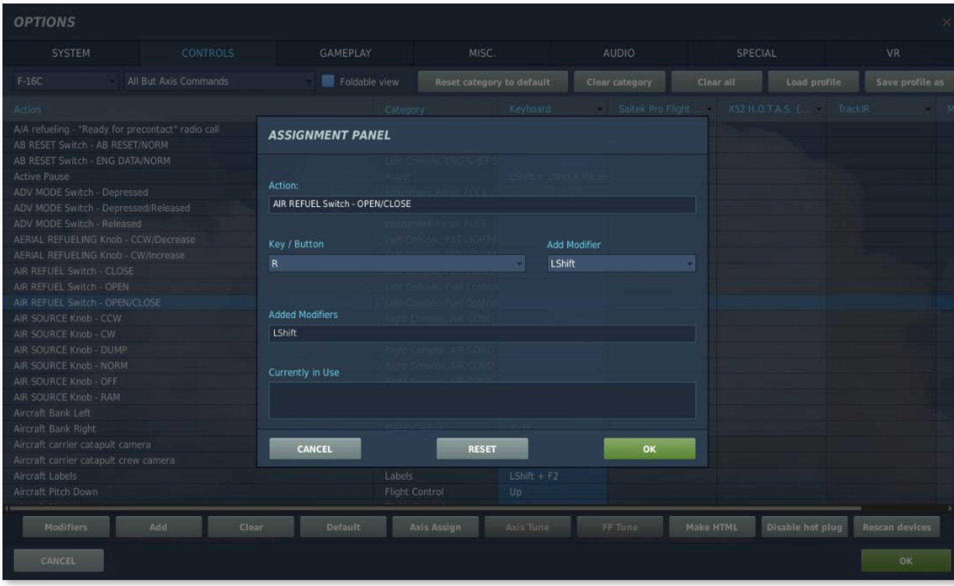
Items that have an asterisk (*) displayed next to them will require a restart of DCS World to take effect.

Note that some missions may enforce different Civ. Traffic settings that override the individual user selection on this tab. This may result in higher or lower levels of expected civilian traffic scenery, or none at all.

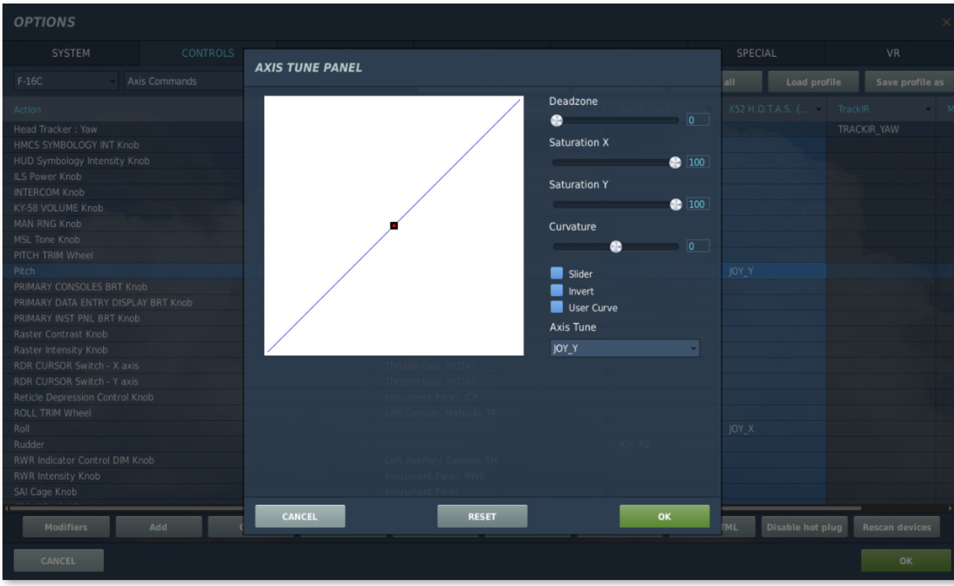
CONTROLS Tab. This tab provides an interface to set up your controls and functional bindings.



- **Aircraft Control Mode.** From this drop-down menu, select "F-16C Sim".
- **Input Functions.** This displays various categories of input functions, such as axis devices, views, cockpit functions, etc. Additionally, "Search…" can be selected from the Input Functions drop-down to manually filter the Action column according to keyword matches.
- **Action column.** This column along the left side of the screen displays the action associated with the corresponding input command entries.
- **Category column**. This column to the right of the Action column displays the function group or cockpit panel each Action is grouped within.
- **Input Device columns.** These columns display which input devices have been detected, including your keyboard, mouse, joysticks, throttle(s), or rudder pedals, and which input commands from the respective input devices will perform the corresponding Action.
- **Add button.** To assign an input command to an Action, left-click the input command entry that corresponds with the desired Action under the desired input device column, then press the Add button along the bottom row. Alternatively, a double left-click on the desired command entry using mouse can be used, or right-clicking on the command entry and selecting "Add combo". Any of these methods will display the ASSIGNMENT PANEL.



- **ASSIGNMENT PANEL.** When this panel is displayed, simply press the button (or combination of buttons) or move the axis of the device to assign it to that Action.
    - *Example 1*: If setting a pitch axis for a joystick, first select AXIS COMMANDS from the Input Functions drop down. Find the box where your joystick input device and the "Pitch" Action intersect and double-click the left mouse button in the box. In the ASSIGNMENT PANEL, move your joystick forward and back to assign the axis. Press OK when finished.
    - *Example 2*: If setting a keyboard or controller device button, first select All But Axis Commands as the Input Function category, or the category that contains the desired Action you wish to edit. Find the box where your input device and the Action intersect, and double-click the left mouse button in the box. In the ASSIGNMENT PANEL, press the keyboard or controller device button you wish to assign to the Action. Press OK when finished.
    - If you make a mistake during the assignment process, press the RESET button and try again.
    - If another Action is already assigned to that button or button combination, that Action will be shown under Currently In Use.
- **Default button.** After assigning a command to an Action, you may revert to the default command assignment for that command entry by clicking on the corresponding entry to highlight, and then clicking the Default button. This can also be accomplished by right-clicking on the command entry and selecting "Reset combo to default".
- **Clear button.** If you wish to remove all commands from an input device for that Action, click on the corresponding command entry to highlight, and then click the Clear button. This can also be accomplished by right-clicking on the command entry and selecting "Clear combo".
- **Axis Tune button**. This button becomes available if an axis command entry is highlighted. When this button is clicked, the AXIS TUNE PANEL is displayed. This can also be accomplished by right-clicking on the command entry and selecting "Tune combo axis".



- **AXIS TUNE PANEL.** When this panel is displayed, the selected axis can be assigned a dead zone, different response curves, and other tuning.

GAMEPLAY Tab. This tab primarily allows you to adjust the game to be as realistic or casual as you want it to be. Choose from various difficulty settings like labels, tooltips, unlimited fuel and weapons, etc. You can also set your preferred language and units of measurement.

Turning Mirrors off can assist with improving performance.

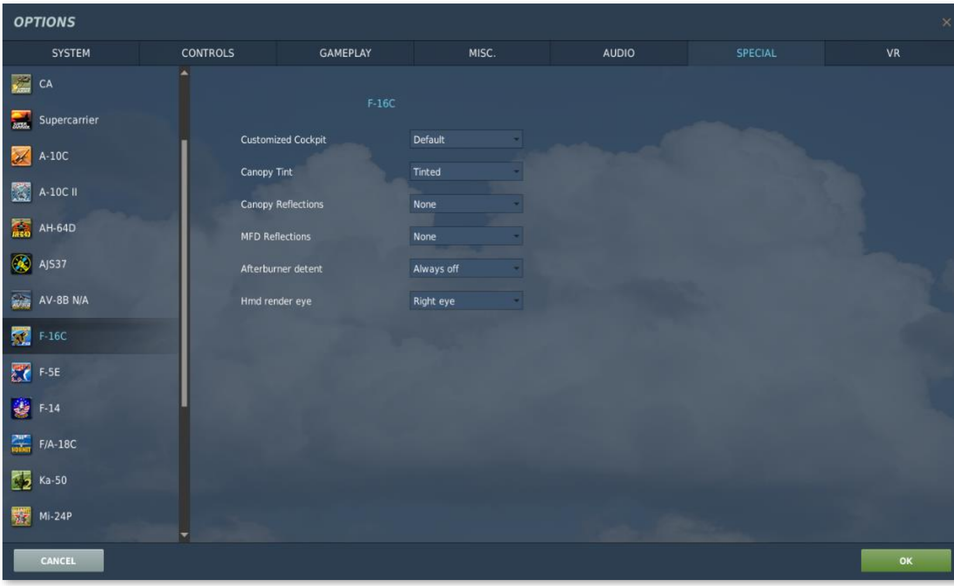
Note that some missions may enforce different gameplay settings that override the individual user selection on this tab. This may result different gameplay behavior than the user expects, such as enforcing no labels or restricting information on the F10 map.

MISC Tab. This tab contains miscellaneous features to further tune the game to your preference.

Note that some missions may enforce different gameplay settings that override the individual user selection on this tab. This may result different gameplay behavior than the user expects, such as enforcing no external views or Battle Damage Assessment overlays.

AUDIO Tab. Use this tab to adjust the audio levels within the game, enable/disable various audio effects, or manage your Voice Chat settings.

SPECIAL Tab. Use this tab to modify module-specific options by selecting the F-16C from the module list along the left side of the screen.



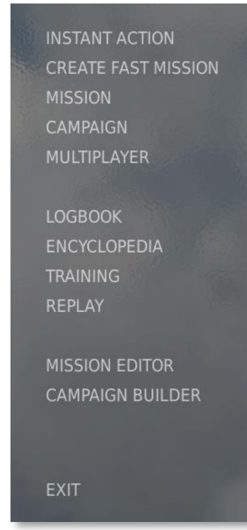
- **Customized Cockpit.** Only one option is available at this time, set to "Default".
- **Canopy Tint.** May be set to "Transparent" or "Tinted".
- **Canopy Reflections.** May be set to "None" or "Static".
- **MFD Reflections.** May be set to "None" or "Static".
- **Afterburner Detent.** May be set to "Always off" or "Always on".
    - **Always off.** In-game throttle will enter afterburner range based on throttle axis input by the user.
    - **Always on.** Throttle Quadrant action "Cycle Afterburner Detent – ON/OFF" will always determine whether the in-game throttle will enter into afterburner range with throttle axis input by the user.
- **HMD Render Eye.** May be set to "Right eye", "Left Eye" or "Both eyes." When using a VR headset, this will determine which eyepiece(s) render the JHMCS flight symbology.

VR Tab. This tab allows you to enable support for a wide variety of VR Headsets and adjust their functionality. When using VR, be particularly aware of the Pixel Density setting as it can have a dramatic effect on game performance.

Fly a Mission

Now that you have configured your game, let's get to why you purchased DCS: F-16C, to fly some missions! You have several options to fly a single or multi-player mission.

On the Main Menu page, you have the options to fly the Viper in an INSTANT ACTION mission, CREATE FAST MISSION, load a MISSION, play a CAMPAIGN, go through a TRAINING lesson, or create a mission in the MISSION EDITOR. You also have the option to jump online and fly with others in MULTIPLAYER.



- **INSTANT ACTION.** Simple missions that place you in the task of your choice. These missions are grouped according to which map they take place in, so selecting a different map from the list along the right side of the Instant Action mission list may provide additional missions to choose from.
- **CREATE FAST MISSION.** Set various mission criteria to allow a mission to be created for you.
- **MISSION.** More in-depth, stand-alone combat missions.
- **CAMPAIGN.** Linked missions to create a campaign narrative.
- **MULTIPLAYER.** Create your own multiplayer session or join a multiplayer session already in progress.
- **TRAINING.** Lessons that provide step-by-step instructions in tasks such as starting the F-16C, takeoff and landing, navigation, or employing weapons.
- **MISSION EDITOR.** Use this very powerful tool to create your own missions.

To get started, we suggest one of the "Free Flight" INSTANT ACTION missions. Later, you can also use these missions to practice starting up the aircraft, takeoffs, landings, navigation, and sensor / weapon employment.

Game Problems

If you encounter a problem, particularly with controls, we suggest you back up and then delete the `Saved Games\DCS\Config` folder in your home directory, which is created by DCS on your operating system drive at first launch. Restart the game and this folder will be rebuilt automatically with default settings, including all the controller input profiles.

If problems persist, we suggest consulting our [online technical support forums].

Useful Links

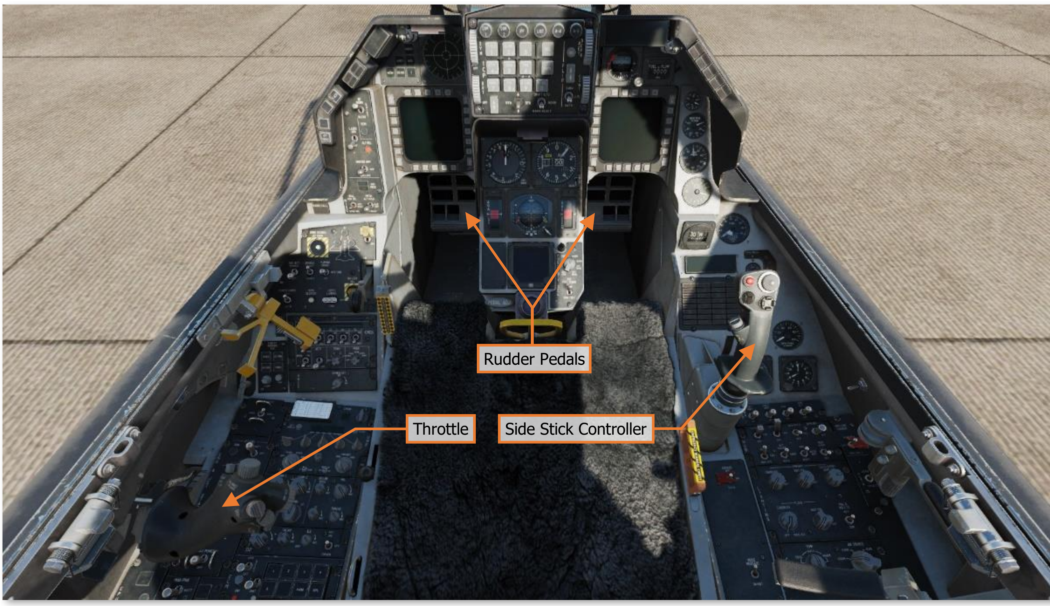
- DCS World homepage
- DCS: F-16C Viper forum

Note about this manual

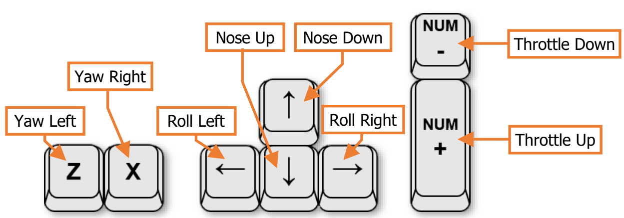
(N/I). This denotes a system or function within this manual that is not implemented in DCS: F-16C Viper.

FLIGHT CONTROL

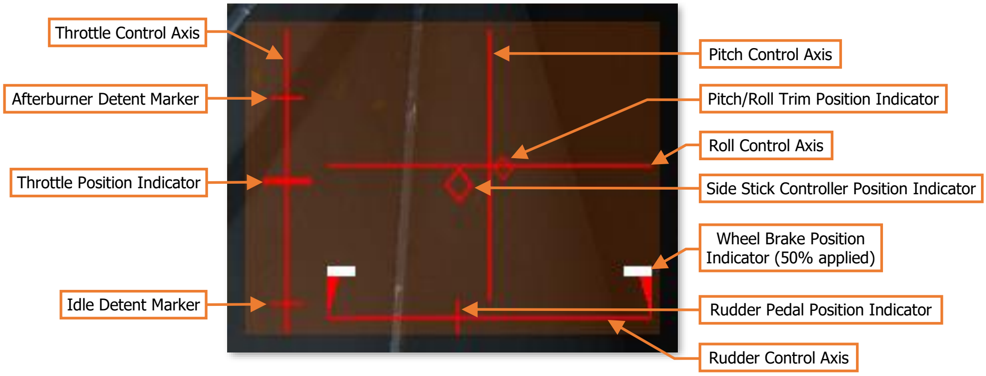
Primary aircraft flight controls include the Side Stick Controller (SSC), Throttle, and Rudder Pedals. The SSC is used to roll the aircraft left and right to perform turns, and pitch the nose up and down to climb or descend. The throttle is used to control engine power and airspeed. The pedals are used in flight to yaw the airplane left and right using the rudder (like a boat); and on the ground to turn the nose wheel when taxiing.



If you are flying with only a keyboard, the primary flight control keys will be the arrow keys to control roll and pitch, **[Numpad+]** and **[Numpad-]** to control throttle, and **[Z]** / **[X]** to control the rudder pedals. If you do have a joystick, it may be equipped with a throttle handle and/or a twist grip, which will allow you to control the rudder pedals.



When flying from the cockpit, the Controls Indicator display may be toggled by pressing **[RCtrl]+[Enter]** to see a visual reference of the positions of your flight controls.



Changing Airspeed

There are several methods to increase or decrease airspeed:

- **Aircraft engine power.** When advancing the throttle, the engine will produce more thrust. Likewise, retarding the throttle will produce less thrust.
- **Aircraft pitch angle and pitch rate.** Generally, pitching the nose up above the horizon will cause the aircraft to slow down; and pitching the nose down below the horizon will cause the aircraft to speed up. Rapid pitch changes can also affect speed, regardless of whether it is a pitch change in the horizontal plane or in the vertical plane. Higher pitch rates increase the Angle-of-Attack (AoA), which increases drag, leading to a loss in airspeed.
- **Speedbrakes.** Opening the speedbrakes will cause an increase in drag, which can cause a loss of speed, or reduce the rate the airspeed increases while in a dive.
- **Landing Gear.** Lowering the landing gear will produce additional drag like the speedbrakes, but they should only be lowered when below 300 knots to prevent damage.

The Airspeed & Velocity Scale on the HUD can be used to monitor airspeed, along with the Airspeed/Mach Indicator on the center section of the instrument panel.

Changing Altitude

Changing the pitch of the aircraft can increase or decrease the altitude.

- **Increase altitude.** Pitching the nose up above the horizon will increase altitude, but this will cause a loss in airspeed unless engine power is increased to compensate. If the aircraft starts to stall, lower the nose and/or increase engine power.
- **Decrease altitude.** Pitching the nose down below the horizon will decrease altitude, but this will cause an increase in airspeed unless engine power is reduced to compensate. Additionally, the speedbrakes can be used to maintain current airspeed in shallow dives.

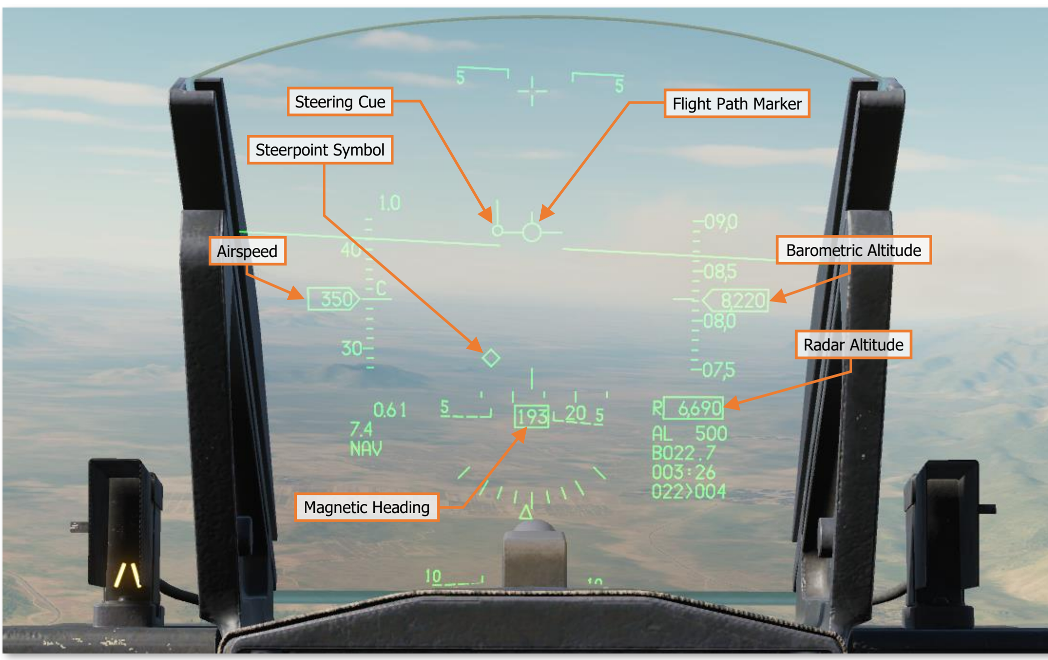
The Barometric Altitude & Altitude Scale and Radar Altimeter on the HUD can be used to monitor altitude, along with the Altimeter on the center portion of the instrument panel. Climb/descent rates can be monitored on the HUD Vertical Velocity Scale, along with the Vertical Velocity Indicator on the center instrument panel.

Changing Heading

Changing the heading of the aircraft in the horizontal plane is accomplished by rolling, or banking, the aircraft in the desired direction. As the bank angle is increased, the stick must be pulled back in pitch to prevent a loss in altitude. At steeper bank angles, pulling back on the stick can increase the turn rate by pitching the nose in the direction of the turn. Just prior to reaching the desired heading, the stick should be used to roll the aircraft back to level flight, so that the aircraft wings return to level just as the desired heading is reached.

Note the following:

- Steep bank angles will require more pitch input to the stick to prevent altitude loss.
- During steep turns, higher pitch rates will increase the turn rate but will also increase the wings' angle-of-attack and cause the aircraft to slow down. If you lose too much speed, the aircraft may become uncontrollable. Increasing engine power or decreasing the turn rate will prevent speed loss.
- Keeping the Flight Path Marker on the Horizon Line throughout the turn will prevent altitude loss. A combination of pitch and roll inputs using the stick can be used to maintain altitude throughout the turn.



The Magnetic Heading Tape on the HUD can be used to monitor heading, which is displayed on either the top or bottom of the HUD, depending on the selected master mode. The Steering Cue shows the relative direction to your steerpoint. If you turn the aircraft to align the Flight Path Marker with the Steering Cue, you will be flying to your steerpoint.

The Electronic Horizontal Situation Indicator (EHSI) also provides the aircraft's heading. The top of the magnetic heading compass that is aligned with the lubber line at the top of instrument is the current heading.

THE F-16C VIPER

USAF Photo
by SSgt Deana Heitzman

AIRCRAFT HISTORY

The history of the F-16 is closely linked to the history of fly-by-wire. Fly-by-wire substitutes the traditional hydromechanical link between pilot and control surfaces for a computer. When the pilot moves the stick left, they are essentially telling the fly-by-wire computer that they wish to bank left; it's then up to the computer to decide how to translate that command into a series of control surface deflections. Fly-by-wire opened the door to aircraft designed with relaxed static stability: designs that would be too unstable for a human pilot to fly manually, but whose instability translated to improved maneuverability.

The F-16's pioneering fly-by-wire system is owed to a man named Harry Hillaker. In the 1940s, fresh out of college, Hillaker joined Consolidated Aircraft as an aircraft designer. There Hillaker contributed to the designs of the B-36 Peacemaker and the F-111, among others, and in doing so, he began to lament a trend among Air Force aircraft: Each new generation was becoming bigger, heavier, and less efficient. By the mid-1960s, Hillaker started contemplating a small, agile fighter that forsook contemporary Air Force dogma.

While Hillaker pondered his new fighter, NASA was breaking ground on fly-by-wire technology. Fly-by-wire was first used on the Gemini 2 capsule, and ultimately made its way to the Apollo lunar landers, where it impressed astronaut Neil Armstrong. Following the cancellation of the Apollo program, Armstrong was promoted to Deputy Associate Administrator for Aeronautics at NASA. Wanting to further investigate fly-by-wire technology, Armstrong acquired a lunar lander computer, and had it installed in an F-8 Crusader, to be used as a testbed for airborne fly-by-wire. This F-8, designated NASA 802, flew in May of 1972, thus becoming the United States's first fly-by-wire aircraft. NASA 802 caught the notice of Hillaker, who noted the drastic improvement in control responsiveness, a full 2.5 times that of an unmodified F-8.

NASA 802 (NASA)

The Fighter Mafia

Col. John Boyd (US)

Few fighter pilots are as well-known (or notorious) as Col. John Boyd. Following a 1953 tour in Korea as an F-86 Sabre pilot, Boyd attended the USAF Fighter Weapons School, where he quickly became a star pupil. His outstanding performance earned him an invite to return as an instructor, and through the 1960s, Boyd worked as teacher and tactician, conceiving of and developing his energy-maneuverability theory. E-M theory was an entirely novel analysis of aircraft combat, with a quantifiable underpinning contributed by mathematician Thomas Christie. Boyd and Christie crunched the numbers using Air Force computers, and the results led Boyd to the conclusion that a fighter with maximal thrust-to-weight ratio and minimal energy loss in turns would hold a competitive advantage over contemporary designs, which emphasized bigger, heavier engines and airframes.

In the late 1960s, in an effort to push his ideas, Boyd put together a team of likeminded experts: The "Fighter Mafia." Among them was Harry Hillaker of Consolidated Aircraft, which had since been sold to General Dynamics. The Fighter Mafia worked from inside the Air Force to advance the concept of a lightweight fighter.

In 1967, Boyd was recalled to USAF headquarters to apply his E-M theory to the flagging F-X project. The F-X project was to be the next generation USAF fighter aircraft, but it had stalled amidst doubts among USAF generals that it had become too large and costly. Boyd's analyses helped convince the Air Force to reduce the weight and complexity of the F-X. The lighter F-X proposal would be nicknamed the F-X "Blue Bird," but Boyd and the Fighter Mafia continued to push for an even smaller, even more nimble air superiority fighter, which they called the F-X "Red Bird."

The Fighter Mafia was a diverse group of fighter pilots and engineers, but they all had in common a desire to see the Air Force adopt a lightweight fighter design. This put them squarely at odds with the Air Force brass, most of whom leaned heavily on the upcoming "Blue Bird." The F-X program was seen as a sort of rebirth for the USAF fighter inventory, at this time comprised mostly of F-111s and F-4s. The F-111 had by then evolved into something ungainly and sluggish, and the F-4 was thought of as the Navy's bird, something the Air Force adopted only afterwards. The F-X represented a prideful Air Force future, embracing its "higher, faster, further" motto, and many in the USAF command ranks were emotionally invested in an aircraft that embodied those words.

F-15 Eagle (USAF)

The F-X program continued undeterred. In 1970, the Air Force announced that McDonnell-Douglas was selected to develop the F-X, now designated the F-15 Eagle.

Lightweight Fighter Program

Towards the end of the 1960s, the Deputy Secretary of Defense, David Packard (of Hewlett-Packard) had become concerned that the upcoming USAF and Navy frontline fighters — the F-15 and the F-14 Tomcat — represented future budget problems for the Armed Forces. The Fighter Mafia had continued to push the USAF towards their "Red Bird" concept, now also known as the F-XX. Their studies also helped convince manufacturers such as General Dynamics and Northrop to start investigating potential lightweight fighter designs. In late 1970, as the F-14 continued to experience budget and maintenance issues, Lockheed-Martin took the initiative and delivered to Packard an unsolicited proposal for a lightweight fighter. Other companies in the industry quickly followed suit, including General Dynamics.


David Packard (DoD)

Deputy SecDef Packard had been looking to implement a new "fly-before-you-buy" purchasing policy and had become recently enamored of competitive prototyping. He saw the new LWF proposals to advance his ideas. The Air Force was still lukewarm to the idea of a lightweight fighter, until the Fighter Mafia coined the "high/low mix" — the concept that the F-15 and F-XX would complement each other, occupying the high-cost and low-cost brackets of Air Force spending, respectively. The high/low mix idea reframed the LWF as an ally to the F-15, and lifted resistance among Air Force brass.

Packard's Lightweight Fighter RFP produced five proposals, among which two were selected for funding: The General Dynamics Model 401, and the Northrop P-600. Each company would be granted funding to build demonstrator aircraft, which would be tested against each other in a series of trials — the fingerprint of Deputy SecD Packard's influence. The P-600 would be redesignated the YF-17, and the Model 401 would become the YF-16.

Air Combat Fighter Competition

At General Dynamics, Robert. H Widmer became the chief engineer on the YF-16 project. At Harry Hillaker's insistence, the YF-16 was to incorporate a production fly-by-wire system — but as the engineers were still uncertain if fly-by-wire was feasible, the YF-16 program was designed with a contingency. Should it be necessary, the YF-16's wings could be shifted aftward to restore the airframe's static stability, and the analog fly-by-wire system was designed to be easily removable and replaced with traditional flight controls.

YF-16 Rollout, 1973 (GD)

Along with its revolutionary control system, the YF-16 became a testbed for other innovations: The aircraft would be capable of 9-g maneuvers, and the seat was reclined 30° to improve the pilot's g-tolerance. The reclined seat, and concern about the pilot's ability to manipulate systems during high-g maneuvering, guided the development of its HOTAS, which put more capability on the stick and throttle than prior aircraft. The small cockpit necessitated that the stick be moved to the side, so that it wouldn't obscure cockpit instruments.

In December 1973, the completed YF-16 prototype was unveiled at Edwards Air Force Flight Test Center, where it began flight trials. Its first flight on January 20, 1974 was unintended: During a fast-taxi run, a fault in the fly-by-wire system created a worsening control problem that forced the test pilot to lift off for a trip around the pattern. The actual, intended first flight occurred a few weeks later in February, following repairs of the prototype.

The Air Force had set the initial stakes of the LWF competition by committing to purchasing 650 aircraft of whichever model won. But by early 1974, interest in the Lightweight Fighter competition had grown, and as word spread to NATO allies, other countries began committing to purchases of the winner as well. In response to the heightened interest, the LWF competition was expanded into a new program called Air Combat Fighter (ACF). The ACF program specified a multirole lightweight fighter aircraft and required that any purchase of the winning model must also be in parallel to a purchase of F-15s. This requirement shut down the last of the resistance to the LWF program within the Air Force.

The expanded ACF program brought in foreign competitors, among them Dassault-Breguet, SEPECAT, and Saab. Ultimately, after flying 330 trial sorties spanning 417 flight hours, test pilots unanimously favored the YF-16. So it was January 13, 1975 when Secretary of the Air Force John L. McLucas announced that General Dynamics had won the ACF competition, and with it, hundreds of domestic and foreign orders for the F-16.

The F-16A and B

Through 1974 and 1975, General Dynamics developed the YF-16 into the F-16, making numerous structural modifications. What was originally envisioned as Boyd's lightweight fighter now had to become a multirole aircraft, per the ACF program requirements. The radome was enlarged to fit the AN/APG-68 radar, and two more pylons were added. These and other changes ultimately netted a 25% weight increase.

First production F-16A Block 10 (USAF)

So much was the Air Force's desire to keep the new fighter from impinging on the F-15's glory, that Air Force brass prohibited the F-16 from carrying AIM-7 Sparrows, the medium-range BVR missile of the day. (This requirement would impel one of the Fighter Mafia, General Mike Loh, to order the design of a medium-range missile that could be mounted on AIM-9 Sidewinder stations — a project that would ultimately produce the AIM-120 AMRAAM.)

In late 1975, the first F-16A FSD (full-scale development) was manufactured, and on October 20, 1978, the first production model rolled off the assembly line. The production F-16A first flew in November of that year, and the Air Force received its first delivery in January. The F-16 entered operational service with the 388th Tactical Fighter Squadron at Hill AFB, Utah in 1979. A year later, the F-16 was given the official moniker of "Fighting Falcon" — but of course, its pilots called it the "Viper."

In all, 475 F-16As and Bs (dual-seat variant) were produced. The model variant spanned Blocks 1, 5, 10, 15, and 20. Many Block 20 F-16As have since undergone the Mid-Life Upgrade (MLU), becoming functionally equivalent to F-16Cs.

The F-16C and D

On June 12, 1987, the Block 30 F-16 was introduced, designated the F-16C and D. Block 30 was the result of the Alternative Fighter Engine (AFE) program, a project to allow the F-16 to be configured with either the existing Pratt & Whitney F100-PW-220 engine, or with the General Electric F110-GE-100 as an alternative. The original plan was for the F-16 to have a common engine bay, allowing any aircraft to swap between the two engines. This idea was scrapped when it was discovered that the GE engine required widening the inlet. Due to the airframe change, beginning with Block 30, the blocks were split in two: Block 30, 40 and 50 were equipped with a General Electric engine; and Block 32, 42, and 52 were equipped with a Pratt & Whitney engine.

Along with the diversity of engine choices, the Block 30/32 F-16C received an upgraded mission computer with more storage, an AN/ALE-47 countermeasures dispenser, and the capability to employ AGM-45 Shrike and AIM-120 AMRAAM missiles.

Block 30/32 F-16Cs would be delivered to the USAF Thunderbirds demonstration squadron in 1986 and 1987; these aircraft are today some of the oldest still-operating F-16s. Other Block 30/32s were delivered to the U.S. Navy, re-designated the F-16N, and used as stripped-down aggressor aircraft in USN air combat training.

F-16C (MSGT Michael Ammons, USAF)

The Block 40/42 model, commonly called the "Night Falcon," was debuted in December 1988. As implied by its nickname, the Night Falcon introduced a suite of night attack technologies, including the LANTIRN navigation/terrain-following radar and targeting pods. The aircraft also got an upgraded fire control radar and RWR, a wide-angle holographic HUD capable of displaying FLIR video, and an improved mission computer. The aircraft got an exterior makeover as well: The hull was treated with radar-absorbent materials, and the iconic gold-tinted canopy debuted. Despite all these improvements, the USAF was in general disappointed with the increased weight and decreased performance of the Night Falcon series.

January 1991 saw the start of Operation Desert Storm in Iraq, and with it, the F-16's first combat deployment for the USAF. Following the Gulf War, on December 27, 1992, LTC Gary North of 33rd Tactical Fighter Squadron earned the first combat kill in a USAF F-16 after shooting down a Syrian MiG-25 that violated airspace restrictions. The MiG-25 was also the first aircraft destroyed by an AIM-120 AMRAAM.

In October of 1991, Block 50/52 rolled out, restoring the Viper's performance and maneuverability. The aircraft got an up-rated engine (the F110-GE-129 or the F100-PW-229), and with it a 20% increase in thrust. The radar was again upgraded, Improved Data Modem (IDM) datalink support was added, and the Block 40's holographic HUD was replaced with the original Block 30 HUD. Some Block 50 F-16Cs were configured to carry the HARM Targeting System (HTS) pod; these SEAD aircraft were designated the F-16CJ and DJ.

The F-16C continues to see improvements and upgrades to keep it in step with technological innovations. Between 2003 and 2010, the Air Force's Common Configuration Implementation Program (CCIP) modernized and standardized the avionics and capabilities across the fleet of Block 40 and Block 50 F-16Cs. The FCC was upgraded, the MFDs were replaced with new color displays, support for JHMCS and DL16 was added, and the IFF was modernized. F-16CJ and DJ SEAD models that underwent modernization through this program were redesignated the F-16CM or DM.

Today, while the USAF no longer purchases F-16s, it still operates a fleet of over 1,000 active-duty F-16Cs and Ds. F-16s have served in virtually every U.S. air combat action since Operation Desert Storm, and F-16s are scheduled to continue to remain in service until 2025, when they will be replaced with the F-35A Lightning II.

Aside from the United States, twenty-six other countries have purchased or leased F-16s, and all but one (Italy) continue to fly them as an integral part of their air forces. After purchasing General Dynamics, Lockheed-Martin continues to improve on the F-16 for foreign customers. The United Arab Emirates funded development of the F-16E and F models (Block 60), and many other countries have pledged to purchase the upcoming F-16V (Block 70/72). The F-16V is expected to be delivered to buyers starting in 2023.

F-16 from the 66th AGRS taking off from Nellis AFB (SRA Dylan Murakami, USAF)

WEAPONS & MUNITIONS

M61A1 Vulcan 20mm Cannon

A1C Kimberly Barrera (USAF)

The F-16 is equipped with an internal M61 Vulcan six-barreled rotary cannon. The M61 can employ M50- or PGU-series 20x102mm projectiles at 6,000 rounds per minute and is effective against both air and surface targets. PGU-series rounds provide increased range and decreased time of flight compared to M50-series ammunition. The ammunition drum carries 510 rounds, of which six different types can be chosen for loading:

M56 HEI. High-Explosive Incendiary rounds. HEI rounds have both explosive and incendiary effects, making them effective against aircraft, light vehicles, and personnel.

M56/M242 HEI-T. High-Explosive Incendiary rounds with Tracer mix. M242 tracer rounds are substituted for HEI rounds at regular intervals. The tracer rounds glow brightly when fired, allowing the pilot to visually see the ballistic path of the fired projectiles.

M53 API. Armor-Piercing Incendiary rounds. Armor-piercing rounds are made from solid steel with a combined incendiary effect, making them capable of penetrating armored vehicles. However, they have no explosive effects upon impact, which makes them less effective against personnel.

M55/M220 TP. Target Practice rounds. TP rounds are inert with only kinetic effects upon impact. TP mix always contains M220 tracer rounds at regular intervals.

PGU-28A/B SAPHEI. Semi-Armor-Piercing High-Explosive Incendiary rounds. These rounds have both incendiary/explosive effects and armor-piercing capability. The rounds are constructed such that the incendiary and explosive effects are triggered after penetration of the armor. SAPHEI rounds are effective against a wide range of vehicles but are not generally effective against personnel.

PGU-27A/B TP. Target Practice rounds. TP rounds are inert with only kinetic effects upon impact. TP mix always contains PGU-30A/B tracer rounds at regular intervals.

AIM-9 Sidewinder

SSgt Darnell T. Cannady (USAF)

The AIM-9 Sidewinder is an infrared-guided (heat-seeking) short-range air-to-air missile. It first entered service in 1956 and has since become one of the most successful missiles in the West. Its longevity is thanks to its versatility and continued improvement over multiple generations.

The AIM-9 uses an array of up to five scanning infrared sensors, cooled by an internal argon bottle (L and M models). The Sidewinder has a maximum speed of over Mach 2.5 and a maximum range of around 10 to 20 miles, depending on the variant. Minimum range is around 3,000 feet.

A single AIM-9 can be mounted on any of the F-16C's air-to-air stations.

AIM-9L Sidewinder. The "Lima" model was the first all-aspect Sidewinder fielded in 1977, meaning it no longer required the target to present a rear profile. The AIM-9L earned its first kill when it struck a Libyan Su-22, after being fired from an F-14 Tomcat, in the infamous Gulf of Sidra engagement of 1981.

AIM-9M Sidewinder. The "Mike" model introduced in 1982 improved on the Guidance Control Section (GCS). Susceptibility to flares was reduced, and background discrimination was improved, resulting in a greater chance of target acquisition. The rocket motor's smoke signature was reduced, making the missile less likely to be seen.

AIM-9X Sidewinder. The "X-ray" model introduced in 2003 is the latest iteration of the Sidewinder. The 9X adds high-angle off-boresight (HOB) capability and the ability to slave the seeker head to a helmet-mounted sight, such as the JHMCS. The missile's maneuverability was boosted with all-axis thrust-vectoring capability. These changes allow the pilot to simply "point their head and shoot" in nearly any direction, greatly increasing reaction time and lethality in air-to-air combat, even when in a defensive position. The infrared sensor was replaced with focal-plane arrays (FPAs) and counter-countermeasures capability was further improved. Electronic fuzing was added to reduce minimum range.

CAP-9M. Captive variant of the AIM-9M. The captive variant has the same size, weight, and drag characteristics as the AIM-9M, for training effectiveness. It also contains an integrated infrared sensor and will provide audio and visual guidance cues to the pilot, but it does not have a rocket motor and cannot be fired from the aircraft.

AIM-120 AMRAAM

The AIM-120 AMRAAM (Advanced Medium-Range Air-to-Air Missile) is an active radar-homing, medium-range air-to-air missile. First introduced in 1982, the AMRAAM was intended to replace the semi-active radar homing AIM-7 Sparrow, which was the medium-range BVR missile in the U.S. inventory at the time.

SSgt Sheila deVera (USAF)

The AIM-120 uses both command guidance and radar homing to reach its target. The AIM-120's integral radar has a comparatively short range and relies on steering signals transmitted automatically from the launching aircraft via a radio datalink. The AMRAAM has a maximum speed around Mach 4 and a maximum range of 30 to 40 miles.

AIM-120B AMRAAM. The B model was fielded in 1994 with improved guidance over the A-model.

AIM-120C-5 AMRAAM. The C-5 variant was fielded in 2000 and featured a slightly larger rocket motor, improved guidance, electronic counter-countermeasures (ECCM), and re-designed fins for carriage within the internal weapon bays of the F-22.

AGM-88 HARM

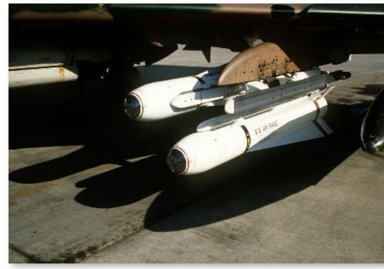
The AGM-88 HARM (High-speed Anti-Radiation Missile) is a passive radar homing air-to-ground missile used in the Suppression of Enemy Air Defenses (SEAD) role. The HARM has a radar receiver and processor that detects and identifies signals from enemy surface radars. When launched, it can guide to the target by homing on its specific radar emissions. The missile also has an inertial guidance system to provide mid-course guidance prior to detection of the radar signal (or if the signal is lost).

SSgt Scott Stewart (USAF)

The AGM-88 has a maximum speed of Mach 1.84 and an operational range of around 80 nautical miles. The missile can be employed using several different engagement profiles that can be selected prior to launch. It uses a laser proximity fuze for detonation to increase its area of weapons effects.

AGM-88C. This mid-1980s variant incorporates field-reprogrammable software and improved guidance and fuzing.

AGM-65 Maverick



SSgt Glenn B. Lindsey (USAF)

The AGM-65 Maverick is a medium-range air-to-ground missile designed for the close air support role. The AGM-65 family contains a diverse set of variants and guidance systems, including infrared, electro-optical, and laser guidance.

The AGM-65 has a maximum range of around 13 nautical miles. A single Maverick can be mounted to an LAU-117 rack, or up to 3 can be carried on an LAU-88 rack.

AGM-65D Maverick. The D model contains an imaging infrared sensor and guidance system. The sensor can locate and track targets during daylight and at night, in clear or restricted-visibility weather conditions. It contains a 125-pound shaped-charge warhead.

AGM-65G Maverick. The G model has the same guidance system as the D model, but with a larger 300-pound penetrating warhead, making it more effective against hardened targets.

AGM-65H Maverick. The H model uses a digital CCD sensor, making it effective in daylight only. The H model is capable of forced correlation and does not require a target centroid to track. It contains a 125-pound shaped-charge warhead.

AGM-65K Maverick. The K model has the same guidance system as the H model, but with a larger 300-pound penetrating warhead.

Mark 80-Series General-Purpose Bombs

SSgt Randy Mallard (USAF)

The Mark 80-series of general-purpose bombs is a series of unguided bombs dating back to the Vietnam War. The bombs come in nominal weights of 500, 1,000, and 2,000 pounds, and can be fitted with a variety of nose and tail fuzes or precision guidance kits.

The Mark 80-series bombs can be fitted to any air-to-ground pylon. The Mk-82 can also be mounted to a triple ejector rack (the TER-9A) in pairs or triples.

Mk-82. A 500-pound, general-purpose bomb.

Mk-82 Snakeye. A Mk-82 with Mk15 retarding petals that extend after release. The petals reduce the bomb's downrange speed after release, allowing aircraft to perform low-level straight-through deliveries at lower altitudes without risk of frag damage.

Mk-82 AIR. A Mk-82 with a BSU-49/B Air Inflatable Retarder (AIR). The AIR is a ballute that expands after release, performing the same retarding function as the Mk15. The BSU-49B is a newer technology and is more effective than the Mk15, making the bomb safe to use at higher speeds than the Snakeyes.

Mk-84. A 2,000-pound, general-purpose bomb.

Mk-84 AIR. A Mk-84 with a BSU-50 Air Inflatable Retarder (AIR). The Mk-84 AIR is available as a 2,000-poound general purpose bomb and a 2,000-pound inert training munition variant.

BDU-50 Training Munitions

The BDU-50 is an inert, releasable training munition with the same mass and shape as the Mk-82 500-pound bomb but lacks a warhead.

The BDU-50 can be mounted directly to any air-to-ground pylon, or up to three can be mounted on a TER-9A triple ejector rack.

BDU-50LD. Simulates the low-drag or "slick" version of the Mk-82.

BDU-50HD. Simulates the high-drag, ballute-equipped Mk-82 AIR.

BDU-50LGB. Simulates the GBU-12, a Mk-82 equipped with a Paveway II laser-guided bomb kit.

SSgt Fernando Serna (USAF)

BDU-33 Training Munitions

The BDU-33 is an inert, releasable training munition with a ballistic flight profile that simulates the Mk-82 500-pound bomb. Upon impact, the BDU-33 releases a smoke cloud that can be used to identify the impact point.

The BDU-33 can be loaded in sets of three on the TER-9A triple ejector rack.

SSgt James R. Ferguson (USAF)

CBU-87 Combined Effects Munition

The CBU-87 Combined Effects Munition is an unguided cluster bomb that was developed in 1986. Each bomb contains an SUU-65/B canister and 202 BLU-97/B submunitions. These have both fragmentation and incendiary effects and are effective against vehicles and personnel.

After being released, the CBU-87 begins to spin at a pre-set speed. It falls to a preprogrammed burst altitude, at which point the canister separates and the submunitions are dispersed.

The CBU-87 can be mounted directly to any air-to-ground pylon, or up to three can be mounted on a TER-9A triple ejector rack.

SrA Edward Braly (USAF)

CBU-97 Sensor-Fuzed Weapon

Cindy Farmer (US)

The CBU-97 Sensor-Fuzed Weapon is an unguided cluster bomb containing target-discriminating submunitions. Each bomb contains a SUU-66/B canister and 10 BLU-108 submunitions. When the bomb approaches its preprogrammed burst altitude, the canister opens and the submunitions are released. The submunitions deploy parachutes at preprogrammed intervals to increase lateral spacing. Once the submunitions reach the burst altitude, the parachute is separated, and a rocket motor spins the submunition and stops its descent. Each submunition releases four "Skeets," which are ejected in four different directions.

The Skeets have ground-facing laser and infrared sensors, both of which are used to detect the presence of a vehicle. When a vehicle is detected, the Skeet detonates, firing an explosively formed projectile (EFP) downward toward the vehicle. The EFP usually strikes the radiative part of the vehicle (usually the engine) as detected by the Skeet's infrared sensor and penetrates its armor, using pure kinetic energy to produce lethal effects.

If a vehicle is not detected, they will self-destruct before reaching the ground. This helps reduce collateral casualties associated with the use of cluster munitions.

The CBU-97 can be mounted directly to any air-to-ground pylon, or up to three can be mounted on a TER-9A triple ejector rack.

Paveway II Laser-Guided Bombs

SSgt Glenn B. Lindsey (USAF)

The Paveway II is a series of laser-guided bombs based on conventional general-purpose bombs. The guidance kit consists of a laser detector and processor in the front and a set of steering fins in the back. The bomb detects and tracks reflected laser energy off a target. The laser designation can come from the launching aircraft, another aircraft ("buddy lasing"), or from a laser-capable ground unit such as a JTAC.

The Paveway II series was introduced in the early 1970s to replace the first-generation Paveway series of laser-guided bombs. The Paveway II improved sensor reliability and added extendible rear fins to extend glide range. The Paveway II series uses "bang-bang" control (where the fins can only deflect fully in either direction), limiting its maximum range and forcing it to follow a sinusoidal path to the target.

The Paveway II series of weapons can be mounted on any air-to-ground pylon. The GBU-12 can be mounted in pairs using a TER-9A triple ejector rack.

GBU-12. Mk-82 500-pound conventional bomb equipped with a Paveway II laser-guidance kit.

GBU-10. Mk-84 2,000-pound conventional bomb equipped with a Paveway II laser-guidance kit.

Paveway III Laser-Guided Bombs

The Paveway III is an improved guidance kit over the earlier Paveway II, for 2,000-pound class bombs. The upgrades include new, larger control surfaces that provide greater aerodynamic efficiency, a larger seeker field-of-regard, improved proportional guidance logic for flying shaped trajectories, and terminal impact options for optimizing weapon effects.

USAF

The Paveway III enables strike aircraft to perform low-level laser-guided bomb attacks from a wide variety of ranges and altitudes by utilizing the greater flight efficiency and trajectory options provided by the kit.

The Paveway III can be mounted on any air-to-ground pylon.

GBU-24A/B. BLU-109 2,000-pound hardened penetration bomb equipped with a Paveway III laser-guidance kit.

Joint Direct Attack Munition (JDAM)

JDAM is an inertial and GPS guidance kit that can be mounted to a general-purpose bomb, enabling it to attack a pinpoint target based on coordinates downloaded from the aircraft. The JDAM's precision is not degraded by weather and the bomb is completely fire-and-forget; however, the JDAM cannot be re-targeted after launch, nor can it engage moving vehicles.

SMSgt Edward E. Snyder (USAF)

JDAM development began in 1992 from a proposal for an adverse-weather precision-guided munition. The proposal was created in response to degraded laser-guided bomb performance during Operation Desert Storm. The first JDAM kits were delivered to the U.S. military in 1997, and the first employment was from a B-2 during Operation Allied Force in 1999.

The GBU-38 and GBU-31 can be mounted on any air-to-ground pylon. The GBU-38 can be mounted in pairs using a BRU-57 bomb rack.

GBU-38. Mk-82 500-pound conventional bomb equipped with JDAM guidance kit.

GBU-31(V)1/B. Mk-84 2,000-pound conventional bomb equipped with JDAM guidance kit.

GBU-31(V)3/B. BLU-109 2,000-pound hardened penetration bomb equipped with JDAM guidance kit.

AGM-154 Joint Stand-Off Weapon (JSOW)

JSOW is an inertially-aided glide bomb with exceptional glide range due to its folding wings. Like JDAM, JSOW can attack pinpoint targets using pre-designated GPS coordinates. The JSOW's precision is not degraded by weather and the bomb is completely fire-and-forget; however, the JSOW cannot be re-targeted after launch, nor can it engage moving vehicles.

TSgt Cary Humphries (USAF)

Range is dependent on launch parameters, especially the altitude and speed of the aircraft at release.

The AGM-154A can be mounted on any air-to-ground pylon or mounted in pairs using a BRU-57 bomb rack.

AGM-154A. The AGM-154A variant was consists of 145 BLU-97/B combined effects submunitions, identical to those used in the CBU-87 and CBU-103.

Wind-Corrected Munitions Dispenser (WCMD)

WCMD (pronounced "wick-mid") is a precision guidance kit for the CBU-87 and CBU-97 cluster weapons. The tail kit includes an integrated INS which is initialized from the aircraft's onboard GPS position just before release. The guidance system can be programmed with the winds aloft to enhance accuracy, giving it as low as an 85-foot circular error probable (CEP).

SrA Jonathan E. Ramos (USAF)

The CBU-103 and CBU-105 can be mounted on any air-to-ground pylon or mounted in pairs using a BRU-57 bomb rack.

CBU-103. CBU-87 Combined Effects Munition (CEM) cluster bomb equipped with WCMD guidance kit.

CBU-105. CBU-97 Sensor-Fuzed Weapon (SFW) cluster bomb equipped with WCMD guidance kit.

2.75-inch Unguided Rockets

The LAU-3 is a 19-tube rocket pod for 2.75-inch Hydra 70 rockets and can be loaded on any air-to-ground pylon. The Hydra 70 is an unguided rocket that accepts many different types of warheads and fuzes. The following warhead variants are available in the DCS F-16C:

BrokenSphere (CC-BY-SA)

M151 HE. High-explosive warhead with fragmentation effects. Effective against personnel and light vehicles.

M156 WP. White phosphorous warhead that creates a smoke effect on impact. Used for marking ground targets.

Mk5 HEAT. High-explosive anti-tank warhead with both fragmentation and armor piercing effects. Effective against personnel and most vehicles.

Mk61 Practice. Training rocket with an inert warhead.

WTU-1/B Practice. Training rocket with an inert warhead.

External Fuel Tanks

External fuel tanks carry additional fuel to increase the F-16's range and combat radius and can be refueled during air-to-air refueling. Like most munitions, the fuel tanks are capable of being jettisoned if necessary.

370-gallon external wing tank. The 370-gallon wing tank adds approximately 2,500 pounds of fuel. It can be carried on pylons 4 and 6 under each wing.

300-gallon external centerline tank. The 300-gallon centerline tank adds approximately 2,000 pounds of fuel. It can only be carried on pylon 5 under the fuselage.

SMSgt Edward E. Snyder (USAF)

Targeting/Sensor Pods

Externally mounted targeting pods can be equipped to the left and right "chin" hardpoints on either side of the intake. These targeting systems provide additional capabilities for detecting, acquiring, and engaging enemy forces such as ground vehicles and air defenses from outside the visual range of the pilot, and with greater accuracy and fidelity than the air-to-ground modes of the fire control radar.

AN/AAQ-28 Litening II. The AN/AAQ-28 Litening II is an electro-optical and infrared targeting pod that can be attached to the right chin hardpoint on the F-16C. It includes a steerable camera with a powerful magnification range for detecting targets at long distances during the day, and a steerable forward looking infrared (FLIR) sensor for detecting targets during the day as well as night. The Litening pod also includes a laser rangefinder/designator for illuminating targets with laser energy and a laser spot tracker for detecting laser designations of other friendly forces on or over the battlefield.

(See Litening II Targeting Pod for more information.)

Litening Targeting Pod (USAF)

AN/ASQ-213 HARM Targeting System (HTS). The HARM Targeting System is an electronic detection and geolocation sensor that is exclusively designed for the F-16C when performing Suppression of Enemy Air Defense (SEAD) missions. The HTS pod detects and classifies hostile air defense radar emissions and uses signals triangulation to precisely determine the location of threat radar systems on the battlefield. When a threat radar is detected, the HTS pod can then handoff the radar location to the AGM-88 HARM missiles for engagement, even threat radars that are well outside the forward search cone of the HARM missiles themselves.

HARM Targeting System (USAF)

While the HTS pod is not required to employ the AGM-88 HARM missile, it does enable the targeting of threat radars more efficiently. The HTS pod also dramatically increases the pilot's situational awareness of the threat radar environment in the surrounding airspace and allows the pilot to make critical decisions regarding which threats must be avoided and which threats must be engaged to accomplish their mission.

(See HARM Targeting System for more information.)

Electronic Countermeasure (ECM) Pods

Electronic Countermeasure pods can be mounted to the centerline station under the fuselage or stations 3 or 7 under the wings. These defensive systems provide an additional layer of protection against radar threats such as surface-to-air missile (SAM) batteries. Depending on the sophistication and range of the radar system that is attempting to acquire and track the aircraft, ECM pods can be used to deny, degrade or delay an attack so that the pilot can escape the engagement envelope of the threat system, evade incoming weapons, or gain additional time to execute their mission before being forced to take evasive maneuvers..

ALQ-131 (Northrop Grumman)

AN/ALQ-131. The ALQ-131 is one of the most proliferated self-protection aircraft-mounted ECM systems to date. The system can employ both barrage ("noise") jamming as well as deception jamming to threat radar systems across multiple frequency bands.

AN/ALQ-184. The ALQ-184 was developed in the 1980's as an upgrade to the 1970's-era ALQ-119. The ALQ-184 uses the same pod as the ALQ-119 but features higher jamming power output, lower response time to threat radar signals, and digital microprocessors to increase its capability against threat radar systems.

AN/ALQ-184 Long. The "Long" version of the ALQ-184 includes additional modules to provide protection against additional radar frequency bands.

(See Electronic Countermeasures for more information.)

AN/ASQ-T50 Tactical Combat Training System (TCTS) Pod

The AN/ASQ-T50 is a Tactical Combat Training System device. It incorporates a sensor platform and datalink transceiver, allowing it to record and transmit real-time aircraft telemetry to monitoring stations. TCTS pods are used during training exercises to monitor and record aircraft positions for many purposes, including debriefing analysis.

The TCTS pod is captive and cannot be released. It can be mounted to either outboard underwing pylon, or either wingtip station.

USAF

MXU-648 Travel Pod

The MXU-648 is a travel pod, used to transport equipment or the pilot's belongings when the aircraft is repositioned. The MXU-648 has a maximum load capacity of 300 pounds, and an internal volume of 4.75 cubic feet.

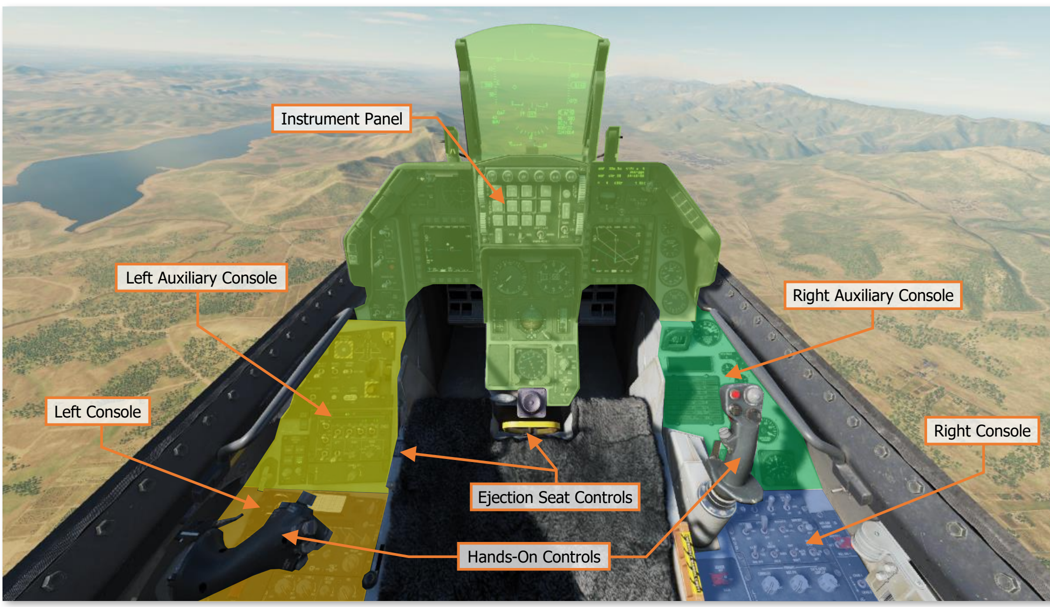
The MXU-648 can be mounted on any air-to-ground pylon.

SrA Theodore J. Koniares (USAF)

COCKPIT OVERVIEW

The F-16's cockpit layout, avionics, and fire control systems are optimized for operation by a single pilot. Critical controls that are needed for aerial combat are located on the Hands-On Controls (Side Stick Controller and Throttle) to provide rapid and seamless control of the radar and weapons during maneuvering flight when moving one's arms and hands under various G forces may be difficult.

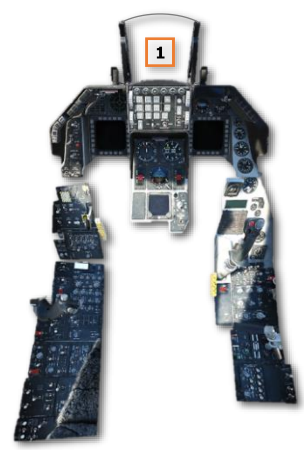
Essential information is displayed on the Heads-Up Display (HUD), the two Multi-Function Displays (MFD), and the Data Entry Display (DED). Panels that contain functions that are not typically needed after start-up are concentrated on the right console, with mission-related equipment or functions that may be used throughout the flight are concentrated on the left console for use by the throttle hand.



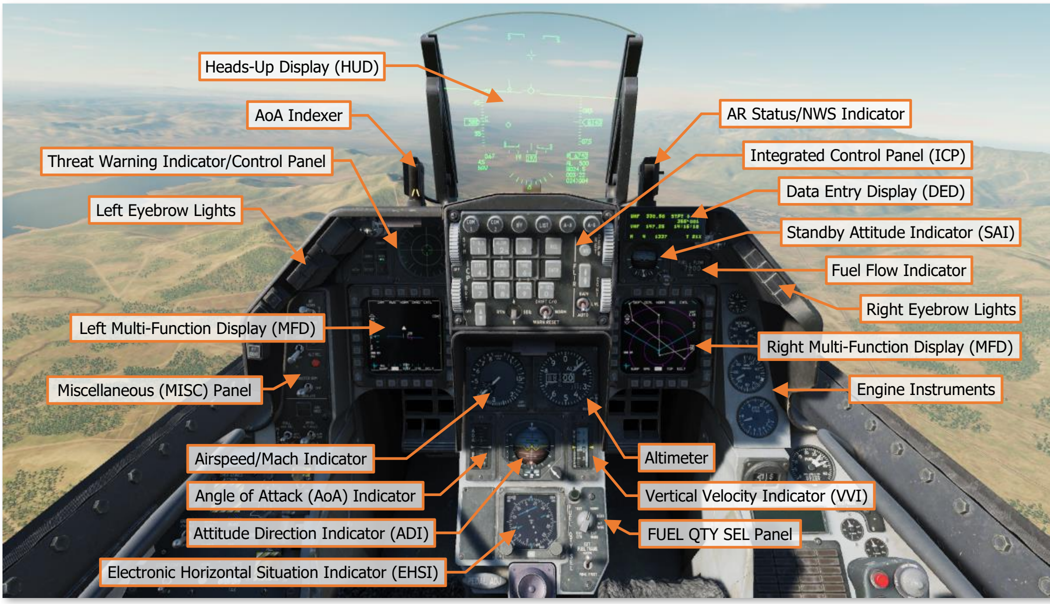
It is important to have a general understanding of where the various controls are located. To help locate items more easily, the cockpit has been delineated into five primary areas: **Left Console**, the **Left Auxiliary Console**, the **Instrument Panel**, the **Right Auxiliary Console,** and the **Right Console**.

Each text box above may be selected to jump to a more detailed description of that instrument panel or console, to include the **Hands-On Controls** and **Ejection Seat Controls**. Selecting the image of the instrument panel or console will return the manual back to this page.

Throughout this manual, a cockpit diagram (as shown at right) may be used to identify specific cockpit components that are used to perform procedures such as start-up, takeoff, navigation, or landing. The component location that is applicable to the step within the procedure will be marked with the corresponding number of the checklist or procedure item to assist the player in rapidly locating it. In the example to the right, the Heads-Up Display (HUD) is marked as step 1.



Instrument Panel

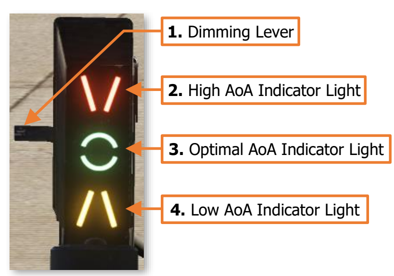


Each text box above may be selected to jump to a more detailed description of that individual instrument or panel. Selecting the image of the instrument or panel will return the manual back to this page.

The Heads-Up Display (HUD), Integrated Control Panel (ICP), Data Entry Display (DED), and Multi-Function Displays (MFD) are described in dedicated sections following the Hands-On Controls (HOTAS). The Threat Warning Indicator/Control Panel is described in the Defensive Systems chapter.

AoA Indexer

The Angle-of-Attack Indexer consists of three lights, which are duplicated from the AoA Indicator on the center instrument panel.



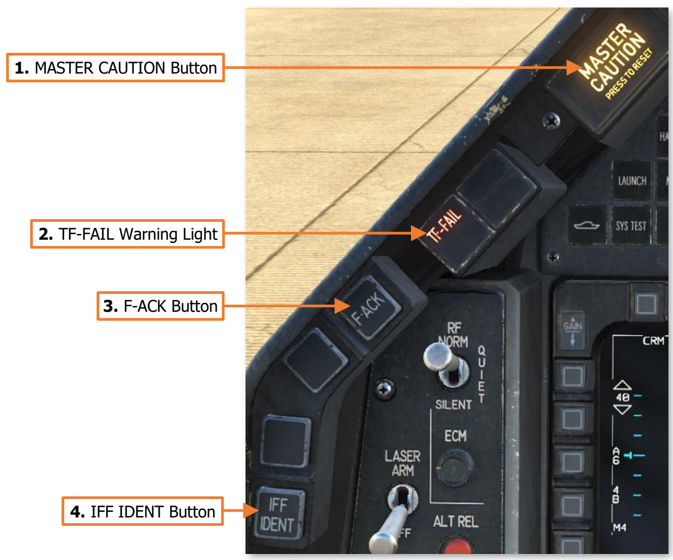
When landing, the pilot should maintain between 11° and 13° of AoA. Note that the AoA Indexer lights are always on, regardless of whether the gear is down or not.

1. **Dimming Lever.** Rotating the lever downward dims the indicator lights.
2. **High AoA Indicator Light.** Aircraft angle-of-attack is greater than 14° or greater. Aircraft is in an energy depleting, greater than optimal, angle-of-attack.
3. **Optimal AoA Indicator Light.** Aircraft angle-of-attack is between 11.1° and 13.9°. Aircraft is on-speed with optimal angle-of-attack.
4. **Low AoA Indicator Light.** Aircraft angle-of-attack is 11° or less. Aircraft is in an energy gaining, less than optimal, angle-of-attack.

AR Status/NWS Indicator

1. **Dimming Lever.** Rotating the lever downward dims the indicator lights.
2. **RDY Indicator Light.** Indicates the aerial refueling door is open and ready.
3. **AR/NWS Indicator Light.** When in the air, indicates that the refueling boom is latched. When on the ground and illuminated, indicates that the nosewheel steering is enabled and controlled using the rudder pedals.
4. **DISC Indicator Light.** Indicates when the refueling boom has disconnected. After a 3-second delay, the system will automatically recycle to ready.

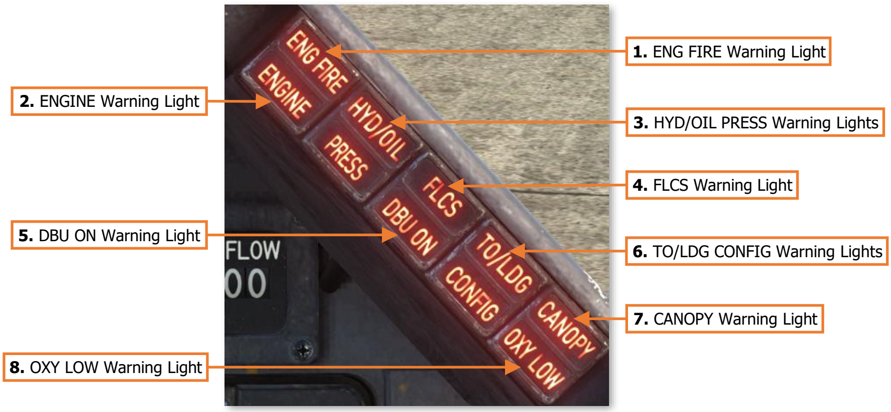
Left Eyebrow Lights



1. **MASTER CAUTION Button.** The MASTER CAUTION pushbutton light will illuminate anytime the Caution Light Panel indicates a malfunction or specific condition has occurred. It can be reset by pressing it.
2. **TF-FAIL Warning Light.** Not functional in the Block 50 F-16.
3. **F-ACK Button.** When a fault appears on the Pilot Fault List Display (PFLD), the Fault Acknowledge (F-ACK) button is pressed to acknowledge the fault message and, depending on the type of fault and severity, clear it from the PFLD.
4. **IFF IDENT Button.** When pressed, the transponder performs an identification-of-position function. This is used to momentarily highlight the ownship position when replying to non-encrypted transponder interrogations (non-Mode 4 interrogations).

Right Eyebrow Lights

Along the right eyebrow are a series of split emergency lights that often require immediate action when illuminated.



1. **ENG FIRE Warning Light.** Illuminates if a fire is detected in the engine compartment.
2. **ENGINE Warning Light.** Illuminates when RPM and FTIT indicator signals indicate an over-temperature, flameout, or stagnation has occurred. Extinguishes when the conditions no longer exist.
   - Engine RPM is less than 60%.

     or
   - Engine FTIT exceeds 1,100° C for 2 seconds or more.
3. **HYD/OIL PRESS Warning Lights.** Illuminate when the engine oil or hydraulics indicate low pressures within either of the systems.
   - Engine oil pressure falls below 10 PSI for more than 30 seconds. Extinguishes when engine oil PSI exceeds 20 PSI.

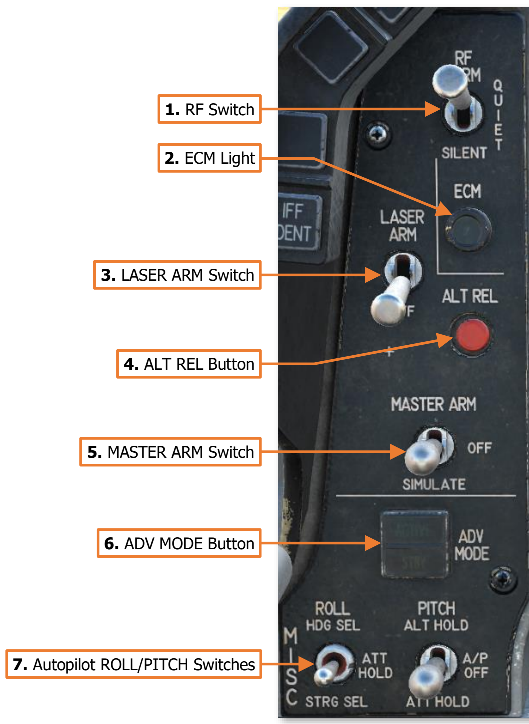
     or
   - Either hydraulic system (A or B) falls below 1,000 PSI. Extinguishes when both hydraulic systems exceed 1,000 PSI.
4. **FLCS Warning Light.** Illuminates when any of the following conditions exist:
   - A malfunction is detected within the FLCS processors, power supplies, input commands or sensors, or angle of attack or air data inputs.
   - FLCS built-in test has failed.
   - Leading-edge flaps are locked.
5. **DBU ON Warning Light.** Illuminates if the FLCS has automatically switched to Digital Backup mode or if manually commanded to DBU mode using the FLT CONTROL Panel.
6. **TO/LDG CONFIG Warning Lights.** Illuminate when each of the following conditions exist:
   - Altitude is less than 10,000 feet.
   - Airspeed is less than 190 knots.

- Descent rate is greater than 250 feet per minute.
- The landing gear is not down and locked or trailing edge flaps are not full down.

This will also correspond to the landing gear intermittent horn sound.

7. **CANOPY Warning Light.** Illuminates when the canopy is not down and locked.
8. **OXY LOW Warning Light.** Illuminates if the Backup Oxygen System (BOS) is depleted and <5 PSI. Illuminates for 10 seconds when an OBOGS BIT has been initiated and will remain illuminated if a fault is detected.

Miscellaneous (MISC) Panel



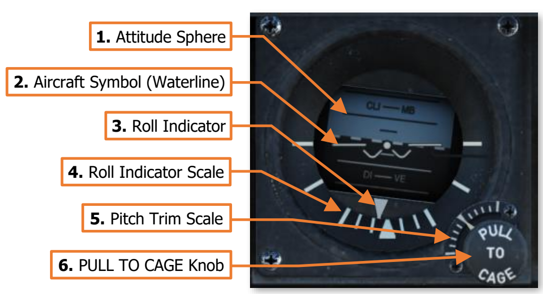
1. **RF Switch.** The Radio Frequency switch controls emissions from aircraft.
   - **NORM.** FCR emissions are permitted.
   - **QUIET.** FCR emissions are inhibited.
   - **SILENT.** FCR emissions are inhibited.
2. **ECM Enable Light.** Illuminates when the ECM pod is actively emitting jamming signals (if equipped and powered).
3. **LASER ARM Switch.** Arms the laser designator within the targeting pod sensor turret (if equipped and powered).
4. **ALT REL Button.** Functions as a backup to the weapons release button on the Side Stick Controller (SSC) in case of its malfunction.
5. **MASTER ARM Switch.** Enables/disables release of aircraft weapons.
   - **MASTER ARM.** FCR and stores management system provide weapons employment cues and symbology. Weapon release and emergency jettison is permitted.
   - **OFF.** Weapons release is inhibited. Emergency jettison is permitted.
   - **SIMULATE.** FCR and stores management system provide weapons employment cues and symbology, however weapon release is inhibited. Emergency jettison is permitted.
6. **ADV MODE Button.** The Advanced Mode button is a terrain following radar function and is not used in the Block 50 F-16.
7. **Autopilot ROLL and PITCH Switches.** Sets the Autopilot mode/sub-modes.
   - The PITCH switch enables/disables the Autopilot Attitude and Altitude Hold modes.
     - **ALT HOLD.** Enables the Autopilot in both Attitude Hold and Altitude Hold modes. Pitch attitudes will function to maintain current barometric altitude. Roll will function in accordance with the mode selected by the ROLL switch.

- A/P OFF. Disables the Autopilot.
- **ATT HOLD.** Enables the Autopilot in Attitude Hold mode only. Attitude Hold will hold current pitch attitude. Roll will function in accordance with the mode selected by the ROLL switch.

- The ROLL switch selects the Autopilot roll mode.
  - **HDG SEL.** The Autopilot will turn to and maintain the heading set by the Heading Set knob on the Electronic Horizontal Situation Indicator (EHSI).
  - **ATT HOLD.** The Autopilot will maintain the current roll attitude. If PITCH switch is set to the ALT HOLD position, the aircraft will maintain the bank angle and barometric altitude (useful for maintaining an orbit).
  - **STRG SEL.** The Autopilot will turn toward the selected steerpoint selected by the navigation system.
- The PITCH switch is automatically moved to the A/P OFF position if any of the following conditions exist:
  - AoA is >15°.
  - Low speed audio warning sounds.
  - The landing gear are extended and locked.
  - AIR REFUEL switch is set to OPEN position.
  - MPO switch is set to OVRD position.
  - TRIM/AP DISC switch is set to DISC position.
  - ALT FLAPS switch is set to EXTEND position.
  - Low speed audio warning sounds.
  - The autopilot has failed or malfunctioned.

Standby Attitude Indicator (SAI)

The Standby Attitude Indicator is a self-contained attitude indicator that displays aircraft pitch and roll only. The SAI is electrically powered and is operated by a vertical gyroscope.



The SAI can develop errors during aggressive maneuvers, which may require it to be caged in flight using the PULL TO CAGE knob. The SAI is mounted in the instrument panel at an angle which will cause the instrument to be 4° nose down compared to the ADI when both instruments are set to their respective pitch trim indexes. If the SAI is required to be caged in flight, the aircraft should be flown wings-level with the pitch held at 4° above the horizon.

A red OFF warning flag will appear when the indicator is caged, or electrical power to the SAI has been lost.

1. **Attitude Sphere.** Rotates within the SAI to indicate pitch and roll attitude throughout most orientations of flight, in relation to the Aircraft Symbol. The light blue hemisphere indicates the aircraft nose is pointed above the horizon toward the sky, in a climb. The dark brown hemisphere indicates the aircraft nose is pointed below the horizon toward the ground, in a dive.

2. **Aircraft Symbol (Waterline).** Provides a fixed attitude reference of the aircraft nose around which the Attitude Sphere rotates. The vertical alignment of the symbol can be manually adjusted using the PULL TO CAGE knob.

3. **Bank Angle Indicator.** Indicates bank angle relative to the horizon. When the indicator is aligned with the fixed triangular bank angle index, the aircraft is in a level attitude.

4. **Bank Angle Indicator Scale.** Indicates the bank angle when used in conjunction with the Bank Angle Indicator. A white triangular bank angle index is set at 0° of bank. Major tick marks are placed at 30°, 60° and 90° angles of bank. Minor tick marks are placed at 10° and 20° angles of bank.

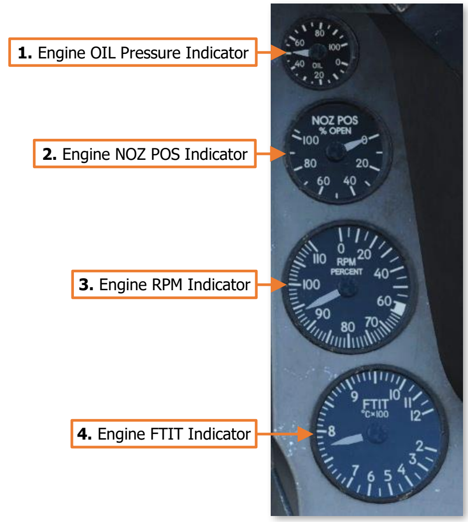
5. **Pitch Trim Scale.** Provides a reference scale of aircraft pitch when rotating the PULL TO CAGE knob to adjust the relative pitch of the Aircraft Symbol. Major tick marks are placed at each side of the Pitch Trim Scale at 25° of pitch and minor tick marks are placed at every 5° of pitch.

6. **PULL TO CAGE Knob.** Cages the SAI and used to adjust the relative pitch of the Aircraft Symbol in relation to the Attitude Sphere. If the knob arrow is aligned with the white triangular index on the Pitch Trim Scale, the SAI pitch trim is at zero. When the knob is pulled outward, the Attitude Sphere is caged to a level attitude orientation regardless of the aircraft's actual attitude, causing the OFF warning flag to appear. When pulled outward and rotated counterclockwise, the SAI is locked in the caged position.

Fuel Flow Indicator

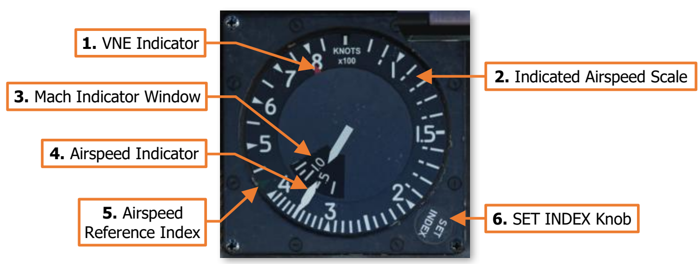
The FUEL FLOW Indicator displays the current engine fuel consumption rate in pounds per hour (PPH), in 100-pound increments.

Engine Instruments



1. **Engine OIL Pressure Indicator.** Indicates the current oil pressure within the engine's self-contained oil lubrication system. The indicator range is 0 PSI to 100 PSI, with major tick marks in 10 PSI increments and minor tick marks in 5 PSI increments. Normal indication is 15 PSI when on the ground at idle, and 60 PSI when in the air at military power and above.
2. **Engine NOZ POS Indicator.** Indicates the current engine nozzle position as a percentage, with major tick marks in 20% increments and minor tick marks in 10% increments.
3. **Engine RPM Indicator.** Indicates the current engine RPM as supplied by the engine alternator. The indicator range is 0% to 110%, with major tick marks every 5%, and minor tick marks every 5% from 0%-60% and every 1% above 65%.
4. **Engine FTIT Indicator.** Indicates the current engine Fan Turbine Inlet Temperature (FTIT) in an average temperature in degrees Celsius. The indicator range is 200° C to 1,200° C, with major tick marks every 100° increments from 200°-700° and 1000°-1200°, and every 50° from 700°-1000°. Minor tick marks every 50° increments from 200°-700° and 1000°-1200°, and every 10° from 700°-1000°.

Airspeed and Mach Indicator



The Airspeed and Mach indicator is pneumatically operated by the pitot-static system.

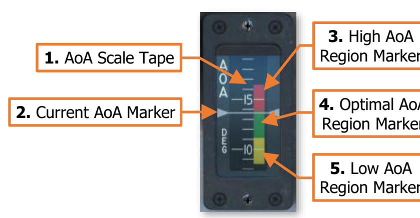
1. **VNE Indicator.** Indicates Velocity Never Exceed. This corresponds with 800 knots at sea level.
2. **Indicated Airspeed Scale.** The outer scale of the instrument, from 80 to 850 knots. Tick marks are set at 10-knot increments between 80 and 400 knots, and 50-knot increments between 400 and 850 knots.
3. **Mach Indicator Window.** Indicates Mach equivalent airspeed from 0.5 to 2.2 Mach.
4. **Airspeed Indicator.** Indicates indicated airspeed along the outer Indicated Airspeed Scale and Mach speed within the Mach Indicator Window.
5. **Airspeed Reference Index.** Pilot-adjustable airspeed reference marker.
6. **SET INDEX Knob.** Adjusts the Airspeed Reference Index position.

Altimeter

The Altimeter is a dual-mode pressure altimeter that is electrically operated by the CADC when set to the ELEC mode, or by static pressure from the pitot-static system when set to PNEU mode.

1. **1000-foot Altitude Scale.** Each major tick mark corresponds with 100-foot increments, with minor tick marks corresponding to 10-foot increments.
2. **1000-foot Scale Indicator.** Indicates the aircraft altitude on the outer 1000-foot scale.
3. **PNEU Flag.** Indicates the altimeter is operating in in PNEU (pneumatic) mode. The altimeter will automatically revert from ELEC to PNEU mode if a malfunction occurs within the CADC or the altimeter electric servo.
4. **Altitude Indicator.** Indicates the current barometric altitude in 100-foot increments from -1,000 feet to 80,000 feet.
5. **"Kollsman" Window.** Indicates current altimeter setting correction in inches of mercury (in/Hg). The altimeter setting on the F-16 is designed to be used in conjunction with QNH barometric altimeter settings to calibrate the altimeter to altitudes above mean sea level (MSL).
6. **Barometric Setting Knob.** Sets altimeter setting correction as displayed in the "Kollsman" Window.
7. **Altimeter Mode Switch.** Selects ELEC (primary) or PNEU (secondary) operating modes of the altimeter by momentarily holding the swtich to either position.

Angle-of-Attack (AoA) Indicator

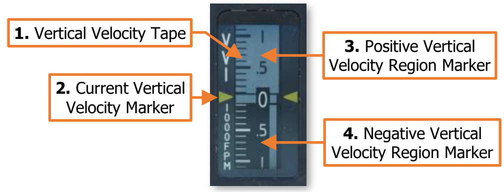


The Angle-of-Attack Indicator displays the same information as the Angle-of-Attack Indexer next to the HUD. The indicator includes colored markers to match the indexer lights next to the HUD.

1. **AoA Scale Tape.** Displays angle-of-attack in a scale from -5° and +32°. Each major tick mark corresponds with 5°-increments, with minor tick marks corresponding to 1°-increments.
2. **Current AoA Marker.** Indicates the aircraft's current angle-of-attack.
3. **High AoA Region Marker.** Indicates an AoA between 14° to 16.5°. Aircraft is in an energy depleting, greater than optimal, angle-of-attack.
4. **Optimal AoA Region Marker.** Indicates an AoA between 11.1° to 13.9°. Aircraft is on-speed with optimal angle-of-attack.
5. **Low AoA Region Marker.** Indicates an AoA between 8.5° to 11°. Aircraft is in an energy gaining, less than optimal, angle-of-attack.

Vertical Velocity Indicator (VVI)

The Vertical Velocity Indicator, or VVI, displays the rate of climb or descent based on information from the CADC.



1. **Vertical Velocity Tape.** Displays vertical velocity in a scale of ±6,000 feet per minute (FPM). Each major tick mark corresponds with 500 FPM increments, with minor tick marks corresponding to 100 FPM increments.
2. **Current Vertical Velocity Marker.** Indicates the current Vertical Velocity.
3. **Positive Vertical Velocity Region Marker.** The light-shaded region indicates a positive vertical velocity or climb.
4. **Negative Vertical Velocity Region Marker.** The dark-shaded region indicates a negative vertical velocity or descent.

Attitude Director Indicator (ADI)

The Attitude Director Indicator, or ADI, displays the aircraft's pitch and roll attitude as supplied by the inertial navigation system, or INS. The ADI includes additional indicators for performing flight while using radio-based navigational aids (NAVAIDs), such as TACAN and ILS stations.

(See TACAN Navigation or ILS Navigation for more information.)

1. **Attitude Sphere.** Rotates within the ADI to indicate pitch and roll attitude throughout all orientations of flight, in relation to the Aircraft Symbol. The light blue hemisphere indicates the aircraft nose is pointed above the horizon toward the sky, in a climb. The dark brown hemisphere indicates the aircraft nose is pointed below the horizon toward the ground, in a dive.
2. **Upper Bank Angle Indicator.** Indicates bank angle relative to the horizon. When the indicator is aligned with the fixed outside bank angle index, the aircraft is in a level attitude.
3. **Pitch Scale.** Provides an attitude reference scale of aircraft pitch in relation to the Aircraft Symbol. Major tick marks are placed at every 10° of pitch and minor tick marks are placed at every 5° of pitch.
4. **Glide Slope Deviation Indicator.** Indicates the relative position of the glide slope when performing an ILS approach. If the indicator is aligned with the center tick mark, the aircraft is on glide slope. If the indicator is above the center of the Glide Slope Deviation Scale, the aircraft is below the ILS glide slope and should shallow the flight path to intercept the glide slope. If the indicator is below the center of the Glide Slope Deviation Scale, the aircraft is above the ILS glide slope and should steepen the flight path to intercept the glide slope.

5. **Glide Slope Deviation Scale.** Provides a vertical reference of relative aircraft position above or below the Glide Slope when tuned to an ILS approach frequency and roughly aligned with the approach path for the associated landing area. Each white dot corresponds with a 2.5° vertical separation from the glide slope. If the Glide Slope Indicator is aligned with the top or bottom white dot of the Glide Slope Deviation Scale, the aircraft is 5° above or 5° below the glide slope, respectively. (See ILS Navigation for more information.)

6. **Aircraft Symbol (Waterline).** Provides a fixed attitude reference of the aircraft nose around which the Attitude Sphere rotates. The vertical alignment of the symbol can be manually adjusted using the Pitch Trim knob.

7. **OFF Warning Flag.** Indicates a failure of the INS or a failure of the ADI itself.

8. **AUX Warning Flag.** Indicates a failure or degraded operation of the INS.

9. **Lower Bank Angle Scale.** Indicates the bank angle when used in conjunction with the Lower Bank Angle Indicator. A white triangular bank angle index is set at 0° of bank. Major tick marks are placed at 30°, 60° and 90° angles of bank. Minor tick marks are placed at 10° and 20° angles of bank.

10. **Lower Bank Angle Indicator.** Indicates bank angle relative to the horizon. When the indicator is aligned with the fixed outside bank angle index, the aircraft is in a level attitude.

11. **Slip Indicator (Ball).** Indicates whether the aircraft is in coordinated flight. With the ball centered between the two black marks, the aircraft is in coordinated flight, which minimizes drag. When performing a "coordinated turn" with the ball kept in the center of the slip indicator, the centripetal force of the turn is maintained in alignment with the bottom of the aircraft, and no lateral acceleration is experienced by the pilot. If the ball slides to one side in the same direction of a bank, the aircraft is in a non-coordinated "slipping turn". If the ball slides to one side in the opposite direction of a bank, the aircraft is in a non-coordinated "skidding turn".

12. **Rate of Turn Indicator.** Indicates the aircraft rate of turn, with the lower white bar moving left and right to indicate an increased turn rate in that direction. One bar width equates to 1° to 1.2° per second turn rate. If the lower white bar is aligned with the upper white bar in the center, the aircraft is not turning. If the lower white bar is aligned with the upper white bars on the left or right, the aircraft is in a standard rate, 3° per second turn. If the lower white bar is centered between two of the upper white bars, the aircraft is in a half standard rate turn.

13. **Pitch Trim Knob.** Used to adjust the relative pitch of the Attitude Sphere in relation to the Aircraft Symbol. If the knob arrow is aligned with the white dot on the face of the ADI, the ADI pitch trim is at zero. Each click of rotation of the knob will adjust the pitch trim ±0.5°.

Electronic Horizontal Situation Indicator (EHSI)

The Electronic Horizontal Situation Indicator (EHSI), or simply "HSI", is a color liquid-crystal display (LCD) that provides the pilot with a top-down view, with the aircraft in the center of the display. The EHSI includes additional indicators for performing flight while using radio-based navigational aids (NAVAIDs), such as TACAN and ILS stations. (See TACAN Navigation or ILS Navigation for more information.)

1. **Magnetic Heading Compass.** Displays the magnetic heading reference around the Aircraft Symbol. Major tick marks are placed at every 10° of azimuth and minor tick marks are placed at every 5° of azimuth.

2. **Heading Marker.** Indicates the current heading reference as set by the Heading Set knob. If the Autopilot ROLL switch on the MISC panel is set to the HDG SEL position, the aircraft will turn to and maintain this heading value.

3. **Range Indicator.** Displays the range in nautical miles (NM) to the currently selected navigation source. If the EHSI is in NAV mode, range to the selected steerpoint is displayed. If the EHSI is set to TCN or TCN/PLS mode, the distance to the current TACAN station is displayed if receiving valid DME (Distance Measuring Equipment) signals. The last digit of the range indicator (highlighted in white) provides a range resolution of 0.1 NM.

4. **Course Indicator.** Displays the current course as set by the Course Set knob.

5. **Warning Display Area.** Displays a failure message indicating a loss in data, such as failures or malfunctions in the INU.

6. **Bearing Pointer.** Indicates the bearing to the currently selected navigation source. If the EHSI is in NAV mode, bearing to the selected steerpoint is displayed. If the EHSI is set to TCN or TCN/PLS mode, bearing to the current TACAN station is displayed if receiving a valid bearing signal.

7. **Course Pointer.** Indicates the current course direction as set by the Course Set knob.

8. **Course Deviation Scale.** Provides a lateral reference of relative aircraft position to either side of the course line. Each white dot corresponds with a 5° lateral separation from the course when the EHSI is in NAV or TCN mode. Each white dot corresponds with a 1.25° lateral separation from the course when the EHSI is in PLS mode. If the Course Deviation Indicator is aligned with either of the outside white dot of the Course Deviation Scale, the aircraft is 10° left or right of the course line if EHSI is in NAV or TCN mode, or 2.5° left or right of the ILS localizer if the EHSI is in PLS mode. (See Navigation for more information.)

9. **Course Deviation Indicator.** Indicates the relative position of the set course to the currently selected navigation source. If the indicator is aligned with the course pointer, the aircraft aligned with the set course to or from the selected navigation source. If the indicator is offset to either side, the aircraft has laterally deviated from the set course to or from the selected navigation source.

10. **Aircraft Symbol.** Provides an overhead plan-view of the aircraft orientation around which the Magnetic Heading Compass rotates.

11. **Heading Set Knob.** Rotating this knob sets the current heading reference on the EHSI, as displayed by the Heading Marker.

12. **Course Set/Brightness Knob.** Rotating this knob sets the course on the EHSI, as displayed by the Course Indicator and Course Pointer. If the knob is depressed, "BRT" will appear in the center of the display just above the Aircraft Symbol, at which time the knob can be used to increase/decrease the brightness intensity of the EHSI LCD display. After two seconds of inactivity, the knob will return to its normal function of setting the EHSI course.

13. **Instrument Mode Selector.** Switches through the available Instrument Modes of the EHSI in a cyclic, repeating sequence of NAV, NAV/PLS, TCN, TCN/PLS, back to NAV, and so on.

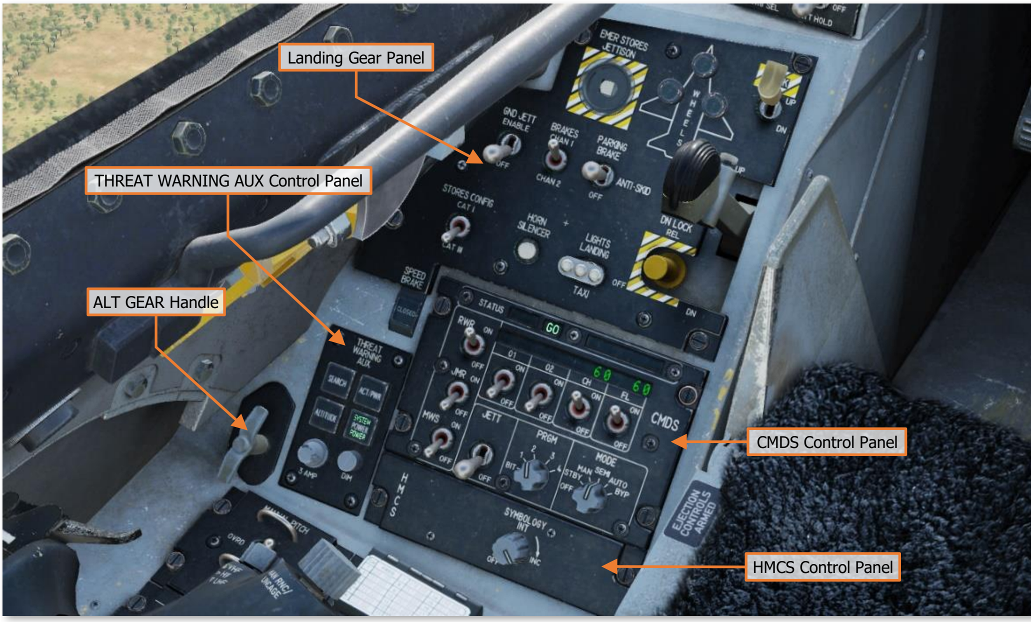
14. **Current Instrument Mode.** Displays the current operating mode of the EHSI. Operating modes include NAV, NAV/PLS, TCN, or TCN/PLS. When set to NAV, the EHSI provides steering and range indications to the currently selected steerpoint. When set to NAV/PLS, the EHSI functions the same as in NAV mode but will provide ILS-based course deviation indications when the ILS receiver is powered, an ILS frequency is tuned, and a localizer signal is received. Accordingly, when set to TCN/PLS, the EHSI functions the same as in TCN mode but will provide ILS-based course deviation indications when the ILS receiver is powered, an ILS frequency is tuned, and a localizer signal is received.

FUEL QTY SEL Panel

The Fuel Quantity Select panel allows the pilot to change what fuel tank(s) are used as the indication source(s) for the Fuel Quantity Indicator analog needles; and set fuel transfer priority from external fuel tanks.

1. **FUEL QTY SEL Knob.** Controls the analog fuel pointers on the Fuel Quantity Indicator.
   - **TEST.** Both analog fuel pointers should be set to 2000 pounds. The Fuel Totalizer window should display 6000 pounds. The FWD FUEL LOW and AFT FUEL LOW lights should illuminate on the Caution Light panel.
   - **NORM.** The AL fuel pointer indicates the sum of fuel in the aft reservoir and the A-1 fuselage tank. The FR pointer indicates the sum of fuel in the forward reservoir tank and the F-1 and F-2 fuselage tanks. Enables bingo fuel computation based on total fuselage fuel.
   - **RSVR.** The AL pointer indicates remaining fuel in the aft reservoir tank only. The FR pointer indicates remaining fuel in the forward reservoir tank only.
   - **INT WING.** The AL pointer indicates remaining fuel in the left internal wing tank only. The FR pointer indicates remaining fuel in the right internal wing tank only.
   - **EXT WING.** The AL pointer indicates remaining fuel in the left external wing tank only. The FR pointer indicates remaining fuel in the right external wing tank only.
   - **EXT CTR.** The FR pointer indicates remaining fuel in the external centerline fuel tank. The AL pointer will indicate 0.
2. **EXT FUEL TRANS Switch.** Controls the fuel transfer priority from external fuel tanks.
   - **NORM.** Transfers fuel from the external centerline tank, followed by the external wing tanks.
   - **WING FIRST.** Transfers fuel from the external wing tanks, followed by the external centerline tank.

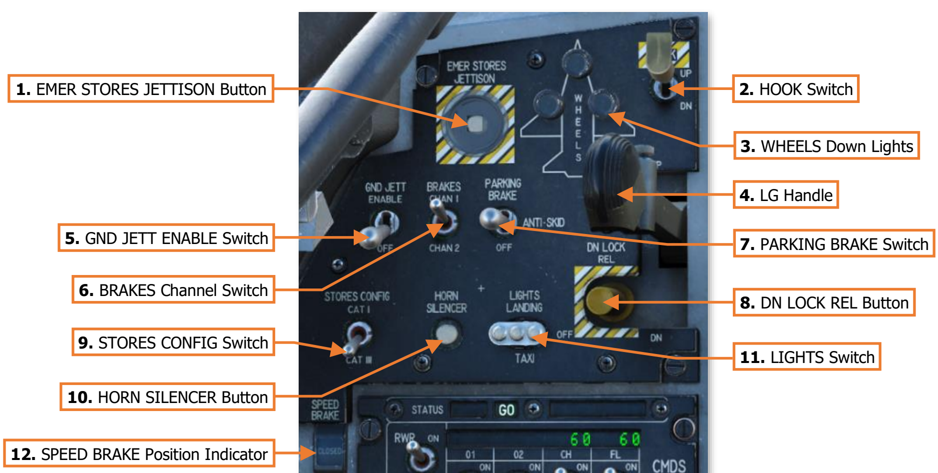
Left Auxiliary Console



Each text box above may be selected to jump to a more detailed description of that panel. Selecting the image of the instrument or panel will return the manual back to this page.

The CMDS Control Panel and THREAT WARNING AUX Control Panel are described in the Defensive Systems chapter.

Landing Gear Panel



1. **EMER STORES JETTISON Button.** When pressed for one full second, this button will apply power to the Stores Management System (SMS) and initiate a jettison sequence of all external fuel tanks, carted suspension racks, and free fall ordnance loaded on stations 3 through 7. Air-to-air missiles will not be jettisoned, nor their missile launchers. There is no requirement for the aircraft to be armed. If the aircraft is on the ground with weight-on-wheels, the GND JETT ENABLE switch is required to initiate the emergency jettison sequence.

2. **HOOK Switch.** This switch extends the hook for emergency arrestment on airfields equipped with an arrestment system. However, once the hook is dropped, it cannot be fully retracted from the cockpit. (N/I)

   - **UP.** Commands the pneumatic pressure holding the hook extended to release, allowing the hook to be raised over runway arresting wires to taxi clear.

   - **DN.** Commands the hook to be released from its stowed position and held to its full extension using pneumatic pressure.

3. **WHEELS Down Lights.** These show the state of the main landing gear and nosewheel. When green, the respective landing gear is down and locked.

4. **LG Handle.** Movement of the handle operates electrical switches to command landing gear retraction or extension. A warning light in the LG handle illuminates when the gear and doors are in transit or have failed to lock in the commanded position. The LG handle warning light also illuminates when the TO/LDG CONFIG warning light illuminates on the right eyebrow lights panel.

5. **GND JETT ENABLE Switch.** Used by maintenance personnel for checkout and testing of aircraft armament systems.

   - **ENABLE.** All arming and release conditions are permitted, regardless of landing gear or weight-on-wheels conditions.

   - **OFF.** When the landing gear are down and the aircraft has weight-on-wheels emergency jettison, selective jettison, and normal weapons release functions are inhibited. When the landing gear is down, selective jettison and normal weapons release functions are inhibited.

6. **BRAKES Channel Switch.** Selects Channel 1 or Channel 2 through which the toe brakes initiate main landing gear braking action. This switch is normally kept in the CHAN 1 position.

7. **ANTI-SKID Switch.** Controls the anti-skid and parking brake functions of the wheel brakes.

   - **PARKING BRAKE.** Applies full brake pressure to each main landing gear brakes when weight-on-wheels and the throttle is in the OFF or IDLE positions. If the throttle is advanced 1 inch beyond IDLE, the switch will automatically be spring-loaded to the ANTI-SKID position and the parking brake will be disengaged. Can be used as an emergency brake in case of a toe brake failure.

   - **ANTI-SKID.** Available any time the toe brakes are powered. When the toe brakes are applied to less than 85%, the anti-skid system provides deceleration skid control. When the toe brakes are applied at 85% or greater, the anti-skid system provides maximum performance skid control.

   - **OFF.** Anti-skid and parking brake functions are disabled.

8. **DN LOCK REL Button.** Mechanically unlocks the spring-actuated lock that holds the LG handle in place, should the associated electrical solenoid fail or not be powered. It also overrides the weight-on-wheels signal and allows the landing gear to be retracted while on the ground if the LG handle is raised.

9. **STORES CONFIG Switch.** Sets the FLCS mode of operation based on external wing stores. When set to CAT III the FLCS limits the angle of attack and onset rates in order to increase departure resistance. This switch has no effect when the FLCS gains are set to takeoff/landing configuration (landing gear deployed or air refueling door open).

   - **CAT I.** Used for air-to-air loadouts without external wing tanks.

- **CAT III.** Used for air-to-ground loadouts or when equipped with external wing tanks.

10. HORN SILENCER Button. Silences the landing gear warning or low-speed warning audio tones.

11. LANDING TAXI LIGHTS Switch. Controls the nose landing gear-mounted light assemblies for takeoff/landing or taxi operations. The lights are automatically disabled when the LG Handle is raised to the UP position.

- **LANDING.** Enables the Landing light.
- **OFF.** The Landing and Taxi lights are disabled.
- **TAXI.** Enables the Taxi light.

12. SPEED BRAKE Position Indicator. Indicates whether the speedbrakes are deployed, fully-retracted, or if receiving no power. When the speedbrakes are fully-retracted the indicator displays CLOSED (left image). When the speed brakes are deployed at any angle, the indicator displays a pattern of nine dots (right image). If the speedbrakes have no power, the indicator displays a striped line pattern (not shown).

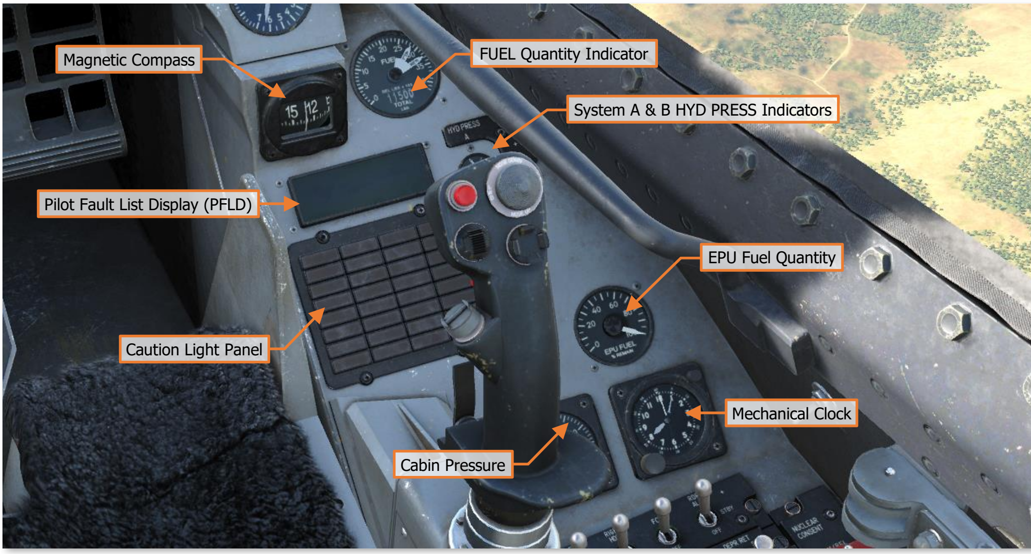
HMCS Control Panel

Controls the brightness of the HMCS symbology projected onto the helmet visor. Rotating the knob clockwise increases the brightness intensity of the symbology and rotating it to the OFF position removes the HMCS symbology from the visor.

ALT GEAR Handle

The Alternate Gear Handle releases the landing gear in case of a hydraulic failure or inability to lower the main landing gear handle. (N/I)

Right Auxiliary Console



Each text box above may be selected to jump to a more detailed description of that individual instrument or panel. Selecting the image of the instrument or panel will return the manual back to this page.

Magnetic Compass

The magnetic compass is a self-contained indicator which shows the heading of the aircraft in relation to magnetic north.

Fuel Quantity Indicator

The FUEL Quantity Indicator displays total remaining fuel in all tanks via the totalizer numerical readout in pounds (lbs) of fuel. Two analog needles indicate fuel in Aft and Left (AL) and Forward and Right (FR) tanks in 100-pound increments.

The FUEL QTY SEL knob can be used to change which internal or external fuel tanks the analog needles are referencing to display calculated fuel quantity.

If the two needles become too divergent, indicating a fuel imbalance, red will be shown at the base of a needle. In such a case, the ENGINE FEED knob on the FUEL Control Panel can be used to correct the imbalance.

Pilot Fault List Display (PFLD)

The Pilot Fault List Display, or PFLD, lists all FLCS detected faults.

Two types of PFLDs are displayed: WARNING level and CAUTION level. Warnings are associated with the FLCS and have a bracket around them. Cautions are associated with other FLCS elements, engine, and avionics systems.

When a PFLD item is displayed, its corresponding caution light indicator will illuminate, and the MASTER CAUTION light will be lit. To clear a PFLD fault, the fault acknowledge (F-ACK) button is pressed.

Caution Light Panel

The Caution Light panel consists of multiple indicator lights associated with possible detected fault conditions.

FLCS FAULT. A dual malfunction has occurred in the Flight Control Computer (FLCC) electronics, the leading-edge flaps (LEF) are locked, or the FLCS BIT has failed.

ENGINE FAULT. An engine-related fault has been detected. Extinguishes when the fault is acknowledged.

AVIONICS FAULT. An avionics-related fault has been detected or the Multiplex Bus (MUX) has lost communication with the engine or the FLCC.

SEAT NOT ARMED. The ejection seat arming lever is in the dis-armed (up) position.

ELEC SYS. An electrical fault has been detected and an associated indicator light is illuminated on the ELEC Control Panel.

SEC. Engine is operating in Secondary control mode.

EQUIP HOT. Cooling air temperature or pressure to the avionics bay is insufficient. Automatically interrupts electrical power to the FCR.

NWS FAIL. A failure in the nose wheel steering system has occurred.

PROBE HEAT. Air flow to the pitot, fuselage air data, or AoA probes has decreased to a level that may indicate an icing condition; or a probe heater or the monitoring system has failed.

FUEL/OIL HOT. Fuel supplied to the engine or the engine oil has become excessively hot.

RADAR ALT. The radar altimeter has malfunctioned.

ANTI SKID. The Anti-Skid switch has been set to the OFF position or a malfunction has been detected in the braking system while ground speed is >5 knots.

CADC. A malfunction in the Central Air Data Computer has been detected.

INLET ICING. Ice accumulation has been detected by the engine inlet ice detector or the inlet ice detector has failed.

IFF. The IFF system has received a Mode 4 interrogation but cannot reply due to Mode 4 replies being inhibited by the RF switch on the Instrument Panel or the MODE 4 REPLY switch on the IFF control panel, or the Mode 4 has been zeroized.

HOOK. The emergency arresting hook is not up and locked in its stowed position.

STORES CONFIG. The STORES CONFIG switch is in the wrong position.

OVERHEAT. An overheat condition has been detected in the engine compartment, main landing gear wheel wells, ECS bay, or EPU bay.

NUCLEAR. (Not implemented)

OBOGS. ECS air pressure is <10 PSI.

ATF NOT ENGAGED. No function.

EEC. No function.

CABIN PRESS. Cockpit pressure altitude is >27,000 feet.

FWD FUEL LOW. Forward reservoir fuel quantity is <400 lb.

BUC. No function.

AFT FUEL LOW. Aft reservoir fuel quantity is <250 lb.

Hydraulic Pressure (System A & System B) Indicators

The HYD PRESS A & B gauges indicate the current pressures for hydraulic systems A and B respectively, in 500 PSI increments from 0 to 4000 PSI. Normal operation is between 2,850 and 3,250 PSI.

EPU Fuel Quantity Indicator

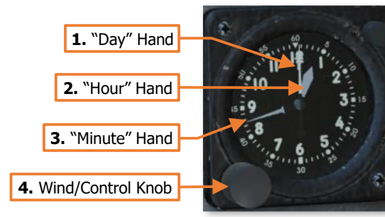
The EPU Fuel Quantity gauge indicates the remaining supply of hydrazine as a percentage in 5% increments. At 100%, the EPU can run for approximately 10-15 minutes.

Cabin Pressure

The Cabin Pressure gauge indicates the current cockpit pressure expressed as an altitude, in 1,000-foot increments from 0 to 50,000 feet.

As an example, an indication of 7 on this gauge indicates the cockpit pressure is equal to a pressure altitude of 7,000 feet.

Mechanical Clock



The mechanical clock is an 8-day, manually wound clock. The clock time can be adjusted by pulling the knob and rotating it until the time is set as desired.

1. **"Day" Hand.** One full revolution equals 8 days.
2. **"Hour" Hand.** One full revolution equals 12 hours, indicated by the inner clock ring.
3. **"Minute" Hand.** One full revolution equals 60 minutes, indicated by the outer clock ring.
4. **Wind/Control Knob.** Rotating this knob clockwise winds the clock spring. Rotating this knob in either direction while pulled adjusts the clock to the desired time.

NOTE: The mechanical clock is automatically set to local time at mission start.

Left Console

Each text box above may be selected to jump to a more detailed description of that panel. Selecting the image of the instrument or panel will return the manual back to this page.

The UHF Backup Control Panel is described in the Radio Communications chapter. The ECM Control Panel is described in the Defensive Systems chapter.

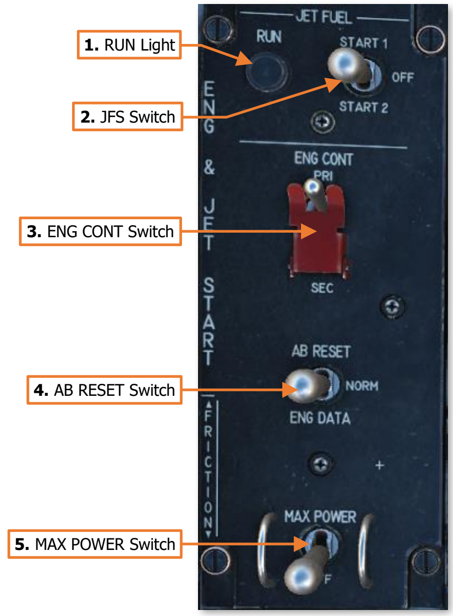
Manual Pitch Override Switch

In case of a deep stall departure, the Manual Pitch Override (MPO) switch allows the pilot to command greater authority from the horizontal stabilators to reinforce pitch oscillations until sufficient pitch rates are present for recovery into controlled flight. The guards on either side of the switch allow the pilot to better grip the switch in case of an inverted departure when hanging upside down from the seat straps.

- **NORM.** Normal operation. The switch is spring-loaded to this position.
- **OVRD.** When held to this position, the horizontal stabilator authority is increased to assist with recovery. Note that pilot roll and yaw commands from the Side Stick Controller (SSC) are inhibited when the switch is held in this position, however the rudder pedals will still retain yaw input authority.

ENG & JET START Control Panel

The Engine & Jet Start panel governs the start system for the F110-GE-129 engine and related controls.



1. **JET FUEL – RUN Light.** Illuminates within 30 seconds after JFS initiation to indicate the Jet Fuel Starter (JFS) is operating at its governed speed.

2. **JET FUEL – JFS Switch.** The JET FUEL switch uses one or both brake/JFS accumulators to drive the hydraulic starter motor of the Jet Fuel Starter. Note that the JFS can still be started even if the MASTER switch on the FUEL control panel is set to OFF.

   - **START 1.** A single brake/JFS accumulator is used to spool up the JFS into operation.
   - **OFF.** Turns off the Jet Fuel Starter. During ground starts, the JFS will automatically switch OFF when the engine RPM attains 55%. During in-flight restarts the JFS will not automatically shut down and must be manually switched to OFF.
   - **START 2.** Both brake/JFS accumulators are used to spool up the JFS into operation.

3. **ENG CONT Switch.** Manually selects the engine control mode.

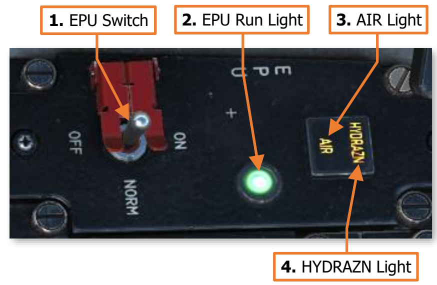
   - **PRI.** Sets engine operation to Primary control mode. This position is used for normal operations, which utilizes the Digital Electronic Control (DEC) to manage the functions of the engine and the afterburner. The DEC is an electronic computer that controls fuel flow, fan and core speed limiting, turbine temperature limiting, pressure ratios, nozzle position, and ensures stable operation throughout all altitudes, airspeeds, and maneuvers to prevent compressor stalls or engine damage.
   - **SEC.** Sets engine operation to Secondary control mode and illuminates the SEC caution light on the Caution Light panel. This system uses only the hydromechanical fuel scheduling of the Main Engine Control (MEC) in case of a malfunction or failure in the DEC. This mode may be entered automatically by the DEC or manually selected by the pilot. When operating in Secondary mode the afterburner will be unavailable, the nozzle will be fixed in the closed position, temperature and speed limiting will be disabled, and overall thrust will be reduced but the engine will produce higher thrust at idle power.

4. **AB RESET Switch.** Spring-loaded to the NORM position and used to record engine diagnostic data. (N/I)

   - **AB RESET.** This switch position is not functional in F-16s equipped with the F110-GE-129 engine.
   - **NORM.** Normal position.
   - **ENG DATA.** Momentarily moving switch to this position records 8 seconds of engine data into the Engine Monitoring System Computer (EMSC), starting with 6 seconds prior to the switch being moved to the ENG DATA position to 2 seconds following.

5. **MAX POWER Switch.** This switch is not functional in F-16s equipped with the F110-GE-129 engine.

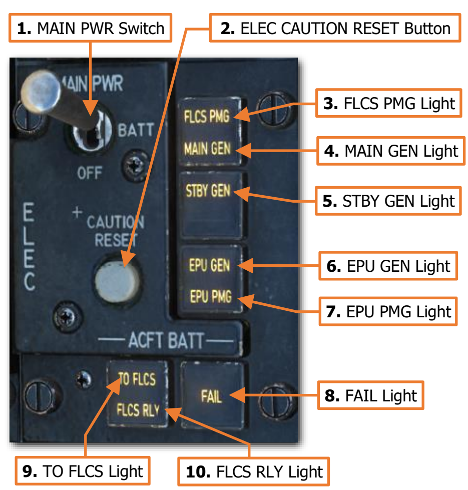
EPU Control Panel



The Emergency Power Unit is a bleed air- and/or hydrazine-powered, self-contained unit that can provide emergency hydraulic and electrical power for approximately 10 to 15 minutes. In the case of an engine failure, the EPU provides power to the Hydraulic system A and electrical systems.

1. **EPU Switch.** Sets the EPU to automatic operation or manually commands the EPU on/off.
    - **OFF.** Manually commands the EPU off during ground operations. Manually commands the EPU off in flight unless both the main and standby generators have failed. EPU operation will be inhibited in flight if the switch has remained in the OFF position since takeoff.
    - **NORM.** Used during normal operations. If set to NORM at any time since takeoff, the EPU will be commanded on automatically if power from the main and standby generators has been lost, or both hydraulic systems have failed. If aircraft is on the ground and the engine is shut down, the EPU will not automatically be commanded to on.
    - **ON.** Manually commands the EPU to on.
2. **EPU Run Light.** Illuminates when the EPU is operating and EPU-driven hydraulic pump discharge pressure is >2,000 PSI.
3. **AIR Light.** Illuminates when the EPU is operating using engine bleed air.
4. **HYDRAZN Light.** Illuminates when the EPU is operating using hydrazine, which is typically required when engine RPM drops below 82%-90%, depending on pressure altitude, or if the engine fails completely.

ELEC Control Panel



The Electrical panel provides controls for the selecting electrical power sources and indications of malfunctions within the electrical system and electrical supply to the FLCS channels.

1. **MAIN PWR Switch.** Selects the electrical power source for the aircraft.
    - **MAIN PWR.** Connects main engine generator or external power to the electrical system. Enables the standby generator. If AC power is not available, battery power is supplied to the battery bus only.
    - **BATT.** Disconnects main generator and external power from the electrical system and resets main generator. Disables the standby generator. Battery power is supplied to the battery bus only.
    - **OFF.** If in flight, disconnects power from main generator and disables the standby generator. If on the ground, disconnects main generator and external power from the electrical system and disables the standby generator.

2. **ELEC CAUTION RESET Button.** Clears MASTER CAUTION and ELEC SYS caution lights and resets the main and standby generators.

3. **FLCS PMG Light.** Illuminates in flight if none of the FLCS branches are receiving power from the FLCS Permanent Magnet Generator. Illuminates on the ground after 60 seconds of weight-on-wheels if one or more of the FLCS branches aren't receiving power from the FLCS PMG.

4. **MAIN GEN Light.** Illuminates when there is no external or main generator power connected to the non-essential AC buses.

5. **STBY GEN Light.** Illuminates when standby generator power is not available.

6. **EPU GEN Light.** The Illuminates when the EPU has been commanded on but is not providing power to both emergency buses. Light is inhibited if EPU switch is set to OFF and aircraft is weight-on-wheels with the engine is running.

7. **EPU PMG Light.** Illuminates when the EPU has been commanded on, but the EPU Permanent Magnet Generator is not providing power to all branches of the FLCS.

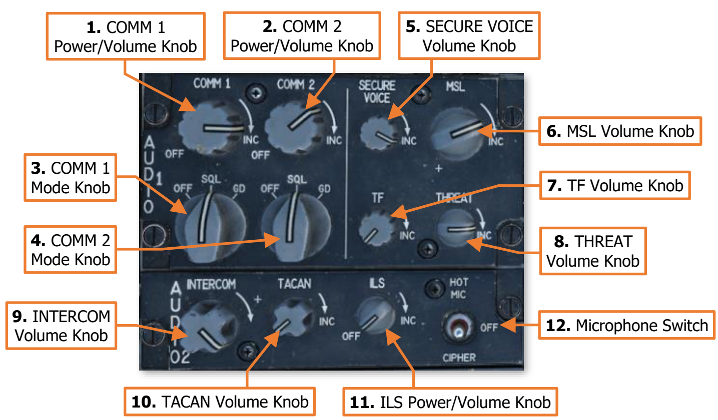
8. **ACFT BATT – FAIL Light.** Illuminates in flight to indicate a battery failure (20 volts or less). Illuminates on the ground after 60 seconds of weight-on-wheels to indicate a batter failure or battery charger failure.

9. **ACFT BATT – TO FLCS Light.** Illuminates in flight if one or more FLCS branches are receiving power from the battery bus of 25 volts or less. Illuminates on the ground if battery power is going to one or more FLCS branches.

10. **ACFT BATT – FLCS RLY Light.** Illuminates if one or more FLCS branches are receiving less than 20 volts from the battery bus or if one or more FLCS branches are not connected to the battery bus. May be reset using the FLCS RESET switch on the FLT CONTROL panel.

AUDIO 1 & AUDIO 2 Control Panels

The AUDIO 1 panel controls the volume of the UHF and VHF radios, missile audio feedback, and RWR threat warning audio. It also includes controls for selecting squelch and GUARD operating modes for the UHF and VHF radios.



The AUDIO 2 panel controls the volume of the intercom, TACAN and ILS, along with the power of the ILS receiver.

1. **COMM 1 Power/Volume Knob.** Rotating this knob clockwise will increase the audio volume from the UHF radio. Rotating this knob fully counterclockwise will disable the UHF radio.

2. **COMM 1 Mode Knob.** Controls the squelch and GUARD functions of the UHF radio.
   - **OFF.** Disables squelch.
   - **SQL.** Enables squelch.
   - **GD.** The UHF radio is tuned to 243.0 MHz and the dedicated GUARD receiver is disabled. This knob position has no effect if C & I knob on IFF control panel is set to BACK UP.

3. **COMM 2 Power/Volume Knob.** Rotating this knob clockwise will increase the audio volume from the VHF radio. Rotating this knob fully counterclockwise will disable the VHF radio.

4. **COMM 2 Mode Knob.** Sets the VHF radio
   - **OFF.** Disables squelch.
   - **SQL.** Enables squelch.
   - **GD.** The VHF radio is tuned to 121.5 MHz.

5. **SECURE VOICE Volume Knob.** No function.

6. **MSL Volume Knob.** Rotating this knob clockwise will increase the audio volume from the currently selected AIM-9 missile.

7. **TF Volume Knob.** No function.

8. **THREAT Volume Knob.** Rotating this knob clockwise will increase the audio volume from the ALR-56M radar warning receiver.

9. **INTERCOM Volume Knob.** Rotating this knob clockwise will increase the audio volume from the intercom system. The intercom system is used to communicate directly to ground crews or the boom operator of an aerial refueling tanker through the refueling boom itself. This knob will also affect the volume of the landing gear and low speed warning tones and avionics voice messages. (N/I)

10. **TACAN Volume Knob.** Rotating this knob clockwise will increase the audio volume from the TACAN receiver. This is used to identify the station the TACAN receiver is tuned to by monitoring the morse code identifier broadcast over the TACAN frequency itself.

11. **ILS Power/Volume Knob.** Rotating this knob clockwise will increase the audio volume from the currently tuned ILS localizer station. This is used to identify the localizer the ILS receiver is tuned to by monitoring the morse code identifier broadcast over the ILS frequency itself. Rotating the knob full counterclockwise to OFF will disable the ILS receiver.

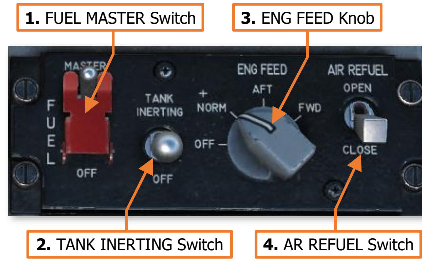
12. **HOT MIC CIPHER Switch.** Controls the operating mode of the intercom and radios. (N/I)
    - **HOT MIC.** Activates direct communication to the ground crew or the boom operator of the aerial refueling aircraft when the boom is seated in the aerial refueling receptacle. Transmitting over the UHF or VHF radios will override this direct communication while transmissions are occurring.
    - **OFF.** Disables HOT MIC and CIPHER functions.
    - **CIPHER.** Placing the switch in this position filters out non-secure radio signals over the UHF and/or VHF radios if secure voice is enabled.

AVTR Control Panel

The Airborne Video Tape Recorder, or AVTR, records the HUD and MFDs or the HMCS and MFDs depending on the setting. (N/I)

FUEL Control Panel

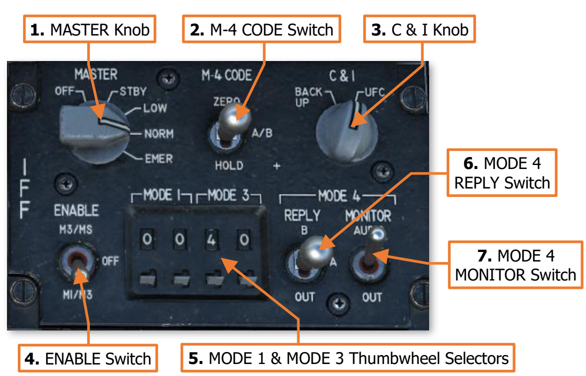
The Fuel panel includes controls for tank pressurization and fuel system management.



1. **FUEL MASTER Switch.** Opens/closes the main fuel shutoff valve to the engine. This is normally kept in the MASTER position with the guard closed.
2. **TANK INERTING Switch.** When set to the TANK INERTING position, non-volatile halon gas is pumped into the fuel tanks to reduce internal pressure and reduce risk of fire during an emergency (e.g., from battle damage).
3. **ENGINE FEED Knob.** Energizes or de-energizes the fuel pumps and maintains the center-of-gravity with fuel loading. If an imbalance is indicated on the fuel quantity indicator by a divergence between the two fuel needles, the AFT and FWD positions allow selective control for the pumps on the respective fuel tanks to manually shift the center-of-gravity.
    - **OFF.** Disables both fuel pumps. Engine is supplied fuel via the Fuel Flow Proportioner (FFP), which is powered by the Hydraulic system A.
    - **NORM.** Enables both fuel boost pumps. Engine is supplied fuel from the forward and aft fuel tanks. Aircraft center-of-gravity (CG) is maintained automatically through fuel balancing.
    - **AFT.** Enables aft fuel boost pump. Engine is supplied fuel from the aft fuel tank only. Fuel is transferred from the aft tanks to the forward tanks. Aircraft CG is shifted forward.
    - **FWD.** Enables forward fuel boost pump. Engine is supplied fuel from the forward fuel tank only. Fuel is transferred from the forward tanks to the aft tanks. Aircraft CG is shifted rearward.
4. **AIR REFUEL Switch.** Controls the aerial refueling door, associated exterior lighting, and fuel tank pressurization for aerial refueling operations. If the aircraft is less than 400 knots airspeed, when switch is set to OPEN the FLCS gains are set to takeoff/landing configuration.
    - **OPEN.** Opens aerial refueling door, reduces internal tank pressurization and depressurizes external tanks. Activates fuselage- and tail-mounted AR floodlights, which can be adjusted using the AERIAL REFUELING knob on the EXT LIGHTING control panel.
    - **CLOSE.** Closes aerial refueling door, increases internal tank pressurization and repressurizes external tanks. Extinguishes fuselage- and tail-mounted AR floodlights.

IFF Control Panel

The IFF panel provides backup control of essential CNI functions and some primary functions of the APX-113 Advanced IFF transponder/interrogator system.



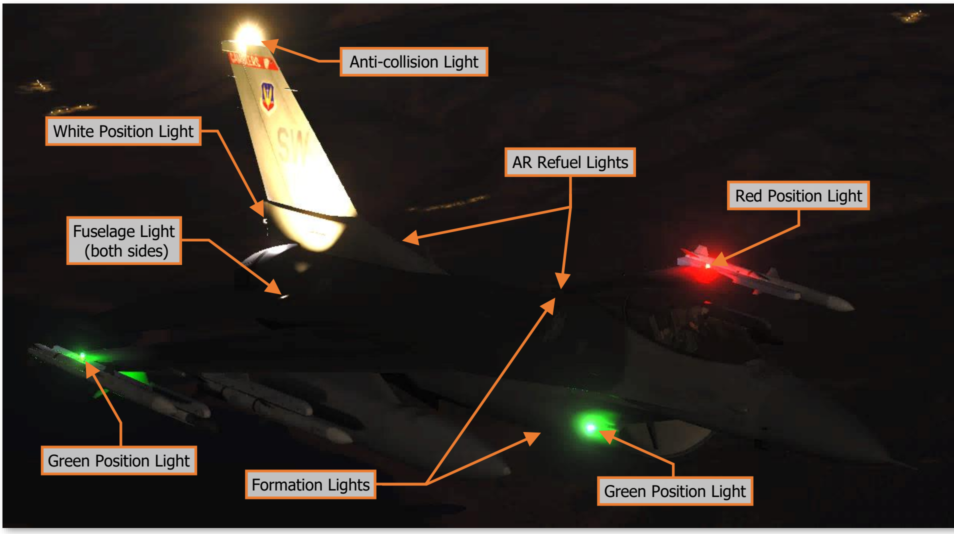
1. **MASTER Knob.** Selects the mode the APX-113 AIFF system operates. This knob functions regardless of the C&I knob position. (N/I)
    - **OFF.** Transponder and IFF interrogation functions are powered off.

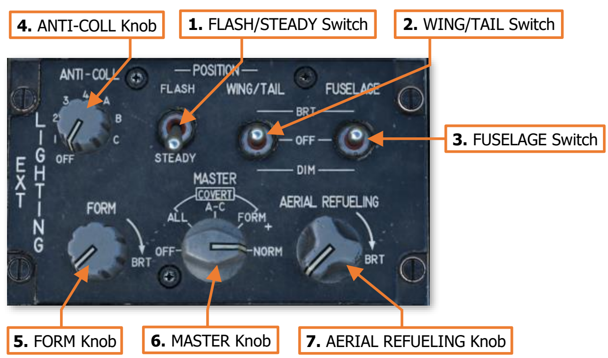
- **STBY.** Transponder functions are inhibited but the IFF interrogator will function normally.
- **LOW/NORM.** Transponder and IFF interrogation functions are operating.
- **EMER.** Transponder will reply with an emergency transponder code when interrogated.

2. **M-4 CODE Switch.** Manages the security of the Mode 4 encrypted codes. (N/I)
   - **A/B.** Enables normal Mode 4 coded replies. Switch is spring-loaded to this position.
   - **ZERO.** Momentarily placing switch in this position will erase encrypted codes from the IFF internal memory.
   - **HOLD.** Momentarily placing switch in this position prior to placing the MASTER knob to OFF will retain the Mode 4 encrypted codes in the IFF internal memory. Otherwise, the encrypted codes will be erased after the IFF is powered off or the aircraft is shut down.
3. **C & I Knob.** Controls how the pilot interacts with the IFF system and UHF radio.
   - **UFC.** Pilot controls primary IFF functions and UHF radio using the Upfront Controls (ICP and DED).
   - **BACK UP.** Pilot controls all IFF functions using the IFF control panel itself. The UHF Backup control panel is used to control the UHF radio.
4. **Enable Switch.** Selects between using Mode 3 and Mode S codes or Mode 1 and Mode 3 codes when the C&I knob is set to the BACK UP position. (N/I)
   - **M3/MS.** Mode 3/A and Mode S are enabled.
   - **OFF.** Mode 1, Mode 3/A, Mode 4 and Mode S are disabled.
   - **M1/M3.** Mode 1 and Mode 3/A are enabled.
5. **MODE 1 & MODE 3 Thumbwheel Selectors.** Allows the pilot to input Mode 1 and Mode 3 codes when the C&I knob is set to the BACK UP position. Note that only the first two digits of Mode 3 can be entered in this manner. The third and fourth digits are internally set to zero, permitting only Mode 3 codes ending in "00" to be used. (N/I)
6. **MODE 4 REPLY Switch.** Allows the pilot to select how the IFF system should reply to Mode 4 interrogations when the C&I knob is set to the BACK UP position. (N/I)
   - **A.** The first IFF encrypted code is used to reply to Mode 4 interrogations.
   - **B.** The second IFF encrypted code is used to reply to Mode 4 interrogations.
   - **OUT.** Replies to Mode 4 interrogations are inhibited.
7. **MODE 4 MONITOR Switch.** Allows the pilot to control the audio tone notification for Mode 4 replies. (N/I)
   - **AUDIO.** An audio tone will sound whenever the IFF transponder system sends an encrypted reply to a Mode 4 interrogation.
   - **OUT.** Mode 4 audio tone is disabled.

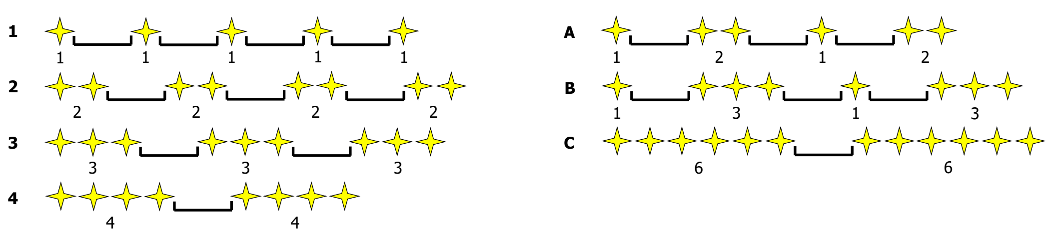
EXT LIGHTING Control Panel

The Exterior Lighting panel controls all externally mounted lights on the aircraft.





1. **POSITION – FLASH/STEADY Switch.** Toggles the WING/TAIL position lights between flashing and steady modes.
2. **POSITION – WING/TAIL Switch.** This switch sets the wingtip and intake red/green and the tail mounted white position lights to fixed brightness levels of bright or dim. If the switch is set to OFF, the wingtip mounted red/green position lights revert to the brightness level set by the FORM knob.
3. **FUSELAGE Switch.** This switch controls the fuselage mounted lights that illuminate the vertical tail.
4. **ANTI-COLL Knob.** This knob can be set to OFF or one of 7 options that vary the flash pattern of the anti-collision light.



ANTI-COLL Knob - Flash Patterns

5. **FORM Knob.** Controls the brightness of the red and green formation lights on each wingtip and the white formation lights on the top and bottom of the center fuselage. The FORM knob functionality is only active for the wingtip lights when the POSITION – WING/TAIL switch is set to OFF.

All lights on and set to bright

All lights off except FORM knob; FORM knob set to minimum

6. **MASTER Knob.** Sets the exterior lighting master mode. The table below details how each position of the MASTER knob enables or overrides the respective lighting system's switch or knob.

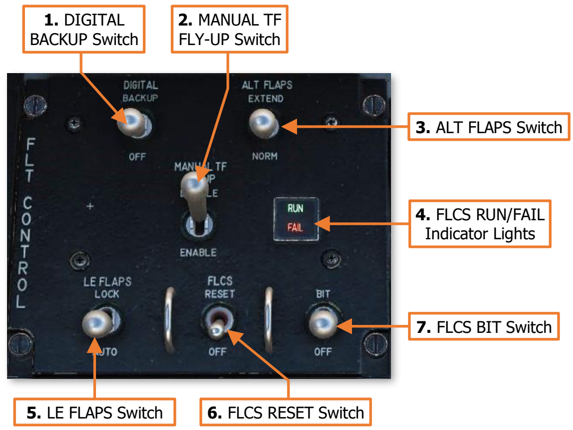
	OFF	**COVERT ALL**	**COVERT A-C**	**COVERT FORM**	**ALL**
ANTI-COLL	Off	Off	Off	Switch	Switch
WING/TAIL	Off	Off	Switch	Off	Switch
FUSELAGE	Off	Off	Switch	Off	Switch
FORM	Off	Off	Knob*	Off	Knob*
AERIAL REFUELING	Off	Knob**	Knob**	Knob**	Knob**

*Requires the WING/TAIL switch to be set to OFF to control the brightness of each wingtip light
**Requires the AR REFUEL switch on the FUEL Control Panel to be set to OPEN

7. **AERIAL REFUELING Knob.** Sets the brightness of the lights that illuminate the dorsal refueling receptacle to assist the air refueling boom operator during night refueling operations. The AERIAL REFUELING knob functionality is only active when the AR REFUEL switch on the FUEL control panel is set to OPEN.

FLT CONTROL Panel

The Flight Control panel controls manual settings of the flight control systems. This panel is normally not used due to the automated nature of the F-16C's flight control systems.



1. **DIGITAL BACKUP Switch.** Selects the FLCC backup software. When enabled, the DBU ON warning light on the right eyebrow panel will illuminate and the HUD will display a flashing WARN message.

2. **ALT FLAPS Switch.** Controls manual deployment of the trailing edge flaps.

   - **EXTEND.** Manually deploys the trailing-edge flaps (TEF) at low speeds prior to landing if the trailing edge flaps have failed to deploy with the landing gear.
   - **NORM.** Enables automatic scheduling of trailing-edge flaps based on FLCS commands

3. **MANUAL TF FLY-UP Switch.** This is a terrain-following radar function and is not used in the Block 50 F-16.

4. **FLCS RUN/FAIL Indicator Lights.** When a FLCS BIT is initiated, the green RUN light illuminates and will extinguish when the test is complete. If a problem is encountered during the BIT, the red FAIL light illuminates, and the failure will be displayed on the Pilot Fault List Display (PFLD).

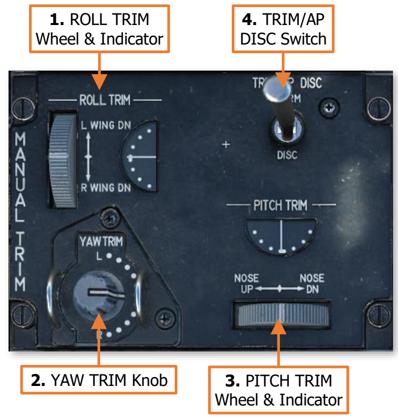
5. **LE FLAPS Switch.** Controls manual deployment of the leading-edge flaps. (N/I)

   - **LOCK.** Manually locks the trailing-edge flaps in position and illuminates the FLCS warning light. This might be used in the case of a leading-edge flap failure with asymmetric flap settings.
   - **AUTO.** Enables automatic scheduling of leading-edge flaps based on FLCS commands.

6. **FLCS RESET Switch.** Resets the FLCS warning lights and servo/electrical failures within the FLCS system. Resets FLCS warning light, MASTER CAUTION light, CADC caution light, FLCS caution light, and clears PFLD if the associated faults are actually cleared.

7. **FLCS BIT Switch.** Commands a BIT test of the FLCS if there is weight-on-wheels and ground speed is <28 knots. Setting the switch to the BIT position will initiate the flight control surface test sequence and is performed during start-up. The test will run for approximately 45 seconds, during which time the switch is magnetically held in the BIT position. When the test is complete the switch is released and will return to the OFF position.

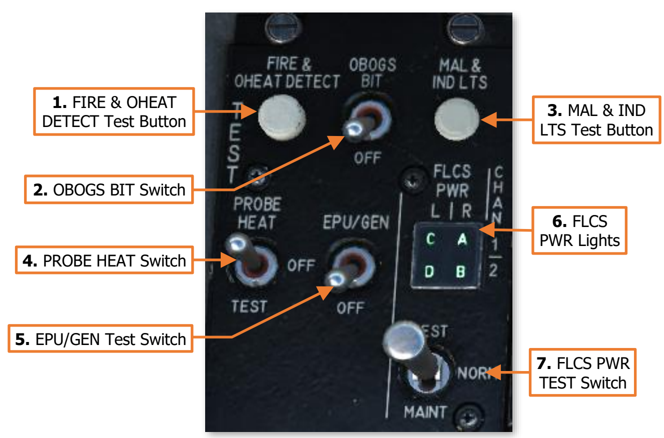
MANUAL TRIM Panel



The Manual Trim panel controls manual trim values in pitch, roll and yaw. This might be used in the case of a malfunction with Trim Switch on the Side Stick Controller (SSC). This panel is normally not used since the F-16C's flight control systems provide automatic trim in pitch, and the pilot can trim in pitch and roll using the 4-way trim switch on the SSC.

1. **ROLL TRIM Wheel & Indicator.** Trims aircraft in the roll axis and indicates the degree of manual trim applied.
2. **YAW TRIM Knob.** Trims aircraft in the yaw axis. The degree of manual yaw trim applied is indicated by the outside dot pattern.
3. **PITCH TRIM Wheel & Indicator.** Trims aircraft in the pitch axis and indicates the degree of manual trim applied.
4. **TRIM/AP DISC Switch.** Controls source of trim inputs and autopilot engagement.
    - **NORM.** Pitch/Roll trim is controlled using either the 4-way Trim Switch on the SSC or this panel. Autopilot engagement is permitted.
    - **DISC.** Pitch/Roll trim is exclusively controlled using this panel. Trim Switch on the SSC is disabled. Autopilot engagement is inhibited.

TEST Panel



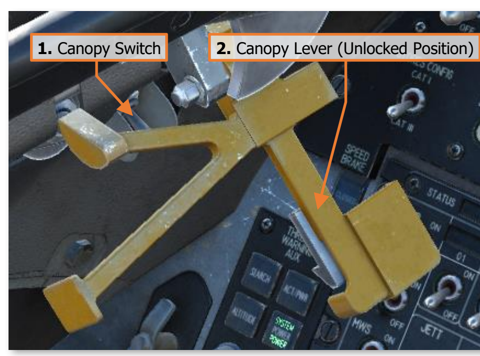
The Test panel includes several controls for performing built-in tests (BIT) of several F-16C systems and test all cockpit indicator lights.

1. **FIRE & OHEAT DETECT Test Button.** Tests the circuit continuity of the fire and overheat detection systems. This will cause the ENG FIRE warning light and the OVERHEAT caution lights to illuminate. This will in turn trigger the MASTER CAUTION light.
2. **OBOGS BIT Switch.** Tests the On-Board Oxygen Generation System (OBOGS). Moving this switch momentarily to the OBOGS BIT position will cause the OXY LOW eyebrow warning light to illuminate for 10 seconds. If no faults are detected within the OBOGS monitoring system, the light will extinguish. If the OXY LOW warning light remains illuminated, a fault has been detected.
3. **MAL & IND LTS Test Button.** Illuminates all warning, caution, and indication lights to verify their function, as well as audio voice messages.

4. **PROBE HEAT Switch.** Controls the external air data probes and probe heat monitoring system when on the ground. When in flight, the pitot, fuselage air data, AoA, and total temperature probes and the probe heat monitoring system are always active.
    - **HEAT.** Enables heating of the pitot, fuselage air data, AoA, and total temperature probes when on the ground. Also enables the probe heat monitoring system.
    - **OFF.** Disables heating of the data probes when on the ground.
    - **TEST.** Performs a test of the probe heat monitoring system. The PROBE HEAT caution light will flash on the Caution Light Panel following a successful test. If it does not illuminate or does not flash, the probe heat monitoring system is inoperative.
5. **EPU/GEN Switch.** Momentarily pressing this switch to the TEST position tests the EPU generator and EPU PMG (Permanent Magnet Generator) output to the FLCS channels without using hydrazine while on the ground.
6. **FLCS PWR Lights.** Illuminates to indicate power output to each of the four redundant flight control channels (A, B, C and D) when the FLCS PWR switch is set to TEST.
7. **FLCS PWR TEST Switch.** Tests power output to the FLCS (pronounced "flick-iss") when MAIN PWR switch is set to BATT or MAIN PWR positions.
    - **TEST.** Tests power output to the FLCS channels.
    - **NORM.** Tests EPU PMG availability when EPU/GEN switch is set to TEST and MAIN PWR switch is set to MAIN PWR.
    - **MAINT.** Used for maintenance tests by ground personnel.

Canopy Switch & Canopy Handle

The Canopy Switch controls the actuator to raise and lower the canopy. The Canopy Handle locks/unlocks the canopy and inflates/deflates the canopy pressure seal.



1. **Canopy Switch.** Controls the canopy actuator.
    - **Up.** When the Canopy Lever is in the unlocked position, this position raises the canopy actuator to full extension. The switch will automatically snap back to the center position when the canopy actuator reaches full extension.
    - **Center.** The canopy actuator stops canopy motion.
    - **Down.** This position lowers the canopy actuator to full retraction. The switch is spring-loaded to center from this position and must be held to lower and close the canopy.
2. **Canopy Lever.** Prevents the canopy from un-latching and controls the canopy pressure seal.
    - **Unlocked (open, pulled outward).** The canopy pressure seal is deflated, and the CANOPY eyebrow warning light illuminates. The Canopy Lever should be placed in this position prior to lowering the canopy. The Canopy Lever also physically limits the full travel of the throttle lever.
    - **Locked (closed, up against cockpit wall).** The canopy is locked and the pressure seal is inflated.

Canopy Jettison T-Handle

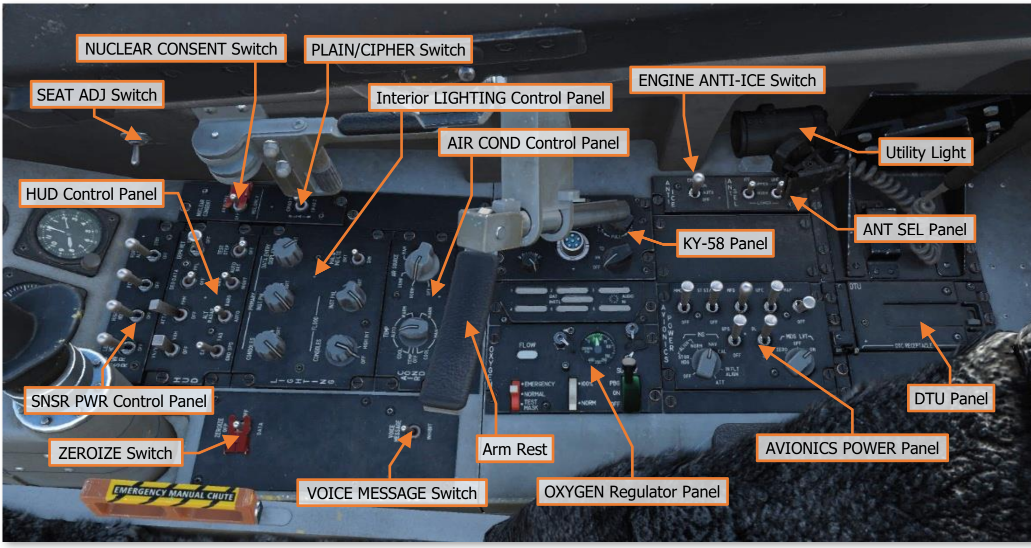
In case of an emergency, the CANOPY JETTISON T-handle provides an alternate means to separate the canopy from the aircraft. This can be used if the primary ejection handle is pulled but the canopy fails to separate, preventing ejection.

DEFOG Lever

The DEFOG lever can be moved forward and back to provide de-fogging to the canopy.

- **MIN.** Most of the airflow is diverted to the vents behind the seat.
- **MAX.** Most of the airflow is diverted to the forward canopy area and the air vent at the bottom of the center instrument panel.
  - When set to the full MAX position with the TEMP knob set to AUTO, the air flow will be set to full warm for 3 minutes. Retarding the lever and returning it to MAX will restart this 3-minute period of full warm.

Right Console

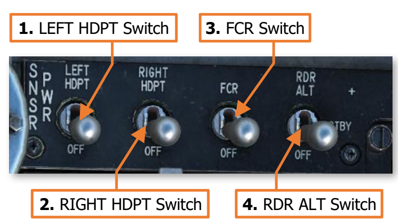


Each text box above may be selected to jump to a more detailed description of that panel. Selecting the image of the instrument or panel will return the manual back to this page.

The HUD Control Panel is described in a dedicated section following the Hands-On Controls (HOTAS).

SNSR PWR Control Panel

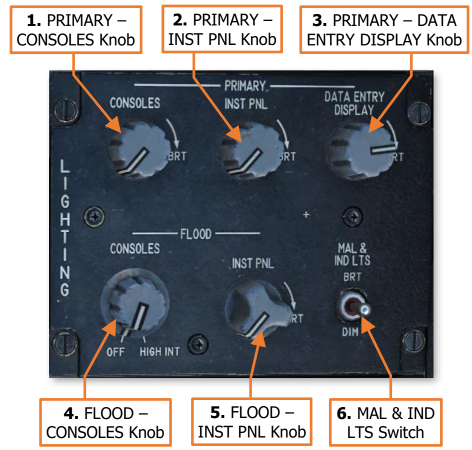
The Sensor Power panel consists of four switches that enable power to the primary sensors.



1. **LEFT HDPT Switch.** Powers the sensor mounted to the left "chin" hardpoint. This will normally be the AN/ASQ-213 HARM Targeting System (HTS) pod.
2. **RIGHT HDPT Switch.** Powers the sensor mounted to the right "chin" hardpoint. This will normally be the AN/AAQ-28 Litening II targeting pod (TGP).
3. **FCR Switch.** Powers the AN/APG-68 Fire Control Radar.
4. **RDR ALT Switch.** Powers the radar altimeter.
    - **RDR ALT.** The radar altimeter is set to transmit.
    - **STBY.** The radar altimeter is powered on but will not transmit.
    - **OFF.** The radar altimeter is powered off

Interior LIGHTING Control Panel

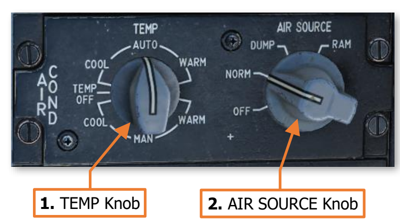
The Interior Lighting panel consists of five knobs that control the brightness of the cockpit instruments, switch panel backlighting, and flood lights. Most of the lighting is green to support night vision systems.



1. **PRIMARY – CONSOLES Knob.** Controls the brightness of the panel backlighting on the left auxiliary console, left console and right console.
2. **PRIMARY – INST PNL Knob.** Controls the brightness of the panel backlighting on the instrument panel and right auxiliary console.
3. **PRIMARY – DATA ENTRY DISPLAY Knob.** Controls the brightness of the DED and PFLD displays.
4. **FLOOD – CONSOLES Knob.** Controls the flood light intensity on the left auxiliary console, left console and right console.
5. **FLOOD – INST PNL Knob.** Controls the flood light intensity on the instrument panel and right auxiliary console.
6. **MAL & IND LTS Switch.** Sets the malfunction and indicator lights and the CMDS expendable inventory counters to either BRT (Bright) or DIM. BRT is automatically selected if the FLOOD – CONSOLES knob is moved past the HIGH INT detent, if the PRIMARY – INST PNL knob is rotated fully counterclockwise, or if emergency DC power is lost.

AIR COND Control Panel

The Air Conditioning panel controls the environmental control systems.



1. **TEMP Knob.** Controls cockpit temperature. (N/I)
2. **AIR SOURCE Knob.** Selects the air source for ventilation of the cockpit and avionics. Note that placing the knob in OFF or RAM will prevent fuel from being transferred from external fuel tanks.
    - **OFF.** Closes all engine bleed air valves. All air conditioning and cooling functions cease. Pressurization functions are disabled, including G-suit and pressure breathing, OBOGS, canopy seal, and fuel tank pressurization.
    - **NORM.** Sets environmental control and pressurization systems to automatic operation.
    - **DUMP.** Dumps cockpit pressure and uses conditioned bleed air to ventilate the cockpit and avionics.
    - **RAM.** Dumps cockpit pressure and closes engine bleed air valves. All air conditioning and cooling functions cease. Pressurization functions are disabled, including G-suit and pressure breathing, OBOGS, canopy seal, and fuel tank pressurization. Uses external ram air to ventilate cockpit and avionics.

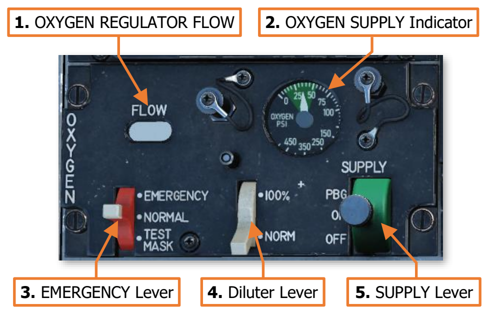
KY-58 Secure Voice Panel

The KY-58 secure voice system is used to provide encryption of voice communications. (N/I)

PLAIN/CIPHER Switch

The Plain/Cipher switch toggles between using unencrypted or encrypted communications over either the UHF or VHF radio. (N/I)

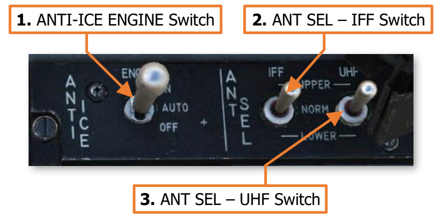
OXYGEN Regulator Panel



The Oxygen Regulator panel controls the flow of O_2 to the pilot's facemask and the oxygen system's mode of operation.

1. **OXYGEN REGULATOR FLOW Indicator.** Alternates between white and black indications. White indicates oxygen flow; black indicates no oxygen flow.
2. **OXYGEN SUPPLY Indicator.** Indicates oxygen pressure, with normal operation between 10 and 55 PSI.
3. **EMERGENCY Lever.** Controls positive pressure mode of oxygen supply system. (N/I)
   - **EMERGENCY.** Provides maximum amount of oxygen under positive pressure. Used by the pilot to test for leaks.
   - **NORMAL.** Positive pressure is provided if cockpit pressure altitude exceeds 28,000 feet.
   - **TEST MASK.** Provides maximum amount of oxygen under positive pressure. Used by life support personnel to test for leaks.
4. **Diluter Lever.** Controls the mixture of cockpit air and pure oxygen. (N/I)
   - **100%.** Maximum amount of oxygen is provided to the pilot.
   - **NORM.** Regulated mix of cockpit air and oxygen is provided to the pilot based on cockpit pressure altitude.
5. **SUPPLY Lever.** Controls mode of operation for the oxygen supply system. When set to PBG (Pressure Breathing for G), the oxygen regulator provides pressure breathing above 4 G's to enhance G tolerance and reduce pilot fatigue.
   - **PBG.** Oxygen is supplied to pilot's facemask. Pressure breathing based on G-force is available.
   - **ON.** Oxygen is supplied to pilot's facemask. Pressure breathing is not available.
   - **OFF.** Turns off the oxygen supply to pilot's facemask.

ANTI ICE & ANT SEL Switches



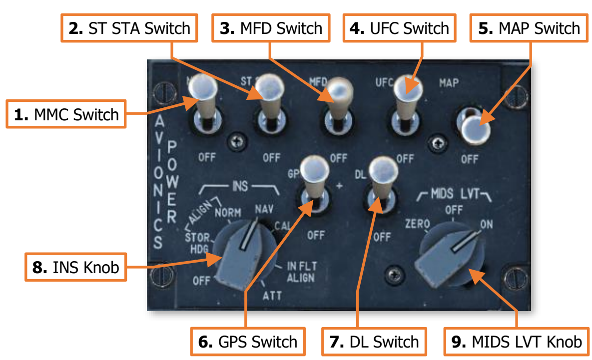
The engine Anti-Ice system prevents ice buildup within the engine intake and includes an inlet ice detector.

1. **ANTI-ICE ENGINE Switch.** Controls automatic or manual activation of the inlet anti-ice heating elements, and enables/disables the inlet ice detector.
   - **ON.** Manually activates the engine anti-ice system and inlet strut heater. The inlet ice detector will still illuminate the INLET ICING caution light on the Caution Light panel if ice accumulation is detected.
   - **AUTO.** If ice accumulation is detected by the inlet ice detector, the engine anti-ice system and inlet strut heater will automatically activate and the INLET ICING caution light will illuminate on the Caution Light panel.
   - **OFF.** The inlet ice detector, engine anti-ice system, and inlet strut heater are disabled.

The Antenna Select panel is used to select the upper, lower, or both antennas for transmissions from the UHF radio and IFF system.

2. **ANT SEL – IFF Switch.** Selects automatic or manual antenna selection for IFF interrogation replies.
   - **UPPER.** Upper IFF antenna is used to receive and reply to IFF interrogation signals.
   - **NORM.** The IFF antenna automatically selects which antenna is used to reply to IFF interrogation signals based on which antenna is receiving the strongest signal.
   - **LOWER.** Lower IFF antenna is used to receive and reply to IFF interrogation signals.
3. **ANT SEL – UHF Switch.** Selects single or both UHF antennas for radio transmission.
   - **UPPER.** Upper UHF antenna is used to transmit and receive UHF radio signals.
   - **NORM.** Both antennas are used to transmit in a cyclic pattern to provide omnidirectional radio transmissions.
   - **LOWER.** Lower UHF antenna is used to transmit and receive UHF radio signals.

AVIONICS POWER Control Panel



The Avionics Power panel enables/disables power to the various avionics systems and controls the alignment functions of the Inertial Navigation System (INS).

1. **MMC Switch.** Powers the Modular Mission Computer.
2. **ST STA Switch.** Powers the underwing and fuselage centerline stores stations.
3. **MFD Switch**. Powers the two cockpit Multi-Function Displays (MFD).
4. **UFC Switch**. Powers the Upfront Controls (ICP and DED).
5. **MAP Switch**. Not functional in the Block 50 F-16.

6. **GPS Switch.** Powers the GPS receiver.

7. **DL Switch.** Powers the Improved Data Modem (IDM). (N/I)

8. **INS Knob.** Sets the operating mode of the Inertial Navigation System (INS) and determines the method of alignment when necessary. While the INS is performing an alignment on the ground, it is imperative that the aircraft is not moved or repositioned in any way, to include reconfiguring externally mounted equipment or arming/re-arming weapons stations. (See INS Alignment for more information.)

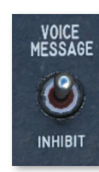
    - **OFF.** Removes power from the INS. The INS knob should remain in this position on aircraft power for a minimum of 10 seconds before moving the INS knob from off or shutting down the aircraft.
    - **ALIGN – STOR HDG.** Initiates an alignment of the INS using a stored heading reference. This allows the alignment process to be completed more rapidly than NORM but requires that the aircraft not be moved after the INS is powered off (assuming the INS had a good alignment prior to the power being removed).
    - **ALIGN – NORM.** Initiates a normal gyrocompass alignment of the INS from manually entered position data. This alignment mode requires more time to complete but allows the aircraft to regain position confidence if the aircraft has been repositioned by ground crews since the last time the INS was powered with a good position fix.
    - **NAV.** Sets the INS to normal navigation functionality after an alignment is complete.
    - **CAL.** No function.
    - **IN FLT ALIGN.** In-Flight Alignment mode performs an INS alignment in flight but requires the pilot to maintain a stable attitude on a constant heading while the alignment proceeds. When the INS knob is initially moved to IN FLT ALIGN, the INS will automatically enter Attitude mode until a coarse alignment can be completed, and the pilot must input the current compass heading into the DED.
    - **ATT.** Attitude mode provides pitch, roll, and heading information only and is used as a degraded mode of operation when the situation dictates. No navigational information will be available except TACAN.

9. **MIDS LVT Knob.** The Multifunctional Information Distribution System (MIDS LVT) knob enables/disables or zeroizes the MIDS LVT terminal.

    - **ZERO.** Zeroizes sensitive data within MIDS LVT terminal's internal memory.
    - **OFF.** Removes power from the MIDS LVT terminal.
    - **ON.** Powers the MIDS LVT terminal.

VOICE MESSAGE Switch

The Voice Message switch is used to silence all aircraft voice messages when set to INHIBIT. This is normally only performed when a voice message is repeating in an erroneous manner.



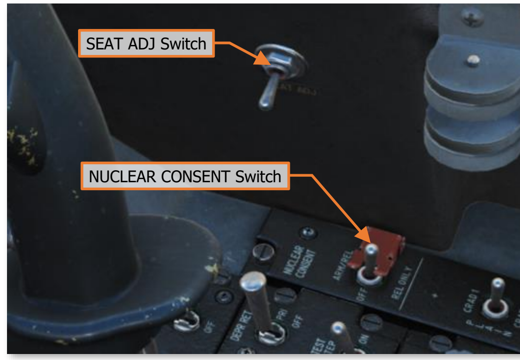
ZEROIZE Switch

In an emergency, the ZEROIZE switch can erase all sensitive data from the systems such as secure voice encryption, GPS keys, and others.

SEAT ADJ Switch

The Seat Adjustment switch controls an electric motor that raises or lowers the pilot seat. This function allows the pilot to ensure their sitting height corresponds with a comfortable view of the instrument panel and alignment of their viewpoint through the HUD. The seat can also be raised during landing for increased visibility over the nose, if desired.

The switch is spring-loaded to the center "off" position, and must be held up or down to adjust the seat height.



NUCLEAR CONSENT Switch

This switch is not implemented.

Ejection Seat Controls

Ejection Handle

The Ejection Handle is pulled to initiate the ejection sequence in an emergency where continued flight or a safe landing is no longer possible or is in doubt. Pulling the handle jettisons the canopy, followed by igniting a rocket motor mounted to the seat, expelling the seat itself along with the pilot to descend to the surface under a parachute.

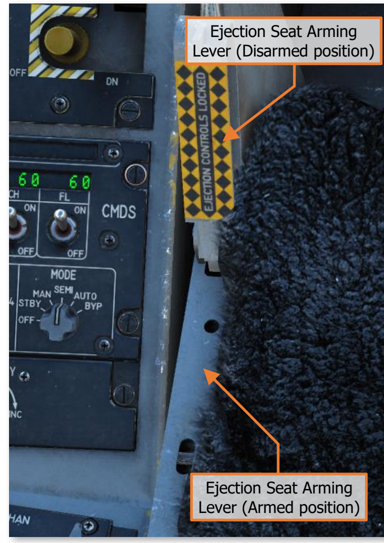
The ejection handle itself is not implemented in DCS: F-16C. The ejection sequence can be initiated by pressing **[LCtrl]+[E]**.

Ejection Seat Arming Lever

The Ejection Seat Arming lever arms the Ejection Handle and associated mechanisms for performing an ejection from the cockpit in an emergency.

When the handle is placed in the upright position, the ejection seat is disarmed, and the SEAT NOT ARMED caution light illuminates on the Caution Light Panel.

When the handle is rotated aft and down so that it is flush with the ejection seat surface, the ejection seat is armed and the SEAT NOT ARMED caution light extinguishes.



Emergency Manual Chute Lever

The Emergency Manual Chute lever allows the pilot to manually initiate seat separation and deployment of his/her parachute following an ejection sequence. (N/I)

This may be necessary if the separation and deployment sequence does not initiate automatically or malfunctions.

HANDS-ON CONTROLS (HOTAS)

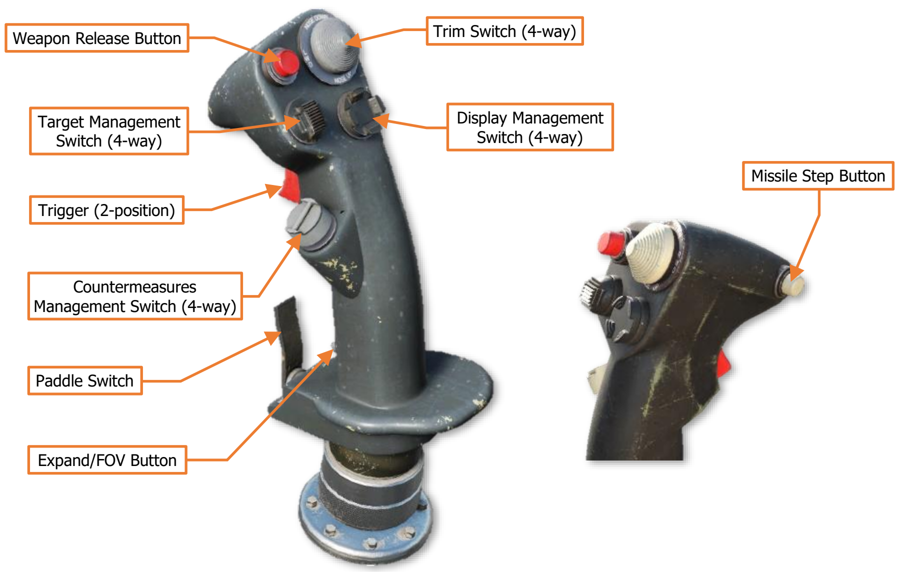
The Hands-On Controls, sometimes referred to as Hands on Throttle and Stick (HOTAS), allows the pilot to interact with the fire control system and various weapons delivery functions without taking his or her hands off the flight controls. Some of these switches are multipurpose and their function at any given time depends upon the aircraft master mode, weapons delivery mode, and/or the selected Sensor-Of-Interest (SOI).

Visual diagrams of the Hands-On Control functions based on Master Mode/SOI can be viewed in Appendix D.

Side Stick Controller (SSC)

The primary function of the Side Stick Controller is to provide pitch and roll commands to maneuver the aircraft. Pushing/pulling on the SSC affects aircraft pitch (moves the horizontal tails) and moving the SSC left/right affects roll (moves the wing trailing edge flaperons and horizontal tails; and to a lesser extent, the vertical rudder).

The SSC has several buttons and multi-position switches that permit manipulation of the key systems.



Weapon Release Button. Press and hold to fire air-to-air missiles or release any air-to-ground munition.

Trigger. Squeezing to the first detent fires the laser designator for accurate ranging if a targeting pod is equipped and in Air-to-Ground (A-G) mode. Squeezing the trigger to the second detent fires the gun if selected and armed.

Trim Switch. Positioning the button forward and aft trims the aircraft nose up (Trim switch aft) and nose down (Trim switch forward). Positioning the button left and right trims the aircraft left wing down and right wing down respectively.

Missile Step Button. This button has different functions depending on the state of the aircraft.

- **Nose-wheel Steering.** On the ground, momentarily pressing the button activates nosewheel steering via the rudder pedals. Pressing the button a second time disables nosewheel steering.
- **AR Disconnect.** When in flight and the AIR REFUEL switch is in the OPEN position, pressing the button manually disconnects the refueling boom from the aircraft's dorsal refueling receptacle.

- **Missile Step.** When in flight and in Air-to-Air, Missile Override or Dogfight modes, a short press (<0.5 sec) will select the next missile station of that type, and a long press (>0.5 sec) will cycle to the next missile type. When in flight and in Air-to-Ground (A-G) mode, a short press cycles between CCIP, DTOS and CCRP modes; or selects the next missile station if AGM-65 or AGM-88 is selected on the SMS page.

ACTION		NAV MODE	A-A MODE	MSL ORIDE MODE	DGFT MODE	A-G MODE	A-G MODE (AGM-65)	A-G MODE (AGM-88)
MSL STEP	Air Short	(No Action)	Missile Step			CCIP→DTOS →CCRP	Missile Step	
	Air Long	(No Action)	Cycle Missile Type			(No Action)		
	Air Refuel	Manually Disconnect Aerial Refueling Boom						
	Ground	Engage/Disengage Nosewheel Steering (NWS)						

Display Management Switch (DMS). The DMS is used to control Sensor-Of-Interest (SOI) selection. Short press duration is <0.5 second; long press duration is >0.5 second.

ACTION		HUD SOI	HMCS SOI	FCR SOI	HSD SOI	HAD SOI	TGP SOI	WPN SOI
FWD	Short	(No Action)		SOI to HUD				
	Long	(No Action)						
LEFT	Short	Cycle Left MFD Format						
	Long	(No Action)						
RIGHT	Short	Cycle Right MFD Format						
	Long	(No Action)						
AFT	Short	SOI to MFD		Swap SOI between MFDs				
	Long	Helmet Display Unit On/Off						

Target Management Switch (TMS). The TMS controls target designation and data management for the selected Sensor-Of-Interest (SOI). Short press duration is <0.5 second; long press duration is >0.5 second. The exception to the long press duration is TWS/RWS Swap, which requires a full 1 second press duration.

ACTION		HUD SOI	HMCS SOI	FCR SOI	HSD SOI	HAD SOI	TGP SOI	WPN SOI
FWD	Short	DTOS/VIS Designate	Designate	Designate / ACM BORE	Designate	Designate	Point Track / MAV Handoff	Track
	Long	SOI to HMCS	(No Action)	RWS Spotlight	(No Action)			
LEFT	Short	(No Action)		Interrogate All	(No Action)	DED to SEAD	TV/FLIR/ FLIR Polarity	MAV Polarity / DED to HARM
	Long	(No Action)		Interrogate Target	(No Action)			
RIGHT	Short	*Sighting Point Rotary	(No Action)	Target step / ACM HUD / *	(No Action)	Target Step	Area Track / MAV Handoff	HARM Target Step
	Long	(No Action)		TWS/RWS Swap (1 sec)	(No Action)			
AFT	Short	Target Reject	Target Reject / SOI to HUD	Target Reject / ACM VERT	Drop	Target Reject / DED to CNI	INR Track / Cursor Zero	Target Reject / Cage MAV
	Long	(No Action)						

* When sighting point options are available in Air-to-Ground (A-G) master mode, pressing TMS right while the HUD or FCR is set as SOI will cycle through the available sighting points.

Countermeasures Management Switch (CMS). The CMS controls deployment of countermeasures and operation of the ECM pod (if installed). (See Defensive Systems for more information.)

ACTION		COUNTERMEASURE FUNCTION
FWD	**ALL**	Dispense 1x Manual Program 1-4 (as selected by CMDS PRGM knob)
LEFT	**ALL**	Dispense 1x Manual Program 6
RIGHT	**MAN**	Deactivate ECM Emissions
	SEMI	Disable ECM Emissions
	AUTO	Disable Dispensing of Auto Program / Interrupt Dispensing of current Program
AFT	**MAN**	Activate ECM Emissions if set to Mode 3
	SEMI	Dispense 1x Auto Program / Enables ECM Emissions if set to Mode 1 or 2
	AUTO	Enable Continuous Dispensing of Auto Program

Expand/FOV Button. Pressing this button cycles through the available fields-of-view for the sensor or system that is currently selected as SOI.

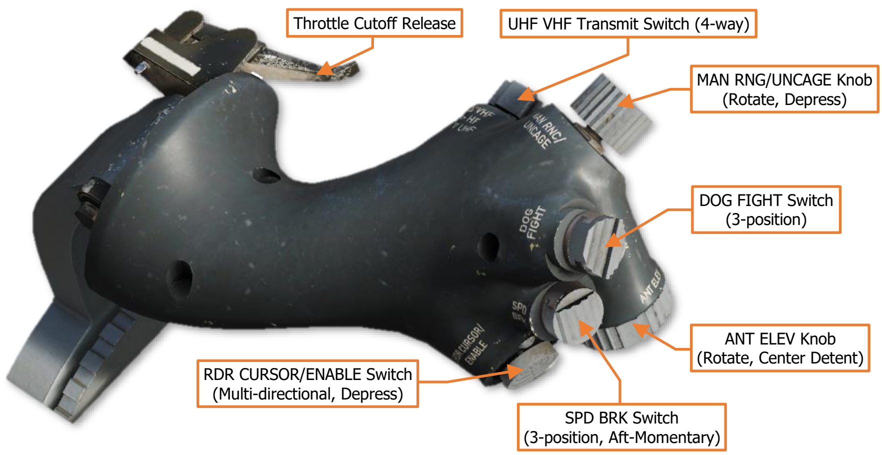
ACTION		HUD SOI	HMCS SOI	FCR SOI	HSD SOI	HAD SOI	TGP SOI	WPN SOI
EXP/ FOV DEPR	**Short**	(No Action)		Cycle FCR EXP Modes	Cycle HSD EXP Modes	Cycle HAD EXP Modes	Toggle TGP Field-Of-View	Toggle AGM Field-Of-View
	Long	HSD ZOOM Mode (for duration of press)						

Paddle Switch. Pressing and holding this switch interrupts the autopilot authority to the flight controls, allowing the pilot to manually maneuver the aircraft as necessary. When the switch is released, the autopilot authority will regain control over the applicable flight control axes and new reference values will be established by any active hold modes. This may be used to adjust the altitude of an orbit when using Altitude Hold or adjust the pitch attitude in a climb when using Attitude Hold.

Throttle

The engine is controlled by a throttle mounted above the left console with detents at OFF, IDLE, MIL, and MAX AB. The OFF position terminates engine ignition and fuel flow. The IDLE position commands minimum thrust and is used for all ground starts and air starts. From IDLE to MIL, the throttle controls the output of the engine. Forward of the MIL position, the throttle controls the operation of the afterburner.

The throttle has several multi-position switches and knobs that permit manipulation of the key systems. As with the Side Stick Controller, the Hands-On Controls functions on the throttle vary in functionality depending on the state and operational modes of the aircraft.



UHF VHF Transmit Switch. The switch initiates UHF (aft) and VHF (forward) radio transmissions. Pressing (IFF IN (right/inboard) or IFF OUT (left/outboard) using short presses (<0.5 sec) controls datalink filters on the FCR. Pressing inboard or outboard with long presses (>0.5 sec) controls transmissions to flight/team members over the selected datalink.

ACTION		DATALINK FUNCTION
LEFT (IFF OUT)	Short	Toggle Datalink Information on FCR
	Long	(No Action)
RIGHT (IFF IN)	Short	Cycle Datalink Filters on FCR
	Long	Transmit selected Steerpoint or HAD Symbol as L16 Markpoint to Flight Members

MAN RNG/UNCAGE Control. The Manual Range/Uncage knob has different functions depending on the master mode and selected system. Rotating the knob controls manual zoom level for targeting pod video. Depressing the control commands the AIM-9 or AGM-65 seeker to uncage, the TGP to enter/exit LSS mode, or declutters the HUD when landing. When the aircraft is airborne with the landing gear down, depressing UNCAGE will remove the Roll Indicator and ILS Bars from the HUD and re-position the Heading Scale to the top portion of the HUD.

ACTION	NAV MODE (LG DOWN)	SMS AIM-9	SMS AGM-65	TGP SOI
DEPRESS	Declutter ILS/Roll Indicator from HUD	Uncage AIM-9 Seeker	Uncage AIM-65 Seeker	Toggle Laser Spot Search

DOG FIGHT Switch. The Dogfight/Missile Override switch is a three-position switch that overrides any mode except emergency jettison. Returning the switch to the center returns to the last selected Master Mode.

- **Dogfight (outboard).** This position will automatically select ACM radar mode, but the radar will go to standby until commanded to transmit. The HUD will display symbology for 20mm gun engagement along with the targeting reticles for AIM-9 or AIM-120, depending on which missile is selected. "DGFT" is displayed in the HUD Master Mode Status.
- **Missile Override (inboard).** This position will automatically select RWS radar mode and display HUD symbology for A-A missile delivery. Gun will be unavailable for selection. "MRM", "SRM" or "HOB" will be displayed in the HUD Master Mode Status, depending on which missile type is selected. If no air-to-air missiles have been loaded, "MSL" is displayed in the HUD Master Mode Status.

ANT ELEV Knob. The Antenna Elevation knob is used to manually set the radar antenna elevation angle.

RDR CURSOR/ENABLE Control. Used for slewing the cursor on the FCR, HSD, and HAD pages; the cursor on the WPN page when AGM-88 is selected in HAS mode; slewing the TGP sensor; or slewing the AGM-65 seeker. When in A-A master mode, pressing and holding this control swaps the BORE/SLAVE option for the AIM-9 missiles while the control is depressed. When in A-G master mode with AGM-65 missiles selected, pressing this control will step through PRE/VIS/BORE mode options.

ACTION	HUD / HMCS SOI	FCR / HSD / HAD SOI	TGP SOI	WPN SOI (AGM-88)	WPN SOI (AGM-65)
SLEW	Slew TD Box / Mark Cue	Slew MFD Cursor	Slew TGP Sensor	Slew HAS Cursor	Slew MAV Seeker

ACTION	A-A MODE	MSL ORIDE MODE	DGFT MODE	A-G MODE (AGM-65)
DEPRESS	Swap AIM-9 BORE/SLAVE (for duration of press)			PRE→VIS→BORE

SPD BRK Switch. The aft position extends the speedbrakes and the forward position retracts the speedbrakes, with the switch spring-loaded out of the aft position back to center. Extension and retraction movement occurs for as long as the SPD BRK switch is held in either position, allowing the speedbrakes to be stopped at any intermediate position as desired.

The speedbrakes are limited to their full extension of 60° when the right main landing gear is not down and locked. When the right main landing gear is down and locked, the speedbrakes are limited to 43° to prevent the lower speedbrake surfaces from striking the ground upon landing. This limitation can be temporarily overridden by holding the SPD BRK switch to the open (aft) position. When the nose landing gear compresses after landing, the speedbrakes may once again be fully opened without needing to hold the SPD BRK switch aft.

Side Stick Controller (SSC) Hands-On Control Functions

ACTION		NAV MODE	A-A MODE	MSL ORIDE MODE	DGFT MODE	A-G MODE	A-G MODE (AGM-65)	A-G MODE (AGM-88)
MSL STEP	Air Short	(No Action)	Missile Step			CCIP→DTOS →CCRP	Missile Step	
	Air Long	(No Action)	Cycle A-A Missile Type			(No Action)		
	Air Refuel	Manually Disconnect Aerial Refueling Boom						
	Ground	Engage/Disengage Nosewheel Steering (NWS)						

ACTION		HUD SOI	HMCS SOI	FCR SOI	HSD SOI	HAD SOI	TGP SOI	WPN SOI
DMS FWD	Short	(No Action)		SOI to HUD				
	Long	(No Action)						
DMS LEFT	Short	Next Left MFD Format						
	Long	(No Action)						
DMS RIGHT	Short	Next Right MFD Format						
	Long	(No Action)						
DMS AFT	Short	SOI to MFD		Swap SOI between MFDs				
	Long	Helmet Display Unit On/Off						
TMS FWD	Short	DTOS/VIS Designate	Designate	Designate / ACM BORE	Designate	Designate	Point Track / MAV Handoff	Track
	Long	SOI to HMCS	(No Action)	RWS Spotlight	(No Action)			
TMS LEFT	Short	(No Action)		Interrogate All	(No Action)	DED to SEAD	TV/FLIR/ FLIR Polarity	MAV Polarity / DED to SEAD
	Long	(No Action)		Interrogate Target	(No Action)			
TMS RIGHT	Short	*Sighting Point Rotary	(No Action)	Target step / ACM HUD / *	(No Action)	Target Step	Area Track / MAV Handoff	HARM Target Step
	Long	(No Action)		TWS/RWS Swap (1 sec)	(No Action)			
TMS AFT	Short	Target Reject	Target Reject / SOI to HUD	Target Reject / ACM VERT	Drop	Target Reject / DED to CNI	INR Track / Cursor Zero	Target Reject / Cage MAV
	Long	(No Action)						
CMS FWD	ALL	Dispense 1x Manual Program 1-4 (as selected by CMDS PRGM knob)						
CMS LEFT	ALL	Dispense 1x Manual Program 6						
CMS RIGHT	MAN	Deactivate ECM Emissions						
	SEMI	Disable ECM Emissions						
	AUTO	Disable Dispensing of Auto Program / Interrupt Dispensing of current Program						
CMS AFT	MAN	Activate ECM Emissions if set to Mode 3						
	SEMI	Dispense 1x Auto Program / Enables ECM Emissions if set to Mode 1 or 2						
	AUTO	Enable Continuous Dispensing of Auto Program						
EXP/ FOV	Short	(No Action)		Cycle FCR EXP Modes	Cycle HSD EXP Modes	Cycle HAD EXP Modes	Toggle TGP Field-Of-View	Toggle AGM Field-Of-View
	Long	HSD ZOOM Mode (for duration of press)						
PADDLE SWITCH		Interrupts Autopilot authority to the flight controls / Sets new Autopilot reference values upon release						

Throttle Grip Hands-On Control Functions

ACTION	HUD / HMCS SOI	FCR / HSD / HAD SOI	TGP SOI	WPN SOI (AGM-88)	WPN SOI (AGM-65)
RDR CURSOR SLEW	Slew TD Box / Mark Cue	Slew MFD Cursor	Slew TGP Sensor	Slew HAS Cursor	Slew MAV Seeker

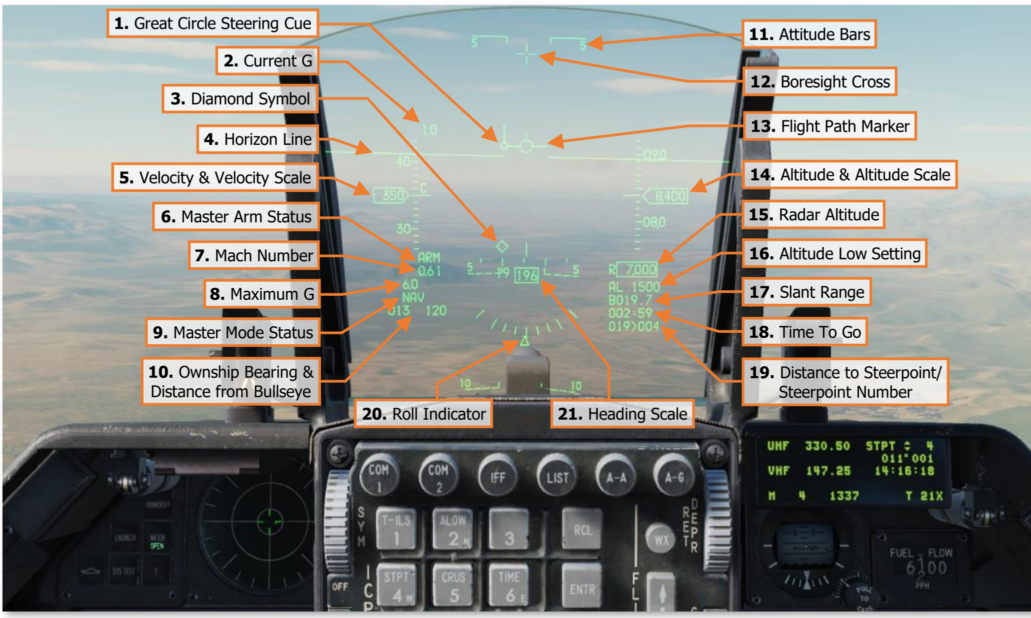
ACTION	A-A MODE	MSL ORIDE MODE	DGFT MODE	A-G MODE (AGM-65)
ENABLE DEPRESS	Swap AIM-9 BORE/SLAVE (for duration of press)			PRE→VIS→BORE

ACTION		COMMAND
UHF VHF FWD		Transmit over ARC-222 VHF-AM Radio
UHF VHF AFT		Transmit over ARC-164 UHF-AM Radio
UHF VHF LEFT	Short	Toggle Datalink Information on FCR
	Long	(No Action)
UHF VHF RIGHT	Short	Cycle Datalink Filters on FCR
	Long	Transmit selected Steerpoint or HAD Symbol as L16 Markpoint to Flight Members
SPD BRK FWD		Retract Speed Brakes
SPD BRK CTR		Hold Speed Brakes in current position
SPD BRK AFT		Extend Speed Brakes
DOG FIGHT UP (OUT)		Enter DOGFIGHT Master Mode, set FCR Mode to ACM, set FCR to Standby
DOG FIGHT CTR		Revert Master Mode to previous Master Mode/Sub-mode prior to entering DOGFIGHT/MISSILE OVERRIDE
DOG FIGHT DOWN (IN)		Enter MISSILE OVERRIDE Mode, set FCR Mode to CRM, set FCR Sub-mode to RWS
ANT ELEV ROTATE		Increase/Decrease FCR Antenna Elevation
MAN RNG ROTATE		Increase/Decrease TGP Manual Zoom Lvel

ACTION	NAV MODE (LG DOWN)	SMS AIM-9	SMS AGM-65	TGP SOI
UNCAGE DEPRESS	Declutter ILS/Roll Indicator from HUD	Uncage AIM-9 Seeker	Uncage AIM-65 Seeker	Toggle Laser Spot Search

HEADS-UP DISPLAY (HUD)

The Heads-Up Display, or HUD, is one of the most important instruments and provides valuable information regarding aircraft flight performance, navigation, targeting, and visual cues for weapons employment. All information is displayed on a combining glass mounted in the forward field-of-view at eye level. The display surface field of view is 25° in diameter and extends down to a line 10.5° below the field-of-view center, with the symbology focused at infinity and superimposed upon the outside world along the flightpath of the aircraft.



Some elements of the HUD symbology are always present, others will be displayed or removed based on the selected master mode, available sensor(s), or weapon profile; and some elements can be optionally displayed or removed based on pilot preference. (See HUD Control Panel for more information.)

HUD Symbology Elements

1. **Great Circle Steering Cue.** Provides a lateral steering indication to the selected steerpoint. The steering cue functions using the great circle method, in that the most direct route across a 3-dimensional sphere is used to determine the course to the destination instead of a fixed heading across a 2-dimensional surface.

   The line extending from the cue indicates the relative bearing of the selected steerpoint from the nose. If the line is pointed to the 12 o'clock, the steerpoint is directly ahead. If the line is pointed to the 3 or 9 o'clock, the steerpoint is 90 to the right or left respectively. If the line is pointed to the 6 o'clock, the steerpoint is behind the aircraft. (See Steerpoint Navigation for more information.)

2. **Current G.** Displays the current aircraft G-load value. The G value is displayed to the nearest tenth of a G, and ranges from +9.9 to -9.9 G's.

3. **Diamond Symbol.** Displays the 3-dimensional position of the selected steerpoint, in both position and altitude. When the Diamond Symbol is out of the HUD field-of-view an X is superimposed across the symbol. (See Steerpoint Navigation for more information.)

4. **Horizon Line.** The Horizon Line is an element of the Attitude Bars that indicates 0° pitch, relative to the Boresight Cross.

5. **Velocity & Velocity Scale.** Velocity is displayed in knots, between 60 to 900 knots CAS. When below 60 knots CAS, the HUD will display 0 knots. Each major tick mark on the Velocity Scale represents 50 knots and is accompanied by a 2-digit label, and each minor tick mark represents 10 knots.

   The Velocity can be set to calibrated airspeed (CAS), true airspeed (TAS), or ground speed (GND SPD) using the Velocity Switch on the HUD Control Panel. A "C" is displayed to the right of the Velocity Scale when set to calibrated airspeed, a "T" is displayed when set to true airspeed, and a "G" is displayed when set to ground speed. The Velocity Scale will automatically revert to calibrated airspeed if in Dogfight mode or if the landing gear are down.

6. **Master Arm Status.** Displays the position of the MASTER ARM Switch on the MISC panel.

   - **ARM.** The MASTER ARM Switch is in the MASTER ARM position.
   - **(Blank).** No text is displayed if the MASTER ARM Switch is in the OFF position.
   - **SIM.** The MASTER ARM Switch is in the SIMULATE position.

7. **Mach Number.** Displays the current Mach number to the hundredths value.

8. **Maximum G.** Displays the maximum G-loading measured during the flight.

   The Drift Cut-Out/Warning Reset switch on the ICP can be used to reset this value to 1.0 when placed momentarily in the WARN RESET position.

9. **Master Mode Status.** Displays the current master mode or sub-mode.

   - **NAV.** Navigation mode.
   - **AAM.** Air-to-Air Missile mode with no missile type selected.
   - **MRM.** Medium Range Missile type selected in Air-to-Air Missile/Missile Override mode.
   - **SRM.** Short Range Missile type selected in Air-to-Air Missile/Missile Override mode.
   - **HOB.** High-Angle Off-Boresight missile type selected in Air-to-Air Missile/Missile Override mode.
   - **EEGS.** Enhanced Envelope Gun Sight, Air-to-Air Guns mode.
   - **MSL.** Missile Override mode with no missile type selected.
   - **DGFT.** Dogfight mode.
   - **CCIP.** Continuously Computed Impact Point, Air-to-Ground sub-mode.
   - **CCRP.** Continuously Computed Release Point, Air-to-Ground sub-mode.
   - **DTOS.** Dive Toss, Air-to-Ground sub-mode.
   - **LADD.** Low Altitude Drogue Delivery, Air-to-Ground sub-mode.
   - **MAN.** Manual, Air-to-Ground sub-mode.
   - **STRF.** Strafe, Air-to-Ground Gun mode.
   - **PRE.** Pre-planned designation, Air-to-Ground sub-mode.
   - **VIS.** Visual designation, Air-to-Ground sub-mode.
   - **BORE.** Boresight designation, Air-to-Ground sub-mode.
   - **HARM.** HARM Missile designation, Air-to-Ground sub-mode.

- **HTS.** HARM Targeting System designation, Air-to-Ground sub-mode.
- **JETT.** Selective Jettison/Emergency Jettison mode.

10. **Ownship Bearing & Distance from Bullseye.** Displays the azimuth and distance as measured from the Bullseye location to the aircraft.

    The Ownship Bearing & Distance from Bullseye can be toggles using the BULL DED page.

11. **Attitude Bars.** A series of horizontal bars (including the Horizon Line) spaced at 5° intervals to indicate aircraft pitch attitude, relative to the Boresight Cross. At pitch angles greater than 60, the attitude bar intervals are spaced at 10 intervals. Positive pitch angles are indicated by a solid attitude bar, and negative pitch angles are indicated by a dashed bar. Each bar includes a small line along the outside pointing toward the Horizon Line.

    The Attitude Bars are caged to the Flight Path Marker in azimuth, which may occur in high crosswinds or lateral drift. The Drift Cut-Out/Warning Reset switch on the ICP can be used to cage the Attitude Bars and FPM to the center of the HUD when set to the DRIFT C/O position.

12. **Boresight Cross.** The Boresight Cross is displayed in all master modes and represents the fuselage reference line.

13. **Flight Path Marker.** The Flight Path Marker (FPM) consists of a circle with three lines extending outward from the circumference at the 12, 3, and 9 o'clock positions. The FPM indicates the aircraft inertial velocity vector.

    When the FPM is out of the HUD field-of-view, which may occur in high crosswinds, lateral drift or high angles-of-attack, an X is superimposed across the symbol. The Drift Cut-Out/Warning Reset switch on the ICP can be used to cage the Attitude Bars and FPM to the center of the HUD when set to the DRIFT C/O position.

    When in Air-to-Ground mode, the FPM will flash when a weapon is released.

14. **Altitude & Altitude Scale.** The Altitude & Altitude Scale is in feet, to the nearest 10 feet. Each major tick mark on the Altitude Scale represents 500 feet and is accompanied by a 2-digit label, and each minor tick mark represents 100 feet.

15. **Radar Altitude.** The Radar Altitude is displayed within a box marked by an "R", to the nearest 10 feet. If the radar altimeter is set to standby or is otherwise not transmitting, the display will be blank.

16. **Altitude Low Setting.** Displays the current CARA ALOW setting in feet. When the radar altimeter indicates an altitude less than this setting, this data field will flash and will be accompanied by an "ALTITUDE…ALTITUDE" voice message alert.

17. **Slant Range.** The Slant Range is the direct, straight-line distance from the aircraft to the current target or SPI location. For range values greater than 1.0 NM, the range is displayed as a four-digit value to the nearest tenth of a nautical mile (i.e., 15.2 NM is displayed as "015.2"). For range values less than 1.0 NM, the range value is displayed as a three-digit value to the nearest hundred feet (i.e., 5500 feet is displayed as "055"). The letter on the left of the display indicates the method the range is determined.

    - **B.** The slant range is determined based on the barometric altitude and steerpoint elevation.
    - **R.** The slant range is determined based on the radar altimeter.
    - **F.** The slant range is determined based on ranging data from the FCR.
    - **M.** A Manual range is being used in an air-to-air mode or in air-to-ground CCIP mode.

18. **Time to Go.** Displays the time that is estimated to elapse before arriving at the selected steerpoint, based on the current ground speed. (See Steerpoint Navigation for more information.)

19. Distance to Steerpoint/Steerpoint Number. The distance to the selected steerpoint is displayed to the left of the chevron in 1 nautical mile increments. The selected steerpoint number is displayed to the right of the chevron. (See Steerpoint Navigation for more information.)

20. Roll Indicator. The Roll Indicator consists of increment marks at 0°, 10°, 20°, 30° and 45° bank angles. As the aircraft rolls in either direction, the caret symbol will rotate along the indicator arc to indicate the current bank angle.

21. Heading Scale. The Heading Scale indicates the magnetic heading of the aircraft. A fixed lubber line along the top of the scale and a digital readout below the scale displays the magnetic heading. Each major tick mark on the tape represents 10° of magnetic heading and is accompanied by a 2-digit label, and each minor tick mark represents 5° of magnetic heading.

When the Velocity Scale is set to ground speed, a triangle symbol is presented along the Heading Scale indicating the aircraft's course track across the ground.

22. Bank Angle Indicator. The Bank Angle Indicator consists of increment marks at 15°, 30°, 45°, and 60° bank angles. The increment marks are caged to the Flight Path Marker and the FPM wings are used as indicators of the bank angle.

The Bank Angle Indicator is displayed in place of the Roll Indicator and is only displayed in NAV master mode and when the Scales Switch is in the VV/VAH position on the HUD Control Panel.

23. Vertical Velocity Scale. The Vertical Velocity Scale is displayed to the left of the Altitude Scale when in NAV master mode. Each major tick mark on the Vertical Velocity Scale represents 1000 feet per minute, and each minor tick mark represents 500 feet per minute.

The Vertical Velocity Scale is only displayed in NAV master mode and when the Scales Switch is in the VV/VAH position on the HUD Control Panel.

24. Manual Bombing Reticle. The Manual Bombing Reticle is displayed using the Primary or Secondary reticle patterns. Using the RET DEPR knob on the ICP, the reticle can be positioned vertically from 0 to -260 mils with respect to the Boresight Cross, and it is fixed horizontally on the HUD center line and not wind-corrected.

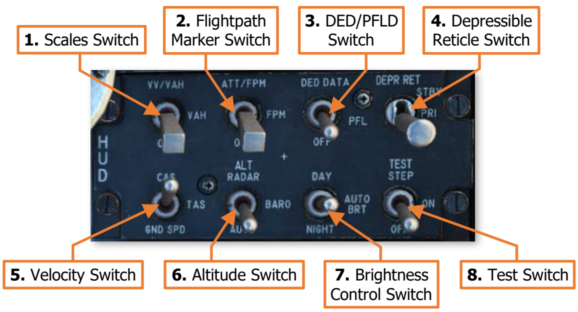
- **Primary Reticle.** The primary reticle consists of a 2-milliradian dot surrounded by a dashed 50-milliradian inner circle and a solid 100-milliradian dotted outer circle.
- **Secondary Reticle.** The secondary reticle consists of a 2-milliradian dot surrounded by dotted 50-milliradian inner circle and a dotted 100-milliradian outer circle. Four 6-milliradian tick marks are positioned along the outer circle marking the 12, 3, 6, and 9 o'clock locations.
- **Manual Reticle Depression Setting.** Indicates the current reticle depression setting of the Manual Bombing Reticle, as set by the RET DEPR knob on the ICP.

Additional HUD symbology elements associated with the various sensors and weapons are described in the applicable chapters of this manual.

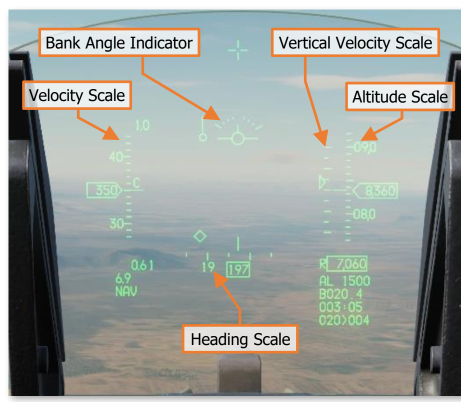
HUD Control Panel

The HUD Control Panel provides the pilot with the ability to tailor which HUD symbology elements are displayed at any given time to suit the current mission, situation, or personal preference.

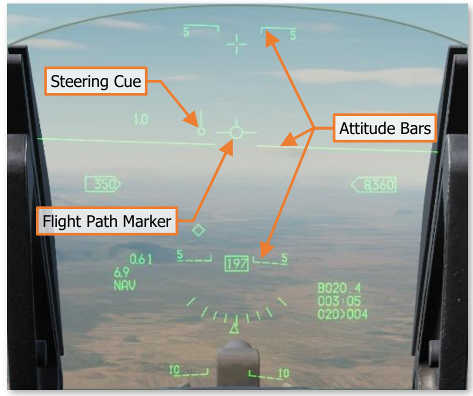
In Navigation master mode, with no targets being tracked by the FCR, the HUD can be de-cluttered as shown in the image to the right.



1. **Scales Switch.** Enables/disables the display of analog scales for primary flight data.
    - **VV/VAH.** Vertical Velocity, Velocity, Altitude, and Heading scales are displayed. If the Flight Path Marker (FPM) is displayed, the Roll Indicator is removed and the Bank Angle Indicator is placed around the FPM.
    - **VAH.** Velocity, Altitude and Heading scales are displayed. The Vertical Velocity scale is removed.
    - **OFF.** Removes all scales, leaving only the digital readouts for velocity, altitude, and heading.



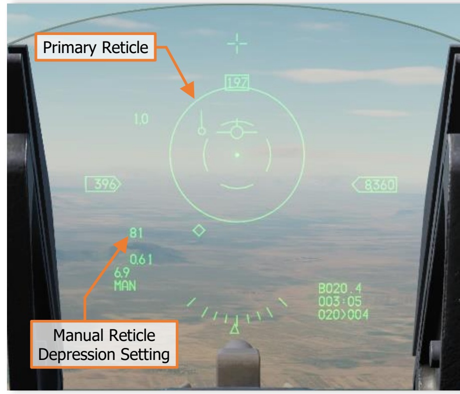
2. **Flightpath Marker Switch.** Enables/disables the display of attitude and flight path information.
   - **ATT/FPM.** Displays the Attitude Bars (horizon line and pitch ladder), the Flight Path Marker (FPM), and the Steering Cue
   - **FPM.** Displays the Flight Path Marker and Steering Cue. The Attitude Bars are removed.
   - **OFF.** The Attitude Bars, Flight Path Marker, and Steering Cue are removed.



3. **DED/PFLD Switch.** Enables/disables the display of PFLD or DED information in the lower portion of the HUD.
   - **DED DATA.** Removes the Roll Indicator and displays a data repeater of the DED.
   - **PFL.** Removes the Roll Indicator and displays a data repeater of the Pilot Fault List Display (PFLD).
   - **OFF.** Displays the Roll Indicator.

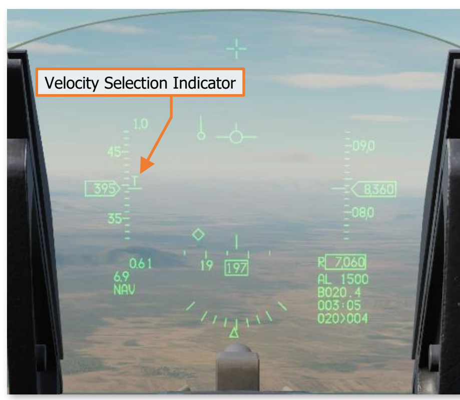
4. **Depressible Reticle Switch.** Controls the display of the Manual Bombing Reticles and Manual Reticle Depression Setting.

- **STBY.** Displays the Standby Reticle and Manual Reticle Depression Setting. Removes all other HUD elements.
- **PRI.** Displays the Primary Reticle and Manual Reticle Depression Setting. All HUD symbology elements are retained.
- **OFF.** Removes the Primary/Standby Reticle and the Manual Reticle Depression Setting.



5. **Velocity Switch.** Controls the velocity scale displayed in the HUD. The velocity selection indicator is only displayed when the Scales switch is in the VV/VAH or VAH positions.

- **CAS.** Displays calibrated airspeed, indicated by a "C" next to the Velocity Scale. The HUD will automatically revert to CAS if in Dogfight mode or if the landing gear are down.
- **TAS.** Displays true airspeed, indicated by a "T" next to the Velocity Scale.
- **GS.** Displays ground speed, indicated by a "G" next to the Velocity Scale. A triangle symbol will be displayed on the Heading Scale, if shown, to indicate the current ground track of the aircraft.



6. **Altitude Switch.** (N/I)

7. **Brightness Control Switch.** Controls HUD brightness intensity automatically or manually.

   - **DAY.** HUD brightness is manually selected to day intensity level.
   - **AUTO BRT.** HUD brightness is automatically adjusted based on ambient light levels. (N/I)
   - **NIGHT.** HUD brightness is manually selected to night intensity level.

8. **Test Switch.** (N/I)

UPFRONT CONTROLS (UFC)

The Upfront Controls (UFC) include the Integrated Control Panel (ICP) and the Data Entry Display (DED). These components provide a method of quick access for navigation control, communications, fire control system modes, and data entry throughout the mission. The most commonly used functions are available on the ICP itself; but less frequently used functions, such as power and audio volume, are located on console panels.

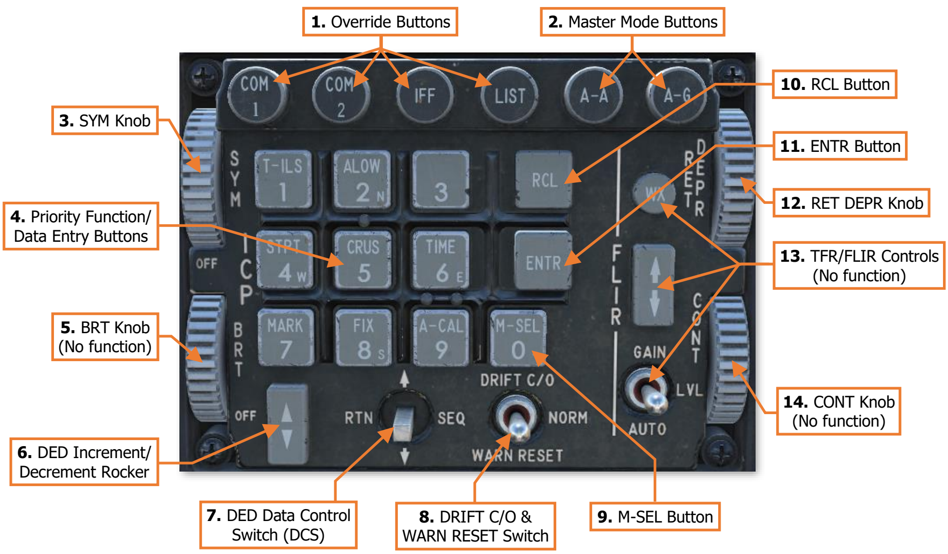
Data accessed through the ICP is displayed on the DED.

The Upfront Controls are available when the C & I knob is set to the UFC position on the IFF control panel. During normal operations, the Upfront Controls are used for various data entry and system management functions of communications, navigation, and IFF. In the event there is a failure with the Upfront Controls, the C & I knob can be set to the BACK UP position, which allows control of the UHF radio and IFF through the use of the UHF Backup panel and the IFF control panel.

Note that even when the C & I knob is set to the UFC position, the MASTER knob on the IFF control panel is still used to enable/disable operation of the APX-113 Advanced IFF transponder/interrogator system.

Integrated Control Panel (ICP)

The Integrated Control Panel fills the top center portion of the instrument panel and is one of the core components for interfacing with the communications, navigation, and IFF systems (also called CNI) of the F-16C. In addition to the CNI-related functions, the ICP provides master mode selection, controls for manipulating and entering data into the DED, and HUD symbology brightness control.



1. **Override Buttons.** Four override buttons provide quick selection and control of high priority systems. These override the current DED page to show the page that corresponds to the pressed button. Pressing the button a second time returns to the previous page.
   - **COM 1.** Selects the UHF DED page.
   - **COM 2.** Selects the VHF DED page.
   - **IFF.** Selects the IFF DED page.
   - **LIST.** Selects the List DED page. The List page displays less frequently used DED pages.
2. **Master Mode Buttons.** Pressing these buttons selects the Air-to-Air or Air-to-Ground master mode. This configures the aircraft systems and displays for the selected attack mode in one easy step. Pressing the same button a second time returns to the previous mode.
3. **SYM Knob.** Rotating this knob up/down will increase/decrease the HUD symbology brightness.
4. **Priority Function/Data Entry Buttons.** Pressing one of the nine labeled buttons on the ICP keypad selects the associated DED page for that frequently used function. The buttons are also used to enter data into the DED as necessary.
5. **BRT Knob.** The HUD raster intensity knob is not used in the Block 50 F-16.
6. **DED Increment/Decrement Rocker.** This switch increases or decreases values for the field selected on the current DED page. Values that can be increased or decreased are identified by an up and down arrow next to them on the display. The DCS is used to cycle between available fields.

7. **Data Control Switch (DCS).** This switch is used to move the asterisks or the increment/decrement symbol on the various DED pages, sequence through different data fields, and return to the CNI page from other DED pages. It's specific functionality for each DED page is described in each respective DED page section.

8. **DRIFT C/O & WARN RESET Switch.**

   - **DRIFT C/O.** Setting the switch to this position will horizontally cage the Flight Path Marker to the center of the HUD and the Attitude Bars to the Boresight Cross. This may be used if the FPM and Attitude Bars drift out of view from crosswinds or sideslip, or if a failure or degradation has occurred in the INS and it is operating in Attitude mode.

   - **NORM.** Spring-loaded to this position from WARN RESET. Allows the FPM and Attitude Bars to drift left or right with the aircraft's true flight path.

   - **WARN RESET.** Resets warnings presented on the HUD and their associated voice messages. Resets the HUD Maximum G indicator to 1.0.

9. **Mode Select (M-SEL) Button.** This button is used on some DED pages to cycle through available modes. The button is also used to enter data into the DED as necessary.

10. **Recall (RCL) Button.** Press this button once to erase the last digit of new data that was entered, (i.e., like a Backspace key). Press it a second time to reject the new data entered and restore the original data.

11. **Enter (ENTR) Button.** Press this button to accept and enter new data into the highlighted data field.

12. **Reticle Depression (RET DEPR) Control.** This knob raises and lowers the depressible reticle when it is displayed on the HUD during MAN bombing mode. Values from 0 to 260 milliradians can be set.

13. **TFR/FLIR Controls.** The TFR WX button, FLIR Increment/Decrement rocker, and FLIR GAIN/LVL/AUTO switch are not used in the Block 50 F-16.

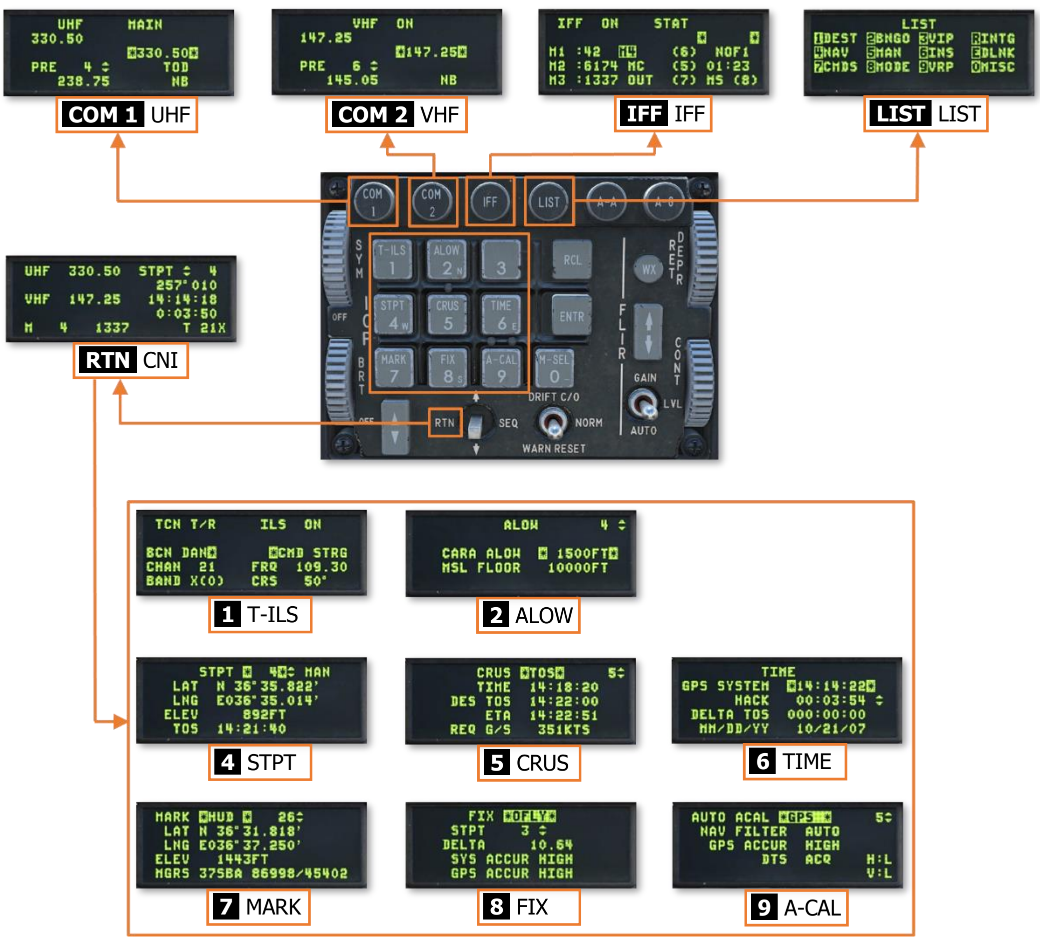
14. **CONT Knob.** The HUD raster contrast knob is not used in the Block 50 F-16.

Data Entry Display (DED)

The Data Entry Display is an LED-display that allows the pilot to view and edit a variety of system settings and data within the F-16C. Each of the DED page labels in the figure below and on the following page can be left-clicked to immediately move to the corresponding manual section describing the function of that page.

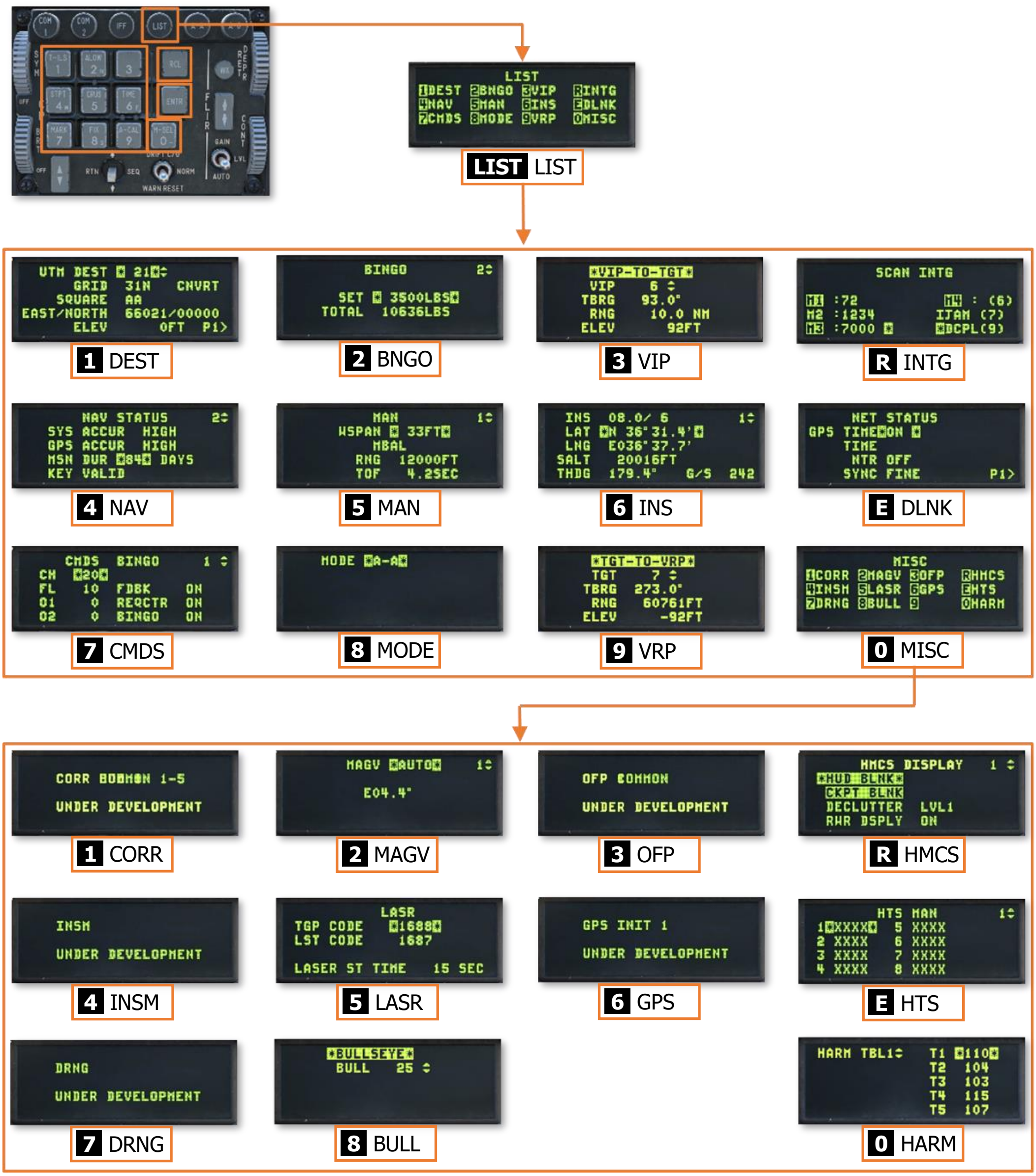
The CNI page can be considered the "home" page, in that it is commonly displayed during a mission when the DED is not in active use, and most DED pages can only be accessed by first returning to the CNI page. Any time the Data Control Switch (DCS), also called the "Dobber" switch, is moved to the RTN position, the DED is returned to the CNI page, and any data that was entered on the previous DED page but not accepted will be erased. The ICP Priority Function buttons can call up their respective pages when the CNI is displayed on the DED.

Any time the UHF, VHF, IFF or LIST pages are called up using their respective Override buttons along the top of the ICP, pressing the button a second time will return the DED to the previous state.



Data Entry Display – Priority Functions

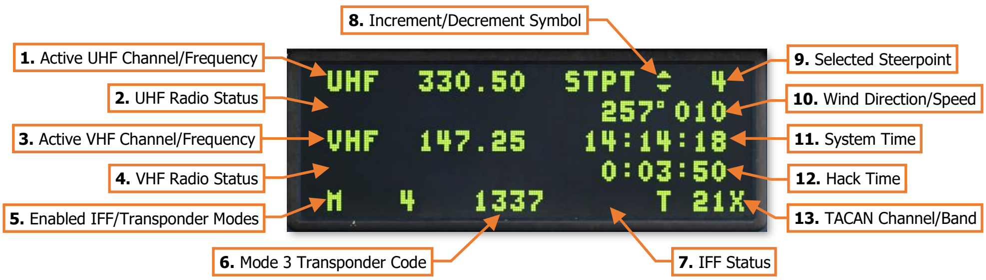
Less frequently used DED pages can be accessed by pressing the LIST Override button, and then use the ICP keypad to select the corresponding page displayed on the DED page. An additional list of miscellaneous DED pages can be accessed through the LIST page by pressing the **0/M-SEL** button on the ICP keypad.

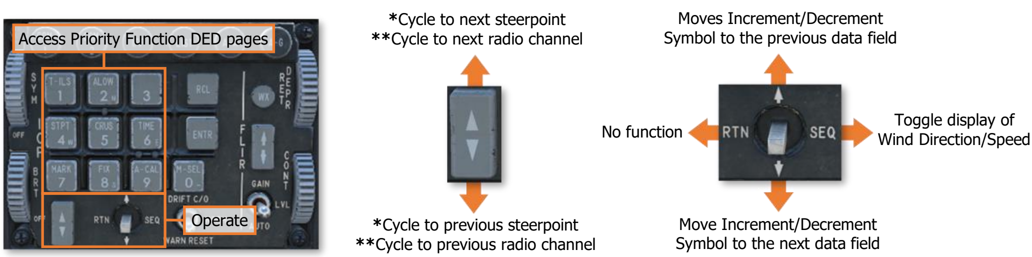


Data Entry Display – Secondary and Miscellaneous Functions

CNI Page

The CNI (Communications, Navigation, IFF) page displays the current radio frequencies or channels the UHF and VHF radios are tuned to, the current navigation steerpoint, TACAN data, wind data, time, and IFF status. The CNI page is displayed at power-up and can be accessed from any DED page by pressing the "Dobber" switch to the RTN (Return) position.





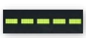
* Cycles to next/previous steerpoint when the Increment/Decrement Symbol is set to the Selected Steerpoint data field.

** Cycles to next/previous UHF or VHF preset radio channel when the Increment/Decrement Symbol is set to the corresponding radio data field and that radio is already set to a preset channel.

1. **Active UHF Channel/Frequency.** Displays the preset radio channel or the manual radio frequency to which the ARC-164 UHF radio is currently tuned.
2. **UHF Radio Status.** Displays the operating mode of the ARC-164 UHF radio.
    - **(Nothing Displayed).** Radio is powered on and controlled via the Upfront Controls (UFC).
    - **GRD.** Radio is powered on and tuned to the UHF GUARD frequency 243.0.
    - **BUP.** Radio is powered on and controlled via the UHF Backup control panel.
    - **OFF.** Radio is powered off.
3. **Active VHF Channel/Frequency.** Displays the preset radio channel or the manual radio frequency to which the ARC-222 VHF radio is currently tuned.
4. **VHF Radio Status.** Displays the operating mode of the ARC-222 VHF radio.
    - **(Nothing Displayed).** Radio is powered on and controlled via the Upfront Controls (UFC).
    - **GRD.** Radio is powered on and tuned to the VHF GUARD frequency 121.5.
    - **BUP.** Radio is powered on but cannot be controlled in BACK UP mode.
    - **OFF.** Radio is powered off.

5. **Enabled IFF/Transponder Modes.** (N/I)
6. **Mode 3 Transponder Code.** (N/I)
7. **IFF Status.** Displays the operating mode of the APX-113 Advanced IFF system.
   - **(Nothing Displayed).** IFF is controlled via the Upfront Controls (UFC) via the IFF DED page.
   - **BUP.** IFF is controlled via the IFF control panel.
8. **Increment/Decrement Symbol.** Indicates which data field the Increment/Decrement rocker will modify.
9. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.
10. **Wind Direction/Speed.** Displays the current magnetic wind direction and speed as calculated by the CADC. When the winds cannot be determined by the CADC, DFLT will be displayed to the left of the wind direction, indicating default values are currently displayed in the data field.
11. **System Time.** Displays the internal system time in a 24-hour time format based on Zulu time (UTC). System time is automatically entered into the avionics system based on GPS data. No manual entering of time is required.
12. **Hack Time.** Displays the current Hack time as set on the TIME DED page.
13. **TACAN Channel/Band.** Displays information regarding the TACAN receiver.
   - 

TACAN is powered and set to REC or T/R mode. Tuned channel and band (X/Y) are displayed.
   - 

TACAN is powered and set to A/A T/R mode. Distance measurement to the paired TACAN station is displayed between 00.1 and 99.9 NM.
   - 

TACAN is powered and set to A/A T/R mode. No distance measurement available.

   (See TACAN Navigation for more information.)

UHF & VHF Pages

The UHF and VHF DED pages are accessed by pressing the COM 1 or COM 2 override buttons (respectively) on the ICP, regardless of the currently displayed DED page. Pressing the same button a second time will return the DED to the previous page. (See Radio Communications for more information.)

IFF Page

The Identification-Friend-or-Foe DED page is accessed by pressing the IFF override button on the ICP, regardless of the currently displayed DED page. Pressing the IFF button a second time will return the DED to the previous page.

This page is not implemented.

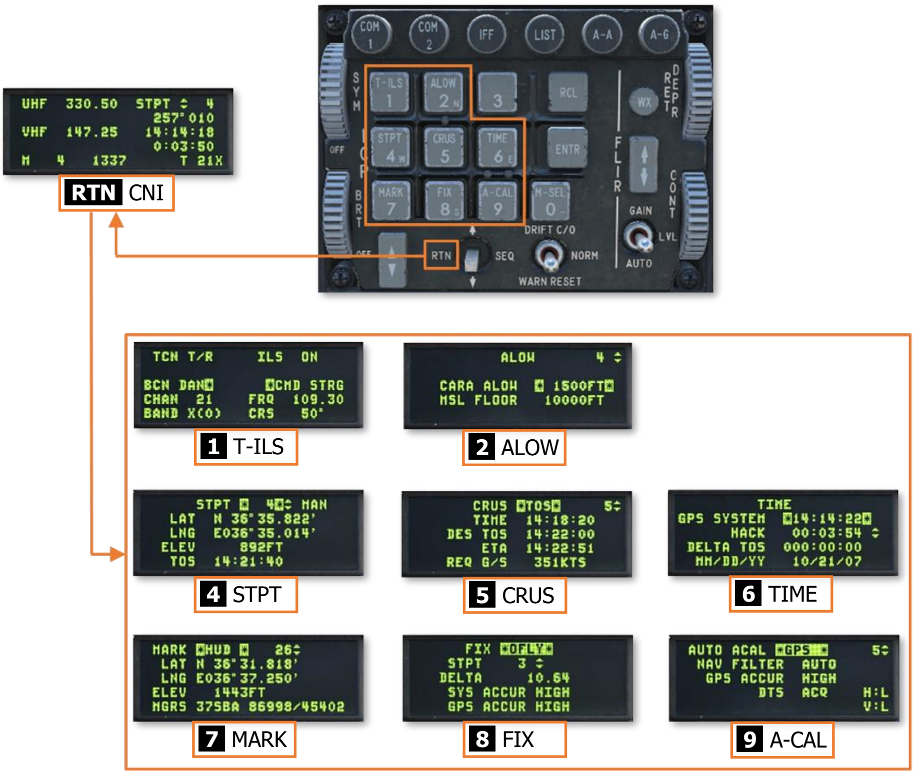
LIST Page

The List DED page is accessed by pressing the LIST override button on the ICP, regardless of the currently displayed DED page. Pressing the LIST button a second time will return the DED to the previous page. The LIST page displays a list of secondary DED pages that may be accessed. The ICP keypad is used to select a page from the list.

An additional list of miscellaneous DED pages may be accessed by pressing the 0/M-SEL button on the ICP keypad while the LIST page is displayed.

Priority Function DED Pages

When the CNI page is displayed on the DED, the buttons on the keypad are used to access eight frequently used DED pages. Each button is labeled with the corresponding DED page that will be accessed when the button is pressed.



Data Entry Display – Priority Functions

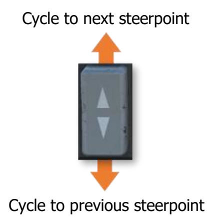
The following Priority Function DED pages are detailed in the applicable sections:

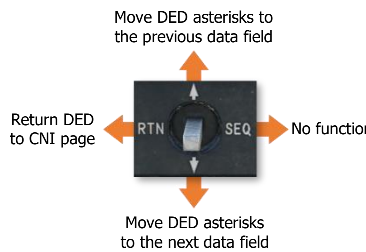
- **T-ILS –** TACAN Navigation & Instrument Landing System (ILS)
- **FIX –** Navigation Fixes and Updates
- **A-CAL –** Navigation Fixes and Updates

The remaining Priority Function DED pages are detailed below.

ALOW Page

The Altitude Low DED page is accessed by pressing the **2/ALOW** button on the ICP keypad when the CNI page is displayed on the DED. Two low altitude warnings can be set; one that is triggered by the Combined Altitude Radar Altimeter (CARA) and the other that is triggered by the barometric altimeter.





1. **CARA ALOW.** Displays the altitude at which the Combined Altitude Radar Altimeter will trigger a low altitude warning. May be modified by placing the DED asterisks over the data field and entering a different value using the ICP keypad and then pressing ENTR.

   When the radar altimeter indicates the aircraft is below this altitude, the Altitude Low Setting will flash in the HUD and an accompanying “ALTITUDE…ALTITUDE” voice message will be heard.

   Note that this setting is based on the altitude above ground level (AGL) and requires the radar altimeter to be powered on and transmitting for this warning to function. If the landing gear is down, the voice message is inhibited.

2. **MSL FLOOR.** Displays the altitude at which the altimeter will trigger a low altitude warning. May be modified by placing the DED asterisks over the data field and entering a different value using the ICP keypad and then pressing ENTR.

   When the barometric altimeter indicates the aircraft is below this altitude, an “ALTITUDE…ALTITUDE” voice message will be heard.

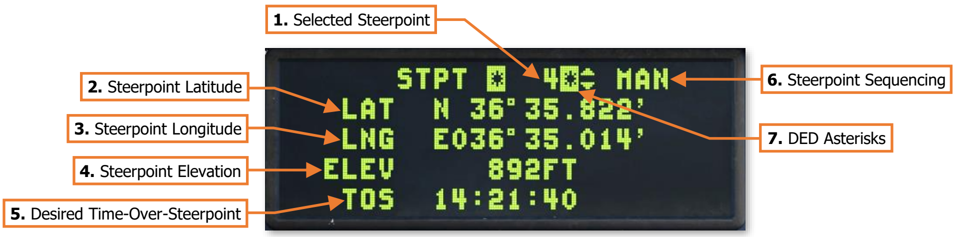
   Note that this setting is based on the altitude above mean sea level (MSL). If the landing gear is down, the voice message is inhibited.

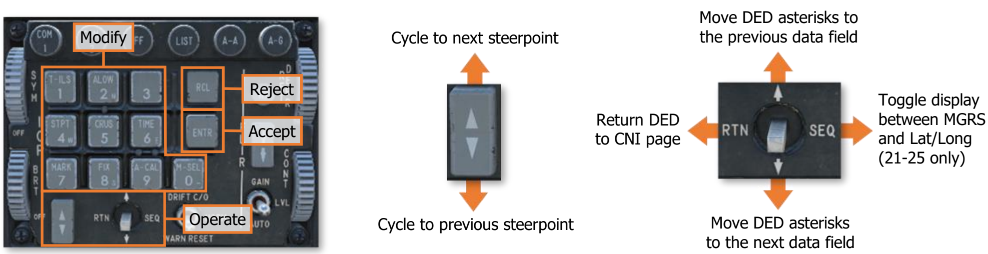
3. **Selected Steerpoint.** Displays the selected steerpoint. The ICP Increment/Decrement rocker may be used to cycle to a different steerpoint.

4. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

STPT Page

The Steerpoint DED page is accessed by pressing the **4/STPT** button on the ICP keypad when the CNI page is displayed on the DED. This page displays the position and elevation of the currently selected steerpoint, along with the desired Time-Over-Steerpoint (TOS), all of which can be modified from this page.





1. **Selected Steerpoint.** Displays the selected steerpoint. The ICP Increment/Decrement rocker may be used to cycle to a different steerpoint. The selected steerpoint can also be changed by placing the DED asterisks over the data field and entering the steerpoint number using the ICP keypad and then pressing ENTR.
2. **Steerpoint Latitude.** Displays the latitude (in DD° MM.MMM' format) of the selected steerpoint. May be modified using the ICP keypad.
3. **Steerpoint Longitude.** Displays the longitude (in DDD° MM.MMM' format) of the selected steerpoint. May be modified using the ICP keypad.
4. **Steerpoint Elevation.** Displays the elevation (in feet) of the selected steerpoint. May be modified using the ICP keypad.
5. **Desired Time-Over-Steerpoint.** Displays the desired Time-Over-Steerpoint (TOS) of the selected steerpoint. May be modified using the ICP keypad.
6. **Automatic Steerpoint Sequencing.** Automatically selects the next steerpoint in sequence when the aircraft is within 2 nautical miles of the selected steerpoint and range is decreasing. The steerpoints will only be automatically sequenced through steerpoints 1-20. When set to MAN, the steerpoints must be manually sequenced by the pilot.

   To toggle between Automatic and Manual steerpoint sequencing, use the DCS Up/Down positions to place the DED Asterisks over AUTO/MAN data field and press the 0/M-SEL button on the ICP.
7. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

STPT Page – Modify the latitude of the selected steerpoint

1. Use the **DCS Up/Down** positions to place the DED Asterisks over the LAT data field.
2. Press **2** on the ICP keypad to enter N (North).

   or

2. Press **8** on the ICP keypad to enter S (South).
3. Use the ICP **keypad** to enter the Latitude. DD° MM.MMM' format is the only format that is accepted, which are entered as DDMMMMM in a continuous string of 7 characters without decimals.
4. Press **ENTR** to accept the new Latitude coordinates into the data field or press **RCL** twice to reject it.

STPT Page – Modify the longitude of the selected steerpoint

1. Use the **DCS Up/Down** positions to place the DED Asterisks over the LNG data field.
2. Press **6** on the ICP keypad to enter E (East).

   or

2. Press **4** on the ICP keypad to enter W (West).
3. Use the ICP **keypad** to enter the Longitude. DDD° MM.MMM' format is the only format that is accepted, which are entered as DDDMMMMM in a continuous string of 8 characters without decimals.
4. Press **ENTR** to accept the new Longitude coordinates or press **RCL** twice to reject it.

STPT Page – Modify the elevation of the selected steerpoint

1. Use the **DCS Up/Down** positions to place the DED Asterisks over the ELEV data field.
2. Use the ICP **keypad** to enter the elevation in feet, and
3. Press **ENTR** to accept the new elevation data or press **RCL** twice to reject it.

STPT Page – Modify the desired Time-Over-Steerpoint (TOS) of the selected steerpoint

1. Use the **DCS Up/Down** positions to place the DED Asterisks over the TOS data field.
2. Use the ICP **keypad** to enter the desired Time-Over-Steerpoint. A 24-hour time format of HH:MM:SS is the only format that is accepted, which is entered as HHMMSS in a continuous string of six characters.
3. Press **ENTR** to accept the new TOS data or press **RCL** twice to reject it.

STPT Page (MGRS to Lat/Long Conversion)

MGRS (Military Grid Reference System) is a UTM-derived coordinate system used as an alternative to Latitude/Longitude and is the primary coordinate system used by many military ground forces. While the majority of the F-16C steerpoints are displayed in Lat/Long degrees/minutes/decimal format, steerpoints 21-25 can also be displayed in MGRS format. Additionally, these steerpoints can be entered using MGRS coordinates, and then converted to Lat/Long format.

Steerpoints 26-30 are reserved as markpoints but can be used to display MGRS coordinates as well. These steerpoints can only be entered or modified using the Lat/Long coordinate format, and cannot be converted from MGRS. However, they will display the equivalent MGRS coordinate formats on the MARK DED page for reference. (See MARK DED Page for more information.)

STPT Page – Toggle between Lat/Long and MGRS

All steerpoints must be in Lat/Long (degrees/minutes/decimal) format to be stored within the navigation database. If the steerpoint already contains Lat/Long coordinates, the STPT page can be toggled to display the equivalent MGRS location by pressing the DCS ("Dobber" switch) to the SEQ position. After a 3-second delay, the MGRS coordinates will be shown.

STPT Page – Lat/Long format (Left) and MGRS format (Right)

The DED will display the MGRS Grid, Square, and Easting/Northing values, as well as the steerpoint elevation.

If a steerpoint is to be entered using MGRS, the STPT page must first be toggled to MGRS format using the DCS SEQ position, the MGRS coordinates entered, and then a conversion must be manually commanded by selecting the CNVRT data field and pressing ENTR. If CNVRT is not commanded before the STPT page is toggled back to Lat/Long format, the conversion will not occur, the MGRS coordinates that were entered will not be stored for that steerpoint, and the Lat/Long coordinates will not correctly correspond with the MGRS location.

The Time-Over-Steerpoint (TOS) and elevation (ELEV) data fields are not required to contain valid data for the conversion to occur. However, elevation can be entered on either format of the STPT page.

The following page illustrates the entire process for entering a location via MGRS into steerpoints 21-25.

STPT Page – Convert MGRS to Lat/Long

To enter a steerpoint using MGRS, a steerpoint must be selected within the range of 21-25.

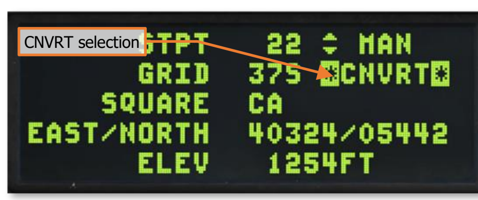
1. Use the **DCS SEQ** position to toggle the STPT page to MGRS format.

2. Use the **DCS Up/Down** positions to place the DED Asterisks over the GRID data field.
3. Use the ICP **keypad** to enter the two numerical digits of the Grid, and press **ENTR** to accept the data or **RCL** to reject it.
4. Use the **Increment/Decrement rocker** to change the final Grid character to the correct letter, and press **ENTR** to accept the data.

5. Use the **DCS Up/Down** positions to place the DED Asterisks over the SQUARE data field, and press **ENTR** to enable editing of the data field.
6. Use the **Increment/Decrement rocker** to change the first Square character to the correct letter, and press **ENTR** to accept the data or **RCL** to reject it.

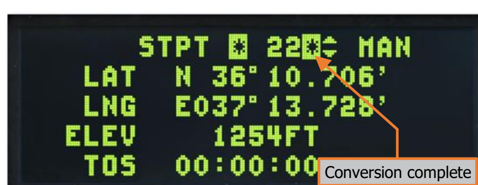
7. Use the **Increment/Decrement rocker** to change the second Square character to the correct letter, and press **ENTR** to accept the data or **RCL** to reject it.
8. Use the **DCS Up/Down** positions to place the DED Asterisks over the EAST/NORTH data field.

9. Use the ICP **keypad** to enter the Easting/Northing in a continuous string of ten characters, and press **ENTR** to accept the data or **RCL** to reject it.
10. Use the **DCS Up/Down** positions to place the DED Asterisks over the ELEV data field.



NOTE: Elevation data is not required for the conversion process to successfully complete, and can be entered separately or not at all.

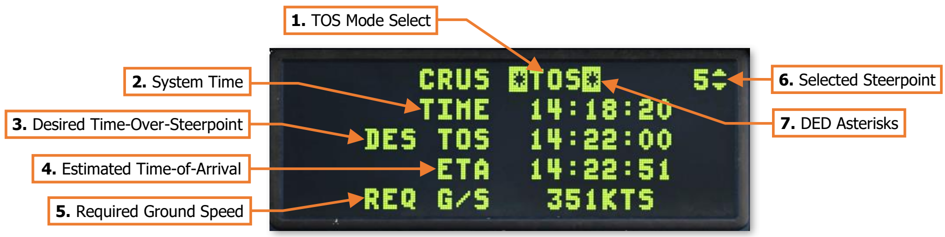
11. Use the ICP **keypad** to enter the elevation in feet, and press **ENTR** to accept the data or press **RCL** to reject it.
12. Use the **DCS Up/Down** positions to place the DED Asterisks over the CNVRT data field, and press **ENTR** to initiate the conversion to Lat/Long coordinates. When the conversion is complete, the DED Asterisks will automatically be placed around the steerpoint data field. At this point, the STPT page can be sequenced back to Lat/Long format.

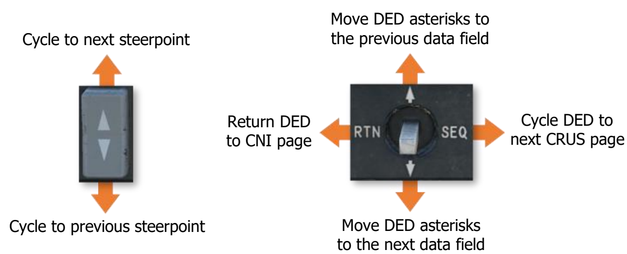


CRUS TOS Page

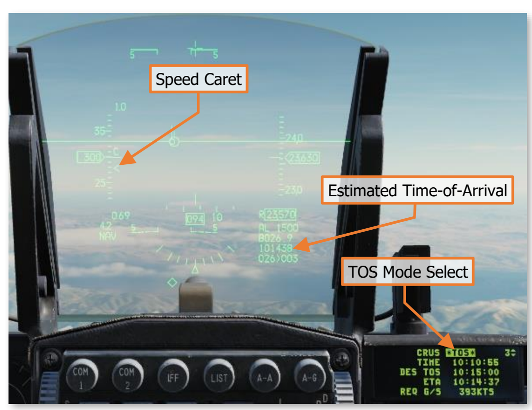
The Cruise DED page is accessed by pressing the **5/CRUS** button on the ICP keypad when the CNI page is displayed on the DED. There are four CRUS modes that can be displayed, each with their own page on the DED. If any of the CRUS modes are enabled, the DED will open to the CRUS page for that mode first. Only one CRUS mode can be enabled at any given time.

The first CRUS DED page is the CRUS Time-Over-Steerpoint page, which displays the desired Time-Over-Steerpoint (TOS) of the selected steerpoint, and the current Time-Over-Steerpoint (ETA) based on the current ground speed, and what ground speed is required in order to arrive at the steerpoint at the desired TOS.





1. **TOS Mode Select.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled, the CRUS Time-Over-Steerpoint mode displays an airspeed caret on the HUD Velocity Scale (if shown) that corresponds with the calculated speed required to arrive at the selected steerpoint's desired TOS, if flown directly toward the steerpoint. The HUD Time to Steerpoint data field will be replaced with the Estimated Time-of-Arrival (ETA) to that steerpoint at the current ground speed. If the landing gear is down, the speed caret is removed from the HUD.

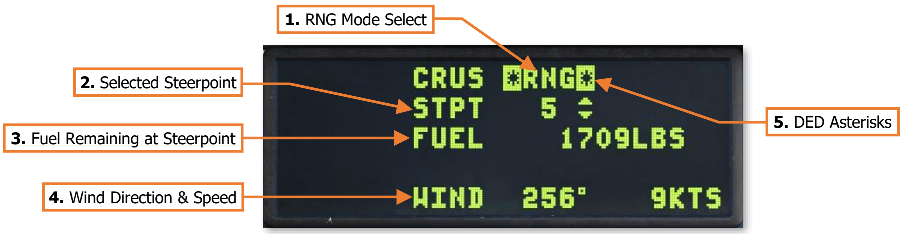


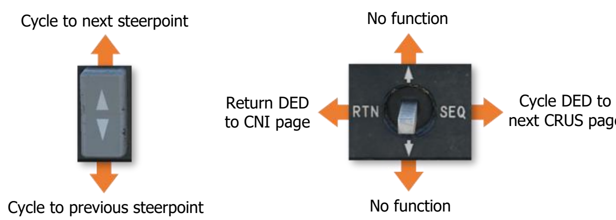
2. **System Time.** Displays the aircraft internal system time in a 24-hour time format.
3. **Desired Time-Over-Steerpoint.** Displays the desired time to arrive over the selected steerpoint, in a 24-hour time format. This can be used to synchronize tactical actions with other forces on or over the battlefield.
4. **Estimated Time-of-Arrival.** Displays the time that the aircraft will arrive over the selected steerpoint at the current ground speed if flown directly toward the steerpoint, in a 24-hour time format.
5. **Required Ground Speed.** Displays the ground speed that is required to be flown in order to arrive over the selected steerpoint at the desired TOS, if flown directly toward the steerpoint.

6. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.
7. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

CRUS RNG Page

The second CRUS DED page is the CRUS Range page, which displays the estimated remaining fuel onboard when the aircraft arrives at the selected steerpoint, and displays a maximum range speed caret on the HUD.





1. **RNG Mode Select.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled, the CRUS Range mode displays an airspeed caret on the HUD Velocity Scale (if shown) that corresponds with the speed that will result in the maximum range based on the current altitude and wind data. If the landing gear is down, the speed caret is removed from the HUD.

2. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.

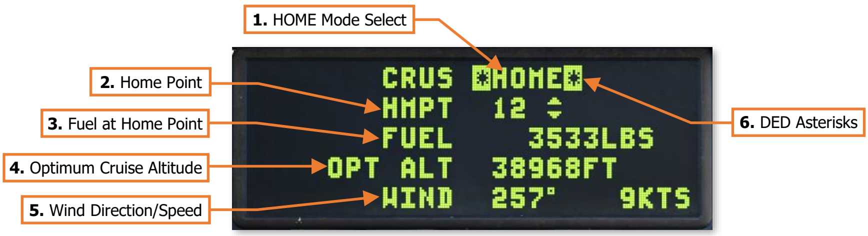
3. **Fuel at Steerpoint.** Displays the estimated remaining fuel onboard when the aircraft arrives at the selected steerpoint based on the current ground speed, range to the selected steerpoint, current fuel consumption, winds, and altitude. If the landing gear is down, this data field will remain at the last calculated value.

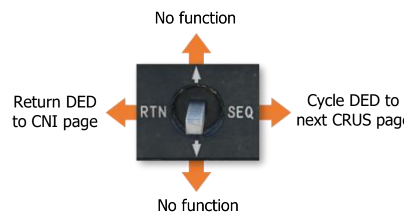
4. **Wind Direction/Speed.** Displays the current magnetic wind direction and speed as calculated by the CADC. If the landing gear is down, this data field will remain at the last calculated value.

5. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

CRUS HOME Page

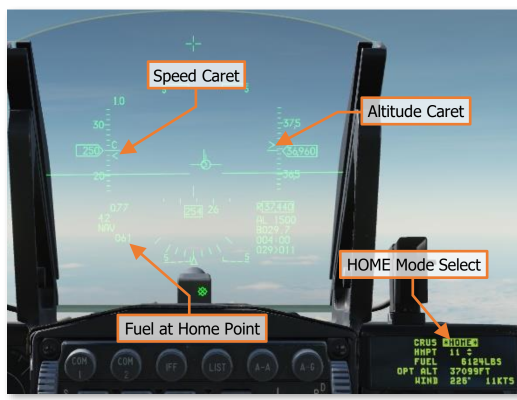
The third CRUS DED page is the CRUS Home page, which displays the estimated remaining fuel onboard when the aircraft arrives at the home steerpoint, the optimum cruising altitude, and displays optimum speed and altitude carets on the HUD.





1. **HOME Mode Select.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled, the CRUS Home mode displays airspeed and altitude carets on the HUD Velocity and Altitude Scales (if shown) that corresponds with the speed and altitude profile that will return to the Home point using the minimum amount of fuel. If the landing gear is down, the speed and altitude carets are removed from the HUD.

   The profile includes a minimum fuel climb at military power or an descent at idle power to the optimum altitude, a cruise climb in which the altitude increases as fuel is burned, and a final descent at idle power to a point 5,000 feet over the Home Point.



2. **Home Point.** Displays the steerpoint to which optimum flight profile calculations are being performed. When CRUS Home mode is enabled, the Home point becomes the selected steerpoint.

3. **Fuel at Home point.** Displays estimated fuel remaining onboard upon arrival at the steerpoint set as the Home point, if flown directly toward the steerpoint at optimum Mach number and altitude. If the landing gear is down, this data field will remain at the last calculated value.

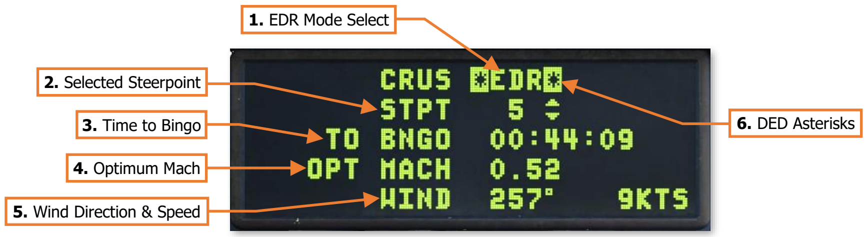
   This value is also displayed on the HUD below the Master Mode, in hundreds of pounds.

4. **Optimum Cruise Altitude.** Displays the altitude that will result in the most fuel efficient flight profile based on the current gross weight and corresponding angle-of-attack required to maintain level flight. As fuel is burned and weight decreases, this altitude will also increase due to the increased fuel efficiency for lower angles-of-attack. If the landing gear is down, this data field will remain at the last calculated value.

5. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

CRUS EDR Page

The fourth CRUS DED page is the CRUS Endurance page, which displays the estimated time until the onboard fuel reaches Bingo, the optimum Mach number, and displays a maximum endurance speed caret on the HUD.



1. **EDR Mode.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled, the CRUS Endurance mode displays an airspeed caret on the HUD Velocity Scale (if shown) that corresponds with the speed that will result in the maximum endurance (flight time) based on the current altitude. If the landing gear is down, the speed caret is removed from the HUD.

2. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.

3. **Time to Bingo.** Displays the estimated time remaining until the onboard fuel reaches the Bingo fuel entered on the BNGO DED page, based on the current Mach number and altitude. If the landing gear is down, this data field will remain at the last calculated value.

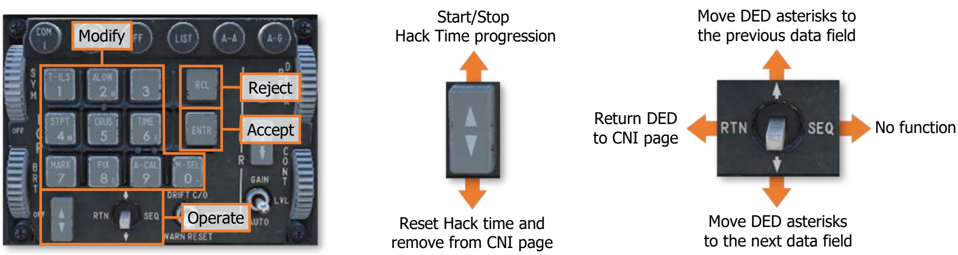
4. **Optimum Mach.** Displays the Mach number that will result in the maximum endurance based on the current altitude. If the landing gear is down, this data field will remain at the last calculated value.

5. **Wind Direction/Speed.** Displays the current magnetic wind direction and speed as calculated by the CADC. If the landing gear is down, this data field will remain at the last calculated value.

6. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

TIME Page

The Time DED page is accessed by pressing the **6/TIME** button on the ICP keypad when the CNI page is displayed on the DED. This page displays the aircraft's internal system time and date, and allows the pilot to set an additional time reference and adjust the Time-Over-Steerpoint (TOS) for all steerpoints simultaneously.



1. **System Time.** Displays the internal system time in a 24-hour time format based on Zulu time (UTC). System time is automatically entered into the avionics system based on GPS data. No manual entering of time is required.

2. **Hack Time.** Displays an additional time reference independent of System Time. This can be used as a separate time reference for the local time zone, or as a stopwatch for low-level navigation or vulnerability periods.

3. **Delta Time-Over-Steerpoint.** This data field is used to update the Time-Over-Steerpoint for all steerpoints at once. When a Delta TOS is accepted into this page, it will automatically increase or decrease all valid TOS entries for each steerpoint. This can be used if a coordinated strike or tactical action needs to be dynamically adjusted mid-mission, where the entire mission timeline needs to be refined at once.

   As an example, if the required time adjustment is 5 minutes, a Delta TOS would be entered as -00:05:00 or 00:05:00, depending on whether the 5 minute adjustment was to an earlier time or a later time. Valid Delta TOS entries range from -23:59:59 to 23:59:59 in HHMMSS format. To enter a negative value (to adjust each TOS to an earlier time), press 0/M-SEL first to enter a negative symbol, followed by the desired time adjustment.

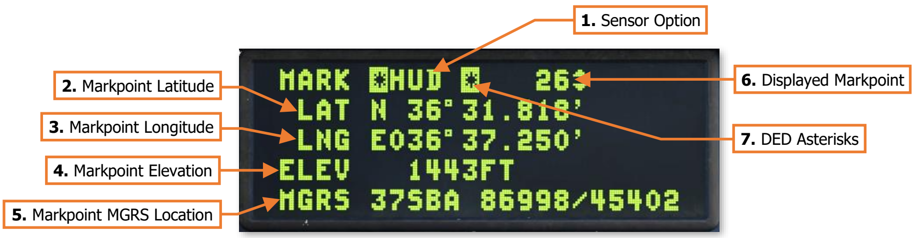
4. **System Date.** Displays the internal system date. System date is automatically entered into the avionics system based on GPS data. No manual entering of the date is required.

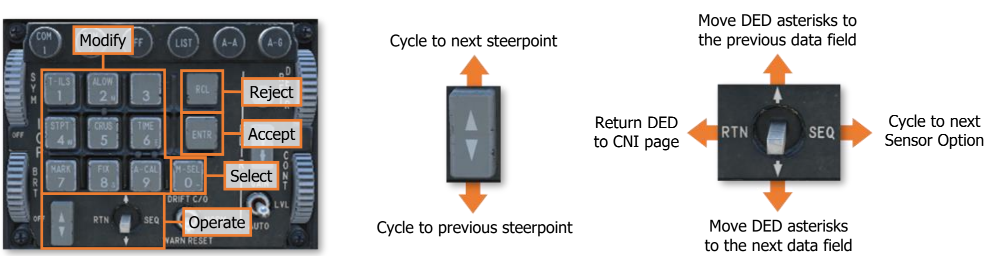
5. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

MARK Page

The Markpoint DED page is accessed by pressing the **7/MARK** button on the ICP keypad when the CNI page is displayed on the DED. There are five methods of storing a markpoint into steerpoints 26-30, depending on the method best suited to the current tactical situation and the available sensors onboard the aircraft.

Markpoints are steerpoints that can be stored during the mission for the purposes of navigation at some point later in the mission, recording a location of interest during reconnaissance, or for follow-on targeting of sensors and/or weapons. Markpoints can be stored by slewing the Mark Cue on the HUD or HMCS to the desired location, by the FCR in Fixed Target Track in an air-to-ground mode, by the Targeting Pod (TGP) when in Point Track mode, or by performing a direct overflight of the desired location. In addition, a markpoint can be manually stored (or edited) by using the ICP keypad to enter Latitude/Longitude coordinates.





1. **Sensor Option.** Displays the sensor that will be used to determine the location of the next markpoint. The next available option can be selected by momentarily positioning the DCS ("Dobber" switch) to the SEQ position.
2. **Markpoint Latitude.** Displays the latitude (in DD° MM.MMM' format) of the displayed markpoint. May be modified using the ICP keypad.
3. **Markpoint Longitude.** Displays the longitude (in DDD° MM.MMM' format) of the displayed markpoint. May be modified using the ICP keypad.
4. **Markpoint Elevation.** Displays the elevation (in feet) of the displayed markpoint. May be modified using the ICP keypad.
5. **Markpoint MGRS Location.** Displays the MGRS location of the displayed markpoint. May be modified using the ICP keypad.
6. **Displayed Markpoint.** Displays the steerpoint number that corresponds with the Lat/Long and MGRS coordinates currently displayed on the DED. When a new markpoint is stored, this number will automatically increment up to the next steerpoint number. Markpoints can only be stored in steerpoints 26-30, in sequential order. If a markpoint is already stored in steerpoint 30, the next markpoint will be stored in 26, overwriting the previous markpoint coordinates. Each subsequent markpoint that is stored will overwrite steerpoints 26-30 in a cyclic fashion.
7. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has

been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

Any time the markpoint that is currently displayed on the MARK page is also the selected steerpoint, a highlighted STPT will appear in the top right corner of the DED page.

The markpoint currently displayed on the MARK DED page can be set as the selected steerpoint directly from MARK page by setting the DED Asterisks around the Sensor Option data field and pressing the 0/M-SEL button.

NOTE: After designating a markpoint using the TGP or FCR, which will incur a "system delta" if slewed from the selected steerpoint, it will be necessary to use the Cursor Zero command to remove any "system delta" values that currently exists. This can be commanded by pressing CZ (OSB 9) on the TGP or FCR MFD formats, or CZ (OSB 10) on the HSD MFD format.

See Litening II Targeting Pod and APG-68 Fire Control Radar for more information on how to use the TGP or FCR for targeting and designation.

MARK Page – Store a markpoint using the HUD

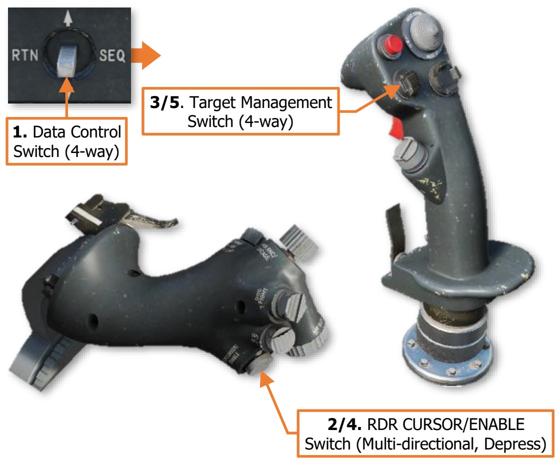
The HUD can be used to designate a location on the ground to store a markpoint using the HUD Mark Cue. When the HUD Sensor Option is selected on the MARK DED page, VIS sub-mode will be entered, the HUD will be selected as SOI, and the FCR will enter AGR mode for accurate ranging.

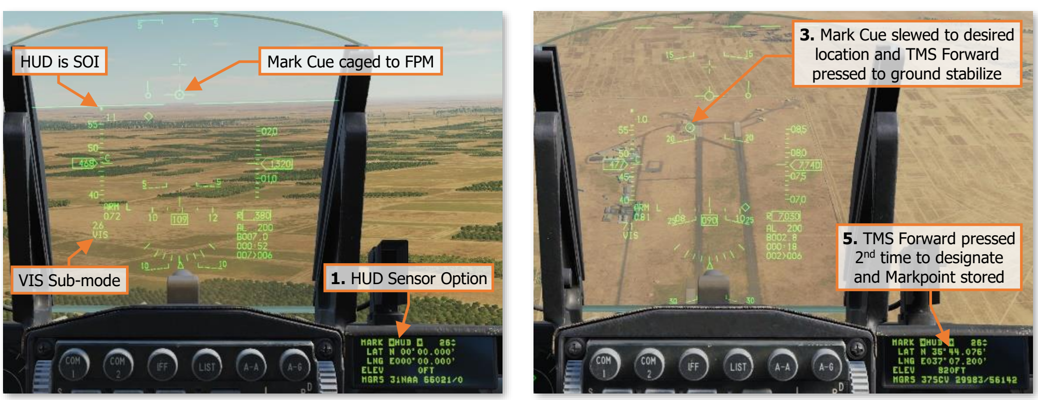
If DMS Aft is used to select a different SOI, VIS mode will be exited and the aircraft will return to the previous master mode and sub-mode. To re-enable the HUD Mark Cue, the Sensor Option on the MARK page must be cycled back to HUD using the DCS SEQ position.

1. Use the **DCS SEQ** position to select HUD in the Sensor Option data field on the MARK DED page.
2. Use the throttle's **RDR CURSOR/ENABLE** switch to slew the Mark Cue to the desired location within the HUD field-of-view.
3. Press **TMS Forward-Short** on the SSC to ground stabilize the Mark Cue.
4. Use the throttle's **RDR CURSOR/ENABLE** switch to make any final adjustments to the Mark Cue's ground stabilized position, as necessary.
5. Press **TMS Forward-Short** on the SSC to designate the location as a markpoint.

or

5. Press **TMS Aft-Short** to cage the Mark Cue to the HUD FPM without designating the markpoint.





Markpoint Designation – HUD Sensor Option

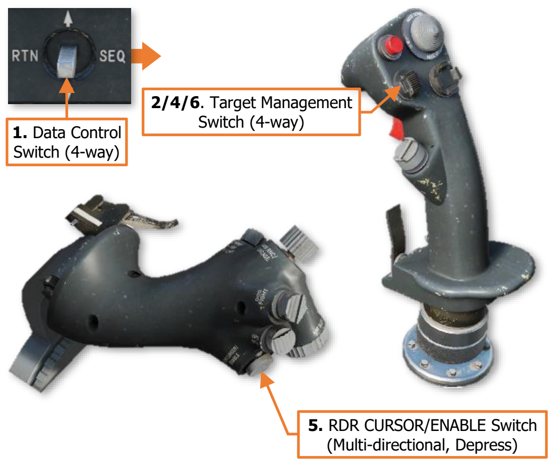
MARK Page – Store a markpoint using the HMCS

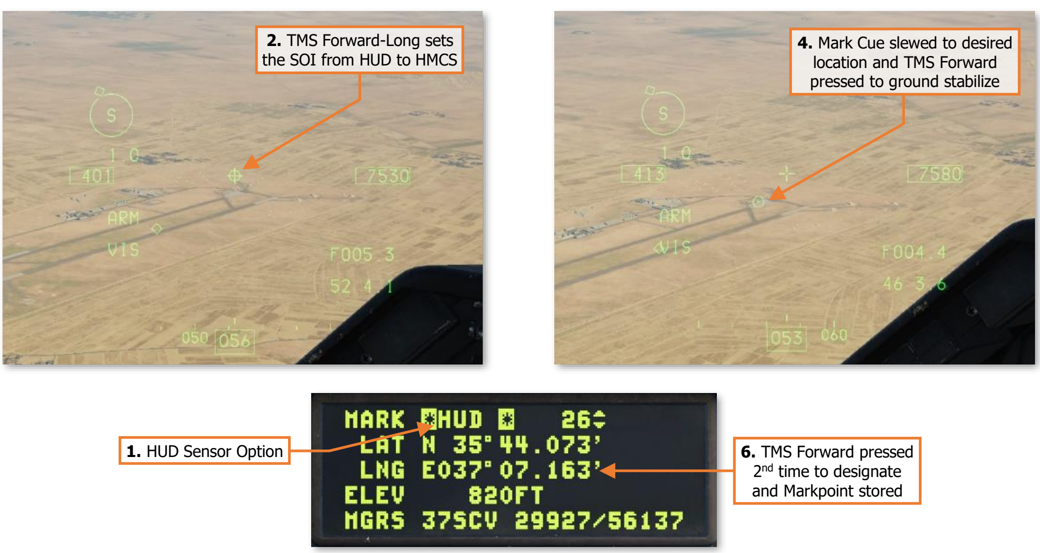
The HMCS can be used to designate a location on the ground to store a markpoint, as an extension of the HUD Sensor Option. As such, it uses the same logic as the HUD. Once the HUD Sensor Option is selected on the MARK DED page, TMS Forward-Long is used to slave the Mark Cue to the HMCS crosshairs. To return the Mark Cue to the HUD, the Mark Cue must be caged back to the HMCS crosshairs, after which TMS Aft-Short will return the Mark Cue to the HUD FPM.

1. Use the **DCS SEQ** position to select HUD in the Sensor Option data field on the MARK DED page.
2. Press **TMS Forward-Long** to select the HMCS as SOI.
3. Place the HMCS Aiming Cross over the desired location by head movement.
4. Press **TMS Forward-Short** on the SSC to ground stabilize the Mark Cue.
5. Use the throttle's **RDR CURSOR/ENABLE** switch to make any final adjustments to the Mark Cue's ground stabilized position, as necessary.
6. Press **TMS Forward-Short** on the SSC to designate the location as a markpoint.

   or

6. Press **TMS Aft-Short** to cage the Mark Cue to the HMCS Aiming Cross without designating the markpoint.





Markpoint Designation – HUD Sensor Option (using HMCS)

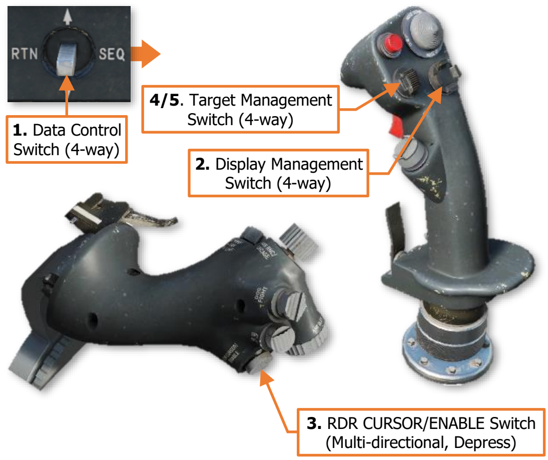
MARK Page – Store a markpoint using the TGP

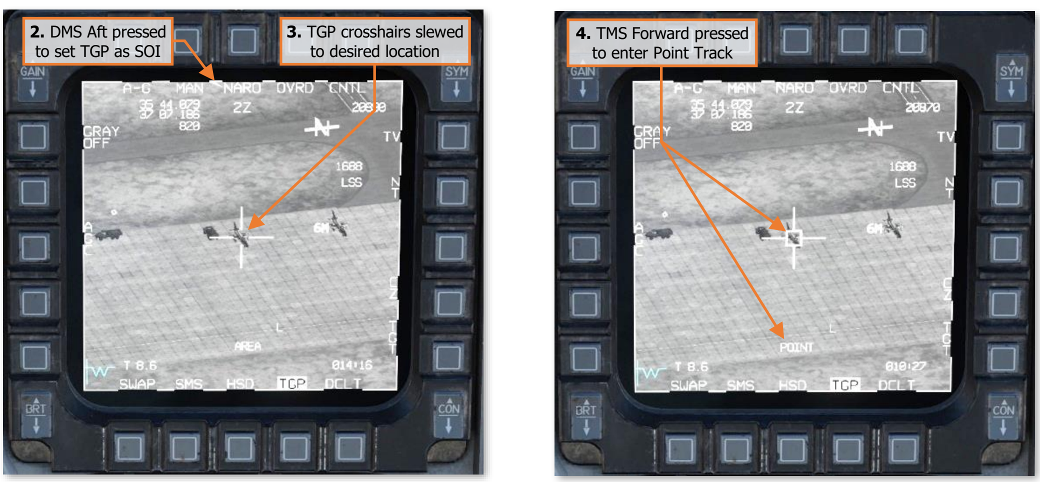
When set to Point Track, the TGP can designate a location on the ground to store a markpoint. If the TGP is already in Point Track when the MARK DED page is selected, only Steps 2 and 5 are necessary.

1. Use the **DCS SEQ** position to select TGP in the Sensor Option data field on the MARK DED page.
2. Press **DMS Down-Short** to select the TGP as SOI on the applicable MFD format.
3. Use the throttle's **RDR CURSOR/ENABLE** switch to slew the TGP crosshairs to the desired location.
4. Press **TMS Forward-Short** on the SSC to switch the TGP to Point Track.
5. Press **TMS Forward-Short** on the SSC to designate the Point Track location as a markpoint.

   or

5. Press **TMS Right-Short** on the SSC to switch back to Area Track without designating the markpoint.





Markpoint Designation – TGP Sensor Option

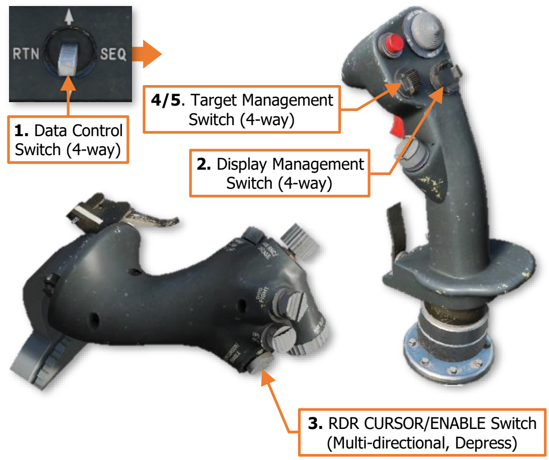
MARK Page – Store a markpoint using the FCR

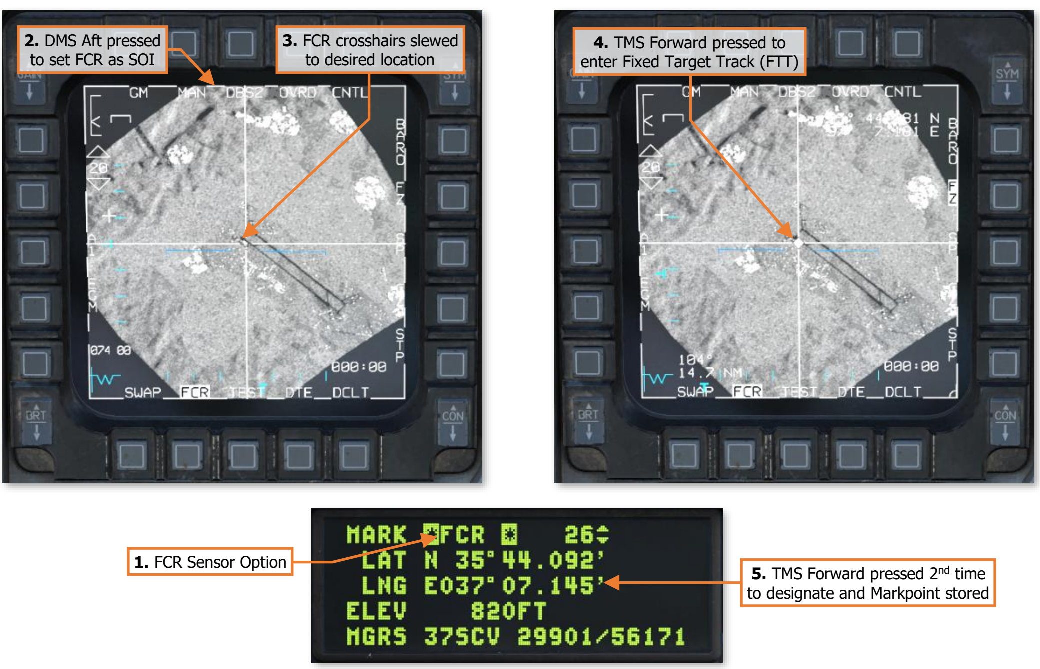
When set to Fixed Target Track (FTT), the FCR can designate a location on the ground to store a markpoint. If the FCR is already in FTT when the MARK DED page is selected, only Steps 2 and 5 are necessary.

1. Use the **DCS SEQ** position to select FCR in the Sensor Option data field on the MARK DED page.
2. Press **DMS Down-Short** to select the FCR as SOI on the applicable MFD format.
3. Use the throttle's **RDR CURSOR/ENABLE** switch to slew the FCR cursor to the desired location.
4. Press **TMS Forward-Short** on the SSC to switch the FCR to Fixed Target Track (FTT).
5. Press **TMS Forward-Short** on the SSC to designate the FTT location as a markpoint.

or

5. Press **TMS Aft-Short** on the SSC to reject the Fixed Target Track (FTT) without designating the markpoint.





Markpoint Designation – FCR Sensor Option

MARK Page – Store a markpoint using OFLY

A markpoint can be designated by directly overflying the intended location and using the aircraft's current position to designate the markpoint.

NOTE: If the master mode is set to Air-to-Air, Dogfight, or Missile Override, the OFLY Sensor Option will be the only functional Sensor Option.

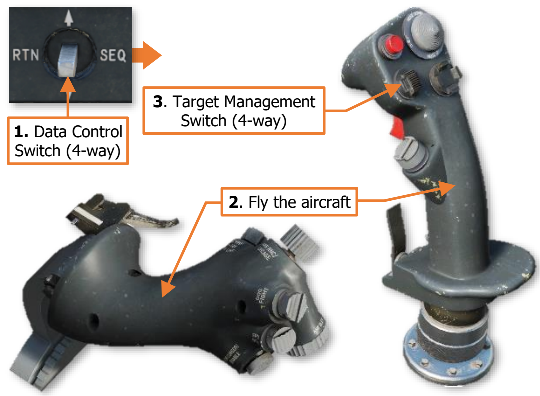
NOTE: If OFLY is displayed in the Sensor Option data field, TMS Forward will designate a markpoint regardless of the selected SOI.

1. Use the **DCS SEQ** position to select OFLY in the Sensor Option data field on the MARK DED page.

   (Only required if in NAV or Air-to-Ground master modes)

2. Maneuver the aircraft as necessary to ensure the flight path will take it over the intended markpoint location.

3. Press **TMS Forward-Short** on the SSC to designate the location as a markpoint as the aircraft passes directly overhead the intended location.



Markpoint Designation – OFLY Sensor Option

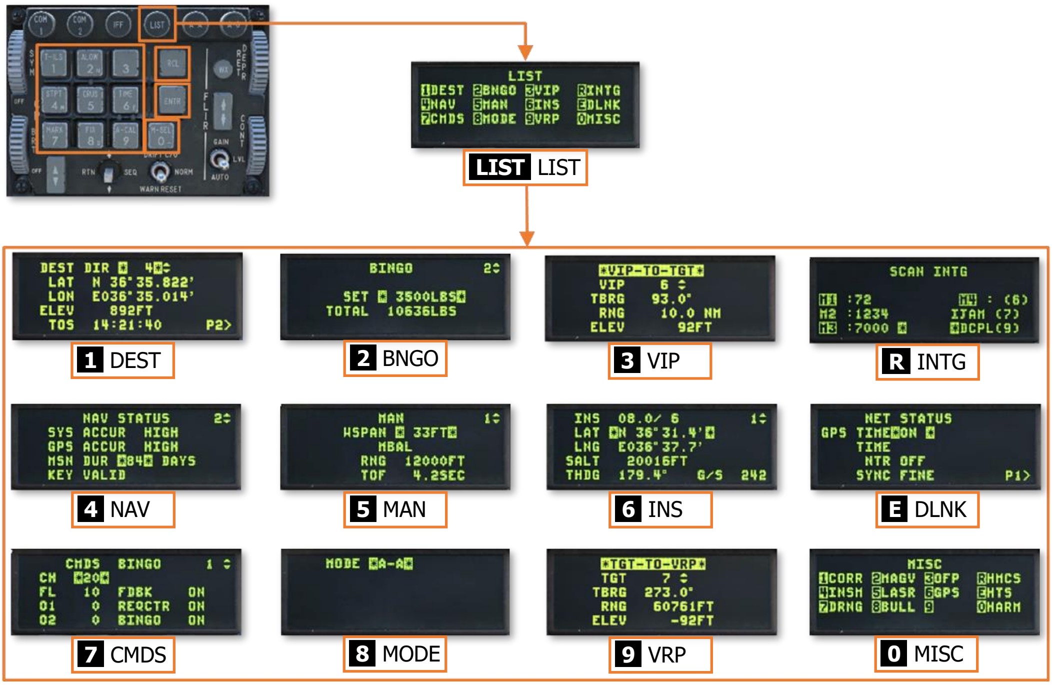
MARK Page – Modify a markpoint using manual entry of latitude/longitude coordinates and elevation

A markpoint can be manually entered on the MARK page by inputting latitude, longitude, and elevation data using the ICP. This procedure functions identically to such manual data entry on the STPT or DEST pages. Additionally, position data of existing markpoints can be edited in a similar manner, if necessary.

NOTE: MGRS coordinates cannot be converted to Lat/Long on the MARK DED page. As such, a markpoint cannot be manually entered via MGRS. Only steerpoints 21-25 can be entered via MGRS and subsequently converted to Lat/Long format. (See STPT DED page or DEST DED page for more information.)

LIST DED Pages

The LIST page displays a list of secondary DED pages that may be accessed by pressing the corresponding buttons on the ICP keypad. An additional list of miscellaneous DED pages may be accessed by pressing the 0/M-SEL button on the ICP keypad while the LIST page is displayed.



Data Entry Display – Secondary Functions

The following LIST DED pages are detailed in the applicable sections:

- **VIP –** VIP & VRP
- **NAV –** Navigation Fixes and Updates
- **INS –** INS Alignment
- **DLNK –** DL16 Datalink
- **CMDS –** Defensive Systems
- **VRP –** VIP & VRP

The following LIST DED pages are not implemented: **INTG**

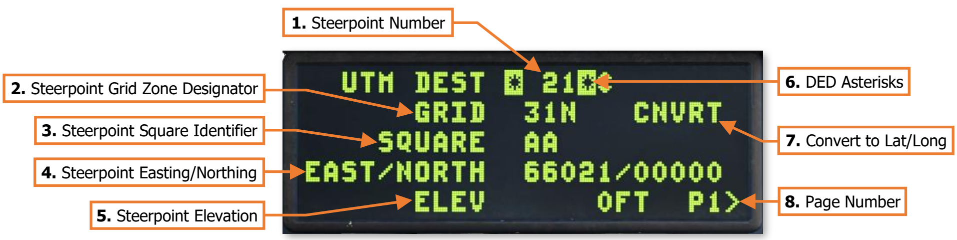
The remaining LIST DED pages are detailed below.

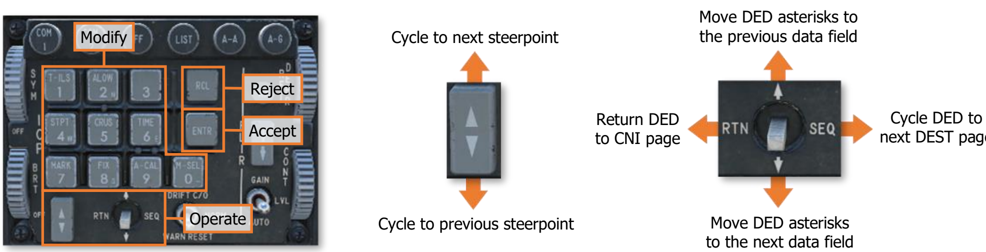
DEST Page

The Destination DED page is accessed by pressing the **1/T-ILS** button on the ICP keypad when the LIST DED page is displayed on the DED. This page is similar to the STPT DED page, in that it displays the position, elevation, and TOS of steerpoints within the navigational database. However, unlike the STPT page, the DEST page permits review and modification of steerpoint data fields without selecting that steerpoint for navigation.

The first DEST DED page is the UTM Destination page, which may display steerpoints 21-25 only for the purposes of MGRS coordinate entry. MGRS (Military Grid Reference System) is a UTM-derived coordinate system used as an alternative to Latitude/Longitude and is the primary coordinate system used by many military ground forces.

All steerpoints must be in Lat/Long (degrees/minutes/decimal) format to be stored within the navigation database. If a steerpoint is entered using MGRS, then a conversion must be manually commanded by selecting the CNVRT data field and pressing ENTR. If CNVRT is not commanded before the DED page is changed (by viewing a different steerpoint or changing the DED page), the conversion will not occur, the MGRS coordinates that were entered will not be stored for that steerpoint, and the Lat/Long coordinates will not correctly correspond with the MGRS location. (See STPT DED page for detailed steps regarding MGRS entry and conversion.)





1. **Steerpoint Number.** Displays the destination steerpoint number. The ICP Increment/Decrement rocker may be used to cycle to a different steerpoint. The destination steerpoint can also be changed by placing the DED asterisks over the data field and entering the steerpoint number using the ICP keypad and then pressing ENTR.
2. **Steerpoint Grid Zone Designator.** Displays the MGRS Grid Zone Designator of the destination steerpoint. May be modified using the ICP keypad and Increment/Decrement rocker.
3. **Steerpoint Square Identifier.** Displays the MGRS Square Identifier of the destination steerpoint. May be modified using the Increment/Decrement rocker.
4. **Steerpoint Easting/Northing.** Displays the MGRS Easting & Northing of the destination steerpoint. May be modified using the ICP keypad.
5. **Steerpoint Elevation.** Displays the elevation (in feet) of the destination steerpoint. May be modified using the ICP keypad.
6. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has

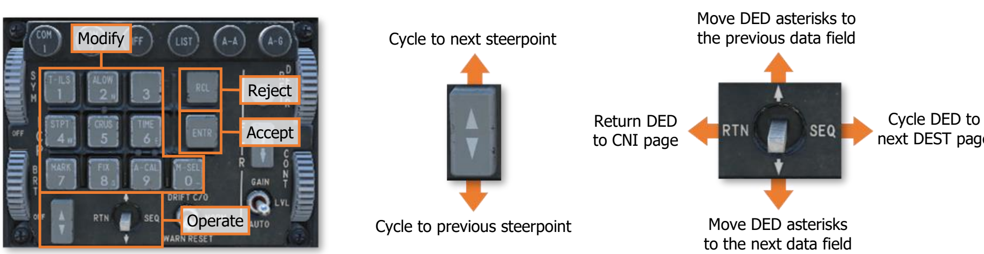
been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

7. **Convert to Lat/Long.** Converts the MGRS coordinates to the equivalent Lat/Long format, which will update the stored position of the destination steerpoint.

8. **Page Number.** Displays the DED page number and indicates that additional pages may be viewed.

DEST DIR Page

The second DEST DED page is the Destination Direct page, which displays the position and elevation of the currently selected steerpoint, along with the desired Time-Over-Steerpoint (TOS), all of which can be modified from this page in the same manner as the STPT DED page.



1. **Steerpoint Number.** Displays the destination steerpoint number. The ICP Increment/Decrement rocker may be used to cycle to a different steerpoint. The destination steerpoint can also be changed by placing the DED asterisks over the data field and entering the steerpoint number using the ICP keypad and then pressing ENTR.

2. **Steerpoint Latitude.** Displays the latitude (in DD° MM.MMM' format) of the destination steerpoint. May be modified using the ICP keypad.

3. **Steerpoint Longitude.** Displays the longitude (in DDD° MM.MMM' format) of the destination steerpoint. May be modified using the ICP keypad.

4. **Steerpoint Elevation.** Displays the elevation (in feet) of the destination steerpoint. May be modified using the ICP keypad.

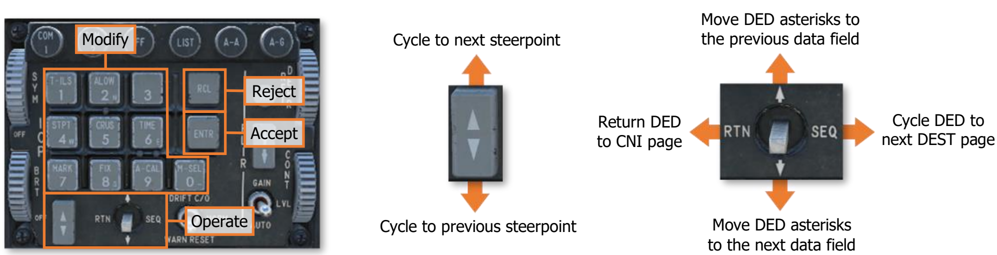
5. **Desired Time-Over-Steerpoint.** Displays the desired Time-Over-Steerpoint (TOS) of the destination steerpoint. May be modified using the ICP keypad.

6. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

7. **Page Number.** Displays the DED page number and indicates that additional pages may be viewed.

DEST OA1 & OA2 Pages

The third and fourth DEST DED pages are the Destination Offset Aimpoint 1 and Offset Aimpoint 2 pages respectively, which display the relative distance, relative direction, and elevation of the destination steerpoint's offset aimpoints. Each offset aimpoint and its respective values can be modified from these pages, but if the steerpoint itself is modified to a new position, the offset aimpoints will move with their associated steerpoint accordingly.



1. **Steerpoint Number.** Displays the destination steerpoint number. The ICP Increment/Decrement rocker may be used to cycle to a different steerpoint. The destination steerpoint can also be changed by placing the DED asterisks over the data field and entering the steerpoint number using the ICP keypad and then pressing ENTR.

2. **Relative Range.** Displays the relative distance (in feet) of the offset aimpoint from the destination steerpoint. May be modified using the ICP keypad.

   NOTE: Depending on the method used for determining the desired distance from the steerpoint to place the offset aimpoint, the following values may be used for conversion to feet:

   - 1 Nautical Mile (NM) = 6,076 feet
   - 1 Kilometer (km) = 3,280 feet

3. **Relative Bearing.** Displays the relative bearing (in degrees, Magnetic) of the offset aimpoint from the destination steerpoint. May be modified using the ICP keypad.

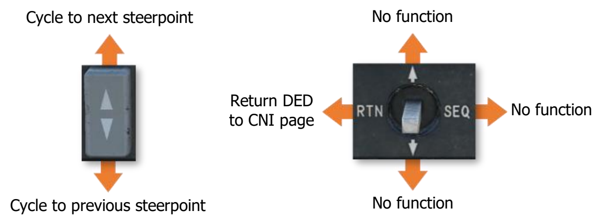
4. **Offset Aimpoint Elevation.** Displays the elevation (in feet) of the offset aimpoint. May be modified using the ICP keypad.

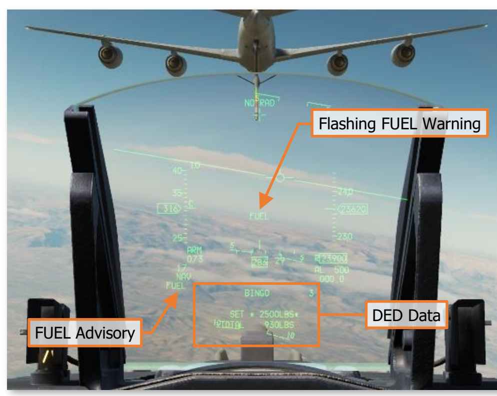
5. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

6. **Page Number.** Displays the DED page number and indicates that additional pages may be viewed.

BNGO Page

The Bingo DED page is accessed by pressing **2/ALOW** on the ICP keypad when the LIST DED page is displayed on the DED. A Bingo fuel setting may be entered that will notify the pilot when the onboard fuel level reaches the Bingo quantity.





1. **Bingo Setting.** Displays the currently set Bingo quantity. When the remaining fuel onboard decreases below this value, FUEL will be displayed in the lower left corner of the HUD, accompanied by a "BINGO…BINGO" voice message. In addition, a FUEL warning will flash in the center of the HUD, which may be acknowledged by momentarily setting the Drift Cut-Out/Warning Reset switch to the WARN RESET position, or may reset by setting a Bingo quantity to a lower value than the Total Fuel quantity.

   NOTE: The Bingo fuel warning and associated voice message are triggered any time either the combined fuselage fuel tanks or total fuel quantities fall below the Bingo setting. If the Bingo quantity is set to any amount over ~6070 pounds when the Fuel Quantity Select knob on the FUEL QTY SEL panel is in the NORM position, or if set to any amount over 6667 pounds when the Fuel Quantity Select Knob is in any position other than NORM, the Bingo fuel warning and voice message will be triggered.

2. **Total Fuel.** Displays the total onboard fuel (to include external fuel tanks) in pounds.

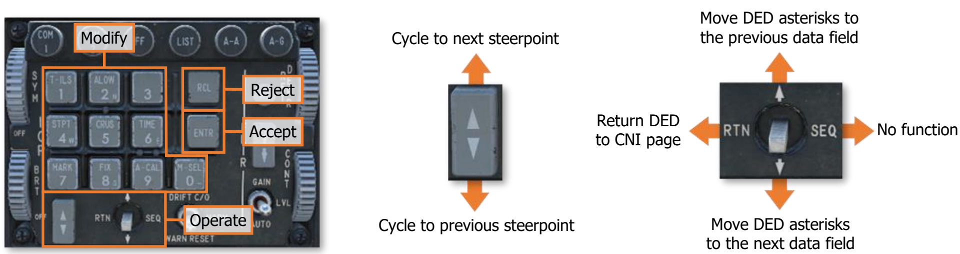
   NOTE: It may be advantageous to have the total fuel quantity displayed in the HUD when engaged with hostile aircraft in close-range air combat maneuvers; or when performing aerial refueling. In both cases, it could be hazardous to look down inside the cockpit, even if only for a few seconds, at the Fuel Quantity Indicator. If it becomes apparent that an air-to-air engagement is about to enter the WVR (Within Visual Range) arena, or when behind an aerial refueling tanker in the Pre-contact position, it may be useful to set the DED to the BNGO page and switch the DED/PFLD switch on the HUD control panel to the DED DATA position.

3. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.

4. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

MAN Page

The Manual DED page is accessed by pressing **5/CRUS** on the ICP keypad when the LIST DED page is displayed on the DED. This page is used to adjust the wingspan settings of the EEGS sub-mode or ballistics data for air-to-ground weapons that lack an integrated SMS profile within the F-16C avionics.



1. **Wingspan.** Displays the manual target wingspan in use by the EEGS sub-mode. This value adjusts the width of the EEGS Funnel to account for aircraft of different wingspans. When the target wings are perfectly bracketed within the EEGS Funnel, an optimal air-to-air gun solution has been obtained.

   This is particularly important when engaging a hostile aircraft when using the Enhanced Envelope Gun Sight (EEGS) in Level II, in which case a passive ranging solution is necessary due to lack of an FCR-derived weapon solution. (See Air-to-Air Gunnery for more information.)

2. **Range.** Displays the horizontal distance a free-fall weapon is expected to travel under specific conditions. (N/I)

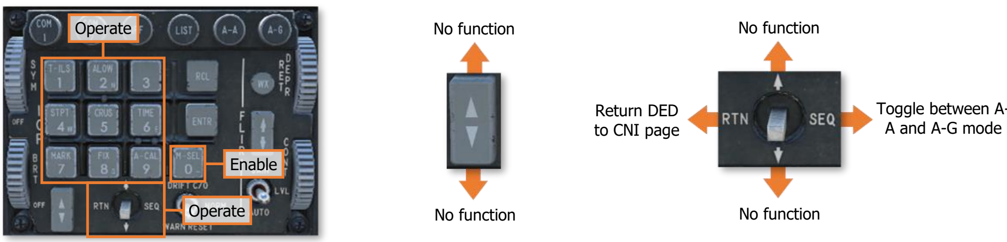
3. **Time-Of-Fall.** Displays the time that is expect to elapse between the time of weapon release and the surface impact under specific conditons. (N/I)

4. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.

5. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

MODE Page

The Mode DED page is accessed by pressing **8/FIX** on the ICP keypad when the LIST DED page is displayed on the DED. This page is used as a backup method to change the master mode between NAV, A-A, or A-G, in case there is a failure of the physical Master Mode buttons on the ICP itself.



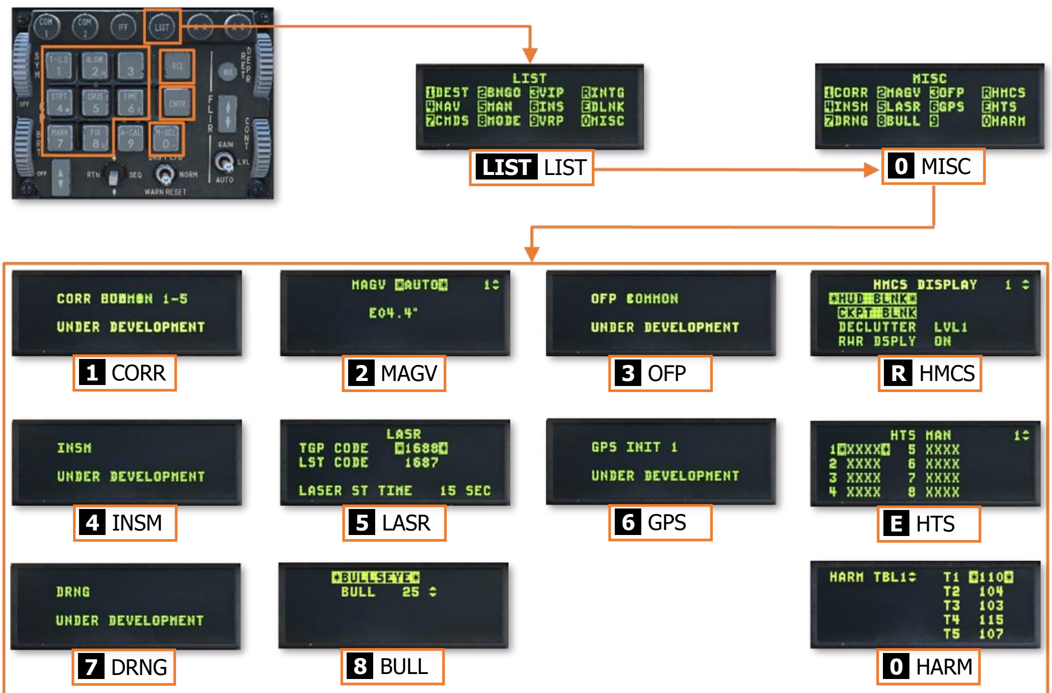
1. **Mode Select.** Displays the master mode ("A-A" or "A-G") that will be entered if the 0/M-SEL button is pressed. Momentarily setting the DCS ("Dobber switch") to the SEQ position or pressing any button on the ICP keypad will toggle the DED page between A-A and A-G modes. If the current master mode matches the mode displayed on the DED Mode page, the text between the DED Asterisks will be highlighted. Pressing the 0/M-SEL button when the DED Mode Select data field is highlighted will set the master mode to NAV.

   NOTE: This page is not functional if the Dogfight switch on the throttle is set to the outboard (Dogfight) or inboard (Missile Override) positions.

2. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

MISC DED Pages

The MISC page extends the LIST page by displaying additional DED pages that may be accessed by pressing the corresponding buttons on the ICP keypad.



Data Entry Display – Miscellaneous Functions

The following MISC DED pages are detailed in the applicable sections:

- **MAGV –** Navigation Fixes and Updates
- **HMCS –** Joint Helmet-Mounted Cueing System
- **LASR –** Litening II Targeting Pod
- **HTS –** HARM Targeting System
- **BULL –** Tactical Systems
- **HARM –** AGM-88 HARM

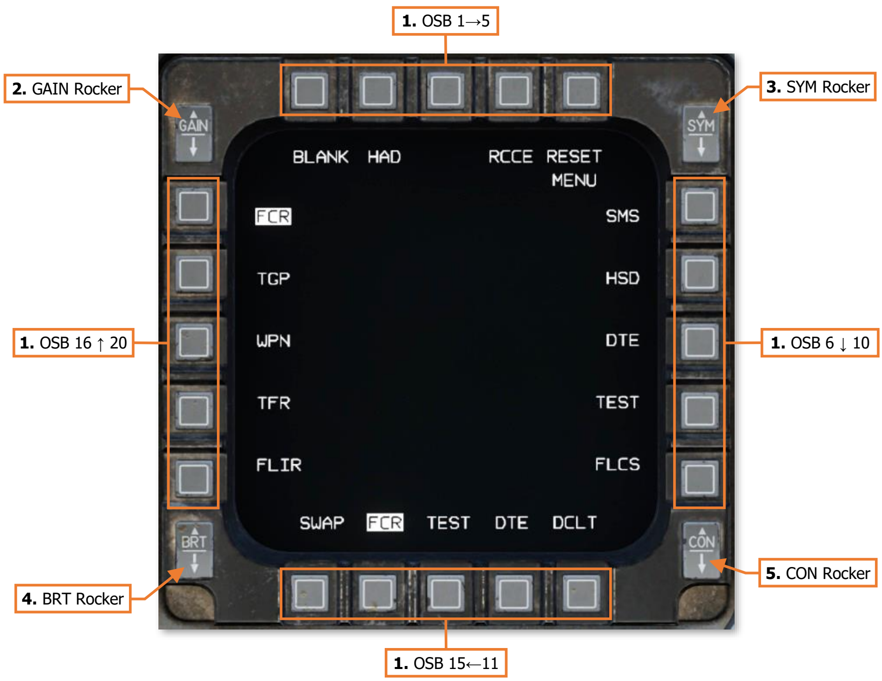
The following MISC DED pages are not implemented: **CORR**, **OFP**, **INSM**, **GPS**, **DRNG**.

MULTI-FUNCTION DISPLAYS (MFD)

Two color Multi-Function Displays (MFD) provide video and text presentations to the pilot for the aircraft's various sensors. The MFDs also serve as the primary interface to the aircraft's external stores, data transfer and loading equipment, and diagnostics for the aircraft systems and flight controls.

Each sensor or aircraft system can be accessed via their respective MFD "format". Some MFD formats will include multiple "pages" that can be selected to access additional options or settings. The options and settings associated with the systems of each format or page are controlled through Option Select Buttons (OSBs) around the display bezel of each MFD. Each OSB interacts with the text displayed next to it to toggle through functions or select a different page.

Additionally, four rocker buttons are present on each MFD that allows the pilot to adjust the appearance of the video and text on the MFD screen itself.



1. **Option Select Button (OSB).** Selects the option corresponding with the displayed text adjacent to the MFD button itself.
    - **OSB 1-5.** The top row of Option Select Buttons are numbered from 1 starting on the far left to 5 on the far right.
    - **OSB 6-10.** The right column of Option Select Buttons are numbered from 6 starting at the top to 10 at the bottom.
    - **OSB 11-15.** The bottom row of Option Select Buttons are numbered from 11 starting on the far right to 15 on the far left.
    - **OSB 16-20.** The left column of Option Select Buttons are numbered from 16 starting at the bottom to 20 at the top.

2. **GAIN Rocker.** Adjusts the brightness of the FCR video when in GM, GMT, SEA or BCN operating modes. The video is adjusted independently of the symbology intensity or overall brightness/contrast settings of the MFD itself. If held continuously to either position, the video will continuously increment to the minimum or maximum allowable brightness settings.

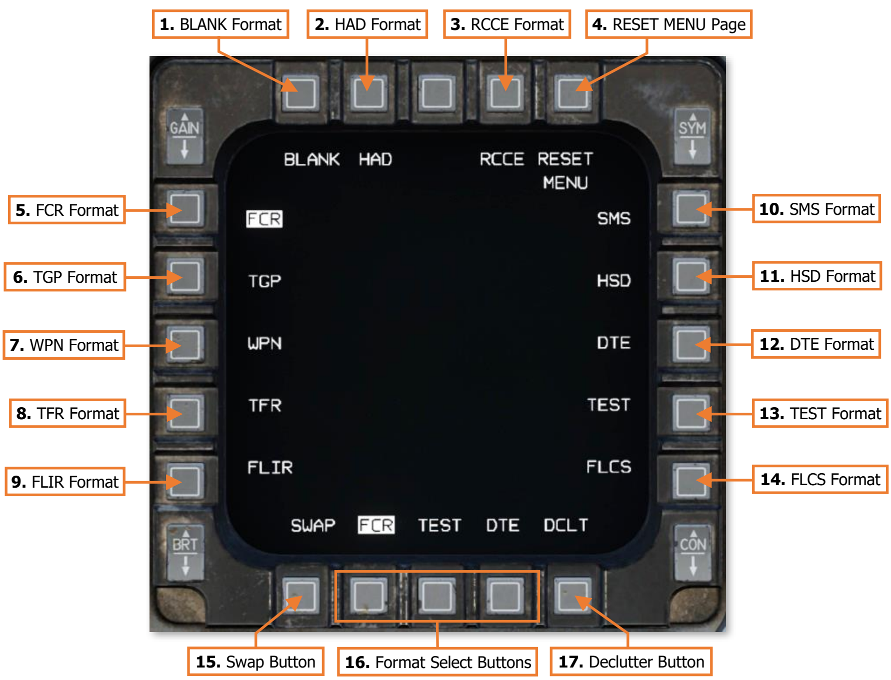
3. **SYM Rocker.** Adjusts the intensity of the MFD symbology independently of the FCR video or overall brightness/contrast settings of the MFD itself. If held continuously to either position, the symbology intensity will continuously increment to the minimum or maximum allowable settings.

4. **BRT Rocker.** Adjusts the overall brightness setting of the MFD display. If held continuously to either position, the brightness setting will continuously increment to the minimum or maximum allowable settings.

5. **CON Rocker.** Adjusts the overall contrast setting of the MFD display. If held continuously to either position, the contrast setting will continuously increment to the minimum or maximum allowable settings.

Format Selection Master Menu Page

The Format Selection Master Menu page is used to assign a specific MFD format to the Format Select buttons (OSB 13, OSB 14, and OSB 15). Additionally, the RESET MENU page is accessed from Master Menu page, which can be used to reset the MFD symbology, brightness and contrast settings to their default values.



1. **BLANK Format.** Assigns the BLANK MFD format to the highlighted Format Select button. When a Format Select button is assigned to the BLANK format, no text will be displayed above the OSB. The format selection corresponding with that OSB will be removed from the MFD format selection cycle when the DMS Left and DMS Right commands are used on the Side Stick Controller (SSC).

2. **HAD Format.** Assigns the HAD MFD format to the highlighted Format Select button. The HARM Attack Display format is used to operate the externally mounted HARM Targeting System pod. The HTS pod is used for detection, classification, and geo-location of ground-based and maritime threat radar systems. The HTS

pod is most commonly used during the Suppressbion of Enemy Air Defenses (SEAD) mission and can hand-off specific threat radar emitters to AGM-88 HARM anti-radar missiles for engagement. However, the HTS pod can also be used to generate targeting data for engagement by other weapons, aircraft, or other allied forces. (See HARM Targeting System for more information.)

3. **RCCE Format.** The Reconnaissance MFD format is not functional in the F-16C variant that is simulated by DCS: F-16C Viper.

4. **RESET MENU Format.** Displays the Reset Menu page. This page includes options to reset the MFD to the default or pre-programmed values for symbology intensity, brightness and contrast. (N/I)

5. **FCR Format.** Assigns the MFD FCR format to the highlighted Format Select button. The Fire Control Radar format is used to operate the APG-68 radar system. The APG-68 is used in air-to-air mode for detection, tracking and engagement of hostile aircraft; and in air-to-ground mode for ground mapping, ranging, and detection and targeting of ground vehicles or maritime vessels. (See APG-68 Fire Control Radar for more information.)

6. **TGP Format.** Assigns the MFD TGP format to the highlighted Format Select button. The Targeting Pod format is used to operate externally mounted electro-optical sensor pods such as the Litening II. Targeting pods are used for medium to high altitude reconnaissance; optical detection and tracking of ground targets; or for designation of ground targets for engagement by precision guided munitions (PGM). (See Litening II Target Pod for more information.)

7. **WPN Format.** Assigns the MFD WPN format to the highlighted Format Select button. The Weapon format is used to relay sensor video and targeting data from munitions such as the AGM-65 TV/IR guided missiles or the AGM-88 HARM anti-radar missile so the pilot can directly control the respective missile's targeting systems prior to weapons release. (See AGM-65 Maverick and AGM-88 HARM for more information.)

8. **TFR Format.** The Terrain Following Radar MFD format is not functional in the F-16C variant that is simulated by DCS: F-16C Viper.

9. **FLIR Format.** The Forward Looking Infrared MFD format is not functional in the F-16C variant that is simulated by DCS: F-16C Viper.

10. **SMS Format.** Assigns the SMS MFD format to the highlighted Format Select button. The Stores Management System format is used to select different munitions for employment, select and modify weapon release profiles, set warhead fuzing, and adjust terminal attack parameters. (See Tactical Systems for more information.)

11. **HSD Format.** Assigns the HSD MFD format to the highlighted Format Select button. The Horizontal Situation Display format provides the pilot with a top-down view of the battlespace around the aircraft to include navigational data, airspace and tactical boundaries, air defense threats, and fuses onboard radar data with tactical information derived from allied aircraft (such as other flight members and AWACS). (See Tactical Systems for more information.)

12. **DTE Format.** Assigns the MFD DTE format to the highlighted Format Select button. The Data Transfer Equipment format is used to load mission planning data from the DTU into the MMC. (N/I)

13. **TEST Format.** Assigns the TEST MFD format to the highlighted Format Select button. The Test format is used to display the Maintenance Fault List (MFL) and perform Built-In Tests (BIT) during system diagnostics and maintenance procedures. (N/I)

14. **FLCS Format.** Assigns the FLCS MFD format to the highlighted Format Select button. The Flight Control System format is used to display data from of Flight Control Computer (FLCC). (N/I)

15. **Swap Button.** Pressing this button will swap the currently displayed MFD formats between the left and right MFDs. In addition, the MFD formats assigned to each Format Select Button will be swapped as well.

16. **Format Select Buttons.** Selects the corresponding MFD format for display on the MFD. When the Format Selection Master Menu page is displayed, selecting the OSB will highlight the text above it and enable a new

format to be assigned to that button. If the text displayed above the OSB is already highlighted, pressing the same OSB will leave the Format Selection Master Menu page and display the MFD format that is assigned to that button.

17. Declutter Button. Removes the text symbology adjacent to each corresponding OSB on the MFD. However, the associated commands for each OSB will still remain. (N/I)

Re-assigning MFD Formats

Each of the seven avionics master modes (Navigation, Air-to-Air, Air-to-Ground, Missile Override, Dogfight, Selective Jettison, and Emergency Jettison) are initialized with pre-configured MFD formats assigned to each Format Select button of each MFD. These MFD format assignments can be re-configured by the pilot at any time via the Format Selection Master Menu page.

To assign a different format to a Format Select button (OSB 12, OSB 13 or OSB 14) on either MFD, set the avionics to the master mode that is meant to be edited.

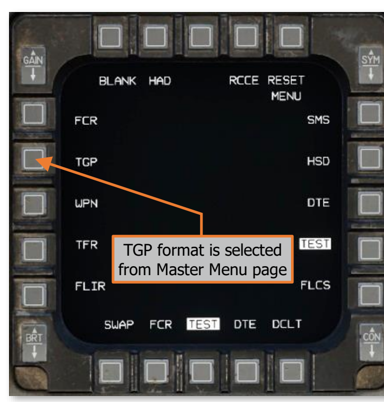
1. If the MFD text above the Format Select OSB that is to be re-assigned to a different MFD format is already highlighted, press that same OSB to open the Format Selection Master Menu page.

   If the MFD text above the Format Select OSB that is to be re-assigned to a different MFD format is not highlighted, press that same OSB to highlight the corresponding text above it, and then press that same OSB a second time to open the Format Selection Master Menu page.

   If the Format Select OSB that is to be re-assigned to a different MFD format is assigned the BLANK format with no corresponding text above it, press that same OSB to highlight the empty text field above it, and then press that same OSB a second time to open the Format Selection Master Menu page.

2. The MFD format that is already assigned to the currently selected Format Select OSB will be highlighted among the available formats displayed on the Master Menu page. Press the OSB next to the corresponding MFD format in the menu to assign that format to the currently selected Format Select OSB. The MFD will exit the Master Menu page and display the assigned format for that Format Select button.

   If the pilot does not wish to change the MFD format of the currently selected Format Select OSB, selecting the format that is already assigned to that Format Select button or selecting any of the Format Select buttons themselves along the bottom of the MFD will exit the Master Menu page with no changes made.



NOTE: In any given master mode, an MFD format can only be assigned to one Format Select button on either MFD at a time. The exception to this limitation is the BLANK format, which can be assigned to multiple Format Select buttons. It is possible that all six Format select buttons on the MFDs could be assigned to the BLANK format for a given master mode, despite the impracticality of it.

If an MFD format is assigned from the Master Menu page that is already assigned to another Format Select button on either MFD, that format will be removed from the other Format Select button and assigned to the currently highlighted OSB, and the BLANK format will be assigned to the former.

PROCEDURES

AIRCRAFT START

The F-16 is designed to be started without ground support equipment and can be airborne within minutes. Although it can be operated off external power sources during extended ground operations or maintenance procedures, it is not necessary.

After performing a walkaround, the pilot climbs into the cockpit, secures seat restraints, oxygen supply hoses, and communications leads. Initial electrical system checks are conducted and the pilot initiates a start of the Jet Fuel Starter (JFS). The JFS is a small gas turbine engine that is used to spool the main engine to sufficient speed prior to introducing fuel into the main engine combustion section. Once the engine RPM has accelerated to 20% and the SEC light on the Caution Light panel extinguishes, the pilot advances the throttle from OFF to IDLE to introduce fuel.

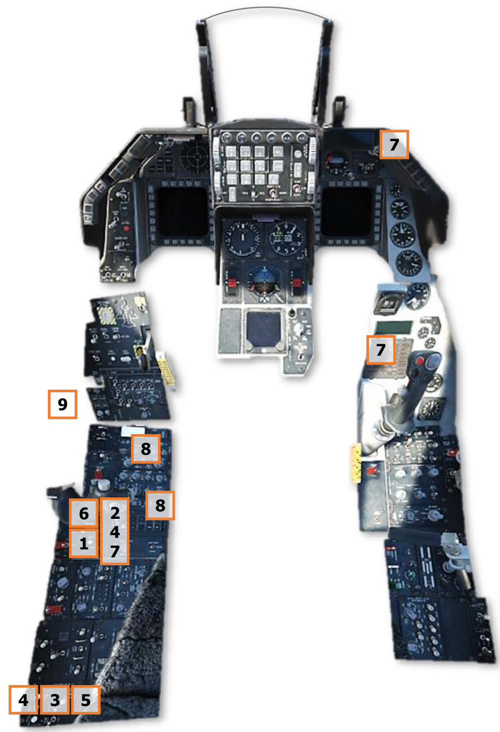
Once the engine stabilizes at idle speed and is providing primary electrical power via the main generator, the pilot initializes the aircraft systems, performs an alignment of the inertial navigation system, and performs remaining pre-flight checks.

If desired, the DCS: F-16C Viper may be started using an auto-start sequence by pressing **[LWin]+[Home]**. To cease the auto-start sequence, press **[LWin]+[End]**.

NOTE: When the auto-start sequence is complete, the following systems will be configured as shown:

- INS Knob – ALIGN NORM
  - Must be set to NAV prior to initiating taxi.
- IFF MASTER Knob – STBY.
- ALR-56M Radar Warning Receiver (RWR) – Powered Off.
- CMDS MODE Knob – OFF.
- ECM PWR Switch – OFF.
  - Requires a 3-minute warm-up prior to operation.

Before Engine Start



1. MAIN PWR switch – BATT.

   NOTE: The amount of power available from the battery is limited so do not leave the MAIN PWR switch in BATT or MAIN PWR for more than 5 minutes without starting the engine or applying external power if more time is needed.

2. Verify light on ELEC Control Panel:
   - ACFT BATT "FLCS RLY" – On.

3. FLCS PWR TEST switch – TEST and hold.

4. Verify lights on ELEC Control Panel:
   - "FLCS PMG" – On.
   - ACFT BATT "TO FLCS" – On.
   - ACFT BATT "FLCS RLY" – Off.

   Verify lights on TEST Panel:
   - FLCS PWR "A", "B", "C", and "D" – On.

5. FLCS PWR TEST switch – Release.

6. MAIN PWR switch – MAIN PWR.

7. Verify warning lights on Right Eyebrow:
   - "ENGINE" – On.
   - "HYD/OIL PRESS" – On.

   Verify lights on Caution Light Panel:
   - "ELEC SYS" – On.
   - "SEC" – On.

   Verify lights on ELEC Control Panel:
   - ACFT BATT "FLCS RLY" – On.
   - "EPU GEN" and "EPU PMG" – Off.

     NOTE: Illumination of either light indicates criteria for EPU activation is met. The EPU will activate and create a hazardous condition if the EPU safety pin is removed by the ground crew. If either of these lights are illuminated, turn MAIN PWR switch to OFF and abort the aircraft (re-start the mission).

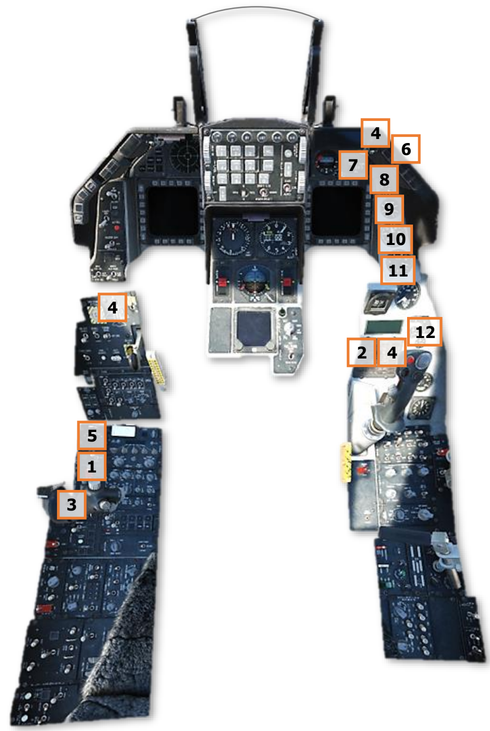
8. Communications – Established with ground crew and Air Traffic Control (ATC) as required for engine start.

9. Canopy – As desired.

10. Chocks – In place.

11. Ground crew – Clear of intake and other danger areas.

Engine Start



1. JFS switch – START 2. The JET FUEL – RUN light illuminates within 30 seconds indicating the Jet Fuel Starter is operational. Engine RPM should start to increase.

   Power is applied to the Flight Control System relays when the JFS switch is set to either the START 1 or START 2 position. The ACFT BATT "FLCS RLY" light should extinguish and the ACFT BATT "TO FLCS" light should illuminate.

2. "SEC" caution light – Off.

3. Throttle – Advance to IDLE at 20% RPM minimum. Engine combustion should occur within a few seconds and engine RPM and FTIT should increase.

   NOTE: When starting on battery power only (no external power applied), only the RPM and FTIT engine instruments will function until the standby generator is online.

4. "ENGINE" warning light – Off (approximately 60% RPM, when the standby generator becomes operational).

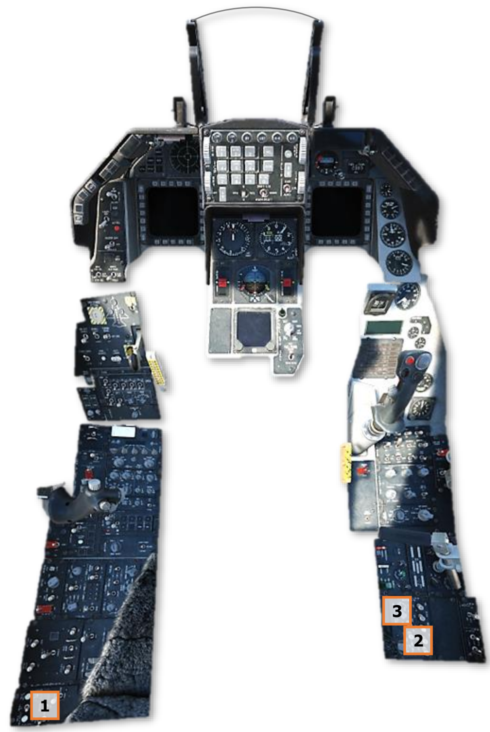
5. Verify the following to confirm the emergency busses are being powered by the standby generator:
   - "SEAT NOT ARMED" caution light – On.
   - Three green WHEELS down lights – On.

   Within 5-10 seconds, the main generator will come online, and the standby generator will go offline.

Once engine RPM is at idle speed, perform the following checks:

6. JFS switch – Confirm OFF; manually set to OFF if necessary.
7. "HYD/OIL PRESS" warning light – Off.
8. FUEL FLOW – 700-1700 PPH.
9. Engine OIL pressure – 15 PSI or greater.
10. Engine NOZ POS – above 94%.
11. Engine RPM – 62%-80%.
12. Engine FTIT – 650° C or less.
13. HYD PRESS A & B – 2850-3250 PSI.

After Engine Start



1. TEST switch panel – Check:

- PROBE HEAT switch – PROBE HEAT. Ensure "PROBE HEAT" caution light is extinguished.

  If the light is illuminated, one or more probe heaters are inoperative or a failure of the monitoring system has occurred.

- PROBE HEAT switch – TEST. "PROBE HEAT" caution light should flash 3-5 times per second.

  If this does not occur, the probe heat monitoring system is inoperative

- PROBE HEAT switch – OFF.

- FIRE & OHEAT DETECT button – Press. Ensure "ENG FIRE" warning light illuminates when the button is pressed.

  This checks for continuity of the fire and overheat detection loops.

- MAL & IND LTS button – Press. Ensure all cockpit warning, caution and indicator lights illuminate when the button is pressed.

  A brief LG warning horn should be heard followed by Voice Message System (VMS) audio alerts, played in priority sequence ("PULL UP", "ALTITUDE", "WARNING", etc.).

2. AVIONICS POWER panel – Set:

- MCC switch – MCC.
- ST STA switch – ST STA.
- MFD switch – MFD.
- UFC switch – UFC.
- GPS switch – GPS.
- DL switch – DL. (N/I)
- MIDS LVT knob – ON.

3. INS – Align. (See INS Alignment for more information.)

4. SNSR PWR panel:

- LEFT HDPT switch – As required. (If an HTS pod is installed, enable power to the hardpoint).
- RIGHT HDPT switch – As required. (If a targeting pod is installed, enable power to the hardpoint)
- FCR switch – FCR.
- RDR ALT switch – RDR ALT.

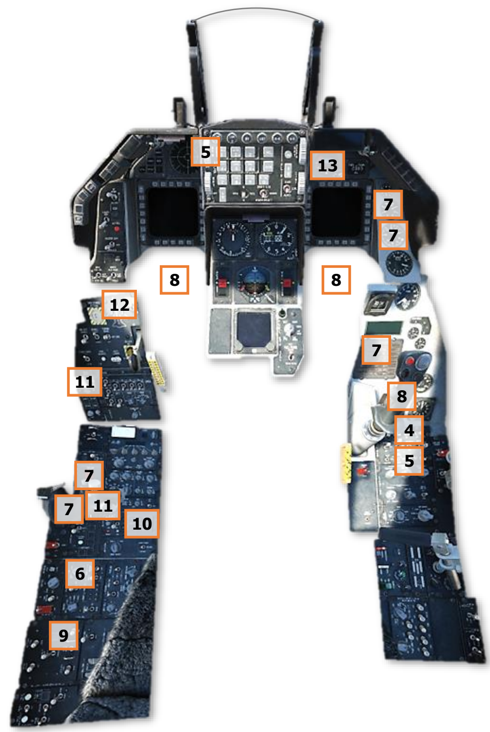
5. HUD – As desired. Ensure the SYM knob on the ICP is rotated up to increase HUD brightness as necessary.

(See HUD Control Panel for more information.)

6. C & I knob – UFC.

7. Secondary (SEC) engine control mode – Check. (May be performed during Before Takeoff check.)

- ENG CONT switch – SEC.
    - "SEC" caution light – On.
    - Engine RPM – Stabilized. RPM may drop up to 10% from PRI value before stabilizing. Stabilized SEC idle RPM may be up to 5% lower than that in PRI.
    - Throttle – Snap to MIL, and then snap to IDLE when RPM reaches 85%. Check for normal indications and smooth operation.
    - NOZ POS – 10% or less within 30 seconds after selecting SEC.
- ENG CONT switch – PRI.
    - "SEC" caution light – Off.
    - NOZ POS – Greater than 94%.



8. Flight controls – Cycle to ensure maximum deflection of flight control surfaces prior to the FLCS BIT.

9. FLCS BIT – Initiate and monitor.

- BIT switch – BIT. FLCS "RUN" light will illuminate for approximately 45 seconds until FLCS BIT completes.
- BIT switch will automatically return to OFF when FLCS BIT completes. Ensure FLCS "FAIL" light is not illuminated when complete.

10. ECM panel – As required. (If an ECM pod is installed, set ECM power switch to STBY)

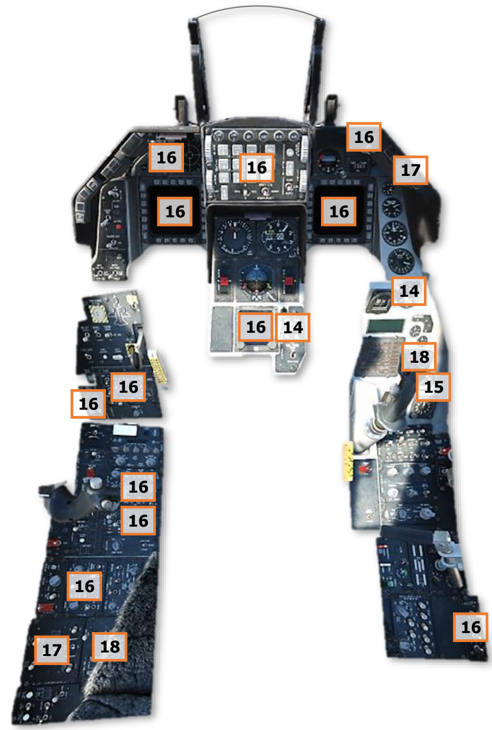
11. SPD BRK switch – Cycle to extended position and then retract.

12. WHEELS down lights – Three green.

13. Standby Attitude Indicator – Uncage and set.

14. FUEL QTY SEL knob – Check.

- TEST – FR and AL pointers should indicate 2,000 (±100) pounds and the totalizer should indicate 6,000 (±100) pounds. Verify the "FWD FUEL LOW" and "AFT FUEL LOW" caution lights illuminate on the Caution Light Panel.
- NORM – AL pointer should indicate approximately 2,810 pounds and FR pointer should indicate approximately 3,250 pounds (if fully-fueled with JP-8).
- RSVR – Each reservoir should indicate approximately 480 pounds.
- INT WING – Each wing should indicate approximately 550 pounds.
- EXT WING – Each external wing tank should indicate approximately 2,420 pounds, if full.
- EXT CTR – FR pointer should indicate approximately 1,890 pounds, if full. AL pointer should indicate 0.
- FUEL QTY SEL knob – As desired.



15. EPU FUEL quantity – 95-102%.

16. Avionics, MFD's, and VHF radio – Configure as required (manual configuration or data transfer cartridge).

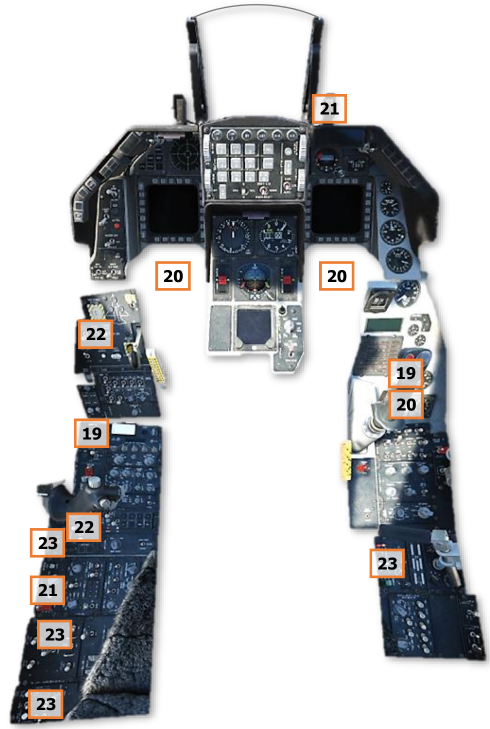
After the FLCS BIT is complete:

17. DBU – Check.

- DIGITAL BACKUP switch – BACKUP. Verify "DBU ON" warning light illuminates
- Operate flight controls – Ensure all flight control surfaces respond normally.
- DIGITAL BACKUP switch – OFF. Verify "DBU ON" warning light extinguishes.

18. TRIM – Check.

- TRIM/AP DISC switch - DISC.
- Side Stick Controller TRIM switch - Activate in roll and pitch. Verify no movement of flight control surfaces and no TRIM wheel/indication motion on the FLT CONTROL Panel.
- TRIM/AP DISC switch - NORM.
- Side Stick Controller TRIM switch - Check and center. Verify movement of flight control surfaces and TRIM wheel/indication motion on the FLT CONTROL Panel.
- Rudder trim check - YAW TRIM knob check and center.



19. MPO – Check.

- Side Stick Controller – Full forward and hold; note horizontal tail deflection.
- MPO switch – OVRD and hold. Confirm that horizontal tail trailing edges deflect further downward.
- Stick and MPO switch – Release. Confirm that the horizontal tail returns to its original position.

20. Operate controls – Verify all surfaces respond normally and no FLCS lights illuminate.

21. Air refueling system (if required) – Check.

- AIR REFUEL switch – OPEN. Verify "RDY" light illuminates and the "DISC" light remains off.
- AIR REFUEL switch – CLOSE. Verify "RDY" light extinguishes.

22. "EPU GEN" and "EPU PMG" lights – Confirm off. If either light is illuminated, cycle the EPU switch to OFF, then back to NORM. If either of these lights remain illuminated, abort the aircraft (re-start the mission).

23. EPU – Check. This check verifies EPU electrical power is available in case of an emergency. (May be performed during Before Takeoff check.)

- OXYGEN Diluter Lever – 100%.
- Throttle – Increase engine RPM 10% above normal idle.
- EPU/GEN TEST switch – EPU/GEN and hold.
- Verify lights on EPU Control Panel:
    - "AIR" – On.
    - EPU Run light – On, for a minimum of 5 seconds.
- Verify lights on ELEC Control Panel:
    - "EPU GEN" – Off; but may come on momentarily at start of test.
    - "EPU PMG" – Off; but may come on momentarily at start of test.
- Verify lights on TEST Panel:
    - FLCS PWR "A", "B", "C", and "D" – On.
- EPU/GEN TEST switch – OFF.
- Throttle – IDLE.
- OXYGEN Diluter Lever – NORMAL.

TAXI

Once the engine is operating and the INS has been aligned, the aircraft may be taxied to the runway. Although it is typical to initialize the remaining avionics systems and perform other pre-flight checks prior to taxi, it may not be possible in a scenario in which the aircraft must be scrambled into the air without delay.

However, even if an immediate takeoff is required, some systems may be initialized or some checks may be performed during the taxi itself, depending on the distance between the aircraft's parking location and the active runway. In such an instance, the priority should be given to those systems that ensure the aircraft is ready to fight as soon as it is airborne.

When ready to taxi, ensure nosewheel steering is engaged by pressing the Missile Step button on the Side Stick Controller (SSC), which may be confirmed by the illumination of the "AR NWS" AR Status light on top of the Instrument Panel to the right of the HUD.

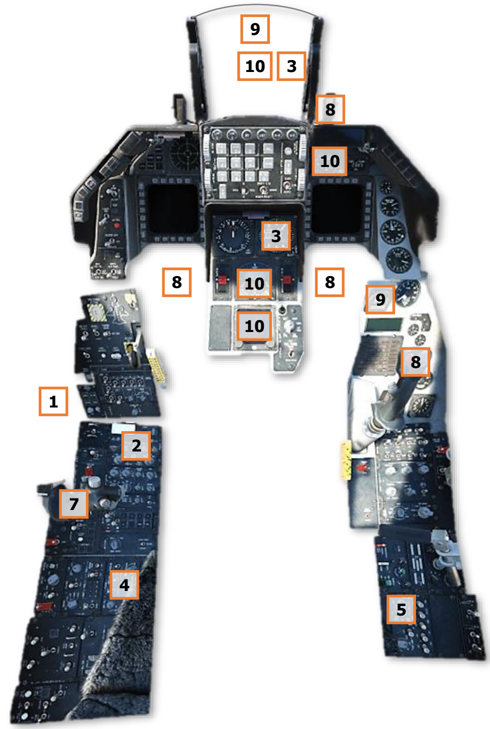
Nosewheel steering gain is proportional to ground speed. As the aircraft speeds up, the pedals will become less sensitive when controlling the nosewheel. However, due to the F-16's narrow landing gear "footprint", care should be taken when performing turns on the ground to prevent a roll-over and impacting either wingtip (or underwing stores) on the ground, damaging the aircraft. If high-speed taxi is necessary, the aircraft should be gently braked to a lower speed before performing any turns.

Only small throttle inputs are necessary to begin a taxi roll, and even at IDLE the aircraft may start to roll forward when operating at low gross weights. Once the desired taxi speed has been reached, retard the throttle back to IDLE to prevent gradual and excessive acceleration.

NOTE: When starting a mission from parking with the aircraft engine running and systems initialized, the following systems will be configured as shown:

- Nosewheel Steering (NWS) – Disengaged.
- ALR-56M Radar Warning Receiver (RWR) – Powered Off.
- CMDS MODE Knob – STBY.
- HMCS Symbology Knob – OFF.

Before Taxi



1. Canopy – Close and lock.
2. Backup UHF radio – Set and check as required.
3. Altimeter and altitude indications – Set and check. Verify altitude displayed on the HUD matches the altitude on the altimeter.
    - Check that the altimeter readings in ELECT and PNEU are ±75 feet of a known elevation and are ±75 feet of one another.
4. Exterior lights – As required.
5. INS knob – NAV. If a complete alignment is desired prior to taxi, verify "RDY" is visible and flashing on the INS DED page and/or "ALIGN" is visible and flashing in the lower left corner of the HUD.

    (See INS Alignment section for information.)
6. Chocks – Remove.

Taxi

7. Throttle – Advance. A throttle setting just beyond idle will be required to begin rolling. Return throttle to idle after desired speed is reached.
8. Brakes and NWS – Check.

    Press the Missile Step button on the SSC to engage nosewheel steering (NWS). The "AR/NWS" AR status light to the right of the HUD should illuminate.

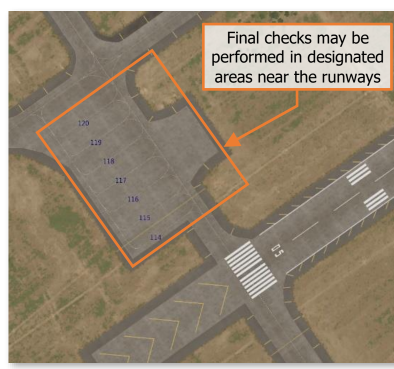
    Gently test the brakes and nosewheel steering immediately after the aircraft begins to move forward. Heat may build up quickly if brakes are used for an extended period so do not ride the brakes to control taxi speed. Use one firm application of the toe brakes to slow the aircraft.
9. Heading – Check.
10. Flight instruments – Check for proper operation. Verify aircraft heading updates as the aircraft turns and that all instruments behave as expected.

TAKEOFF

The F-16C's powerful F110-GE-129 engine affords the aircraft impressive acceleration at takeoff for its size. Even when heavily loaded, the F-16C can accelerate quite rapidly when the afterburner is fully engaged. As a result, it is critical that the pilot ensures the landing gear is fully retracted and the landing gear doors are closed prior to exceeding 300 knots. This prevents wiring or other landing gear components from becoming detached or causing damage to the landing gear doors.

A series of final checks are made just prior to entering the runway, to ensure the aircraft is properly configured for flight, the ejection seat is armed, and to perform one final check for malfunctions within the flight controls.

Some airfields have arm/de-arm areas near the runway (often called "EOR" or "End of Runway" areas) that may be used to keep the taxiway clear for other traffic. These checks may also be performed while on the taxiway, in queue for takeoff.



Once aligned on the active runway, the brakes are applied and the throttle is advanced no further than 90% RPM. This allows the pilot to perform a final scan of the engine instruments to verify the engine is operating as expected; a critical check for a single-engine fighter prior to takeoff. Once this brief check is complete, the brakes are released and the throttle advanced to either MIL or AB.

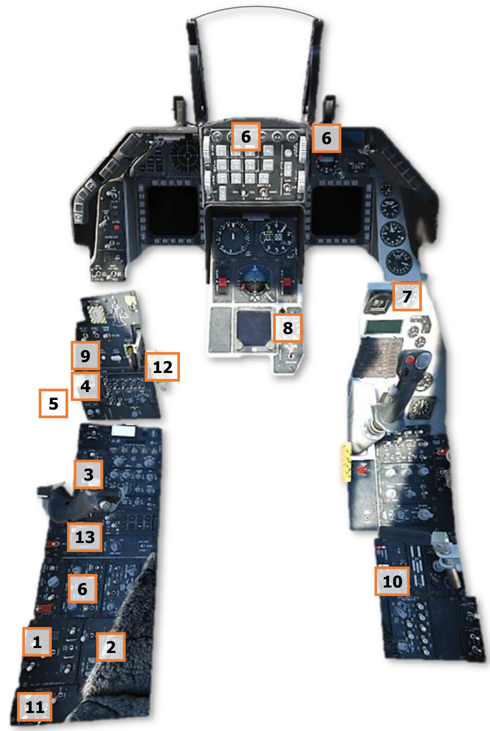
When departing as a flight, each aircraft takes off one at a time, in short intervals, and then rejoins once airborne.

NOTE: When starting a mission on the runway for takeoff, the following systems will be configured as shown:

- Nosewheel Steering (NWS) – Disengaged.
- ALR-56M Radar Warning Receiver (RWR) – Powered Off.
- CMDS MODE Knob – STBY.
- HMCS Symbology Knob – OFF.

Before Takeoff

Prior to entering the runway for takeoff, perform the following:



1. ALT FLAPS switch – Verify NORM.

2. Trim – Check.

- Pitch and yaw trim – Centered
- Roll trim - As required

This is a final verification the trim settings are correct for takeoff and have not been inadvertently changed.

3. ENG CONT switch – Verify PRI (guard down).

4. Speedbrakes – Verify closed.

5. Canopy – Verify closed and locked.

- Verify "CANOPY UNLOCKED" caution light is not illuminated.

6. IFF – Set and check. (N/I)

7. External fuel tanks – Verify feeding.

Wing external fuel tanks should feed first and have a lower quantity than at engine start. The internal wing tanks should be full.

If three external tanks are installed, verify that the centerline tank is feeding.

8. FUEL QTY SEL knob – NORM.

The FUEL QTY SEL knob must be set to the NORM position to allow the automatic forward fuel transfer system, trapped fuel warning, and for the BINGO fuel warning computation to be based on fuselage fuel.

9. STORES CONFIG switch – As required.

- CAT I: Air to Air loadouts without external wing tanks.
- CAT III: Air to Ground loadouts, or any loadout with external wing tanks.

10. OXYGEN SUPPLY lever – PBG (if high-G maneuvers are expected immediately following takeoff).

11. PROBE HEAT switch – PROBE HEAT.

This should be done at least two minutes prior to takeoff if icing conditions exist. Manual activation of probe heat on the ground when icing is not expected may cause overheat and damage to probe components.

Probe heat is automatically active once airborne.

12. Ejection safety lever – Down (Armed).

This arms the ejection seat and allows ejection when the ejection handle is pulled. This is delayed for as long as possible to prevent inadvertent ejection on the ground. Egress through other means is usually preferable.

13. Flight controls – Cycle. This is to verify freedom of movement and ensure controls are not obstructed.

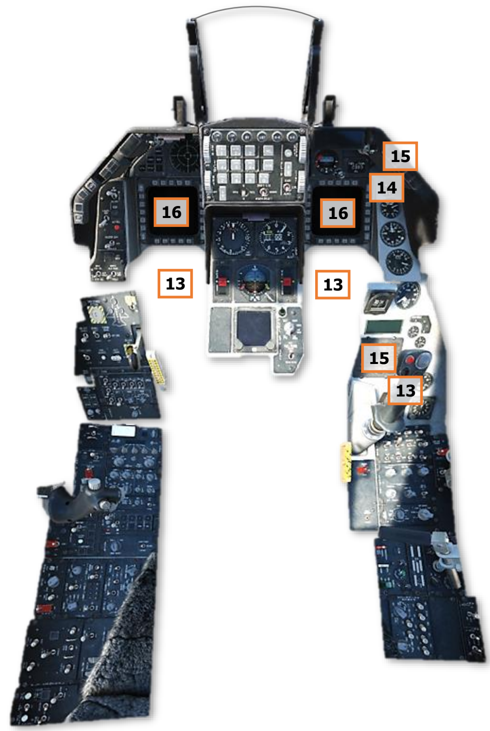
14. Engine OIL pressure – 15-65 PSI.

15. Warning and caution lights – Verify no unexpected conditions.

16. Targeting pod – Stow (if installed).

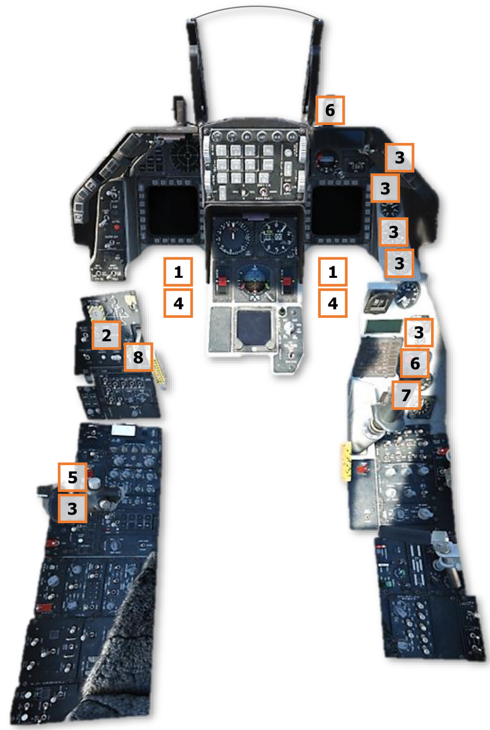
Targeting Pod is stowed by selecting STBY on the Targeting Pod Control Page.

This is done prior to takeoff and before landing to prevent foreign object damage to components.



Takeoff

Once lined up for takeoff on the directed runway, perform a final run-up check and initiate the takeoff roll:



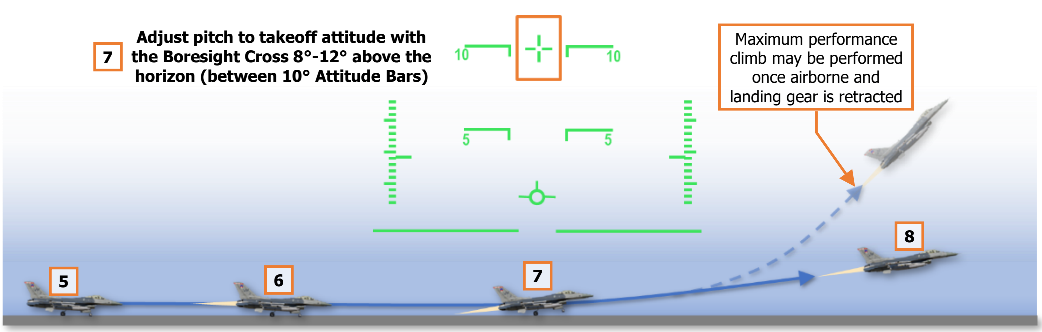
1. Brakes – Hold.
2. Parking Brake – Verify disengaged.
3. Throttle – 90% RPM. Check for normal engine indications:
   - HYD/OIL PRESS warning light – Off
   - OIL pressure – 25-65 PSI
   - FTIT – 935° C or less
   - HYD PRESS A & B – 2850-3250 PSI
4. Brakes – Release.
5. Throttle – Advance to desired thrust.
6. NWS – Disengage at 70 knots (or as necessary to maintain controllability) to prevent oversteering.
7. Pull back on the stick 10 knots below takeoff speed for MIL power or 15 knots below takeoff speed for AB and establish takeoff attitude (8–12°).(See chart below for takeoff speed)

   NOTE: Pulling back on the stick too soon may lead to over-rotation, skipping, or wallowing and will increase the distance needed to take off.
8. LG Handle – UP; after a positive rate of climb is established. The trailing edge flaps retract at the same time as the landing gear and may cause the aircraft to settle and scrape the runway when lift is lost.

   NOTE: Ensure landing gear is fully retracted with the gear doors closed before exceeding 300 KCAS.

TAKEOFF SPEED BASED ON AIRCRAFT GROSS WEIGHT

GROSS WEIGHT (GWT)	20,000 lbs.	24,000 lbs.	28,000 lbs.	32,000 lbs.	36,000 lbs.	40,000 lbs.	44,000 lbs.
TAKEOFF SPEED (KCAS)	128 kts	142 kts	156 kts	168 kts	178 kts	188 kts	198 kts



Takeoff

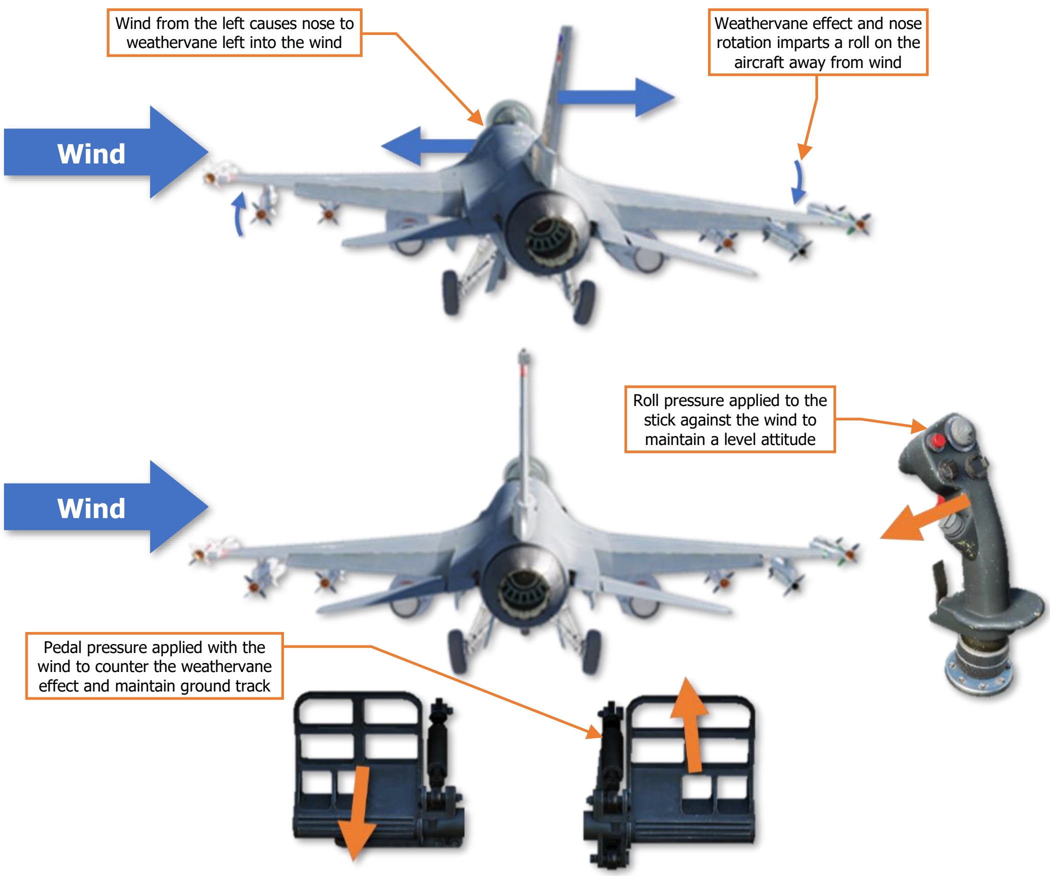
Crosswind Takeoff

When taking off in a crosswind, the wind acting upon the vertical tail will create a "weathervane" effect, causing the nose to turn into the wind. This will in turn raise the upwind wing, causing the aircraft to roll away from the wind direction.

To counter the effects of the crosswind during the takeoff roll:

1. Apply a slight amount of left/right stick pressure against the wind direction to keep the wings level.
2. Apply slight rudder input with the wind, or as necessary, to keep the aircraft centered on the runway throughout the takeoff roll.

During the rotation to takeoff attitude, smoothly remove the countering rudder input as necessary to allow the nose to weathervane back into the wind and establish a proper crab angle into the wind. With a proper crab angle, the Flight Path Marker (FPM) should be aligned down the runway when becoming airborne.



Control inputs to counter crosswinds during takeoff

LANDING

Compared to other fighter aircraft, the F-16 can be somewhat difficult to land. Due to its aerodynamics and narrow "footprint" of its landing gear, maintaining control throughout the final approach, touchdown and deceleration can be a challenge for inexperienced pilots.

Depending on the type of approach to be flown, weather conditions, and the nature of the airfield and its operations, a straight-in approach or an overhead break may be flown.

The F-16C relies on the combined effects of aerodynamic drag and main landing gear wheel brakes to decelerate the aircraft after touchdown. Just prior to contact with the runway, the pilot raises the nose in a "flare" maneuver to reduce the descent rate as much as possible. This flare maneuver is especially critical when landing with high gross weights to prevent over-stressing the main landing gear, but it also allows the pilot to maintain a nose-high attitude after touchdown for aerodynamic braking; instead of slamming the nose gear down onto the runway following a touchdown with a high descent rate.

This type of landing, in which only the main landing gear is used during the initial touchdown and roll-out, is called a "two-point" landing. The pilot uses forward/aft stick inputs to maintain the nose-high attitude, which generates aerodynamic drag across the underside of the wings and fuselage to decelerate the aircraft. The nose is typically lowered around 100 knots to allow the nose landing gear to contact the ground, after which the wheel brakes on the main landing gear are used to bring the aircraft to a stop.

Descent/Before Landing

Prior to committing to the approach, configure the aircraft for landing:

1. Fuel – Check quantity/transfer/balance.
2. Landing Light – On.
3. Altimeter – Set and check.

   Verify altitude displayed on the HUD matches the altitude on the altimeter.

   Check that the altimeter readings in ELECT and PNEU are ±75 feet of a known elevation and are ±75 feet of one another.
4. Attitude References – Check.

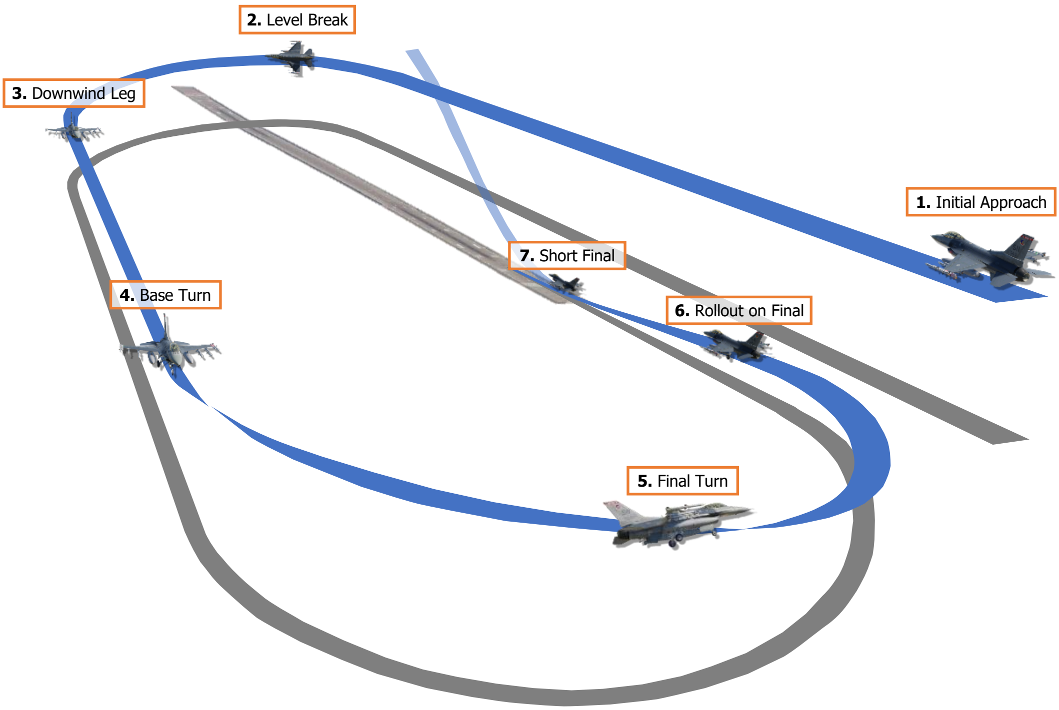
   Attitude indications for ADI, HUD and SAI should agree.
5. ANTI ICE switch – As required.
6. Targeting pod – Stow (if installed).

   Targeting Pod is stowed by selecting STBY on the Targeting Pod Control Page.

   This is done prior to takeoff and before landing to prevent foreign object damage to components.

Overhead Break

The overhead break is a type of visual approach pattern used by military pilots to expedite landing procedures in an efficient manner. These landings expedite the approach into an airfield by using a 180° turn at a low throttle setting to rapidly deplete airspeed and can also be used to rapidly generate precise timing intervals between wingmen when a formation of aircraft is coming in for landing.

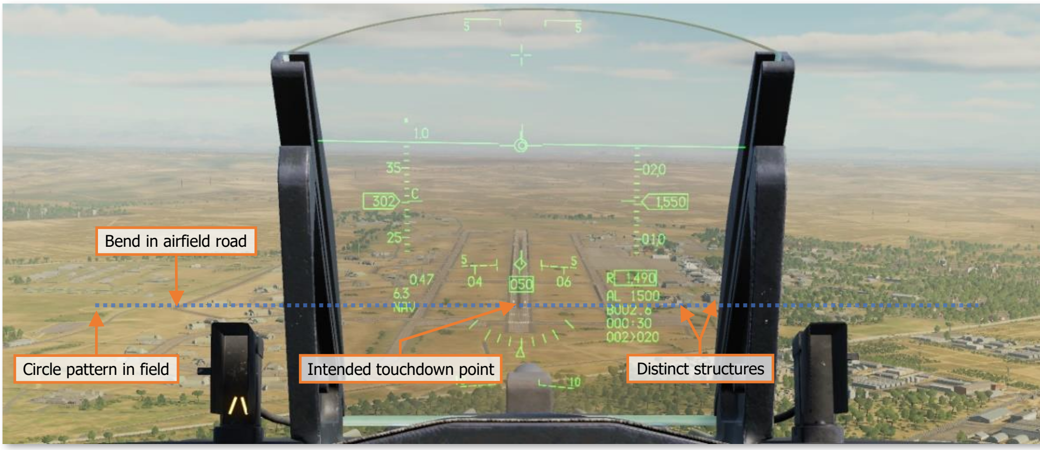


Overhead Break Pattern

1. **Initial Approach.** Upon initial approach to the airfield, align the aircraft with the landing runway at 1,500 feet above ground level (AGL) and 300 knots calibrated airspeed (KCAS). When aligned with the runway, note the current aircraft heading on the HUD and calculate the reciprocal heading; this will be the heading for the downwind leg following the turn into the level break.

   As the intended landing area comes into view, it is recommended to visually identify one or multiple distinct reference points in the airfield environment that are adjacent to the intended touchdown point. The turn into the level break is normally initiated when directly over the intended touchdown point, but as this location will be directly below the aircraft and cannot be seen from within the cockpit, visual reference points directly abeam the touchdown location will allow the pilot to determine when the aircraft is indeed over the touchdown point. (see figure on the following page)

   Alternatively, if no visual reference points are available, the level break could be initiated once overhead the center of the airfield, or simply executed based on the pilot's judgement of when it is appropriate to do so.

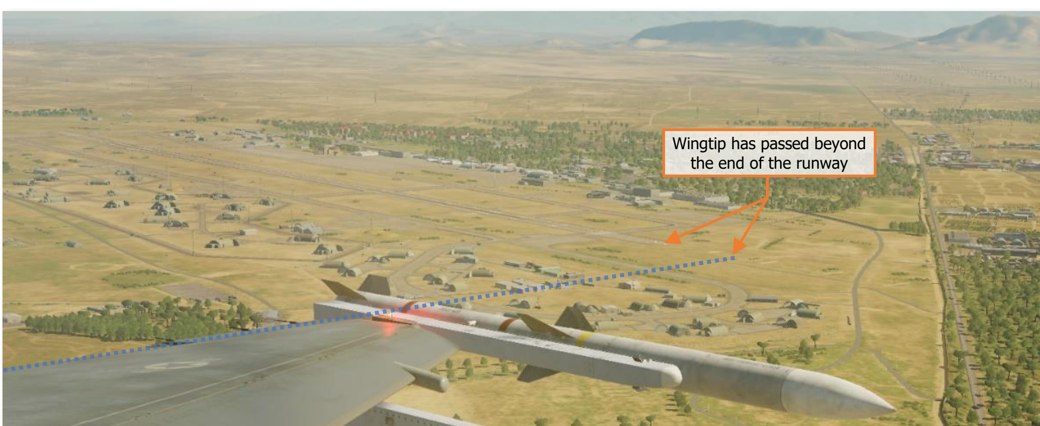


Visual reference points during initial approach

2. **Level Break.** When the aircraft is overhead the touchdown point, roll the aircraft to approximately 70° of bank into the intended break direction, set throttle to about 80% RPM, and open the speedbrakes. Pull into the break at approximately 3 G. Adjust the attitude as necessary to keep the Flight Path Marker (FPM) on the HUD aligned with the Horizon Line to maintain a level altitude throughout the turn.

3. **Downwind Leg.** Roll out on the downwind leg opposite the landing heading between 200-220 KCAS and 1,500 feet AGL. Extend the landing gear and confirm three green WHEELS down lights are illuminated. Reduce speed as required to prevent excessive airspeed buildup in the base turn and trim to an Angle-of-Attack (AoA) of 11°.

4. **Base Turn.** Initiate the base turn when abeam the intended point to rollout on final. This may be estimated by viewing the wingtip from the cockpit. Once the wingtip is at the end of the runway, lower the nose slightly so the FPM is between the -2.5° and -5° pitch ladder markers, enter a 30-45° bank angle and fly the turn at approximately 11° AoA, which will be toward the top of the AoA Bracket symbol.

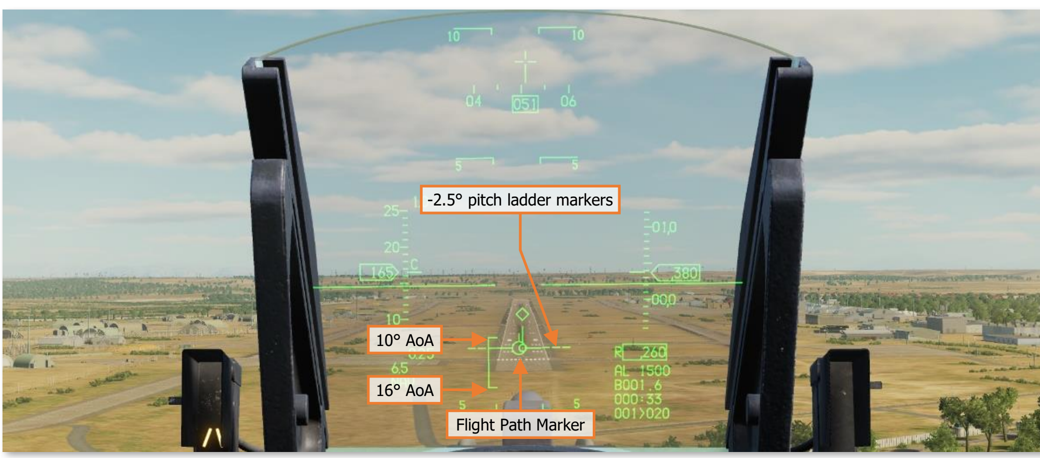


Wingtip reference for initiating base turn

5. **Final Turn.** Use the throttle to control airspeed while using the Side Stick Controller to maintain the AoA at approximately 11-13° through the turn from base to final. Maintain a bank angle between 30-45°, or as necessary to ensure the aircraft is aligned with the runway upon roll-out.

AoA and glide path references in base turn to final

6. **Rollout on Final.** Roll out on final and adjust the controls to achieve the desired glide path and maintain the appropriate AoA. The intent is to roll out of the turn aligned with the runway, approximately one nautical mile from the touchdown point and 300 feet AGL. Align the HUD Flight Path Marker (FPM) and 2.5° pitch ladder with the runway threshold to ensure proper glide path while maintaining 11-13° AoA.



AoA and glide path references on final

If desired, the MAN RNG/UNCAGE knob may be depressed to the Un-cage position to declutter the lower portion of the HUD. When this is occurs, the Heading Tape will be repositioned to the top portion of the HUD and the Roll Indicator will be removed (as will the ILS indicators if in use).

7. **Short Final.** See Landing procedure on the following page.

Landing

1. **Rollout on Final.** Align the HUD Flight Path Marker (FPM) and 2.5° pitch ladder markers with the runway threshold to ensure proper glide path while maintaining 11-13° AoA.

   NOTE: If necessary to perform a go-around for another approach and landing attempt, initiate the go-around prior to performing the flare over the runway.

   Go-around. Increase throttle, arrest the descent rate, and begin a climb. When a positive rate of climb is established, retract the landing gear. Ensure landing gear is fully retracted with the gear doors closed before exceeding 300 KCAS. Turn onto crosswind to re-enter the pattern when at the appropriate altitude to do so.

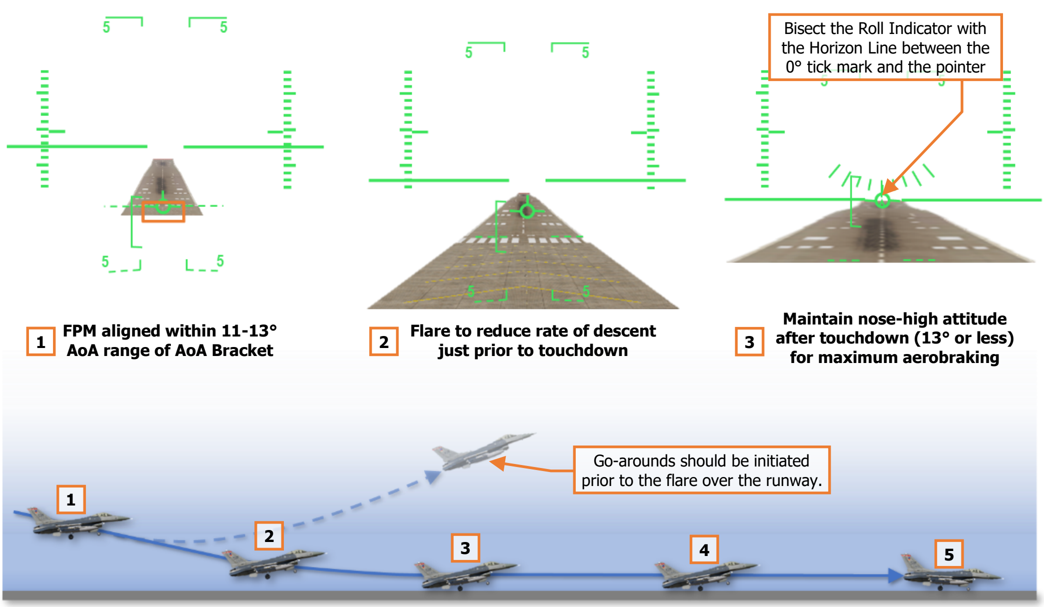
2. **Short Final.** When crossing the runway overrun (the portion of the runway before the primary surface starts), apply aft pressure on the stick to shift the FPM forward to a point 300-500 feet further down the runway. Gently pull back on the stick to flare and reduce the descent rate but do not level off.

3. **Two-Point Touchdown.** Retard the throttle to idle and touchdown with a maximum AoA of 13°. An AoA greater than 15° during the touchdown or aerodynamic braking may cause the speedbrakes, ventral fins, or engine nozzle to contact the runway. Use small inputs to the stick to avoid overcontrolling the aircraft.

4. **Two-Point Aerobraking.** Maintain a nose-up attitude (13° maximum) for two-point aerodynamic braking until the airspeed has been reduced to approximately 100 knots.

   NOTE: A good reference to use for maximum aerobraking is the Roll Indicator. Adjust the back pressure on the stick so that the Horizon Line bisects the lower curve of the Roll Indicator, between the 0° tick mark and the pointer.

5. **Three-Point Roll-Out.** At approximately 100 knots, reduce back pressure on the stick and lower the nosewheel to the runway. Apply moderate to heavy braking to slow the aircraft. After the nosewheel has compressed, the speedbrakes may be fully opened and full aft pressure on the stick may be applied for maximum braking effectiveness (for short-field landings). Engage nosewheel steering when below 30 knots unless it is required earlier to maintain ground track and/or prevent departure from the runway.



Short Final and Landing Roll-out

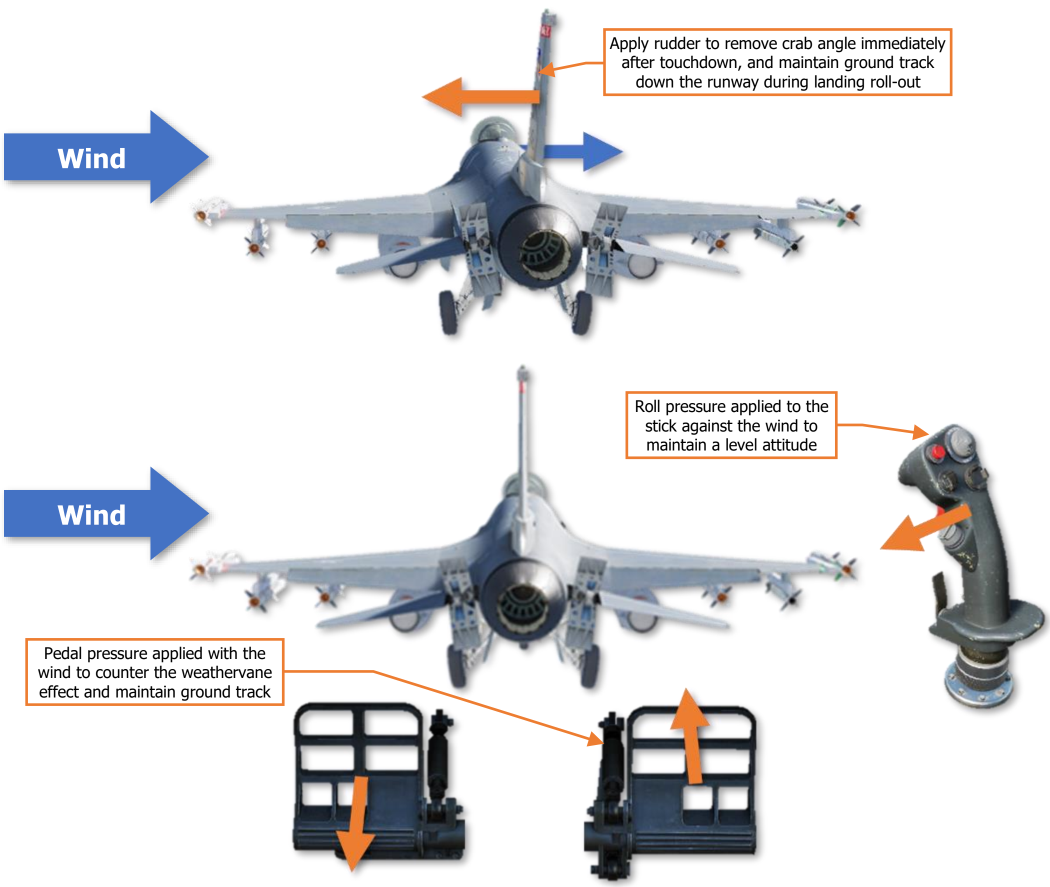
Crosswind Landing

When landing in a crosswind, the wind acting upon the vertical tail will create a "weathervane" effect, causing the nose to turn into the wind. During the approach, maintain wings-level and allow the aircraft to crab with the nose into the wind until touchdown.

At touchdown of the main landing gear, counter the effects of the crosswind during the landing roll-out:

1. Immediately apply rudder input to remove the crab angle and maintain alignment down the runway, or use differential wheel braking as necessary, to keep the aircraft centered on the runway throughout the roll-out.
2. Apply a slight amount of left/right stick pressure against the wind direction to keep the wings level.
3. Perform the remainder of the landing roll-out with normal two-point aerobraking until below 100 knots or until aircraft control becomes difficult and nosewheel steering is necessary to maintain ground track down the runway.

Use caution when engaging nosewheel steering as a strong pedal input may cause an abrupt yaw when nosewheel steering is engaged. If possible, center the rudder before engaging the nosewheel steering and then gently re-apply rudder input as necessary to maintain ground track down the runway.



Control inputs to counter crosswinds during landing

AIRCRAFT SHUTDOWN

Once the aircraft is safely back on the ground and the flight is to be terminated, an After Landing check is performed after departing the runway. This configures the aircraft for ground operations and makes the aircraft safe to approach by ground personnel.

These checks may be configured while taxiing to the parking area or may be performed in designated arm/de-arm areas immediately after departing the runway (often called "EOR" or "End of Runway" areas).

After arriving at the intended parking location, ground crews place wheel chocks to prevent any un-intended aircraft movement and the pilot powers down the various avionics and aircraft systems.

Due to its small, lightweight airframe, the F-16 is not equipped with an integrated boarding ladder and relies on the ground crew to place such equipment next to the cockpit for egress. The pilot secures his or her gear, climbs out of the cockpit, discusses with the ground crew about any maintenance-related issues encountered during the flight, and then departs for debriefing while the ground personnel regenerate the aircraft for future sorties.

After Landing

When clear of the runway, perform the following:

1. PROBE HEAT switch – Verify OFF.

Manual activation of probe heat on the ground when icing is not expected may cause overheat and damage to probe components.

2. ECM Power switch – OFF.

3. Speedbrakes – Close.

4. Ejection Safety Lever – Safe (Up).

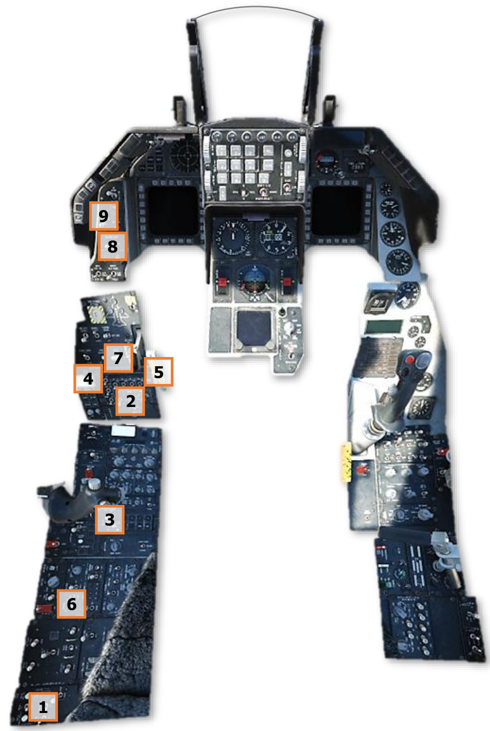
The ejection seat is safed after landing to prevent inadvertent ejection. A ground egress is usually preferable to ejection in case of an emergency while on the ground.

5. IFF MASTER knob – STBY.

6. LANDING/TAXI Light switch – As required.

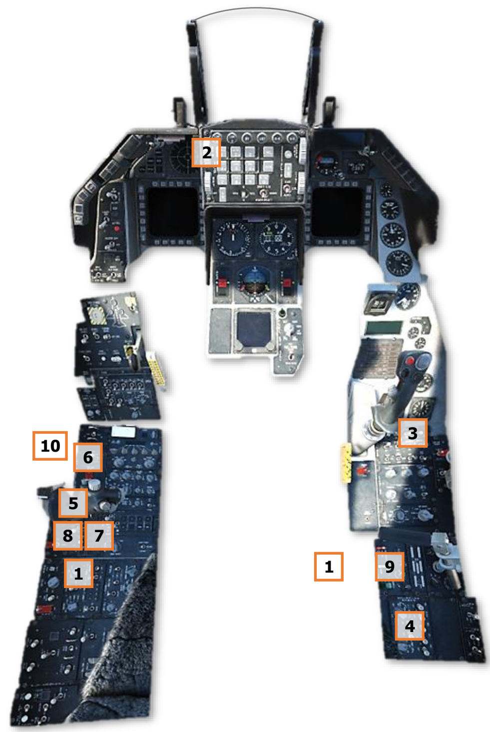
7. MASTER ARM and LASER ARM switches – OFF.

This should be accomplished before ground personnel approach the aircraft.



Engine Shutdown

After reaching the designated parking location, perform the following:



1. C & I knob – BACKUP.
2. HUD SYM knob – Minimize.
3. SNSR PWR panel – Set:
    - LEFT HDPT – OFF.
    - RIGHT HDPT – OFF.
    - FCR – OFF.
    - RDR ALT – OFF.
4. AVIONICS POWER panel – Set:
    - INS knob – OFF.
    - MIDS LVT knob – OFF.
    - DL switch – OFF. (N/I)
    - GPS switch – OFF.
    - UFC switch – OFF.
    - MFD switch – OFF.
    - ST STA switch – OFF.
    - MCC switch – OFF.
5. Throttle – OFF.

    NOTE: Wait at least 10 seconds after INS knob has been moved to OFF before shutting down the engine. This allows the INU to complete its shutdown sequence before the engine spools down and the generator drops offline.

6. JFS RUN light – Confirm off.
7. "EPU GEN" and "EPU PMG" – Confirm off.

    Check after main generator power drops offline. Lights on may indicate impending activation of the EPU and a hazardous condition.

8. MAIN PWR switch – OFF.

    Delay placing MAIN PWR switch to OFF until after engine rpm decreases through 20 percent. This delay should allow the exhaust nozzle to remain open and makes it easier for the crew chief to accomplish the post flight inspection.

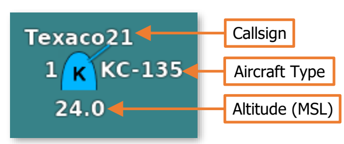
9. OXYGEN SUPPLY lever – OFF.
10. OXYGEN Diluter lever – 100%.
11. Canopy – Open.

AERIAL REFUELING

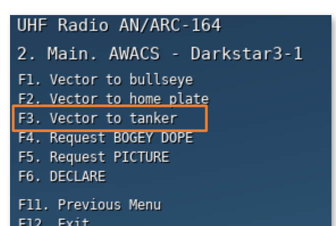
Aerial refueling enables the F-16 and other aircraft to extend their range beyond what may be achieved with internal fuel or external fuel tanks without landing at an airfield to refuel. Aerial refueling is often critical when performing trans-oceanic flights, conducting long-range sorties beyond the reach of airbases in friendly or allied territory, or extending the duration of combat air patrols.

Even if additional fuel is not required to fly to the objective, execute the mission, and return to base, it may be prudent to perform aerial refueling prior to committing to the objective area. This allows the pilot additional loiter time over the objective, the option to conduct low-level ingress or egress at higher speeds, more liberal use of the afterburner in combat, or provide additional options for any contingencies encountered during the mission.

Air-to-Air Refueling (AAR) tracks are areas within which aerial refueling tanker aircraft, such as the KC-135, will orbit during a mission. These AAR track locations are normally included within the mission briefing; however, the F10 map may also be referenced during the mission itself to aid in locating these aircraft (assuming the mission options allow such information to be displayed on the F10 map). Aerial refueling tankers will be designated by friendly aircraft icons marked with a “K”.

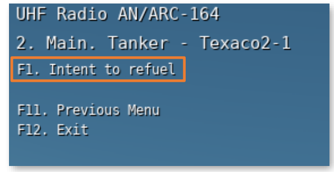


Alternatively, if an AWACS is on-station, a vector to the nearest tanker may be requested over the AWACS radio frequency to aid in navigation to an AAR track.

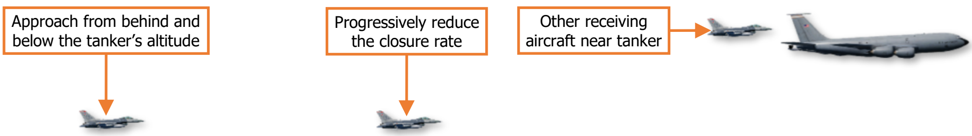


Approach and Rendezvous

When approaching the AAR track, prior to performing the rendezvous with the tanker, a radio call should be made to the tanker crew to announce an intent to refuel. The tanker crew will respond with their current altitude and airspeed, and whether the receiving aircraft is cleared to the Pre-Contact position. The receiving aircraft should ensure altitude separation is established prior to entering the AAR track and visual or radar contact has been made with the tanker aircraft prior to initiating the rendezvous.



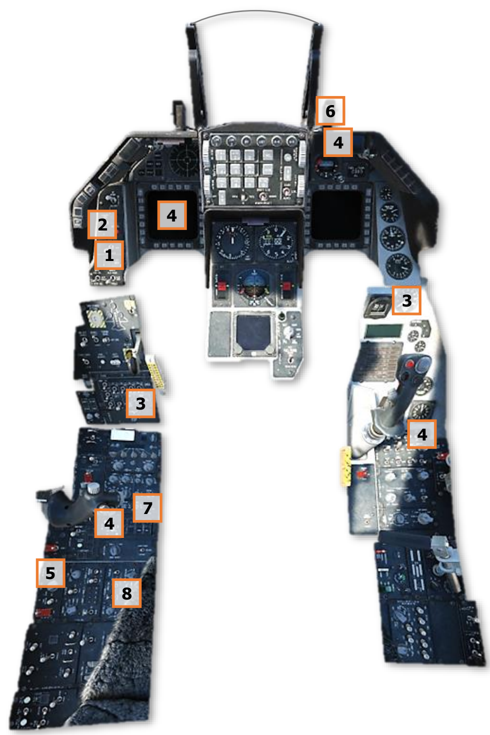
When performing the rendezvous with the tanker, the closure speed and relative altitude should be closely monitored. The approach should be made from behind and below. There may be other aircraft performing refueling operations in the vicinity of the tanker, so caution should be exercised to avoid a mid-air collision.



Approach and rendezvous with refueling tanker

Pre-refueling Checklist

Prior to completing the rendezvous with the tanker, perform the following steps:



1. MASTER ARM switch – OFF.
2. LASER ARM switch – OFF.
3. CMDS MODE knob – STBY.
4. Emitters – Off or Standby:
   - FCR – Set to STBY Mode.
   - ECM Power switch – STBY.
   - TACAN – Set to REC mode.
   - RDR ALT switch – STBY.

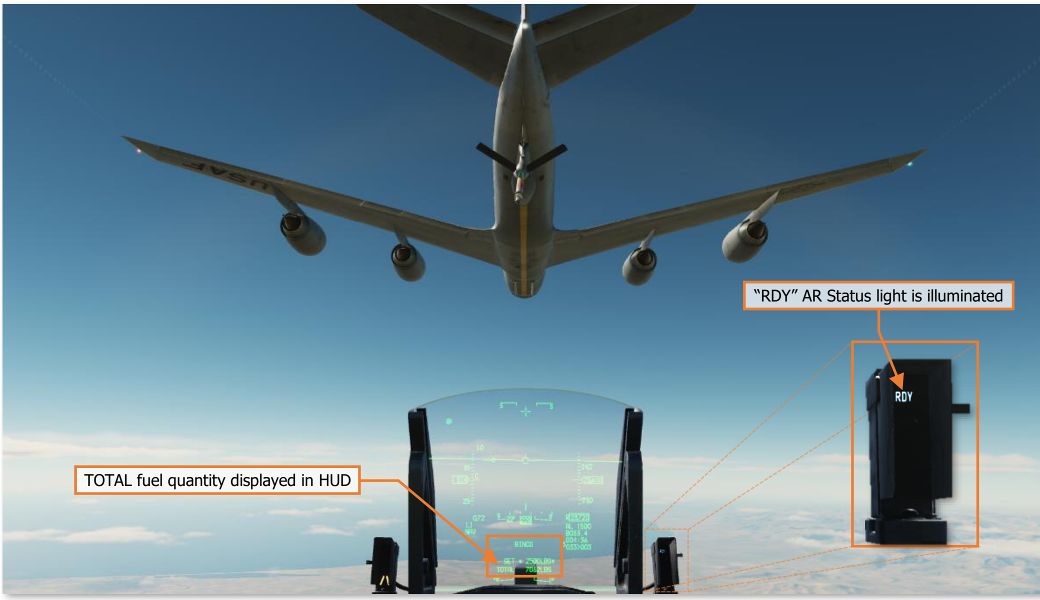
   NOTE: Emitters should be disabled prior to reaching the Pre-contact position.
5. AIR REFUEL switch – OPEN.

   This should be done 3-5 minutes prior to refueling if equipped with external fuel tanks to depressurize the tanks and allow them to be filled.

   NOTE: FLCS gains are set to takeoff/landing configuration when set to OPEN.
6. AR Status Light – Verify RDY.
7. HOT MIC/CIPHER switch – HOT MIC.
8. Exterior Lights – As required. At night, exterior lights should be set to DIM and STEADY settings and the Anti-Collision light should be set to OFF.

Pre-contact Position

When cleared to Pre-contact position, the receiving aircraft lines up directly behind the tanker and matches its speed. The Pre-contact position allows the boom operator to ensure they have positioned the boom for contact, the refueling system is set to the appropriate transfer rate for the type of aircraft being refueled, and the boom operator establishes their required visual reference points on the receiving aircraft below them.



As a technique, the BNGO page may be displayed on the DED (and the HUD if desired), which will display the total fuel in a cockpit location that is more conducive to maintaining a focus on the tanker. This precludes the pilot from needing to look down at the fuel quantity indicator in the cockpit.

(See BNGO Page for more information.)

To display the DED page directly on the HUD, set the DED/PFLD switch to the DED DATA position on the HUD Control Panel.

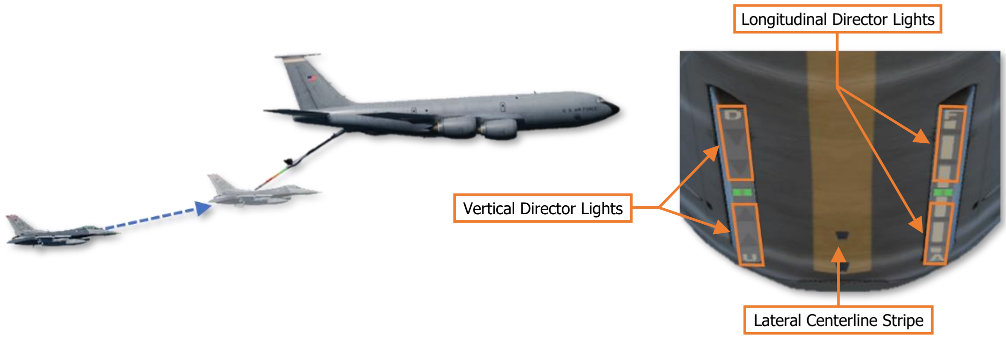
Once stable and ready to move in for refueling, the pilot in the receiving aircraft radios to the boom operator that he/she is established in the Pre-contact position and is ready to move into the contact position.

Pre-contact Position

Contact Position

Once cleared to the Contact position by the boom operator, use small but smooth control inputs, with very slight changes to the throttle. After a throttle adjustment, it is prudent to wait several moments to see the effects of the change before making another.

Allow the boom to pass just left or right of the canopy, about 2 or 3 feet overhead. Continue to move forward slowly, maintaining lateral alignment with the yellow stripe painted along the underside of the KC-135.

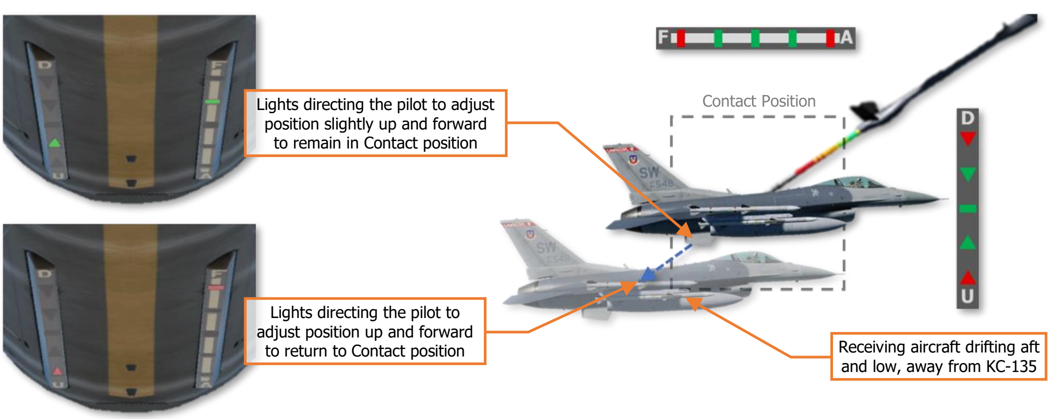


Contact Position

Use the director lights along the underside of the tanker's forward fuselage to establish and maintain the Contact position. The boom operator will "fly" the refueling boom using the boom-mounted control surfaces to align and insert the boom into the F-16's dorsal refueling receptacle.

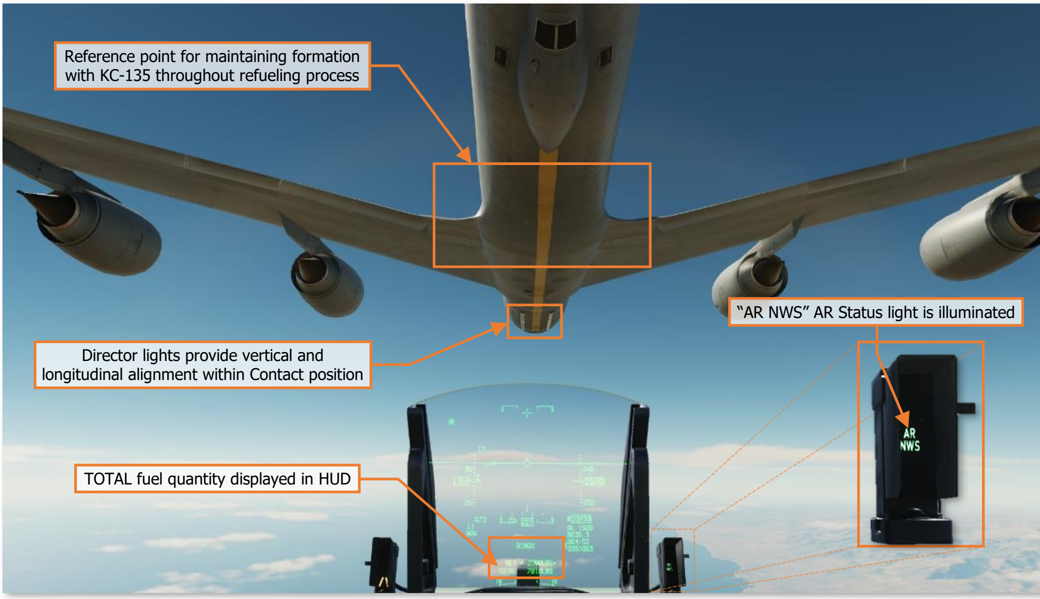
The lights under the forward fuselage of the KC-135 are directive in nature, meaning they indicate to the pilot the required corrections that must be made to remain within the ideal Contact position. The left row of lights indicates vertical alignment, and the right row of lights indicates longitudinal alignment. Green lights indicate a slight correction and red lights indicate the aircraft is at the limits of the boom's travel within the Contact position.

- Arrows that are biased toward the "D" or the "U" indicate a required correction "Down" or "Up", respectively, and are corrected by slight forward/aft pressures on the stick.
- Dashes that are biased toward the "F" or the "A" indicate a required correction "Forward" or "Aft", respectively, and are corrected by small adjustments of the throttle.



KC-135 Director Light Corrections

When the boom has been seated within the receiving aircraft's receptacle, the boom operator will announce "Contact" and confirm positive fuel flow. When this occurs, the "AR NWS" AR Status light illuminates.



Once refueling has begun, the receiving aircraft simply needs to maintain the Contact position relative to the KC-135 and monitor the total fuel quantity. It is not wise to focus on the boom, nor should the pilot's focus be solely on the director lights or the cockpit indications for more than a brief moment. A good reference point for maintaining formation with the KC-135 is the center fuselage along the trailing edge of the main wing roots. This location is close enough to detect small deviations from the intended position before they become apparent on the director lights, and the wing roots serve as an immediate attitude indicator of the KC-135 (which is especially important as the tanker enters or rolls out from a turn within the AAR track). Occasional cross-checks of the director lights, HUD flight information, total fuel quantity, and the "AR NWS" light should be conducted throughout the refueling, but the primary focus should remain on the KC-135 itself.

Note that the flying characteristics of the aircraft will subtlety and continuously change as the aircraft takes on fuel and the gross weight increases. This will cause the aircraft to drop away from the KC-135, requiring a slight adjustment to the pitch attitude to maintain altitude. This will in turn increase the AoA of the aircraft, which will require a slight adjustment of the throttle to counter the increase in drag and maintain airspeed.

It is possible to unintentionally disconnect at some point during the refueling process. If this occurs, the "DISC" AR Status light will illuminate. The pilot may adjust the flight controls to re-enter the correct alignment within the Contact position, at which the boom operator will repeat "Contact" and confirm resumption of fuel flow, or the pilot may back away to the Pre-contact position prior to approaching the Contact position again.

If it is necessary to disconnect from the tanker prior to receiving a full offload, the Missile Step button may be pressed on the Side Stick Controller, which will disconnect the boom from the refueling receptacle and illuminate the "DISC" AR Status light.

Once clear of the boom, the aircraft should be slowly backed away to the Pre-contact position while maintaining alignment directly behind the tanker. Prior to leaving the Pre-contact position, ensure to visually scan the immediate areas to the left and right of the tanker for other aircraft waiting to refuel, or wingmen waiting for you to finish before departing from the tanker's wing.

Breakaway Procedure

At any point during the refueling, if the distance and/or closure rate is such that a potential mid-air collision with the tanker or the refueling boom is likely, the boom operator will call for an emergency breakaway maneuver by stating "Breakaway, breakaway." When an emergency breakaway is commanded, immediately apply forward pressure on the stick to initiate a descent away from the tanker and retard the throttle to reduce airspeed and gain separation. The maneuver should be deliberate and expeditious in nature, but not necessarily aggressive.

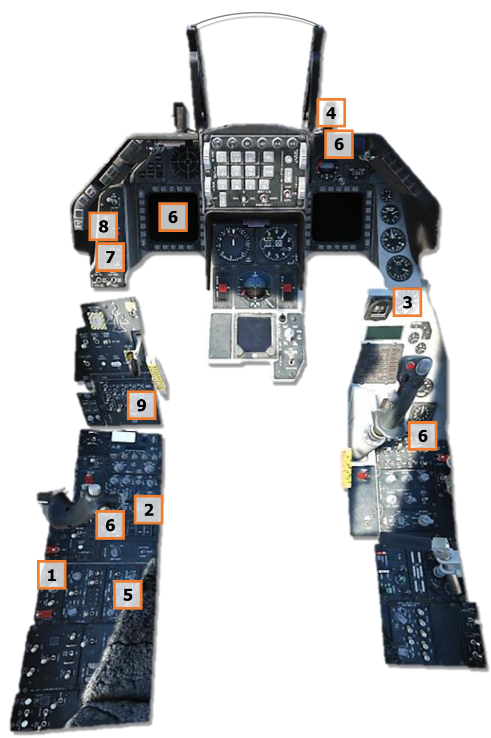
Breakaway Maneuver

After completing a breakaway, the boom operator will clear the receiving aircraft back to the Pre-contact position prior to resuming the refueling process, if necessary.

Post-refueling Checklist

After completing refueling and gaining a safe distance from the tanker, perform the following:

1. AIR REFUEL switch – CLOSE.
2. HOT MIC/CIPHER switch – OFF.
3. Fuel quantity – Check. Verify proper transfer and balance.
4. AR Status Lights – All off.
5. Exterior Lights – As required.
6. Emitters – As required:
    - FCR – As required.
    - ECM Power switch – As required.
    - TACAN – As required.
    - RDR ALT switch – RDR ALT.
7. MASTER ARM – As required.
8. LASER ARM – As required.
9. CMDS MODE knob – As required.



NAVIGATION

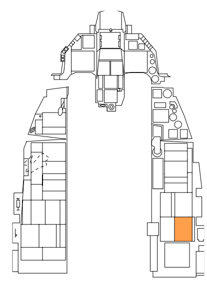
USAF Photo
by MSgt Burt Traynor

INS ALIGNMENT

This section's revision is currently a work-in-progress.

The inertial navigation system (INS) is the primary navigation system of the F-16C and provides accurate attitude, navigation, and vertical and horizontal steering information. The Upfront Controls (UFC) are the primary interface device to the INS. In this Navigation chapter we will discuss the practical application of using the INS for navigation purposes.

The navigation system can be aligned by a variety of methods on the ground or in the air. This is started by positioning the INS knob on the Avionics Power panel to the desired position. The INS knob is set to NAV when the alignment is complete.



The **Normal (NORM)** Alignment is the primary alignment mode. The NORM alignment requires approximately eight minutes to fully accomplish.

The **Stored Heading (STOR HDG)** Alignment allows for a quick alignment in 90 seconds or less in some conditions. This can only be used if the aircraft has been set up specifically for this alignment beforehand.

An **Inflight Alignment (INFLT ALIGN)** places the INS in ATT mode and performs an in-flight alignment. The pilot must hold the aircraft steady and level during this process.

In **Attitude (ATT)** mode, only attitude and heading information is given to the avionics.

Normal Gyrocompass (NORM) Alignment

A full INS alignment in the NORM position should be accomplished prior to every flight. This is normally started just after engine start and avionics power-up to allow time for the full alignment to complete prior to taxi.

1. **Position the INS knob to the NORM position.**

   This begins the INS alignment and calls up the INS page on the DED. The progress of the alignment may be monitored from here.

Time into Alignment. This is the elapsed time in minutes and decimal seconds since the INS alignment began.

Alignment Status. This is an estimate of the alignment quality. Values count down from 99 with the following meanings:

- 99 – Initialization
- 90 – Valid attitude data, coarse align begins
- 79 – Valid heading data
- 70 – Degraded navigation state, steady RDY displayed on DED, steady ALIGN displayed on HUD
- 60-20 – Circular error probability (CEP) multiplier compared to fully aligned state; 60 = 6.0 times normal CEP, 20 = 2.0 times normal CEP
- 10 – INS fully aligned, RDY flashes on DED, ALIGN flashes on HUD
- 6 – INS fully aligned and enhanced to 0.6 times normal precision with GPS data or other techniques

Latitude. Latitude of start position.

Longitude. Longitude of start position

System Altitude. Altitude used by the fire control computer for air to ground weapons delivery

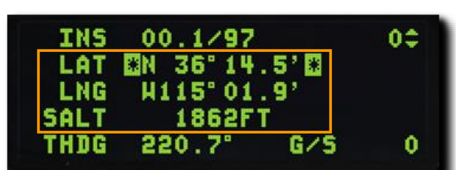
True Heading. Last known true heading or heading derived during alignment

Ground Speed. Current ground speed.

2. **Enter the latitude, longitude, and altitude for the starting location.**

The last known coordinates and estimate of altitude are displayed when the alignment begins, however the data must be re-entered even if it is still correct.

If the data is accurate, use the DCS switch to highlight each line and press ENTR for each in turn. If the data is not accurate, enter the correct data for each field with the ICP keypad.



Failure to enter the data will flag the alignment as degraded and not allow important monitoring functions to take place. Navigation, weapons delivery and targeting pod pointing errors may also result.

The alignment will stop and start again if the data is entered later than two minutes into the alignment.

3. **Monitor alignment progress and switch INS knob to NAV.**

   The RDY on the DED and ALIGN on the HUD will begin to flash when the alignment is complete. This should happen in 8 minutes or less. Position the INS knob to NAV to accept the alignment.

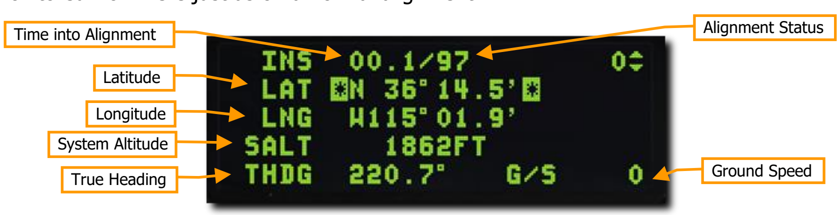
Stored Heading (STOR HDG) Alignment

A Stored Heading alignment option is available to allow a faster INS alignment in certain situations. This can be useful for "scramble" missions or for situations when your playtime is limited.

This alignment assumes a full gyrocompass alignment was already performed before the aircraft was last shut down and the aircraft has not been moved. The previously computed true heading is stored in the Inertial Navigation Unit (INU), a component of the INS, and is used to give the alignment process a head start. The new alignment should take about 90 seconds.

1. **Position the INS knob to the STOR HDG position.**

   This begins the INS alignment and calls up the INS page on the DED. The progress of the alignment may be monitored from here just as on a normal alignment.



2. **Verify, but <u>do not enter</u>, the latitude, longitude, altitude, and true heading for the starting location.**

3. **Monitor alignment progress and switch INS knob to NAV.**

   The RDY on the DED and ALIGN on the HUD will begin to flash when the alignment is complete. This should happen in about 90 seconds. Position the INS knob to NAV to accept the alignment.

Inflight (INFLT) Alignment

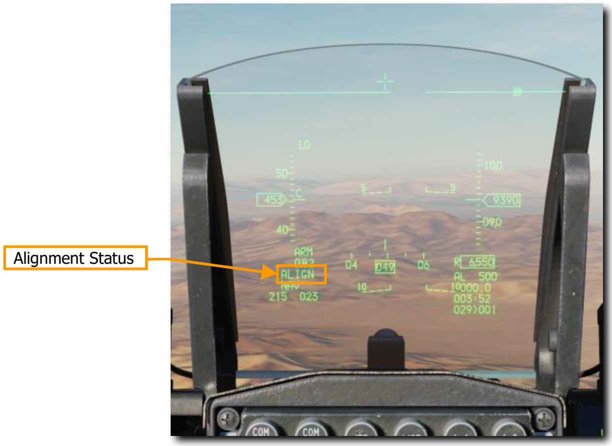
It is possible to lose your INS alignment inflight due to electrical failure, battle damage or switchology errors. A new alignment may be obtained while airborne provided the INS is functional and GPS data is available. If GPS is not available, the inflight alignment will not complete.

1. **Position the INS knob to OFF for 10 seconds.**
2. **Maintain straight, level and unaccelerated flight.**
3. **Position the INS knob to the INFLT position.**

   This begins the inflight INS alignment and calls up the INFLT ALIGN page on the DED. No action or data entry is required on this page if GPS data is available. An initial heading may be entered based on magnetic compass reading or other outside sources, but this is not required.

   The STBY mnemonic will replace the max G indication in the HUD, showing that coarse alignment of the inertial platform is in progress. Horizon line, pitch ladders and compass information may be displayed but will not be accurate.

4. **Maintain straight, level and unaccelerated flight for approximately one minute, until ALIGN appears in the HUD.**

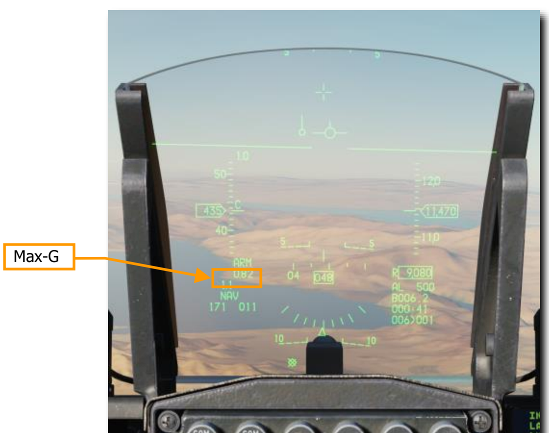


This indicates that coarse alignment is complete and fine alignment is in progress. Attitude information becomes available in the HUD and ADI, and the aircraft may be maneuvered normally.

Shortly after attitude information appears, the flight path marker, steering cue, aircraft heading, and HSI navigation data become available. Reliability of the data increases as the alignment progresses.\

5. Switch INS knob to NAV after Max-G replaces ALIGN in the HUD.

Replacement of ALIGN with Max-G shows that the alignment is complete. The mission may proceed normally from there.

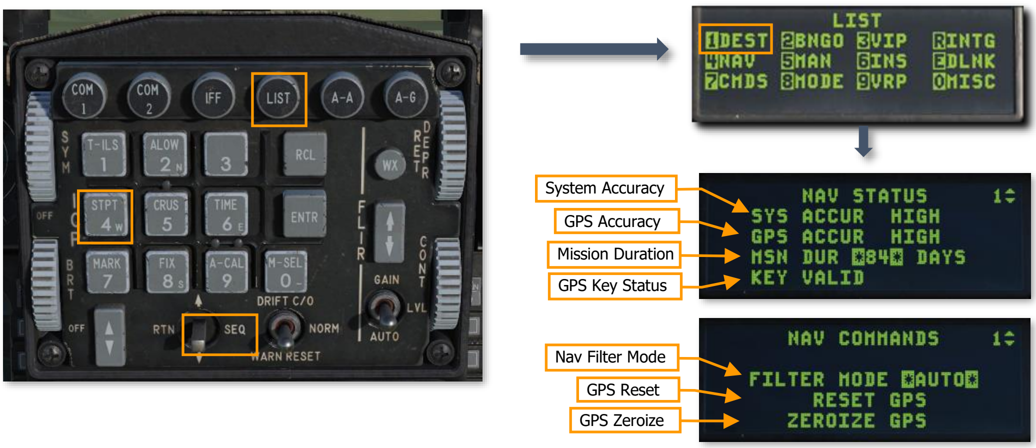


NAVIGATION FIXES AND UPDATES

This section's revision is currently a work-in-progress.

NAV Page

This page shows the status and health of the navigation system. It is accessed by selecting option (4) NAV from the LIST menu. Cycle between the NAV STATUS and NAV COMMANDS page by toggling the DCS right to SEQ.



System Accuracy. This is an estimation of total nav system accuracy. Possible options are HIGH (less than 50 ft), MED (less than 600 ft), or LOW (greater than 600 ft).

GPS Accuracy. This is an estimation of GPS system accuracy. Possible options are HIGH (less than 300 ft), LOW (greater than 300 ft), and NO TRK (no satellites tracked).

Mission Duration. This is an enterable number that represents the desired number of consecutive days of GPS keys. This affects the GPS Key Status listed below.

GPS Key Status. The validity of loaded GPS keys for the number of entered days. Possible options are KEY VALID (valid daily keys), KEY INVALID (invalid daily keys), INSUFF KEYS (insufficient keys for entered mission duration), KEY NOT VERIFIED (key validity unknown), EXPIRE AT 2400 HRS (keys expire at next midnight GMT), Blank (no keys loaded).

Nav Filter Mode. Navigation system GPS filter mode. Toggles between AUTO (GPS data is integrated with INS data using a Kalman filter) or INS (GPS data is ignored and only INS data is used).

GPS Reset. The GPS Receiver may be reset by highlighting this field and pressing the M-SEL (0) button on the keypad.

GPS Zeroize. The GPS data may be erased (zeroized) by highlighting this field and pressing the M-SEL (0) button on the keypad. This erases crypto data from the GPS and INS memory.

MAGV Page

This page allows manual entry for Magnetic Variation, or number of degrees between magnetic north and true north. This data is used by the aircraft navigation system. It is accessed by selecting option (0) MISC from the LIST menu, then pressing 2 to select the MAGV page.

Two options are available: **AUTO (automatic)** and **MAN (manual)**. These may be toggled by pressing any number key on the ICP or positioning the DCS Switch right to SEQ.

In AUTO, magnetic variation is set based on values stored in the navigation system for the aircraft location. In MAN, a new value may be entered manually by highlighting the field and entering the desired value.

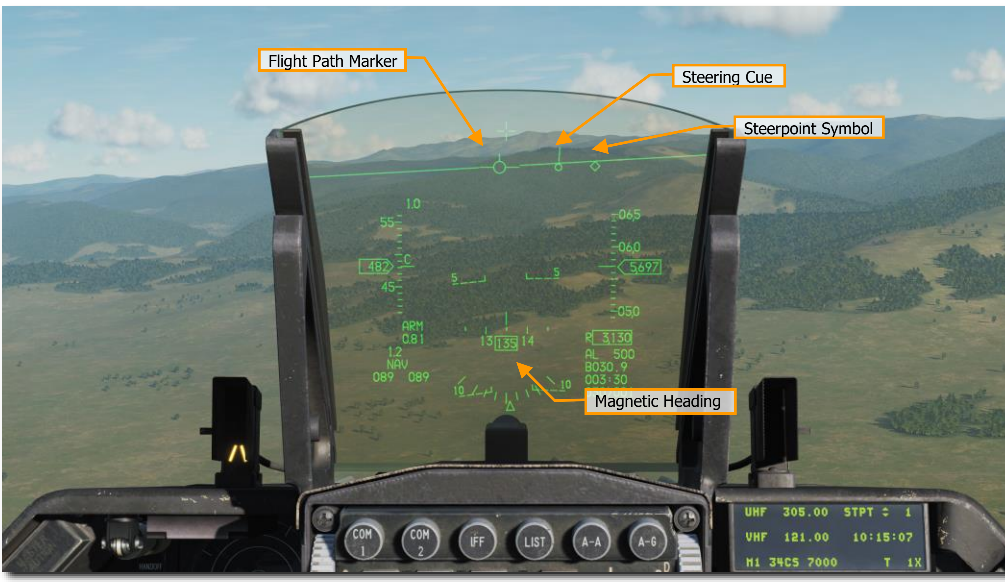
STEERPOINT NAVIGATION

This section's revision is currently a work-in-progress.

HUD Indication

You can view your current heading on the top or bottom of the HUD, depending on the selected master mode. The heading scale shows your current magnetic heading indicated by the central caret.

The Steering Cue shows the heading to your selected steerpoint. If you turn the aircraft to align the Flight Path Marker with the Steering Cue, you will be flying to your steerpoint.

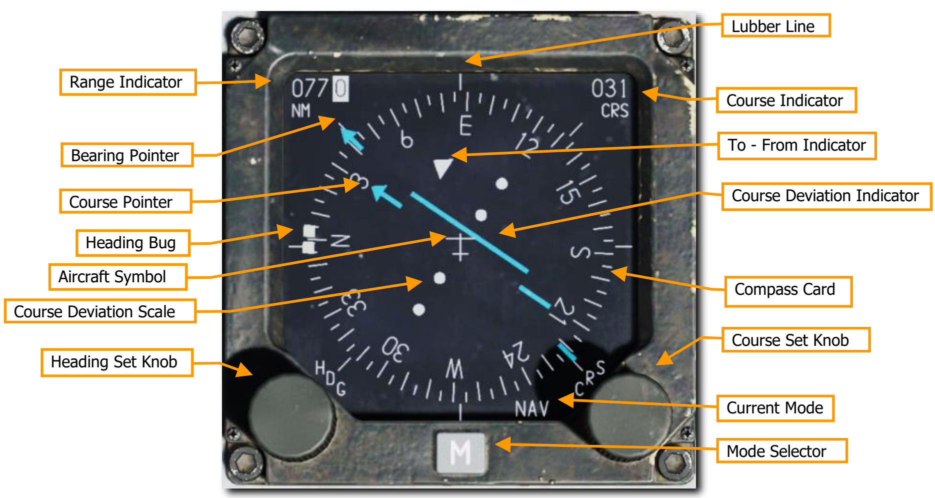


Horizontal Situation Display (HSD) Indication

When there is an active steerpoint, it will be displayed on the HSD as a solid circle. Other steerpoints will be displayed as empty circles with lines connecting them all to show the route. The ownship marker shows your aircraft's current position.

Horizontal Situation Indicator (HSI) Indication

The HSI is your primary gauge to assist in navigation to steerpoints, TACAN beacons, and radio beacons. While you will likely be using HUD symbology for most of your navigation purposes, a firm understanding of the HSI is necessary for access to additional navigation data that is not present on the HUD or DED displays, and in case of battle damage.



Compass Card. Arrayed around the periphery of the HSI, this is a compass that rotates such that the top of the compass indicates the aircraft's magnetic heading.

Aircraft Symbol. In the center of the gauge is the aircraft symbol that always remains static. All HSI displays reference this symbol.

Lubber Line. This is a fixed line that runs from the aircraft symbol to the top of the gauge. This line represents current aircraft heading in relation to the compass card.

Range Indicator. Indicating range in nautical miles, this three-place drum indicator provides slant distance from your aircraft to the selected steerpoint or TACAN station.

Bearing Pointer. This arrow-shaped indicator moves around the outside of the compass card and points to the selected steerpoint or TACAN station. Located 180° from the Bearing Pointer head is the tail that represents the reciprocal bearing.

Heading Set Knob. Located in the lower left portion of the gauge, when rotated, this knob allows you to set the position of the Heading Marker on the compass card.

Heading Bug. Shown as two thick lines on the outside of the compass card, this marker can be moved around the compass card using the Heading Set Knob. After being set, this marker rotates with the Compass Card to provide a heading to the selected magnetic bearing.

Course Set Knob. Positioned in the lower right corner of the gauge, this knob, when rotated, allows you to set the course numeric in the Course Selector Window and move the course pointer around the compass card.

Course Indicator. This window displays the course set using the Course Set Knob numerically in degrees.

Course Pointer. Set by the Course Set Knob, these two lines represent the set course and reciprocal course on the compass card.

Course Deviation Indicator. This line that runs through the center area of the gauge provides an indication of how accurately you are flying on the set course line. When the line runs through the aircraft symbol in the center of the gauge, you are on course. If it is to either side, you need to correct your heading to place the aircraft back on the course line.

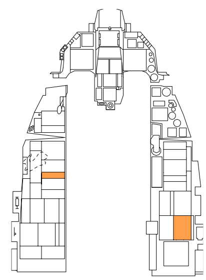
To-From Indicator. These two triangles along the intended course line indicate the course the aircraft will fly to or away from the selected TACAN station or steerpoint.

TACAN NAVIGATION

The Tactical Air Navigation (TACAN) system is a world-wide array of omni-directional beacons with unique frequency codes used primarily by military aircraft. Civilian aircraft use a similar system called VOR's (VHF omni-direction Beacon) on a different frequency range. Many VOR stations are collocated with a TACAN. These stations broadcast both signals so they can be used by military and/or civilian aircraft. These stations are known as "VORTACS".

TACAN beacons can not only be set on the ground, but they can also be attached to aircraft and even ships (aircraft carriers). TACAN serves as a useful means to quickly navigate to a defined location.

The TACAN is part of the MIDS terminal and must be activated by rotating the MIDS LVT knob on the Avionics Power Panel to the ON position. TACAN audio tone volume is controlled on the AUDIO 2 panel.



The currently selected TACAN station is always displayed on the bottom right of the CNI DED page. You can see station 1X is selected in this example.

Before navigating using TACAN though, you will want to do the following:

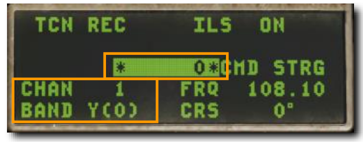
T-ILS page

1. To select a new station, press the T-ILS priority function button on the ICP. That displays the TACAN/ILS page on the DED. Information on the TACAN system is displayed on the left half of the page.

2. On the ICP, toggle the DCS switch down to highlight the CHAN field. Use the ICP keypad to type in the new channel. Press ENTR to accept the changes.

   In this example, channel 25 is entered. The system has identified it as beacon GTB, a TACAN station at Tbilisi.

3. If required, you may change the band by typing 0 (M-SEL) into the CHAN field or scratchpad and pressing ENTR. This toggles the band between X and Y.



4. On the ICP, toggle the DCS right to cycle through the following options: REC, T/R, A/A REC, or A/A TR.

   REC. The TACAN operates in receive mode only and provides bearing, course deviation, and station identification.

   T/R. The TACAN acts in a transceiver mode (send and receive) and provides bearing, range, deviation, and station identification. This will be your most common selection.

   A/A REC. TACAN operates in Air-to-Air mode and can only receive bearing, course deviation and station identification for a TACAN-equipped aircraft.

   A/A T/R. TACAN operates in Air-to-Air transceiver mode and provides bearing, range, deviation, and station identification with a TACAN-equipped aircraft.

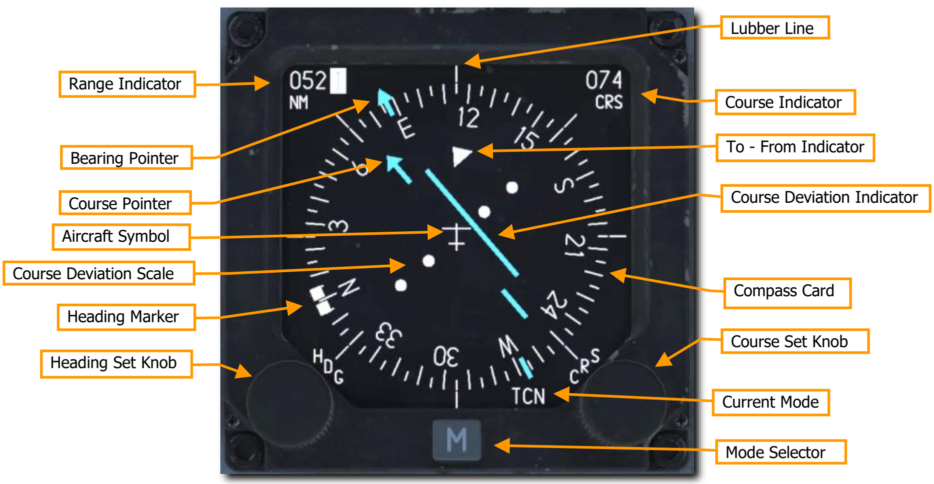
   In most cases, you will keep the TACAN set to the T/R mode.

5. Toggle the DCS left to RTN. This will return you to the CNI page where your new TACAN channel is displayed at the bottom right.

Navigate to Selected TACAN Station

Once a valid TACAN station has been entered on the DED, the station is within operative range, steering information is available on the HSI.

Press the Mode selector until TCN is displayed in the Current Mode field. Operation is identical to steerpoint navigation except the bearing pointer points to the TACAN station instead of the steerpoint.



Note: TACANs are considered reliable for only 130 nm, so the maximum distance between TACAN stations is generally 260 nm.

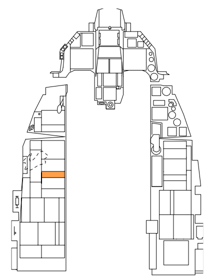
INSTRUMENT LANDING SYSTEM (ILS)

The landing approach using the Instrumented Landing System (ILS) is generally used under Instrument Flight Rules (IFR) conditions due to night or bad weather. When used, the ILS provides vertical and horizontal steering information to help you fly down the correct glide slope and heading to a safe landing. The ILS frequency is set using the Upfront Controls (UFC) and ILS steering is selected on the HSI. Steering information is then presented on the HUD, ADI and HSI instruments. The ILS provides steering for a straight in approach.

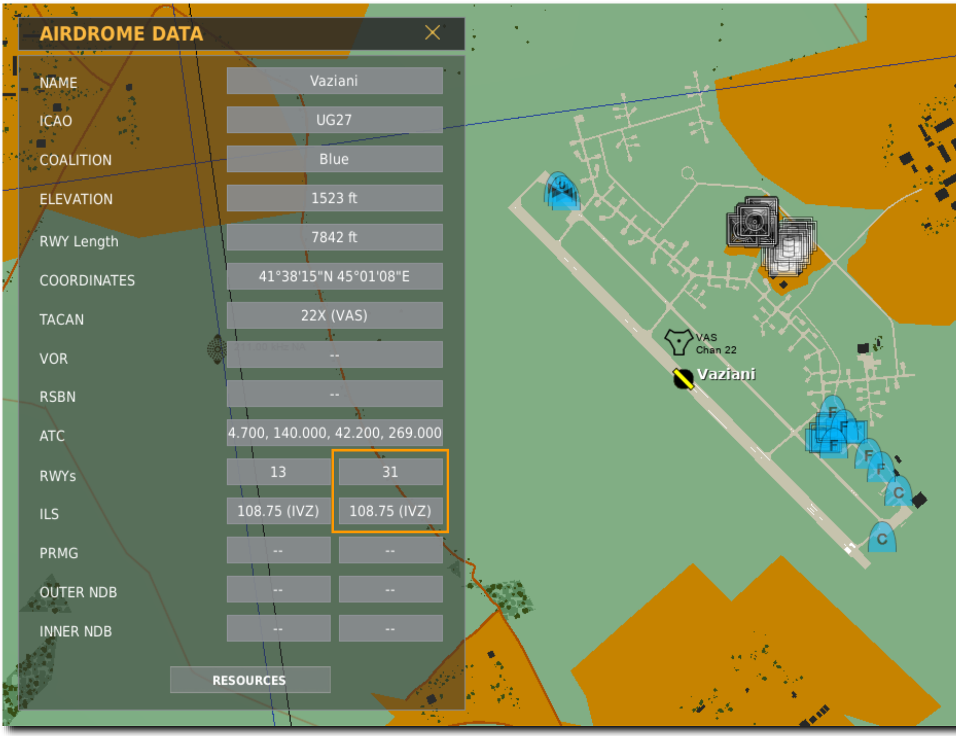
In addition to the instrument indications, the ILS has a localizer audio signal. The ILS provides an audio cue when flying over either the outer or inner marker beacons. You can control the audio levels on the Audio 2 control panel.

Most, but not all runways, allow landings from either direction but will depend on the wind direction. The ILS system should be used for the appropriate landing runway as directed by ATC.

The ILS system must be activated by rotating the ILS knob on the Audio 2 Control Panel out of the OFF position.



The ILS operates between 108.1 and 111.95 MHz. The frequency for any runway equipped for ILS may be seen on the Mission Planner map before mission start or in-game using the F10 map view. Click any airfield and the information will be displayed.



In the next example, we will set the system up for a landing at Vaziani runway 31, using frequency 108.75.

T-ILS page

1. To select a new station, press the T-ILS priority function button on the ICP. That displays the TACAN/ILS page on the DED. Information on the ILS system is displayed on the right half of the page.

2. On the ICP, toggle the DCS switch down to highlight the FREQ field. Use the ICP keypad to type in the new frequency.

   Press ENTR to accept the changes.

3. Then, toggle the DCS switch down to highlight the CRS field. Use the ICP keypad to type in the localizer course.

   Press ENTR to accept the changes.

In this example, we set the system up for a landing at Vaziani runway 31, using frequency 108.75. CMD STRG is highlighted indicating the ILS signal is being received.

Navigate with ILS Glide Slope and Localizer

Once a valid ILS station has been entered, the station is within operative range, and ILS is selected as the activate navigation mode, you will be provided steering information on the ADI and HSI to the selected station (much like TACAN).

Selecting one of the PLS (Precision Landing System) modes on the HSI is required before ILS deviation data (localizer and glide slope) can be displayed on the HSI, HUD, and ADI.

HUD Indications

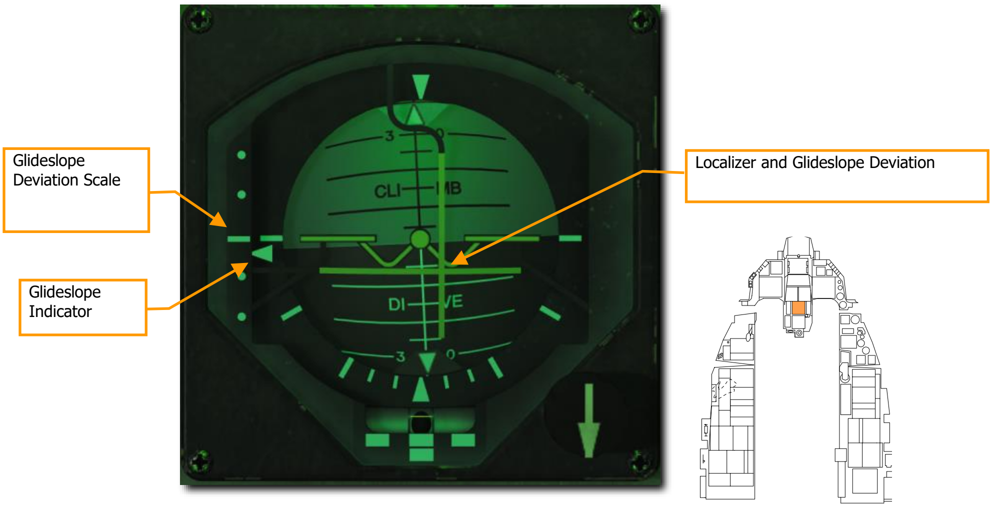
The HUD also shows your position in relation to the glideslope. Command Steering guidance is also provided if CMD STRG is highlighted on the ILS DED page.

Command Steering Symbol. This symbol will be displayed on the HUD to guide you through the approach when valid localizer data is received. A tic mark appears on the symbol when nearing the center of the glideslope to indicate the pitch steering data is valid.

Localizer and Glide Slope Bars. These bars serve the same function as those on the ADI. When the horizontal bar is centered on the **Flight Path Marker (FPM)**, you are flying down the glide slope projected by the ILS vertical steering component. If the bar is above the center of the FPM, it indicates that you are below glide slope and you need to increase altitude. The vertical localizer bar indicates if you are left or right of runway alignment. If the bar is right of FPM center, fly to the right to center it. For a proper glide slope approach, you want the two bars centered and forming a perfect cross on the FPM (aka "center the bars").

ADI Indications

The ADI provides indications that show your position in relation to the glideslope.



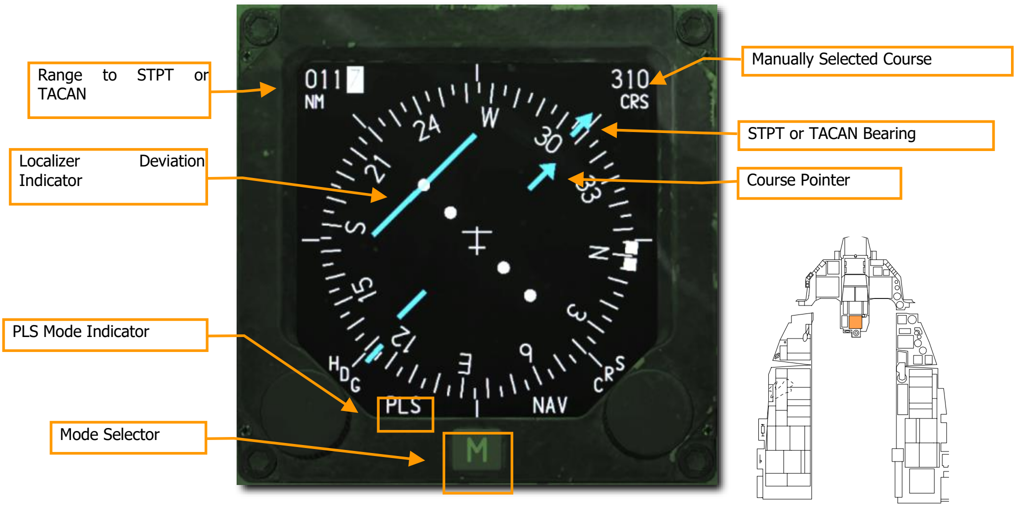
Localizer and Glide Slope Deviation. When the horizontal bar is centered on the ADI, you are flying on glide slope. If the bar is above the center of the ADI, it indicates that you are below glide slope and you need to increase altitude. The vertical localizer bar indicates if you are left or right of runway alignment. If the bar is right of ADI center, fly to the right to center it, then resume localizer course. For a proper glide slope approach, you want the two bars centered and forming a perfect cross on the ADI (aka "center the bars").

Glide Slope Deviation Scale and Glide Slope Indicator. Located along the left side of the ADI, this fixed scale and moving caret indicator displays the position of the glide slope in relation to the aircraft. Basically, the caret is the glide slope. If it is high, you are low. For example: if the caret is on the bottom dot, you are above the glide slope. The common terminology would be "you are 2 dots high". Conversely, if the caret is on the first dot above middle you are below the glide slope. The term would be "you are 1 dot low". It is a general rule that if you go more than 1 dot low or more than 2 dots high you go missed approach and try again.

Glide Slope and Localizer Warning Flags (not visible). When displayed, this indicates that there is a problem in receiving adequate ILS glide slope or localizer signal.

HSI Indications

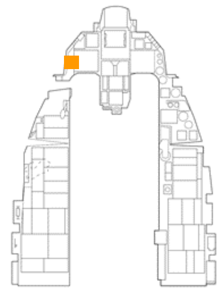
Press the Mode Select button on the HSI until either PLS NAV or PLS TCN mode is displayed.



Operation is identical to steerpoint navigation except the bearing pointer points to the ILS localizer instead of the steerpoint.

AUTOPILOT

The two autopilot switches allow you to set and hold pitch and roll. Any combination of switch settings may be used.



PITCH – ALT HOLD. This maintains the aircraft at a constant altitude. The autopilot will attempt to maintain the current altitude from when the switch is set but may not be able to capture the desired altitude if the aircraft is in a climb or dive. An altitude within the control authority of the autopilot will be commanded. The altitude may be changed by pressing the paddle switch, flying to a new altitude, and releasing the paddle switch.

PITCH – ATT HOLD. This maintains the aircraft's current pitch attitude, nose up or nose down. The autopilot will not engage if the pitch angle exceeds ±60°, however, the switch may remain engaged. The Side Stick Controller (SSC) may be used to change the attitude in this mode.

ROLL – HDG SEL. This causes the aircraft to fly the heading selected on the HSI. Roll commands are limited to a 30° bank or a 20° per second roll rate to capture the desired heading. The autopilot will not engage if the roll angle exceeds ±60°, however, the switch may remain engaged.

ROLL – ATT HOLD. This maintains the aircraft's current roll attitude. The autopilot will not engage if the roll angle exceeds ±60°, however, the switch may remain engaged. The SSC may be used to change the attitude in this mode.

The switches are held in place until they are returned to the OFF position or any of these situations occur:

- air refueling door opened
- alt flaps extended below 400 knots
- A/P FAIL PFL
- AoA exceeds 15°
- DBU on
- landing gear extended
- low-speed warning
- MPO switch in OVERRIDE
- STBY GAIN PFL
- TRIM/AP DISC switch set to DISC

Holding the paddle switch presses disengages the autopilot until the switch is released.

RADIO COMMUNICATIONS

USAF Photo
by TSgt Christopher Boitz

RADIO COMMUNICATIONS

The F-16C is equipped with an AN/ARC-164 UHF radio and an AN/ARC-222 VHF radio. These radio systems primarily function as the pilot's voice communications system with other flight members, allied aircraft, ground forces, and air traffic control. The radios also function as a data exchange system for the Improved Data Modem (IDM) datalink system.

AN/ARC-164 & AN/ARC-222 Radio Antenna Locations

The ARC-164 is a UHF AM radio that can transmit/receive AM radio signals between 225.000 to 399.975 MHz. The UHF radio is also capable of HAVE QUICK frequency hopping as an electronic counter-countermeasures (ECCM) technique and includes an auxiliary GUARD receiver for monitoring 243.000 MHz. Radio transmissions can be selectively routed through either the upper or lower UHF antennas, mounted to the center fuselage, which are shared with the AN/APX-113 Advanced IFF transponder/interrogator system. (See ANT SEL switches for more information.)

The ARC-222 is a VHF AM/FM radio that can receive AM radio signals between 108.000 and 115.975 MHz, and transmit/receive AM radio signals between 116.000 and 151.975 MHz or FM radio signals between 30.000 MHz and 87.975 MHz. The VHF radio antenna is embedded within the leading edge of the vertical tail surface.

Both radios in the F-16C are capable of supporting secure radio encryption and may be pre-programmed with up to 20 unique radio channels for efficient communications, however manually tuning of individual frequencies is also possible.

The primary radio interface for both radio systems is through the Upfront Controls (UFC), with a dedicated DED page for each radio system. However, in the event of a main power failure or a failure within the UFC itself, the UHF can also be controlled through a backup control panel located on the left console.

(The IDM, radio encryption, and frequency hopping functions are not implemented in DCS: F-16C Viper.)

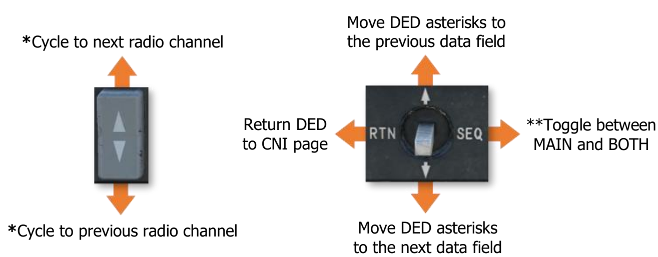
Upfront Controls

The Upfront Controls are available when the C & I knob is set to the UFC position on the IFF control panel. During normal operations, the Upfront Controls are used for communications functions. In the event there is a failure with the Upfront Controls, the C & I knob can be set to the BACK UP position, which allows control of the UHF radio through the use of the UHF Backup control panel.

Note that even when the C & I knob is set to the UFC position, if the aircraft is operating on battery power only, control of the UHF radio will revert to the UHF Backup control panel. This is commonly used to communicate with the appropriate air traffic control (ATC) agencies prior to engine start.

UHF & VHF Pages

The UHF and VHF DED pages are accessed by pressing the COM 1 or COM 2 override buttons (respectively) on the ICP, regardless of the currently displayed DED page. Pressing the same button a second time will return the DED to the previous page. The UHF and VHF pages function identically, with the exception of the DCS SEQ position, which has no function on the VHF page.



* Cycles the Preset Channel Number data field to the next/previous preset radio channel for editing the assigned frequency of that preset; the radio will not be tuned to that preset channel or frequency.
** The DCS SEQ position has no function on the VHF DED page.

1. **Active Channel/Frequency.** Displays the preset radio channel or the manual radio frequency to which the radio is currently tuned.

2. **Preset Channel Number.** Displays the preset radio channel that corresponds with the preset frequency in the data field below. The ICP Increment/Decrement rocker may be used to cycle to a different preset radio channel. The displayed preset channel can also be changed by placing the DED asterisks over the data field and entering the channel number using the ICP keypad and then pressing ENTR.

Note that modifying this data field does not change the preset radio channel to which the radio is tuned.

3. **Preset Channel Frequency.** Displays the frequency that is assigned to the displayed preset radio channel in the data field above. The frequency may be changed by placing the DED asterisks over the data field and entering the channel number using the ICP keypad and then pressing ENTR.

   Note that modifying this data field does not change the radio frequency to which the radio is tuned.

4. **Radio Mode/Power Status.** When the UHF DED page is displayed, this data field displays the current mode of the UHF radio (OFF, MAIN or BOTH). The mode may be cycled between MAIN and BOTH by momentarily placing the "Dobber switch" (DCS) to the SEQ position.

   When the VHF DED page is displayed, this data field displays the power status of the VHF radio (OFF or ON).

5. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

6. **Scratchpad.** This data field is used to tune the radio to a different preset channel or frequency by placing the DED asterisks over the data field and entering the channel number or frequency using the ICP keypad and then pressing ENTR.

   When a valid preset channel number or frequency is accepted into the Scratchpad using the ENTR button, the DED will return to the previous page prior to pressing the COM 1 or COM 2 override button.

7. **Receiver Band.** Displays the bandwidth setting of the radio. May be changed placing the DED asterisks around the data field and pressing any ICP keypad button 1-9 to toggle between narrowband (NB) and wideband (WB).

When the C & I knob is set to the BACK UP position on the IFF control panel, control of the UHF radio will revert to UHF Backup control panel.

The UHF DED page may still be accessed by pressing the COM 1 override button on the ICP; however the page will be displayed in the BACKUP format. The ICP will have no effect on the function of the UHF radio, but the page will indicate the currently tuned UHF frequency.

Radio Communications Management

During a mission, the frequencies for any unit the pilot intends on communicating with must be known, such as wingmen, AWACS, refueling tankers, or ground units. Each radio call will need to be transmitted over the correct radio while tuned to the correct frequency. As such, there may be instances where multiple frequencies must be managed during a mission within a short time period. The frequency preset features of the radios may prove invaluable in juggling the required communications requirements.

Frequencies that are required to successfully perform a mission are typically noted in the mission briefing and should be programmed into the aircraft radios at the start of the mission. Prior to takeoff or while en-route to the mission area or objective, it may be wise to verify the frequencies assigned to each preset radio channel to ensure they are appropriately set within the cockpit.

Editing a Preset UHF/VHF Frequency using the DED

The frequency assigned to a preset radio channel may be edited on the applicable UHF or VHF page.

1. Press **COM 1** to access the UHF DED page or press **COM 2** to access the VHF DED page.
2. Use the **Increment/Decrement** rocker to cycle to the desired preset to be edited.

   or

2. Use the **DCS Up/Down** positions to place the DED Asterisks over the Preset Channel Number, use the ICP **keypad** to type the desired preset channel to be edited, and press **ENTR**.
3. Use the **DCS Up/Down** positions to place the DED Asterisks over the Preset Channel Frequency.
4. Use the ICP **keypad** to enter the new frequency for the displayed Present Channel, in a continuous string of 5 numbers.
5. Press **ENTR** to accept the new frequency or press **RCL** twice to reject it.

Tuning a Preset UHF/VHF Frequency using the DED

A preset radio channel may be tuned by entering a 1- or 2-digit number into the Scratchpad data field on the applicable UHF or VHF page.

1. Press **COM 1** to access the UHF DED page or press **COM 2** to access the VHF DED page.
2. Use the ICP **keypad** to enter a 1- or 2-digit number between 1-20, corresponding with the desired preset channel to be tuned.
3. Press **ENTR** to accept the new frequency or press **RCL** twice to reject it.

If the entered number is valid (1-20), the radio will be tuned to the corresponding preset channel, the Active Channel/Frequency data field will update accordingly, and the DED will return to the previous page prior to pressing the COM 1 or COM 2 override button.

Alternatively, if the applicable radio is already tuned to any preset channel, the radio may be cycled incrementally through the 20 preset channels on the CNI page.

1. Use the **DCS Up/Down** positions to place the DED Asterisks over the Active Channel/Frequency.
2. Use the **Increment/Decrement** rocker to cycle to the desired preset channel.

Tuning a Manual UHF/VHF Frequency using the DED

A manual frequency may be tuned by entering a 5-digit number into the Scratchpad data field on the applicable UHF or VHF page.

1. Press **COM 1** to access the UHF DED page or press **COM 2** to access the VHF DED page.
2. Use the ICP **keypad** to enter a 5-digit number corresponding with the desired frequency to be tuned.
3. Press **ENTR** to accept the new frequency or press **RCL** twice to reject it.

If the entered number is within the radio's range of usable frequencies, the radio will be tuned to the corresponding frequency, the Active Channel/Frequency data field will update accordingly, and the DED will return to the previous page prior to pressing the COM 1 or COM 2 override button.

UHF Backup Control Panel

Communication functions are normally controlled through the Upfront Controls, however a backup radio control panel is also available. The UHF Backup control panel can be used on battery power, and as such is the only radio that can be used prior to engine start.

1. **Preset Channel Card & Access Door.** The top of the access door displays the frequencies that correspond with each preset selection. Lifting the access door allows the UHF radio presets and anti-jam functions to be programmed. (N/I)
2. **TEST DISPLAY Button.** Illuminates all display segments within the Frequency Status/Display and CHAN Display windows for a functional test.
3. **CHAN Display.** If Mode knob is set to PRESET, displays the currently selected frequency preset. If Mode knob is set to MNL, the display will be blank.
4. **CHAN Knob.** Selects the desired frequency preset.
5. **Frequency Status/Display.** Displays the manual frequency that has been selected using the Manual Frequency Knobs.
6. **STATUS Button.** When this button is depressed, the frequency that the UHF radio is tuned to will be momentarily shown in the Frequency Status/Display. This allows the pilot to verify the frequency of the currently selected preset when the Mode Knob is set to PRESET.
7. **A-3-2 Knob.** Selects anti-jamming or single-frequency functionality of the UHF radio.
   - **A.** Selects AJ (Anti-Jam) function of the radio. (N/I)
   - **3.** When Mode knob is set to MNL, sets the 1st digit of the tuned frequency to (i.e., 325.000 MHz).
   - **2.** When Mode knob is set to MNL, sets the 1st digit of the tuned frequency to (i.e., 225.000 MHz).
8. **Manual Frequency Knobs.** When Mode knob is set to MNL, permits manual tuning of the frequency in 0.025 MHz increments from 225.000 MHz to 399.975 MHz.
9. **Function Knob.** Selects the functional mode of operation of the UHF radio.
   - **OFF.** Power is removed from UHF Backup control panel. If the UHF radio is powered by the battery bus or the C & I knob on the IFF control panel is set to BACK UP, this knob position also removes power from the UHF radio itself.
   - **MAIN.** If COMM 1 power/volume knob on the AUDIO 1 Control Panel is not set to OFF, the UHF radio is operating on the selected preset/frequency. UHF GUARD auxiliary receiver is disabled.

- **BOTH.** If COMM 1 power/volume knob on the AUDIO 1 Control Panel is not set to OFF, the UHF radio is operating on the selected preset/frequency. UHF GUARD auxiliary receiver is enabled to monitor 243.0 MHz.
- **ADF.** No function.

10. **Mode Knob.** Selects the tuning mode of the UHF radio.
    - **MNL.** The UHF radio is tuned to the frequency displayed in the Frequency Status/Display window. Frequency is tuned using the Manual Frequency knobs.
    - **PRESET.** The UHF radio is tuned to the frequency that corresponds with the preset displayed in the CHAN Display. Preset frequency is selected using the CHAN knob.
    - **GRD.** The UHF radio is tuned to 243.0 MHz and the dedicated GUARD receiver is disabled.
11. **TONE Button.** Interrupts radio reception and transmits a tone on the current frequency. (N/I)
12. **VOL Knob.** No Function.
13. **SQUELCH Switch.** Enables/Disables the squelch function.

Radio Management Using the UHF Backup Control Panel

The UHF Backup control panel is not typically used during normal operations after the engine is started and the aircraft is operating on generator power. However, during final checks prior to entering the combat area, it may be wise to configure this panel to the preset radio channel that would be desired if there was some sort of main power loss (due to malfunction or battle damage).

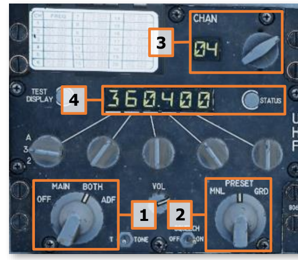
For example, it may be wise to set the radio to the radio channel that would allow you to communicate with your wingmen or the AWACS aircraft (if present). If the aircraft were to revert to battery power after taking damage from hostile fire, the UHF radio control would revert to the UHF backup control panel. When this occurs, the UHF radio would immediately be tuned to the required frequency that would be necessary to request assistance in maintaining situational awareness, direct your wingman to provide support, receive a bearing to the nearest tanker, or receive a bearing to your home airfield.

Additionally, two frequencies can be set into the UHF backup control panel for rapidly switching between two radio nets: one using the CHAN knob and the other using the Manual Frequency knobs. Once both frequencies are selected, the UHF radio can be rapidly switched between them by simply rotating the Mode knob between PRESET and MNL.

Alternatively, although it is intended to be used as a backup in the event of power loss, the UHF Backup control panel can serve as an auxiliary “Scratchpad” of sorts when the Upfront Controls are managing the UHF radio. The Manual Frequency knobs can be used to “record” a frequency in the Frequency Status/Display for entry into the UHF DED page at a later point in the mission.

Tuning a Preset UHF Frequency using the UHF Backup Control Panel

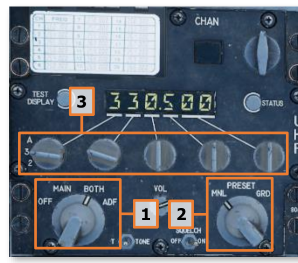
A preset radio channel may be tuned by setting the UHF Backup control panel to PRESET mode and cycling to the desired channel.



1. Ensure the **Function** knob is set to **MAIN** or **BOTH**.
2. Set the **Mode** knob to **PRESET**.
3. Rotate the **CHAN** knob until the desired preset channel is displayed within the CHAN Display indicator.
4. The frequency assigned to the currently tuned preset channel may be verified by pressing the **STATUS** button and observing the FREQUENCY STATUS/DISPLAY indicator.

Tuning a Manual UHF Frequency using the UHF Backup Control Panel

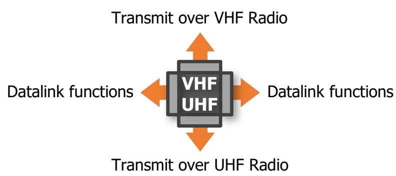
A frequency may be manually tuned by setting the UHF Backup control panel to MNL mode and setting the desired frequency.

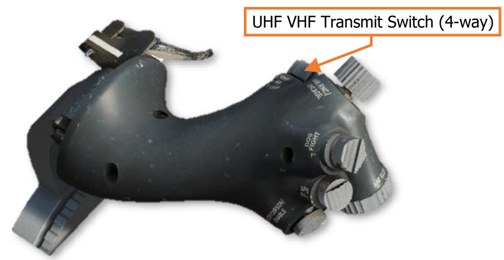


1. Ensure the **Function** knob is set to **MAIN** or **BOTH**.
2. Set the **Mode** knob to **MNL**.
3. Rotate the **A-3-2** and **Manual Frequency** knobs until the desired frequency is displayed in the FREQUENCY STATUS/DISPLAY indicator.

HANDS-ON CONTROLS

The UHF VHF Transmit Switch on the Throttle initiates voice communications over the UHF and VHF radios. The UHF VHF Transmit switch is 4-way switch that continuously transmits over either voice radio when held to the Forward (VHF transmit) or Aft (UHF transmit) positions, in a Push-To-Talk (PTT) manner.





In DCS World, when sending commands or requests to other units, either switch position must be utilized to open the **Call Radio menu** for the correct radio. When communicating with the ground crew, you may use the intercom system to issue requests using the **Communication menu** command.

Keyboard Commands:

- Transmit switch – VHF (call radio menu) **[RCtrl + \]**
- Transmit switch – UHF (call radio menu) **[RAlt + \]**
- Communication menu **[\]**

For example, if your wingmen are tuned to a VHF frequency, you must also be tuned to the same frequency on your VHF radio and open the VHF call radio menu to issue them commands. This is the more realistic mode and requires you to know the correct frequencies for each unit you intend on communicating with during your mission, such as wingmen, AWACS, refueling tankers, or ground units. Each radio call will need to be transmitted over the correct radio while tuned to the correct frequency.

However, for more casual players that do not desire as in-depth of a radio management simulation, there is an option available under the DCS Options GAMEPLAY Tab labeled “Easy Communication”.

Easy Communication Option

The radio communications menu is accessed by a press of the backslash key **[\]** (for US keyboards; other language keyboards may vary). Upon doing so, the list of radio command recipients is displayed along with the function key (**[F1]** through **[F10]**) required to view its sub-menu command list.

When the radio menu is displayed, recipients are color-coded as follows:

- Recipients on which at least one of the player’s radios is tuned to are colored white.
- Recipients on which at least one of the player’s radios can be tuned to, but are not currently on the correct frequency, are colored gray.
- Recipients that cannot be contacted due to range or terrain masking / earth curvature are colored black.

Each will also have their frequency listed. When you select a recipient, the appropriate radio will automatically be tuned to communicate with the selected recipient.

TACTICAL SYSTEMS

USAF Photo
by SSgt Vernon Young

MASTER MODES

The F-16C's avionics are primarily controlled through the use of pilot-selectable master modes. There are seven master modes in total, with multiple sub-modes for different methods of targeting, designation, and weapons employment.

When the pilot switches from one master mode to another, avionics settings and MFD states are retained within the previous master mode. This allows the pilot to configure specific avionics settings for each master mode prior to the mission for efficient cockpit management when in the mission area; or to return to a previous task if forced to switch to a different master mode without warning. This can be especially useful if engaged by hostile fighters during a strike mission, in which case the pilot would need to rapidly re-configure the FCR, SMS weapon profile, and MFDs for aerial combat. In the F-16C, this can be accomplished with a single push of a button, allowing the pilot to respond immediately to changes in the tactical situation as they occur.

The three primary master modes are Navigation mode, Air-to-Air Missile mode, and Air-to-Ground mode, which are accessed using the A-A and A-G master mode buttons on the Integrated Control Panel (ICP). Two secondary master modes are Dogfight mode and Missile Override mode, which can be accessed using the DOG FIGHT switch on the throttle grip.

Two additional modes are Selective Jettison mode and Emergency Jettison mode. The former is entered by accessing the SMS Selective Jettison (S-J) page. The latter is entered when the Emergency Jettison button on the Left Auxiliary Console is pressed.

Navigation (NAV) Mode

Navigation mode is the default master mode the aircraft will be set to when the avionics are initialized. NAV mode is used for takeoff, landing, navigation, and nav position updates. "NAV" is displayed in the HUD Master Mode Status.

When Navigation mode is entered, the following changes will take effect:

- The FCR will default to CRM mode but can be changed to any air-to-air or air-to-ground mode if desired.
- The HUD will display navigation-related symbology only.
- "NAV" will be displayed in the HUD Master Mode Status.
- MFD formats and format selections will be displayed as last set for Navigation mode.

Additionally, TGP and HTS pods can be used while in NAV mode (to include firing the laser rangefinder/designator or designating threat radars on the HAD MFD format), but weapons employment will not be possible.

The default MFD formats for each MFD when the aircraft is set to Navigation mode are shown to the right. However, these may be changed at any time during the mission and will be retained during master mode switchovers.

Air-to-Air Missile (AAM) Mode

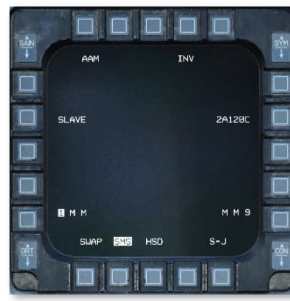
Air-to-Air Missile mode is used for aerial combat and employing air-to-air guided missiles and the 20mm rotary cannon against enemy aircraft. AAM mode is entered by pressing the A-A master mode button on the ICP if the master mode is set to either NAV or A-G mode. Pressing the A-A master mode button when already in AAM will set the master mode to NAV.

When Air-to-Air Missile mode is entered, the following changes will take effect:

- The FCR will default to CRM mode but can be changed to any air-to-air mode if desired.
- The HUD will display missile-related symbology, based on the selected missile type.
- "MRM", "SRM", or "HOB" will be displayed in the HUD Master Mode Status, depending on which missile type was last selected in Missile Override mode, along with the missile quantity of that type. If no air-to-air missiles are loaded, "AAM" is displayed in the HUD Master Mode Status.
- If the Master Arm switch is set to ARM, AIM-9 seekers on any air-to-air missile stations will be cooled.
- MFD formats and format selections will be displayed as last set for Air-to-Air Missile mode.

Note, it is possible to set a specific missile type for each air-to-air master mode (AAM, MSL and DGFT), so that by simply switching between these modes, a different missile type will automatically be selected.

The default MFD formats for each MFD when the aircraft is set to Air-to-Air Missile mode are shown to the right. However, these may be changed at any time during the mission and will be retained during master mode switchovers.



Air-to-Ground (A-G) Mode

Air-to-Ground mode is used for delivering munitions against ground targets. A-G mode is entered by pressing the A-G master mode button on the ICP if the master mode is set to either NAV or A-A mode. Pressing the A-G master mode button when already in A-G will set the master mode to NAV.

When attacking ground targets, the F-16C can utilize pre-planned weapon employment sub-modes against targets at known locations or using visual weapon employment sub-modes against targets that are visually identified by the pilot. Each type of sub-mode differs in how the target is designated and what type of weapon employment symbology cues are provided to the pilot.

Pre-planned weapon delivery sub-modes include:

- CCRP
- LADD
- E-O PRE
- E-O BORE
- HARM
- HTS

Visual weapon delivery sub-modes include:

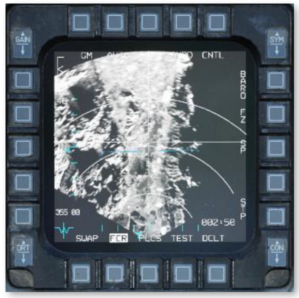
- CCIP
- DTOS
- E-O VIS
- STRF

When Air-to-Ground mode is entered, the following changes will take effect:

- The FCR will default to GM mode if the weapon delivery sub-mode is CCRP, DTOS, LADD, PRE, VIS, BORE, HARM, or HTS, or AGR mode if the weapon delivery sub-mode is CCIP or STRF, but can be changed to any air-to-ground mode if desired.
- The HUD will display weapon delivery symbology, based on the selected delivery sub-mode and SMS weapon profile.

- The weapon delivery sub-mode is displayed in the HUD Master Mode Status.
- MFD formats and format selections will be displayed as last set for Air-to-Ground mode.

The default MFD formats for each MFD when the aircraft is set to Air-to-Ground mode are shown to the right. However, these may be changed at any time during the mission and will be retained during master mode switchovers.



Missile Override (MSL) Mode

Missile Override mode is used to rapidly configure the aircraft for aerial combat without taking hands off the controls. Missile Override mode is selected by moving the DOG FIGHT switch to the inboard position on the throttle, and will take precedence over the previous master mode, with the exception of Emergency Jettison. Returning the DOG FIGHT switch to the center position will return the aircraft systems to the previous master mode prior to entering Missile Override.

When Missile Override mode is entered, the following changes will take effect:

- The FCR will default to CRM mode but can be changed to any air-to-air mode if desired.
- The HUD will display missile-related symbology, based on the selected missile type.
- "MRM", "SRM", or "HOB" will be displayed in the HUD Master Mode Status, depending on which missile type was last selected in Missile Override mode, along with the missile quantity of that type.
- If the Master Arm switch is set to ARM, AIM-9 seekers on any air-to-air missile stations will be cooled.
- MFD formats and format selections will be displayed as last set for Missile Override mode.

Note, it is possible to set a specific missile type for each air-to-air master mode (AAM, MSL and DGFT), so that by simply switching between these modes, a different missile type will automatically be selected.

The default MFD formats for each MFD when the aircraft is set to Missile Override mode are shown to the right. However, these may be changed at any time during the mission and will be retained during master mode switchovers.

Dogfight (DGFT) Mode

Dogfight mode is used to rapidly configure the aircraft for close-range aerial combat without taking hands off the controls. Dogfight mode is selected by moving the DOG FIGHT switch to the outboard position on the throttle, and will take precedence over the previous master mode, with the exception of Emergency Jettison. Returning the DOG FIGHT switch to the center position will return the aircraft systems to the previous master mode prior to entering Dogfight.

When Dogfight mode is entered, the following changes will take effect:

- The FCR will default to ACM mode but can be changed to any air-to-air mode if desired.
- The M61 20mm rotary cannon will be enabled in EEGS sub-mode.
- The HUD will be decluttered and optimized for close-range aerial combat maneuvers. EEGS-related symbology will be displayed.
- "MRM", "SRM", or "HOB" will be displayed in the HUD Master Mode Status, depending on which missile type was last selected in Dogfight mode, along with the missile quantity of that type.
- If the Master Arm switch is set to ARM, AIM-9 seekers on any air-to-air missile stations will be cooled.
- MFD formats and format selections will be displayed as last set for Dogfight mode.

Note, it is possible to set a specific missile type for each air-to-air master mode (AAM, MSL and DGFT), so that by simply switching between these modes, a different missile type will automatically be selected.

The default MFD formats for each MFD when the aircraft is set to Dogfight mode are shown to the right. However, these may be changed at any time during the mission and will be retained during master mode switchovers.

Selective Jettison (JETT) Mode

Selective Jettison mode is used to jettison individual weapons and/or weapon stations from the underwing pylons without arming the weapons themselves. Selective Jettison mode is entered by pressing OSB 11 on the SMS MFD format. Pressing OSB 11 when already in S-J mode will set the master mode back to the previous selection.

The default MFD formats for each MFD when the aircraft is set to Selective Jettison mode are shown to the right. However, these may be changed at any time during the mission and will be retained during master mode switchovers.

Emergency Jettison (JETT) Mode

Emergency Jettison mode is used to jettison all weapons (except for air-to-air missiles) and fuel tanks from underwing stations 3 through 7. Emergency Jettison mode is entered by pressing and holding the Emergency Jettison button on the Left Auxiliary Console, which will override all other master modes. Releasing the Emergency Jettison button will set the master mode bac k to the previous selection.

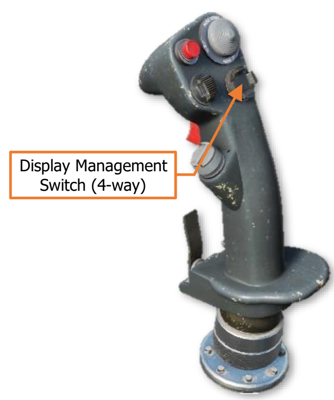
The default MFD formats for each MFD when the aircraft is set to Emergency Jettison mode are shown to the right.

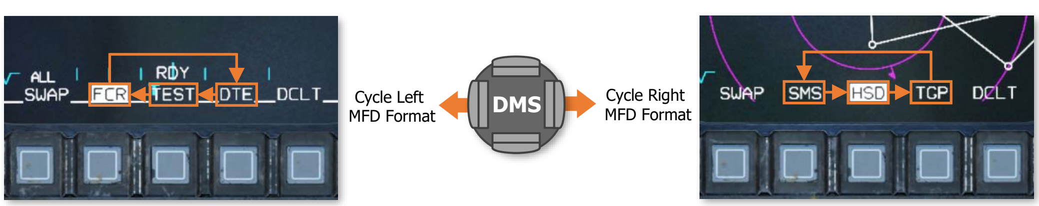
Cycling MFD Formats using Side Stick Controller

Each MFD is assigned three formats for each master mode. These formats can be selected for display by pressing the corresponding Format Select OSB below the format label. The assigned format for each Format Select button can be re-assigned at any time during the mission. (See Multi-Function Displays for more information.)

The displayed format can also be cycled using the Display Management Switch (DMS) on the Side Stick Controller (SSC), allowing the pilot to seamlessly select a different MFD format while maintaining hands on the flight controls. This can be especially useful during high-G maneuvers that might preclude reaching out to an MFD to directly press the OSB.

When the DMS is pressed left or right, the corresponding MFD will cycle to the next assigned format in an outwards fashion. If one of the Format Select buttons have been assigned to the BLANK MFD format, that button will be skipped in the sequence, and will simply toggle between the two remaining formats. If two of the Format Select buttons have been assigned to the BLANK MFD format, DMS will have no effect on that MFD.



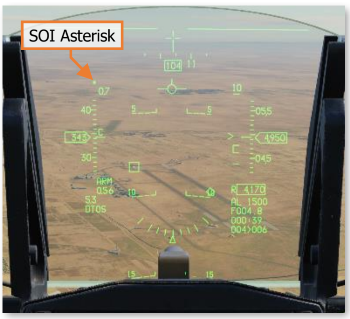


MFD Format cycle logic using Display Management Switch

SENSOR-OF-INTEREST (SOI)

The Sensor-Of-Interest is the sensor or display for which the hands-on controls are currently active. The controls on the Side Stick Controller (SSC) and throttle grip, such as the Target Management Switch (TMS), Expand/FOV button, or RDR CURSOR/ENABLE switch, will only affect the sensor or display that is currently assigned as SOI.

The SOI can be identified by a white box around the MFD screen or an asterisk in the top left of the HUD. Additionally, when an MFD is displaying a format that can be assigned as SOI, but is currently not the SOI, a "NOT SOI" advisory message will be displayed in the upper portion of the MFD.



The SOI is assigned to the HUD or either MFD by the Display Management Switch (DMS) on the SSC. The MFD formats that can be assigned as SOI are FCR, TGP, WPN, HSD and HAD. When re-assigning SOI from the HUD, if either MFD format can be assigned as SOI, the priority MFD format for the current mode will be set as SOI.

SOI assignment cycle logic using Display Management Switch

VISUAL INITIAL POINT (VIP) & VISUAL REFERENCE POINT (VRP)

The F-16C has the capability of displaying visual indicators to assist in making attacks from locations relative to the target. These indicators can assist the pilot in knowing where the target is relative to a prominent visual reference, where to commence the attack, and when to begin a pop-up attack. These visual indicators are programmed using the Data Entry Display (DED) and are displayed on the HUD in pre-planned air-to-ground sub-modes (e.g., CCRP).

A **visual initial point** (VIP) is used when the location of the target is not known precisely but is known relative to a visually prominent object. For example, the target may be known to be five miles northwest of an identifiable bridge. A **visual reference point** (VRP) is used when the pilot desires a visual indication of a location to begin an attack (or otherwise reference relative to a known target position). A **pull-up point** (PUP) is a location where a pop-up attack commences.

Note that a single steerpoint cannot have both a VIP and a VRP active.

Using Visual Initial Points

When a visual initial point is specified for a steerpoint, the steerpoint is treated as the initial point, and a target indication is automatically shown relative to that steerpoint on the HUD. Navigation steering is provided to the initial point, the idea being that the pilot flies to and visually acquires the initial point, and then performs an INS update using an overfly or HUD designation. (At this time, INS updates are not implemented.) Once the initial point location has been updated, the target designation should be directly on top of the actual target position.

In the screenshot above, the location of the target (a factory) is known relative to a radio tower, marked as steerpoint 1 and depicted as a diamond. The target is shown as a TD box.

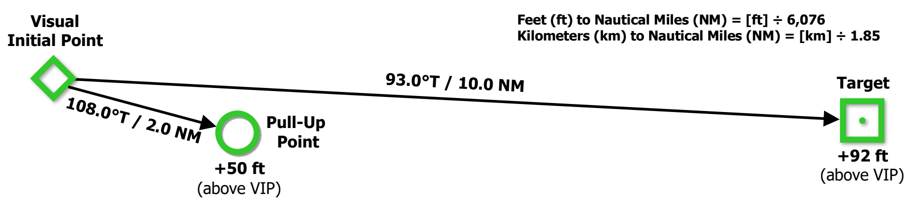
To define a VIP, first ensure that you are in air-to-ground CCRP mode, then press LIST on the ICP, then "3", to show the VIP page. The VIP-TO-TGT page is then shown. Ensure the "VIP-TO-TGT" text is surrounded by the cursor, and press "0" (M-SEL) to activate VIP-TO-TGT. (It will be displayed in reverse video when active.)

Dobber down to the VIP line and select the steerpoint located at the visual initial point. Dobber down to each successive line and enter the bearing from the VIP to the target, then the range from the VIP to the target, and finally the elevation difference from the VIP to the target. (To enter a negative number, first press "0" twice.)

On the HUD, a TD box will appear at the target location when in air-to-ground mode and when the VIP steerpoint is active. Navigation steering will be to the VIP, and the ASL will reference the target.

VIP DED Page

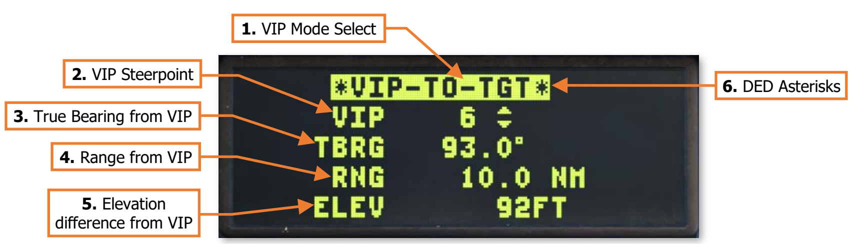
The Visual Initial Point DED page is accessed by pressing **3** on the ICP keypad when the LIST DED page is displayed on the DED. Visual Initial Point (VIP) is a sighting option used for low-altitude CCRP or LADD air-to-ground sub-modes in which a target location is referenced from an easily identifiable landmark that the pilot can visually see when approaching along the planned attack profile, and update the navigation system accuracy if necessary.

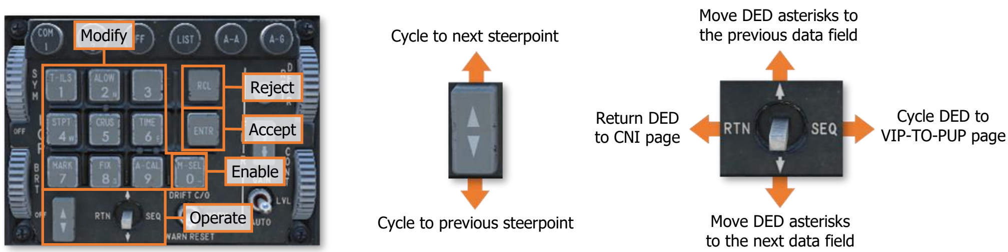


Visual Initial Point (VIP) Sighting Method

In the example above, attack geometry has been pre-planned as shown and is entered into the VIP DED page. When using VIP, a steerpoint is placed at the Visual Initial Point location, and the target location is entered based on its true bearing (as opposed to magnetic), range, and elevation relative to the VIP.

NOTE: Only one steerpoint can be set as a VIP at any time. Additionally, a steerpoint cannot use VIP and VRP sighting options at the same time. If a steerpoint is set as the VIP steerpoint on the VIP DED page *and* as the TGT steerpoint on the VRP DED page, enabling the VIP Mode Select will disable the VRP Mode Select.





1. **VIP Mode Select.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled and the selected steerpoint is also the VIP steerpoint, the Target Designator box will be displayed in the HUD at the location set on this page.

2. **VIP Steerpoint.** Displays the steerpoint to be used as the Visual Initial Point (VIP). The ICP Increment/Decrement rocker may be used to cycle the VIP to a different steerpoint. The VIP steerpoint can also be changed by placing the DED asterisks over the data field and entering the steerpoint number using the ICP keypad and then pressing ENTR.

3. **True Bearing from VIP.** Displays the relative bearing (in degrees True) from the VIP where the target is located. May be modified using the ICP keypad.

4. **Range from VIP.** Displays the range (in nautical miles) from the VIP where the target is located. May be modified using the ICP keypad.

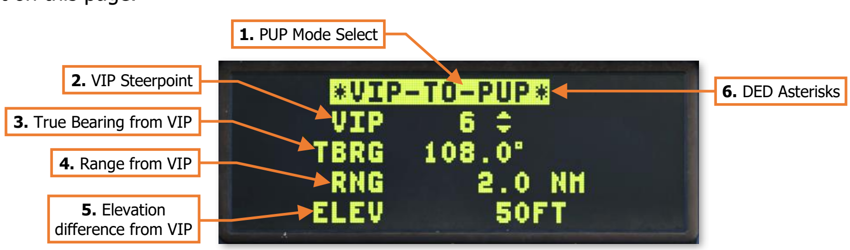
5. **Elevation difference from VIP.** Displays the difference in elevation (in feet) of the target from the VIP. Negative values indicate the target is lower in elevation than the VIP. May be modified using the ICP keypad.

   NOTE: For negative values, the 0/M-SEL button should be pressed once to enter a leading zero, and then once more to enter a negtive (–) sign; followed by the desired numerical value.

6. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

If performing a low-level "pop-up" style weapon delivery method, a Pull-Up Point may also be entered and enabled for display within the HUD. The PUP may be enabled for display independently of the VIP, using the 0/M-SEL button when on the VIP-TO-PUP page. However, if the VIP Steerpoint is changed on the VIP-TO-PUP page, it will also be changed on the VIP-TO-TGT page.

When enabled and the selected steerpoint is also the VIP steerpoint, a circle will be displayed in the HUD at the location set on this page.



All values entered on the VIP-TO-PUP page are entered in the same manner as on the VIP-TO-TGT page. To return to the VIP-TO-TGT page, momentarily position the DCS ("Dobber" switch) to the SEQ position.

Using Visual Reference Points

A visual reference point (VRP) is used when a target location is known, and the pilot wishes to mark a reference point relative to the target. This could be a location to commence the attack from, the location of friendly forces, etc. With a VRP, the steerpoint is the target point, and the reference point is defined relative to the target steerpoint. (A VIP works the opposite way; the steerpoint is the reference point, and the target is defined relative to the reference point).

In the screenshot above, steerpoint 2 is over the target (TD box), and a visual reference point (diamond) is defined relative to it.

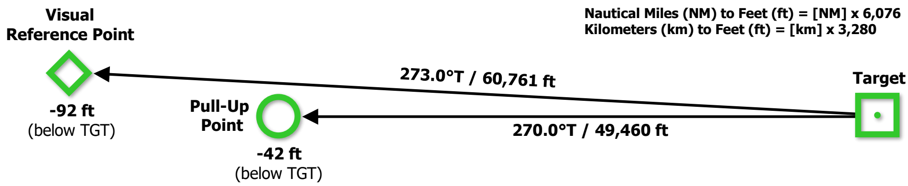
To define a VRP, first ensure that you are in air-to-ground CCRP mode, then press LIST on the ICP, then "9", to show the VRP page. The TGT-TO-VRP page is then shown. Ensure the "TGT-TO-VRP" text is surrounded by the cursor, and press "0" (M-SEL) to activate TGT-TO-VRP. (It will be displayed in reverse video when active.)

Dobber down to the TGT line and select the target steerpoint. Dobber down to each successive line and enter the bearing from the target to the VRP, then the range from the target to the VRP, and finally the elevation difference from the target to the VRP. (To enter a negative number, first press "0" twice.)

On the HUD, a diamond will appear over the VRP when in air-to-ground mode with the target steerpoint selected. Both navigation and weapon release steering will be to the target, as normal.

VRP DED Page

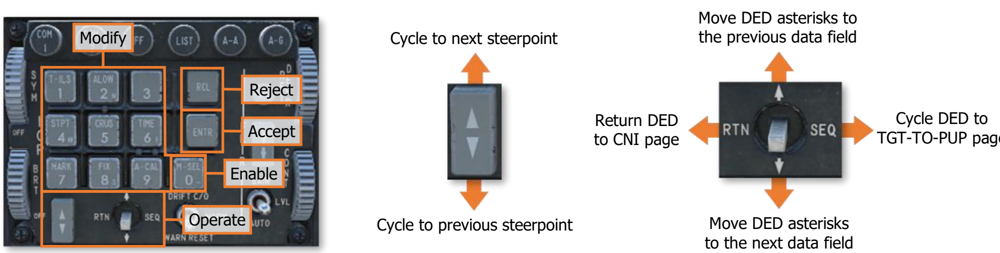
The Visual Reference Point DED page is accessed by pressing **8/FIX** on the ICP keypad when the LIST DED page is displayed on the DED. Visual Reference Point (VRP) is a sighting option used for low-altitude CCRP or LADD air-to-ground sub-modes in which an easily identifiable landmark is referenced from a known target location to visually aid the pilot in performing the planned attack profile, and update the navigation system accuracy if necessary.



Visual Reference Point (VRP) Sighting Method

In the example above, attack geometry has been pre-planned as shown and is entered into the VRP DED page. When using VRP, a steerpoint is placed at the target location, and the Visual Reference Point is entered based on its true bearing (as opposed to magnetic), range, and elevation relative to the steerpoint.

NOTE: Only one TGT steerpoint can be set for use with a VRP at any time. Additionally, a steerpoint cannot use VRP and VIP sighting options at the same time. If a steerpoint is set as the TGT steerpoint on the VRP DED page *and* as the VIP steerpoint on the VIP DED page, enabling the VRP Mode Select will disable the VIP Mode Select.



1. **VRP Mode Select.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled and the selected steerpoint is also the TGT steerpoint, a steerpoint diamond will be displayed in the HUD at the location set on this page.

2. **Target Steerpoint.** Displays the steerpoint to be used as the target (TGT). The ICP Increment/Decrement rocker may be used to cycle the TGT to a different steerpoint. The TGT steerpoint can also be changed by placing the DED asterisks over the data field and entering the steerpoint number using the ICP keypad and then pressing ENTR.

3. **True Bearing to VRP.** Displays the relative bearing (in degrees True) from the TGT steerpoint where the VRP is located. May be modified using the ICP keypad.

4. **Range to VRP.** Displays the range (in nautical miles) from the TGT steerpoint where the VRP is located. May be modified using the ICP keypad.

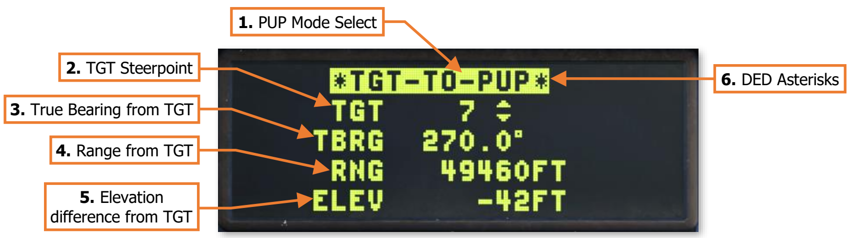
5. **Elevation difference from Target.** Displays the difference in elevation (in feet) of the VRP from the TGT steerpoint. Negative values indicate the VRP is lower in elevation than the TGT steerpoint. May be modified using the ICP keypad.

   NOTE: For negative values, the 0/M-SEL button should be pressed once to enter a leading zero, and then once more to enter a negtive (–) sign; followed by the desired numerical value.

6. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

If performing a low-level "pop-up" style weapon delivery method, a Pull-Up Point (PUP) may also be entered and enabled for display within the HUD. The PUP may be enabled for display independently of the VRP, using the 0/M-SEL button when on the TGT-TO-PUP page. However, if the TGT Steerpoint is changed on the TGT-TO-PUP page, it will also be changed on the TGT-TO-VRP page.

When enabled and the selected steerpoint is also the TGT steerpoint, a circle will be displayed in the HUD at the location set on this page.



All values entered on the TGT-TO-PUP page are entered in the same manner as on the TGT-TO-VRP page. To return to the TGT-TO-VRP page, momentarily position the DCS ("Dobber" switch) to the SEQ position.

Using Pull-Up-Points

A pull-up-point (PUP) is a location where a pop-up attack begins. Pull-up locations are typically precomputed to allow an aircraft to make a preplanned pop-up attack with sufficient altitude and time to release weapons and perform a safe-escape maneuver prior to reaching minimum safe altitude. Once these calculations are completed, the pull-up point configured in the DED the aircraft and displayed on the HUD.

In the screenshot above, a pull-up point is defined relative to the target steerpoint. The target is depicted as a TD box and the pull-up point is shown as a circle. If the pull-up point is outside the HUD FOV, the circle is clamped to the edge of the HUD and drawn inscribed with an "X".

To define a pull-up point relative to the target steerpoint, first ensure that you are in air-to-ground mode, then press LIST on the ICP, then "9", to show the VRP page. The TGT-TO-VRP page is then shown. Press DCS Sequence to move to the TGT-TO-PUP page. Ensure the "TGT-TO-PUP" text is surrounded by the cursor, and press "0" (M-SEL) to activate TGT-TO-PUP. (It will be displayed in reverse video when active.)

Dobber down to the TGT line and select the target steerpoint. Dobber down to each successive line and enter the bearing from the target to the pull-up point, then the range from the target to the pull-up point, and finally the elevation difference from the target to the pull-up point. (To enter a negative number, first press "0" twice.)

If you are using VIP sighting for a target, you can define the pull-up point relative to the VIP rather than the target. To do this, first ensure that you are in air-to-ground mode, then press LIST on the ICP, then "3", to show the VIP page. The VIP-TO-TGT page is then shown. Press DCS Sequence to move to the VIP-TO-PUP page. Ensure the "VIP-TO-PUP" text is surrounded by the cursor, and press "0" (M-SEL) to activate VIP-TO-PUP. (It will be displayed in reverse video when active.)

Dobber down to the VIP line and select the visual initial steerpoint. Dobber down to each successive line and enter the bearing from the VIP to the pull-up point, then the range from the VIP to the pull-up point, and finally the elevation difference from the VIP to the pull-up point. (To enter a negative number, first press "0" twice.)

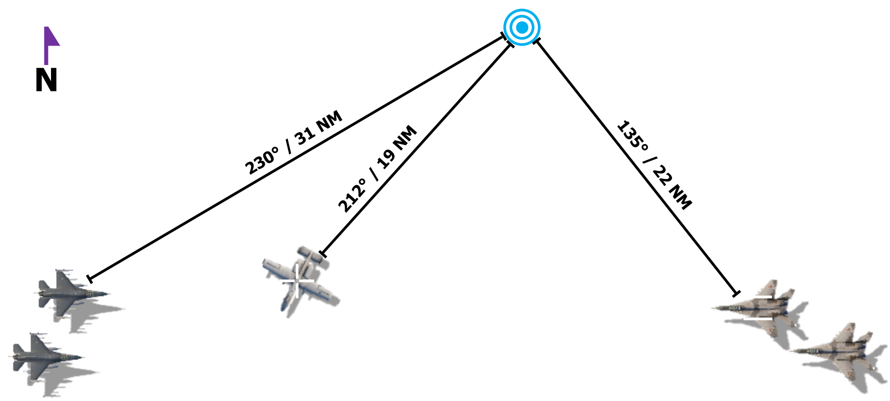
"BULLSEYE" REFERENCE POINT

"Bullseye" is a method of generating position data of aircraft, targets, threats or other locations by using a common reference point known only to allied forces. This is a method often used by AWACS controllers or friendly aircraft to ensure all aircraft operating in the area and on the same radio frequency can easily understand the tactical situation as it develops and changes.

When a Bullseye call is transmitted over the radio, the position being referenced is always the azimuth in degrees Magnetic *from* the Bullseye reference, along with the distance in nautical miles. An example is shown below:

AWACS: "*Viper 1-1, Darkstar 2-1. Pop-up group, at Bullseye one-three-five, twenty-two, at ninetween thousand.*"

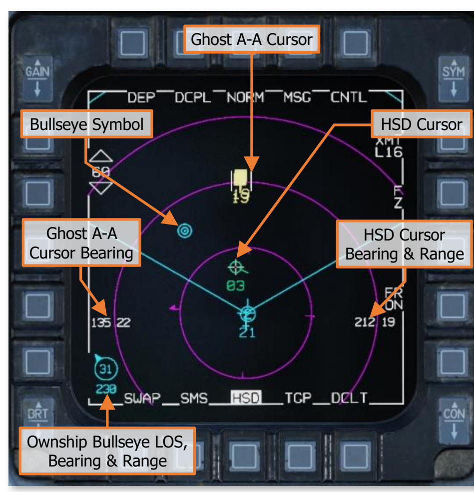
F-16C: "*Friendly aircraft at Bullseye two-one-two, nineteen, at Angels three, this is Viper 1-1. Flow southwest at low level. Viper flight engaging Bandits approaching at your 8 o'clock.*"



"Bullseye" position reference

The F-16C avionics provides several tools to the pilot to integrate Bullseye communications into the cockpit displays. Depending on the specific display in use, positions of the ownship, MFD cursor, or designated target can be displayed relative to Bullseye.

On the MFD to the right, the HSD format is displayed, depicting the same scenario as shown in the figure above. When Bullseye information is displayed, the ghost A-A and HSD cursors are referenced from the Bullseye symbol, not the selected steerpoint. In addition, the ownship's position relative to the Bullseye position is displayed in the bottom left corner of the MFD. This provides the pilot with three Bullseye references which can be used for coordination over the radio, or to maintain situational awareness within the battlespace.



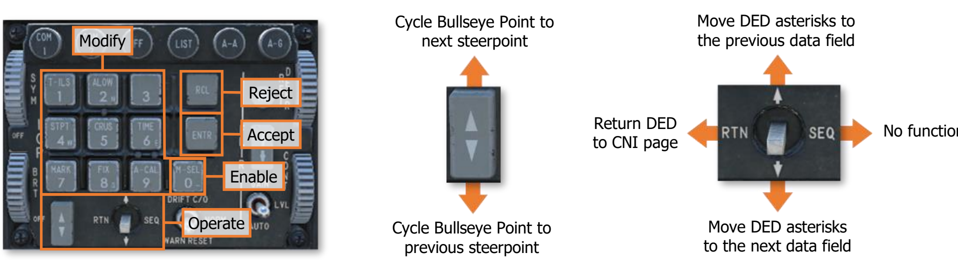
Configuring "Bullseye" Reference Point

Bullseye, like other points within the F-16C avionics, is set using a steerpoint within the database. The steerpoint normally used for Bullseye is steerpoint 25 and is automatically configured as such when a mission is loaded. However, if necessary, Bullseye can be set to a different steerpoint. Additionally, Bullseye information must be enabled for it to be displayed within the HUD or on the FCR, HSD or HAD MFD formats.

Both of these tasks can be performed on the BULL DED page.

BULL DED Page

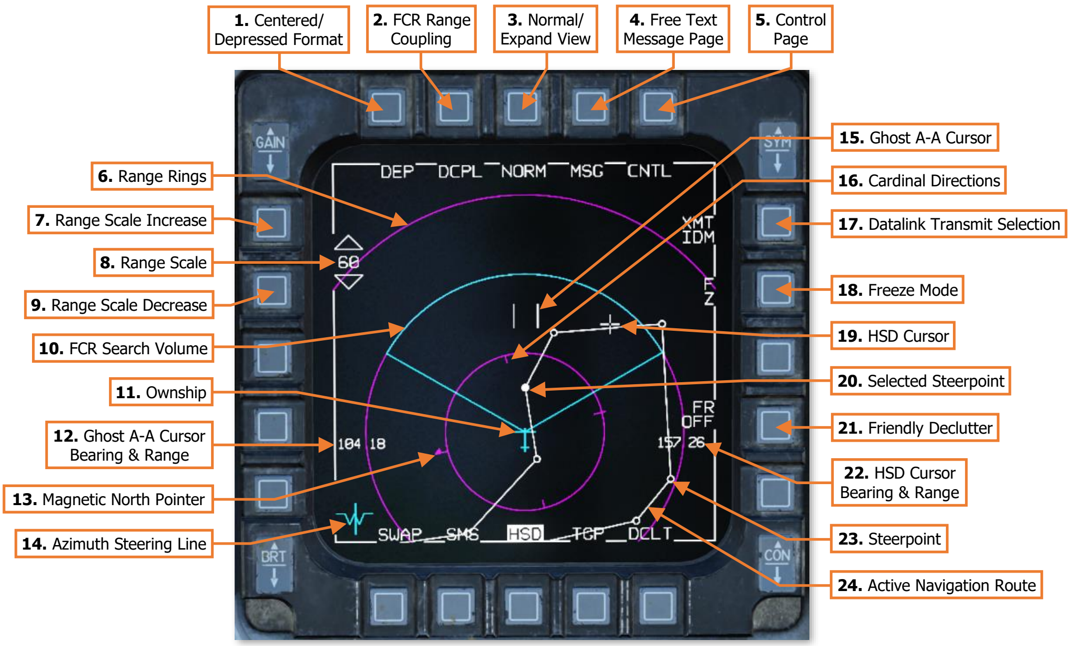
The Bullseye DED page is accessed by pressing **8/FIX** on the ICP keypad when the MISC DED page is displayed on the DED. This page is used to enable or disable "Bullseye" position references on the HUD and MFDs, or to set a different steerpoint as the Bullseye reference point if necessary.



1. **Bullseye Select.** Displays the status of the Bullseye reference indications in the cockpit. When highlighted, Bullseye indications are enabled. Pressing the 0/M-SEL button when the DED asterisks are set to this data field will enable/disable the Bullseye references within the HUD and on the FCR, HSD, and HAD MFD formats.
2. **Bullseye Point.** Displays the steerpoint currently being used as the Bullseye reference point. The ICP Increment/Decrement rocker may be used to cycle the Bullseye Point to a different steerpoint. The Bullseye Point can also be changed by placing the DED asterisks over the data field and entering the steerpoint number using the ICP keypad and then pressing ENTR.
3. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

HORIZONTAL SITUATION DISPLAY (HSD)

The HSD MFD format displays a top-down, plan-view depiction of the battlespace around the aircraft (ownship), with graphical representations of flight members, hostile aircraft, air defenses, steerpoints, routes, and sensor information. Many of these symbology elements can be selectively toggled on the HSD Control page, and are meant to enhance and maintain the pilot's situational awareness of the tactical environment.



HSD Base Page – Primary symbology

1. **Centered/Depressed Format.** Toggles between Depressed (DEP) and Centered (CEN) HSD formats. When set to Depressed, the ownship is biased to the bottom portion of the HSD, allowing the HSD to primarily depict battlespace in front of the aircraft. This format may be more useful when performing offensive counter-air (OCA, suppression of enemy air defenses (SEAD), offensive strikes, or general navigation along a flight route.

   When set to Centered, the ownship is displayed in the center of the HSD, depicting battlespace in all directions around the aircraft equally. This format may be more useful when loitering or performing orbits in an area, such as air interdiction (AI), close air support (CAS), reconnaissance, or supporting combat search and rescue (CSAR).

2. **FCR Range Coupling.** Toggles between Decoupled (DCPL) and Coupled (CPL) HSD modes. When set to Coupled (CPL) mode, the HSD range scale is coupled to the FCR range, otherwise when set to Decoupled (DCPL) mode, the FCR range has no effect on the HSD range scale.

   When set to CPL, the HSD range scale will be set to match the FCR range when in Centered format or to 1.5x the range of the FCR range when in Depressed format (one additional magenta range ring in front of the FCR search volume).

3. **Normal/Expand View.** Cycles the HSD between NORM, EXP1 and EXP2 viewing modes when HSD is set as SOI and the Expand/FOV button is pressed on the Side Stick Controller (SSC) or OSB 3 is pressed on the HSD MFD format. (See HSD Expand (EXP) Mode for more information.)

4. **Free Text Message Page.** Toggles the MFD between the HSD base page and the Free Text Message page. (N/I)
5. **Control Page.** Toggles the MFD between the HSD base page and the Control page.
6. **Range Rings.** Depicts sub-ranges below the current range scale. When the HSD is set to Depressed format, the outer ring will correspond with the HSD range scale, with two additional inner rings set at ⅔ and ⅓ of the range scale. When the HSD is set to Centered format, the outer ring will correspond with the HSD range scale, with an inner ring set at ½ the range scale.
7. **Range Scale Increase.** Increases the HSD range scale by one level. When the HSD is set to its highest range scale, this option is removed from the HSD.
8. **Range Scale.** Displays the range (in nautical miles) of the furthest HSD range ring. The minimum range that the HSD can be set to is 10 NM (Centered format) or 15 NM (Depressed format). The maximum range that the HSD can be set to is 160 NM (Centered format) or 240 NM (Depressed format).
9. **Range Scale Decrease.** Decreases the HSD range scale by one level. When the HSD is set to its lowest range scale, this option is removed from the HSD.
10. **FCR Search Volume.** Depicts the lateral boundaries of the APG-68 radar scans in azimuth and range, based on the current azimuth setting, range setting, and antenna steering.
11. **Ownship.** Depicts the location of the ownship.
12. **Ghost A-A Cursor Bearing & Range.** When the ghost A-A cursor is displayed, this data field will display the bearing (in degrees Magnetic) and range (in nautical miles) from the currently selected steerpoint to the ghost A-A cursor. If Bullseye is enabled on the BULL DED page, this data field will display the bearing and range from the Bullseye point to the ghost A-A cursor.
13. **Magnetic North Pointer.** Depicts the magnetic North direction around the innermost magenta range ring.
14. **Azimuth Steering Line.** Displays the relative alignment of the aircraft heading with the bearing to the current steerpoint, SPI, or weapon release solution. If the line is to the left or right of the watermark, the pilot must turn left or right respectively toward the vertical line to align the aircraft with the desired course or target. If the line aligned through the center of the watermark, the aircraft is on course toward the selected steerpoint, SPI, or weapon release solution.
15. **Ghost A-A Cursor.** When the FCR format is present on the opposite MFD and operating in Combined Radar Mode (CRM), the relative location of the FCR cursor will be depicted on the HSD. This assists the pilot in correlating radar information seen on the FCR display within the overall tactical situation depicted on the HSD format.
16. **Cardinal Directions.** Depicts the magnetic cardinal directions of East, South, and West around the innermost magenta range ring.
17. **Datalink Transmit Selection.** Controls the method of transmission of current SPI, steerpoint or SEAD target over the datalink when the VHF UHF Transmit switch is pressed Right-Long (>0.5 seconds). Each press of OSB 6 will cycle through three transmission (XMT) options.
    - **IDM.** SPI is transmitted over the IDM datalink. (N/I)
    - **L16.** SPI is transmitted over the DL16 datalink.
    - **OFF.** SPI transmission is inhibited.
18. **HSD Freeze Mode.** Not implemented.
19. **HSD Cursor.** When the HSD is selected as SOI, the HSD cursor will appear at the ownship symbol, unless the ghost A-A cursor is displayed in which case the HSD cursor will appear within the ghost A-A cursor. If HSD is no longer selected as SOI, the HSD cursor is removed.

The HSD cursor is slewed using the RDR CURSOR/ENABLE switch and can be used to set a steerpoint or markpoint on the HSD as the selected steerpoint for navigation, or used in conjunction with the HSD Expand mode.

20. **Selected Steerpoint.** The steerpoint selected as the current navigation steerpoint (steerpoints 1-25) is displayed as a solid white circle.

21. **Friendly Declutter.** Controls the display of friendly aircraft PPLI symbols received over DL16 datalink. Each press of OSB 9 will cycle through three declutter levels.

    - **FR ON.** All friendly aircraft PPLI symbols received are displayed.
    - **FL ON.** Only flight member PPLI symbols are displayed. All other friendly aircraft PPLI symbols are hidden.
    - **FR OFF.** All friendly aircraft PPLI symbols are hidden.

22. **HSD Cursor Bearing & Range.** When the HSD cursor is displayed, this data field will display the bearing (in degrees Magnetic) and range (in nautical miles) from the currently selected steerpoint to the HSD cursor. If Bullseye is enabled on the BULL DED page, this data field will display the bearing and range from the Bullseye point to the HSD cursor.

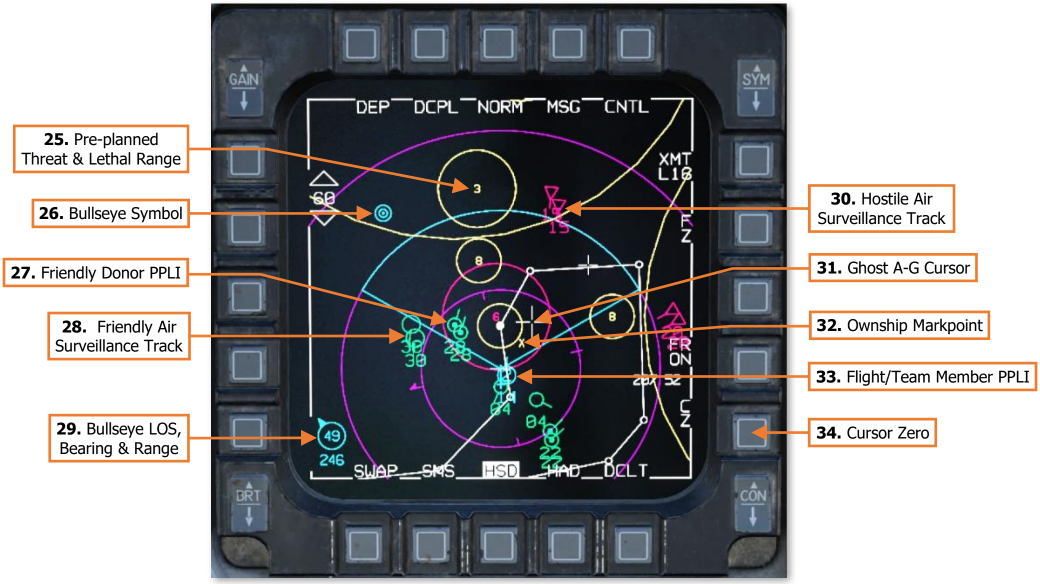
23. **Steerpoint.** Steerpoints that are not the selected steerpoint are displayed as hollow white circles.

24. **Active Navigation Route.** The active navigation route is displayed as a solid white line linking sequential steerpoints 1-25.

25. **Pre-planned Threat & Lethal Range (next page).** Pre-planned air defense unit locations with a corresponding lethality ring that is sized based upon the threat type. If the ownship enters the lethality range of a pre-planned threat, the threat symbol and lethality ring will be displayed in red.

    NOTE: These are static locations of air defenses and do not reflect whether or not the air defense threat is destroyed, or if any new threats have been detected after the aircraft has been started. These threat locations are loaded via the DTC only and do not update in real-time.

26. **Bullseye Symbol (next page).** Depicts the location of the Bullseye point. The Bullseye point is normally set to Steerpoint 25 but can be set to a different steerpoint on the BULL DED page.



HSD Base Page – Tactical symbology

27. **Friendly Donor PPLI (DL16).** Friendly, DL16 participant aircraft that are set as donors to the ownship.

28. **Friendly Air Surveillance Track (DL16).** Friendly, non- DL16 participant aircraft that are detected by other DL16 participants such as friendly fighters or AWACS aircraft.

29. **Bullseye LOS, Bearing & Range.** Displays a pointer symbol that indicates the relative direction (line-of-sight or LOS) to the Bullseye point from the nose of the ownship. Displays the ownship's range (in nautical miles) and bearing (in degrees Magnetic) from the Bullseye point, with the range displayed inside the pointer symbol and the bearing from Bullseye displayed below it.

30. **Hostile Air Surveillance Track (DL16).** Hostile aircraft that are detected by other DL16 participants such as friendly fighters or AWACS aircraft.

31. **Ghost A-G Cursor.** Depicts the location of the System-Point-of-Interest when in Air-to-Ground master mode and the TGT sighting option is selected.

32. **Markpoint.** Depicts the location of an ownship markpoint location (steerpoints 26-30) or a steerpoint received via DL16 (stored as a markpoint).

33. **Flight/Team Member PPLI (DL16).** Friendly, DL16 participant aircraft that are set as flight or team members to the ownship.

34. **Cursor Zero.** Commands a cursor zero to remove any "system delta" that has been incurred as a result of slewing the SPI away from its original location.

HSD Control (CNTL) Page

The HSD Control page is used to configure individual HSD graphic elements and symbology to suit the tactical situation or individual preferences of the pilot. The first page displays options regarding base level HSD graphics, navigation routes, and geographic lines loaded from the DTC. The second page displays options regarding the datalink symbology received through the IDM and DL16 datalink systems.

HSD Control Page – Page 1

1. **FCR Search Volume.** Toggles the display of the FCR search volume.
2. **Pre-planned Threats.** Not implemented.
3. **Advanced Identification-Friend-or-Foe.** Toggles the display of AIFF interrogation replies. (N/I)
4. **Navigation Route 1.** Toggles the display of the first navigation route loaded from the DTC. (N/I)
5. **Navigation Route 2.** Toggles the display of the second navigation route loaded from the DTC. (N/I)
6. **Navigation Route 3.** Toggles the display of the third navigation route loaded from the DTC. (N/I)
7. **Range Rings.** Toggles display of the range rings.
8. **Geographic Line 1.** Toggles the display of first pre-planned line or shape loaded from the DTC. (N/I)
9. **Geographic Line 2.** Toggles the display of second pre-planned line or shape loaded from the DTC. (N/I)
10. **Geographic Line 3.** Toggles the display of third pre-planned line or shape loaded from the DTC. (N/I)
11. **Geographic Line 4.** Toggles the display of fourth pre-planned line or shape loaded from the DTC. (N/I)
12. **Page Sequence.** Cycles the MFD to Page 2 of the HSD Control page.

HSD Control Page – Page 2

13. **Engagement Status (DL16).** Not implemented.
14. **Reference Point (DL16).** Not implemented.
15. **Primary Datalink Track Range (DL16).** Not implemented. (N/I)
16. **Air Target Tracks (DL16).** Toggles display of airborne target tracks transmitted by flight members and donors via DL16. (N/I)
17. **Ground Targets (IDM) & Ground Surveillance Tracks (DL16).** Toggles display of non-SAM ground targets received via IDM or ground surveillance tracks via DL16. (N/I)
18. **SAM Sites (IDM/ DL16).** Toggles display of pre-planned SAM threats, or SAM threats received as a SEAD target via IDM or via DL16.
19. **Ships (DL16).** Toggles display of friendly or hostile ship positions received via DL16. (N/I)
20. **Air Targets (IDM).** Toggles display of airborne targets transmitted by other fighters via IDM. (N/I)
21. **Air Surveillance Tracks (DL16).** Toggles the display of air surveillance tracks received over DL16 from AWACS aircraft. These may include hostile aircraft, or friendly aircraft that are not DL16 capable but are visible to the AWACS radar and have been determined to be friendly.
22. **Friendly Ground PPLI/Ground Tracks (DL16).** Toggles display of friendly ground unit PPLI or ground tracks received via DL16. (N/I)
23. **Launch Acceptability Region.** No function.
24. **Mission Planned Target.** No function.
25. **Page Sequence.** Cycles the MFD to Page 1 of the HSD Control page.

HSD Expand (EXP) Mode

The HSD can be cycled between NORM, EXP1 and EXP2 viewing modes when the HSD is SOI and OSB 3 is pressed on the HSD MFD format or the Expand/FOV button is pressed on the Side Stick Controller (SSC). When EXP1 or EXP2 are entered, the HSD will be centered at the location the HSD cursor was placed at the moment Expand mode was selected.

When Expand mode is entered, the HSD will switch to a 2:1 zoom ratio (EXP1) or a 4:1 zoom ratio (EXP2). Additionally, the following options are removed from the HSD:

- Centered/Depressed format option at OSB 1.
- FCR Range Coupling option at OSB 2.
- Range Scale and Range Scale Increase/Decrease options at OSB 19 and OSB 20.
- Range Rings.
- Cardinal Directions.

HSD NORM (Left), EXP1 (Center), and EXP2 (Right) Modes

Any of the following actions will exit Expand view:

- Press OSB 3 on the HSD MFD format to cycle back to NORM.
- Press the Expand/FOV button on the SSC to cycle back to NORM.
- Set SOI to something other than HSD.

HSD Zoom Mode

The HSD can be momentarily commanded to a 5 NM (Centered format) or 7.5 NM (Depressed format) range scale around the ownship by pressing and holding the Expand/FOV button on the Side Stick Controller (SSC) for >0.5 seconds, regardless of the current SOI. This provides a means of viewing the immediate surroundings around the ownship, specifically when in formation with other aircraft in which multiple symbols may be clustered around and/or superimposed on the ownship symbol at normal HSD range scale levels.

The NORM/EXP1/EXP2 mode option at OSB 3 will be replaced with ZOOM to indicate the HSD is in Zoom mode. Additionally, the following options are removed from the HSD:

- Centered/Depressed format option at OSB 1.
- FCR Range Coupling option at OSB 2.
- Free Text Message Page option at OSB 4.
- Control Page option at OSB 5.
- Datalink Transmit Selection option at OSB 6.
- HSD Freeze Mode option at OSB 7.
- Friendly Declutter Option at OSB 9.
- Range Scale Increase/Decrease options at OSB 19 and OSB 20.
- Range Scale

HSD Zoom Mode

Releasing the Expand/FOV button on the SSC will exit HSD Zoom mode.

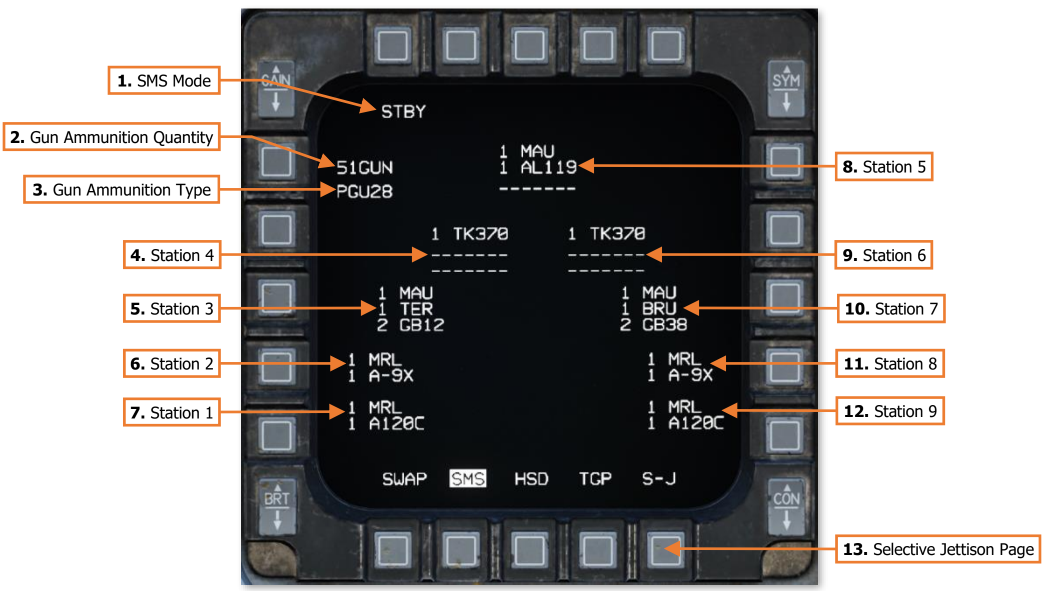
STORES MANAGEMENT SYSTEM (SMS)

The SMS MFD format is used for reviewing and configuring loaded munitions and external stores. SMS weapon profiles and settings are retained for each master mode. When the pilot switched to a different master mode, the SMS base page will be set to the SMS mode corresponding with the retained settings and/or sub-mode for the current master mode.

Functions of the SMS page that relate to employment of specific weapons are covered in their respective manual sections with the Air-to-Air Employment and Air-to-Ground Employment chapters.

SMS Inventory (INV) Page

An Inventory page is available that shows all munitions, missile launchers, weapon racks, and external stores loaded on each station. When the aircraft master mode is set to Navigation, Selective Jettison, or Emergency Jettison modes, the SMS Inventory page is displayed as the base page. When the aircraft master mode is set to Air-to-Air Missile, Air-to-Ground, Missile Override, or Dogfight modes, the INV page may be accessed from each respective base page by pressing INV (OSB 4).



SMS Inventory Page – Navigation mode

1. **SMS Mode.** The SMS is in standby mode.
2. **Gun Ammunition Quantity.** Displays the remaining ammunition quantity onboard for the M61 20mm rotary cannon, in 10 round increments (e.g. "51" indicates 510 rounds remaining).
3. **Gun Ammunition Type.** Displays the type of 20mm ammunition loaded into the internal ammunition drum. "M56" will be displayed for any M50-series ammunition. "PGU-28" will be displayed for any PGU-series ammunition.
4. **Station 4.** Displays the external stores installed on the left inboard underwing pylon.

5. **Station 3.** Displays the external stores installed on the left middle underwing pylon.
6. **Station 2.** Displays the external stores installed on the left outboard underwing pylon.
7. **Station 1.** Displays the external stores installed on the left wingtip missile pylon.
8. **Station 5.** Displays the external stores installed on the centerline fuselage pylon.
9. **Station 6.** Displays the external stores installed on the right inboard underwing pylon.
10. **Station 7.** Displays the external stores installed on the right middle underwing pylon.
11. **Station 8.** Displays the external stores installed on the right outboard underwing pylon.
12. **Station 9.** Displays the external stores installed on the right wingtip missile pylon.
13. **Selective Jettison Page.** Selects Selective Jettison mode, overriding the current aircraft master mode.

Stations 1, 2, 8, and 9 are air-to-air stations only, with the respective station data displayed in a two-line format. The top line displays the type of missile launcher installed on the station. The bottom line displays the air-to-air munition that is loaded onto that missile launcher.

Stations 3, 4, 5, 6 and 7 can be loaded with a variety of various stores, including air-to-air or air-to-ground munitions, fuel tanks, and ECM or travel pods. These stations are displayed in a three-line format. Depending on the combination of external munitions or equipment that is installed on these stations, the station data may be composed of one, two or three lines of data.

In the example on the previous page, stations 3 and 7 are both installed with a MAU-12 Ejector Rack. However, the MAU-12 installed on station 3 is carrying a TER-9/A Triple Ejector Rack loaded with a pair of GBU-12 laser-guided bombs, whilst station 7 is carrying a BRU-57/A Smart Multiple Carriage Rack loaded with a pair of GBU-38 inertially-aided bombs.

In addition to the gun ammunition type displayed in the top left corner of the inventory page, the SMS will use a series of weapon and equipment codes to indicate specifically what external stores are loaded onto the underwing and centerline fuselage stations on the aircraft. A list of these codes are provided on the following page.

SMS Weapon/External Stores Codes

CODE	MUNITION/EQUIPMENT	CODE	MUNITION/EQUIPMENT
M56	M50-series 20mm ammunition	MAU	MAU-12 Ejector Rack
PGU28	PGU-series 20mm ammunition	TER	TER-9/A Triple Ejector Rack
		MRL	LAU-129A/A Missile Rail Launcher
TA9LM	CAP-9M Captive Air Training Missile	L03	LAU-3/A 19-tube Rocket Launcher
A-9LM	AIM-9L or AIM-9M IR-guided missile	L88A	LAU-88/A Triple Rail Missile Launcher
A-9X	AIM-9X IR-guided missile	L117	LAU-117A(V)3/A Maverick Missile Launcher
A120B	AIM-120B active radar-guided missile	L118	LAU-118(V)2/A Guided Missile Launcher
A120C	AIM-120C active radar-guided missile	BRU	BRU-57/A Smart Multiple Carriage Rack
ACMI	AN/ASQ-T50 TCTS pod	TK300	300-gallon external centerline tank
AL131	AN/ALQ-131 ECM pod	TK370	370-gallon external wing tank
AL119	AN/ALQ-184 ECM pod		
		GB12	GBU-12 or BDU-50LGB laser-guided bomb
BD33T	BDU-33 practice bomb	GB10C	GBU-10C/B laser-guided bomb
B49	Mk-82 AIR or BDU-50HD with BSU-49	GB24A	GBU-24A/B laser-guided bomb
M82	Mk-82 or BDU-50LD bomb	GB31A	GBU-31(V)1/B INS/GPS-guided bomb
M82S	Mk-82 bomb with Mk15 Snakeye pedals	GB31B	GBU-31(V)3/B INS/GPS-guided bomb
M84	Mk-84 bomb	GB38	GBU-38 INS/GPS-guided bomb
B50	Mk-84 AIR bomb with BSU-50		
BD50	Mk-84 AIR practice bomb with BSU-50	CB103	CBU-103 INS/GPS-guided cluster bomb
		CB105	CBU-105 INS/GPS-guided cluster bomb
CB87B	CBU-87 with 202 BLU-97B submunitions		
CB97B	CBU-97 with 40 BLU-108 submunitions	AG65D	AGM-65D IR-guided missile 125lb warhead
		AG65G	AGM-65G IR-guided missile 300lb warhead
M151	M151 high explosive rockets	AG65H	AGM-65H TV-guided missile 125lb warhead
M156	M156 white phosphorus rockets	AG65K	AGM-65K TV-guided missile 300lb warhead
M5	Mk5 high explosive anti-tank rockets	AG88	AGM-88C anti-radar guided missile
M61	Mk61 or WTU-1/B training rockets	A154A	AGM-154A INS/GPS-guided glide bomb

SMS Selective Jettison (S-J) Page

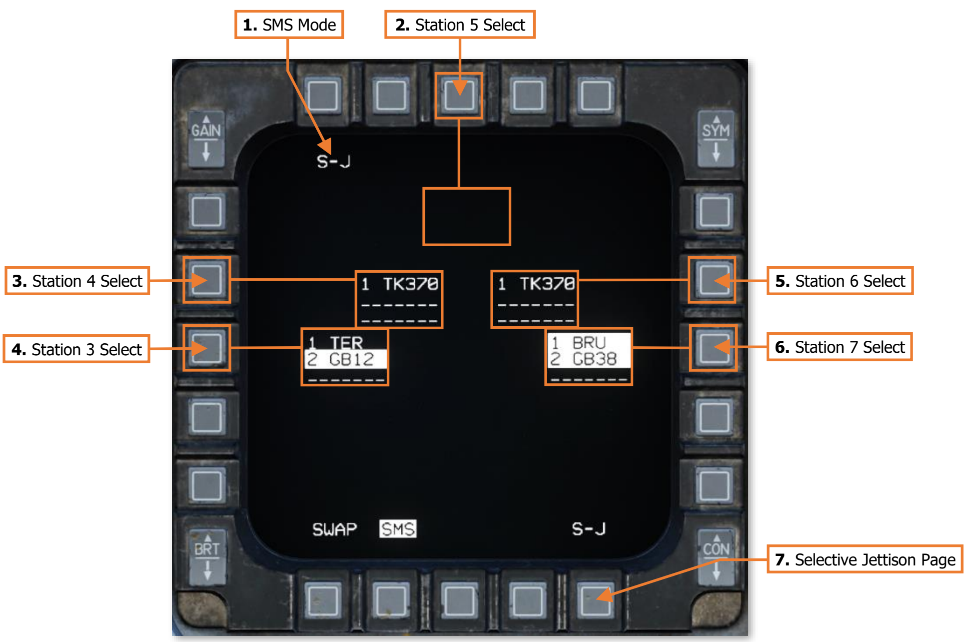
The Selective Jettison page facilitates jettison of individual weapons and/or weapon racks from the external stations. This allows the pilot to have greater control over what is physically jettisoned from the aircraft.

When the Selective Jettison page is displayed on the SMS MFD format, the Selective Jettison master mode is entered, which overrides the existing master mode, and "JETT" will be displayed in the HUD Master Mode Status. Pressing OSB 11 again while on the Selective Jettison page will exit the Selective Jettison master mode and return to the previous master mode. Alternatively, if any other master mode is selected, Selective Jettison mode will be exited.

Only external stores that are capable of being jettisoned will be displayed on the SMS Selective Jettison page. These include external fuel tanks, air-to-ground weapons, and air-to-ground weapon racks. Air-to-air missiles, air-to-air missile rails, and ECM/Travel pods cannot be jettisoned and will not be displayed.

External stores are selected by pressing the corresponding OSB for that external wing or fuselage station. Any items that are highlighted in white are selected for jettison. If more than one item exists on a given station, the first press of the corresponding OSB will enable the lowest external store (shown below on Station 3), and the second press of the OSB will highlight the next highest external store (shown below on Station 7). An additional press will disable jettison for all items on that station and the stores will be de-highlighted.

If the Weapon Release button on the Side Stick Controller is pressed while the Selective Jettison page is displayed, any highlighted external stores will be jettisoned in an unarmed state, regardless of whether the MASTER ARM switch is set to MASTER ARM, OFF, or SIMULATE.



SMS Selective Jettison page

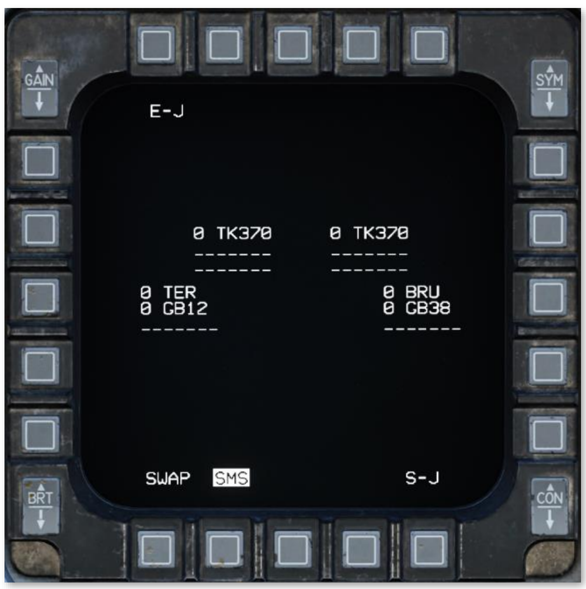
1. **SMS Mode.** The SMS is in Selective Jettison mode and will display any external stores that can be selected for jettison.
2. **Station 5 Select.** Selects centerline fuselage pylon for jettison. This option will only be displayed when a 300-gallon external centerline tank is loaded.

3. **Station 4 Select.** Selects left inboard underwing pylon for jettison. This option will only be displayed if a 370-gallon external wing tank is loaded or if an air-to-ground weapon and/or weapon rack is loaded.
4. **Station 3 Select.** Selects left middle underwing pylon for jettison. This option will only be displayed when an air-to-ground weapon and/or weapon rack is loaded.
5. **Station 6 Select.** Selects right inboard underwing pylon for jettison. This option will only be displayed if a 370-gallon external wing tank is loaded or if an air-to-ground weapon and/or weapon rack is loaded.
6. **Station 7 Select.** Selects right middle underwing pylon for jettison. This option will only be displayed when an air-to-ground weapon and/or weapon rack is loaded.
7. **Selective Jettison Page.** Exits Selective Jettison mode, returning the aircraft to the previous master mode.

SMS Emergency Jettison (E-J) Page

When the Emergency Jettison button is pressed on the Left Auxiliary Console, the Emergency master mode is entered, overriding the existing master mode, and the SMS Emergency Jettison page is displayed on the SMS MFD format. "JETT" will be displayed in the HUD Master Mode Status. Releasing the Emergency Jettison buttons will exit Emergency Jettison mode and return to the previous master mode.

Like the SMS Selective Jettison page, the Emergency Jettison page only displays external stores that can and have been jettisoned. These include external fuel tanks, air-to-ground weapons, and air-to-ground weapon racks. Air-to-air missiles, air-to-air missile rails, and ECM/Travel pods cannot be jettisoned and will not be displayed.

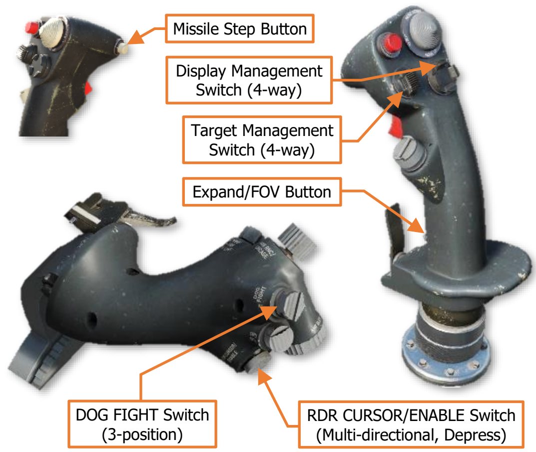


SMS Emergency Jettison page

HANDS-ON CONTROLS

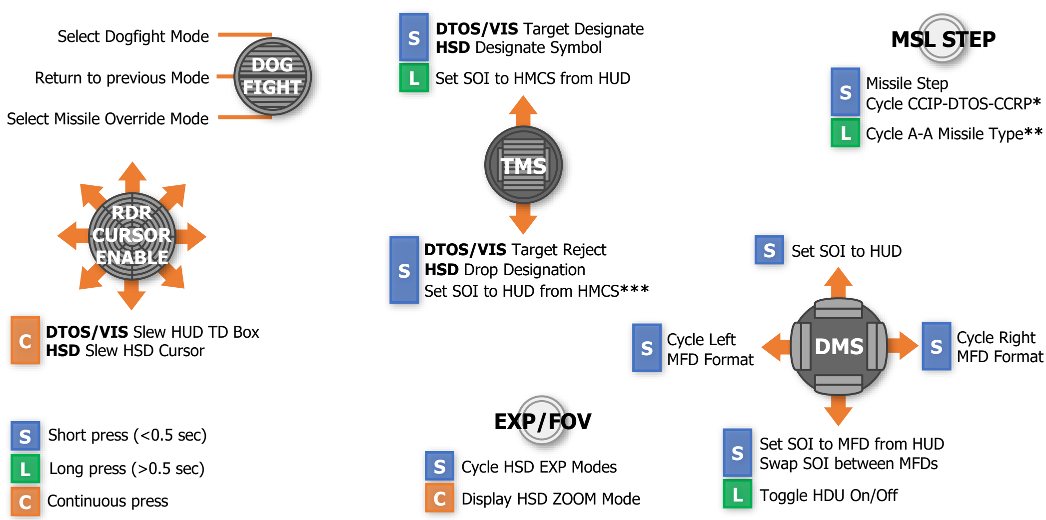
The Display Management Switch (DMS), Target Management Switch (TMS) and Expand/FOV button on the Side Stick Controller (SSC), along with the RDR CURSOR/ENAB LE switch on the throttle grip, are the pilot's controls for selecting a Sensor-Of-Interest (SOI), changing MFD formats, designating locations seen visually by the pilot, or manually slewing existing designations or sighting points.

The Missile Step button on the SSC is the pilot's control for cycling between Air-to-Air or Air-to-Ground sub-modes. The DOG FIGHT switch on the throttle grip allows the pilot to rapidly transition to an air-to-air combat mode from an existing master mode when an imminent threat to the aircraft exists from hostile fighters.



Throttle Grip Commands. The RDR CURSOR/ENABLE switch is multi-directional, allowing the HUD TD Box or HSD cursor to be moved in any direction.

Side Stick Controller (SSC) Commands. The Target Management Switch (TMS), Missile Step button, and Expand/FOV button commands are contextual, based on the SOI, master mode, whether a HUD or HMCS designation exists, and in some cases the current SMS weapon profile.



* Master mode must be set to Air-to-Ground and SMS weapon profile must not be AGM-65 or AGM-88 missiles.

** Master mode must be set to Air-to-Air Missile mode, Missile Override mode, or Dogfight mode.

*** An existing HMCS designation must be rejected before SOI can be returned to HUD from HMCS.

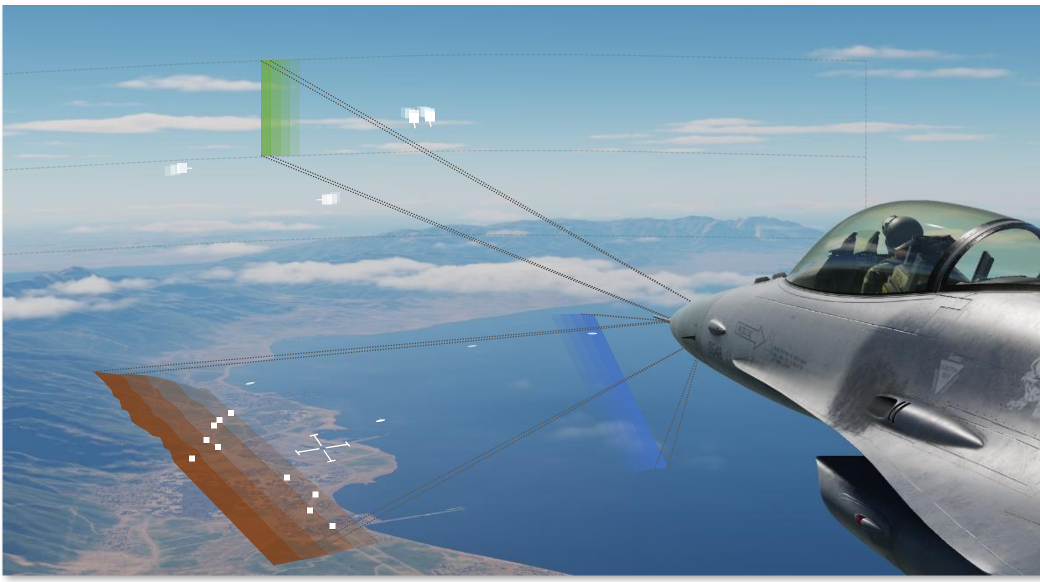
APG-68 FIRE CONTROL RADAR

USAF Photo
by A1C Jordyn Fetter

FIRE CONTROL RADAR

This section's revision is currently a work-in-progress.

The Westinghouse AN/APG-68(V)5 is a pulse-Doppler radar that functions as the F-16C's Fire Control Radar (FCR), and includes operating modes for targeting, weapons employment, and navigation.



AN/APG-68 Detection, Targeting, and Ground Mapping

The APG-68 occupies the forward nose section of the F-16's fuselage and consists of a mechanically-steered planar array transmitter/receiver antenna, radio frequency signal generators, and associated processors and electronics. The FCR includes several modes for both air-to-air and air-to-ground operations and can be used to perform updates to the inertial navigation system while enroute if necessary.

Fire Control Radar Activation

The FCR is powered by positioning the FCR switch to the forward position on the SNSR PWR control panel on the right console.

The fire control radar cannot function without the MMC or MFD avionics systems, or without a properly aligned INS.

AIR-TO-AIR MODES

This section's revision is currently a work-in-progress.

The FCR provides two basic A-A modes for target detection, acquisition, and tracking:

Combined Radar Mode (CRM). This mode combines air-to-air sub-modes used for search under one interface. Sub-modes are:

- Range While Search (RWS)
- Track While Scan (TWS)

Air Combat Mode (ACM). This mode combines all sub-modes for automatic target acquisition under one interface. Sub-modes are:

- 30° × 20°
- Boresight
- 10° × 60°
- Slewable

Single Target Track (STT) is an additional mode entered by locking a target in CRM or ACM sub-modes.

Air-to-Air weapon employment using the radar is discussed in the following sections:

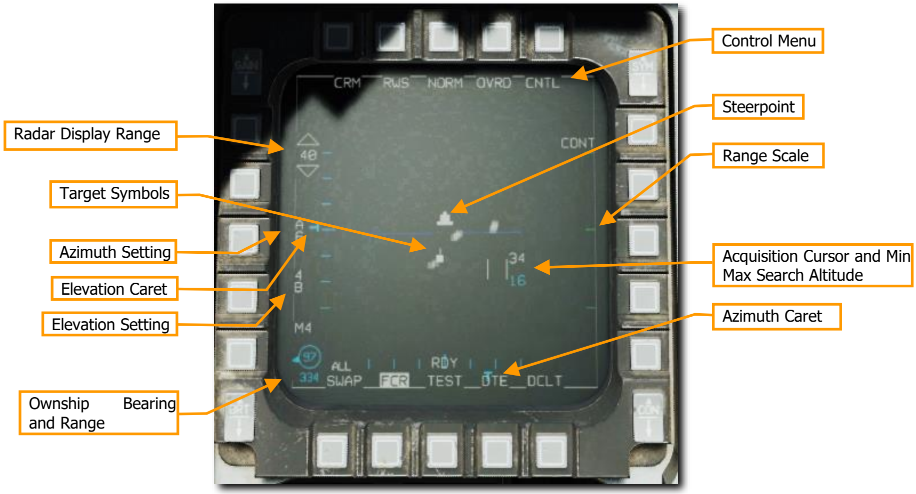
Air to Air Gunnery

AIM-9M/X Employment

AIM-120 Employment

We will first discuss aspects of the radar that spans multiple modes, and then later we will discuss radar functions specific to unique applications/weapons.

The air-to-air radar display uses a standard B-scope format in which the ownship (your aircraft) is in the bottom center of the display. As such, all indications on the b-scope are ahead of the ownship. Targets on the scope are displayed in range from the closest being at the bottom and the more distant being toward the top. Contacts left and right of the ownship are represented as being indicted left and right of the center of the display to indicate azimuth.



Important, basic components of the display include:

Radar Display Range. The currently selected range displayed on the MFD is shown on the left of the display. This can be increased or decreased by pressing the adjacent OSBs or by slewing the acquisition cursor to the top or bottom of the display.

Target Symbols. Target symbols are displayed as solid squares (bricks). The horizonal position of the target symbol indicates angular position in respect to ownship heading. The vertical position indicates range.

Acquisition Cursor. Consisting of two parallel, vertical lines, this cursor is moved in response to Cursor/Enable Switch commands. When in a RADAR search mode, the altitude band being covered by the RADAR beam is indicated above and below the cursor.

Targets are locked by slewing the cursor over the target symbol and commanding TMS Up on the Side Stick Controller (SSC).

Range Scale. The right side of the b-scope represents RADAR range. The scale includes marks for ¼, ½, and ¾ of the selected radar range.

Azimuth Setting. Indicates the azimuth setting, in tens of degrees. A setting of "A6" means the radar is scanning 60° to either side of boresight, which is the maximum scan azimuth. Options are A6, A3, and A1. Azimuth setting will be A1 during the RWS acquisition process. Higher azimuth settings will result in a longer detection period and a slower refresh rate.

Elevation Setting. Indicates the elevation area scanned, in number of bars. A setting of "4B" means the radar is sweeping four different elevations (corresponding to a 40° elevation range). Options are 4B, 2B, and 1B. Higher elevation settings will result in a longer detection period and a slower refresh rate.

Antenna Azimuth and Elevation Caret. The current radar azimuth is shown by a T symbol on the bottom of the display. The current radar elevation is shown by a T symbol on the left of the display. The carets move along scales that show the full ±60º sweep range of the antenna.

Ownship Bearing and Range. This shows the bearing and range from your own aircraft to the Bullseye.

Control Menu. Pressing this OSB takes you to the control menu. See Control (CNTL) .

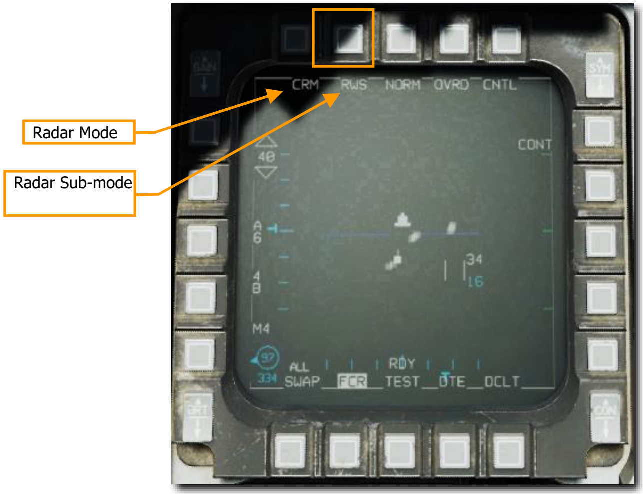
Radar modes are selected by pressing the OSB adjacent to the current mode (OSB 1). After pressing this OSB, a menu of all available air-to-air modes is displayed on the left side of the display. Press the OSB adjacent to the desired mode to select it.

Combined Radar Mode (CRM)

This mode is selected by default at power-up. It is designed to reduce pilot workload by combining air-to-air sub-modes used for search under one interface. Sub-modes are:

- Range While Search (RWS)
  - Situational Awareness Mode (SAM)
  - Dual Target Track (DTT)
- Track While Scan (TWS)
- Single Target Track (STT)

The RWS and TWS sub-modes may be cycled by pressing OSB 2 adjacent to the sub-mode.



You can also cycle between RWS and TWS by holding TMS right for more than one second.

Range While Search (RWS) Sub-mode

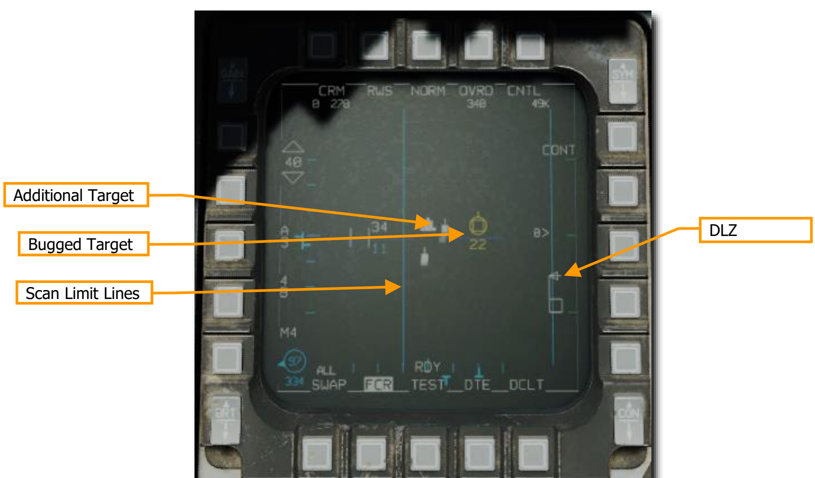
The Range While Search (RWS) sub-mode is used for fast, long-range acquisition and engagement. The pilot can set the acquisition range (10, 20, 40, 80, or 160 nautical miles) and change the azimuth width and elevation.

Targets may be acquired and tracked in three ways: Situational Awareness Mode (SAM), Dual Target Track (DTT), or Single Target Track (STT).

- **Situational Awareness Mode (SAM).** Placing the acquisition cursor over a target and pressing TMS forward commands SAM. The antenna will be directed to the cursor position and a 4-bar, ±10° spotlight scan will be performed while TMS forward is held.

If a target is not under the acquisition cursor when TMS forward is released or no target is detected, the scan coverage reverts to the previous scan pattern. The SAM acquisition sequence will only commence if a target was under the TDC when TMS forward was pressed.

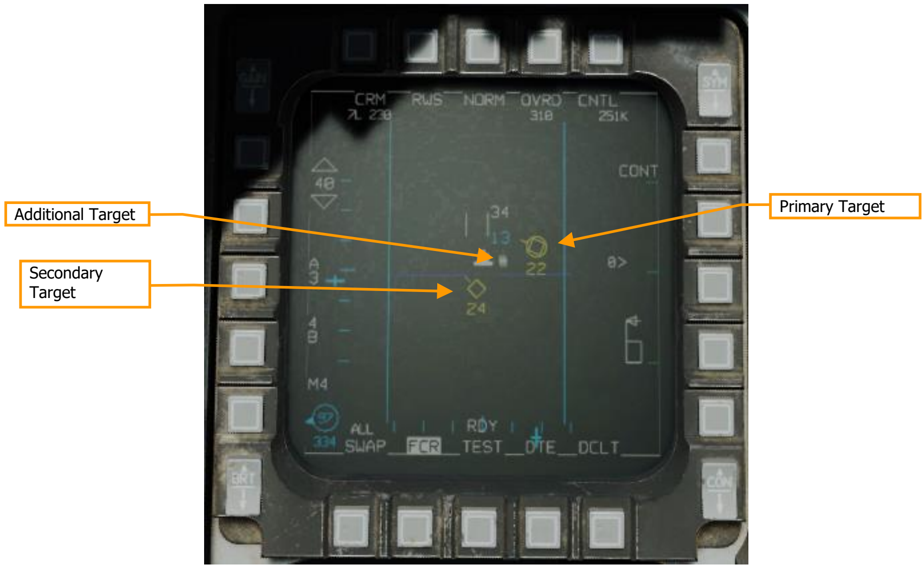
After a successful acquisition, the radar enters SAM mode, with the target bugged. The radar will continue a scan pattern, pausing to dwell on the bugged target periodically. An AIM-120 AMRAAM will guide on the bugged target even without an STT lock.



If a missile is selected (AIM-9 or AIM-120), the DLZ will be displayed along the right edge.

SAM mode may be exited with TMS aft. Positioning the acquisition cursor over the bugged target and pressing TMS forward commands Single Target Track. Positioning the acquisition cursor over another target and pressing TMS forward commands Dual Target Track.

- **Dual Target Track (DTT).** Dual Target Track is entered from SAM by bugging a second target. In DTT mode, the radar will dwell on two targets while continuing a scan pattern centered around the secondary target. If the primary target closes within 10 NM of the aircraft, the scan pattern is inhibited, and the radar will "ping-pong" between the two bugged targets.



In DTT, pressing TMS right will swap the primary and secondary targets. The radar will shift its scan pattern to be centered around the new secondary target. AIM-120 launches in DTT will track the primary target.

- **Single Target Track (STT).** Placing the acquisition cursor over a primary bugged target and pressing TMS forward commands Single Target Track mode. Placing the acquisition target over a non-bugged target and pressing TMS up twice in quick succession accomplishes the same function.

  In STT, the radar focuses all its energy on a single target and provides high-resolution and high-frequency updates. However, the radar does not scan, and will no longer detect other contacts. If the enemy has a RWR onboard, it will be alerted to the STT lock.

STT mode may be exited with TMS aft. TMS Aft once returns to SAM mode with the target bugged. TMS Aft twice returns to the previous CRM mode.

This mode is discussed in the Single Target Track (STT) section below.

Track While Scan (TWS) Sub-mode

TWS mode is a multi-target tracking mode. In TWS, the radar will initially detect only hits, like RWS. However, as successive hits in proximity are detected in subsequent scans, the radar will attempt to combine these hits into targets. Each detected target is represented by a trackfile, which stores a history of detected hits. This history is used to build a picture of the target's heading, speed, and other properties.

TWS has several restrictions. The radar will attempt to build trackfiles for each contact, but given a large scan volume, there will be a sizable refresh time between scans. During each scan the radar will try to predict the position of the contact for the next scan. If, however, the target takes evasive, high-G maneuvers and quickly changing its trajectory and speed, the radar can lose the track by making an incorrect trackfile prediction, and the contact will disappear from the radar, replaced only with a hit on the next scan.

TWS, when combined with the AIM-120, provides a powerful ability to engage multiple targets quickly. Nevertheless, target tracking is not as reliable as SAM, and especially less reliable than STT. Unlike STT though, a TWS lock does not trigger an elevated RWR indication. As such, the first warning the enemy pilot will likely get is when the radar seeker of the AIM-120 goes active.

Trackfiles are automatically established on up to 10 targets based on information received from each radar sweep. The radar scan volume options are identical to those used for RWS but are reduced to 3-bar, ±25° when a target is designated.

Four types of target symbols are available to help sort contacts. They are, in increasing order of importance: Search Target, Track Target, System Target, and Bugged Target. In addition, two other target symbols can appear: Cursor Target and Locked Target.

Search Target. These are radar hits that have not been resolved well enough to build a track. They are displayed as a small brick in much the same way as in RWS.

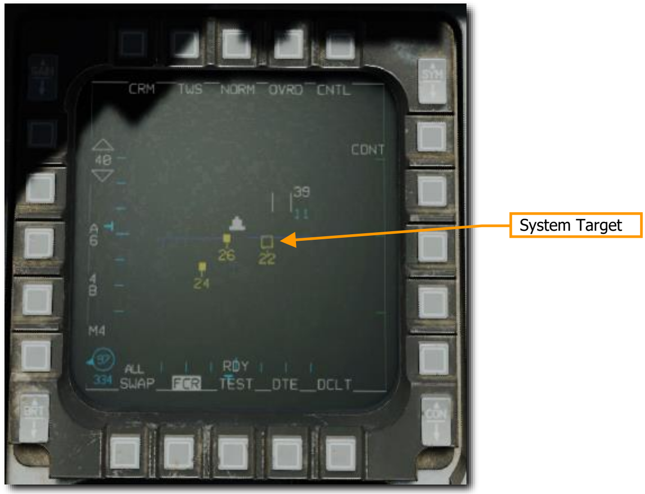
These targets disappear after a few sweeps if a track cannot be obtained. If a valid track is obtained, usually after being detected on two consecutive sweeps, the contact automatically becomes a Track Target.

Track Target. Once enough information about a Search Target has been received to build a trackfile, it is upgraded to a Track Target. These targets are displayed as a larger brick with a velocity vector line showing their direction of travel. Their altitude is displayed just below each contact. Up to 10 of these tracks may be present at one time.

Track targets can be considered the most basic radar contact. Other options become available after a trackfile has been established. The pilot can upgrade any Track Targets of interest to System Targets.

System Target. System Targets are Track Targets designated by the pilot. System Targets are not given any additional radar energy; the System Target feature is only used by the pilot to designate those targets that the pilot may wish to monitor or employ weapons against later.

To upgrade a Track Target to a System Target, position the radar cursor over a Track Target and press **TMS Forward**. If no System Targets have yet been designated, pressing TMS Right upgrades all Track Targets to System Targets.



You can position the acquisition cursor over any System Target to increase its scan priority, making it a Cursor Target.

The radar will limit its scan to a 3-bar, ±25° pattern centered on that target to provide faster updates and reduce the chance of losing the Cursor Target. This does not designate the target for AIM-120 employment, only increases its priority for radar updates.

The Cursor Target can be changed by slewing the cursor to another system target. Slewing away from all system targets returns the radar to a normal TWS scan.

A System Target can be designated as the **Bugged Target** by placing the radar cursor over it and pressing **TMS Forward**. This changes the scan to a 3-bar, ±25° pattern centered on the bugged target to provide faster updates and reduce the chance of losing the track.

The Bugged Target is also selected for weapons employment. AIM-9 and AIM-120 DLZ information in the HUD and FCR format references the Bugged target.

TMS Right will select the closest System Target as the bugged target. Subsequent presses of **TMS Right** will cycle through all displayed System Target in range order, making each the Bugged Target in turn.

The Bugged Target can be transitioned to an STT lock by pressing **TMS Forward** with the cursor over the Bugged Target. This will transition the radar to STT mode.

Pressing **TMS Aft** downgrades a Bugged Target to a System Target, or a System Target to a Tracked Target.

Air Combat Mode (ACM)

The Air Combat Mode (ACM) automatically acquires aircraft at short ranges. This mode is used most often when the target is already acquired visually. The pilot flies the aircraft to position the target in the proper position for radar acquisition.

Different scan patterns are available in the four different sub-modes:

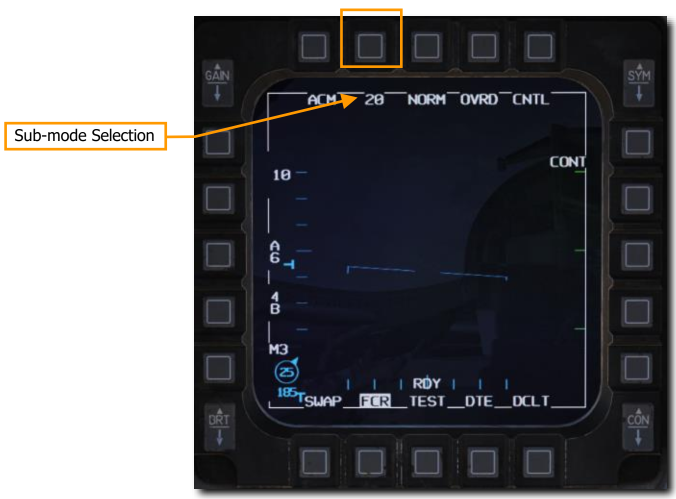
- Boresight (BORE)
- 10° × 60° (Vertical Scan)
- 30° × 20° (HUD Scan)
- Slewable

The radar locks the first target it detects within each sub-mode's search pattern. Maximum acquisition range is 10 nautical miles. Each sub-mode has its own strengths and weaknesses and is best used in different situations.

ACM may be entered in two ways:

- Position the Dogfight/Missile Override (DOGFIGHT) Switch to DGFT. This selects ACM automatically. Or,
- Press the OSB next to the radar mode and select ACM from the options on the left of the screen.

The 30° × 20° sub-mode is entered in a non-radiating (NO RAD) state by default when ACM mode is selected. The radar is activated when a sub-mode is selected by either cycling through sub-modes on the MFD or using the Target Management Switch (TMS).



HOTAS functions of the TMS in ACM radar mode and the radar as SOI are:

- TMS Up: Boresight (BORE) Sub-mode
- TMS Down: 10° × 60° (Vertical Scan)
- TMS Right: 30° × 20° (HUD Scan)
- TMS Left: No function

30° × 20° (HUD Scan) Sub-mode

The 30° × 20° HUD scan pattern searches an area slightly larger than the HUD field of view. The lock range is 10 nautical miles. The radar automatically locks on to the first target in this zone. When locked, the target is automatically tracked in STT mode.

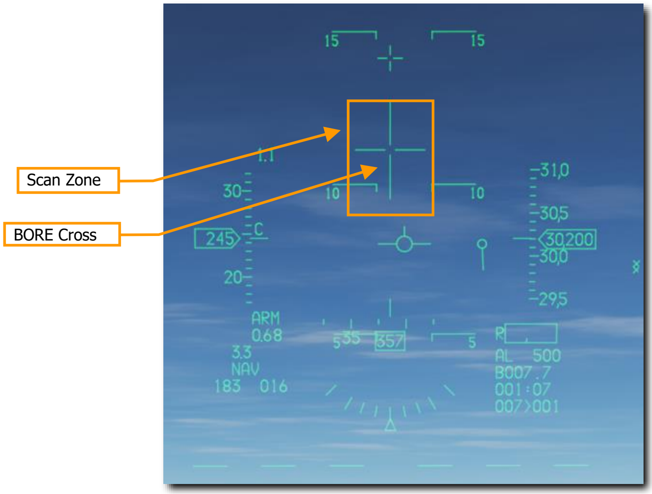
There is no special HUD symbology for this sub-mode. The FCR format will display "ACM 20."

This sub-mode is less precise than the BORE sub-mode and may take longer to achieve a lock because of the larger target area for the radar scan to cover.

Boresight (BORE) Sub-mode

The BORE scan pattern searches a small one-beamwidth area located 3° below the HUD's gun cross. An additional **Boresight Cross** is displayed on the HUD at the center of the radar scan zone to aid in positioning the target in the radar beam.

The FCR format will display "ACM BORE."

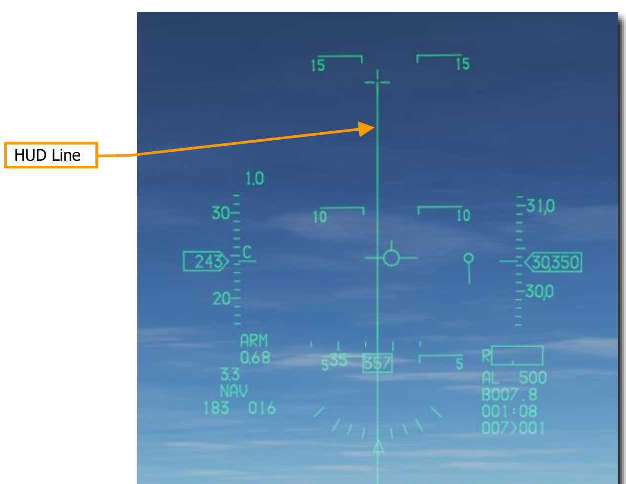


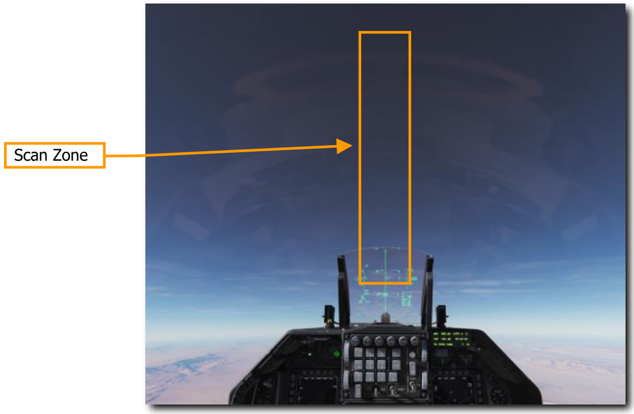
BORE is useful for quickly locking a target within visual range (WVR) and allows a degree fine control as to the target being locked. The first target detected within 20 nautical miles is locked and automatically tracked in STT mode.

10° × 60° (Vertical Scan) Sub-mode

In the 10° × 60° vertical scan sub-mode, the radar searches an area with 10° in width and 60° in the vertical. The scan center is 23° above the HUD's gun cross. This mode is indicated by a vertical line extending from the gun cross to the bottom of the HUD.

The FCR format will display "ACM 60."





The lock range is 10 nautical miles. The radar automatically locks on to the first target in this zone. When locked, the target is automatically tracked in STT mode.

This mode is most often used during air combat maneuvering (ACM) dogfights. During such fights, you are often trying to place the target on the lift vector and "pull" the target into the HUD. When in this mode, you can often lock on to the target earlier, even when it is well above the HUD frame.

Slewable Sub-mode (later in early access)

The scan pattern is approximately 20° high × 60° wide. When selected, the scan is centered directly in front of the aircraft on the horizon. The scan is slewable via the CURSOR/ENABLE control until a target is acquired. The amount of slew is limited by the radar gimbal limits.

The FCR format will display "ACM SLEW."

As with the other sub-modes, the radar automatically locks on to the first target in this zone. When locked, the target is automatically tracked in STT mode.

This mode is useful when you have a direction to look, for example 'bandits 2 o'clock high', but have not picked them up visually yet.

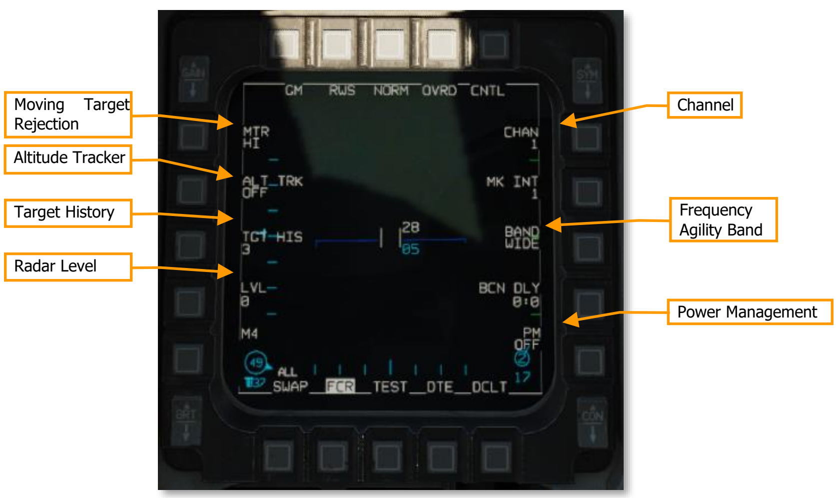
Single Target Track (STT) Mode

After you have locked the target from RWS or ACM sub-modes, the radar will change to STT mode. The radar now focuses all its energy on a single target and provides constant updates. However, the radar will no longer detect other contacts and the enemy may be alerted by this radar lock.

The MFD display in STT mode remains much the same as RWS mode with these differences: The **locked radar target** is displayed as a circled triangle symbol with a flight vector line. The **target's altitude** is displayed below the target symbol. The top of the display shows **aspect angle, ground track** (direction the contact is traveling over the ground)**, calibrated airspeed**, and **closure rate**.

Control (CNTL) Menu

The Control Menu allows configuration of the FCR in air-to-air mode and the air-to-air presentation. Some options are only applicable to air-to-ground radar modes; the air-to-air options are documented below.



Channel. Selects the frequency channel the radar uses, 1 through 4 (not implemented). Different aircraft within a flight should use different channels to avoid radar interference with each other.

Frequency Agility Band. Toggles between wide (WIDE) and narrow (NARO) frequency agility bandwidth (not implemented). *Frequency agility* refers to the radar's technique of randomly hopping between different frequencies within the agility band, to increase the difficulty of being jammed.

Power Management. Not implemented.

Radar Level. Not implemented.

Target History. Sets the number of frames that a radar return lives (default 3). When set to 1, a radar return is only displayed during the frame that it is detected. When set to 2, 3, or 4, the radar return is displayed for additional scan frames, becoming dimmer with each new frame. By setting the target history, you can get a broad idea of target relative bearing, since the frames will appear to form a line.

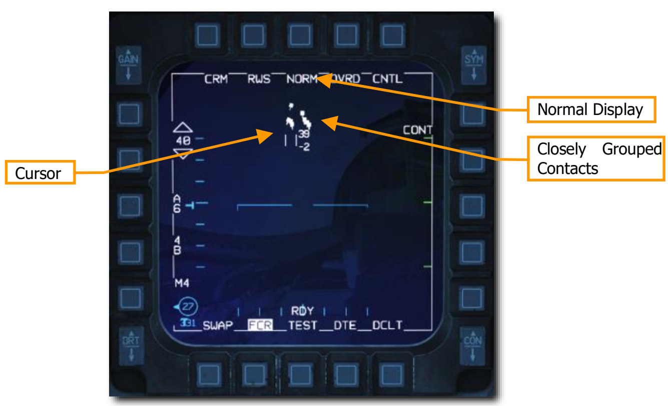
Altitude Tracker. Toggles on and off the altitude line tracker/blanker (not implemented). When on, blanks all targets which are detected at the range of the altitude line.

Moving Target Rejection. Sets the minimum relative velocity that a detected aircraft must have before it is displayed (Doppler gate). Not implemented.

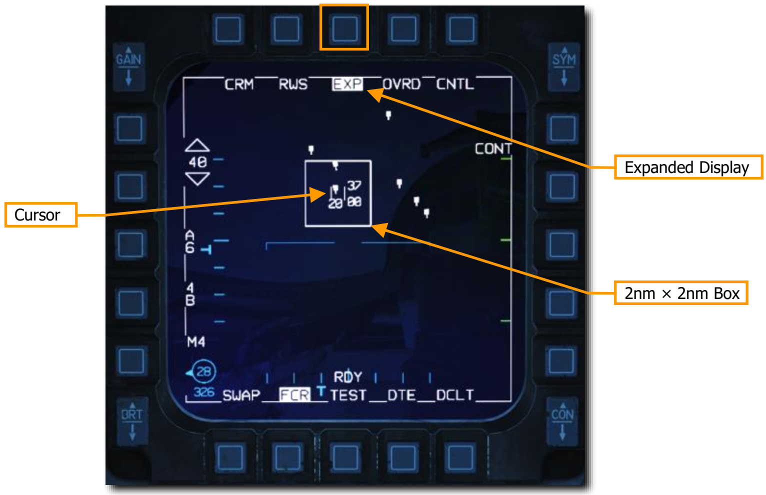
Expand (EXP) Feature

The radar provides the ability to enter an expanded field of view display that allows sorting and resolution of closely grouped contacts. This can be thought of as a zoom feature that provides a 4:1 scale view centered around the radar cursor. This feature is available in all radar modes.

The expanded display may be toggled on or off by selecting the OSB next to NORM/EXP or by pressing the **Expand/FOV Button** while the FCR is sensor of interest.



The expanded display features a 2 nm × 2 nm reference box centered on the cursor. Basic functions and symbology are unchanged from the normal display.

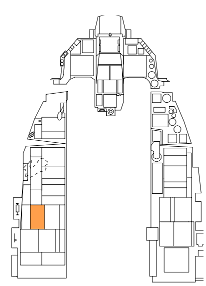


IFF Interrogation

The Identification Friend or Foe (IFF) system allows interrogation of aircraft to determine if they are friendly or hostile. This is done by transmitting a coded signal aimed at a specific radar contact or volume of space within the selected radar azimuth and elevation. Transponders in friendly aircraft receive this signal and reply with the correct coded response.

Contacts are classified based on the response and symbols identifying contacts as friendly or hostile are displayed on the radar screen. The IFF system is not radar dependent so interrogation of contacts is still possible with the radar off.

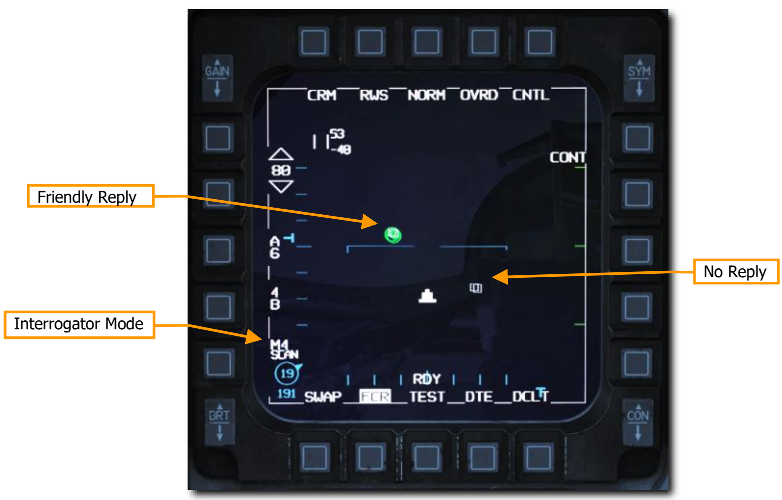
The IFF Master Switch must be set to NORM or LOW on the IFF panel to enable IFF interrogation.



Interrogation is initiated by HOTAS command in one of two modes:

- **Scan.** Press TMS Left short (1 second or less) to interrogate all contacts in the radar scan volume.
- **Line of Sight (LOS).** Press TMS Left long (more than 1 second) to interrogate the locked target or immediate area around the radar cursor.

If the contact is friendly a green circle is drawn around the contact for three seconds. If no reply is received, no indication is displayed, and the contact is classified as unknown. These contacts may be assumed to be hostile depending on the rules of engagement (ROE) in your current scenario.



AIR-TO-GROUND MODES

This section's revision is currently a work-in-progress.

The air-to-ground radar operates in six different selectable modes:

- Ground Map (GM)
- Ground Moving Target (GMT)
- Sea Search (SEA)

In addition, there are three additional modes that the radar uses in certain situations:

- Fixed Target Track (FTT)
- Air-to-Ground Ranging (AGR)
- Situational Awareness Mode (SAM)

Currently, the GM and SEA sub-modes are selectable.

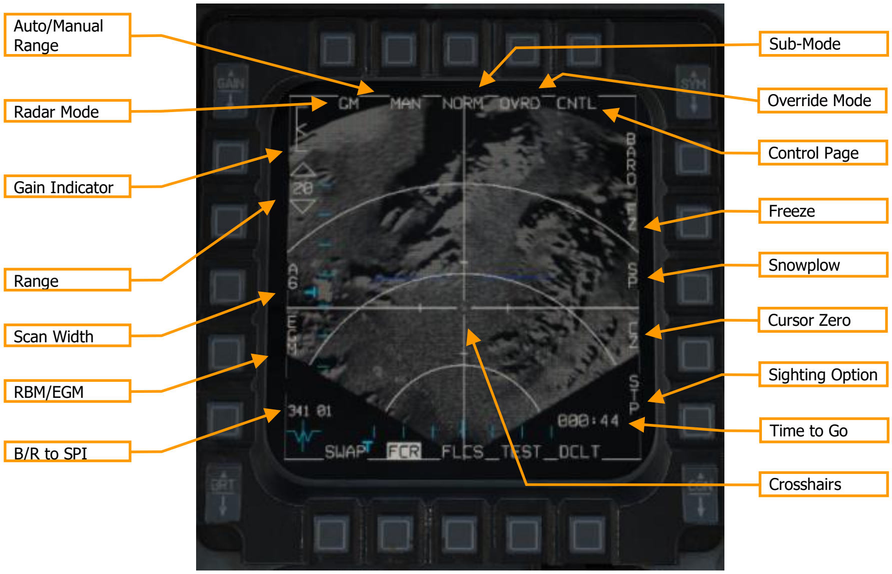
Ground Mapping (GM) Mode

The Ground Mapping mode is a B-scope raster scan of terrain ahead of the aircraft. Image intensity is a function of the strength of a radar return. Certain ground features will have higher intensity (e.g., buildings or vehicles) and others will have lower intensity (e.g., water). Terrain or tall structures will impede the radar beam from traveling further, creating distinctive shadows, giving the resulting image the appearance of an elevation relief map.

Normally, the radar only scans the area around the SPI, regardless of aircraft location or heading. If the SPI moves outside the radar field of view, the radar antenna is boresighted. To scan directly ahead of the aircraft instead, use Snowplow (SP) Mode.

The ground mapping mode operates in one of four sub-modes:

- NORM: Normal mode
- EXP: Expanded mode, a 4:1 expansion of the NORM scan area.
- DBS1: Doppler beam sharpening mode level 1. The DBS mode can create a higher-resolution image than the enhanced ground mapping mode, though it takes longer to render the image. DBS level 1 produces a 24:1 sharpening. The rendered area is the same size as EXP mode.
- DBS2: Doppler beam sharpening mode level 2. Level 2 creates an even sharper image, at 64:1, but raster takes three times longer than DBS1. The rendered area depends on range to target, with a minimum of 8 NM square.



Radar Mode. Pressing this OSB displays the radar mode menu. Radar modes will be displayed along the right side and can be selected with the adjacent OSB. Only GM and SEA are available currently.

Sub-Mode. Cycles between NORM, EXP, DBS1, and DBS2 sub-modes. See Expanded Sub-Modes, below.

Override Mode. When highlighted, places the radar in standby mode and suppresses radar transmission.

Range. Pressing these OSBs moves between the radar range options: 80, 40, 20, and 10 NM.

Auto/Manual Range. Pressing this OSB toggles between AUTO and MAN (manual) range control. When in AUTO mode, moving the crosshairs to the top or bottom of the display increases or decreases the range. The label displays the mode that will be set if the OSB is pressed: AUTO is displayed when manual mode is active, and MAN is displayed when automatic mode is active.

Gain Indicator. The scale indicates the range of possible radar gain values. The caret indicates the current radar gain. Radar gain is adjusted with the GAIN rocker to the left. Higher gain values will produce a brighter image but may wash out details.

Scan Width. Press to cycle between azimuth width options. The radar will only scan inside that azimuthal area. Options are A6 (60° to each side of center), A2 (20° to each side), and A1 (10° to each side). Decreasing scan azimuth will increase refresh rate but hinder situational awareness.

RBM/EGM. Toggles between Real Beam Mode (RBM) or Enhanced Ground Map (EGM). RBM uses raw radar data to quickly produce an image. EGM uses post-processing to improve the image resolution but takes longer to render an image. When EGM is on, only the center portion of the radar image is post-processed. EGM is not available at large bank angles.

Crosshairs. The crosshairs indicate the current sensor point of interest (SPI). When not in snowplow mode, the Cursor Enable control can be used to move the crosshairs and change the SPI.

B/R to SPI. Displays the bearing and range from the aircraft's position to the SPI.

Time to Go. Displays the time (minutes:seconds) until reaching the SPI.

Control Page. Pressing displays the Control menu. See Control (CNTL) Menu.

Freeze. Pressing this OSB puts the radar in standby mode and freezes the current radar image on the display. See Freeze (FZ) Function, below.

Snowplow. Pressing this OSB moves the crosshairs to the center of the display and causes the radar to scan in front of the aircraft, regardless of its location relative to the SPI.

Cursor Zero. Pressing this OSB resets all cursor slew.

Sighting Option. Toggles between different sighting options. The selected sighting option determines the relationship between the selected steerpoint and the SPI.

- **STP.** SPI is the selected steerpoint. Default in NAV master mode.
- **TGT.** SPI is the designated target (or the selected steerpoint if no target is designed). Default in A-G master mode.
- **OA1.** SPI is Offset Aimpoint 1 for the selected steerpoint.
- **OA2.** SPI is Offset Aimpoint 2 for the selected steerpoint.
- **RP.** SPI is the Visual Reference Point for the selected steerpoint (See Visual Reference Points).
- **IP.** SPI is the Visual Initial Point for the selected steerpoint (See Visual Initial Points).

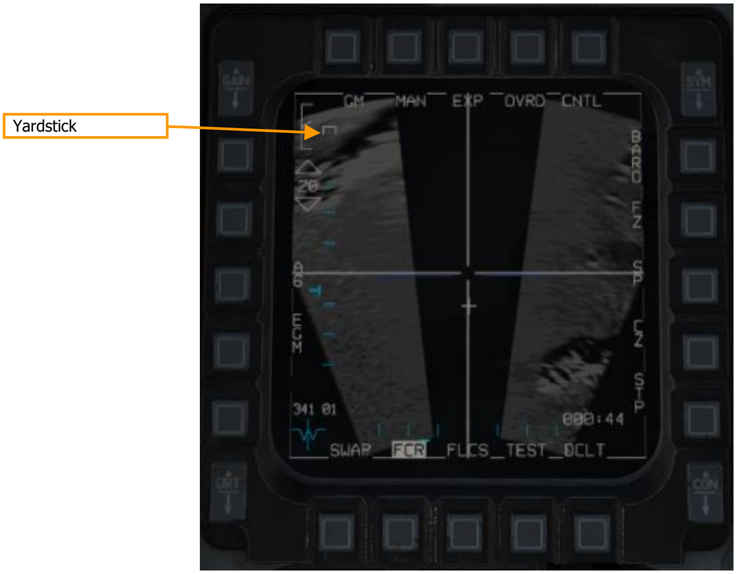
When in GM mode, pressing TMS forward designates a target (see Fixed Target Track (FTT)). Pressing TMS aft undesignates that target.

Pressing the Expand/FOV button cycles between the different sub-modes (NORM, EXP, DBS1, and DBS2).

Expanded Sub-Modes

The expanded sub-modes cannot resolve radar information directly ahead of the aircraft's nose. When using an expanded sub-mode, only off-azimuth radar data will be shown.

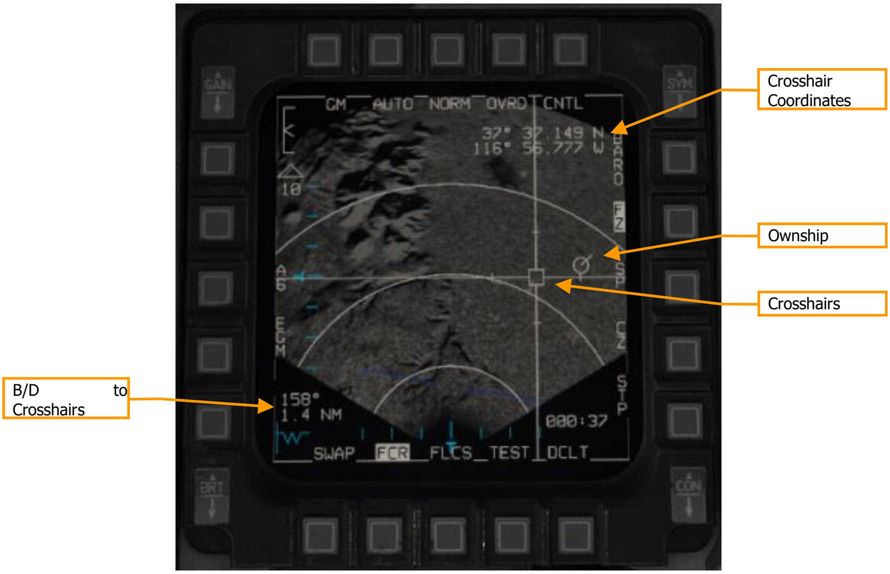
When in an expanded sub-mode, the crosshairs are fixed at the center of the screen, and using the Cursor Enable control slews the image, not the crosshairs.



Yardstick. Indicates a ¼ nautical mile distance.

Freeze (FZ) Function

When OSB 7 is pressed, the Freeze function is activated. The radar image will freeze. If the radar continues to maintain line of sight to the imaged area, the image will continue to refresh with subsequent scans, though the location and bounds of the image will not change. If the radar loses LOS, it will coast, and the last scanned composite image will be preserved on the display.



Crosshairs. Used to designate a target. Controlled by the Cursor Enable control. When the radar is coasting, the crosshair center is displayed as a hollow box. When the radar is actively scanning the crosshair area, the crosshairs center is displayed as a filled triangle.

Ownship. Displays the location of the aircraft within the radar image. Not displayed if the aircraft is outside the radar image dimensions.

Bearing and Distance to Crosshairs. Displays the bearing and distance from the present position (represented by the ownship) to the crosshairs.

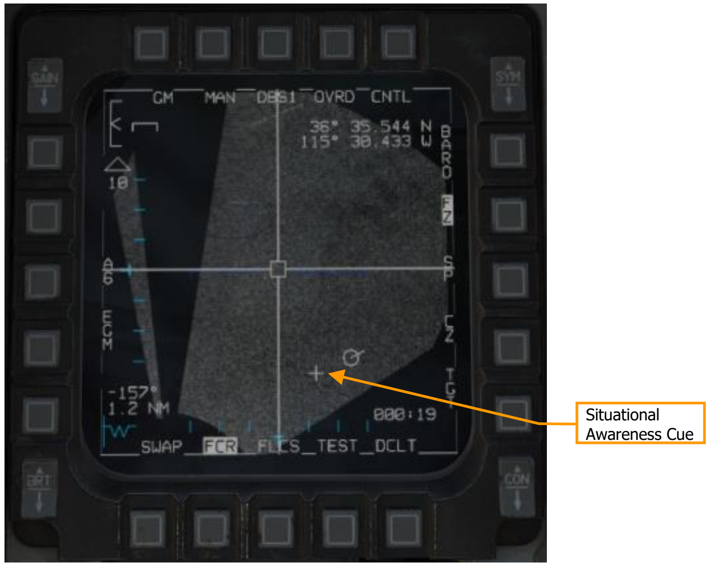
Crosshair Coordinates. Displays latitude and longitude of crosshair position. Holding TMS aft temporarily blanks this text.

Fixed Target Track (FTT)

When a location is designated with TMS Forward, the radar enters FTT sub-mode. This sub-mode has identical symbology and operation to the FZ (Freeze) function, described above, although the radar beam remains locked on the designated location and is no longer used to create a raster image.

FTT is appropriate for tracking fixed ground targets or slow-moving sea targets such as ships. To track moving land targets or fast-moving sea targets, use Ground Moving Target (GMT) mode (will be implemented later).

When in FTT, the designated location becomes the SPI. The radar will continue to track the target location while line-of-sight is maintained. If LOS is lost, the radar will coast for 10 seconds before the radar returns to GM or SEA mode. If the designated location moves outside the radar field of view, the radar will slew to boresight until the target returns into the radar FOV, at which point the radar will reacquire the target. If the target remains outside the radar FOV for 60 seconds, the radar will return to GM or SEA.



Situational Awareness Cue. The point about which the map has been expanded.

Snowplow (SP) Mode

In Snowplow mode, the radar scans directly ahead of the aircraft, independent of the SPI location. The radar cursor is fixed at the center of the display.

Pressing TMS Forward while in Snowplow mode ground-stabilizes the cursor and exits Snowplow mode. You can then either designate a target, or press Cursor Zero (CZ) if desired to reset the cursor to the steerpoint location.

Sea Search (SEA) Mode

SEA mode works identically to GM mode (see above). SEA mode is appropriate for tracking slow-moving or stationary objects on the water's surface.

DL16 DATALINK

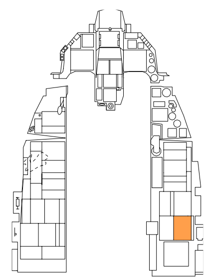
USAF Photo
by A1C Matthew Seefeldt

OVERVIEW

This section's revision is currently a work-in-progress.

The aircraft relies on the Multifunction Information Distribution System (MIDS) radios that allow the transmission and reception of data over the DL16 Tactical Data Information Link (TADIL) network.

DL16 allows various types of aircraft to share data with each other. DL16 is part of the MIDS radio system and must be activated by rotating the MIDS LVT knob on the Avionics Power Panel to the ON position. The DL switch next to the knob is not applicable to this block of the F-16C and may be left OFF if desired.



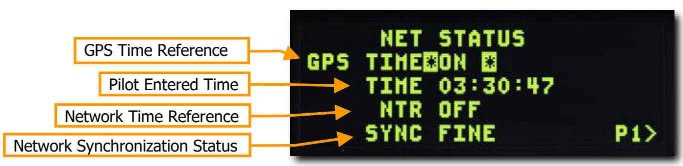
The primary purpose of DL16/MIDS is to provide a near-real-time picture of the tactical area around the pilot's aircraft. Data from ownship sensors, other friendly fighters on the network, and surveillance assets like AWACS are correlated to create a unified situational awareness picture. This in turn allows a more coordinated engagement and less chance of fratricide.

DLNK DED Pages

Three datalink (DLNK) pages are available on the DED to monitor and verify configuration of the DL16 system. The first page is accessed by pressing the LIST button on the ICP and selecting ENTR ("E"). The next page can be selected by toggling the DCS right to the SEQ position.

NET STATUS Page

Page 1 displays network status and time references.



GPS Time Reference. All DL16 network participants must work off a common time reference. This is provided by GPS clock data when this is set to ON.

Pilot Entered Time. If GPS is not used or not available, network participants may enter a time based on a pre-arranged reference.

Network Time Reference. If enabled, this identifies the aircraft as the network controller. This is normally set to OFF.

Network Synchronization Status. This displays the quality of time synchronization with the network.

DL16 Page

Page 2 sets MIDS radio options, including channels for data reception and transmission power.

Fighter, Mission and Surveillance Channel selection. This selects the MIDS channel data from flight members, other flights and AWACS aircraft is received on. These are pre-set and do not need to be changed.

Callsign. This is the identifier for data coming from the aircraft.

Flight Lead Identifier. If enabled, this identifies the aircraft as the flight lead.

Transmission Power. This selects the power output for the MIDS radios.

DL16 STN Page

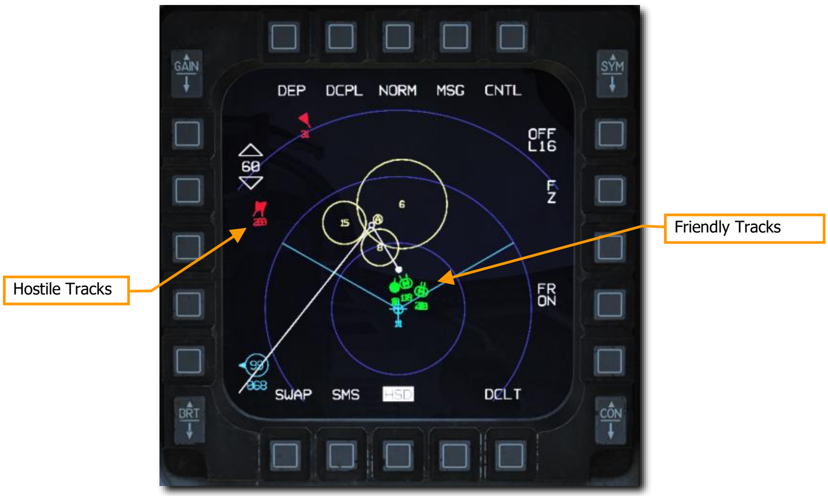
Page 3 allows management and identification of flight member station track numbers (STN) on the network.

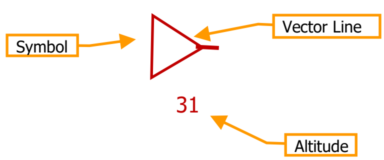
Flight Member Track Numbers. These identify the tracks for members of a flight. These are pre-set and do not need to be changed.

Own Flight Position. This identifies the aircraft's position in the flight.

DISPLAY SYMBOLOGY

Each trackfile is represented by a symbol on the HSD and Radar Display. Depending on the shape and color, you can determine whether it is friendly or hostile, and what the source of the track is; onboard systems, offboard donors, or a combination of the two.



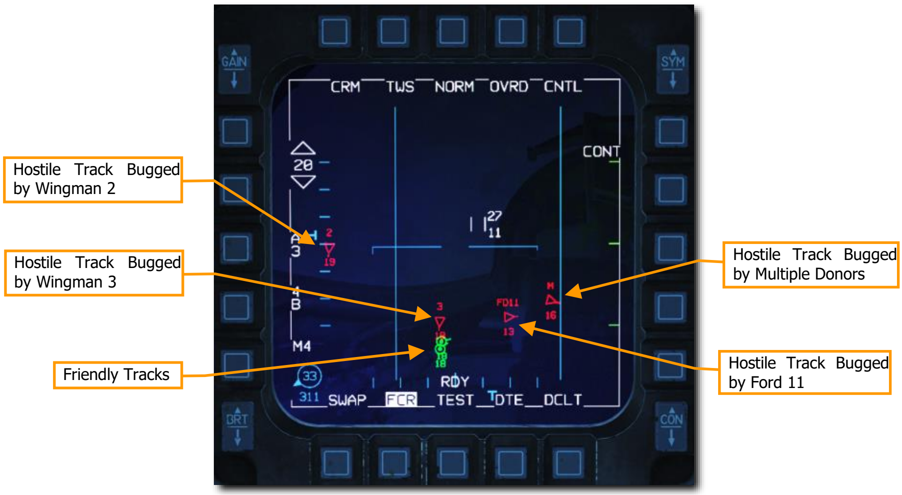


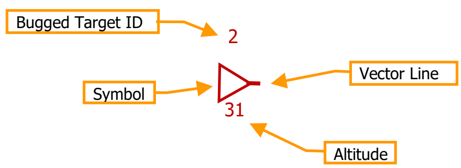
Symbol. The basic symbol changes shape and color to represent different information. See below for examples.

Vector Line. This line points in the direction the track is heading.

Altitude. This displays the track's altitude in thousands of feet

The Radar Display presents the information in much the same way as the HSD but includes an additional identifier when a target is 'bugged' as the primary target by another donor aircraft on the network. This is a great aid to target sorting as it allows the pilot to prioritize targets not being engaged by other aircraft in the area.





The **Bugged Target ID** shows the aircraft that is currently targeting a hostile track and may be interpreted as follows:

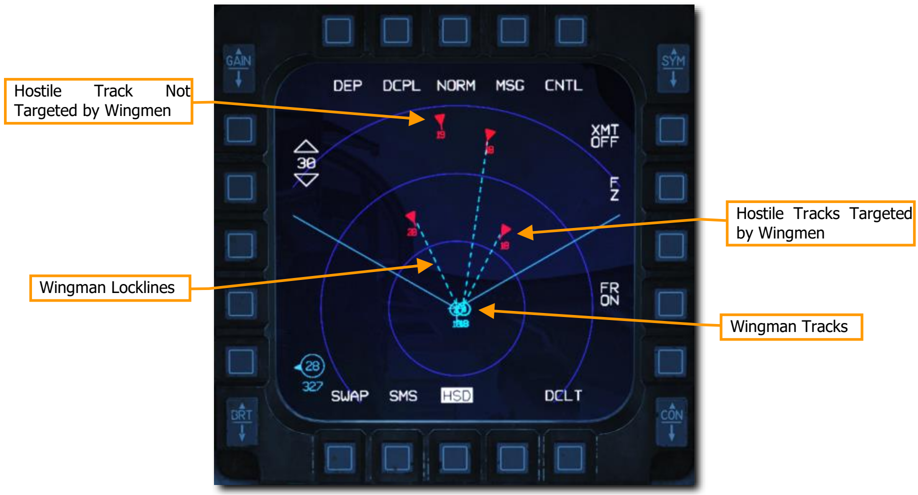
1, 2, 3, or 4. These identify the member of the pilot's flight that is currently bugging the target.

FD11, EN23, CY14, etc. The first and last letters of the callsign and flight position number is displayed when a target is bugged by a donor that is not a member of the pilot's flight. For example, FD11 identifies Ford 11, CY14 identifies Chevy 41, and so on.

M. The target is bugged by multiple donors.

Bugged targets are identified differently on the HSD than on the radar display. A dashed cyan **Wingman Lockline** is drawn from wingmen to their currently bugged targets. Wingman Locklines are only displayed for flight members and not for all donors on the network.

Bugged Target IDs are shown on the radar display only and Wingman Locklines are displayed on the HSD only.

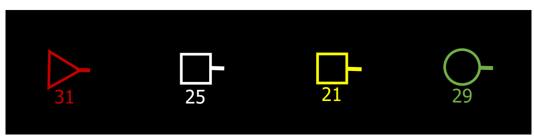


DL16/MIDS can receive and display three types of trackfiles:

- **Surveillance Tracks.** These are tracks provided by data sources like AWACS and radar ground stations.

	Hostile	Unknown	Suspect	Friendly

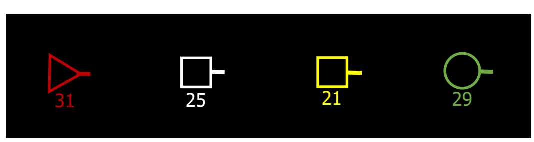
Surveillance Tracks



- **Fighter Tracks.** These are tracks provided by donor aircraft, other fighters providing track data, on the network. They are all correlated against each other to avoid duplicate trackfiles. These are visually identical to surveillance tracks.

	Hostile	Unknown	Suspect	Friendly

Fighter Tracks



- **Precise Participant Location and Identification (PPLI) Tracks.** These show the location and status of members of the pilot's own flight and up to four additional donor aircraft.

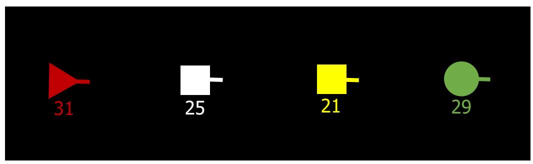
Wingman **Other Donor**

PPLI Tracks

Trackfiles from each of these three sources (offboard) are then correlated with the sensors of the player's aircraft (onboard). This is termed Multi Source Integration (MSI).

Hostile **Unknown** **Suspect** **Friendly**

Tracks Correlated with Onboard Sensors



Wingman **Other Donor**

PPLI Tracks Correlated with Onboard Sensors

Radar Display Filtering

Track symbols displayed on the FCR page may be filtered using the UHF/VHF Transmit switch. This affects tracks displayed on the radar display only and does not affect those displayed on the HSD.

Positioning the switch **inboard short** (less than .5 sec) rotates between three filter options:

- **ALL.** All symbols are displayed
- **FTR+.** Surveillance tracks are removed
- **TGTS.** Surveillance and PPLI tracks are removed

Positioning the switch **outboard short** (less than .5 sec) selects **NONE** and removes all datalink tracks. Selecting **outboard short** again returns to the previously selected filter option.

The current option is displayed at the bottom left of the radar display.

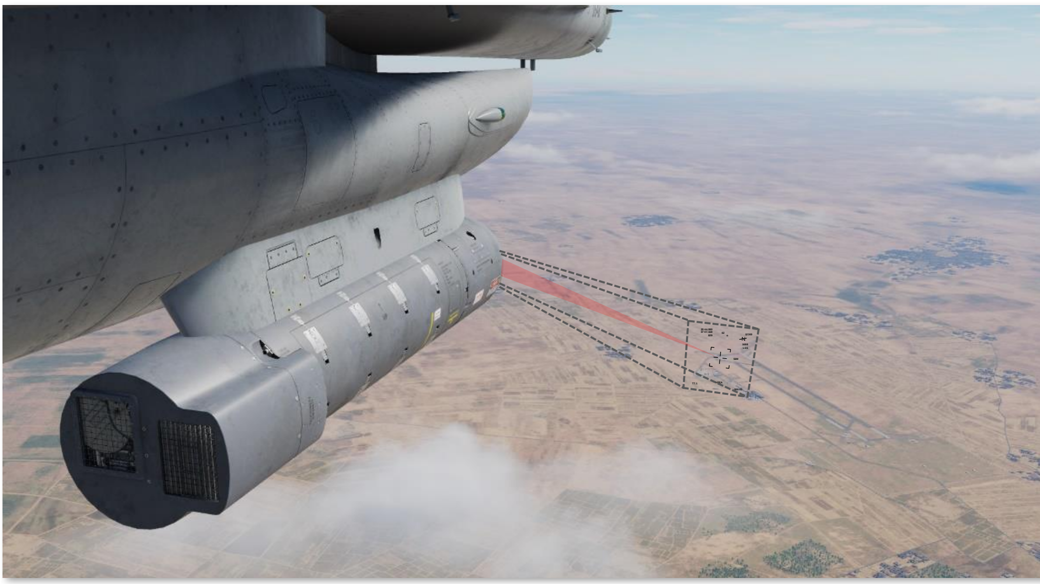
LITENING II TARGETING POD

USAF Photo
by MSgt Kevin J. Gruenwald

LITENING II TARGETING POD

This section's revision is currently a work-in-progress.

The AN/AAQ-28 Litening II Targeting Pod (TGP) enables the F-16C to electro-optically search, acquire, track, and designate targets on the ground or in the air, during day or night. The Litening pod can be used to perform reconnaissance from high altitudes, laser designate ground targets for engagement by precision-guided munitions, or even optically identify aircraft from long-range.



AN/AAQ-28 Reconnaissance, Targeting, and Designation

The Litening II targeting pod includes four sensors within a steerable turret located on the forward face of the pod itself: a charge-coupled device (CCD) TV camera, a forward looking infrared (FLIR) thermographic camera, a laser rangefinder/designator for designating targets or ground locations, and a laser spot tracker for detecting offboard laser designations.

Targeting Pod Activation

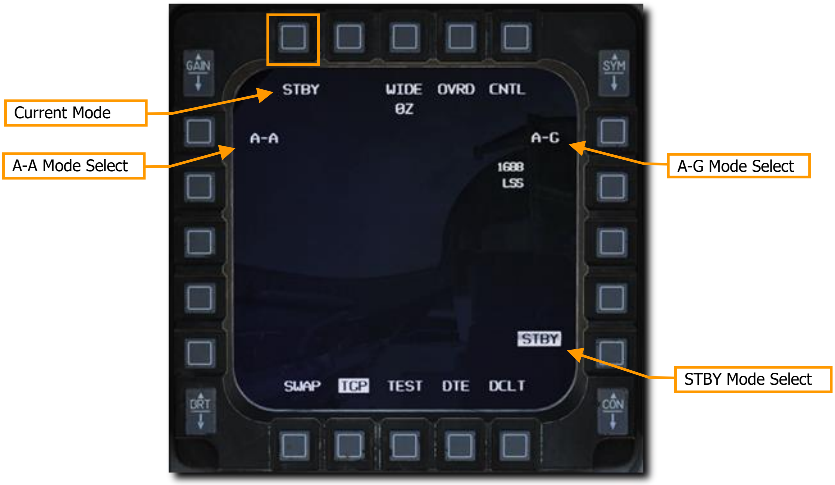
The TGP (if equipped) is powered through the right "chin" hardpoint. This is accomplished by positioning the RIGHT HDPT switch to the forward position on the SNSR PWR control panel on the right console.

The TGP will require approximately 2 minutes to initialize, perform self-tests, and cool down the FLIR sensor. During this time, the TGP MFD format will display a "NOT TIMED OUT" message along with a "FLIR NOT COOL" advisory.

The targeting pod cannot function without the MMC, ST STA, UFC, or MFD avionics systems, or without a properly aligned INS.

Mode Selection

You may change modes by pressing the OSB 1 adjacent to STBY. The following options will be displayed depending on Master Mode:



A-A Mode Select. Pressing this OSB selects A-A mode.

A-G Mode Select. Pressing this OSB selects A-G mode.

STBY Mode Select. Pressing this OSB selects STBY mode.

The main function modes and sub-modes for the TGP include:

- Standby (STBY)
- Air-to-Ground (A-G)
  - Slave (Ground)
  - AREA Track
  - POINT Track
  - INR Track
  - Laser Spot Search (LSS)
- Air-to-Air (A-A)
- Slave (Body)
  - POINT Track
  - RATE Track
  - HUD

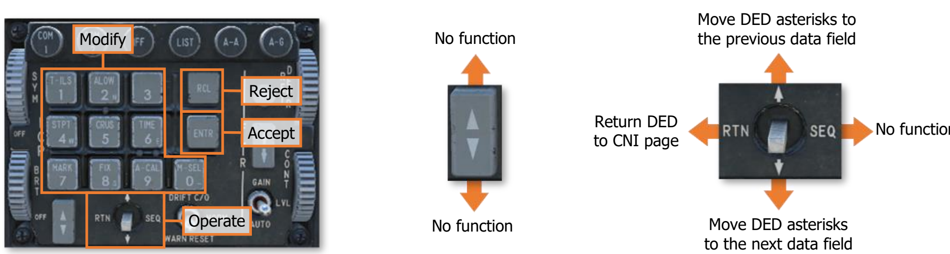
Each of these modes also has a Control Page that provides you with the ability to configure TGP features.

After initialization is complete, the LASR DED page can be used to set the laser codes for the TGP laser designator and laser spot tracker, along with the automatic laser designation time setting.

LASR DED Page

The Laser DED page is accessed by pressing **5/CRUS** on the ICP keypad when the MISC DED page is displayed on the DED. This page is used to configure the targeting pod (if equipped) for laser ranging and designation operations.

NOTE: The TGP and LST CODE data fields cannot be edited if the targeting pod is powered off or still initializing. When the pod has fully initialized and is in STBY mode, these data fields will accept data entry.



1. **TGP Designation Code.** Displays the laser PRF code that will be emitted from the targeting pod's laser rangefinder/designator (LRFD). May be modified using the ICP keypad and can be set to designate PRF codes 1111-1788 or PIM codes 2111-2888.
2. **Laser Spot Tracker Code.** Displays the laser PRF code that the targeting pod's laser spot tracker (LST) will search for when enabled. May be modified using the ICP keypad and can detect PRF codes 1111-1788 or PIM codes 2111-2888.
3. **Laser Start Time.** Displays the Time-To-Impact value at which the targeting pod will automatically begin laser designation for terminal guidance of laser-guided munitions. May be modified using the ICP keypad, with acceptable values between 0 and 176 seconds. A value of 0 will disable automatic laser designation.
4. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

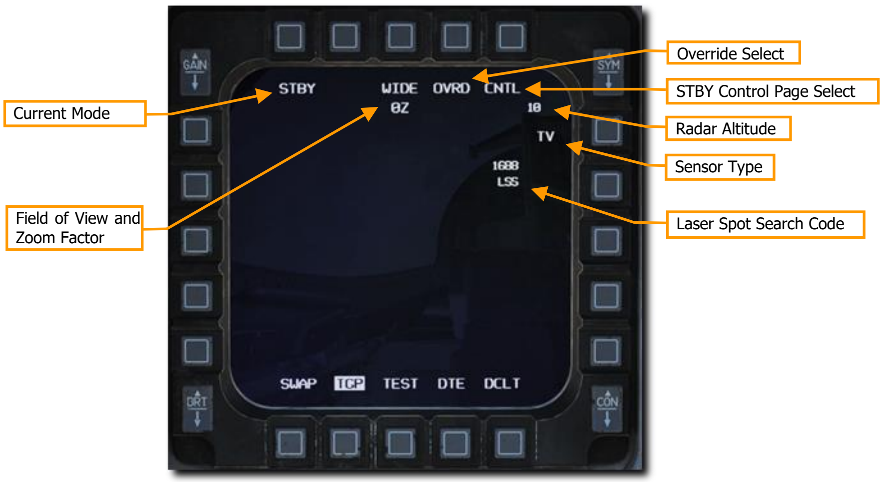
To employ laser-guided munitions autonomously, the TGP designation code on this page must match the pre-programmed laser code on the bomb guidance sections. Note that the F-16C can only be equipped with laser-guided munitions that can guide on laser PRF codes between 1511 and 1788, despite the F-16C targeting pod's capabilities to designate outside of this PRF range. (See Terminal Laser Guidance Codes for more information.)

When performing targeting operations within the flight, it is often advantageous to set the LST code to the wingman's TGP designation code during run-up. This technique can facilitate an immediate target handover between aircraft when both targeting pods are oriented in the same geographic area, by simply setting the TGP as SOI and depressing the MAN RNG/UNCAGE knob to initiate a Laser Spot Search (LSS).

STANDBY (STBY) MODE

This will be the first TGP mode screen displayed upon activation of the TGP. After the "NOT TIMED OUT" message has been removed (after 3 minutes), the mode may be exited by selecting one of the other two TGP modes or the standby control page.

The following OSB functions may be displayed:



Current Mode. This is the mode the TGP is currently in.

Field of View. Pressing this OSB toggles between Narrow Field of View (NFOV) or Wide Field of View (WFOV). These views can vary between the CCD and FLIR sensors in the TGP.

- FLIR field of view:
  - Wide Field of View (WFOV) is 4° × 4°
  - Narrow Field of View (NFOV) is 1° × 1°
- CCD field of view:
  - Wide Field of View (WFOV) is 3.5° × 3.5°
  - Narrow Field of View (NFOV) is 1° by 1°

Zoom Factor. Within an FOV selection, you may additionally adjust the zoom-factor by zooming in and out with the RANGE knob. The zoom range goes from 0Z (no zoom) to 9Z (highest level of zoom within FOV). Objects within the TGP field of view double in size from 0 to 9 zoom.

OVRD Select. Pressing this OSB overrides any current mode and returns to STBY. The last selected mode is returned to when OVRD is selected a second time.

STBY Control Page Select. Pressing this OSB selects the STBY Control Page. Options and functions are described below.

Radar Altitude. The current radar altitude is displayed.

Sensor Type. Displayed in the upper right corner, this text field indicates the current video mode that the TGP is collecting in. The three options include:

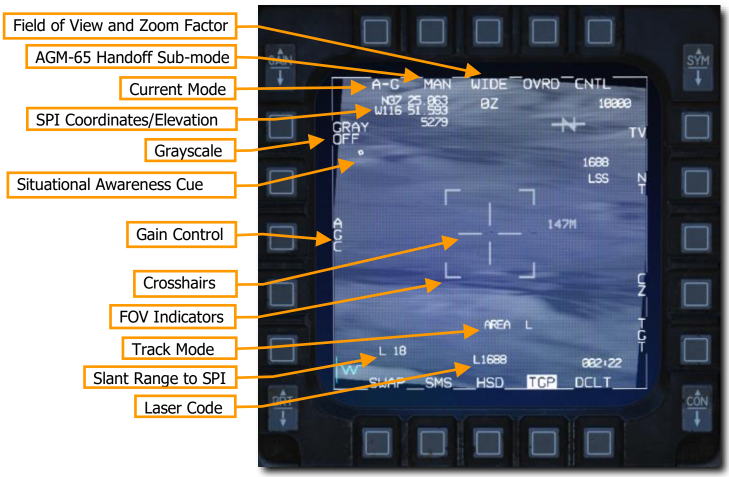
- WHOT. Using the FLIR camera, hot objects appear lighter than a cooler background.

- BHOT. Using the FLIR camera, hot objects appear darker than a cooler background.
- TV. The Charge Coupled Device camera displays this image. This is a daytime, electro-optical camera.

Laser Spot Search Code. This is the laser pulse rate frequency (PRF) code the TGP will attempt to locate in laser spot search (LSS) mode.

AIR-TO-GROUND (A-G) MODE

When A-G mode is first entered, the TGP will boresight at 150 mils below the zero sight line of the aircraft, directly forward and slightly down. The following elements may be displayed:



Field of View. Pressing this OSB toggles between Narrow Field of View (NFOV) or Wide Field of View (WFOV). These views can vary between the CCD and FLIR sensors in the TGP.

- FLIR field of view:
  - Wide Field of View (WFOV) is 4° × 4°
  - Narrow Field of View (NFOV) is 1° × 1°
- CCD field of view:
  - Wide Field of View (WFOV) is 3.5° × 3.5°
  - Narrow Field of View (NFOV) is 1° by 1°

Zoom Factor. Within an FOV selection, you may additionally adjust the zoom-factor by zooming in and out with the RANGE knob. The zoom range goes from 0Z (no zoom) to 9Z (highest level of zoom within FOV). Objects within the TGP field of view double in size from 0 to 9 zoom.

AGM-65 Handoff Sub-mode. This OSB toggles between **MAN** and **AUTO** for AGM-65D/G Maverick hand off mode.

- MAN. The AGM-65 will be slaved to the Line of Sight of the TGP but will not automatically be handed off the lock. Pilot must manually change SOI to AGM-65 and command lock manually.
- AUTO. TMS right will hand off the lock to the AGM-65 if the target contrast and size meets criteria of missile lock.

Current Mode. This is the mode the TGP is currently in.

SPI Coordinates/Elevation. The lat/lon coordinates and elevation in feet of the current System-Point-of-Interest (SPI) is displayed. This is usually the point in the center of the crosshairs at ground level.

Grayscale. When pressed, it displays a 10-stage gray scale bar at the bottom of the display. When enabled, the label changes to GRAY ON.

Situational Awareness Cue. The SA cue provides you a reference to indicate the TGP's current line of sight in reference to the pod's longitudinal (boresight) axis, which is coincidental with the aircraft longitudinal axis. The cue is represented as a small square that can move to any spot within the display. The position of the SA square represents the current TGP line of sight.

Gain Control. Pressing this OSB toggles between manual and automatic gain control for the FLIR video.

- MGC. If selected, level control arrows are displayed on the OSBs below (not shown). Gain may be controlled with the physical gain rocker switch on the top left of the MFD. The current selected gain is indicated on the top left corner of the TGP page (not shown).
- AGC. Gain is adjusted automatically, and the level control arrows and gain indicator are both removed.

Note: The AGC/MGC label and associated OSB labels are displayed even if the TGP is in TV mode.

Crosshairs. Line of sight for targeting and laser fire.

Field of View (FOV) Indicators. These four corner brackets are only shown when WIDE FOV is enabled and indicate the portion of the image that will be displayed if NARO FOV is enabled.

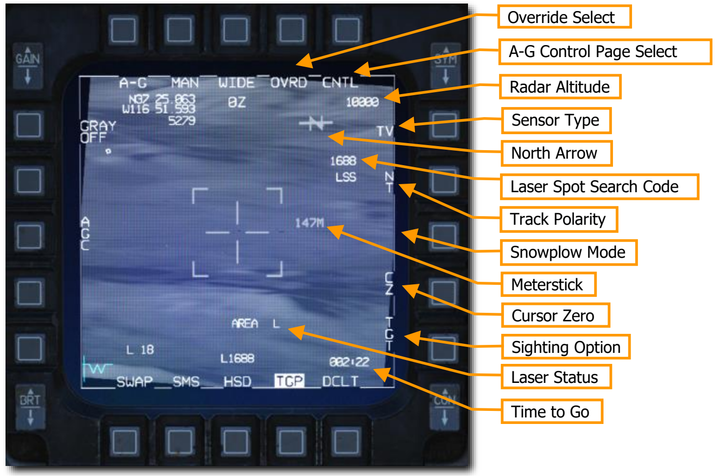
Track Mode. If the TGP is in a track mode, this field will indicate the track mode it is in. Types include:

- AREA. In AREA track mode, the TGP performs image correlation to track an overall scene. AREA track mode is effective at tracking fixed objects.
- POINT. In POINT track mode, the TGP attempts to follow the centroid of a visible object using edge detection. POINT track mode is effective at tracking moving objects that are well-defined against their background, either because they are warmer (in HOC/COH sub-modes) or brighter (TV sub-mode).
- INR (inertial rates). In INR mode, the TGP maintains its LOS on a position using only inertial integration. It does not do any image processing. INR track mode is effective at approximately maintaining the TGP LOS when the target is at risk of being masked or obscured.

Slant Range to SPI. This indicates the slant range in nautical miles to the SPI. The preceding letter indicates the source of the range data.

- L. Laser (priority over all other sources)
- T. TGP passive ranging
- (blank). Sensor that is not the TGP is providing range (for example, FCR A-G ranging)

Laser Code. If the laser is firing (flashing L), the targeting pod laser code being used should display the code as set on the LASR DED page. This is an octal value of 1 to 8 with a range between 1111 and 2888.



OVRD Select. Pressing this OSB overrides any current mode and returns to STBY. The last selected mode is returned to when OVRD is selected a second time.

A-G Control Page Select. Pressing this OSB selects the STBY Control Page.

Radar Altitude. The current radar altitude is displayed.

Sensor Type. Displayed in the upper right corner, this text field indicates the current video mode that the TGP is collecting in. The three options include:

- WHOT. Using the FLIR camera, hot objects appear lighter than a cooler background.
- BHOT. Using the FLIR camera, hot objects appear darker than a cooler background.
- TV. The Charge Coupled Device camera displays this image. This is a daytime, electro-optical camera.

North Arrow. The north arrow cue consists of the letter N with an arrow, displayed on the top right corner of the TGP base page. The arrow points to magnetic north in 1.4° increments relative to the TGP cross hairs line of sight.

Laser Spot Search Code. This is the laser pulse rate frequency (PRF) code the TGP will attempt to locate in laser spot search (LSS) mode.

Track Polarity. For either FLIR or TV, pressing this OSB toggles between Neutral Track (NT) and White Track (WT). When TV is selected, the OSB cycles between NT, WT, and Black Track (BT).

- NT mode allows both white and black targets to be point tracked. This is the default A-G mode.
- WT only allows white point targets to be tracked. This is the default A-A mode
- BT allows black point targets to be tracked.

Pressing this OSB twice within 0.5 seconds toggles the Laser Spot Tracker (LST) function on and off.

Snowplow Mode. This mode is available in NAV and A-G modes while the TGP is not tracking. This mode is available when SP is displayed adjacent to the OSB (not shown). When SP is pressed, both the FCR and TGP are commanded to snowplow mode.

In snowplow mode, the TGP LOS is commanded straight ahead and angled downwards to point to the ground ahead at ½ of the currently selected FCR scale (for example, if selected FCR scale is 40nm, the TGP will look at the point on the ground 20nm ahead). Because the location determined by the reticle is snowplowing, the SPI itself will also snowplow.

Slewing is disabled; however, it is possible to ground-stabilize by pressing TMS-fwd. This will exit SP mode and enter a normal AREA track.

Meterstick. The meterstick is a number to the right of the reticle that indicates the length of the ground under the crosshair, in meters.

Cursor Zero. Pressing CZ erases the cursor slew and returns the SPI to the currently selected steerpoint.

Sighting Option. This OSB will cycle between TGT-OAP1-OAP2 where OAP is the Offset Aim-Point (OAP) which can be added to each steer point. An OAP can be useful if the target is obscured by weather, but the OAP is in the clear. By selecting OAP1 or 2, the TGP slaves to the clear OAP and the aiming can be confirmed, although the steering and weapon delivery calculations will be to the target.

Laser Status. This displays the current state of the laser designator.

- (blank). Laser not armed
- L. Laser armed.
- Flashing L. Laser firing.

Time to Go. This shows the time to the next event depending on the aircraft status. Time to reach the steerpoint is displayed if in NAV master mode. Time to release weapon is displayed if in A-G mode if a target has been designated in an auto-delivery mode. Time to impact is displayed if a weapon has been released.

Weapons delivery using the TGP in A-G mode is covered in the Laser Guided Bombs section.

Track Modes

The Litening II targeting pod can employ one of three different modes to track a target: AREA, POINT, INR (inertial rates), and SP (snowplow). Each track mode is suitable for a different situation.

- In AREA track mode, the TGP performs image correlation to track an overall scene. AREA track mode is effective at tracking fixed objects.
- In POINT track mode, the TGP attempts to follow the centroid of a visible object using edge detection. POINT track mode is effective at tracking moving objects that are well-defined against their background, either because they are warmer (in HOC/COH sub-modes) or brighter (TV sub-mode).
- In INR mode, the TGP maintains its LOS on a position using only inertial integration. It does not do any image processing. INR track mode is effective at approximately maintaining the TGP LOS when the target is at risk of being masked or obscured.
- In SP mode, TGP LOS is commanded straight ahead and angled downwards to point to the ground ahead at ½ of the currently selected FCR scale (for example, if selected FCR scale is 40nm, the TGP will look at the point on the ground 20nm ahead).

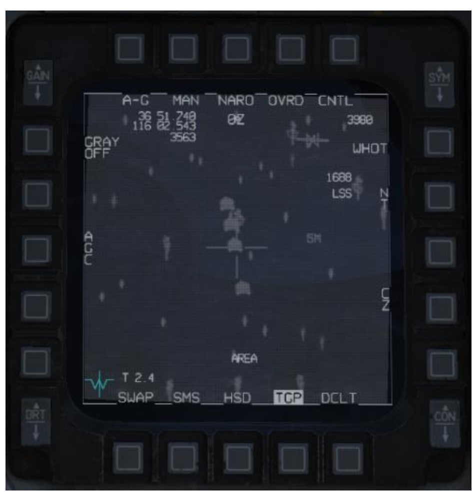
Therefore, it is recommended to use AREA track mode for stationary targets and POINT track mode for moving targets. In situations where the targeting pod is likely to become masked (intensive maneuvering, concealment behind terrain, or turning away from the target), it's recommended to first change the TGP to INR track mode to preserve the LOS as best as possible. SP mode is useful for locating targets directly ahead without reference to steerpoints or other anchor points loaded into the aircraft.

When the targeting pod is initially brought out of standby, it is not in any track mode. The pilot can move the targeting pod between track modes using the TMS switch:

	INR MODE	AREA MODE	POINT MODE	SP MODE
TMS FORWARD	Commands POINT track	Commands POINT track		Commands POINT track

	INR MODE	AREA MODE	POINT MODE	SP MODE
TMS RIGHT	Commands AREA track		Commands AREA track	Commands AREA track
TMS DOWN	Commands Cursor Zero	Commands INR track	Commands INR track	

Targeting pod in INR (inertial rates) track mode (crosshair is enlarged)



Targeting pod in AREA track mode

Targeting pod in POINT track mode (box encloses track target)

When the TGP cursor is slewed, the targeting pod automatically and temporarily changes to INR track mode. The previous track mode (AREA or POINT) is re-commanded once slewing stops.

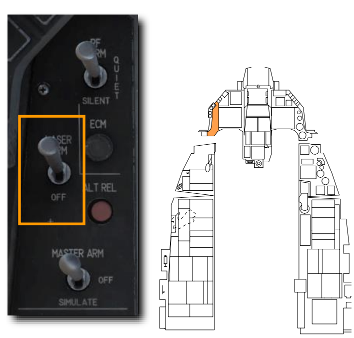
Laser Ranging

One very important feature of the Targeting Pod's laser designator is the ability to measure the slant range to the target. The laser is fired and the time it takes to receive the reflected laser energy is measured, providing a precise range. This information is then fed to the Fire Control Computer to update the stored target elevation and greatly improve the accuracy of the computed firing solution.

This can and should be done when possible for all weapons delivery types, not just laser guided bombs. To facilitate this, the TGP automatically slaves to the pipper while in gun, rocket, and bomb CCIP modes, and to the target designator while in CCRP and DTOS modes.

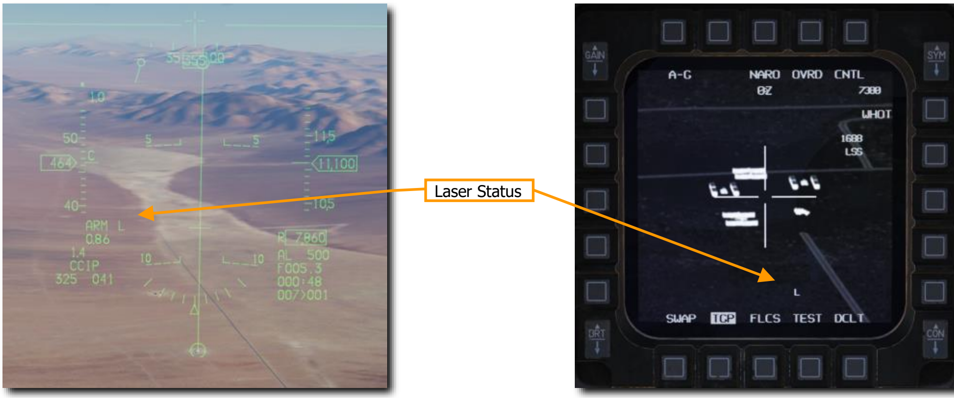
These weapons delivery modes are discussed fully in the Air-to-Ground Employment section.

To take a laser range, the Laser Arm Switch must be set to ARM. Laser firing is inhibited with the switch set to OFF.



The Laser status is displayed as an L on the HUD and TGP display when the Laser Arm switch is set to arm.

The laser is fired by squeezing the trigger to the first detent. The L flashes when the laser designator is firing. Releasing the trigger stops lasing.



AIR-TO-AIR (A-A) MODE

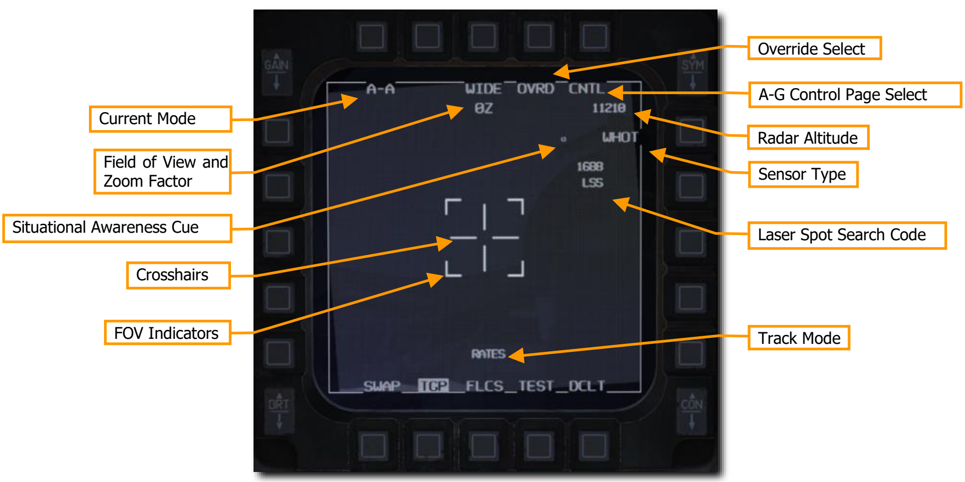
The TGP is automatically commanded to the radar line-of-sight when A-A master mode is selected, and the radar is tracking a target. If the radar is not tracking an aerial target, the pod directs its line-of-sight straight ahead at -3° elevation.

From the boresight, you may slew the TGP crosshair using the CURSOR switch. When slewing, the TGP camera moves in a space stabilized manner. When in this slewed mode, but not tracking a target, "RATES" is indicated on the display. After being slewed, the crosshairs will be reduced to half-size.

If the valid air target passes within the narrow field of view area (represented by the four corner markers), the TGP will attempt to track the target and place a cross "+" on it. If the target flies outside the narrow field of view area, the cross will disappear.

If you then command TMS Forward Short HOTAS command (command point track), the target will be centered in the crosshair and a box will be drawn around the target to conform to its size. When in this mode, "POINT" will be displayed as well as the tracking cross. To exit POINT track, the user may command INR track (TMS Right) or return to slave mode (TMS Aft).

The following elements may be displayed:



Current Mode. This is the mode the TGP is currently in.

Field of View. Pressing this OSB toggles between Narrow Field of View (NFOV) or Wide Field of View (WFOV). These views can vary between the CCD and FLIR sensors in the TGP.

- FLIR field of view:
  - Wide Field of View (WFOV) is 4° x 4°
  - Narrow Field of View (NFOV) is 1° x 1°
- CCD field of view:
  - Wide Field of View (WFOV) is 3.5° x 3.5°
  - Narrow Field of View (NFOV) is 1° x 1°

Zoom Factor. Within an FOV selection, you may additionally adjust the zoom-factor by zooming in and out with the RANGE knob. The zoom range goes from 0Z (no zoom) to 9Z (highest level of zoom within FOV). Objects within the TGP field of view double in size from 0 to 9 zoom.

Crosshairs. Line of sight for targeting and laser fire.

Field of View (FOV) Indicators. These four corner brackets are only shown when WIDE FOV is enabled and indicate the portion of the image that will be displayed if NARO FOV is enabled.

OVRD Select. Pressing this OSB overrides any current mode and returns to STBY. The last selected mode is returned to when OVRD is selected a second time.

A-G Control Page Select. Pressing this OSB selects the STBY Control Page.

Radar Altitude. The current radar altitude is displayed.

Sensor Type. Displayed in the upper right corner, this text field indicates the current video mode that the TGP is collecting in. The three options include:

- WHOT. Using the FLIR camera, hot objects appear lighter than a cooler background.
- BHOT. Using the FLIR camera, hot objects appear darker than a cooler background.
- TV. The Charge Coupled Device camera displays this image. This is a daytime, electro-optical camera.

Laser Spot Search Code. This is the laser pulse rate frequency (PRF) code the TGP will attempt to locate in laser spot search (LSS) mode.

Track Mode. If the TGP is in a track mode, this field will indicate the track mode it is in. Types include:

- RATES. When in A-A mode and the slew function is released, the TGP will automatically enter RATES mode (indicated in the tracking-type field).

- POINT. As with A-G mode, the user may command a Point track over an object. This mode is also used for radar locked targets.

Situational Awareness Cue. The SA cue provides you a reference to indicate the TGP's current line of sight in reference to the pod's longitudinal (boresight) axis, which is coincidental with the aircraft longitudinal axis. The cue is represented as a small square that can move to any spot within the display. The position of the SA square represents the current TGP line of sight.

HOTAS COMMANDS

The following HOTAS commands are available when the TGP is sensor of interest (SOI):

TMS Fwd. Enters AREA track when pressed, then POINT track when released. If POINT track fails, it remains in AREA track.

TMS Aft. If TGP is tracking, break track and return to slave mode (e.g., slaved to A-G SPI or A-A FCR line of sight). If TGP is already in slave mode, cursor zero (i.e., return to boresight position).

TMS Left. Toggle FLIR polarity between white hot and black hot.

TMS Right (Maverick not selected). Enter AREA track mode.

TMS Right (Maverick selected). Attempt Maverick handoff.

Trigger (First Detent). Fire Laser.

Trigger (Second Detent). Fire laser for 30 seconds if in CCIP bombing mode. (See Laser Ranging section.)

Expand/FOV. Toggle FOV between Wide and Narrow.

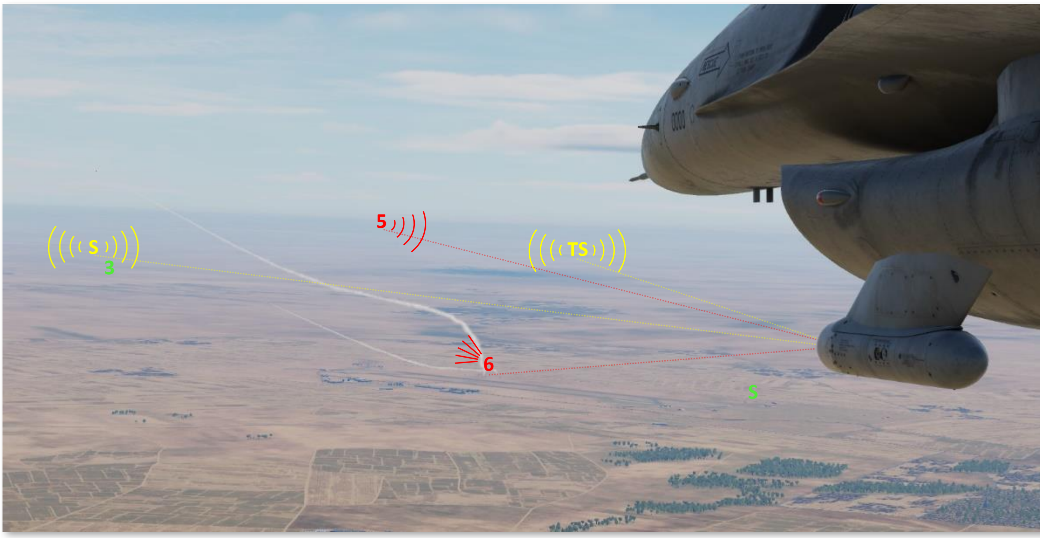
Manual Slew. The TGP view can be slewed to scan the scene and search for targets using the cursor controls. Manual slew is available is either in Slave mode or in one of the tracking sub-modes (e.g., area track or point track).

HARM TARGETING SYSTEM

USAF Photo
by TSgt Gregory Brook

HARM TARGETING SYSTEM

The AN/ASQ-213 HARM Targeting System (HTS pod) enables the F-16C to efficiently perform the Suppression of Enemy Air Defenses (SEAD) mission. The HTS pod detects and classifies hostile radar emissions and then utilizes signals triangulation to passively range and locate threat radar systems on the battlefield.



AN/ASQ-213 Detection, Classification, and Triangulation

The HTS pod is not required to employ the AGM-88 HARM missile, however it does enable the targeting of threat radars more efficiently. Most notably, when equipped with an HTS pod, the pilot is not limited by the field-of-view of the HARM missile seeker itself. Even radar systems that are to the side or even behind the aircraft can be handed off to the AGM-88 for engagement.

Although originally designed to enhance the tactical employment of HARM anti-radiation missiles against air defenses, the HTS pod can be used designate threat radars for the employment of other sensors or weapons. The HTS also dramatically increases the pilot's situational awareness of the threat radar environment in the surrounding airspace and allows the pilot to make critical decisions regarding which threats must be avoided and which threats must be engaged to accomplish the mission.

HARM Targeting System Activation

The HTS pod (if equipped) is powered through the left "chin" hardpoint. This is accomplished by positioning the LEFT HDPT switch to the forward position on the SNSR PWR control panel on the right console.

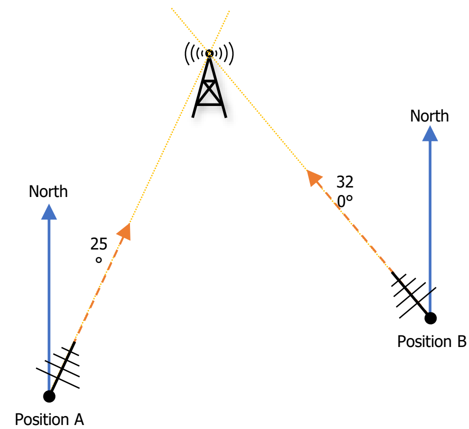
The HTS will require approximately 30 seconds to initialize.

The HARM Targeting System cannot function without the MMC, ST STA, or MFD avionics systems, or without a properly aligned INS.

Radio Direction Finding and Triangulation

Just as aeronautical navigational aids can be received by specialized receivers onboard an aircraft to determine their bearing relative to the receiver, other radio signals can be received using specialized radio antennas. Using such antennas, an "angle-of-arrival" can be determined within a margin of error that is predicated on the sophistication of the equipment and the receiving antenna. This process of measuring angle-of-arrival is known as radio direction finding.

If the same radio signal can be received and measured using radio direction finding equipment at multiple locations, the corresponding bearings can be used to triangulate the position of the radio emitter. This technique is known as radio triangulation. Using such techniques, the location of any emitter of electromagnetic signals can be determined using passive radio receivers.

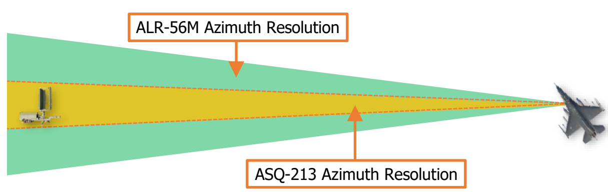


Radio triangulation from two known positions

As with other forms of radio signals, radar emissions can likewise be received by an antenna that is specifically tuned to process such radar signals. Many military aircraft possess radar warning receivers (RWR) that are not only able to plot the relative azimuth of radar signals around the aircraft in 360 degrees but are also capable of warning the aircrews of the type of threat and when the radar characteristics have changed in such a way that indicates that the aircraft is under attack.

Like other angle-of-arrival measurements, the accuracy of these radar warning receivers is subject to the sensitivity and sophistication of their radar receivers as well as the capabilities of the RWR display itself. Often times, the azimuth resolution of an RWR is only necessary to the extent of warning the aircrew of the general threat direction for the purposes of determining appropriate defensive actions or evasive maneuvers to be performed.

If radio direction finding devices onboard an aircraft are designed to calculate precise angle-of-arrival data in order to triangulate the position of threat radar emitters, often times such specialized devices will possess a finer azimuth resolution for determining the angle-of-arrival of such signals compared to an RWR.



Angle-of-arrival azimuth resolution of radar signals

The F-16C is equipped with an ALR-56M radar warning receiver in addition to the HARM Targeting System. Unlike the ALR-56M, which is a defensive system intended to warn the pilot of an impending attack on the aircraft, the HARM Targeting System is designed as an offensive system for passively locating enemy air defense radar sites. As such, in the case of the F-16C, the HTS pod is more capable than the F-16's own ALR-56M for determining precise threat direction.

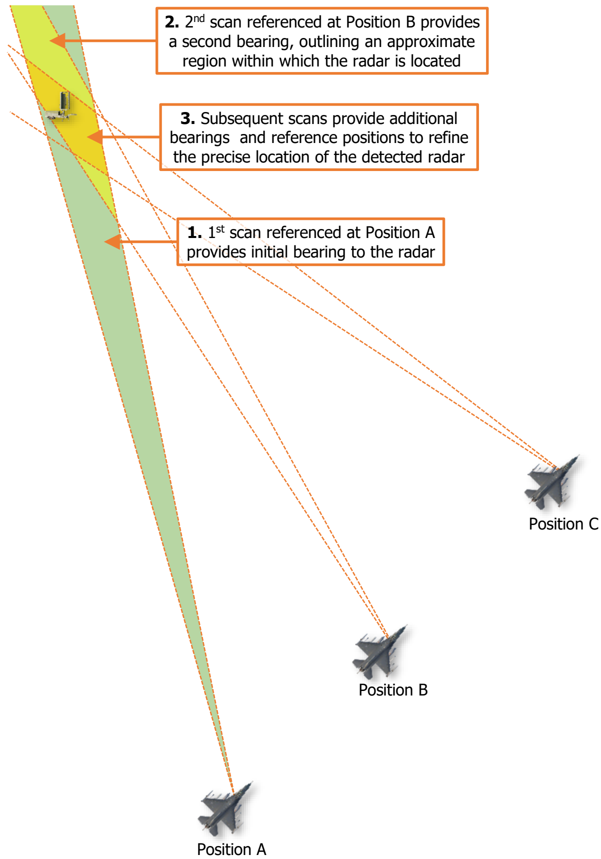
However, like the ALR-56M, the HARM Targeting System is subject to the same negative impacts to accuracy that occur while the aircraft is performing aggressive maneuvers or is flying at extreme attitudes in pitch and roll.

Passive Ranging and Geo-location of air defense radar systems

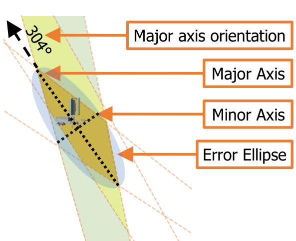
The AN/ASQ-213 HARM Targeting System passively provides ranging and position data of threat radars by calculating the angle-of-arrival of detected radar signals over the course of multiple scans. Using the known position of the aircraft during each scan, the HTS triangulates a threat radar's location within an area of probability called an "error ellipse".

As the radar signal data is processed, the location and size of the error ellipse is determined based on several angle-of-arrival measurements; and is continuously updated with subsequent measurements provided by each scan in which the radar signal is received. As the size of the error ellipse shrinks, the accuracy of the calculated position of the threat radar improves. The error ellipse will rarely be re-calculated in a uniform manner following each scan, with the computed major and minor axes changing in size and orientation. This may sometimes lead to intermittent "jumps" of the threat radar's computed position.

The accuracy, or position quality, of this passive ranging is based on the relative offset between each measured angle-of-arrival and the number of scans within which the same radar signal was received. If the threat radar is at a long distance or if the aircraft is flying directly toward or away from it, the relative difference between each subsequent angle-of-arrival measurement will be very narrow and the error ellipse will be very large. Flying at oblique angles relative to the radar's angle-of-arrival will improve the HTS pod's ability to reduce the size of the error ellipse.



Passive ranging of threat radar emissions



Geo-location Error Ellipse

The size of the error ellipse is categorized by the HARM Targeting System within five PGM classification levels, which represents the position quality of the ranging data for employing precision guided munitions. These PGM levels are ranked PGM 1 through PGM 5, with PGM 5 being the least accurate with a large error ellipse, and PGM 1 being the most accurate with a small error ellipse.

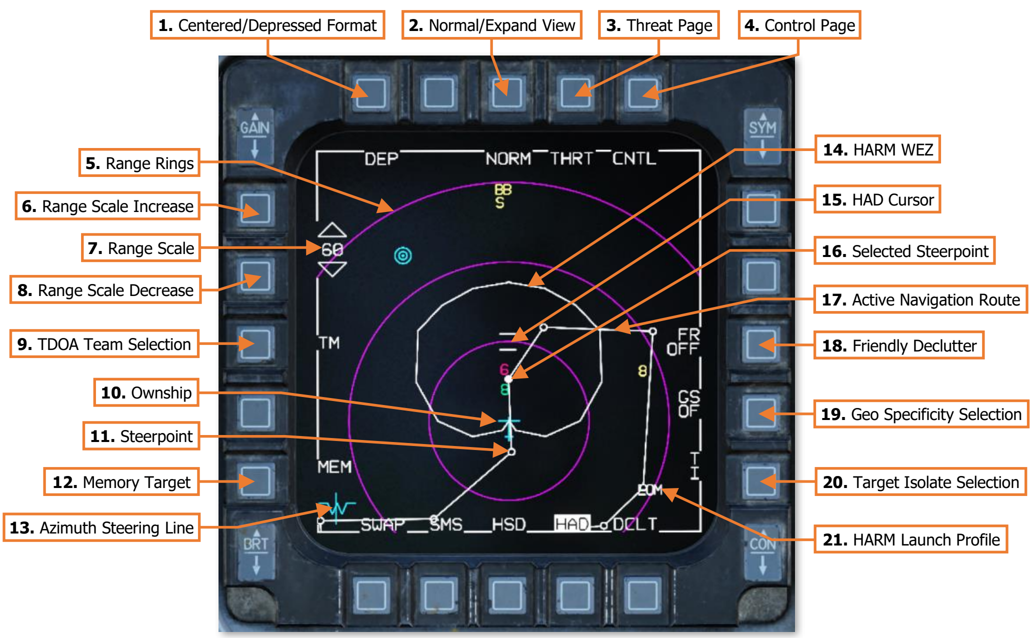
When attempting to electro-optically acquire an air defense battery through the targeting pod, position quality data that is categorized as PGM 1 or PGM 2 will typically generate a SPI location quite close to the radar's true location. In these instances, a brief search in the vicinity of the SPI is usually all that is required to spot the air defense battery.

HARM ATTACK DISPLAY (HAD)

The HAD MFD format displays a top-down, plan-view depiction of the threat radar environment around the aircraft (ownship), with additional graphical representations of flight members, datalink information, steerpoints, and routes. The HAD format is very similar to the Horizontal Situation Display (HSD) MFD format presentation, but with some slight differences. Like the HSD, many of the symbology elements on the HAD format can be selectively toggled on the HAD Control page, but are meant to provide the pilot situational awareness of threat radar locations and emission status within the overall tactical environment.

Threat radar symbols are classified by radar type using alphanumeric codes and categorized by radar mode using colors. A complete list of threat radar symbol types can be reviewed in Appendix C.

- 6 Radar is emitting in Search mode.
- 6 **(Steady)** Radar is emitting in Track mode.
- 6 **(Flashing)** Radar is emitting in Launch mode.
- 6 Radar is not emitting. If a radar's emissions have not been detected for at least 2 minutes, the symbol will turn green. If a radar's emissions have not been detected for over 4 minutes, the symbol will be removed from the HAD.



HAD Base Page – Primary symbology

1. **Centered/Depressed Format.** Toggles between Depressed (DEP) and Centered (CEN) HAD formats. When set to Depressed, the ownship is biased to the bottom portion of the HAD, allowing the HAD to primarily depict battlespace in front of the aircraft. This format may be more useful when performing offensive counter-air (OCA), suppression of enemy air defenses (SEAD), offensive strikes, or general navigation along a flight route.

When set to Centered, the ownship is displayed in the center of the HSD, depicting battlespace in all directions around the aircraft equally. This format may be more useful when loitering or performing orbits in an area, such as air interdiction (AI), close air support (CAS), reconnaissance, or supporting combat search and rescue (CSAR).

2. **Normal/Expand View.** Cycles the HAD between NORM, EXP1 and EXP2 viewing modes when HAD is set as SOI and the Expand/FOV button is pressed on the Side Stick Controller (SSC) or OSB 3 is pressed on the HAD MFD format. (See HAD Expand (EXP) Mode for more information.)
3. **Threat Page.** Toggles the MFD between the HAD base page and the Threat page.
4. **Control Page.** Toggles the MFD between the HAD base page and the Control page.
5. **Range Rings.** Depicts sub-ranges below the current range scale.

   When the HAD is set to Depressed format, the outer ring will correspond with the HAD range scale, with two additional inner rings set at ⅔ and ⅓ of the range scale.

   When the HAD is set to Centered format, the outer ring will correspond with the HAD range scale, with an inner ring set at ½ the range scale.
6. **Range Scale Increase.** Increases the HAD range scale by one level. When the HAD is set to its highest range scale, this option is removed from the HAD.
7. **Range Scale.** Displays the range (in nautical miles) of the furthest HAD range ring. The minimum range that the HAD can be set to is 10 NM (Centered format) or 15 NM (Depressed format). The maximum range that the HAD can be set to is 160 NM (Centered format) or 240 NM (Depressed format).
8. **Range Scale Decrease.** Decreases the HAD range scale by one level. When the HAD is set to its lowest range scale, this option is removed from the HAD.
9. **TDOA Team Selection.** Not implemented.
10. **Ownship.** Depicts the location of the ownship.
11. **Steerpoint.** Steerpoints that are not the selected steerpoint are displayed as hollow white circles.
12. **Memory Target.** Not implemented.
13. **Azimuth Steering Line.** Displays the relative alignment of the aircraft heading with the bearing to the current steerpoint, SPI, or weapon release solution. If the line is to the left or right of the watermark, the pilot must turn left or right respectively toward the vertical line to align the aircraft with the desired course or target. If the line bisects the center of the watermark, the aircraft is on course toward the selected steerpoint, SPI, or weapon release solution.
14. **HARM WEZ.** Depicts the weapon engagement zone (WEZ) of the AGM-88 HARM missile, which is based on the selected POS mode HARM launch profile along with the ownship's current attitude, altitude, and speed. If the aircraft is flying at high speeds, high altitudes, and/or in a climb, the depicted WEZ will dynamically grow in size to represent the improved kinematic performance of the AGM-88 when launched from those high speeds and altitudes. If the aircraft is operating at slower speeds, low altitudes, and/or in a dive, the WEZ will dynamically shrink to represent the negative impacts such launch conditions will have on the range and performance of the AGM-88.

    When handing off a threat radar to the HARM missile, the AGM-88 should only be launched at the selected target if the threat radar is within the depicted HARM WEZ outline. If the HARM WEZ extends beyond the current range scale of the HAD, the WEZ will be shown with a dashed outline.

HARM WEZ in EOM (Left), RUK (Center), and PB (Right) launch profiles

The POS mode launch profile can be changed on the WPN MFD format when the SMS weapon profile is set to AG88. (See AGM-88 HARM for more information.)

15. **HAD Cursor.** The HAD cursor is slewed using the RDR CURSOR/ENABLE switch and can be used to view expanded information of a threat radar when placed over a radar symbol, or can be used to select the threat radar for handoff when TMS Forward is pressed while the cursor is placed over a radar symbol.

16. **Selected Steerpoint.** The steerpoint selected as the current navigation steerpoint is displayed as a solid white circle.

17. **Active Navigation Route.** The active navigation route is displayed as a solid white line linking sequential steerpoints 1-25.

18. **Friendly Declutter.** Controls the display of friendly aircraft PPLI symbols received over DL16 datalink. Each press of OSB 9 will cycle through three declutter levels.

- **FR ON.** All friendly aircraft PPLI symbols received are displayed.
- **FL ON.** Only flight member PPLI symbols are displayed. All other friendly aircraft PPLI symbols are hidden.
- **FR OFF.** All friendly aircraft PPLI symbols are hidden.

19. **Geo Specificity Selection.** Not implemented.

20. **Target Isolate Selection.** Not implemented.

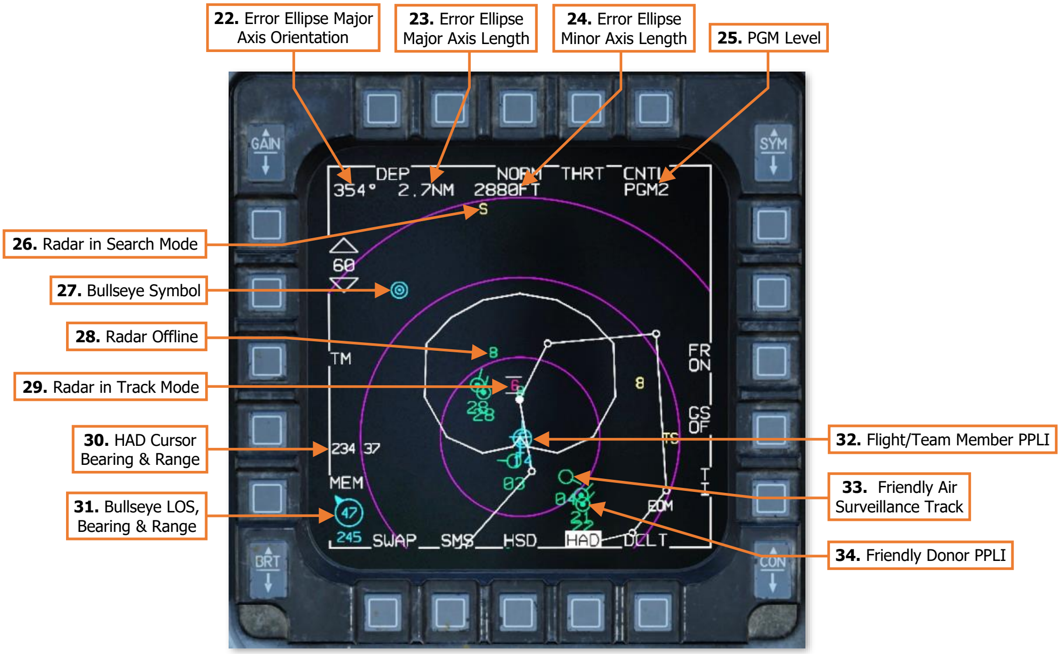
21. **HARM Launch Profile.** Displays the currently selected launch profile for the AGM-88 POS sub-mode.

22. **Error Ellipse Major Axis Orientation (next page).** Displays the orientation (in degrees Magnetic) of the major axis of the error ellipse for the threat radar under the HAD cursor.

23. **Error Ellipse Major Axis Length (next page).** Displays the length of the major axis of the error ellipse for the threat radar under the HAD cursor. Lengths are displayed in nautical miles (NM), unless the length is less than 6,000 feet, in which case the length will be displayed in feet.

24. **Error Ellipse Minor Axis Length (next page).** Displays the length of the minor axis of the error ellipse for the threat radar under the HAD cursor. Lengths are displayed in nautical miles (NM), unless the length is less than 6,000 feet, in which case the length will be displayed in feet.

25. **PGM Level (next page).** Displays the quality of the ranging data for employing precision guided munitions. PGM levels are ranked PGM 1 through PGM 5, with PGM 5 being the least accurate with a large error ellipse, and PGM 1 being the most accurate with a small error ellipse.



HSD Base Page – Tactical symbology

26. **Radar in Search Mode.** Depicts a threat radar that is actively emitting in Search mode.

27. **Bullseye Symbol.** Depicts the location of the Bullseye point. The Bullseye point is normally set to Steerpoint 25 but can be set to a different steerpoint on the BULL DED page.

28. **Radar Offline.** Depicts a threat radar that has not been detected as actively emitting for at least 2 minutes. If the threat radar has not been detected as actively emitting after 4 minutes, this symbol will be removed from the HAD.

29. **Radar in Track Mode.** Depicts a threat radar that is actively emitting in Track mode. If the threat radar begins actively emitting in a distinct Launch mode, the symbol will flash.

30. **HAD Cursor.** If Bullseye is enabled on the BULL DED page, this data field will display the bearing and range from the Bullseye point to the HAD cursor.

31. **Bullseye LOS, Bearing & Range.** Displays a pointer symbol that indicates the relative direction (line-of-sight or LOS) to the Bullseye point from the nose of the ownship. Displays the ownship's range (in nautical miles) and bearing (in degrees Magnetic) from the Bullseye point, with the range displayed inside the pointer symbol and the bearing from Bullseye displayed below it.

32. **Flight/Team Member PPLI (DL16).** Friendly, DL16 participant aircraft that are set as flight or team members to the ownship.

33. **Friendly Air Surveillance Track (DL16).** Friendly, non- DL16 participant aircraft that are detected by other DL16 participants such as friendly fighters or AWACS aircraft.

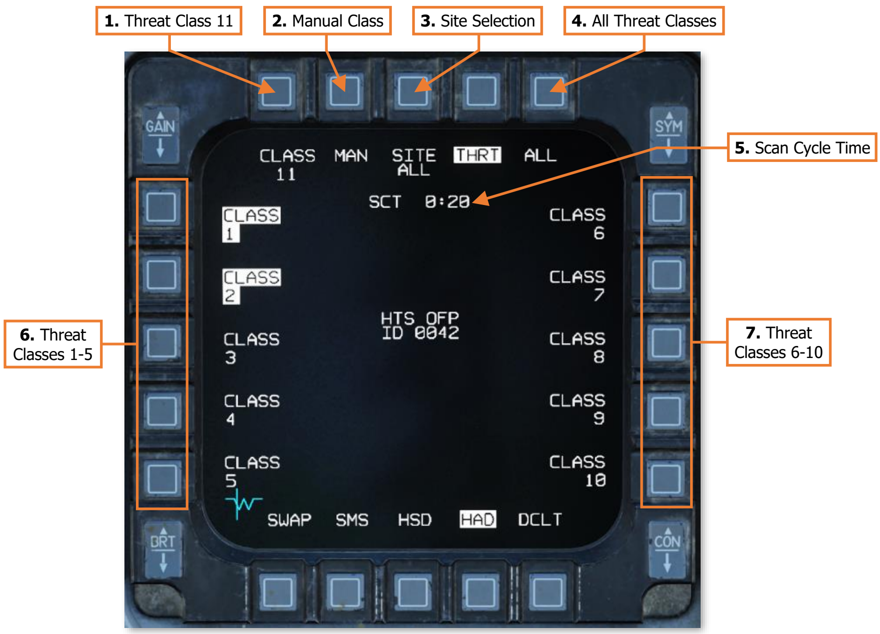
34. **Friendly Donor PPLI (DL16).** Friendly, DL16 participant aircraft that are set as donors to the ownship.

HAD Threat (THRT) Page

The HARM Targeting System includes several threat "classes" with specific radar types grouped within each class. Enabling or disabling specific threat classes from the HAD Threat page allows the pilot to optimize the HTS scan intervals for more efficient detection and geo-location of the types of threat radars that are anticipated to be encountered during the mission.

Each HAD threat class is pre-programmed into the HARM Targeting System and cannot be configured from the cockpit. However, the HTS can be configured to utilize a Manual threat class, which can be edited from the HTS DED page at any point during the mission.

A complete list of each threat class can be reviewed in Appendix C.



HAD Threat Page

1. **Threat Class 11.** When highlighted, threat radars within threat class 11 are added to each HTS scan cycle.
2. **Manual Class.** When highlighted, threat radars within the Manual threat class are added to each HTS scan cycle. This option is only displayed on the HAD Threat page when threat radars have been added to the Manual threat class on the HTS DED page.
3. **Site Selection.** Not implemented.
4. **All Threat Classes.** Highlights/de-highlights all threat classes simultaneously. If some threat classes are highlighted while others are not, the first press of this button will highlight all threat classes. Each subsequent press will highlight/de-highlight all threat classes at once. If MAN is displayed at OSB 2, each subsequent press of ALL at OSB 5 will alternate between enabling classes 1-11 and just the Manual threat class.
5. **Scan Cycle Time.** Displays the time the HTS requires to perform one complete scan cycle and refresh the HAD with the estimated locations and emission status of each detected threat radar. The scan cycle time is dependent on the number of threat radar types the HTS must scan for. Highlighting only the required threat

classes needed to perform the mission will increase the efficiency of the HARM Targeting system and reduce the time required to accurately determine the location of detected threat radar systems.

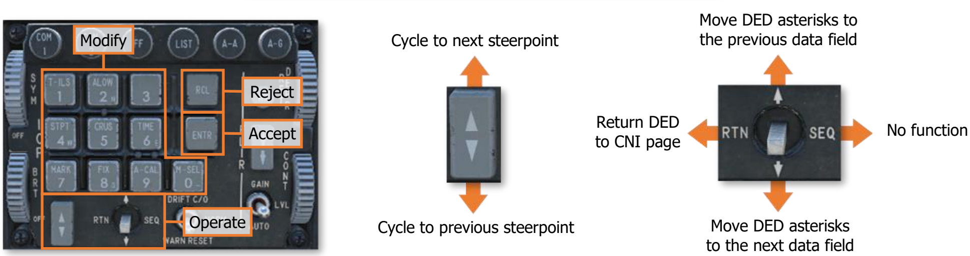
6. **Threat Classes 1-5.** When highlighted, threat radars within the threat classes next to their respective OSB are added to each HTS scan cycle. These threat classes include ground and naval air defense systems of Russian or Chinese design.

7. **Threat Classes 6-10.** When highlighted, threat radars within the threat classes next to their respective OSB are added to each HTS scan cycle. These threat classes include ground and naval air defense systems of American or western European design.

HTS Page

The HARM Targeting System DED page is accessed by pressing **ENTR** on the ICP keypad when the MISC DED page is displayed on the DED. This page is used to configure a Manual threat class for use on the HARM Attack Display (HAD) MFD format. The Manual threat class can be utilized to better tailor the HTS scan cycles to the radar signals that are anticipated to be encountered during the mission.

The HTS DED page will only be displayed on the MISC page list when an HTS pod is installed on the aircraft and powered using the SNSR PWR control panel.



1. **Threat Number.** Up to eight radar types can be added to the HAD Manual threat Class.

2. **Threat ALIC Code.** Displays the ALIC code representing a specific radar type that is loaded into the corresponding threat entry. An empty ALIC code slot will be displayed by four X characters. May be modified using the ICP keypad.

3. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.

4. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

HAD Control (CNTL) Page

The HAD Control page is used to configure individual HAD graphic elements and symbology to suit the tactical situation or individual preferences of the pilot, or to configure specific functions of the HTS pod itself. The first page displays options regarding HAD symbols, navigation routes, and geographic lines loaded from the DTC. The second page displays additional options and functions of the AN/ASQ-213 HARM Targeting System.

HAD Control Page – Page 1

1. **Pre-planned Threats.** Toggles the display of pre-planned air defense threats loaded from the DTC. (N/I)
2. **Tertiary Table.** Not implemented.
3. **Navigation Route 1.** Toggles the display of the first navigation route loaded from the DTC. (N/I)
4. **Navigation Route 2.** Toggles the display of the second navigation route loaded from the DTC. (N/I)
5. **Navigation Route 3.** Toggles the display of the third navigation route loaded from the DTC. (N/I)
6. **SAM Threat Radars.** Toggles display of HTS-detected threat radar symbols.
7. **Geographic Line 1.** Toggles the display of first pre-planned line or shape loaded from the DTC. (N/I)
8. **Geographic Line 2.** Toggles the display of second pre-planned line or shape loaded from the DTC. (N/I)
9. **Geographic Line 3.** Toggles the display of third pre-planned line or shape loaded from the DTC. (N/I)
10. **Geographic Line 4.** Toggles the display of fourth pre-planned line or shape loaded from the DTC. (N/I)
11. **Page Sequence.** Cycles the MFD to Page 2 of the HAD Control page.

HSD Control Page – Page 2

12. **Data Recorder.** Not implemented.
13. **Data Recording Rate.** Not implemented.
14. **RPD Mode.** Not implemented.
15. **Geo-Pack Selection.** Not implemented.
16. **Data Recorder Zeroize.** Not implemented.
17. **GPS Zeroize.** Not implemented.
18. **DTC Download.** Not implemented.
19. **AA Mode.** Not implemented.
20. **Page Sequence.** Cycles the MFD to Page 1 of the HAD Control page.

HAD Expand (EXP) Mode

The HAD can be cycled between NORM, EXP1 and EXP2 viewing modes when the HAD is SOI and OSB 3 is pressed on the HAD MFD format or the Expand/FOV button is pressed on the Side Stick Controller (SSC). When EXP1 or EXP2 are entered, the HAD will be centered at the location the HAD cursor was placed at the moment Expand mode was selected.

When Expand mode is entered, the HAD will switch to a 2:1 zoom ratio (EXP1) or a 4:1 zoom ratio (EXP2). Additionally, the following options are removed from the HAD:

- Centered/Depressed format option at OSB 1.
- Range Scale Increase/Decrease options at OSB 19 and OSB 20.
- Range Scale.
- Range Rings.

HAD NORM (Left), EXP1 (Center), and EXP2 (Right) Modes

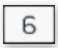
Any of the following actions will exit Expand view:

- Press OSB 3 on the HAD MFD format to cycle back to NORM.
- Press the Expand/FOV button on the SSC to cycle back to NORM.
- Set SOI to something other than HAD.

HAD TARGET DESIGNATION

Threat radars may be designated on the HARM Attack Display, which will assign the SPI to the calculated 3-dimensional location and hand off the threat radar to AGM-88 HARM missiles for engagement. This can be performed by setting the HAD as SOI using DMS Aft on the Side Stick Controller (SSC), placing the HAD cursor over the threat radar symbol using the RDR CURSOR/ENABLE switch, and using TMS Forward on the SSC to designate the threat radar symbol as the target. Pressing TMS Aft on the SSC will reject the currently designated threat radar as a target but will not reset the SPI back to the selected steerpoint.

When a threat radar is designated on the HAD, a handoff will be attempted to the LAU-118 station selected for launch. The threat radar symbol will be highlighted to identify its status as the designated target and whether a successful handoff to the AGM-88 missile was successful.

-  Radar is designated but no handoff was completed.
-  Radar is designated and handed off to the selected AGM-88 missile.

If AGM-88 missiles are loaded and have been powered on, the threat radar will be handed off to the LAU-118 station selected for launch, regardless of the master mode or SMS weapon profile. If the master mode is subsequently switched to A-G and the SMS weapon profile is set as AG88, the AGM-88 can be fired at the designated radar immediately. If a radar has been designated prior to powering the AGM-88 missiles, the radar designation will need to be rejected and then re-designated to hand off the radar to the AGM-88 missile after it has been powered on.

HAD Target Designation

When a threat radar has been handed off to an AGM-88 missile and is within the HARM Weapon Engagement Zone (WEZ), the time to impact (based on estimated HARM time of flight) and time of impact will be displayed in the bottom right corner of the HAD above the HARM launch profile. This information is identical to the pre-launch data displayed on the WPN MFD format when set to POS mode and the HARM launch profile is set to EOM or PB. These can be referenced to coordinate and maximize the effect of multiple HARM missiles when employed against heavily defended targets.

Once a threat radar has been designated, regardless of the selected SMS weapon profile, the SPI will be placed at the calculated location of the designated radar. Other onboard sensors such as the FCR and TGP will accordingly be cued to the new SPI location, allowing the pilot to engage the radar or associated air defenses with other weapons if necessary, or store a markpoint at the location. Specifically in the case of the TGP, this will also allow the pilot to visually confirm the accuracy of the calculated radar location. However, depending on the tactical situation and the nature of the air defenses, this may not always be possible.

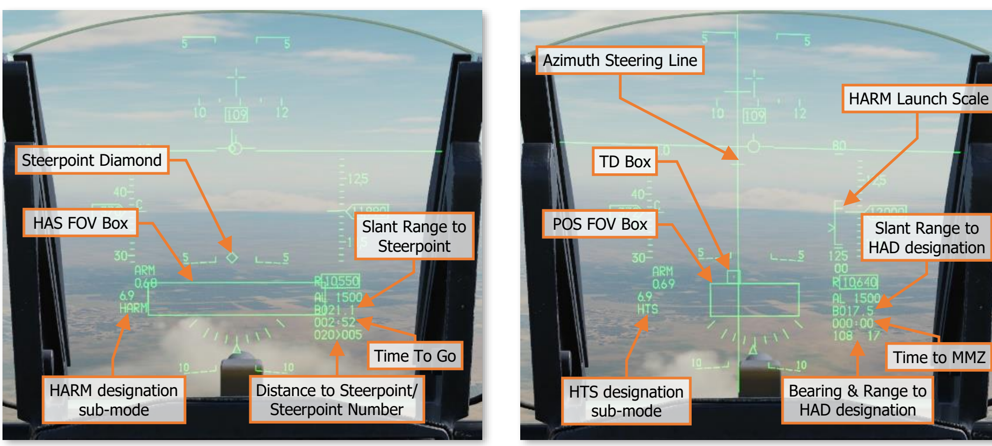
If a threat radar is designated, pressing TMS Right on the Side Stick Controller (SSC) will step to the next threat radar detected by the HTS pod and designate that location for the SPI and handoff the newly designated radar to the AGM-88 missile.

Air defense radar locations passively ranged by the HTS cannot be stored into steerpoint locations directly from the HAD. However, by cueing other onboard sensors to these locations and performing accurate targeting, air defenses can be plotted with greater precision compared to passive ranging of radar signals alone. Accurate targeting can be accomplished using air-to-ground or air-to-surface radar scans at long range, electro-optical TGP reconnaissance at medium range, or visual "out the window" identification at short-range.

Once air defense locations are confirmed with other sensors or by visual identification, markpoints can be designated using the MARK DED page, or coordinates can be directly entered into the ICP using the STPT or DEST DED pages from coordinate data displayed on the TGP or FCR MFD formats. Even if air defenses cannot be confirmed by radar, electro-optical, or visual means, the SEAD DED page can be used to manually write down coordinates for future input, reporting, and targeting.

HUD Designation & Launch Symbology

If the master mode is set to Air-to-Ground (A-G) and the SMS weapon profile is set to AG88, the HUD Master Mode status will display "HARM" to indicate the aircraft's targeting system is operating in HARM designation sub-mode. The HUD will display the Steerpoint Diamond and associated steerpoint information, and the HARM FOV Box will be derived from the HARM mode set on the WPN MFD format.

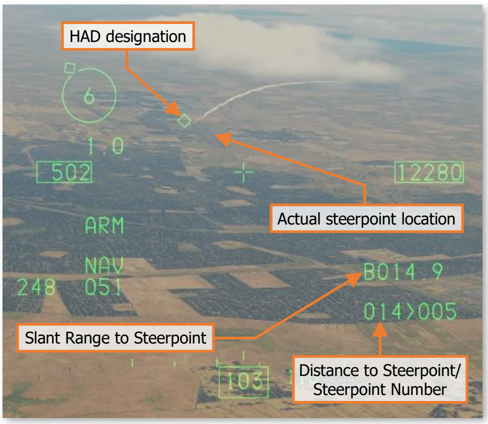


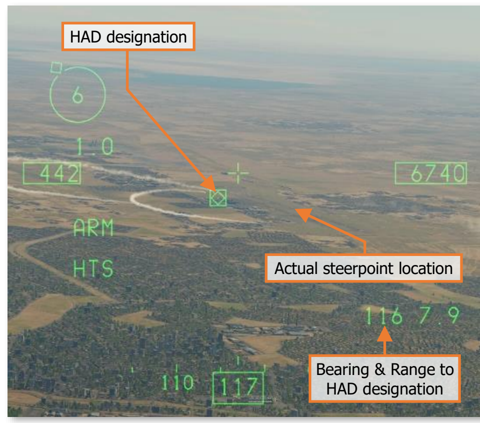
HUD Symbology pre-designation (left) & post-designation (right)

When a threat radar is designated on the HAD, the HUD Master Mode status will display "HTS" to indicate the HARM Targeting System is being used for weapons designation in lieu of the seeker of the AGM-88 missile itself. The steerpoint information will be replaced by the slant range to the HAD designation, time to the Missile Maneuvering Zone (MMZ), bearing and range to the HAD designation, and the TD Box will be placed at the location of the HAD designation. If set to HARM-As-Seeker (HAS) mode on the WPN MFD format, the AGM-88 will switch to POS mode and use the selected POS launch profile after handoff is complete, which will update the size of the HARM FOV box and display the associated AGM-88 HUD symbology. (See AGM-88 HARM for more information.)

Sighting Point Designation

Any time a threat radar is designated on the HAD MFD format, the current sighting point will be moved to the calculated location of the designated radar. If the location of the designated radar is re-calculated by the HTS, the current sighting point will be moved to the updated location. If the HAD designation is rejected, the sighting point can be reset back to the selected steerpoint by selecting Cursor Zero (OSB 10 on the HSD MFD format, OSB 9 on the FCR or TGP MFD formats, or TMS Aft on the SSC when TGP is set as SOI).





HAD designation in NAV mode (left) & HTS A-G sub-mode (right)

Depending on the master mode or sub-mode, either the STP sighting option (depicted by the steerpoint diamond), or the TGT sighting option (depicted by the TD Box), will be set to the HAD designation. The sighting point may be subsequently slewed using the RDR CURSOR/ENABLE switch if a SOI other than HAD is selected that permits cursor slew in the current master mode/sub-mode. However, if HAD is selected as SOI while a HAD designation exists, the current sighting point will again be set to the calculated location of the designated threat radar.

If Cursor Zero is commanded while the SOI is set to HUD, FCR, or TGP, the current sighting point will be set to the selected steerpoint, not the HAD designation. However, if HAD is selected as SOI, the sighting point will again be set to the calculated location of the designated radar.

In the specific case of A-G master mode and in HARM designation sub-mode, when a threat radar is initially designated, the STP sighting point will be set to the HAD designation. When the handoff to the AGM-88 missile is complete, the sighting option will automatically change to TGT, which will also be set to the HAD designation. The TGT sighting point can be subsequently slewed using the RDR CURSOR/ENABLE switch if a SOI other than HAD is selected.

When acquiring an air defense battery or vehicle using the TGP following a HAD designation of a threat radar, slewing the sighting point can be useful in updating the HUD/HMCS symbology to the true location of the hostile air defenses for a visual or electro-optical engagement using cluster munitions or AGM-65 missiles. However, to avoid inadvertently returning the sighting point and its associated symbology back to the HAD designation (which may not be accurate to the true location of the hostile air defenses), it may be wise to reject the HAD designation prior to switching to a different SOI.

SEAD DED Page

If a threat radar has been designated on the HARM Attack Display and the HAD is SOI, the coordinates for the designated radar can be displayed by accessing the SEAD DED page.

The SEAD DED page can only be accessed under these conditions and is displayed using TMS Left on the Side Stick Controller (SSC). The Latitude, Longitude, Elevation and Time Over Target (TOT) of the ownship are displayed, based on the calculated position of the radar system.

Due to the nature of the HARM Targeting System's passive ranging capability, the accuracy of these coordinates is dependent on the position quality of the ranging data for that specific radar emitter. The size of the error ellipse and corresponding PGM level should be taken into consideration when using these coordinates for targeting purposes.

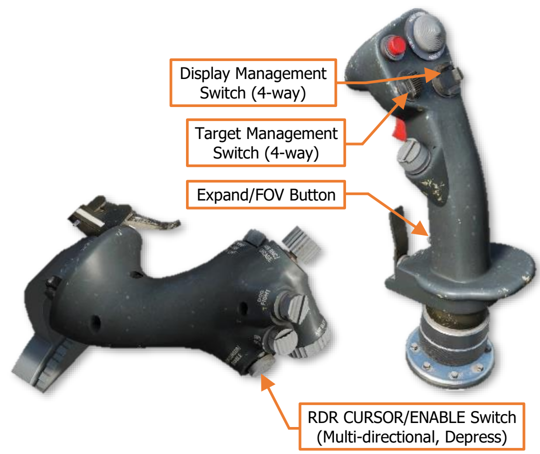
The SEAD page will always reflect the calculated coordinates of the designated threat radar on the HAD MFD format. If TMS Right is used to step to a different threat radar designation on the HAD, the SEAD page will update to reflect the location for the currently designated threat radar.

TMS Aft will return the DED to the CNI page and reject the currently designated threat radar as a target, but it will not reset the SPI back to the selected steerpoint.

HANDS-ON CONTROLS

The Target Management Switch (TMS) and Expand/FOV button on the Side Stick Controller (SSC), along with the RDR CURSOR/ENABLE switch on the throttle grip, are the pilot's controls for interacting with the HARM Attack Display (HAD) and designating threat radars for targeting by the aircraft's sensors or engagement by AGM-88 HARM anti-radar missiles.

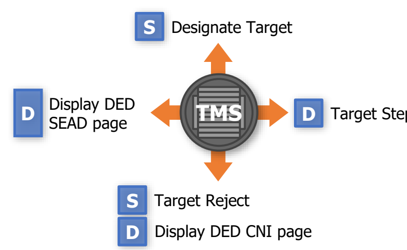
NOTE: These commands are only active when the Display Management Switch (DMS) is used to set the HAD MFD format as the Sensor-Of-Interest (SOI). (See Tactical Systems for more information.)



Throttle Grip Commands. The RDR CURSOR/ENABLE switch is multi-directional, allowing the HAD cursor to be moved in any direction.

- S Short press (<0.5 sec)
- D Short press, DED SEAD displayed
- C Continuous press

Side Stick Controller (SSC) Commands. The Target Management Switch (TMS) commands are contextual, based on whether a threat radar has been designated as a target on the HAD MFD format.



* TMS Right and TMS Left commands are only available when a threat radar is designated on the HAD MFD format.

** TMS Aft will only return the DED to the CNI page from the SEAD DED page.

JOINT HELMET-MOUNTED CUEING SYSTEM

USAF Photo
by A1C Kevin Tanenbaum

HELMET MOUNTED CUEING SYSTEM

The Joint Helmet Mounted Cuing System (JHMCS) features a Helmet Display Unit (HDU) that can be attached to the pilot's flight helmet, which projects aircraft, sensor, and weapon information directly onto the helmet visor, without needing to look forward through the HUD or down inside the cockpit. The JHMCS system, which is installed on various military aircraft, is simply referred to as the Helmet Mounted Cueing System (HMCS) in the F-16C avionics.

The HMCS also allows sensors and weapons to be slaved, or "cued", to the pilot's helmet line-of-sight, up to 80° off-boresight. This is a particularly effective system when paired with the AIM-9X missile, which contains a high-angle off-boresight (HOB) seeker that is capable of tracking targets that are significantly outside of the HUD field-of-view. This capability can be quite lethal during air-to-air engagements that occur within visual range (WVR).

Joint Helmet Mounted Cueing System (JHMCS)

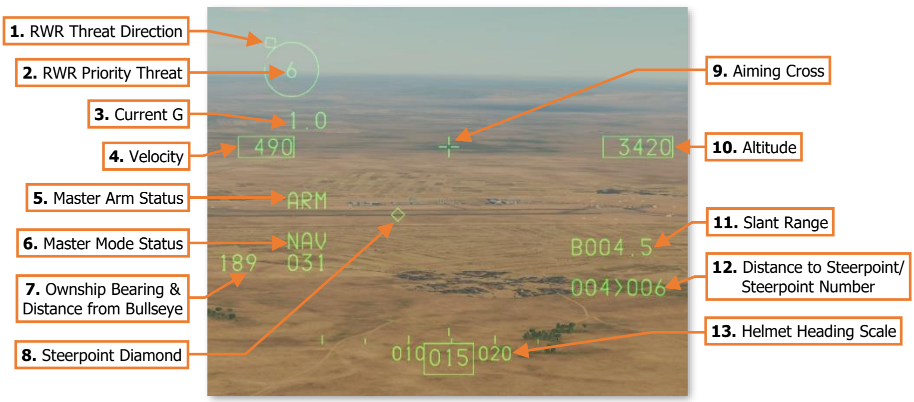
The JHMCS visor itself contains a Magnetic Receiver Unit (MRU), which detects magnetic signals emitted by the Magnetic Transmitter Unit (MTU) to relay helmet position and orientation to the aircraft electronics. These signals are used by the aircraft electronics to steer sensors and weapons when commanded, and to determine the appropriate virtual symbology to augment the pilot's vision in order to increase situational awareness.

In realty, JHMCS symbology is projected onto the helmet visor in front of the right eye only. However, for some DCS players, this may cause discomfort in VR. DCS: F-16C Viper allows players to selectively project the JHMCS symbology onto either eye or both eyes, depending on player preference. This option may be set on the SPECIAL Tab within the DCS: World Options.

HMCS Symbology

The HMCS is enabled using the SYMBOLOGY INT knob on the HMCS control panel. Rotating the knob clockwise increases the brightness intensity of the symbology and rotating it to the OFF position removes the HMCS symbology from the visor and disables the system.

Some elements of the HMCS symbology are always present, others will be displayed or removed based on the selected master mode, available sensor(s), or weapon profile; and some elements can be optionally displayed or removed based on pilot preference. (See HMCS DED Settings for more information.)



1. **RWR Threat Direction.** Displays the relative azimuth of the priority threat detected by the RWR, indicated by a diamond. If the diamond is located at the top of the circle, the priority threat is directly in front of the aircraft. If the diamond is located at the bottom of the circle, the priority threat is directly behind the aircraft. If no priority threat is present, this symbology element will blank.

   A gap in the circle indicates the azimuth of the HMCS line-of-sight (LOS) to cue the pilot to the priority threat direction. If the threat direction diamond is centered within the gap, the HMCS LOS is aligned with the priority threat direction (in azimuth only), aiding the pilot in visually acquiring the threat aircraft, air defense system, or weapon's signature.

   NOTE: The directional accuracy of this symbology is subject to the same limitations as the ALR-56M Threat Warning Azimuth Display.

2. **RWR Priority Threat.** Displays the priority threat detected by the RWR. If no priority threat is present, this symbology element will blank.

3. **Current G.** Displays the current aircraft G-load value. The G value is displayed to the nearest tenth of a G, and ranges from +9.9 to -9.9 G's.

4. **Velocity.** Velocity is displayed in knots, between 60 to 900 knots CAS. When below 60 knots CAS, the HMCS will display 48 knots.

   The Velocity can be set to calibrated airspeed (CAS), true airspeed (TAS), or ground speed (GND SPD) using the Velocity Switch on the HUD Control Panel. The Velocity will automatically revert to calibrated airspeed if in Dogfight mode or if the landing gear are down.

5. **Master Arm Status.** Displays the position of the MASTER ARM Switch on the MISC panel.

   - **ARM.** The MASTER ARM Switch is in the MASTER ARM position.

- **(Blank).** No text is displayed if the MASTER ARM Switch is in the OFF position.
- **SIM.** The MASTER ARM Switch is in the SIMULATE position.

6. **Master Mode Status.** Displays the current master mode or sub-mode.
    - **NAV.** Navigation mode.
    - **AAM.** Air-to-Air Missile mode with no missile type selected.
    - **MRM.** Medium Range Missile type selected in Air-to-Air Missile/Missile Override mode.
    - **SRM.** Short Range Missile type selected in Air-to-Air Missile/Missile Override mode.
    - **HOB.** High-Angle Off-Boresight missile type selected in Air-to-Air Missile/Missile Override mode.
    - **EEGS.** Enhanced Envelope Gun Sight, Air-to-Air Guns mode.
    - **MSL.** Missile Override mode with no missile type selected.
    - **DGFT.** Dogfight mode.
    - **CCIP.** Continuously Computed Impact Point, Air-to-Ground sub-mode.
    - **CCRP.** Continuously Computed Release Point, Air-to-Ground sub-mode.
    - **DTOS.** Dive Toss, Air-to-Ground sub-mode.
    - **LADD.** Low Altitude Drogue Delivery, Air-to-Ground sub-mode.
    - **MAN.** Manual, Air-to-Ground sub-mode.
    - **STRF.** Strafe, Air-to-Ground Gun mode.
    - **PRE.** Pre-planned electro-optical, Air-to-Ground sub-mode.
    - **VIS.** Visual electro-optical, Air-to-Ground sub-mode.
    - **BORE.** Boresight electro-optical, Air-to-Ground sub-mode.
    - **HARM.** HARM Missile designation, Air-to-Ground sub-mode.
    - **HTS.** HARM Targeting System designation, Air-to-Ground sub-mode.
    - **JETT.** Selective Jettison/Emergency Jettison mode.
7. **Ownship Bearing & Distance from Bullseye.** Displays the azimuth and distance as measured from the Bullseye location to the aircraft.

    The Ownship Bearing & Distance from Bullseye can be toggled using the BULL DED page.
8. **Diamond Symbol.** Displays the 3-dimensional position of the selected steerpoint, in both position and altitude. When the Diamond Symbol is out of the HMCS field-of-view (FOV) an X is superimposed across the symbol. (See Steerpoint Navigation for more information.)
9. **Aiming Cross.** Displays the HMCS line-of-sight (LOS) for sensor cueing and target designation. If in Air-to-Air, Dogfight, or Missile Override master modes, the Aiming Cross becomes dynamic to aid the pilot in designating a target during high look-up angles and/or high-G conditions.

    If the pilot aims the HMCS LOS greater than 30° above the horizontal plane, relative to the aircraft's fuselage, the Aiming Cross will be increasingly re-positioned higher in within the vertical plane of the HMCS FOV. The Aiming Cross will reach its maximum vertical deflection at an 80° look-up angle.
10. **Altitude.** The Altitude is in feet, to the nearest 10 feet.

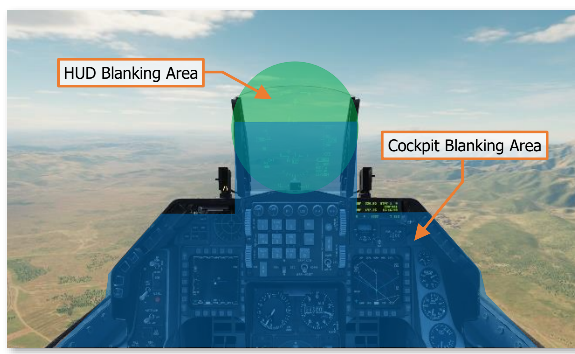
11. **Slant Range.** The Slant Range is the direct, straight-line distance from the aircraft to the current target or SPI location. For range values greater than 1.0 NM, the range is displayed as a four-digit value to the nearest tenth of a nautical mile (i.e., 15.2 NM is displayed as "015.2"). For range values less than 1.0 NM, the range value is displayed as a three-digit value to the nearest hundred feet (i.e., 5500 feet is displayed as "055"). The letter on the left of the display indicates the method the range is determined.
    - **B.** The slant range is determined based on the barometric altitude and steerpoint elevation.
    - **R.** The slant range is determined based on the radar altimeter.
    - **F.** The slant range is determined based on ranging data from the FCR.
    - **M.** A Manual range is being used in an air-to-air mode or in air-to-ground CCIP mode.
12. **Distance to Steerpoint/Steerpoint Number.** The distance to the selected steerpoint is displayed to the left of the chevron in 1 nautical mile increments. The selected steerpoint number is displayed to the right of the chevron. (See Steerpoint Navigation for more information.)
13. **Helmet Heading Scale.** The Helmet Heading Scale indicates the magnetic heading of the HMCS line-of-sight (LOS). A fixed lubber line along the top of the scale and a digital readout below the scale displays the HMCS LOS. Each major tick mark on the tape represents 10° of magnetic heading and is accompanied by a 2-digit label, and each minor tick mark represents 5° of magnetic heading.

Additional HMCS symbology elements associated with the various sensors and weapons are described in the applicable chapters of this manual.

HMCS DED Settings

The HMCS symbology is designed to work in conjunction with the existing cockpit structure and Heads-Up Display (HUD). As such, the avionics is configured to removed (or "blank") the HMCS display when the pilot's helmet line-of-sight (LOS) is detected to be within specifically configured blanking areas.

The F-16C has two blanking areas, one for the HUD and the other for the cockpit itself, with some overlap. If HMCS is enabled, whenever the pilot's helmet LOS is detected to be outside of these boundaries, the HMCS symbology will appear within the pilot's visor. However, each of these blanking areas can be individually toggled off, should the pilot choose to do so.



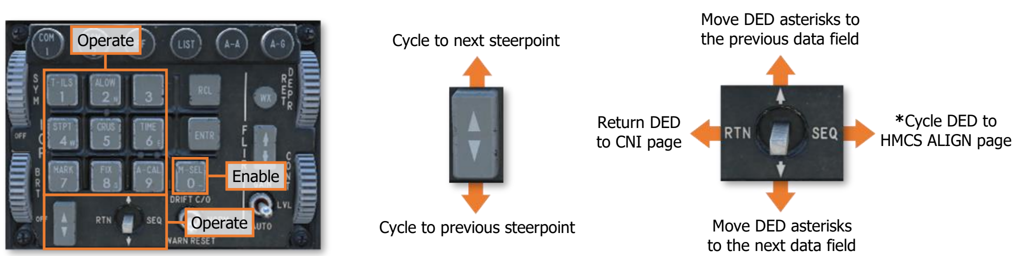
HMCS Blanking Areas

The HMCS must be aligned prior to takeoff. This ensures that sensors and weapons are precisely cued to the HMCS Aiming Cross and virtual symbology elements are accurately placed within the pilot's field-of-view. If the mission begins with the aircraft already operating (engine running and systems initialized, the HMCS alignment is completed for you. However, if performing a start sequence yourself (i.e. "cold start"), the HMCS alignment will need to be completed to ensure precise cueing and display during your mission.

HMCS DISPLAY Page

The Helmet Mounted Cueing System DED page is accessed by pressing **RCL** on the ICP keypad when the MISC DED page is displayed on the DED. This page is used to configure the HMCS display settings and perform an alignment to ensure the helmet LOS measurements are calibrated to the individual pilot.

The first HMCS DED page is the HMCS Display page, which allows the pilot to tailor the display elements to individual preferences and toggle the HMCS blanking areas, if desired.



* HMCS ALIGN page is only accessible when the master mode is set to NAV.

1. **HUD Blanking.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled, the HMCS will blank when the helmet LOS is within the boundaries of the HUD blanking area.

2. **Cockpit Blanking.** Displayed in highlighted text when enabled using the 0/M-SEL button. When enabled, the HMCS will blank when the helmet LOS is within the boundaries of the cockpit blanking area.

3. **Declutter Level.** Displays the HMCS declutter level. May be changed by placing the DED asterisks around the data field and pressing any ICP keypad button 1-9 to cycle between LVL1, LVL2, and LVL3.

   - **LVL1.** All symbology elements are displayed.
   - **LVL2.** Altitude, Distance to Steerpoint/Steerpoint Number, and Helmet Heading Scale are removed.
   - **LVL3.** Current G, Velocity, and Master Arm Status are removed, in addition to LVL2 removed elements.

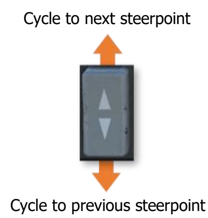
4. **RWR Display.** Enables/Disables the display of the RWR priority threat and direction. May be changed by placing the DED asterisks around the data field and pressing the 0/M-SEL button to toggle between ON and OFF.

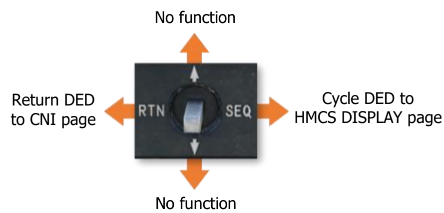
5. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.

6. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

HMCS ALIGN Page

The second HMCS DED page is the HMCS Align page, which allows the pilot to ensure the HMCS is calibrated to the correct helmet position for accurate LOS cueing and to ensure virtual symbology elements are displayed at their correct positions within the pilot's vision.



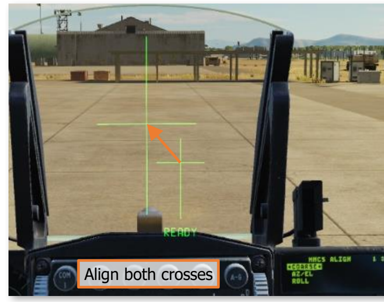


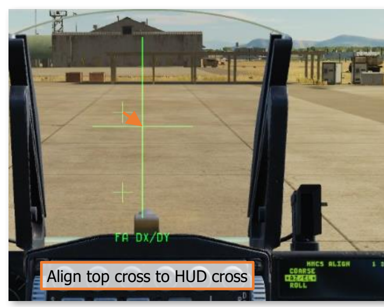
1. **Coarse Alignment.** Initiates a coarse alignment of the HMCS. To initiate the alignment sequence, set the SYMBOLOGY INT knob on the HMCS control panel to any position other than OFF and press the 0/M-SEL button.
2. **Azimuth/Elevation Alignment.** Initiates a fine alignment of the HMCS in the azimuth and elevation axes. To initiate the alignment sequence, complete a COARSE alignment, and then press the 0/M-SEL button when the DED asterisks sequence to the AZ/EL data field.
3. **Roll Alignment.** Initiates a fine alignment of the HMCS in the roll axis. To initiate the alignment sequence, complete an AZ/EL alignment, and then press the 0/M-SEL button when the DED asterisks sequence to the ROLL data field.
4. **Selected Steerpoint.** Displays the currently selected navigational steerpoint.
5. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

HMCS ALIGN Page – Perform a HMCS alignment

A HMCS alignment is initiated with the COARSE alignment function on the HMCS ALIGN page. Ensure the HMCS SYMBOLOGY INT knob on the HMCS control panel is rotated out of the OFF position. If HMCS symbology is not displayed, ensure the aircraft is equipped with JHMCS (may be requested through the Ground Crew using the communications menu) and that DMS Aft-Long hasn't toggled the HMCS off.

1. Press **0/M-SEL** to initiate the COARSE alignment. The COARSE data field on the DED will become highlighted and the HUD will display an Alignment Cross. The HMCS will display a Coarse Alignment Cross along with a "READY" message in the lower portion of the HMCS field-of-view (FOV).
2. Use head movements to adjust the position of the HMCS so that both alignment crosses are aligned with each other and depress the **RDR CURSOR/ENABLE** control on the throttle grip. The "READY" message will change to an "ALIGNING" message. After several seconds, during which both crosses must remain aligned, the "ALIGNING" message will be replaced with an "ALIGN OK" message.
3. Press **0/M-SEL** to accept the alignment. The COARSE data field will be de-highlighted and the DED Asterisks will automatically move to the AZ/EL data field.
4. Press **0/M-SEL** to initiate the AZ/EL alignment. The AZ/EL data field on the DED will become highlighted and the HUD will display an Alignment Cross. The HMCS will display a DX/DY Cross in the center, and a DROLL Cross and an "FA DX/DY" message in the lower portion of the HMCS FOV.
5. Use the **RDR CURSOR/ENABLE** control on the throttle grip to position the DX/DY cross so that it is aligned with the HUD Alignment Cross.
6. Press **0/M-SEL** to accept the alignment. The AZ/EL data field will be de-highlighted and the DED Asterisks will automatically move to the ROLL data field.
7. Press **0/M-SEL** to initiate the ROLL alignment. The ROLL data field on the DED will become highlighted and the HUD will display an Alignment Cross. The HMCS will display a DROLL Cross and an "FA DROLL" message in the lower portion of the HMCS FOV.
8. Use the **RDR CURSOR/ENABLE** control on the throttle grip to position the DROLL cross so that it is aligned with the lower vertical stadia line of the HUD Alignment Cross.
9. Press **0/M-SEL** to accept the alignment. The ROLL data field will be de-highlighted and the DED Asterisks will automatically move back to the COARSE data field, indicating the HMCS alignment is complete.





AIR-TO-AIR EMPLOYMENT

USAF Photo
by SrA Peter Reft

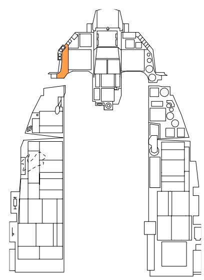
AIR COMBAT PREPARATION

This section's revision is currently a work-in-progress.

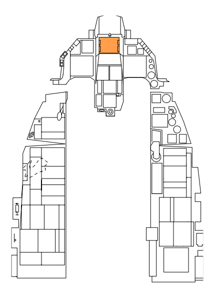
Remember to anticipate what is coming up next and stay ahead of the curve. You do not have to wait until you are about to make an attack to set the aircraft up.

When entering an area where you expect to encounter enemy aircraft, you will want to take the following steps:

1. Position the Master Arm Switch to ARM. Weapons may be released normally when in the ARM position. If the Master Arm switch is placed in the OFF position, weapon release is inhibited.



2. Press the A-A Master Mode Button on the ICP to place the fire control system in Air-to-Air Missile (AAM) Mode.



This is one method for preparing the aircraft for an air-to-air attack. There are also two air-to-air override modes that can be quickly selected using HOTAS commands. Those are described below.

DOGFIGHT AND MISSILE OVERRIDE MODES

Two override modes are available to quickly configure the aircraft for an air-to-air engagement: **Dogfight** and **Missile Override**. These modes are selected using the DOGFIGHT switch located on the throttle grip. It is a three-position switch that overrides any mode except emergency jettison.

- DOGFIGHT (outboard). This mode provides symbology on the HUD for both 20mm gun firing and AIM-9 Sidewinder missile delivery.
- MSL OVRD (inboard, unlabeled). This provides symbology for AIM-120 missile firing only. If no AIM-120 is loaded, AIM-9s are selected.
- Center position. Returns to the last selected master mode.

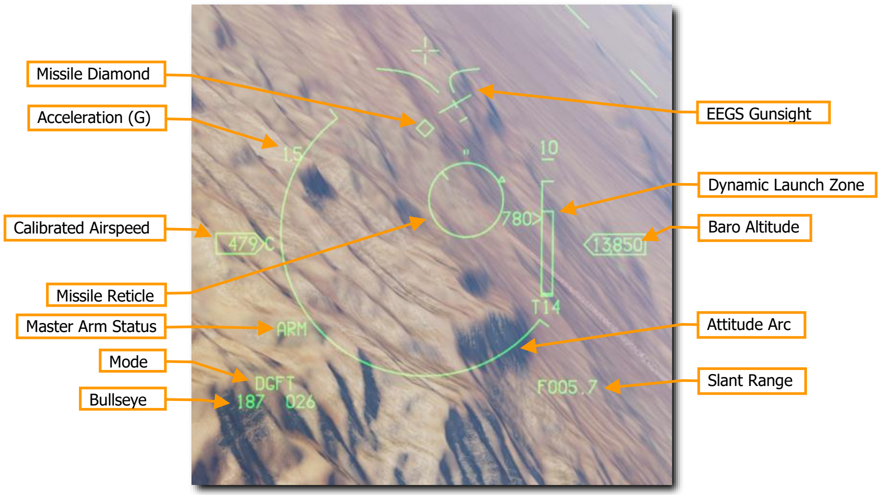
Requests for master mode changes made using the ICP will be ignored while either of these modes are active.

Changes to missile or radar settings made while either override mode is active will be saved throughout the mission. A common technique is to configure the displays, radar, and missiles for each mode as desired during ground operations. This provides three distinct weapon delivery options (Dogfight, Missile Override and Default) without the need to remove your hands from the controls.

Dogfight Mode

With the switch in the DOGFIGHT (outboard) position, the HUD is configured for Gun and AIM-9 missile firing. The left MFD is configured with the radar in ACM Boresight mode and the right MFD is configured with the Dogfight SMS page.

The Dogfight HUD combines elements of the Missile and Guns HUD modes into one decluttered display. Note that the heading bar, flight path marker and attitude bars are removed.



See the sections on Air to Air Gunnery and AIM-9 Sidewinder Employment for details on each display and how to use them.

Missile Override Mode

With the switch in the Missile Override (inboard) position, the HUD is configured for AIM-120 missile firing. The left MFD is configured with the radar in RWS mode and the right MFD is configured with the Missile SMS page.

See the section on AIM-120 AMRAAM Employment for details on each display and how to use them.

M61A1 20MM CANNON

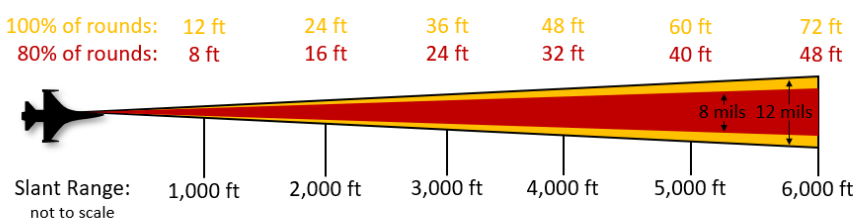
The M61A1 20mm automatic gun system provides the pilot with a formidable weapon capability. It is a six-barrel Gatling type gun mounted in the left strake of the aircraft. The system has a capacity of 512 rounds of ammunition fired at 6,000 rounds per minute.

Gun Dispersion

Rounds fired from any gun system do not follow a perfectly straight path but are dispersed in a cone shaped pattern after they leave the gun's muzzle. The dispersion pattern becomes a larger and larger cone as slant range increases. The density of rounds within the cone becomes less and less as the edge of the cone is approached.

The average dispersion of the M61A1 is 8 mils diameter for 80% of the rounds fired and 12 mils for 100% of the rounds fired.[1] USAF units maintain a boresight program to ensure gun systems installed on aircraft continue to meet these specifications while in operational use.

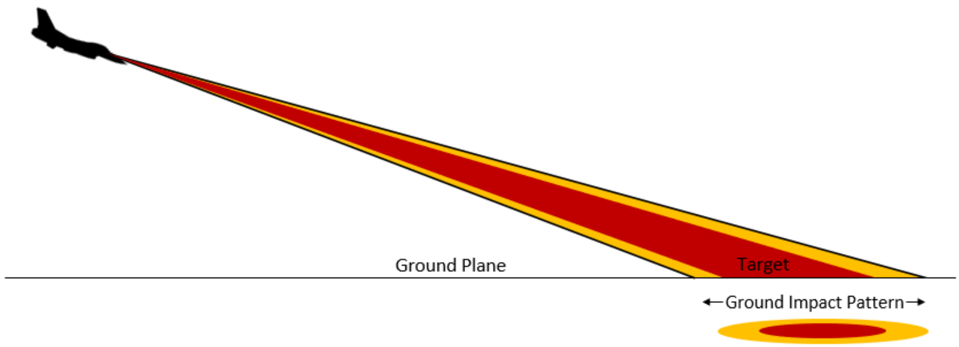
One mil is equal to 1/1000 of a radian so 8 mils equals an 8 foot diameter circle at 1,000 feet range and 12 mils equals a 12 foot diameter circle. The size of the circle continues to increase with range.



In practical terms, this means you have some leniency in accuracy when firing the gun. In this example, the green gun pipper is a 4-mil diameter circle. This is where bullets are most dense within the cone. The red shaded area is the 8-mil circle 80% of the rounds will pass through at the target range. The orange shaded area is the 12-mil circle that 100% of the rounds will pass through at the target range.

The dispersion pattern of rounds fired from the gun is a circle only if the target is perpendicular to the flight path. It resembles an ellipse when firing against a horizontal target on the ground.

[1] This is based on MIL-DTL-45500/1A that states "At a range of 1,000 inches, 80 percent of a 75 round (min.) burst shall be completely within an 8.0 inch diameter circle for accuracy" and the manufacturer's data sheet that states "8 milliradians diameter, 80 percent circle".



Summary

1. Select A-A master mode **[1]** or DGFT override mode **[3]**
2. Set Master Arm Switch to Arm
3. Acquire target using ACM radar mode (optional)
4. Fly the EEGS funnel and pipper onto the target
5. Squeeze the Trigger **[Space]** to the second detent to fire the gun

Air to Air Gunnery

1. There are two ways to get into the correct SMS configuration for air-to-air gunnery. They are:
   - **Select the Air-to-Air Gunnery operating mode on the MFD by pressing OSB 1 until GUN is displayed, or**
   - **Position the Dogfight/Missile Override (DOGFIGHT) Switch to DGFT.**

   This provides symbology on the HUD for both 20mm gun firing and A-A missile delivery.

2. **Verify A-A GUN symbology is displayed in the HUD.**

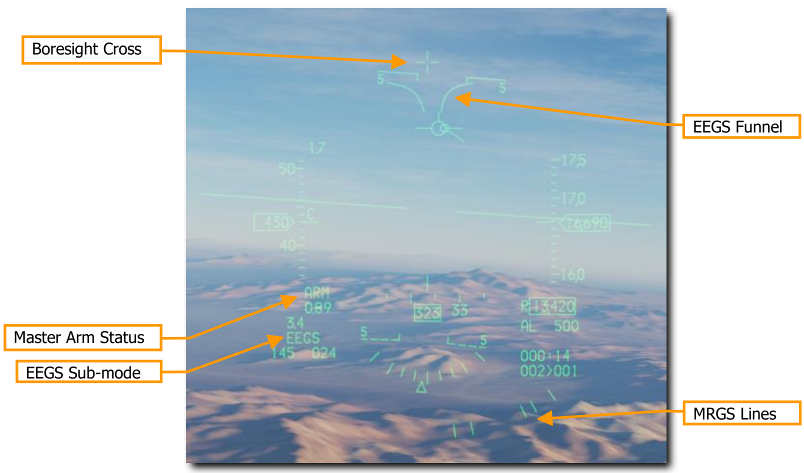
The Enhanced Envelope Gun Sight (EEGS) provides different levels of information depending on whether the radar is locked on the target.

Level I is a failure mode that only displays the **Boresight Cross** in the event of a Rate Sensor Unit (RSU) and INS failure. It should almost never be encountered.

Level II provides a prediction of the bullet path when there is no radar lock. The **Boresight Cross**, **EEGS Funnel** and **Multiple Reference Gunsight (MRGS) Lines** are provided.

Level III and IV are intermediate levels that lead to the Level V display. These are usually not seen by the pilot.

Level V is displayed after radar lock-on and a firing solution has been computed using that data. Additional references in the HUD include the **Target Designator, T-Symbol, Range to Target, Closure Rate** and **Level V Pipper.**



Level II Symbology (no radar lock)

Boresight Cross. This symbol is always available and shows the boresight direction. This is the direction rounds will travel before other influences like gravity or air resistance take effect.

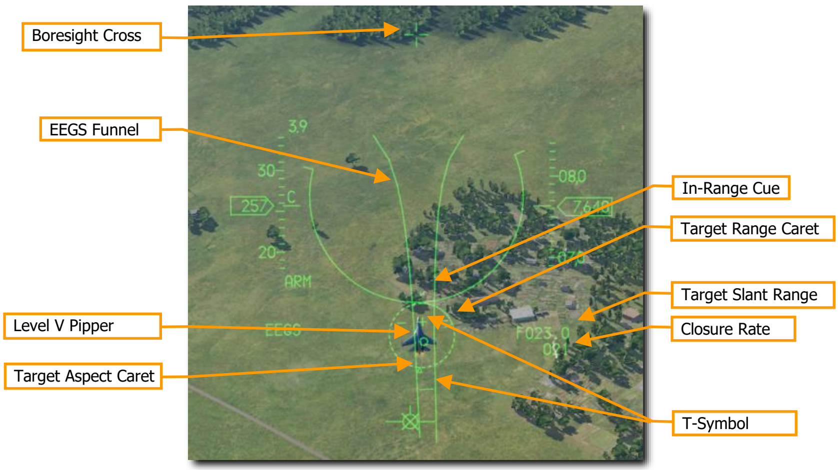
EEGS Funnel. Each point along the funnel represents the target at a specific range for which the gun is correctly aimed. In other words, an aircraft whose wings are the same width as the funnel is at the correct range to be hit by rounds fired at that moment.

As the range decreases, the target size will increase. As this occurs, you must place the target higher in the funnel to keep the target wingspan just touching the sides of the funnel. This results in placing the target higher in the HUD or, more importantly, closer to the Boresight Cross which results in reduced lead for the reduced range.

The target aircraft wingspan must be known for the funnel to provide accurate range information.

Multiple Reference Gunsight Lines. The MRGS sight is composed of a series of five line segments pointing toward the Gun Bore Line, and spaced in an arc near the bottom of the HUD. They aid in lining up long range, high aspect shots by providing the correct lateral aiming solution so the target flies up the funnel.

When using an MRGS line, if the target is smaller than the line, it is either out of range or moving faster than anticipated and requires extra lead. If the target is larger than the MRGS line, the target is moving slower than anticipated and will require less lead.



Level V Symbology (with radar lock)

Target Designator. This symbol is centered on the locked radar target. The triangular **Target Aspect Caret** shows the target's aspect angle. Maximum effective gun range is shown by an **In-Range Cue**, two small lines on the outside of the symbol. The position of the **Target Range Caret** indicates the range to the locked target. Each o'clock position represents 1,000 feet of range, so:

- 12 o'clock = 12,000 ft
- 9 o'clock = 9,000 ft
- 6 o'clock = 6,000 ft
- 3 o'clock = 3,000 ft

Target Range. The distance to the locked target. Tenths of a mile are displayed for ranges greater than one mile. Hundreds of feet are displayed at ranges less than one mile.

Closure Rate. The rate of closure with the target in knots.

T-Symbol. This symbol shows two firing solutions for the locked target. The + symbol, or 'one-G pipper' shows the lead angle against a non-maneuvering target. The small horizontal bar, or 'nine-G pipper' shows the lead angle for a target turning at maximum sustained rate. These may be used as a backup in situations the Level V Pipper is not displayed.

Two maneuver potential lines are displayed on either side of the 1g pipper. The longer the lines, the greater the out-of-plane maneuver potential of the target.

Level V Pipper. This represents the gunfire solution computed for the target's current range and rates. The goal is to stabilize this pipper over the target and fire.

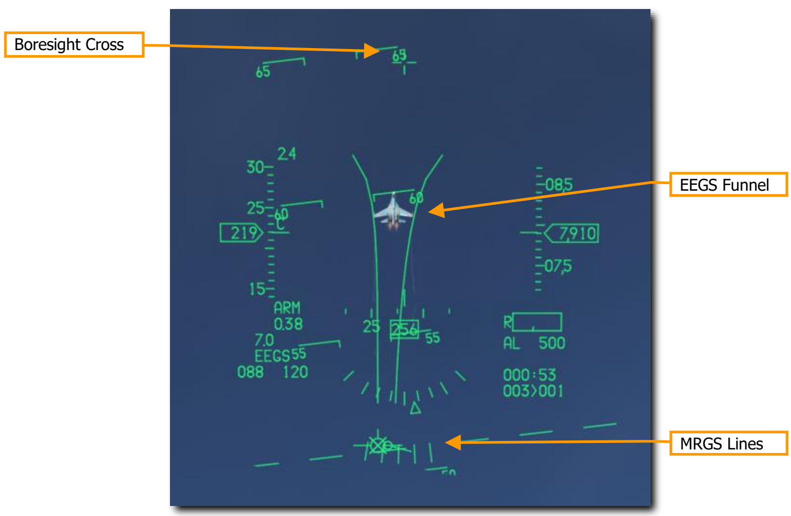
3. **Maneuver your aircraft to frame the target aircraft within the EEGS funnel.**

Each point along the funnel represents the target at a specific range for which the gun is correctly aimed. In other words, an aircraft whose wings are the same width as the funnel is at the correct range to be hit by rounds fired at that moment.

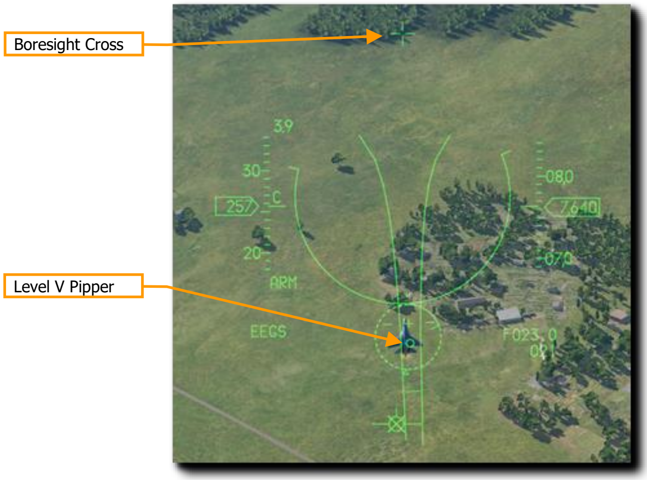
Place the enemy aircraft in the funnel so that the wingtips touch the edges or the Level V Pipper is stabilized over the target.

4. **Squeeze the trigger all the way to the second detent to fire the gun when the wingtips touch the funnel (Level II) or Pipper is over the target (Level V).**

Target range greatly affects gun effectiveness. As the rounds come out of the gun, they will gradually disperse and lose velocity. Increased dispersion and loss of velocity reduce the accuracy and effectiveness of the gun. The top of funnel represents the minimum range of approximately 600 feet. The bottom of the funnel represents the maximum range of approximately 3,000 feet. If the target is smaller than the bottom of the funnel, it is out of range.

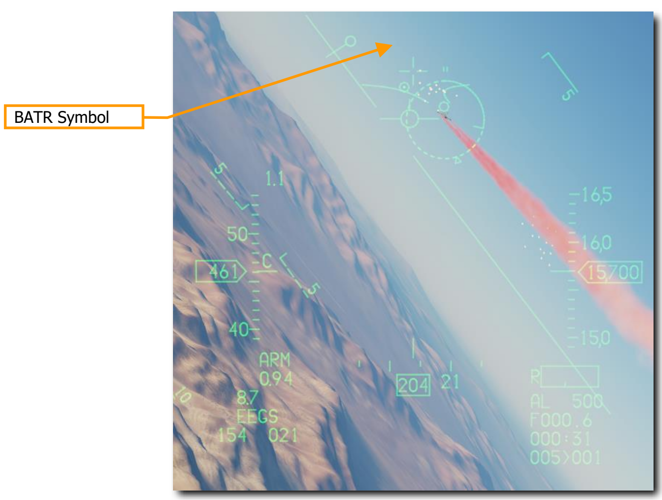


Level II Symbology (no radar lock)



Level V Symbology (with radar lock)

An additional symbol known as the **Bullets at Target Range (BATR) Symbol** is displayed after rounds are fired. The BATR is displayed as the first real or simulated round passes the target range and is removed after the last round has passed. This is only available with a radar lock and EEGS Level III, IV or V symbology displayed.



AIM-9M/X SIDEWINDER

The AIM-9 is a short-range, infrared-guided missile best used in a dogfight. It is fire-and-forget and can be used with or without a radar lock. The primary indication of a seeker lock is a higher-pitched lock tone. The seeker can also be uncaged to ensure the seeker is tracking the target when it has first been sensor-slaved to the target.

Note that the AIM-9 can be decoyed by flares and it's a good idea to ensure you have a good seeker lock before launching an AIM-9 with flares in the seeker field of view.

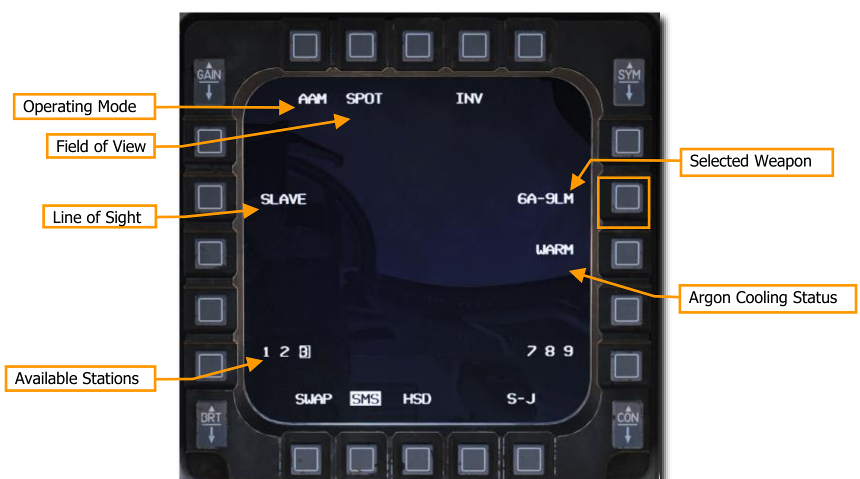
Summary

1. Select AAM **[4]** or DGFT **[3]** master mode
2. Set Master Arm Switch to Arm
3. Acquire target using radar (optional)
4. Maneuver until target is in launch zone
5. Depress Uncage switch **[C]** to command missile track (if required)
6. Verify missile diamond is on target and lock tone is audible
7. Depress Weapon Release **[RAlt]+[Space]** switch to fire missile

AIM-9M/X Employment

1. There are two ways to get into the correct SMS configuration for firing an AIM-9. They are:
   - **Select AIM-9s on the MFD by pressing OSB 7 until AIM-9s are displayed, or**
   - **Position the Dogfight/Missile Override (DOGFIGHT) Switch to DGFT.**

   This overrides any other master mode and configures the displays for air combat. The DOGFIGHT position provides symbology on the HUD for both 20mm gun firing and A-A missile delivery. The MSL position provides symbology on the HUD for A-A missile delivery only.



The number and type of missiles is displayed next to OSB 7. The stations with missiles loaded are displayed at the bottom and the selected station is boxed. Step through available stations with the Missile Step button or by selecting the adjacent OSB.

SPOT/SCAN commands the missile seeker to either scan in a narrow field of view (SPOT) or wide field of view (SCAN). The wider field of view is achieved by seeker nutation around the line of sight. Detection range is decreased when SCAN is used. SCAN mode is not currently implemented.

SLAVE/BORE commands the missile to either follow the radar line of sight (SLAVE) or keep looking straight ahead down the boresight (BORE). Pressing and holding the **CURSOR/ENABLE control** overrides the current selected option. Releasing the control returns to the option selected on the MFD.

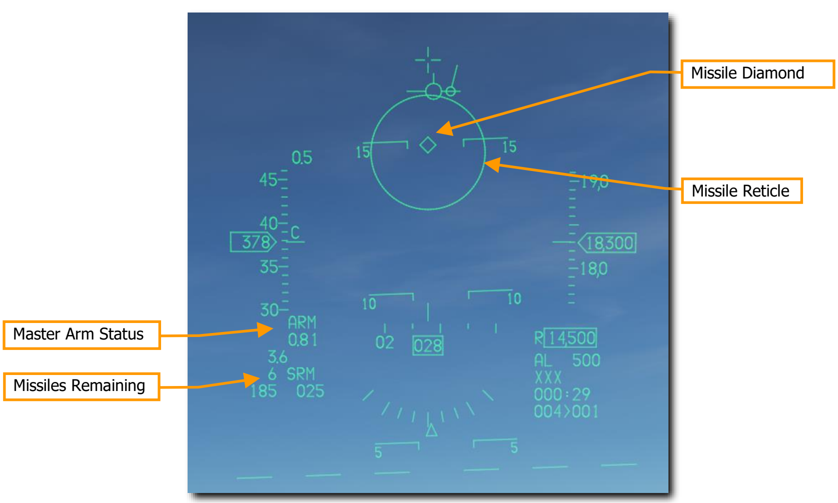
WARM/COOL activates or deactivates argon cooling of the seeker. **This should be set to COOL prior to an engagement to cool the seeker and increase detection sensitivity**. COOL is selected automatically when entering DGFT or MSL Override mode. Argon supply duration varies depending on outside air temperature, pressure, and bottle charge level at installation, but the average duration is 90 minutes.

2. **Verify A-A Missile symbology is displayed in the HUD.**

The air-to-air HUD provides information on the status and targeting of air-to-air missiles. Most of the symbology from the NAV mode is retained but several new features are added to aid in target acquisition and missile launch.

The **Missile Diamond** indicates the position of the AIM-9 seeker head. This starts at the seeker boresight position but unlatches to follow the radar line of sight or track a locked target when a lock is achieved.

The **Missile Reticle** shows the seeker field of view. This will be shown as different sizes depending on the SPOT/SCAN field of view setting chosen on the MFD.



3. **Acquire target using radar (optional).**

Perhaps the most common and easiest way to target an aircraft with the AIM-9 is to acquire a target with one of the ACM Radar Modes. This slews the AIM-9 seeker to the radar target if SLAVE is selected on the missile. This results in an AIM-9 lock if the target is in range and other IR detection conditions are met.

4. **Maneuver until target is in launch zone.**

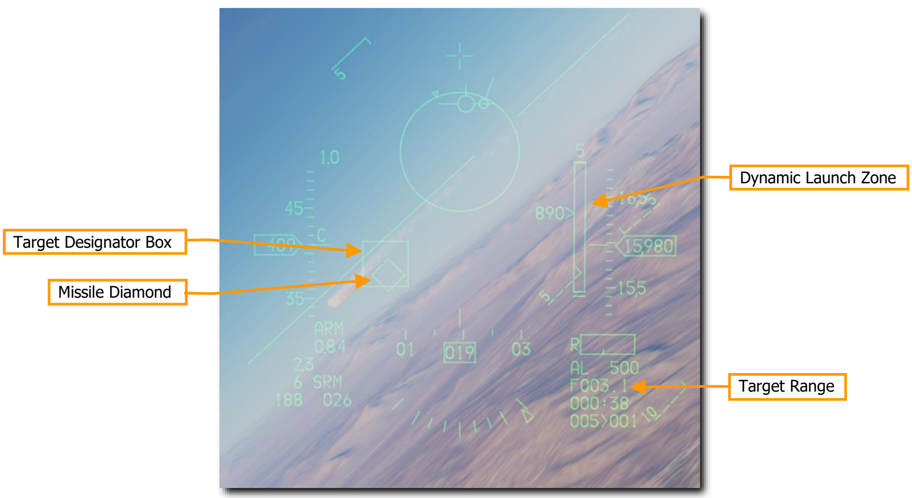
   Fly the missile reticle in the HUD over a target. If the missile detects enough IR energy from the target, target detection is indicated by an audio missile detection tone (growling sound).

5. **Press Uncage switch to command missile self-track.**

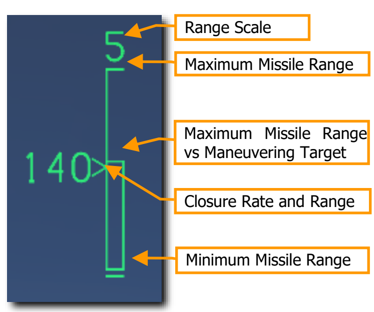
   When the AIM-9 seeker detects a target, it can be uncaged by pressing the **Cage/Uncage button** to allow the seeker lock on and follow the target within the confines of the missile seeker's field of view. The M**issile Diamond** latches to the target when locked.

6. **Verify missile diamond is on target and lock tone is audible.**

   The missile growl will become high pitched when the target is locked. A **Target Designator Box** will be present over a target locked with radar. If firing against a radar target, the **Missile Diamond** should be over the Target Designator box. The **Target Range** is displayed if radar is used.



The **Dynamic Launch Zone** (DLZ) will be displayed on the right side of the HUD when a target is designated with the radar. Monitor the DLZ and assess the threat situation to determine the optimal missile firing point. The missile diamond flashes when the target is within maximum aerodynamic range (Raero). The missile reticle flashes when the target is within maximum maneuvering range (Rtr, when the missile would be effective against even a target that immediately turns and runs).



7. Press the Weapon Release switch to fire the missile.

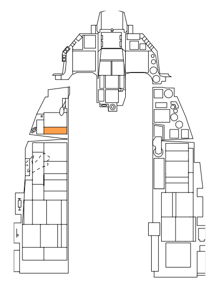
The missile will attempt to intercept the target and the next missile in sequence will be selected. The AIM-9 is a fire and forget weapon so there is no need to continue tracking the target.

AIM-9M/X HMCS Missile BORE Employment

The Helmet Mounted Cueing System (HMCS) allows the AIM-9M or AIM-9X missiles to slave to the HMCS Aiming Cross when BORE mode is selected on the missile. This is useful in situations where no radar lock is possible or desired. This can be thought of as normal AIM-9 employment, except the HMCS line of sight is used instead of the HUD line of sight. The mechanization is otherwise the same.

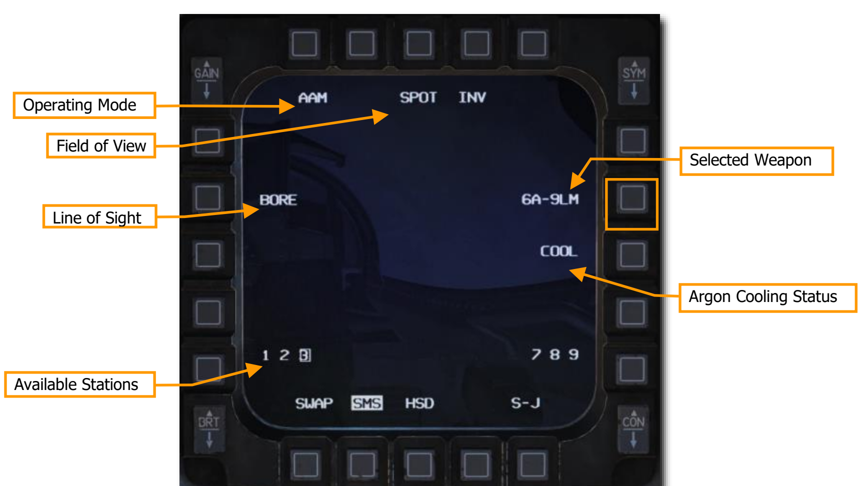
1. Turn on the Helmet Mounted Display (HMCS) symbology.

Power to the HMCS is selected from the **HMCS Symbology** control knob on the left auxiliary console. Rotating the knob clockwise from the OFF position to INC (increase) provides power to the HMCS. Continued clockwise rotation increases symbology brightness.



2. Select AIM-9s on the MFD by pressing OSB 7 until AIM-9s are displayed, or position the Dogfight/Missile Override (DOGFIGHT) Switch to DGFT.

Symbology and functions are identical to non-HMCS employment. Set the **Line-of-Sight** mode to **BORE** to use the HMCS for AIM-9M/X targeting without radar.



3. Acquire the target in the HMCS.

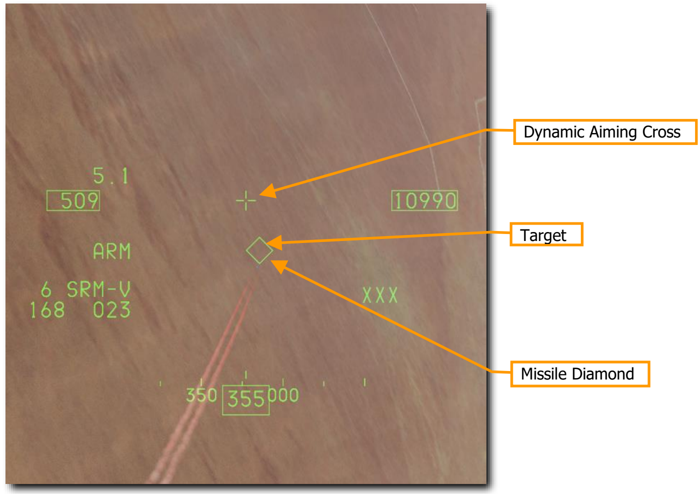
With the AIM-9 set to BORE and the HMCS on, the seeker will follow the **Dynamic Aiming Cross** in the HMCS display. The aiming cross is treated as the boresight position. Simply look at the target instead of flying the aircraft all the way into position for an AIM-9 lock.

Remember, you will still be constrained by the missile seeker gimbal limits when looking around. The **Missile Diamond** shows where the missile seeker is looking. If you look beyond the missile seeker gimbal limits, the diamond symbol will be displayed with an "X" through it and will be clamped to the edge of the HMCS display area.

The other symbology on the display intentionally mimics the symbology from the HUD.

4. Press Uncage switch to command missile seeker track.

When the AIM-9 seeker detects a target, it can be uncaged by pressing the **Cage/Uncage button**. This allows the seeker to lock on and follow the target within the confines of the missile seeker's gimbal limits. The **Missile Diamond** latches to the target when the seeker has locked on.



5. **Verify missile diamond is on target and lock tone is audible.**

   The missile growl will become high pitched when the target is locked. The **Missile Diamond** should be latched to the target and no longer follow the **Aiming Cross**.

6. **Press the Weapon Release switch to fire the missile.**

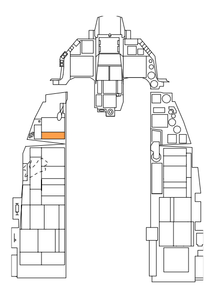
   The missile will track the target and the next missile in sequence will be selected. The AIM-9 is a fire and forget weapon so there is no need to continue tracking the target.

AIM-9M/X HMCS Radar BORE Employment

The Helmet Mounted Cueing System (HMCS) allows the Fire Control Radar to slave to the HMCS Aiming Cross when ACM BORE radar mode is selected. This can be thought of as normal AIM-9 employment, except the HMCS line of sight is used instead of the HUD line of sight. The mechanization is otherwise the same.

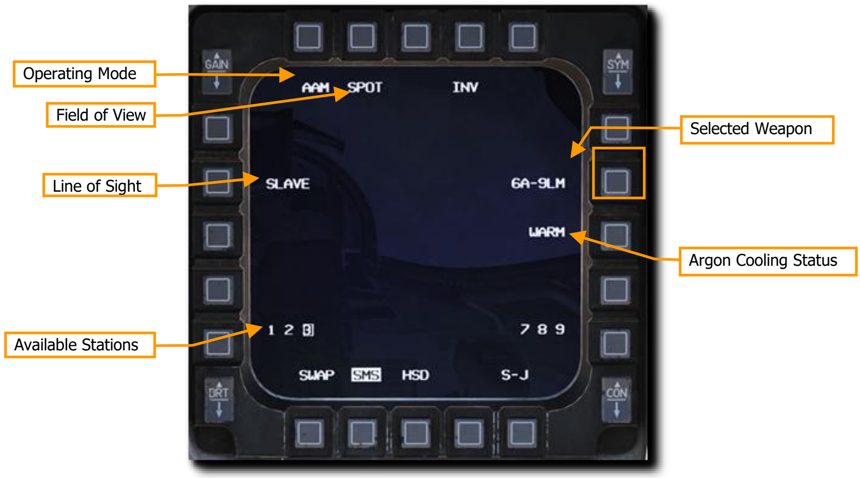
1. **Turn on the Helmet Mounted Display (HMCS) symbology.**

   Power to the HMCS is selected from the **HMCS Symbology** control knob on the left auxiliary console. Rotating the knob clockwise from the OFF position to INC (increase) provides power to the HMCS. Continued clockwise rotation increases symbology brightness.



2. Select AIM-9s on the MFD by pressing OSB 7 until AIM-9s are displayed, or position the DOGFIGHT Switch to DGFT.

Symbology and functions are identical to non-HMCS employment. Set the **Line-of-Sight** mode to **SLAVE** to use the HMCS and radar for AIM-9M/X targeting.

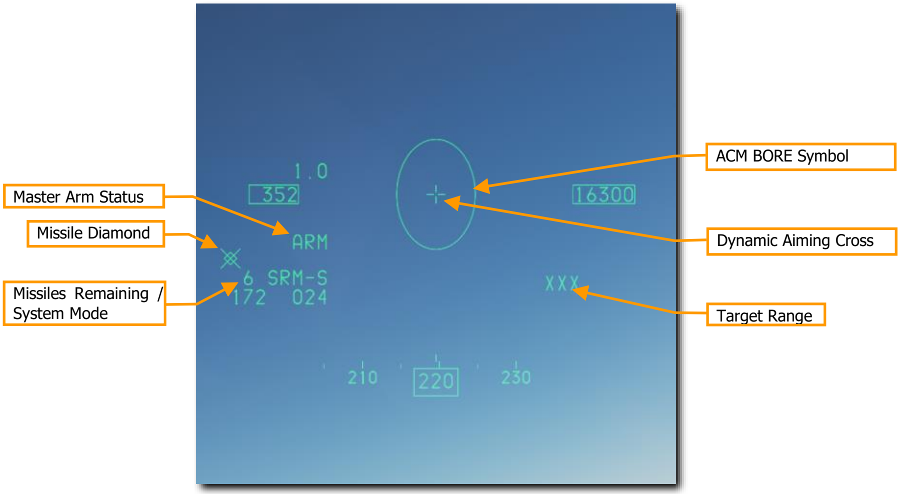


3. Select ACM BORE radar mode, press TMS forward, and acquire the target in the HMCS.

With the **ACM BORE** radar mode selected and the HMCS on, the radar will follow the **Dynamic Aiming Cross** in the HMCS display. The aiming cross is treated as the boresight position. Press TMS forward once, then simply look at the target instead of flying the aircraft all the way into position for a radar lock.

Remember, you will still be constrained by the radar gimbal limits when looking around. The **ACM BORE Symbol** shows where the radar is pointing. If you look too far off the aircraft boresight, the radar will not be able to follow.

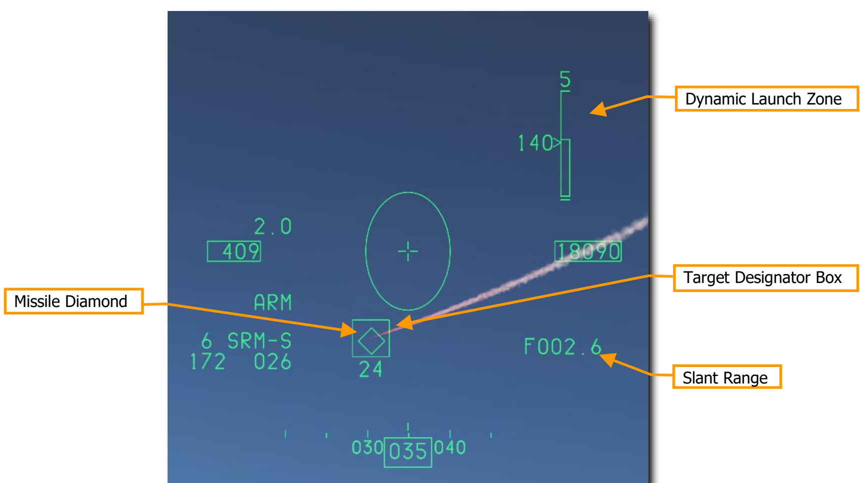
The **Target Range** is displayed after radar lock. The other symbology on the display intentionally mimics the symbology from the HUD.



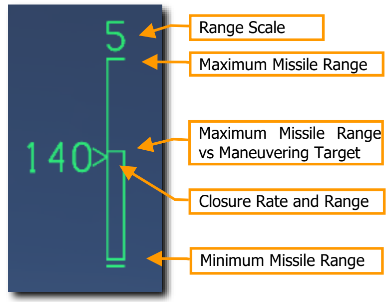
4. **Achieve radar lock in ACM BORE Mode.**

The radar will lock the first target detected within the **ACM Bore Symbol**. A **Target Designator Box** will be present over a target locked with radar.

With the AIM-9 line of sight set to SLAVE, the seeker will slew to the radar line of sight. When the AIM-9 seeker detects a target, it can be uncaged by pressing the **Cage/Uncage button**. This allows the seeker to lock on and follow the target within the confines of the missile seeker's gimbal limits. The **Missile Diamond** latches to the target when the seeker has locked on.



The **Dynamic Launch Zone** (DLZ) will be displayed on the right side of the HMCS when a target is designated with the radar. Monitor the DLZ and assess the threat situation to determine the optimal missile firing point. The missile diamond flashes when target is within maximum range against a maneuvering target.



5. **Verify missile diamond is on target and lock tone is audible.**

   The missile growl will become high pitched when the target is locked. The **Missile Diamond** should be latched to the target.

6. **Press the Weapon Release switch to fire the missile.**

   The missile will attempt to intercept the target and the next missile in sequence will be selected. The AIM-9 is a fire and forget weapon so there is no need to continue tracking the target.

AIM-120 AMRAAM

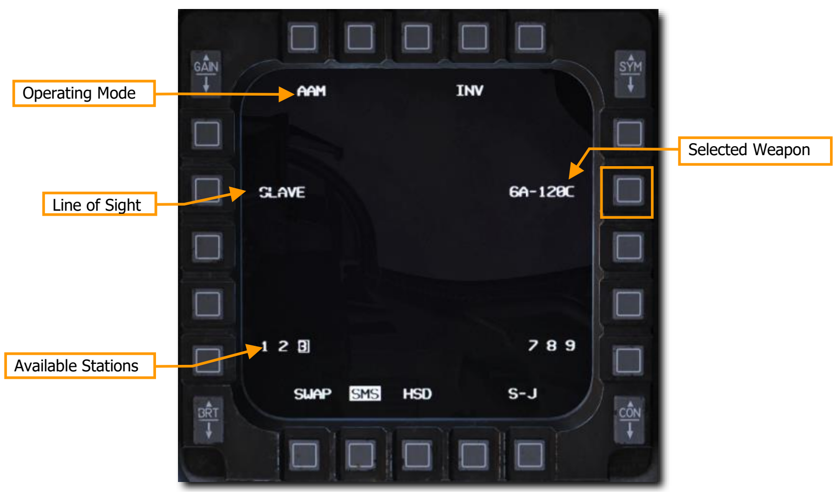
The AIM-120 AMRAAM is an Active Radar-Homing (ARH) air-to-air missile that can self-guide to a target using an active radar seeker in its nose. The missile is guided initially via datalink commands from the launching aircraft, and transitions to onboard active radar homing once within range. Because of the active seeker, the pilot can engage multiple targets at once without needing to support the missile for its entire time of flight.

The AIM-120 is a medium range missile and can engage targets outside 20 nm. However, engagement range is highly dependent on target aspect, engagement altitude, launch speed, and target post-launch maneuvering. As such, the engagement range of the AIM-120 can be less than 10 nm in some situations.

In WVR combat, the AIM-120 can also be launched in BORE mode without a radar lock. Once the missile is launched, it will track and attempt to hit the first target it detects within the AIM-120 reticle on the HUD.

SMS Format

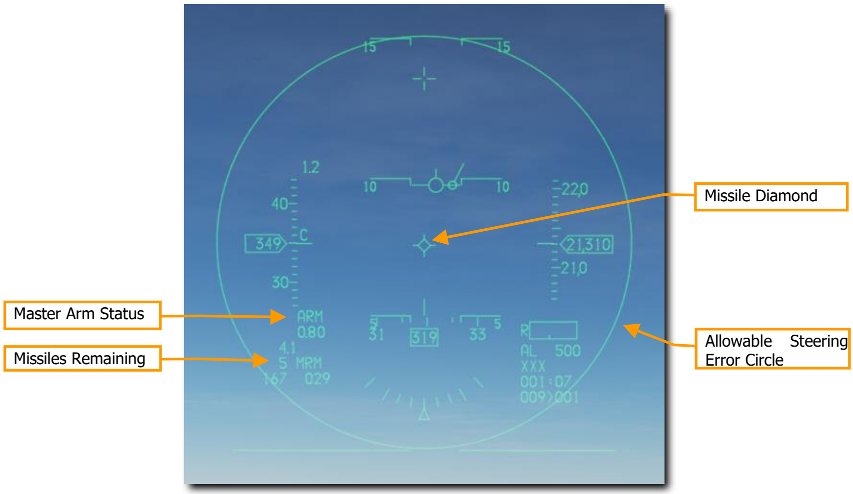
With AIM-120s selected, the SMS format appears as shown:



Line of Sight. When set to SLAVE, missile radar line of sight is slaved to the aircraft's radar. The missile will receive datalink steering from the launching aircraft until it's within radar range, then it will attempt to track the target. When set to BORE, the missile's radar scans straight ahead. It will track the first detected target after launch. Pressing Cursor Enable also cycles between SLAVE and BORE modes.

HUD Symbology

No Target Lock



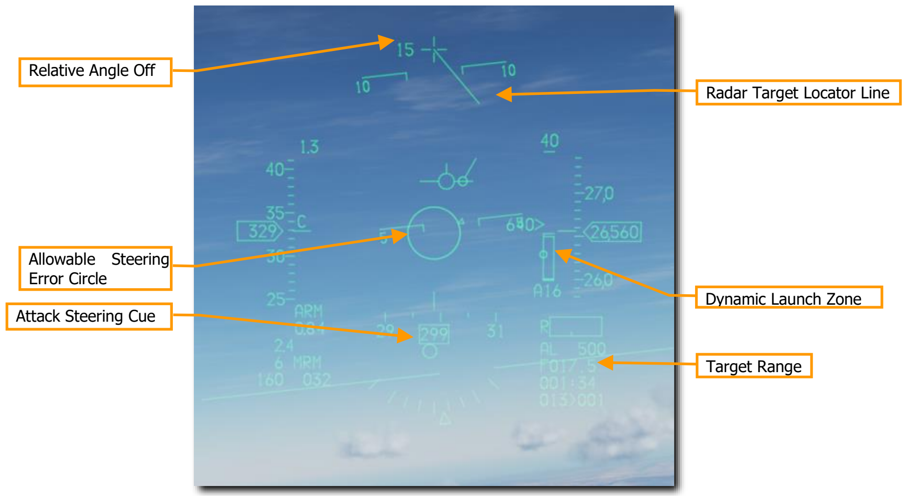
Master Arm Status. Displays "ARM" when Master Arm is on.

Missiles Remaining. Displays the number of missiles remaining and "MRM" for medium-range missile.

Missile Diamond. Indicates missile radar line of sight. This is initialized at seeker boresight position but will slew to target LOS when SLAVE mode is selected, and a target is locked.

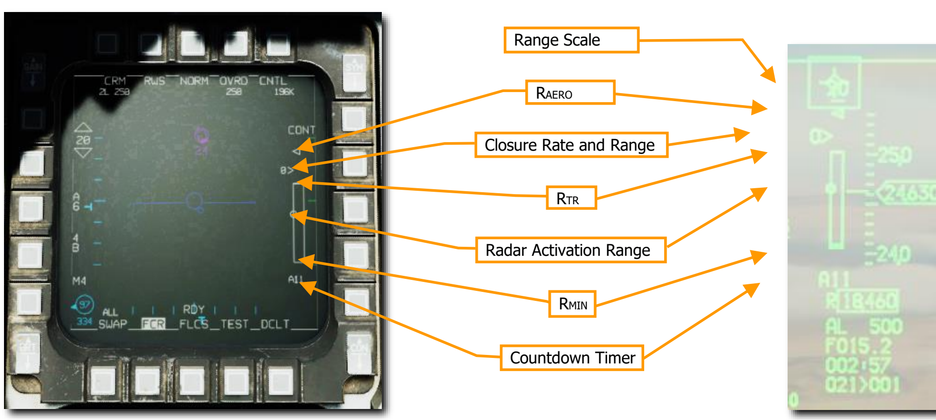
Allowable Steering Error Circle (ASEC). Indicates the zone in which the **Attack Steering Cue (ASC)** should be located prior to launch to hit the target with a high probability kill (PK). The ASC is displayed after radar lock. The **ASEC** shows the maximum angular steering error probability. In other words, the circle increases in size when the distance to the target intercept point decreases, which means that as the distance decreases, the missile can be launched with greater steering error.

With Target Lock



Relative Angle-Off. Displays the angular difference between aircraft heading and target bearing.

Dynamic Launch Zone. Displays information about the missile's capabilities against a target at its current range.



Range Scale. Indicates the range represented by the highest tick mark.

RAERO (aerodynamic range). The maximum kinematic range of the missile. A shot at this distance would only be effective against a target that continues its current course and speed and does not maneuver.

Closure Rate and Range. The caret indicates the current target range against the DLZ, and the adjacent number is the closure rate in knots.

RTR (turn-and-run range). The maximum range where the missile is guaranteed to reach the target regardless of target maneuvering. A shot at this distance would hit a target that immediately turns 180° away from the missile while maintaining speed.

Radar Activation Range. The range at which the missile will activate its own radar, and no longer needs continued support from the launching aircraft.

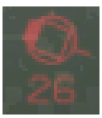
R_{MIN} (minimum range). The closest range that allows the missile to activate its seeker, lock a target, arm, and detonate safely.

Countdown Timer. Displayed after missile launch. Displays "A" followed by the number of seconds until the missile activates its seeker, then "T" followed by the number of seconds until predicted impact.

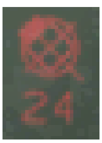
FCR Post-Launch Symbology

Following AIM-120 launch, the FCR format will display different symbols to indicate different missile employment statuses:

A target with an AMRAAM in flight is displayed in magenta with a solid "tail" opposite its trend vector.



A target with at least one AMRAAM in flight that has gone active is displayed in red, and the tail flashes.



A target with at least one AMRAAM that has reached predicted time of impact is displayed with a flashing "X" through it.

AIM-120 Employment

Summary

1. Select A-A master mode **[1]** or MSL override mode **[4]**
2. Set Master Arm Switch to Arm
3. Acquire target using radar (optional but recommended)
4. Maneuver until target is in launch zone
5. Depress Weapon Release **[RAlt]+[Space]** switch to fire missile

1. **There are two ways to select the AIM-120 for employment:**
    - Select AIM-120s on the MFD by pressing OSB 7 until AIM-120s are displayed, or
    - Position the Dogfight/Missile Override Switch to MSL OVRD. This overrides any other master mode and configures the displays for air combat. The MSL position provides symbology on the HUD for A-A missile delivery and selects the longest-range missile type loaded.
2. **Verify A-A Missile symbology is displayed in the HUD.**

The air-to-air HUD provides information on the status and targeting of air-to-air missiles. Most of the symbology from the NAV mode is retained but several new features are added to aid in target acquisition and missile launch.

3. **Acquire target using the radar**

Typically, a target will be locked using RWS, TWS, or any ACM radar sub-mode and the AIM-120 set to SLAVE.

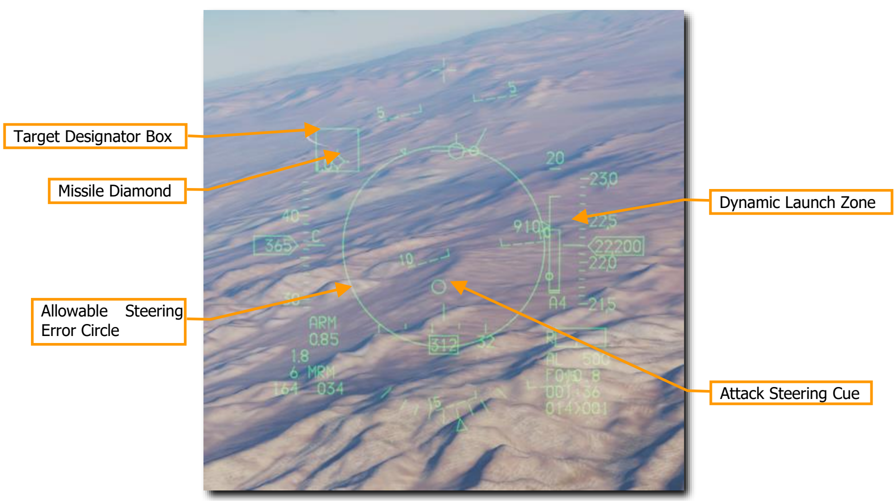
When the locked target is outside the HUD field on view as shown below, a **Target Locator Line (TLL)** extends from the Gun Cross and points directly at the target. The **Relative Angle** is displayed next to the Gun Cross showing the angle in degrees between the cross and the target.

The **Allowable Steering Error Circle (ASEC)** changes size and the **Attack Steering Cue (ASC)** becomes visible. The **Target Range** is displayed after target radar lock.

4. **Maneuver until Attack Steering Cue (ASC) is inside the Allowable Steering Error Circle (ASEC)**

The size of the **Allowable Steering Error Circle** will vary depending on the target range and aspect. Ensure that the **Attack Steering Cue** is located as close to the **Allowable Steering Error Circle** center as possible when firing to achieve the best performance out of the missile.

When the target enters the HUD, the **Target Designator Box** will be displayed over the target and the **Missile Diamond** will track that location.



Monitor the **Dynamic Launch Zone** and assess the threat situation to determine the optimal missile firing point.

5. **Press and hold the Weapon Release switch to fire the missile.**

The missile will track the target and the next missile in sequence will be selected.

The AIM-120 may also be employed in BORE mode without a radar lock on the target. This is used when a quick shot must be taken, or no radar emissions are desired. The missile radar will go active at launch and guide on the first target it detects so use this mode with care.

Simultaneous Employment Against Multiple Targets

The F-16C FCR can support up to four simultaneous in-flight AMRAAMS against up to four targets. Simultaneous employment is accomplished in TWS or RWS DTT mode.

Summary

8. Select A-A master mode **[1]** or MSL override mode **[4]**
9. Set Master Arm Switch to Arm
10. Acquire at least two targets using TWS or DTT
11. Maneuver until all targets are in launch zone
12. Depress Weapon Release **[RAlt]+[Space]** to fire first missile
13. Press TMS Right to cycle bug to next target
14. Depress Weapon Release **[RAlt]+[Space]** to fire second missile

1. **Select AIM-120s for employment:**

    a. Activate A-A master mode using the ICP, then on the SMS format, press OSB 6 until AIM-120 is selected; or

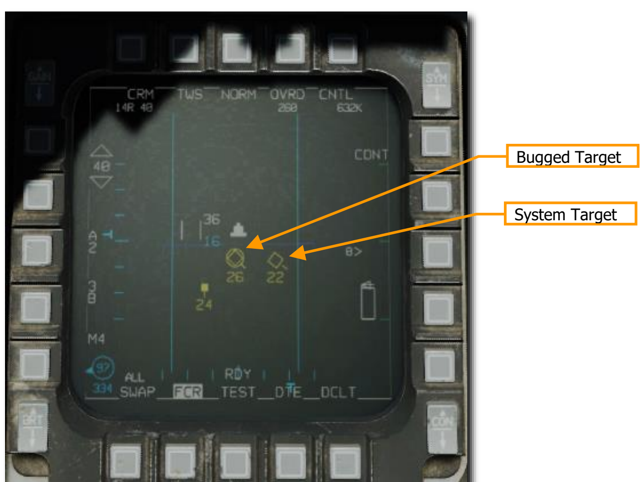
    b. Place the Dogfight/Missile Override switch in MSL OVRD.

2. **Set the Master Arm switch to Arm.**

3. **Acquire at least two targets using TWS or DTT.**

    In RWS mode, move the acquisition cursor over the first target and press TMS Forward to designate it. Then, move the acquisition cursor over the second target and press TMS Forward to designate it.

    In TWS mode, move the acquisition cursor over each target and press TMS Forward to designate it as a System Target. You may designate up to four System Targets for AMRAAM employment.



4. **Maneuver until all targets are within the launch zone.** DLZ information is only displayed for the current bugged target. Use TMS Right to cycle between bugged targets and track DLZ status for each.

5. **Depress Weapons Release to fire first missile**, then press TMS Right to cycle the bug to the next target, and press Weapons Release again to fire the second missile. If using TWS, you can repeat this process up to four times total.

AIR-TO-GROUND EMPLOYMENT

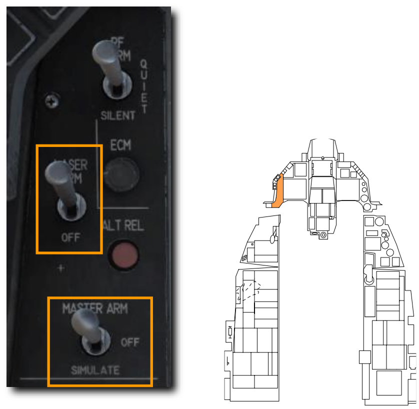
USAF Photo
by TSgt Robert Cloys

ATTACK PREPARATION

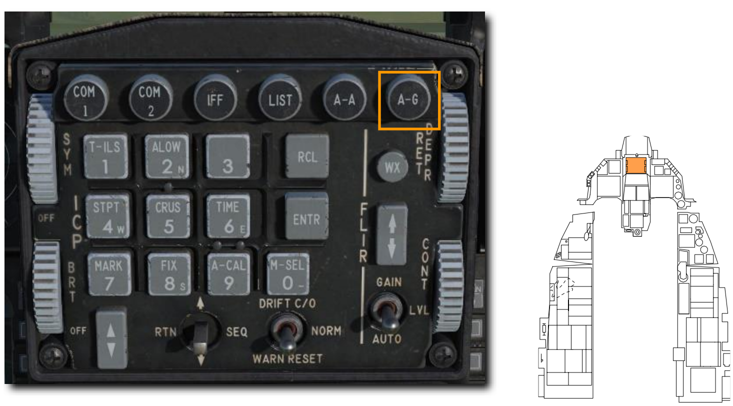
This section's revision is currently a work-in-progress.

Prior to reaching the target area and conducting your attack, you will want to configure several aircraft systems ahead of time so that you can most efficiently communicate and set up your attack. When at a minimum of 40 nm from the target, you will want to take the following steps:

1. Position the Master Arm Switch to ARM. Weapons may be released normally when in the ARM position. If the Master Arm switch is placed in the OFF position, weapon release is inhibited.
2. Position the Laser Arm Switch to ARM. This is required to enable firing of the laser designator. Laser firing is inhibited with the switch set to OFF.



3. Place the fire control system in A-G mode by pressing the A-G Master Mode Button on the ICP.



M61A1 20MM CANNON STRAFE

The M61A1 20MM automatic gun system provides the pilot with a formidable weapon capability. It is a six-barrel Gatling type gun mounted in the left strake of the aircraft. The system has a capacity of 512 rounds of ammunition fired at 6,000 rounds per minute.

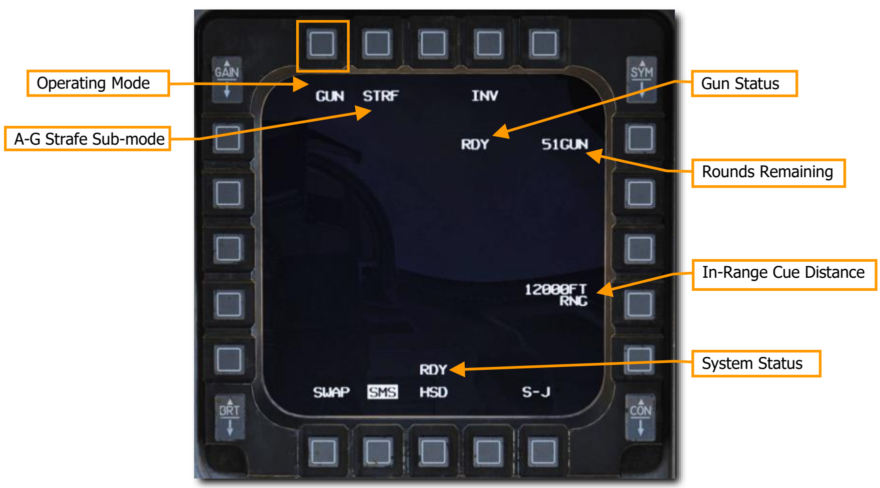
Summary

1. Select A-G Master Mode [2]
2. Set Master Arm Switch to Arm
3. Set Laser Arm Switch to Arm if laser ranging updates are desired
4. Select STRF sub-mode on SMS MFD
5. Fly the Pipper onto the target
6. Squeeze the Trigger [Space] to the second detent to fire the gun

Target Attack

Upon selection of the A-G master mode, the SMS Air-to-Ground (SMS A-G) page is displayed on the right MFD. Based on the priority weapon, the information on the SMS A-G page can vary. Follow these steps to achieve the correct configuration and attack ground targets with the gun:

1. **Select the STRF sub-mode on the MFD by pressing OSB 1 until GUN is displayed.**



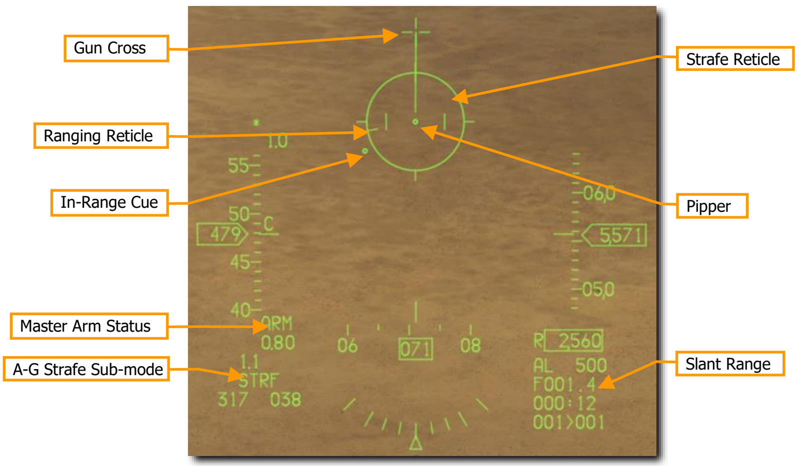
2. **Verify STRF symbology is displayed in the HUD.**

The Strafe Reticle is the default air to ground gunsight and provides aiming information required to fire the gun effectively. The center of the reticle is the aiming pipper and represents where the gun rounds will go assuming the target is within range. Using the pipper, it is simply a case of "putting the thing on the thing" and pulling the trigger.

Line of sight range is indicated by the digital range numeric on the bottom right of the HUD and the ranging reticle that winds or unwinds within the reticle. The position of the ranging reticle indicates the slant range to the pipper's position on the ground. Each quarter circle tick on the strafe reticle represents 3,000 feet of slant range, so:

- 12 o'clock = 12,000 ft
- 9 o'clock = 9,000 ft
- 6 o'clock = 6,000 ft
- 3 o'clock = 3,000 ft

The in-range cue position may be set by the pilot provide an additional visual cue for the effective range against the planned target.



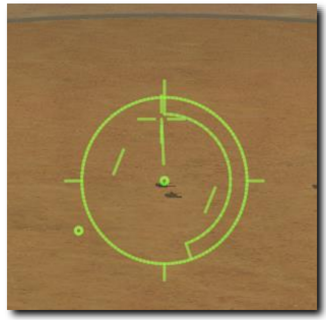
3. Maneuver your aircraft to position the pipper on target.

One technique is to place the pipper short of the target and allow it to track along the ground until it reaches the target. This will happen naturally as slant range decreases.


Laser ranging may be performed to improve the computed firing solution if a targeting pod is installed. (See Laser Ranging for more information.)

4. Squeeze the trigger all the way to the second detent to fire the gun when the pipper is over the target and you are within effective range.

In this example, the pipper is on-target at a slant range of about 5,500 feet as shown by the position on the ranging reticle.



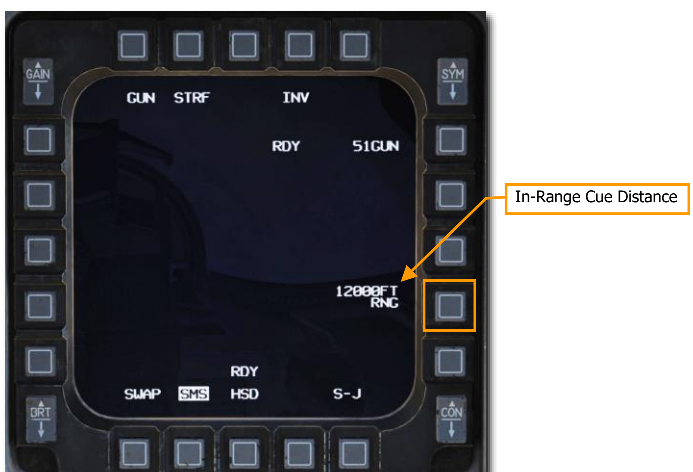
Slant range greatly affects gun effectiveness. As the rounds come out of the gun, they will gradually disperse and lose velocity. Increased dispersion and loss of velocity reduce the accuracy and effectiveness of the gun. Effective engagement range is generally from 2,500 to 7,000 feet. For armored vehicles, closer is better, and you should attack from behind the target where its armor is weakest.

When lining up a shot, be careful to avoid target fixation. Target fixation can lead to you not noticing an unseen threat or pressing the attack too close. Don't make yourself an easy target for the machine gun on the top of that APC!

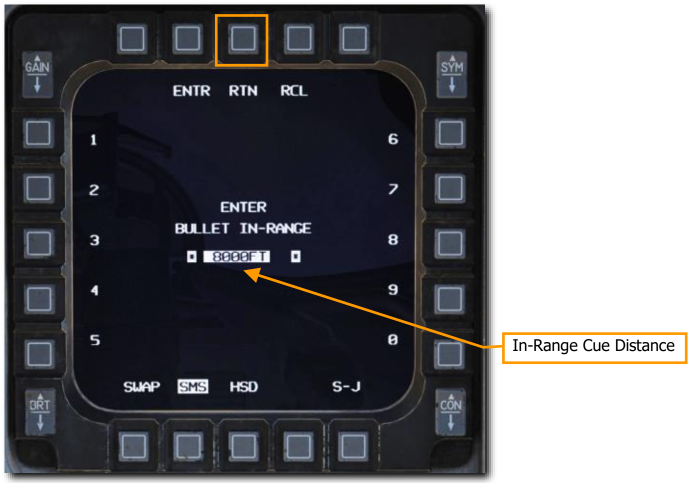
Once you have reached the minimum attack range, break off in both the horizontal and vertical to avoid hostile return fire. You may also wish to release flares in case an infrared-SAM near the enemy target has been launched at you, but you did not see it.

In-Range Cue Update

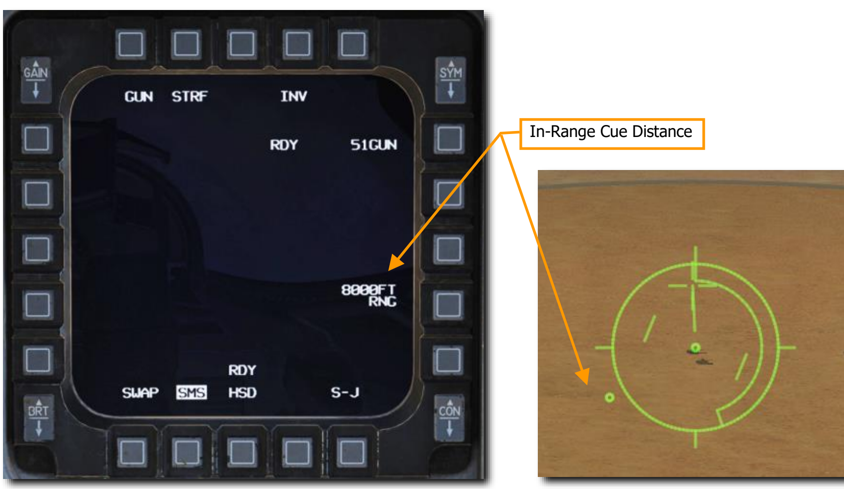
The position of the In-Range Cue on the reticle may be updated by selecting the OSB next to the In-Range Cue distance on the SMS page.



Type in the new in-range cue distance using the OSBs on the left and right of the display and select ENTR. You may correct numbers entered in error by selecting RCL or return to the SMS page without making changes by selecting RTN.



You will be returned to the SMS page and the new value will be displayed. The cue will be placed on the HUD Strafe Reticle at that new distance.



2.75-INCH ROCKETS

Aerial rockets pack more punch than the 20mm gun but are still best used as an area suppression weapon. These come with different warhead options for different purposes including High Explosive (HE), High Explosive Anti-Tank (HEAT), and Armor Piercing (AP). White Phosphorus (WP) rounds may also be used for incendiary effect or to mark targets on the ground with their distinctive white smoke.

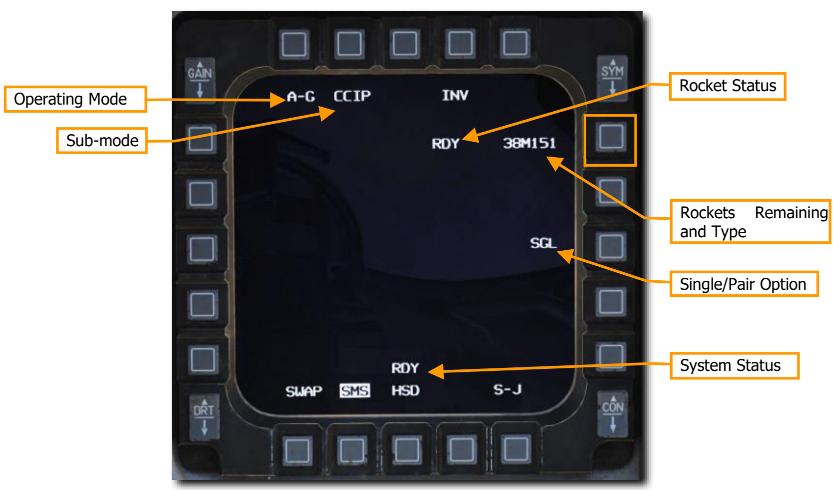
Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Set Laser Arm Switch to Arm if laser ranging updates are desired
4. Select Rockets and desired options on SMS MFD
5. Fly the Pipper onto the target
6. Depress the Weapons Release button **[RAlt]+[Space]** to fire the rockets

Target Attack (CCIP)

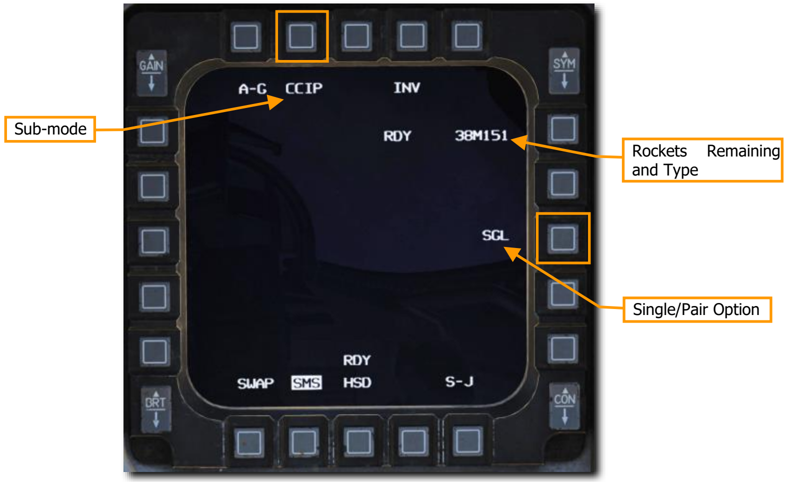
Upon selection of the A-G master mode, the SMS Air-to-Ground (SMS A-G) page is displayed on the right MFD. Based on the priority weapon, the information on the SMS A-G page can vary. Follow these steps to achieve the correct configuration and attack ground targets with rockets in CCIP mode:

1. Select the Rockets on the MFD by pressing OSB 6 until rockets are displayed.



2. Verify CCIP release mode is selected (OSB 2) and set desired Single/Pair option (OSB 8).

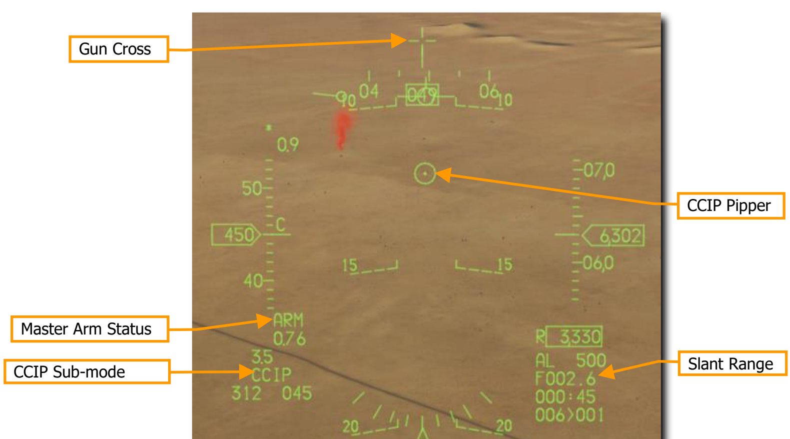
Rockets may be fired with either Single (SGL) or Pair (PAIR) selected. With SGL selected, rockets will be fired from only one launcher. With PAIR selected, rockets will be fired from each rocket launcher, assuming launchers are loaded on station 3 and 7.



3. **Verify CCIP Rockets symbology is displayed in the HUD.**

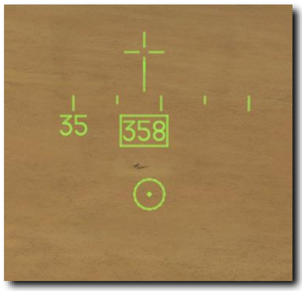
CCIP mode is perhaps the most intuitive means to put a weapon on target and mostly involves placing the "death dot" of the CCIP pipper over the target and releasing the weapon… put the thing on the thing.

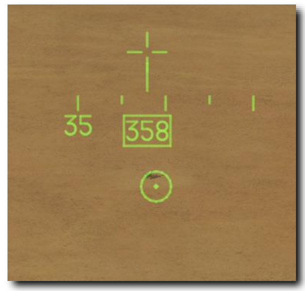
The center of the CCIP pipper represents where the rockets will go assuming the target is within range. Line of sight range is indicated by the digital range numeric on the bottom right of the HUD. An In-Range Cue will be displayed over the CCIP pipper when slant range is less than 8,000 feet and rockets are most effective.



4. **Maneuver your aircraft to position the CCIP pipper on target.**

One technique is to place the pipper just short of the target and allow it to track along the ground until it reaches the target. This will happen naturally as slant range decreases. Monitor slant range displayed in the bottom right of the HUD and watch for the in-range cue to appear over the pipper.

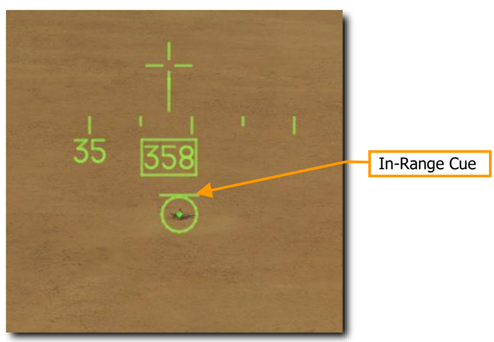




Laser ranging may be performed to improve the computed firing solution if a targeting pod is installed. (See Laser Ranging for more information.)

5. **Press the Weapon Release button to fire the rockets when the CCIP pipper is over the target and you are within effective range.**

   The In-Range Cue is a line over the CCIP pipper that is displayed when slant range is less than 8,000 feet. In this example, the pipper is on-target and the in-range cue is displayed.



When lining up a shot, be careful to avoid target fixation. Target fixation can lead to you not noticing an unseen threat or pressing the attack too close. Don't make yourself an easy target for the machine gun on the top of that APC!

Once you have reached the minimum attack range, break off in both the horizontal and vertical to avoid hostile return fire. You may also wish to release flares in case an infrared-SAM near the enemy target has been launched at you, but you did not see it.

UNGUIDED BOMBS

Unguided bombs that the F-16C can employ fall into three categories: General Purpose (GP), Cluster, and Training.

General Purpose Bombs

Mk-82 LDGP. The standard Mk-82 is a low drag "slick" bomb, also referred to as a Low Drag General Purpose (LDGP) bomb. The bomb is aerodynamically streamlined with four conical tail fins for flight stability. The bomb has a thin steel jacket that contributes to fragmentation effects.

The Mk-82 may be carried singly on a Wing Weapons Pylon (WWP) or three may be loaded on a Triple Ejector Rack (TER)

The Mk- 82 serves as the basis for several other bombs including the Mk-82 AIR, GBU-12, and GBU-38.

Mk-82 AIR. This version of the Mk-82 adds the BSU-49/B high drag tail assembly, also called a "ballute". This allows the bomb to rapidly slow down after release. By slowing down, you can release such a retarded weapon at low altitude and not be caught in the blast effect of the weapon. You can choose to release the Mk-82AIR in either retarded or "slick" (no ballute deployed) modes. To drop as a slick, select only a nose fuze, and to release retarded, select nose/tail or tail fuze setting on the SMS page.

Mk-82 SE. This 'Snake Eye" version of the Mk-82 pre-dates the Mk-82 AIR and uses fins that deploy from the Mk-15 tail assembly to slow the bomb's fall. You can choose to release the Mk-82 Snakeye in either retarded or "slick" modes. To drop as a slick, select only a nose fuze, and to release retarded, select nose/tail or tail fuze setting on the SMS page.

Mk-84 LDGP. The Mk-84 is the big brother of the Mk-82 and it weighs 2,039 lbs. with 945 lbs. of H-6 or Tritonal high explosive. Although most effective against unarmored and lightly armored targets, the Mk-84 can also be effective against armored targets when dropped in proximity. The Mk-84 can only be mounted on a WWP and cannot be loaded on a TER.

The Mk-84 forms the basis for other bombs including the GBU-10 and GBU-31 that the F-16C also carries.

Cluster Bombs

CBU-87. The CBU-87 Combined Effects Munitions (CEM) weighs 950 lbs. and is an all-purpose cluster bomb. The SUU-65 Tactical Munitions Dispenser that makes the body of the bomb contains 202 BLU-97/B Combined Effects Munitions (CEM) bomblets and they are effective against lightly armored and unarmored targets. The dispersal footprint of the bomblets depends on the Height of Function (HOF) and RPM spin setting set with dials on the bomb and displayed on the SMS page. However, the general bomblet footprint coverage is 200 by 400 meters.

The CBU-87 can be mounted singly on a WWP. Only two may be loaded on a TER when wing external fuel tanks are installed due to clearance constraints. This is commonly referred to as a 'slant load'.

Each BLU-97/B CEB consists of a shaped charge, a scored steel casing, and a zirconium ring, for anti-armor and anti-personnel fragmentation and incendiary effects. Each CEB is designed to fragment into 300 fragments. Given the top attack angle of the weapon, the CEB can be effective against the generally light armor covering the top of an armored vehicle such as a tank.

CBU-97. The CBU-97 is a 1,000-pound class weapon containing sensor-fuzed sub-munitions in a SUU-66B Dispenser for specifically attacking armor. This Sensor Fuzed Weapon (SFW) contains 10 BLU-108/B sub-munitions, and 40 "hockey puck" shaped skeet infrared sensing projectiles.

As with the CBU-87, the dispersal footprint of the bomblets depends on the Height of Function (HOF) set with dials on the bomb and displayed on the SMS page. The RPM is not applicable on this dispenser. The same carriage restrictions as the CBU-87 apply: one per WWP and two per TER.

Training Bombs

BDU-33. The BDU-33 is a miniaturized training bomb that mimics the ballistics of larger general-purpose bombs. The BDU-33 contains a small smoke charge to help round spotting.

Unguided/Laser Guided Bombs SMS Page

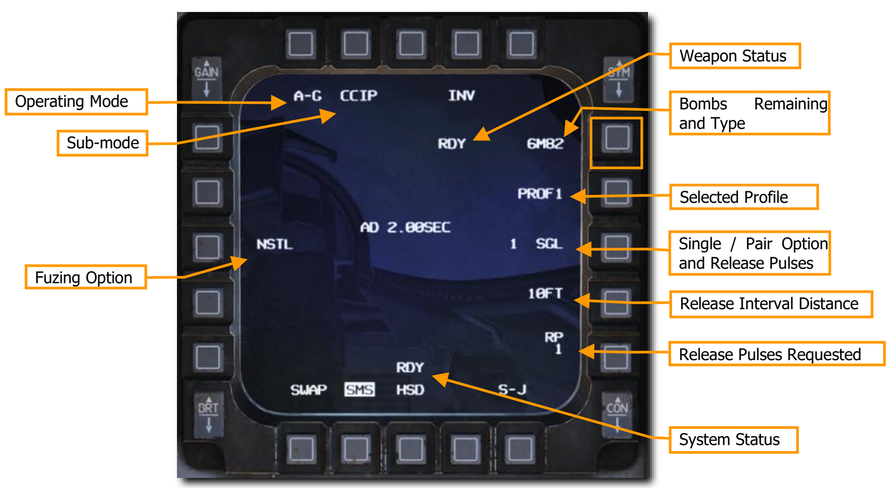
The A-G SMS display and procedure for setting up an attack with guided or unguided bombs is very similar for all types. The initial set-up will only be covered once, with differences in CCIP, CCRP sub-modes covered in separate sections below.

Summary

1. Select A-G Master Mode **[2]**
2. Select bombs and set desired options on SMS A-G MFD

Upon selection of the A-G master mode, the SMS Air-to-Ground (SMS A-G) page is displayed on the right MFD. Based on the priority weapon, the information on the SMS A-G page can vary. Follow these steps to achieve the correct configuration and attack ground targets with GP bombs in CCIP mode:

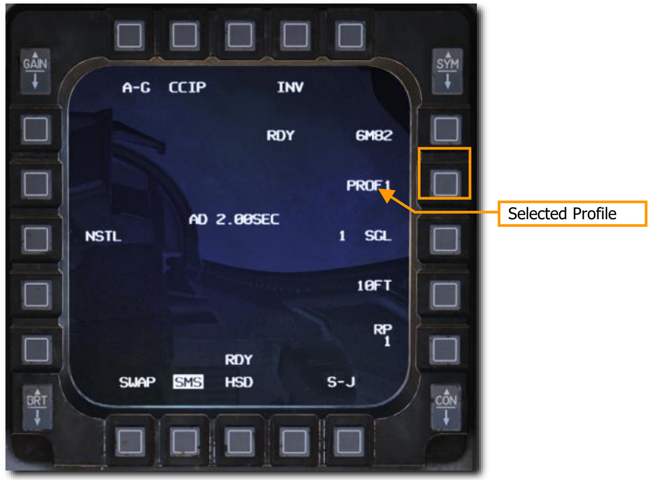
1. **Select the desired weapons on the MFD by pressing OSB 6 until the weapons you want to release are displayed.**



2. **Select the desired profile for the selected weapons.**

   Two different profiles are pre-set by default. These include typical settings for delivery mode, fuze arming option, bomb impact spacing, and release quantity. If a profile already matches your planned attack profile, you are all set; no more changes are required! If not, follow the steps that follow in this section to set the profile up to your liking.

Selecting the OSB next to the current profile to cycle between the two options: PROF1 and PROF2.



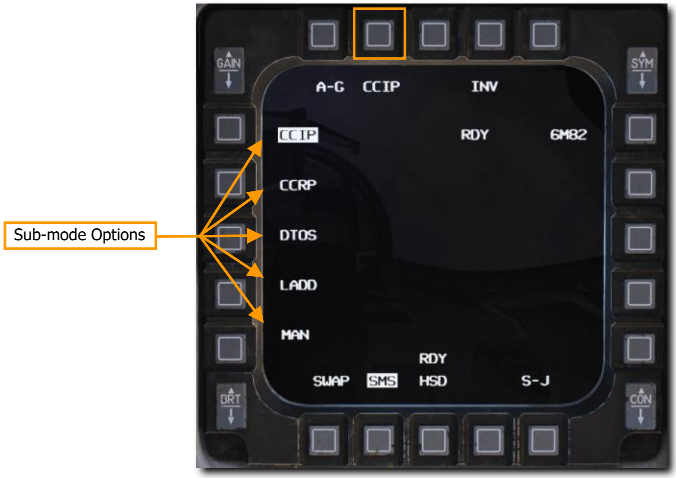
Changes to settings made while a profile is selected are saved for later use. These should typically be set or verified as part of aircraft startup, although they may be changed at any time.

3. Select your desired release sub-mode. (OSB 2)

If a sub-mode other than the one you want is selected, you may press OSB 2 to display the following options:

- CCIP – Continuously Computed Impact Point
- CCRP – Continuously Computed Release Point
- DTOS – Dive Toss
- LADD – Low Altitude Drogue Delivery
- MAN – Manual

Then, select the OSB next to your desired sub-mode. That will set the new active sub-mode and return you to the SMS A-G page.

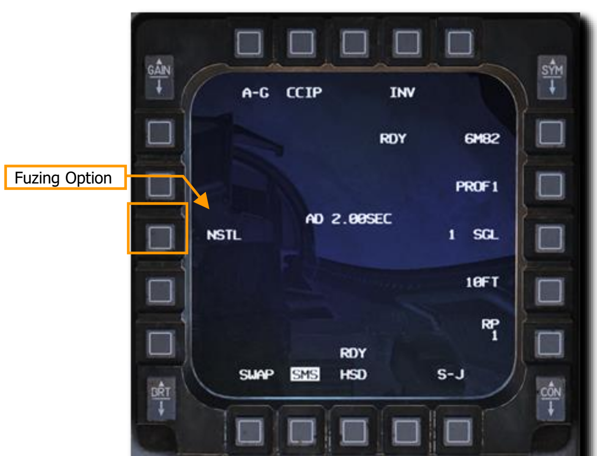


You may also cycle between sub-modes by pressing the Missile Step button on the Side Stick Controller (SSC).

4. Set desired bomb fuzing option. (OSB 18)

Bombs are typically equipped with two fuzes, one in the nose and one in the tail. These are sometimes set with different impact delay settings to provide the pilot with the choice of how the fuze functions and when the bomb detonates after impact. Sometimes an instantaneous detonation is desired for fragmentation effects and sometimes a delayed detonation is desired to allow target penetration or cratering.

Selecting OSB 18 cycles between three fuze arming options: NOSE, TAIL and NSTL (Nose/Tail). This is typically set to NSTL (Nose/Tail) for redundancy unless a specific effect is desired when the weapon detonates.

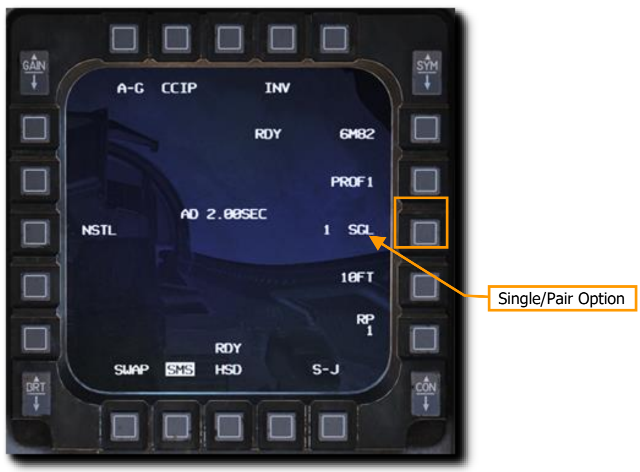


There are also some special cases where the fuze option changes how the weapon behaves after release:

- Mk-82 AIR/SE
  - NSTL – High Drag
  - NOSE – Low Drag
  - TAIL – High Drag
- CBU-87/97
  - NSTL – Bomblets dispense using settings displayed on SMS page
  - NOSE – Bomblets dispense immediately after release
  - TAIL – Dud

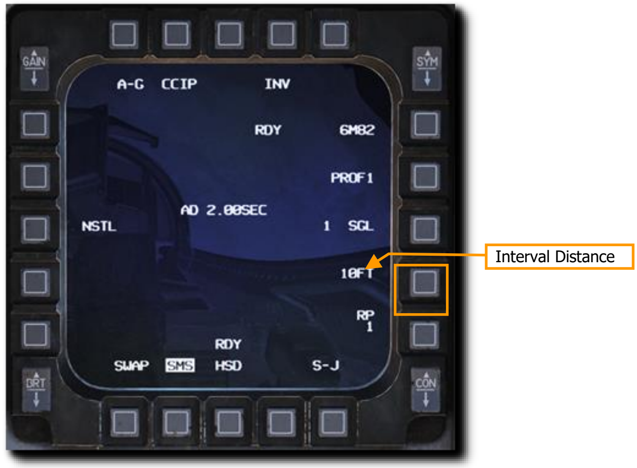
5. Set desired Single/Pair option. (OSB 8)

Bombs may be released with either Single (SGL) or Pair (PAIR) selected. With SGL selected, bombs will be released from only one station. With PAIR selected, bombs will be released from both opposite stations, assuming identical bombs are loaded on stations 4 and 6 or 3 and 7.

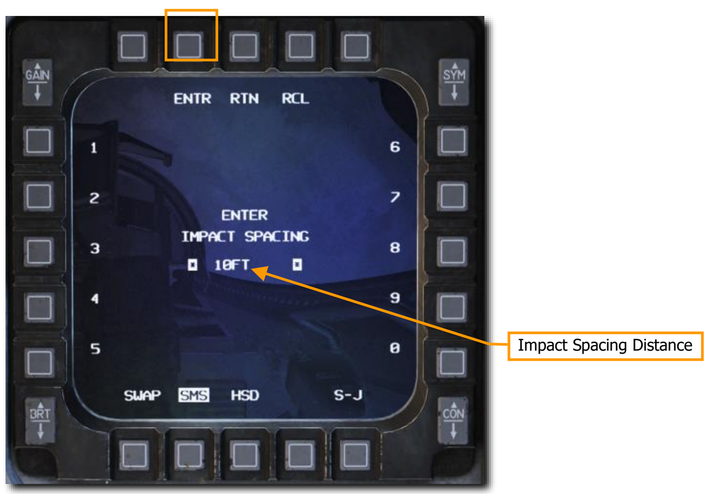


6. Set the desired release interval distance if more than one bomb is to be released. (OSB 9)

The timing between release pulses is computed by the aircraft to space multiple weapons in a 'stick' along the ground at the specified distance. Valid distances range from 10-999 feet. This setting has no effect if only one bomb or one pair of bombs is released.

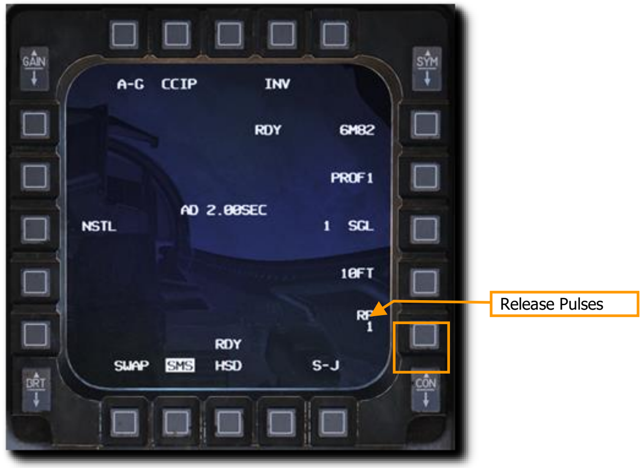


Type in the new impact spacing distance using the OSBs on the left and right of the display and select ENTR. You may correct numbers entered in error by selecting RCL or return to the SMS page without making changes by selecting RTN.

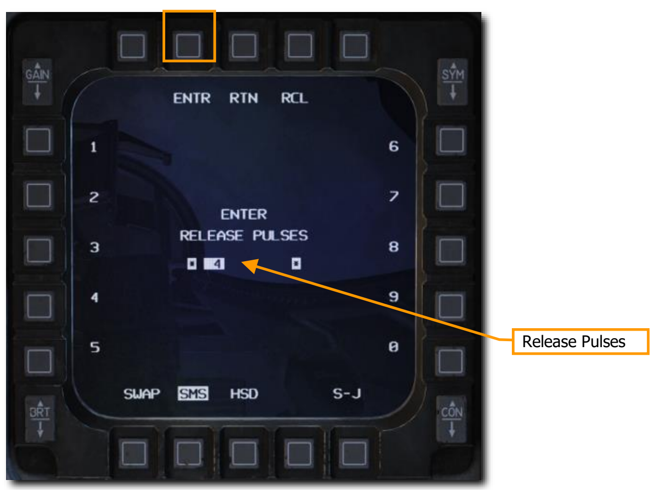


7. Set the number of release pulses if more than one bomb is to be released. (OSB 10)

This sets the number of release pulses sent to the weapons stations when the Weapon Release button is pressed. For example, a setting of 1 releases only one bomb or pair of bombs at a time while a setting of 4 releases four bombs or pairs of bombs at a time. This is commonly known as a 'ripple release'.



Type in the desired number of release pulses using the OSBs on the left and right of the display and select ENTR. You may correct numbers entered in error by selecting RCL or return to the SMS page without making changes by selecting RTN.



Unguided Bombs CCIP Attack

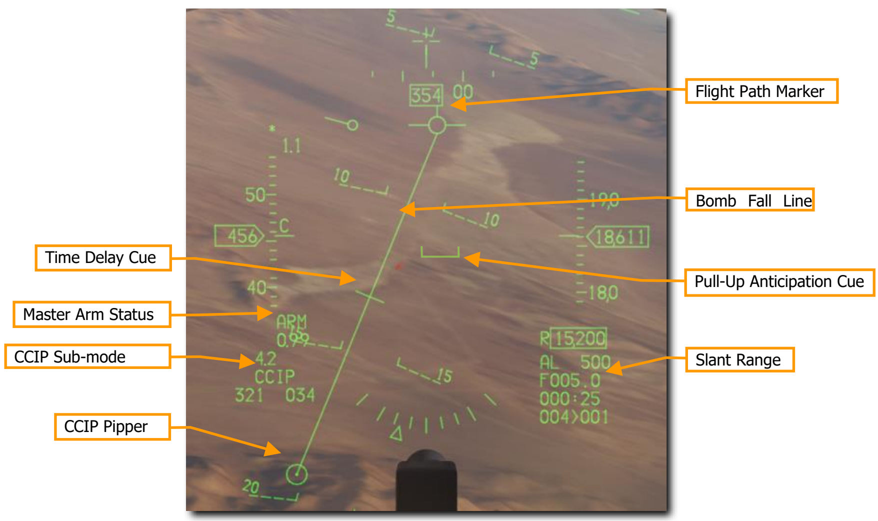
The Continuously Computed Impact Point (CCIP) mode is a computed visual delivery mode with manual weapon release. This mode allows a high degree of flexibility since the point on the ground at which the weapon will impact is continuously indicated by a CCIP Pipper on the HUD. No target designation is required. Place the thing on the thing and drop the bomb.

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Set Laser Arm Switch to Arm if laser ranging updates are desired
4. Select Bombs and desired options on SMS MFD
5. Fly the Pipper onto the target
6. Depress the Weapons Release button **[RAlt]+[Space]** to expend weapons

1. Verify CCIP symbology is displayed in the HUD.

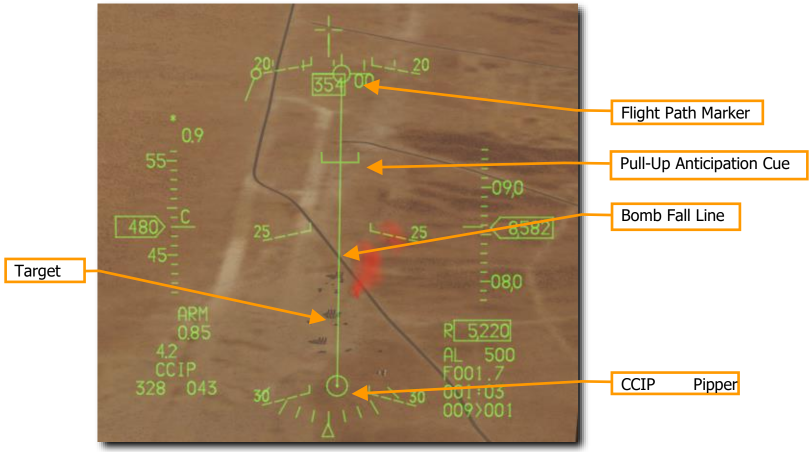
If the CCIP impact point does not lay within the HUD field of view, the Time Delay Cue (TDC) is shown as a short, horizonal line on the Bomb Fall Line. The CCIP Pipper is outside the HUD field of view when this is displayed. A second, 'post-designate CCIP' technique may be used in this situation but that will be covered in the next section.



2. Maneuver your aircraft to position the CCIP Pipper on target.

When the TDC is no longer displayed on the Bomb Fall Line, the pipper is in the HUD field of view. That will be the impact point if the bombs are released immediately.

One technique is to place the FPM ahead of the target and the pipper just short of the target. Fly the Bomb Fall Line over the target and allow the pipper to track straight up the line. This will happen naturally as slant range decreases.

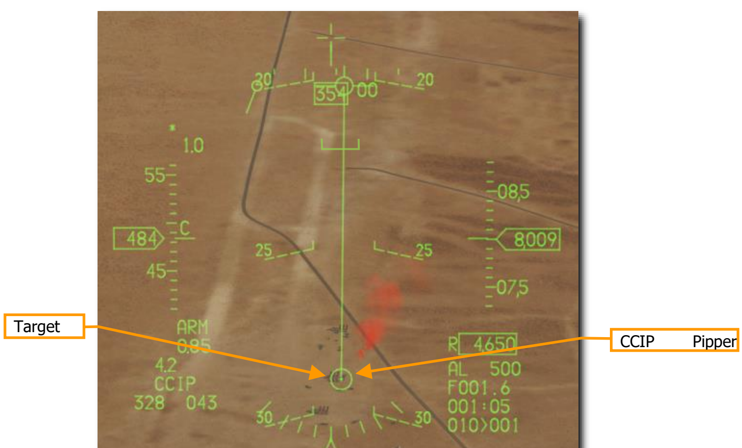


Monitor the Pull-Up Anticipation Cue to ensure it does not go above the Flight Path Marker. The Pull-Up Anticipation Cue (PUAC) provides a visual representation of the altitude required for the bomb fuze to arm or altitude to initiate a pull-up to avoid impacting the ground, whichever is more immediate. It moves up toward the Flight Path Marker (FPM) as the aircraft loses altitude. Releasing a bomb with the FPM below the PUAC will not give the bomb time to arm and result in a dud.

Laser ranging may be performed to improve the computed firing solution if a targeting pod is installed. (See Laser Ranging for more information.)

3. Press the Weapon Release button to release the bombs when the CCIP pipper is over the target.

The pipper will be at the center of the ‘stick’ if more than one bomb is released in a ripple delivery. Hold the Weapons Release button long enough to ensure all weapons come off. The FPM flashes after weapons are released.



Pull up immediately and take evasive action to avoid flying into bomb fragments and to avoid enemy fire.

Unguided Bombs CCIP Attack (Post-Designate)

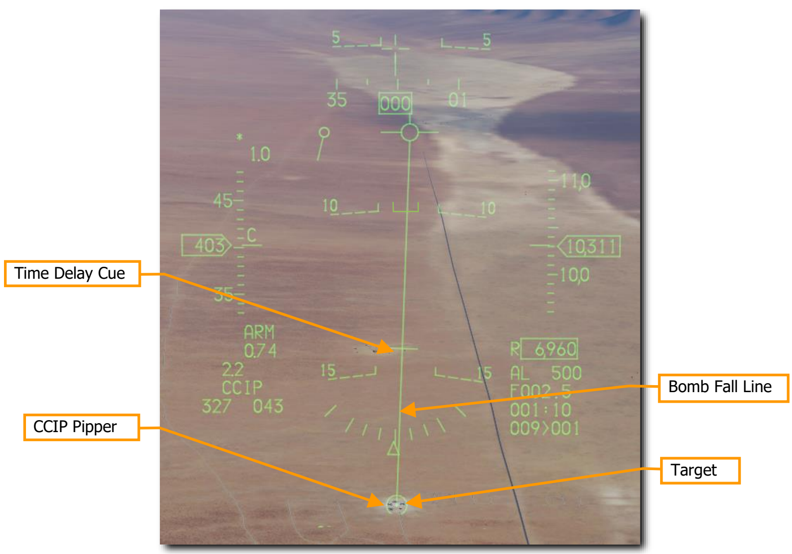
An additional option for CCIP bombs delivery is available for situations where the target cannot be within the HUD field of view at release. This can sometimes happen on attacks from a shallow dive angle or high altitude.

The steps to enter CCIP mode are the same as described above. The difference is in when you press and hold the Weapons Release button.

1. **Maneuver your aircraft to position the CCIP Pipper on target.**

   When the Time Delay Cue is displayed on the Bomb Fall Line, the pipper is not in the HUD field of view, however you will still place the pipper over the intended target.

   You will designate that location as the target by pressing and holding the Weapons Release button. The fire control computer will do the rest.

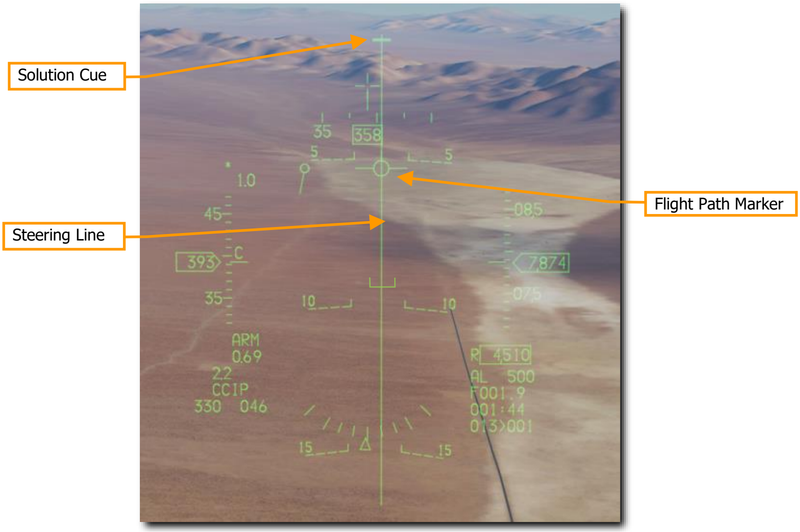


   Laser ranging may be performed to improve the computed firing solution if a targeting pod is installed. (See Laser Ranging for more information.)

2. **Press and HOLD the Weapons Release button.**

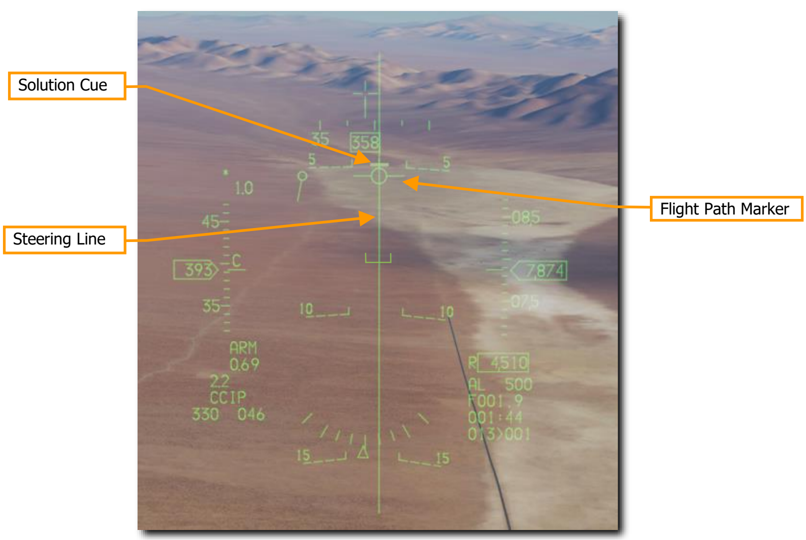
   The HUD symbology displayed is identical to that used for a CCRP delivery. Keep the Flight Path Marker aligned with the Steering Line. This will align your aircraft with the target even though the target will be out of sight.

   A Solution Cue is displayed at the top of the Steering Line. It will fall down the line as the range decreases and the weapon is about to be released.



3. Keep the Weapons Release button held until after the Solution Cue passes the Flight Path Marker.

Keep flying the Flight Path Marker over the Steering Line as the Sulution Cue continues to track downward. The bombs are released when the Steering Cue passes the Flight Path Marker.



Hold the Weapons Release button long enough to ensure all weapons come off. The FPM flashes after weapons are released. Pull up immediately and take evasive action to avoid flying into bomb fragments and to avoid enemy fire.

Unguided Bombs CCRP Attack

The Continuously Computed Release Point (CCRP) mode provides computed, automatic release of bombs. This can be done from a dive, but also from wings-level or a nose-high attitude.

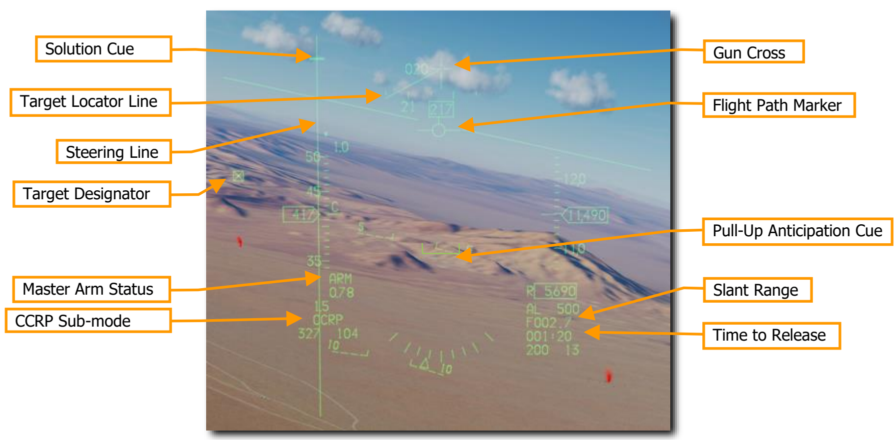
This mode requires a target designation point from which to build the bombing solution. Command steering is provided to the appropriate weapon release point and the weapon will release automatically at the proper time such that the weapons hit the target.

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Set Laser Arm Switch to Arm if laser ranging updates are desired
4. Select Bombs and desired options on SMS MFD
5. Set desired steerpoint number or designate target with TGP
6. Center FPM on Steering Line
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to expend weapons at computed point

1. **Verify CCRP symbology is displayed in the HUD.**

   The fire control system provides a Steering Line (SL) to provide steering to the designated target. By placing the Flight Path Marker (FPM) on the SL and holding down the Weapon Release Button, the weapon will release at the proper time and account for wind.



   A Solution Cue is displayed at the top of the SL. It will fall down the line as the range decreases and the weapons are about to be released.

   When the Target Designator (TD) is outside the HUD field on view as shown above, a Target Locator Line (TLL) extends from the Gun Cross pointing directly at the target. The relative angle is displayed next to the Gun Cross showing the number of degrees in tens between the cross and the target.

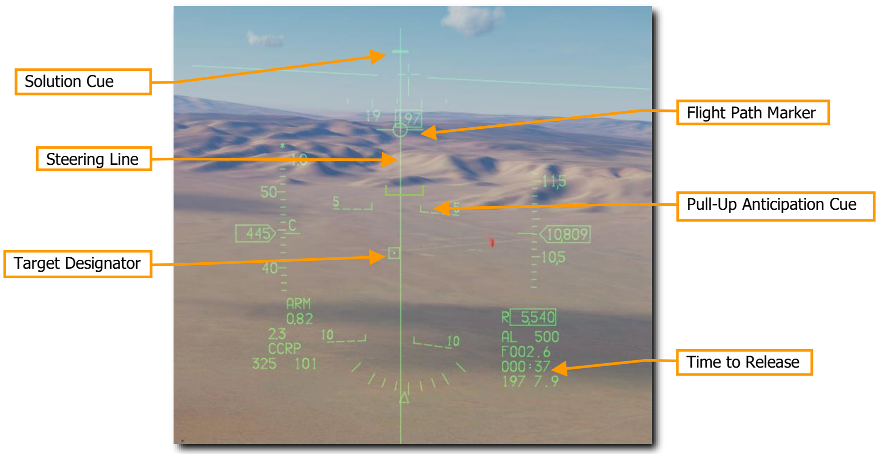
2. **Designate the desired target.**

   To calculate a bombing solution in CCRP mode, a target first must be designated. This can be done by:

   - Selecting a Steerpoint that was placed at the target location

- Designating a target with the Targeting Pod (if installed)

Updates to the target location may be made by slewing the TD Box in the HUD or slewing the TGP cursor onto a new position with the Cursor/Enable Control.



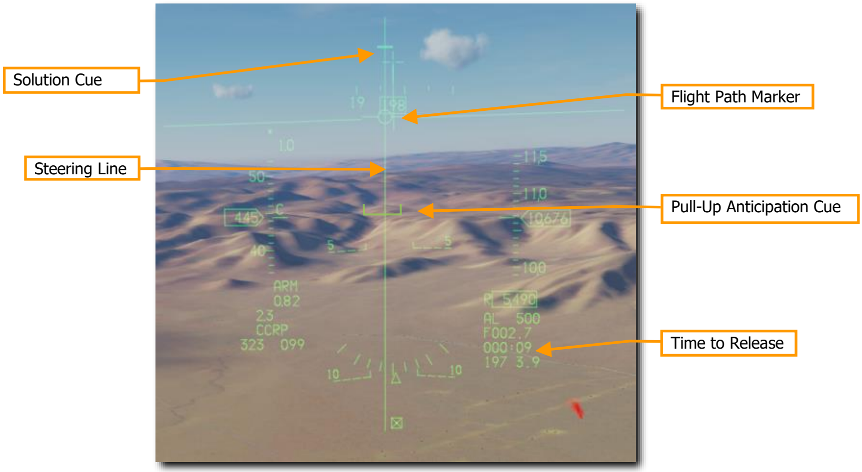
Monitor the Pull-Up Anticipation Cue to ensure it does not go above the Flight Path Marker. The Pull-Up Anticipation Cue (PUAC) provides a visual representation of the altitude required for the bomb fuze to arm or altitude to initiate a pull-up to avoid impacting the ground, whichever is more immediate. It moves up toward the Flight Path Marker (FPM) as the aircraft loses altitude. Releasing a bomb with the FPM below the PUAC will not give the bomb time to arm and result in a dud.

Laser ranging may be performed to improve the computed firing solution if a targeting pod is installed. (See Laser Ranging for more information.)

3. Press and HOLD the Weapon Release button.

Keep the Flight Path Marker aligned with the Steering Line. This will align your aircraft with the target even though the target will be out of sight.

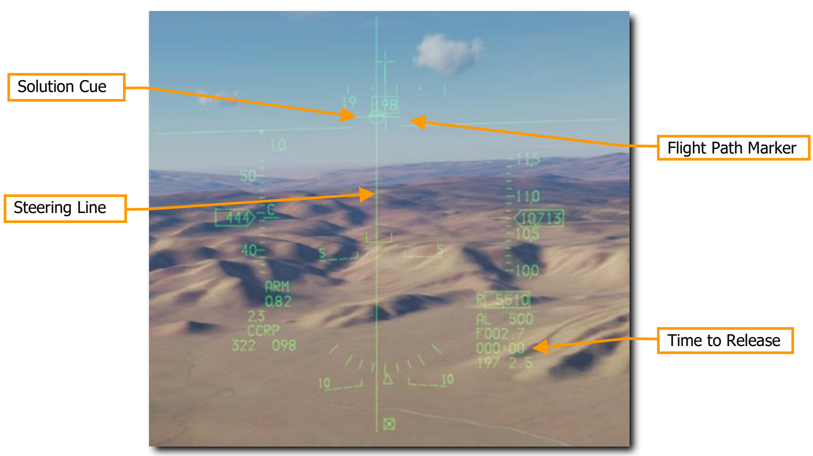
Time to release counts down at the lower right of the HUD.



When the Solution Cue begins to move down the Steering Line, about 10 seconds prior to release, press and hold the Weapon Release button. This provides the fire control computer consent to release the weapons.

4. **Keep the Weapons Release button held until after the Solution Cue passes the Flight Path Marker.**

Keep flying the Flight Path Marker over the Steering Line as the Sulution Cue continues to track downward. The bombs are released when the Steering Cue passes the Flight Path Marker.



Hold the Weapons Release button long enough to ensure all weapons come off. The FPM flashes after weapons are released.

LASER-GUIDED BOMBS

The development of laser guided weapons has dramatically improved the accuracy of weapon guidance and delivery. With the assistance of build-up guidance kits, general GP bombs are turned into laser-guided bombs (LGBs). The kits consist of a computer- control group (CCG), guidance canards attached to the front of the warhead to provide steering commands, and a wing assembly attached to the aft end to provide lift. LGBs are maneuverable, free-fall weapons requiring no electronic interconnect to the aircraft. They have an internal semi-active guidance system that detects laser energy and guides the weapon to a target illuminated by an external laser source. The designator can be in the delivery aircraft, another aircraft, or a ground source.

All LGB weapons have a Computer Control Group (CCG), a warhead (bomb body with fuze), and an airfoil group. The computer section transmits directional command signals to the appropriate pair of canards. The guidance canards are attached to each quadrant of the control unit to change the flight path of the weapon. The canard deflections are always full scale (referred to as "bang, bang" guidance).

The LGB flight path is divided into three phases: ballistic, transition, and terminal guidance. During the ballistic phase, the weapon continues via the unguided trajectory established by the flight path of the delivery aircraft at the moment of release. In the ballistic phase, the delivery attitude takes on additional importance since maneuverability of the LGB is related to the weapon velocity during terminal guidance. Therefore, airspeed lost during the ballistic phase equates to a proportional loss of maneuverability. The transition phase begins at acquisition. During the transition phase, the weapon attempts to align its velocity vector with the line-of-sight vector to the target. During terminal guidance, the LGB attempts to keep its velocity vector aligned with the instantaneous line-of-sight. At the instant alignment occurs, the reflected laser energy centers on the detector and commands the canards to a trail position, which causes the weapon to fly ballistically with gravity biasing towards the target.

GBU-10 Paveway II. This Guided Bomb Unit (GBU) weighs 2,562 lbs. and is basically a laser-guided version of the Mk-84 unguided bomb with a general-purpose warhead. The laser detector on the nose of the seeker detects the reflected energy of the designating laser at the set laser code. Once dropped, the wing-like airfoil surfaces at the rear of the bomb extend and are used to maneuver the bomb to the laser designation point. Rather than smooth and constant input of course-corrections to reach the target, the bomb uses a series of discreet input corrections and this is often referred to as "bang-bang" guidance mode.

GBU-10 can only be hung from a MAU-12 ejector rack on stations 3, 4, 6, and 7.

Suitable targets for the GBU-10 are large and/or hardened targets that require an accurate and powerful strike. Such targets often include bridges, bunkers, and hardened command posts.

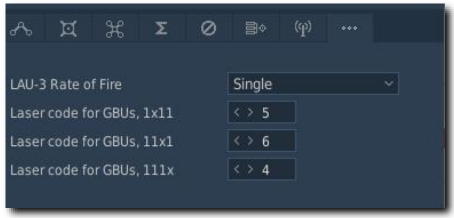
GBU-12 Paveway II. This GBU is the laser-guided version of the Mk-82 unguided, general purpose bomb. The GBU-12 guides using the same principles as the GBU-10, the only difference being the bomb the LGB is based on.

The GBU-12 can be mounted singly on a MAU-12 ejector rack at stations 3, 4, 6, and 7. Only two may be loaded on a TER when wing external fuel tanks are installed due to clearance constraints. This is commonly referred to as a 'slant load'.

Terminal Laser Guidance Codes

The seeker head on each laser guided bomb is set to track only a specific laser pulse rate frequency (PRF) code. These are manually set by the weapons load crew during ground operations and may not be set from the cockpit during flight.

To replicate this, the laser code may be set using the mission editor. In this example, the laser code on each bomb seeker head is 1564.



An additional method to set the bomb seeker laser code is included on the in-game kneeboard. You may access this using keyboard command **[RShift]+[K]**, then use the **[** and **]** (bracket) keys to access the page. Use the keyboard commands listed to the right of each digit to change the laser code.

Bomb seeker laser codes can only be changed using this method on the ground prior to engine start and with the STA POWER switch on the right console OFF.

The laser designator on the Targeting Pod must be set to match the code on the bomb. (See LASR DED Page for more information.)

SMS Page

The A-G SMS display and procedures for setting up an attack with guided or unguided bombs are identical. See the Bombs A-G SMS Page section for procedures.

Laser Guided Bomb CCRP Attack

The Continuously Computed Release Point (CCRP) mode provides computed, automatic release of bombs. This can be done from a dive, but also from wings-level or a nose-high attitude. The laser guided bomb attack is identical to unguided bombs with the addition of laser designation with the Targeting Pod (TGP)

This mode requires a target designation point from which to build the bombing solution. Command steering is provided to the appropriate weapon release point and the weapon will release automatically at the proper time such that the weapons hit the target.

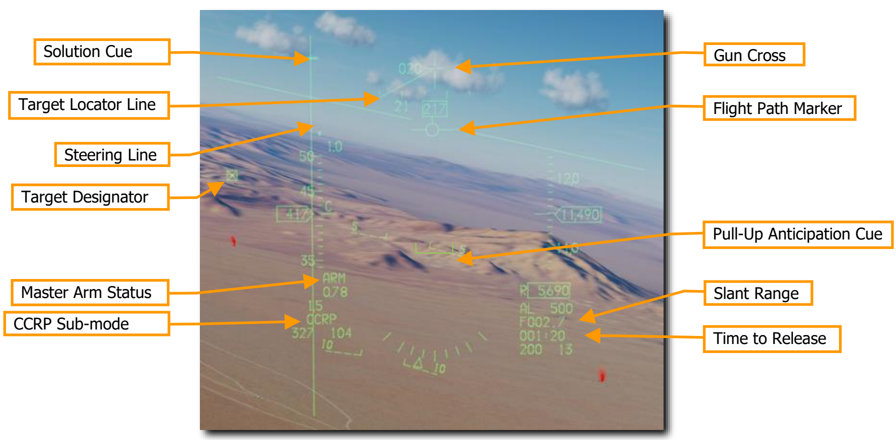
The bomb laser code must match the TGP laser designator laser code. See the Bomb Seeker Laser Code and Laser Designator Code sections for procedures.

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Set Laser Arm Switch to Arm
4. Select Bombs and desired options on SMS MFD
5. Set desired steerpoint number or designate target with TGP
6. Center FPM on Steering Line
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to release at the computed point
8. Lase target at least 8-12 seconds prior to impact

1. Verify CCRP symbology is displayed in the HUD.

The fire control system provides a Steering Line (SL) to provide steering to the designated target. By placing the Flight Path Marker (FPM) on the SL and holding down the Weapon Release Button, the weapon will release at the proper time and account for wind.



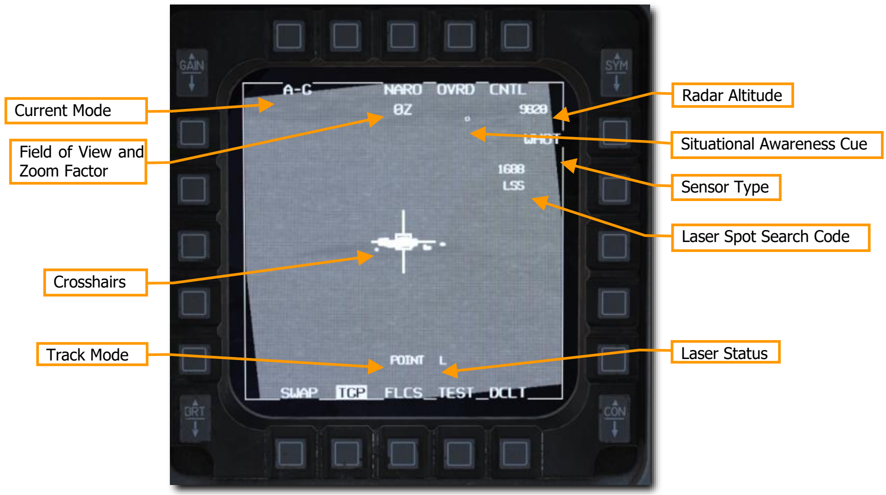
A Solution Cue is displayed at the top of the SL. It will fall down the line as the range decreases and the weapons are about to be released.

When the Target Designator (TD) is outside the HUD field on view as shown above, a Target Locator Line (TLL) extends from the Gun Cross pointing directly at the target. The relative angle is displayed next to the Gun Cross showing the number of degrees in tens between the cross and the target.

2. Verify TGP is configured for target search and laser fire.

Select A-G mode on the TGP to configure it for target acquisition and weapon guidance. The line of sight will slave to the selected steerpoint when CCRP delivery mode is selected.

The TGP display may be made the sensor of interest (SOI) by positioning the Display Management Switch (DMS) Down. The current SOI can be identified by the box surrounding the display.



The TGP crosshairs may then be slewed to a new position using the Cursor/Enable Control. Slewing the Target Designator with the HUD as SOI will also slew the TGP crosshairs.

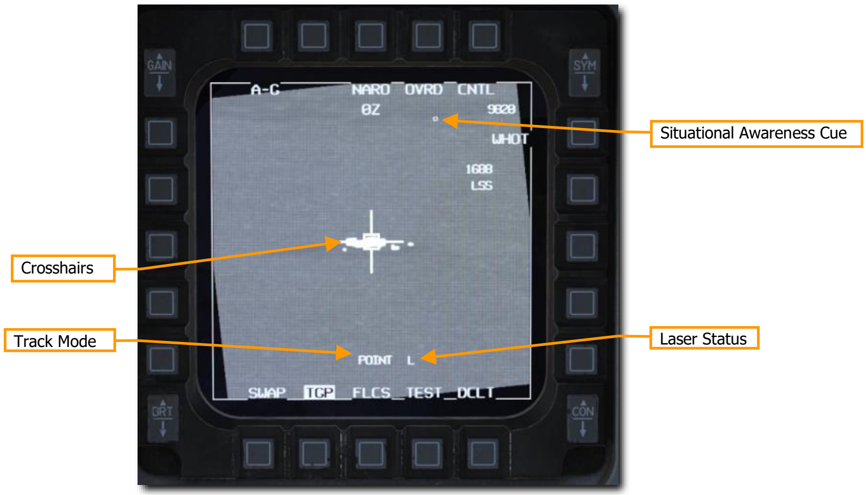
3. Locate and designate the desired target.

To calculate a bombing solution in CCRP mode, a target first must be designated. This can be done in two ways:

- **Select a Steerpoint that was placed at the target location.** The Target Designator box on the HUD will be placed at the steerpoint. The TGP will slave to that location when CCRP mode is selected.
- **Locate a target with the Targeting Pod.** With the TGP SOI, position the TMS Down to undesignate. The TGP will return to the boresight position near the center of the HUD. Fly or slew the TGP line of sight to the desired target location. TMS Up to designate. The Target Designator box on the HUD will be placed at that location.

Updates to the target location may be made by slewing the TD Box in the HUD or slewing the TGP cursor onto a new position with the Cursor/Enable Control. The Targeting Pod line of sight is used to calculate the bombing solution regardless of the track mode used.

Command an area track with TMS Up to stabilize the crosshairs over the target. A Point Track may also be commanded using TMS Up to aid in targeting if desired.



Laser ranging may be performed prior to weapon release to improve the computed firing solution. (See Laser Ranging for more information.)

The laser designator may be fired with any sensor type selected and from any track mode. The Laser status is displayed as an L near the bottom of the display when the Laser Arm switch is set to arm.

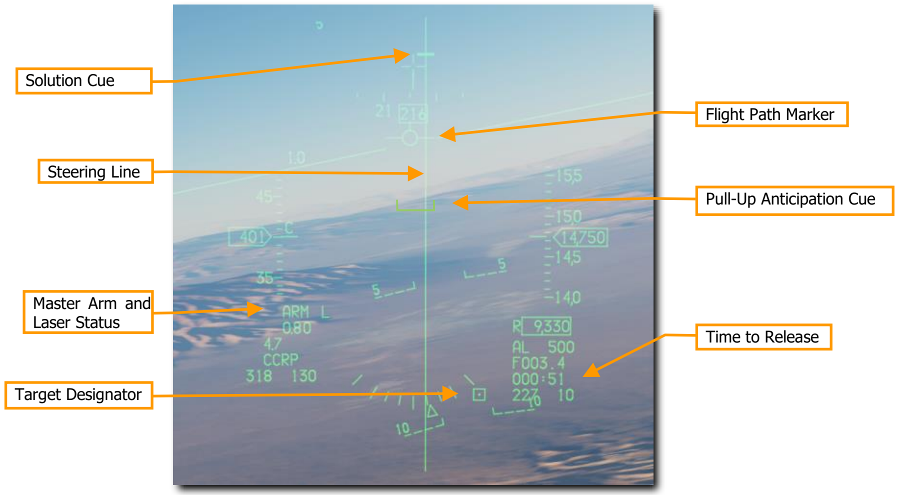
The laser is fired by squeezing the trigger to the first detent. The L flashes when the laser designator is firing.

4. Execute a CCRP bombing delivery.

Weapons delivery for laser guided bombs is identical to unguided bomb CCRP delivery.

Keep the Flight Path Marker aligned with the Steering Line. This will align your aircraft with the target even though the target will be out of sight.

The Steering Cue will fall down the Steering Line as the range decreases and the weapon is about to be released. Time to release counts down at the lower right of the HUD.

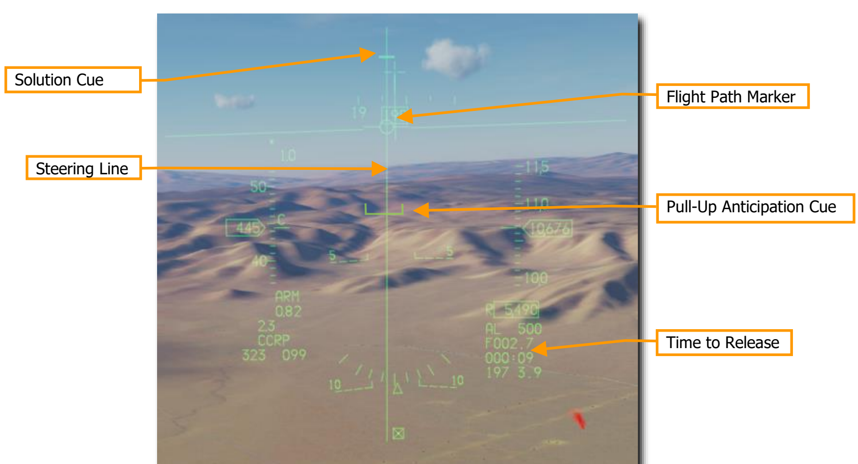


Monitor the Pull-Up Anticipation Cue to ensure it does not go above the Flight Path Marker. The Pull-Up Anticipation Cue (PUAC) provides a visual representation of the altitude required for the bomb fuze to arm or altitude to initiate a pull-up to avoid impacting the ground, whichever is more immediate. It moves up toward the Flight Path Marker (FPM) as the aircraft loses altitude. Releasing a bomb with the FPM below the PUAC will not give the bomb time to arm and result in a dud.

5. Press and HOLD the Weapon Release button.

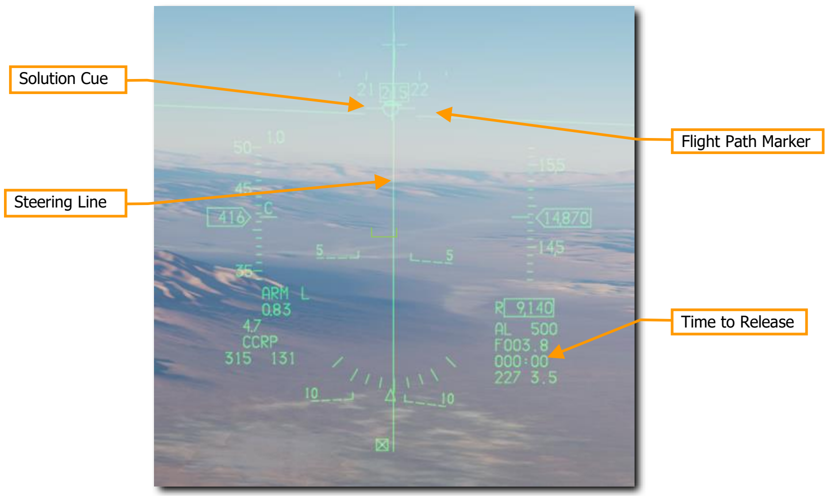
When the Solution Cue begins to move down the Steering Line, about 10 seconds prior to release, press and hold the Weapon Release button. This provides the fire control computer consent to release the weapon.

Keep the Flight Path Marker aligned with the Steering Line. This will align your aircraft with the target even though the target will be out of sight.



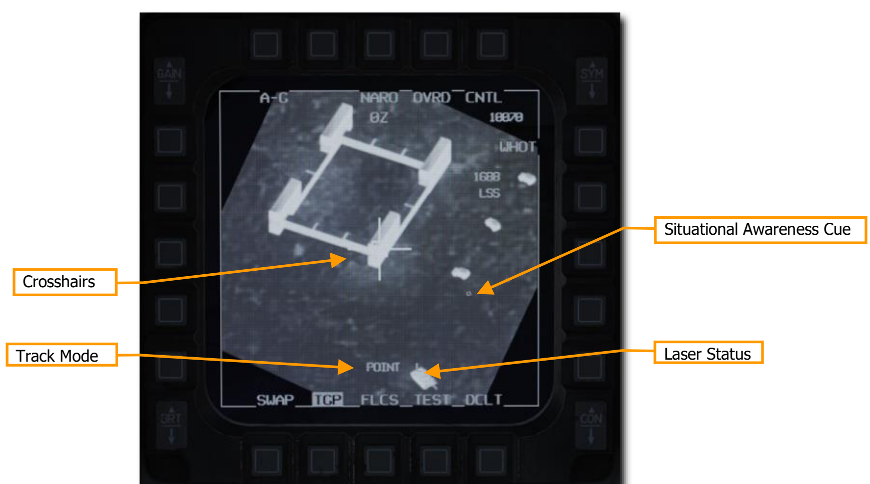
6. Keep the Weapons Release button held until after the Solution Cue passes the Flight Path Marker.

Keep flying the Flight Path Marker over the Steering Line as the Sulution Cue continues to track downward. The bombs are released when the Steering Cue passes the Flight Path Marker.



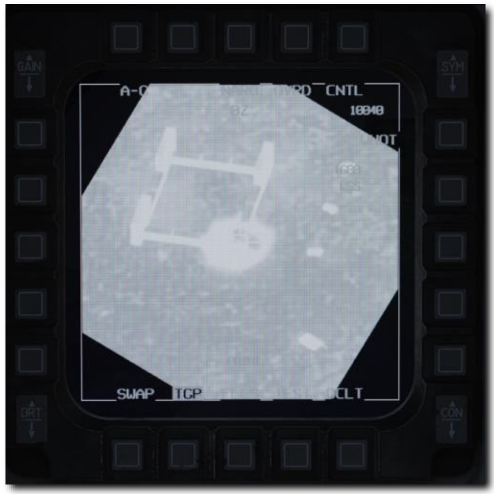
Hold the Weapons Release button long enough to ensure all weapons come off. The FPM flashes after weapons are released.

Execute a 30-45 degree check turn to the left or right to avoid overflight of the target and possible TGP gimbal roll. Continue to track the target in the TGP and update the crosshair aimpoint if necessary.



7. Lase the target with the TGP.

Squeeze the Trigger to lase the target no later than 8-12 seconds prior to impact. The L flashes when the laser designator is firing. At impact, the screen will wash out from the IR energy of the explosion.

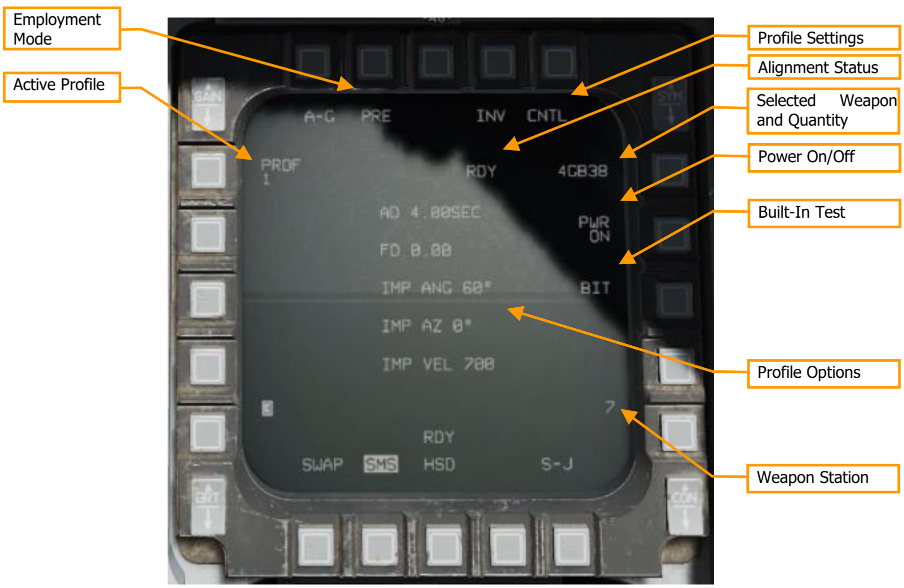


Switch to a wide field of view for an assessment and documentation of target damage. Set up for a re-attack if necessary or exit the area.

JOINT DIRECT ATTACK MUNITIONS (JDAM)

JDAM is an inertial and GPS guidance kit that can be attached to the Mk-82 or Mk-84 general-purpose bombs. When released, the aircraft downloads the target coordinates to the JDAM. The JDAM then guides to those coordinates. The weapon is completely fire-and-forget but cannot be steered or re-targeted post-launch.

JDAM SMS Format



Employment Mode. Toggles between pre-planned (PRE) and visual (VIS) employment modes (see Employment in Pre-Planned (PRE) Mode and Employment in Visual (VIS) Mode).

Active Profile. Cycles between four different employment profiles (see SMS Control Page).

Profile Settings. Press this OSB to open the Control page, where you can modify the active profile (see SMS Control Page).

Alignment Status. When the weapon is first powered on, will display "A10" (unstable alignment). During the alignment process, it will count down, and then display "RDY" when alignment is complete.

Selected Weapon and Quantity. Displays the weapon quantity and "GB38" or "GB31".

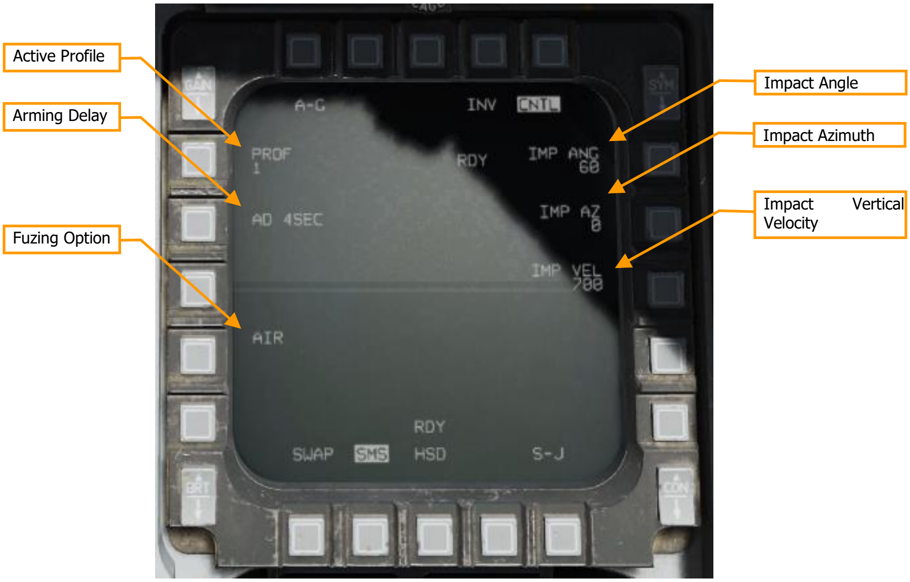
Power On/Off. Press to toggle power to all JDAM stations.

Built-In Test. Runs built-in tests. (N/I)

Profile Options. Displays the parameters of the selected profile (see SMS Control Page).

Weapon Station. The selected weapon station for the next release is displayed in reverse video.

SMS Control Page



Active Profile. Cycles between four different profiles to edit.

Arming Delay. Selects the delay between weapon release and arming. Options are 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 14, 21, and 25 seconds.

Fuzing Option. Sets the fuzing option:

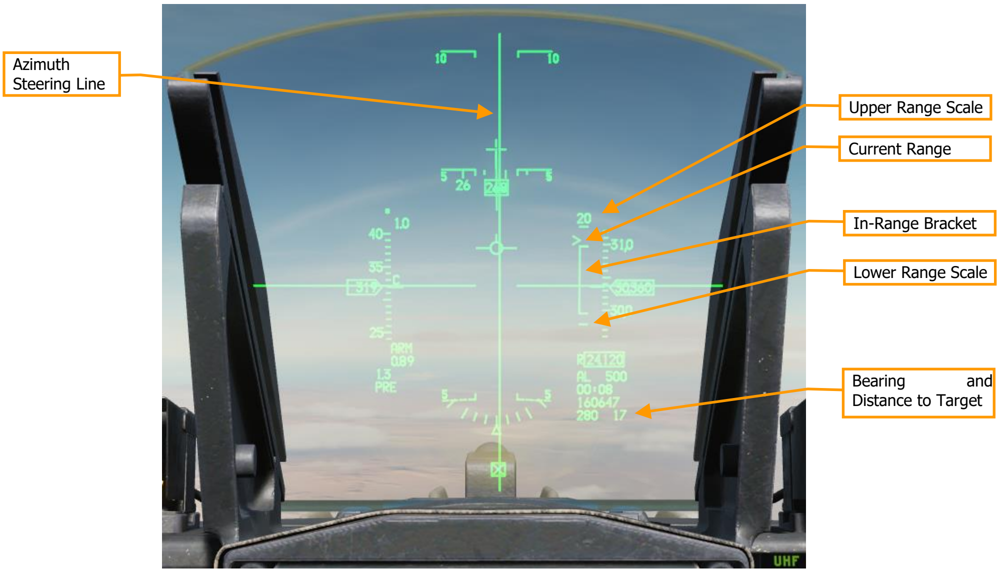
- AIR: Weapon will air-burst above the target. This reduces the penetrative effect of the bomb but improves its area effect.
- GND: Weapon will explode on impact. Selecting GND will reveal an additional option labeled FD (fuzing delay). Selectable fuzing delays are 0 (instant), 5, 15, 25, 45, 60, 90, 180, and 240 milliseconds. Adding a fuzing delay allows the weapon to penetrate the target prior to exploding.
- GND DLY: Weapon will impact target inert, and then explode after an extended period. Selecting GND DLY will reveal an additional option labeled FD (fuzing delay). Selectable fuzing delays are 0.25, 0.5, 0.75, 1, 4, 8, 12, 16, 20, and 24 hours after impact.

Impact Angle. Sets the angle that the bomb will attempt to impact the target at (e.g., 60°). A higher impact angle should be used if tall structures surround the target.

Impact Azimuth. Sets the heading that the bomb will attempt to fly to the target during the terminal phase. A value of "0" means no specific heading; use a value of "360" if you want the bomb to impact the target from the south flying north.

Impact Vertical Velocity. Sets the vertical velocity the bomb will attempt to achieve when impacting the target, in feet per second. A higher vertical velocity creates more effective penetration.

JDAM HUD Symbology



Azimuth Steering Line. Center the Flight Path Marker over this line to fly the fastest course to the launch acceptability region (LAR).

Upper Range Scale. Indicates the top range of the dynamic launch zone (DLZ) in nautical miles.

Current Range. The caret indicates the aircraft's current range to the target. If the caret is within the in-range bracket, the weapon can reach the target if released.

In-Range Bracket. Indicates the range where the weapon can reach the target.

Lower Range Scale. Indicates zero range.

Bearing and Distance to Target. Indicates the bearing (degrees) and distance (nautical miles) the current SPI, which is the location the bomb will fly to after release.

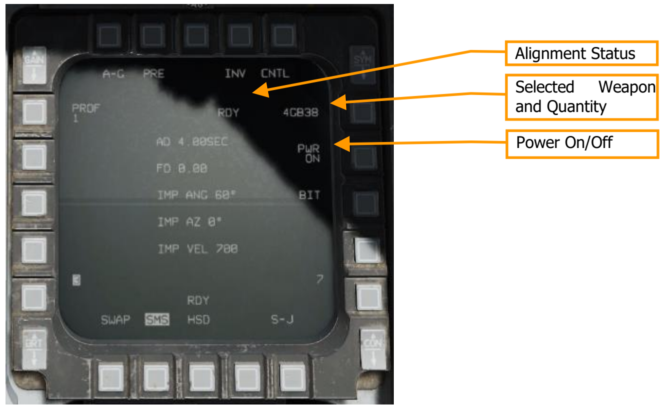
Employment in Pre-Planned (PRE) Mode

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Select JDAM and power on
4. Set desired options on SMS format
5. Set desired steerpoint or designate target
6. Center FPM on Steering Line and fly in range
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to release at the computed point

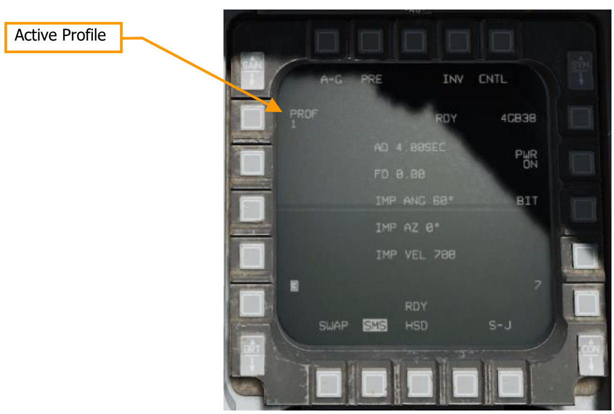
1. **Select JDAM and power on.**

   Set the master mode to A-G, and on the SMS format, use OSB 6 to select GBU-38 (GB38) or GBU-31 (GB31) as the active weapon. Press OSB 7 (PWR OFF) to power on the weapon and begin the alignment process. Alignment will take a few minutes.



2. **Set desired options on SMS format.**

   On the SMS format, select and configure the profile you want to use.

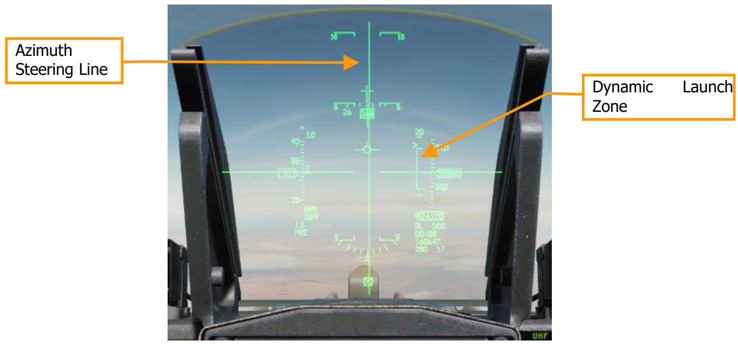


3. **Set desired steerpoint or designate target**

   The weapon will guide to the current sensor point of interest (SPI) when released. If no cursor has been added, or cursor zero (CZ) has been pressed, the SPI will be the selected steerpoint. Designating a target (e.g., using the targeting pod) will shift the SPI to that location.

4. **Center FPM on Steering Line and fly in range**

   Steer to place the azimuth steering line (ASL) over the flight path marker. Fly until the range caret is within the in-range bracket.



5. Depress and hold Weapons Release button

You must hold the Weapons Release button continuously until the weapon releases. During this process, target coordinates and profile data is downloaded to the JDAM kit. If this process is interrupted by releasing the Weapons Release button before the download finishes, the weapon will become a hung store and will be unusable.

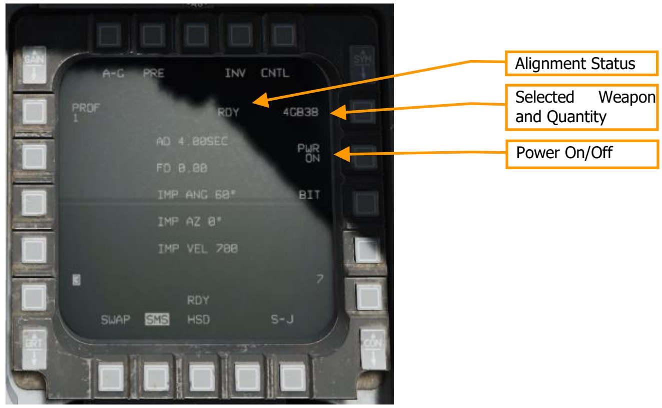
Employment in Visual (VIS) Mode

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Select JDAM and power on
4. Set VIS mode and desired options on SMS format
5. Use HUD and TDC to designate target
6. Center FPM on Steering Line and fly in range
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to release at the computed point

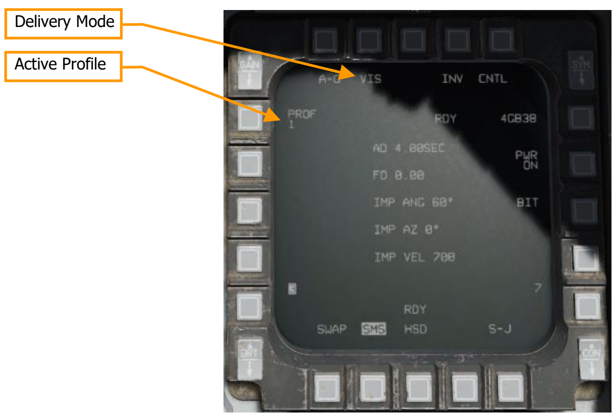
1. Select JDAM and power on.

Set the master mode to A-G, and on the SMS format, use OSB 6 to select GBU-38 (GB38) or GBU-31 (GB31) as the active weapon. Press OSB 7 (PWR OFF) to power on the weapon and begin the alignment process. Alignment will take a few minutes.



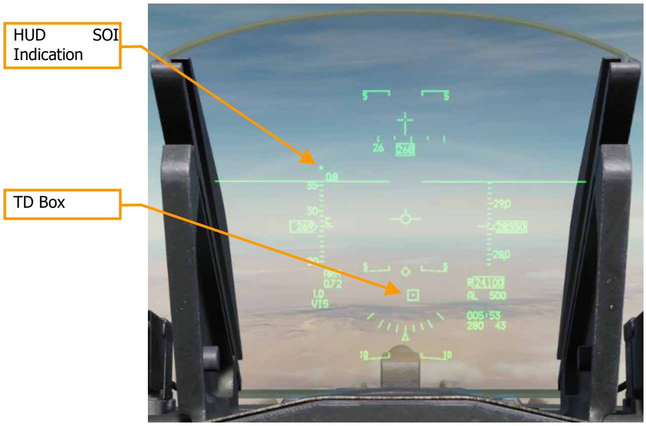
2. **Set VIS mode and desired options on SMS format.**

   On the SMS format, select and configure the profile you want to use. Press OSB 2 to change the delivery mode to VIS.



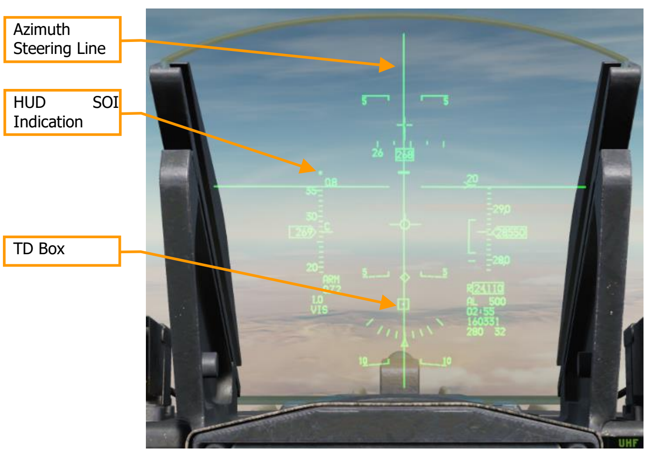
3. **Use HUD and TDC to designate target**

   Upon enabling VIS mode, a target-designator (TD) box will appear on the HUD, and the HUD will become SOI. Use the TDC to slew the TD box over the target, then press TMS Forward to designate.



4. Center FPM on Steering Line and fly in range

Steer to place the azimuth steering line (ASL) over the flight path marker. Fly until the range caret is within the in-range bracket. You can continue to adjust the position of the TD box using the TDC.



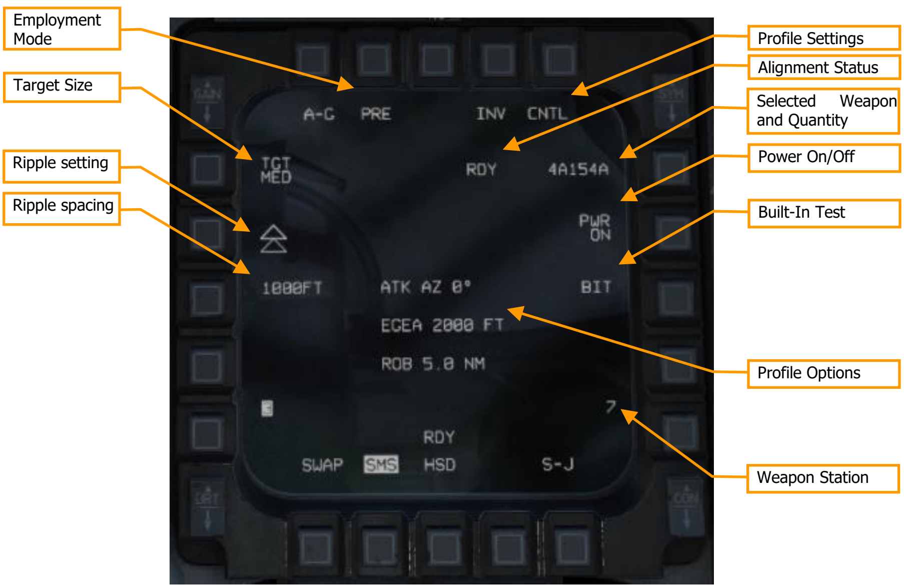
5. Depress and hold Weapons Release button

You must hold the Weapons Release button continuously until the weapon releases. During this process, target coordinates and profile data is downloaded to the JDAM kit. If this process is interrupted by releasing the Weapons Release button before the download finishes, the weapon will become a hung store and will be unusable.

AGM-154 JOINT STANDOFF WEAPON (JSOW)

JSOW is an inertially-aided glide bomb capable of striking targets up to 70 NM away, depending on the altitude and speed of launch. When released, the aircraft downloads the target coordinates to the JSOW. The JSOW then guides to those coordinates. The weapon is completely fire-and-forget. The AGM-154A variant has BLU-97/B warheads and cannot be re-targeted after launch.

JSOW SMS Format



Employment Mode. Toggles between pre-planned (PRE) and visual (VIS) employment modes (see Employment in Pre-Planned (PRE) Mode and Employment in Visual (VIS) Mode).

Target Size. Not yet implemented.

Profile Settings. Press this OSB to open the Control page, where you can modify the active profile (not implemented).

Alignment Status. When the weapon is first powered on, will display "A10" (unstable alignment). During the alignment process, it will count down, and then display "RDY" when alignment is complete.

Selected Weapon and Quantity. Displays the weapon quantity and "A154A".

Power On/Off. Press to toggle power to all JSOW stations.

Built-In Test. Runs built-in tests. (N/I)

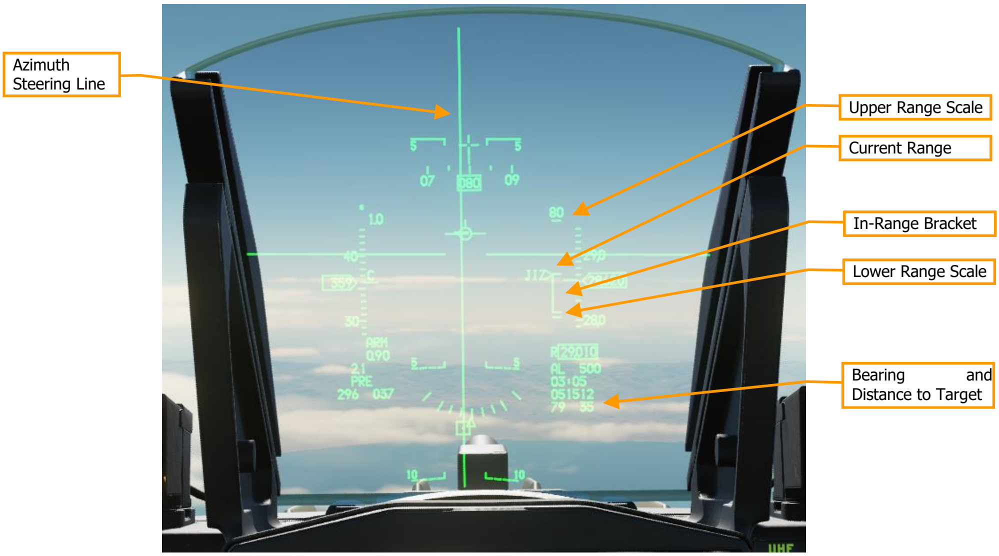
Profile Settings. Displays the parameters of the selected profile. (N/I)

Weapon Station. The selected weapon station for the next release is displayed in reverse video.

Ripple setting. Toggle between single release and pairs release with longitudinal or lateral separation.

Ripple spacing: Press to enter the distance in feet between the two bombs at height of function. Not displayed if the single release mode is selected.

JSOW HUD Symbology



Upper Range Scale. Indicates the top range of the dynamic launch zone (DLZ) in nautical miles.

Current Range. The caret indicates the aircraft's current range to the target. If the caret is within the in-range bracket, the weapon can reach the target if released.

In-Range Bracket. Indicates the range where the weapon can reach the target.

Lower Range Scale. Indicates zero range.

Bearing and Distance to Target. Indicates the bearing (degrees) and distance (nautical miles) the current SPI, which is the location the bomb will fly to after release.

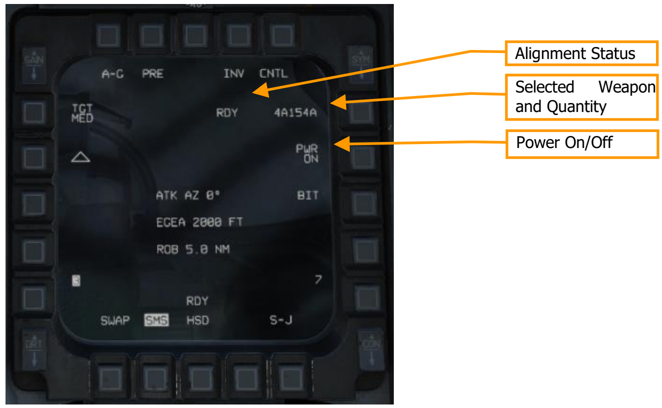
Employment in Pre-Planned (PRE) Mode

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Select JSOW and power on
4. Set desired options on SMS format
5. Set desired steerpoint or designate target
6. Center FPM on Steering Line and fly in range
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to release at the computed point

1. **Select JSOW and power on.**

   Set the master mode to A-G, and on the SMS format, use OSB 6 to select AGM-154A (A154A) as the active weapon. Press OSB 7 (PWR OFF) to power on the weapon and begin the alignment process. Alignment will take a few minutes.



2. **Set desired options on SMS format.**

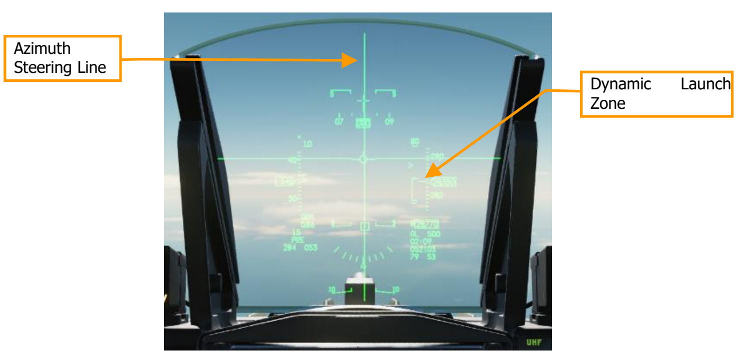
   On the SMS format, configure the weapon as desired.

3. **Set desired steerpoint or designate target**

   The weapon will guide to the current sensor point of interest (SPI) when released. If no cursor has been added, or cursor zero (CZ) has been pressed, the SPI will be the selected steerpoint. Designating a target (e.g., using the targeting pod) will shift the SPI to that location.

4. **Center FPM on Steering Line and fly in range**

   Steer to place the azimuth steering line (ASL) over the flight path marker. Fly until the range caret is within the in-range bracket.



5. **Depress and hold Weapons Release button**

   You must hold the Weapons Release button continuously until the weapon releases. During this process, target coordinates and profile data is downloaded to the JSOW. If this process is interrupted by releasing the Weapons Release button before the download finishes, the weapon will become a hung store and will be unusable.

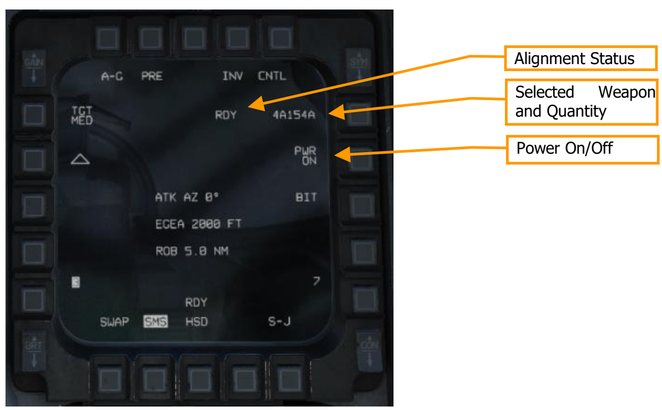
Employment in Visual (VIS) Mode

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Select JSOW and power on
4. Set VIS mode and desired options on SMS format
5. Use HUD and TDC to designate target
6. Center FPM on Steering Line and fly in range
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to release at the computed point

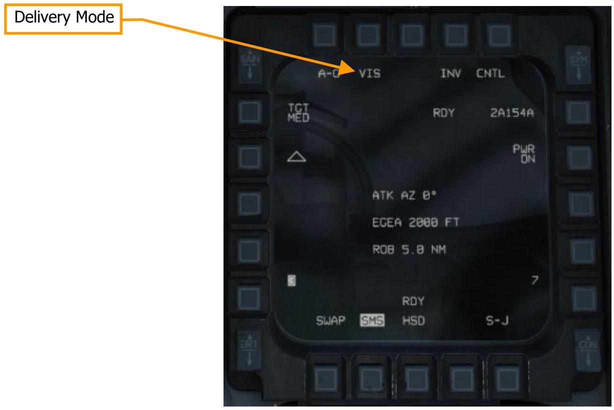
1. Select JSOW and power on.

Set the master mode to A-G, and on the SMS format, use OSB 6 to select AGM-154A (A154A) as the active weapon. Press OSB 7 (PWR OFF) to power on the weapon and begin the alignment process. Alignment will take a few minutes.



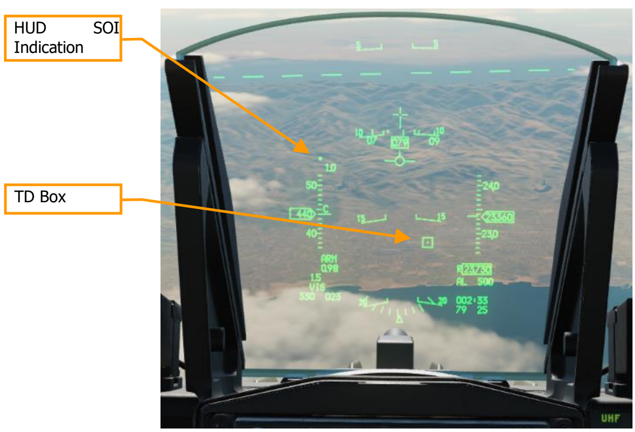
2. Set VIS mode and desired options on SMS format.

On the SMS format, select and configure the options you want to use. Press OSB 2 to change the delivery mode to VIS.



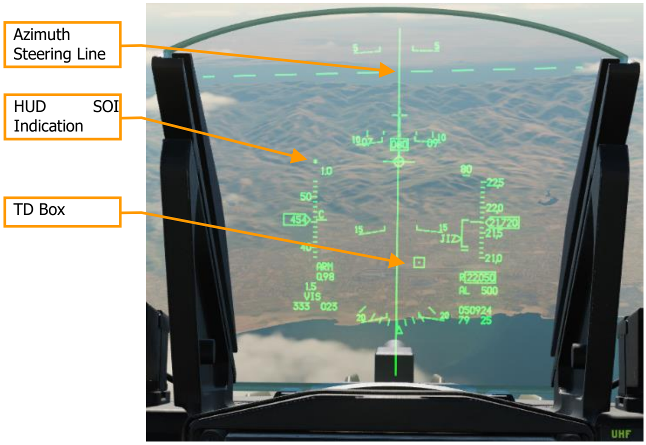
3. Use HUD and TDC to designate target

Upon enabling VIS mode, a target-designator (TD) box will appear on the HUD, and the HUD will become SOI. Use the TDC to slew the TD box over the target, then press TMS Forward to designate.



4. Center FPM on Steering Line and fly in range

Steer to place the azimuth steering line (ASL) over the flight path marker. Fly until the range caret is within the in-range bracket (labeled "JIZ"). You can continue to adjust the position of the TD box using the TDC.



5. Depress and hold Weapons Release button

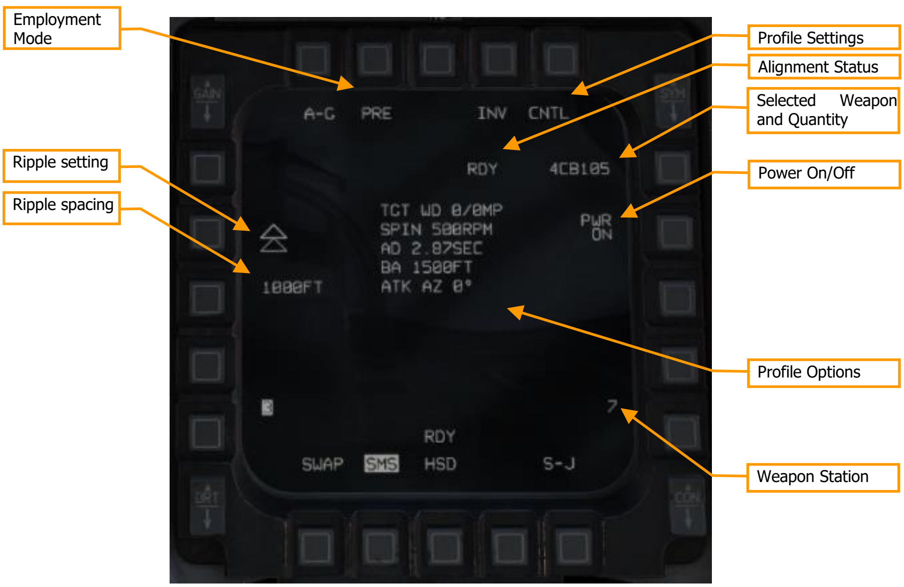
You must hold the Weapons Release button continuously until the weapon releases. During this process, target coordinates and profile data is downloaded to the JSOW. If this process is interrupted by releasing the Weapons Release button before the download finishes, the weapon will become a hung store and will be unusable.

WIND-CORRECTED MUNITIONS DISPENSERS (WCMD)

Wind-Corrected Munitions Dispensers (WCMD, pronounced "wick-mid") are tail kits that can be equipped to a CBU-87 CEM or CBU-97 SFW, giving the precision guidance capability. WCMD includes an onboard INS and can be programmed with the winds aloft to improve accuracy.

When the CBU-87 is equipped with WCMD, it is called the CBU-103. A CBU-97 with WCMD is called a CBU-105.

WCMD SMS Format



Employment Mode. Toggles between pre-planned (PRE) and visual (VIS) employment modes (see Employment in Pre-Planned (PRE) Mode and Employment in Visual (VIS) Mode).

Profile Settings. Press this OSB to open the Control page, where you can modify the active profile (see WCMD CNTL Page).

Alignment Status. When the weapon is first powered on, will display "A10" (unstable alignment). During the alignment process, it will count down, and then display "RDY" when alignment is complete.

Selected Weapon and Quantity. Displays the weapon quantity and "CB103" or "CB105".

Power On/Off. Press to toggle power to all WCMD stations.

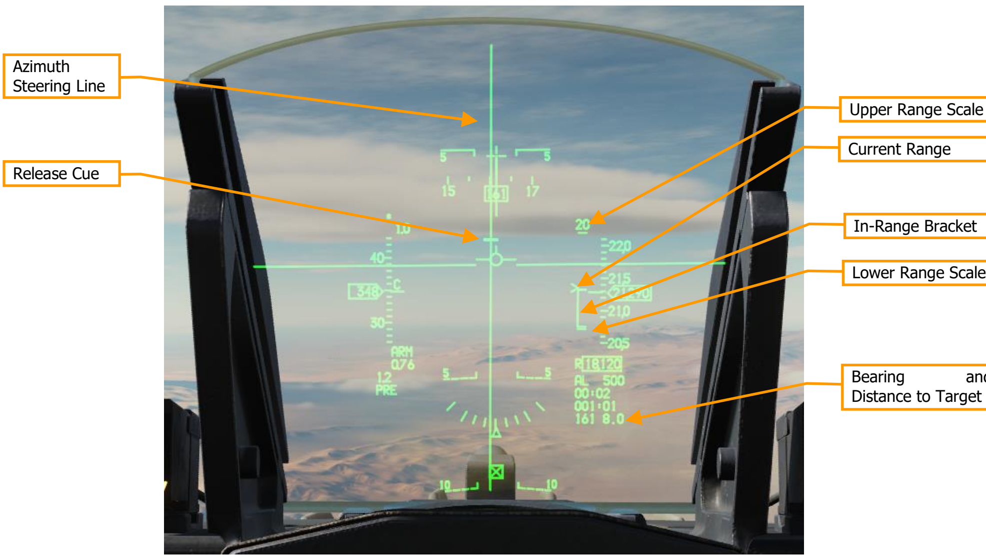
Profile Settings. Displays the parameters of the selected profile.

Weapon Station. The selected weapon station for the next release is displayed in reverse video.

Ripple setting. Toggle between single release and pairs release with longitudinal or lateral separation.

Ripple spacing: Press to enter the distance in feet between the two bombs at height of function. Not displayed if the single release mode is selected.

WCMD HUD Symbology



Upper Range Scale. Indicates the top range of the dynamic launch zone (DLZ) in nautical miles.

Current Range. The caret indicates the aircraft's current range to the target. If the caret is within the in-range bracket, the weapon can reach the target if released.

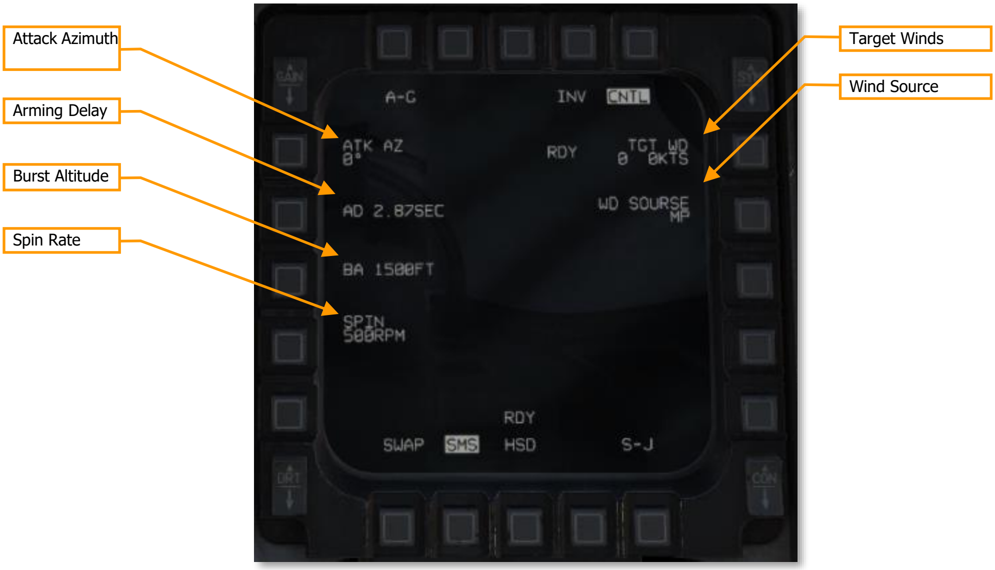
In-Range Bracket. Indicates the range where the weapon can reach the target.

Lower Range Scale. Indicates zero range.

Bearing and Distance to Target. Indicates the bearing (degrees) and distance (nautical miles) the current SPI, which is the location the bomb will fly to after release.

WCMD CNTL Page

The CNTL page lets you configure the WCMD engagement profile and other options.



Attack Azimuth. Sets the attack direction that the bombs will attempt to achieve. A setting of "0" means that the bombs will use the most direct attack direction ("360" means attack heading north). (Not implemented.)

Arming Delay. Sets the delay after release before the weapon arms. (Not implemented.)

Burst Altitude. Sets the height of function, which is the altitude (MSL) when the submunitions will be released. Higher burst altitudes create a wider dispersal.

Spin Rate. The bomb will begin rotating at this RPM value prior to submunitions release (CBU-103 only). Higher spin rates create a wider dispersal.

Target Winds. Manual winds aloft entry. Not implemented.

Wind Source. Toggles wind data from mission planning (MP), pilot-entered (PI), and avionics system (SY). Currently only MP is available.

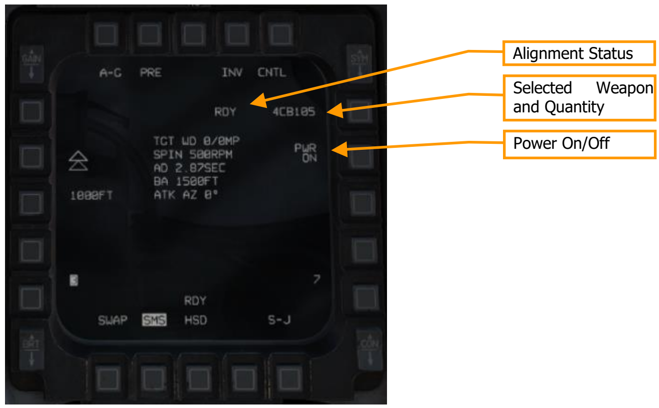
Employment in Pre-Planned (PRE) Mode

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Select WCMD and power on
4. Set desired options on SMS format
5. Set desired steerpoint or designate target
6. Center FPM on Steering Line and fly in range
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to release at the computed point

1. **Select WCMD and power on.**

Set the master mode to A-G, and on the SMS format, use OSB 6 to select WCMD (CB103 or CB105) as the active weapon. Press OSB 7 (PWR OFF) to power on the weapon and begin the alignment process. Alignment will take a few minutes.



2. Set desired options on SMS format.

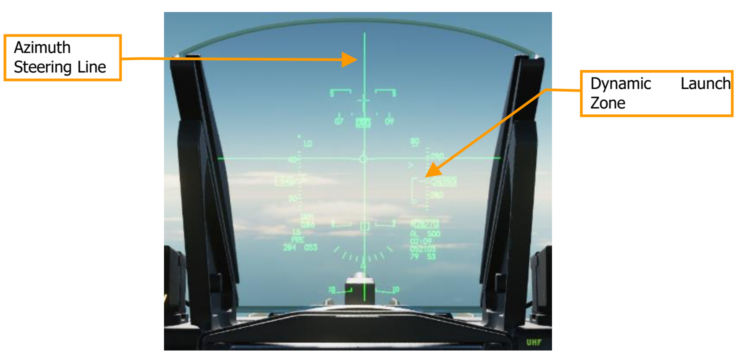
On the SMS format, configure the weapon as desired.

3. Set desired steerpoint or designate target

The weapon will guide to the current sensor point of interest (SPI) when released. If no cursor has been added, or cursor zero (CZ) has been pressed, the SPI will be the selected steerpoint. Designating a target (e.g., using the targeting pod) will shift the SPI to that location.

4. Center FPM on Steering Line and fly in range

Steer to place the azimuth steering line (ASL) over the flight path marker. Fly until the range caret is within the in-range bracket.



5. Depress and hold Weapons Release button

You must hold the Weapons Release button continuously until the weapon releases. During this process, target coordinates and profile data is downloaded to the WCMD. If this process is interrupted by releasing the Weapons Release button before the download finishes, the weapon will become a hung store and will be unusable.

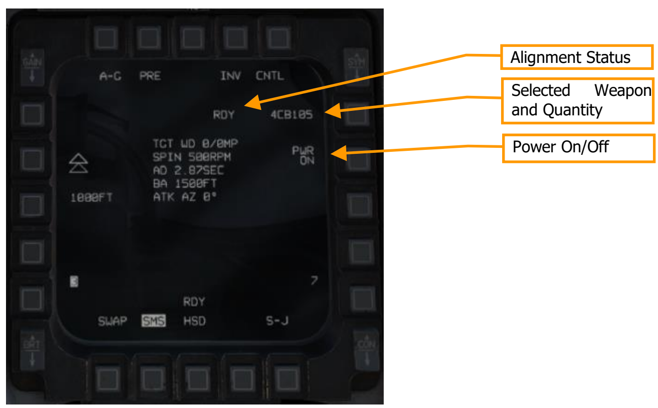
Employment in Visual (VIS) Mode

Summary

1. Select A-G Master Mode **[2]**
2. Set Master Arm Switch to Arm
3. Select WCMD and power on
4. Set VIS mode and desired options on SMS format
5. Use HUD and TDC to designate target
6. Center FPM on Steering Line and fly in range
7. Depress and hold Weapons Release button **[RAlt]+[Space]** to release at the computed point

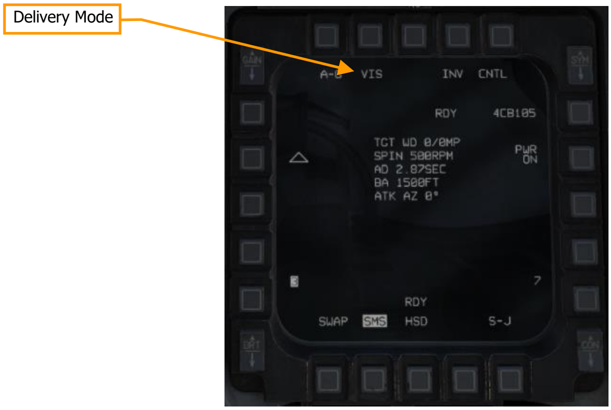
1. Select WCMD and power on.

Set the master mode to A-G, and on the SMS format, use OSB 6 to select WCMD (CB103 and CB105) as the active weapon. Press OSB 7 (PWR OFF) to power on the weapon and begin the alignment process. Alignment will take a few minutes.



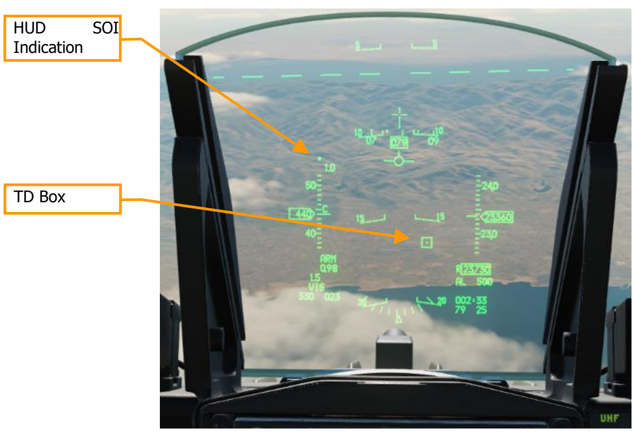
2. Set VIS mode and desired options on SMS format.

On the SMS format, select and configure the options you want to use. Press OSB 2 to change the delivery mode to VIS.



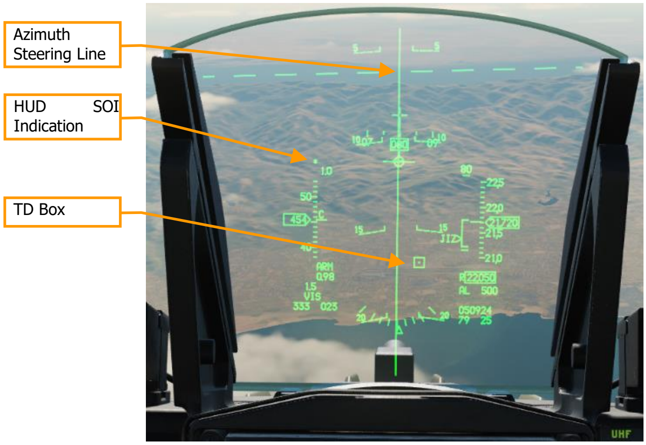
3. Use HUD and TDC to designate target

Upon enabling VIS mode, a target-designator (TD) box will appear on the HUD, and the HUD will become SOI. Use the TDC to slew the TD box over the target, then press TMS Forward to designate.



4. Center FPM on Steering Line and fly in range

Steer to place the azimuth steering line (ASL) over the flight path marker. Fly until the range caret is within the in-range bracket. You can continue to adjust the position of the TD box using the TDC.



5. Depress and hold Weapons Release button

You must hold the Weapons Release button continuously until the weapon releases. During this process, target coordinates and profile data is downloaded to the WCMD. If this process is interrupted by releasing the Weapons Release button before the download finishes, the weapon will become a hung store and will be unusable.

AGM-88 HARM

The AGM-88C High-speed Anti-Radiation Missile (HARM) is a supersonic, passive radar-guided air-to-ground missile intended to strike air defense radar sites and vehicles. The missile has an onboard radar receiver that homes in on radar energy emitted by ground-based radars, making it fire-and-forget. The pilot can designate targets using the missile's onboard radar receiver or using the HARM Targeting System (HTS) external sensor pod. The HARM may be loaded on stations 3, 4, 6, or 7, but is typically only employed from stations 3 and 7.

The HARM can be targeted using one of three modes: position known (POS), HARM-as-sensor (HAS), or datalink (DL). Currently, DL is not implemented in DCS.

Communication with the HARM missile is managed by the aircraft launcher interface computer (ALIC) within the LAU-118 missile launcher. The ALIC provides HARM sensor video to the SMS and allows the SMS to hand off threat types to the AGM-88. After launch, the AGM-88 will home on threat radars matching the handed-off threat type.

Preparation

Prior to departure, set up your HARM threat tables as necessary. The threats you expect to fire against must be present on the selected threat table for the AGM-88 to detect them. Most of the time, you will be able to use one of the default threat tables:

WPN	TBL1 (*MODERN SAM SYSTEMS*)	WPN	TBL2 (*AAA & SHORAD*)	WPN	TBL1 (*OLDER SAM SYSTEMS*)
10	SA-10 "FLAP LID"	19	SA-19 "HOT SHOT"	3	SA-3 "LOW BLOW"
BB	SA-10 "BIG BIRD"	15	SA-15 "SCRUM HALF"	S	P-19 "FLAP LID B"
CS	SA-10 "CLAM SHELL"	8	SA-8 "LAND ROLL"	6	SA-6 "STRAIGHT FLUSH"
11	SA-11 "FIRE DOME"	A	ZSU-23-4 "GUN DISH"	2	SA-2 "FAN SONG"
SD	SA-11 "SNOW DRIFT"	DE	PPRU-M1 "DOG EAR"	13	SA-13 "SNAP SHOT"

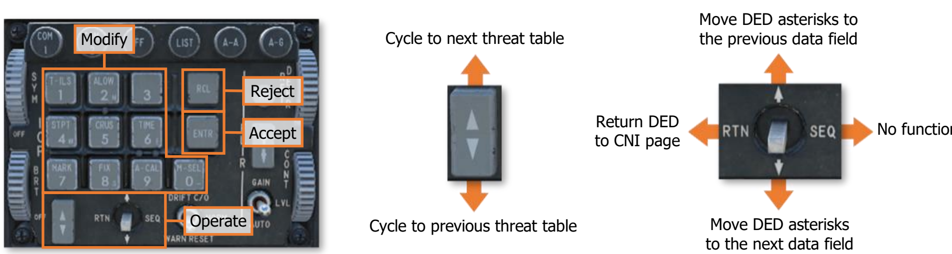
If any expected threats do not appear on these tables, you will need to edit one or more of the tables. It may be wise to consolidate the expected threats to one table to improve the efficiency of employing HARM missiles during the mission.

The HARM DED page is used to edit the default HARM threat tables.

HARM DED Page

The HARM DED page is accessed by pressing **0/M-SEL** on the ICP keypad when the MISC DED page is displayed on the DED, or by pressing **UFC** (OSB 5) on the MFD Weapon (WPN) format, when "AG88" is the current SMS profile. This page is used to configure the HARM threat tables to better tailor the AGM-88 scans to the radar signals that are anticipated to be encountered during the mission.

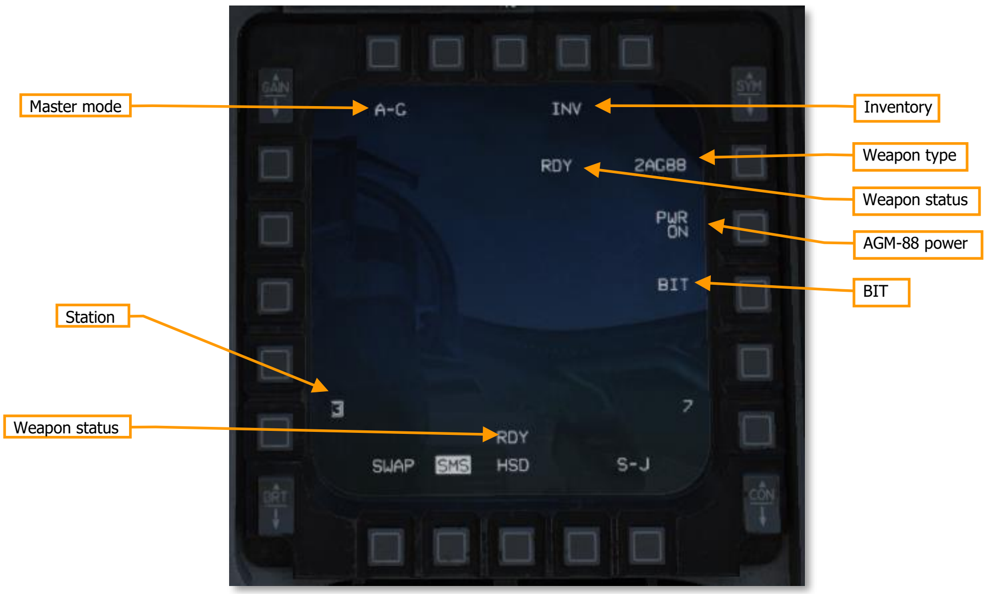
(See Appendix B for a complete list of all threat radar ALIC codes.)



1. **HARM Threat Table.** Displays the HARM threat table that corresponds with the displayed threat ALIC codes. The ICP Increment/Decrement rocker may be used to cycle to a different threat table.
2. **Table Threat Number.** Displays five threat entries that may accept an ALIC code for the displayed threat table.
3. **Threat ALIC Code.** Displays the ALIC code representing a specific threat radar type that is loaded into the corresponding threat entry. May be modified using the ICP keypad.
4. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.

SMS Format

Prior to employing HARMs, press the A-G button on the ICP to select air-to-ground master mode. Ensure that the SMS and WPN formats are visible on an MFD. From the SMS format, power on the HARMs:



Master mode: Toggles between A-G and STRF (gun strafe) air-to-ground modes.

Inventory: Pressing this OSB displays the Inventory page.

Weapon type: Displays "AG88" for AGM-88 HARM, and the number of missiles loaded.

Weapon status: Displays "RDY" when the AGM-88 is ready for launch.

AGM-88 power: Displays "PWR ON" or "PWR OFF". Pressing commands spin-up or spin-down to all loaded AGM-88 missiles.

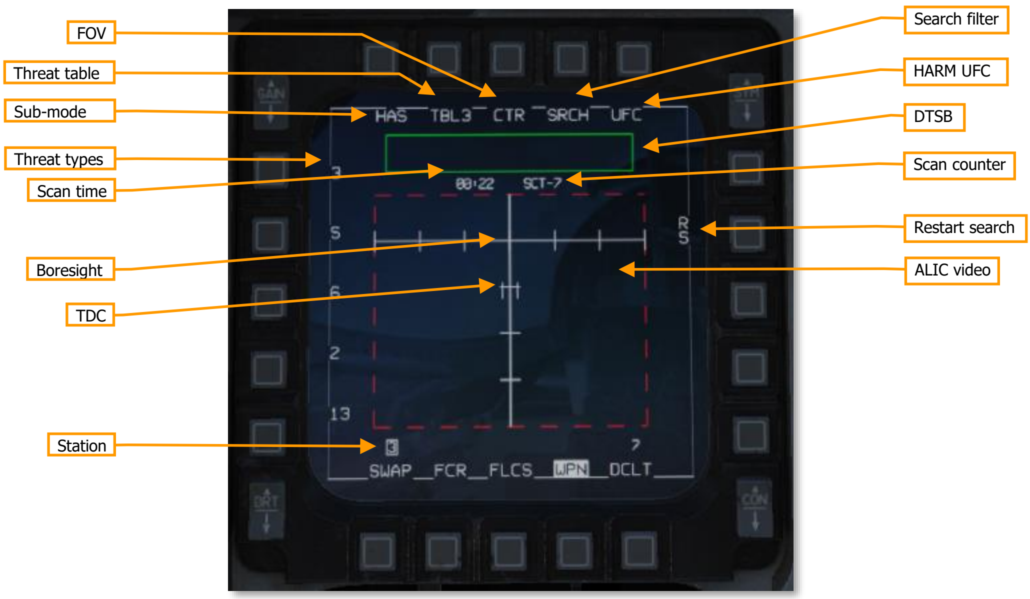
BIT: Commands execution of a built-in test. The status of each station will be updated following completion of the BIT.

Station: Displays the stations on which HARMs are loaded. The station selected for launch is boxed. Above the station number is a character indicating the missile degrade state for that station: "D" for degraded or "F" for failed. No character above the station number indicates a functioning missile.

WPN Format

The AGM-88 HARM can be targeted using its onboard sensor in one of three modes: position known (POS), HARM-as-sensor (HAS), or datalink (DL). (Currently DL is not supported in DCS.) Each mode has its own WPN format.

HAS Mode



Sub-mode: Displays "HAS" in HARM-as-Sensor sub-mode.

Threat table: Displays the current threat table (TBL1, TBL2, or TBL3). Pressing cycles through the three tables. Pressing the TMS switch left when the WPN page is SOI also cycles through threat tables.

FOV: Displays the missile field of view: "CTR" for center, "LT" for left, "RT" for right, and "WIDE" for wide. Pressing cycles through FOV settings. The FOV setting controls which portion of the missile's forward hemisphere it searches. Pressing the Expand/FOV button on the SSC also cycles FOV settings.

Search filter: Pressing this OSB allows the pilot to toggle on and off threats within the current threat table. Reducing the number of threats that the ALIC is searching for reduces the time for each scan cycle.

HARM UFC: Pressing this OSB displays the HARM page on the DED, where threat tables can be modified.

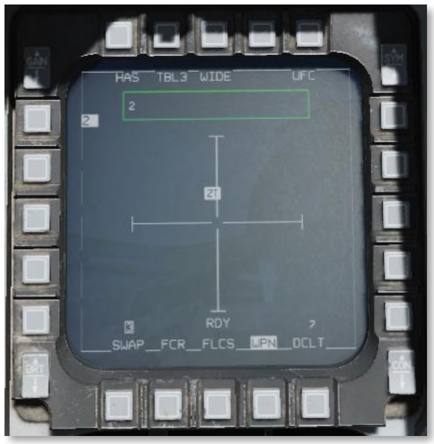
DTSB: The detected target status box lists detected threat types. When a new threat is detected, its type (e.g., "2" for SA-2) is added to the DTSB.

Scan counter: This counter increments after each successive scan made by the AGM-88.

Restart search: Pressing this OSB cancels the current scan cycle and begins a new one.

ALIC video: Detected threats are displayed in this area. Only threats from the active threat table are displayed. ALIC video is ground stabilized and referenced to missile boresight line. Threats displayed as characters representing their type (e.g., "2" for SA-2). If the threat is active (radiating), the letter "A" follows the threat type. If the threat is tracking (guiding an in-flight missile), the letter "T" follows the threat type. If the threat is not radiating (memory threat), or multiple threats of the same time are co-located, no "A" or "T" is shown.

Pressing TMS forward commands designation of the threat under the TDC. The ALIC video display will switch to a non-ground-stabilized display of the targeted threat, with crosshairs indicating missile boresight.



Station: Shows which stations have AGM-88s loaded. The station selected for next launch is boxed. A "D" or "F" is displayed over the station number to indicate a degraded or failed missile.

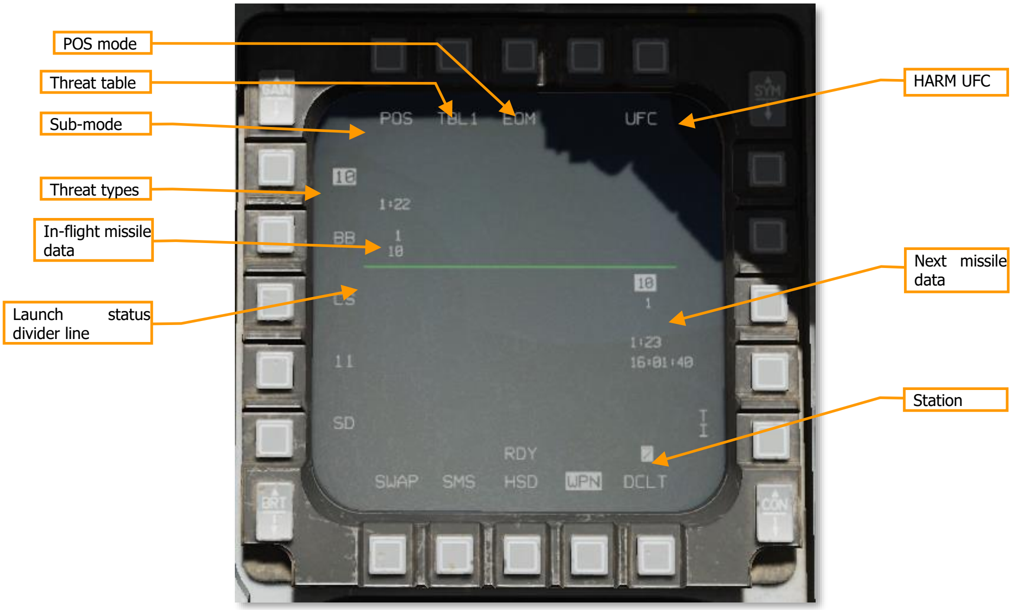
TDC: The target designator cursor is slewed over a target the pilot wishes to designate, using the cursor control on the TQS. Pressing TMS forward commands designation of the threat under the TDC, and hands off the threat type to the AGM-88.

Boresight: Indicates the missile boresight axis.

Scan time: Shows worst-case scan time. The ALIC will repeatedly scan for threats according to the chosen parameters. Reducing the number of threats to be scanned using the SRCH OBS, or reducing the FOV, will reduce the scan time and therefore decrease the amount of time before a threat is detected.

Threat types: The five threat types for the current threat table (TBL1, TBL2, or TBL3) are shown along the left side. If a threat is designated, its type is highlighted. The adjacent OSBs have no function in the HAS sub-mode.

POS Mode



Sub-mode: Displays "POS" in Position Known sub-mode.

Threat table: Displays the current threat table (TBL1, TBL2, or TBL3). Pressing cycles through the three tables. Pressing the TMS switch left when the WPN page is SOI also cycles through threat tables.

HARM UFC: Pressing this OSB displays the HARM page on the DED, where threat tables can be modified.

POS mode: Selects the attack profile to use: EOM (equations of motion), PB (pre-briefed), or RUK (range unknown).

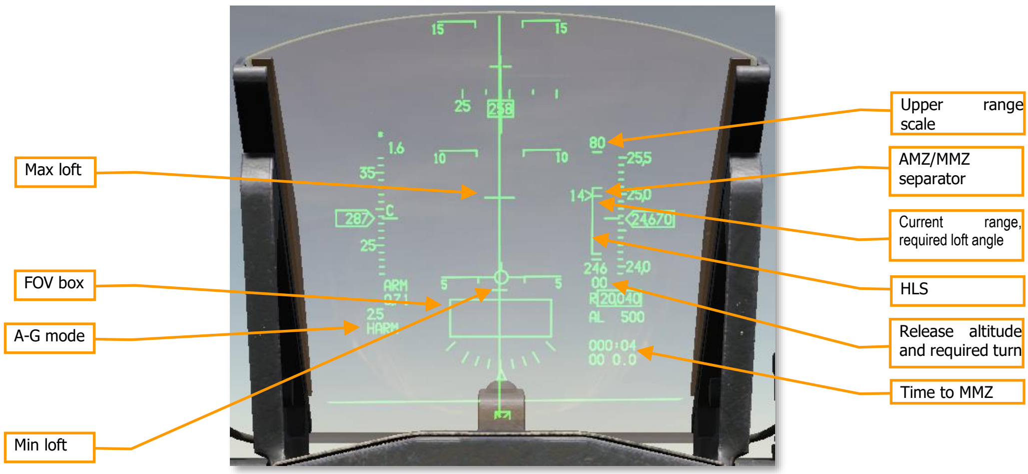
Threat types: Lists the threats in the current table. Pressing the OSB adjacent to a threat hands off that threat type to the ALIC.

Next missile data: Information about the next missile to be launched. Not displayed if all missiles have been launched. Line 1 is the threat type to be handed off to the missile. Line 2 is the steerpoint to be handed off to the missile. Line 3 is the predicted time until impact, and line 4 is the predicted impact time, if the missile were launched now. Only lines 1 and 2 are shown for RUK attacks.

In-flight missile data: Information about the in-flight missile. If multiple missiles are in-flight, multiple datablocks will be shown along this row. Line 1 is the predicted time until impact. Line 2 is the steerpoint that was handed off to the missile, and line 3 is the threat type that was handed off to the missile. Only lines 2 and 3 are shown for RUK attacks.

Launch status divider line (LSDL): Divides in-flight missile information from next missile information.

HUD Symbology



On the right side is the HARM Launch Scale (HLS), which indicates the range potential of the missile to reach the current target. The target is assumed to be at the selected steerpoint. The SMS estimates both the aircraft maneuver zone (AMZ), and the missile maneuver zone (MMZ). The AMZ is the zone where the missile can reach the target if the launching aircraft lofts or turns towards the target first. The MMZ is the zone where the missile can reach the target by doing entirely its own maneuvering.

FOV box: Indicates the end-game field-of-view of the HARM. The FOV box flashes when the aircraft is within the missile maneuver zone, target handoff is completed, and the missile is ready to be fired.

HLS: The HARM launch scale (HLS) staple represents the combined AMZ and MMZ; in other words, the ranges at which the missile can reach the target with or without aircraft maneuvering. The horizontal dash within the staple indicates the top of the MMZ range and the bottom of the AMZ range. The bottom of the staple indicates minimum launch distance. The pickle button is only hot when the staple is within the MMZ.

The HLS and all associated symbology are inhibited in HAS mode.

Current range, required loft angle: The position of the caret along the staple represents the current aircraft range to target along the HLS range scale. If the caret is above the AMZ/MMZ separator, the aircraft must first maneuver before the missile can reach the target. The number adjacent to the caret is the required loft angle to place the aircraft within the MMZ. The loft angle is prefixed by an "A" when the aircraft is within the MMZ. The caret is inhibited when in PB mode and more than 10° off-bearing.

Upper range scale: Will be either 40 or 80 NM, whichever is sufficient to cover the distance to the target.

Zero range: The bottom end of the HLS is a target distance of zero.

Min loft, optimal loft, max loft: The horizontal ticks along the azimuth steering line (ASL) indicate the minimum and maximum loft required for the missile to reach the target. Maximum loft is the larger tick and represents the loft angle that will give the missile maximum range. Minimum loft is the smaller tick and represents the range where the missile would have to do a max-g pulldown to reach the target. In PB mode, optimal loft is also shown as a pair of whiskers along the ASL. Optimal loft represents the loft angle that gives the missile the maximum energy available at impact.

Loft cues are inhibited in HAS and POS/RUK modes.

Release altitude: The top number of this datablock is the predicted release altitude assuming the aircraft makes a 4-g loft to the optimal loft altitude (or the maximum loft altitude if not within the MMZ).

Required turn: The bottom number of this datablock is the required turn to place the aircraft within the MMZ (e.g., "L03" if a 3° left turn is required). Shows "00" if the aircraft is on-bearing but not yet within the MMZ range. Once the aircraft is within the MMZ, this field shows the aircraft required turn to face the target (e.g., "L90" if the aircraft nose is 90° right of the target).

This datablock is not displayed in HAS and POS/RUK modes.

Time to MMZ: Displays the estimated time until the aircraft reaches the MMZ. Displays "0:00" when the aircraft is inside the MMZ. Not displayed in HAS or POS/RUK modes.

Bearing and distance to target: The bearing and distance (in nautical miles) from the aircraft's present position to the target. Not displayed in HAS mode.

Employment using HARM-as-Sensor (HAS) Mode

Summary

1. Select A-G Master Mode **[2]**.
2. Set MASTER ARM switch to ARM.
3. Select AG88 on SMS page (OSB6).
4. Select HAS sub-mode on the WPN page (OSB1).
5. Make the WPN page SOI.
6. Select the desired threat table on the WPN page (OSB2).
7. Wait until your threat appears in the ALIC video display on the WPN page.
8. Move the TQS cursor over the threat and designate with TMS forward **[RCtrl]+[Up]**.
9. Fire the missile using the weapon release button **[RAlt]+[Space]**.

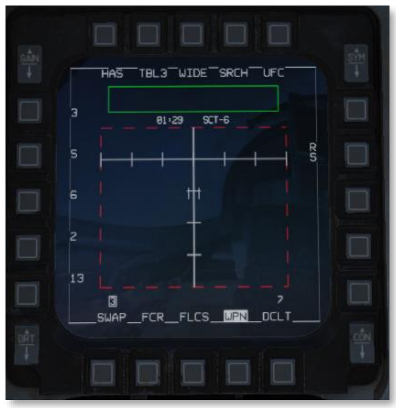
HARM-as-sensor (HAS) mode is a target-of-opportunity employment mode using the HARM's onboard radar receiver. The HARM detects air defense radar signals and transmits that information to the aircraft. The pilot can then select a radar to attack and launch a HARM against it. With this mode, distance to the target is not known, only bearing, so the HARM does not loft, which decreases its effective range.

In HAS mode, the HARM repeatedly scans for threats that match the current active threat table. The HARM begins with a full scan of its FOV, once for each of the selected threat types. If any targets are found, a detailed scan is performed to determine the target coordinates. The HARM then steps to the next threat type. In all, this results in a worst-case scan cycle time of 90 seconds.

The ALIC is in HAS mode when the master mode is A-G, AG88 is the selected weapon on the SMS page, and "HAS" is displayed as the active sub-mode on the WPN page.

1. **Select HAS mode and make WPN page SOI.**

   Press OSB 1 if necessary to change to HAS sub-mode. Ensure that the WPN page is SOI; if not, press DMS aft to change SOI to the WPN page.



2. **Select the appropriate threat table.**

   Press OSB 2 or TMS left until the desired threat table is selected.

3. **Reduce the scan time by selecting only the threats you wish to scan for (optional).**

   If you want to reduce scan time, press SRCH (OSB 4), then leave highlighted only the threats you are interested in searching for.

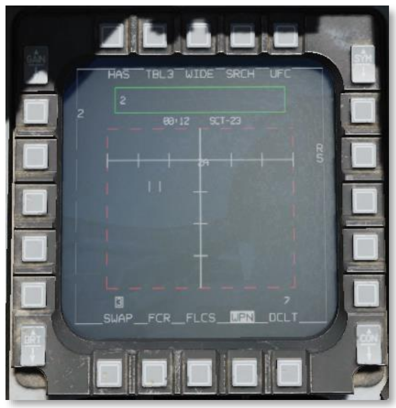
Press HAS (OSB 1) to return to the HAS page.

4. **Select an FOV (optional).**

   You can further reduce scan time by using the Expand/FOV button (or OSB 3) to cycle through FOV options until you find an appropriate FOV.

5. **Locate and designate your target.**

   Point your aircraft (and the missile seeker) in the direction of your expected threat. As each scan cycle completes, detected threats will be shown in the ALIC video area and placed into the DTSB.



Slew the cursor over the detected threat, then press TMS forward to designate it. The HAS display will change to indicate the designated threat.

Note that you can designate and fire against any threat that appears on the HAS display, but many radar operators will cycle their radars on and off or track different targets. This will result in the HARM being unable to continue tracking the target, and the missile will become ineffective.

To increase probability of kill, you may wish to wait until the threat radar is guiding a missile at you ("T" appears next to threat type on HAS display) before firing, since a radar operator is less likely to cease tracking you while guiding a missile. However, this strategy comes with its own obvious risks!

6. **Fire the missile.**

   Verify the proper threat is highlighted, "RDY" is displayed in the SMS and WPN pages, and the FOV box in the HUD is flashing, then press and hold the pickle button to fire the missile.

Employment using Position Known (POS) Mode

Summary

1. Select A-G Master Mode **[2]**.
2. Set MASTER ARM switch to ARM.
3. Select AG88 on SMS page (OSB6).
4. Select POS sub-mode on the WPN page (OSB1).
5. Select the attack profile on the WPN page (OSB3).
6. Select the desired threat table and threat on the WPN page (OSB2).
7. Select the target steerpoint.
8. Fly to the AMZ, follow the loft and turn cues, and wait until the FOV box on the HUD is flashing.
9. Fire the missile using the weapon release button **[RAlt]+[Space]**.

Position Known (POS) mode is a pre-planned employment mode that relies on a steerpoint being placed at or near the target radar. The radar type will be downloaded to the ALIC, and the HARM will fly towards the target steerpoint until the radar is detected, at which point it will home on the radar signal.

In POS mode, the pilot selects one of three attack profiles: Equations of Motion (EOM), Pre-Briefed (PB), or Range Unknown (RUK). Each of these profiles makes different assumptions about the aircraft maneuver zone (AMZ) and missile maneuver zone (MMZ). The AMZ is the zone where the missile can reach the target, assuming the aircraft maneuvers to a required bearing and loft angle first. The MMZ is the zone where the missile can reach the target without requiring the aircraft to turn or loft.

Equations of Motion (EOM) mode is the most effective profile for off-boresight launches but requires the most accurate target steerpoint data. To launch with EOM selected, the pilot must first fly to the AMZ, then loft and launch once within the MMZ. EOM is useful when attacking threats that require high-angle off-boresight (HOB) defensive tactics.

Pre-Briefed (PB) mode is the most effective profile at longer ranges but requires an on-bearing attack. To launch with PB selected, the pilot must first turn the aircraft to point at the target, then fly to the AMZ, then loft and launch once within the MMZ. PB is most effective at longer ranges but requires the aircraft to fly directly at the target.

Range Unknown (RUK) mode is the most versatile profile when working with degraded target data. To launch with RUK selected, the pilot must fly the aircraft into the MMZ, where the missile can make all required maneuvering to reach the target. RUK is much more tolerant of inaccurate target steerpoints, or when fighting threats where only bearing information is available.

1. **Select POS sub-mode on the WPN page.**

   Press OSB 1 if necessary to change to POS sub-mode. You will see the launch status divider line (LSDL) and next-launch information below the LSDL.

2. **Select the attack profile.**

   On the WPN page, press OSB 3 until the desired attack profile is shown.

3. **Select the threat table and threat.**

   On the WPN page. press OSB 2 until the desired threat table is shown, and then press the OSB adjacent to the threat you wish to attack from the list on the left side. This will hand off the threat to the ALIC.

4. **Select the target steerpoint.**

   Activate the steerpoint co-located with the threat you are attacking.

5. **Fly to the AMZ, follow the required turn and loft cues, and wait until the FOV box on the HUD is flashing.**

   The attack profile you will fly is dependent on whether you have selected EOM, PB, or RUK.

EOM Attacks

In EOM mode, you can launch from any relative bearing, as long as you follow the cues to the MMZ. First fly towards the target until the HLS range caret indicates that you are within the AMZ. If a required turn is indicated on the datablock below the HLS, turn as indicated until it reads “00”. (You do not necessarily need to be facing the target, as long as there is no required turn.) Then, pull up until the VVI is between the minimum and maximum loft cues on the ASL. When the FOV box is flashing, you can launch.

PB Attacks

In PB mode, you must be within 10° of bearing to the target. Once your aircraft is pointed towards the target, fly towards the target until within the AMZ. You will see the minimum, optimal, and maximum loft cues on the ASL. Pitch the aircraft to place the VVI between the minimum and maximum loft cues. When the FOV box is flashing, you can launch.

RUK Attacks

In RUK mode, you must fly the aircraft all the way to the MMZ. Follow the azimuth steering line (ASL) on the HUD towards the target until the FOV box on the HUD is flashing. Once it is flashing, you are within the MMZ and the weapon release button will be hot. For RUK attacks, the HARM will loft, but the loft angle will be limited to the maximum the missile can achieve while keeping the threat within its field of view.

Because range information is degraded or unavailable for RUK attacks, no time-until-intercept or time-to-impact data is shown on the WPN page, and loft information is suppressed on the HUD.

AGM-65 MAVERICK

The AGM-65 Maverick is an optically guided air-to-ground missile intended for the close air support (CAS) mission. It uses an onboard electro-optical (E/O) or infrared imager that tracks the target, giving it "fire and forget" capability. The pilot locks the target using the image from the onboard seeker head and fires the missile. The missile tracks to the target using the image from its seeker head.

The AGM-65 was developed by Hughes Missile Systems Division in 1966 and entered service in 1972.

Operation

The AGM-65 must be warmed up before it can be used. During the warm-up period, onboard image-stabilizing gyroscopes spin up to operating speed. The missile's video can be used before the gyroscopes have spun up, but the image will not be ground stabilized.

Missile video will become available on the WPN page once the gyroscopes are spun up. If you wish to shorten the warm-up period, pressing the Uncage button while the WPN page is SOI will activate missile video once the gyroscopes have reached 90% of operating speed.

The pilot can locate and designate targets using the fire control radar (FCR) or heads-up display (HUD), using the AGM-65's own seeker head, or the pilot can handoff targets designated from the Sniper Advanced Targeting Pod (TGP).

When handing off targets from the TGP, the missile boresight correlator (MBC) compares the image from the targeting pod with the image from the missile seeker head and slews the missile seeker head until the images match. The MBC is only active when in A/G mode with an AGM-65 selected, and the TGP is sensor of interest (SOI).

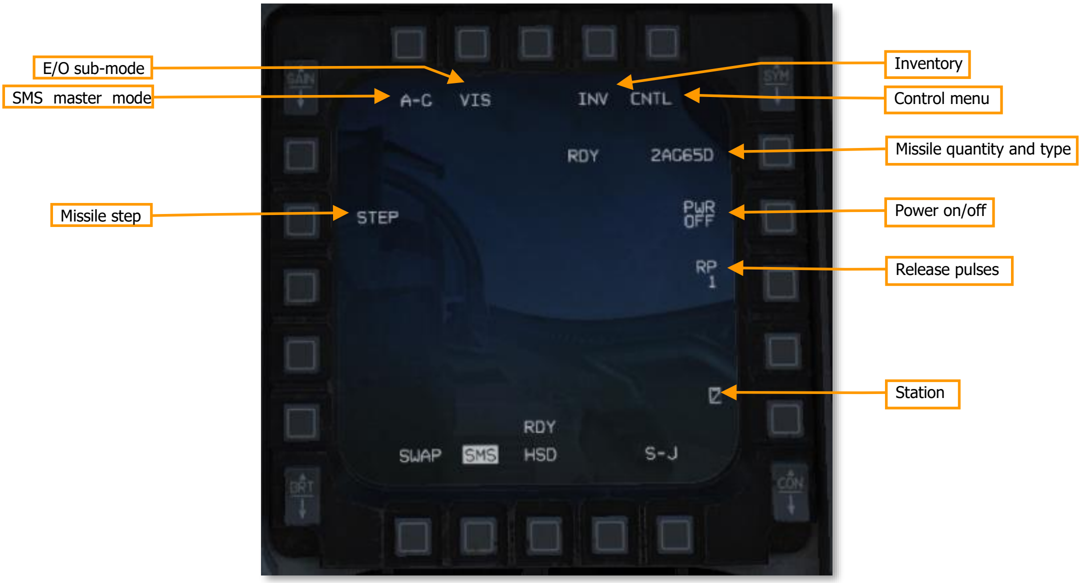
When the Maverick is fired, its onboard imager continues to track the target until the target grows to fill about 75% of the seeker head field of view (FOV). At this point, to continue to impact, the Maverick uses forced correlation.

The AGM-65 has a ground-configurable fuzing delay and a ground-selectable LAND/SHIP selector that changes the tracking algorithm to be more suitable for vehicles or ships.

Limitations

Standby time	1 hour
Video time	30 minutes
Seeker gimbal limits	
AGM-65D	±42° horizontally ±30-54° vertically

SMS Page



SMS master mode: Toggles between A-G and STRF (gun strafe) master modes.

E/O sub-mode: Cycles between PRE, VIS, or BORE E/O sub-modes. You can also toggle sub-modes using the cursor enable button quadrant system (TQS). (See Employment sections below for more.)

Inventory page: Press to show the Inventory page.

Control page: Press to show the Control page.

Missile quantity and type: Cycles between different types of loaded AGM-65s.

Auto power toggle: Toggles on or off the auto-power feature (see Automatic Power-On, below).

Release pulses: Controls the number of missiles released per press of the weapon release button. Only available for AGM-65D and -65G.

Stations: Shows the stations loaded with AGM-65s. The next station to fire is highlighted.

Missile step: Cycles the next station to fire between loaded stations.

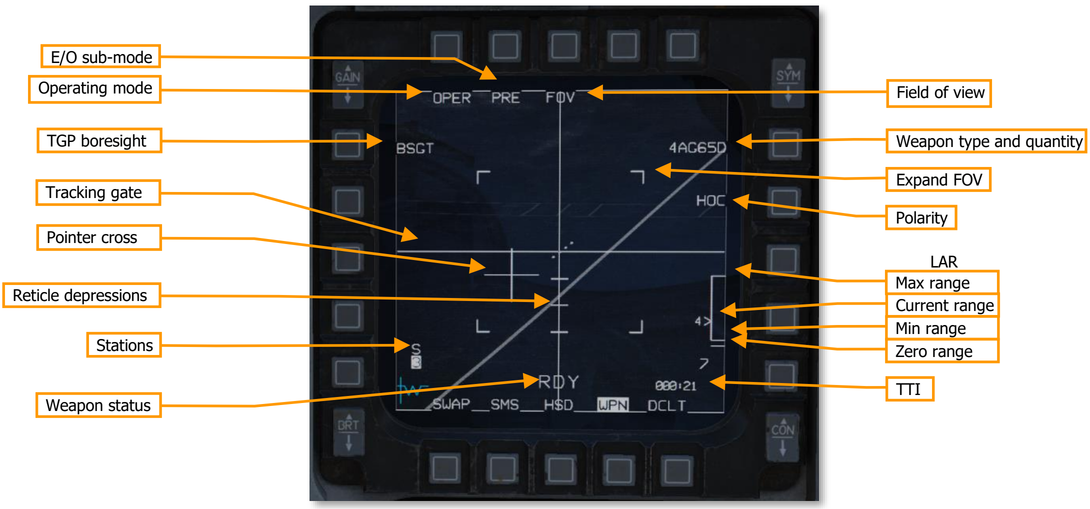
SMS Page, CNTL Sub-Page

Auto power toggle: Turns on or off the auto power-on feature.

Auto power steerpoint: Sets the steerpoint where the Maverick will automatically turn on.

Auto power direction: Sets the general direction the airplane must be going when it crosses that steerpoint to automatically power on the Mavericks. Cycles between north/east/south/west.

WPN Page



Operating mode: Cycles between STBY (standby) and OPER (operating) modes.

E/O sub-mode: Cycles between PRE, VIS, or BORE E/O sub-modes. You can also toggle sub-modes using the Cursor Enable button on the TQS. (See Employment sections below for more information.)

TGP boresight: Press to mark this Maverick station as boresighted to the targeting pod. This should be done after confirming that the targeting pod and Maverick seeker head are pointing at the same target. (See Missile Boresighting for more information.)

Tracking gate: Indicates the missile track target. The crosshairs will expand to indicate the boundaries of the target being tracked.

Pointer cross: Indicates the seeker head direction relative to boresight (center of the screen). The AGM-65D seeker head is capable of ±42° horizontally, and +30–54° vertically.

The pointer cross will flash when any of the following launch criteria are not met:

- Seeker head must be within 10° horizontally and vertically of boresight.
- Target image must be large enough to maintain continuous track.

Reticle depressions: Indicates 5°, 10°, and 15° of reticle depression.

Stations: Shows the stations loaded with AGM-65s. The next station to fire is highlighted. Above the station number will be a character indicating the status of the MBC:

- S: Slave (MBC has not been commanded to slew missile)
- 1: Slew 1 (MBC is slewing to match missile LOS to TGP LOS)
- 2: Slew 2 (MBC is slewing to match missile video to TGP video)
- T: Track (MBC has commanded missile to track)
- C: Complete (MBC has finished correlating)
- I: Impossible (MBC was unable to complete handoff)

Weapon status: One of the following:

- REL: Release signal being transmitted to weapon.
- RDY: Weapon is armed and ready for release.
- MAL: Weapon cannot be released due to malfunction.
- SIM: Weapon is unarmed and will not be released, but release symbology is being displayed.
- (blank): MASTER ARM is in OFF position.

Field of view: Toggles between wide and narrow FOV. You can also toggle FOV using the Expand/FOV button on the Side Stick Controller (SSC) when the WPN format is SOI, or using the Un-cage function on the MANRNG/UNCAGE knob regardless of SOI.

Weapon type: Cycles between the different types of loaded AGM-65s. Shows the quantity and type of AGM-65 loaded and active.

Expand FOV: Outlines the boundaries of the expanded field of view.

Polarity: Toggles between hot-on-cold (HOC) and cold-on-hot (COH) polarity. You can also press TMS right to toggle between polarities. The AGM-65G and -H additionally have an AREA mode for forced correlation mode (see Force Correlate, below).

LAR: The launch acceptable region for the next missile, showing the acceptable launch range and current range adjacent to the caret. Accurate range data is only available if the SPI is in proximity to the missile LOS.

Time to impact (TTI): The time until the next missile impacts its target, if launched now.

Preparation

The AGM-65 has a duty cycle of one hour in standby, and 30 minutes when active. After powering the AGM-65s, the missiles will begin their 3-minute warm-up period. Once three minutes has passed, the missiles are in standby mode and ready for employment. In standby mode, the missiles have one hour of available duty time. Once a missile's video is activated, it has 30 minutes of available duty time. When a missile's duty time has expired, it must be powered off for two hours.

Automatic Power-On

The SMS can be configured to automatically power on the Mavericks when crossing a configured steerpoint, so that the pilot does not need to remember to power them on at least three minutes prior to employment.

Summary

1. On the SMS format, select Mavericks.
2. Display the Control page.
3. Choose the steerpoint.
4. Choose the direction and enable auto power-on.

1. On the SMS format, select Mavericks.

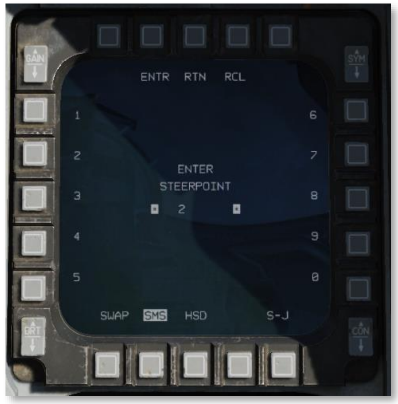
On the SMS format, press OSB 6 until AG65 is shown as the active weapon.

2. **Display the Control page.**

   Press the CNTL (OSB 5) to display the Control page.

3. **Choose the steerpoint.**

   Press OSB 19, labeled STPT *X*.



Using the OSBs, enter the steerpoint number, then press the OSB labeled ENTR. The Mavericks will be powered on upon crossing this steerpoint. You can press RCL to undo an errant digit, or RTN to return to the Control page without changing the steerpoint number.

4. **Choose the direction and enable auto power-on.**

   Press OSB 20 (NORTH OF) to cycle between different direction options. The Maverick will not be powered on until the aircraft crosses the configured steerpoint traveling in generally this direction.

   Press AUTO PWR (OSB 7) to turn on the automatic power-on feature.

You can leave the Control page by pressing the CNTL (OSB 5) again.

Missile Boresighting

Missile boresighting should be done prior to employing Mavericks using TGP handoff. It can be done either on the ground or in the air while enroute.

Summary

1. Power on the Mavericks and TGP.
2. Set GND JETT switch to ENABLE, MASTER ARM switch to MASTER ARM or SIMULATE, A-G master mode [2], and TGP to A-G mode.
3. On the SMS format, select AG65 and set E/O sub-mode to PRE or VIS.
4. On the TGP format, slew the seeker head to the boresight target.
5. On the WPN format, slew the seeker head to the same target and designate.
6. Press the BSGT button (OSB 20).
7. Repeat steps 4–6 for each station.
8. Power off the Mavericks and reset all switches.

1. Power on the Mavericks and TGP.

Place the TGP format on one MFD, and the SMS format on another.

If the Mavericks are not already powered on: On the SMS format, press the PWR OFF (OSB 7) to power on the Mavericks.

If the TGP is not already powered on: Set the RIGHT HDPT power switch to on, on the SENSOR panel.

2. Set GND JETT ENABLE ON, MASTER ARM SIM, A-G master mode, and A/G TGP mode.

If on the ground, set GND JETT ENABLE to ON. Press the A-G button on the ICP to switch to air-to-ground master mode. Set the MASTER ARM switch to SIM.

If the TGP is not already in air-to-ground mode, then on the TGP format, press the OSB labeled STBY, then the OSB labeled A-G to put the targeting pod in A/G mode.

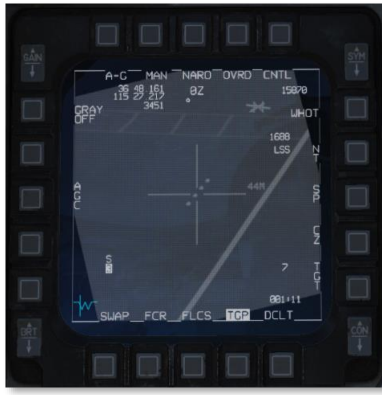
3. On the SMS format, select AG65 and set E/O sub-mode to PRE or VIS.

On the SMS format, press OSB 2 until PRE or VIS is shown as the Maverick sub-mode. (You can also use the cursor enable button on the TQS to cycle between delivery modes.) Use PRE if your boresight target is co-located with a steerpoint; use VIS if you are visually locating your boresight target. Confirm that AGM-65 PRE or VIS symbology is shown on the HUD. Choosing a target further away will reduce parallax errors.

Change the MFD displaying the SMS format to the WPN format. On the WPN format, verify that NOT TIMED OUT is no longer displayed, indicating the missiles have completed their three-minute warm-up. The WPN page should begin displaying video from the missile seeker head.

4. **On the TGP format, slew the seeker head to the boresight target.**

   Use DMS aft to move SOI to the TGP. Using the TQS cursor, slew the TGP pointing cross over the boresight target.



5. **On the WPN format, slew the seeker head to the same target and designate.**

   Press DMS aft until SOI moves to the WPN format. Use the TQS cursor to slew the Maverick tracking gate over that same boresight target, then press TMS forward to designate. Verify that the tracking gate closes, and the correct target is being tracked.

6. **Press the BSGT button (OSB 20).**

   Press OSB 20, labeled BSGT, to boresight the missiles.

   Press TMS aft to break missile track, then verify the missile LOS follows the TGP LOS.

7. **Repeat steps 4–6 for each station.**

   Press the Missile Step button to move to the next pylon. Repeat this procedure for each pylon loaded with AGM-65s.

8. **Power off the Mavericks and reset all switches.**

When you are finished boresighting your missiles, go back to the SMS format and press the OSB labeled PWR ON. This will prevent your Mavericks from running through their duty time before you enter the combat area.

Be sure to reset the positions of the MASTER ARM and GND JETT ENABLE switches, as well as the master mode.

Employment using PRE mode

The PRE (pre-planned) delivery mode allows you to lock targets in the vicinity of a sensor point of interest (SPI), such as a steerpoint. PRE uses CCRP-style HUD symbology, and the Maverick seeker head will be slaved to the SPI.

Summary

1. On the WPN format, set E/O sub-mode to PRE. Make sure WPN page is SOI.
2. Slew the tracking gate over the target and designate **[RCtrl]+[Up]**.
3. Fire the missile **[RAlt]+[Space]**.

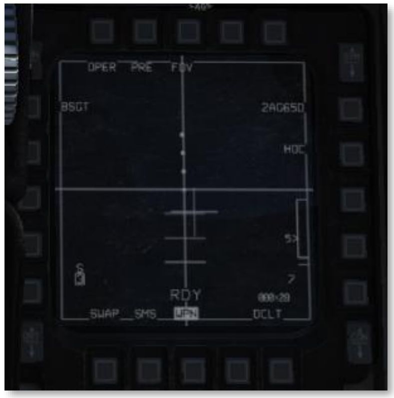
1. On the WPN format, set E/O sub-mode to PRE. Make sure WPN page is SOI.

On the WPN format, set the delivery mode to PRE using Cursor Enable or OSB 2. The Maverick seeker head will be slaved to the SPI (typically the selected steerpoint). Confirm that seeker head video is available.

Press DMS aft until the WPN page is SOI.

2. Slew the tracking gate over the target and designate.

Use the TQS cursor to slew the tracking gate over the target, then press TMS forward to designate. The tracking gate will close on the target. Confirm that the missile is tracking the correct target, the pointer cross is not flashing, and that the target is in range.



3. **Fire the missile.**

   Fire the missile with the weapon release button.

Employment using VIS mode

The VIS (visual) delivery mode allows you to lock targets that you can see in front of you, by using the HUD to slew a TD box onto the target. VIS uses DTOS-style sighting. VIS mode is unavailable if the Mavericks are loaded onto an LAU-88/A rack.

Summary

1. On the WPN format, set E/O sub-mode to PRE.
2. On the HUD, slew the TD box over the target and designate **[RCtrl]+[Up]**.
3. On the WPN format, slew the tracking gate over the target and designate **[RCtrl]+[Up]**.
4. Fire the missile **[RAlt]+[Space]**.

1. **On the WPN format, set E/O sub-mode to PRE.**

   On the WPN format, set the delivery mode to VIS using cursor enable or OSB 2. SOI will move to the HUD, and a TD box will appear, initially caged to the flight path marker (FPM). Confirm that seeker head video is available on the WPN page.

2. **On the HUD, slew the TD box over the target and designate.**

   Uncage the TD box and slew it over the target using the TQS cursor.

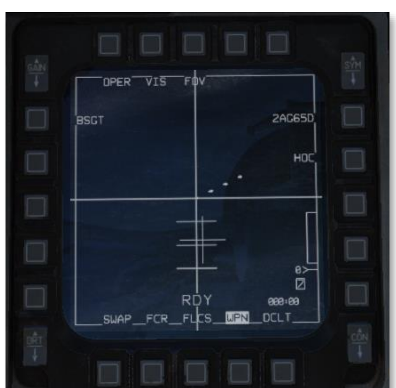
   Press TMS forward to designate the target in the TD box. The TD box will ground-stabilize and SOI will move to the WPN format.

   If the wrong target is designated, reject the designation by setting HUD as SOI using DMS forward, and then undesignate with TMS aft.

3. **On the WPN format, slew the tracking gate over the target and designate.**

   Use TMS left or OSB 7 to change video polarity, if desired.

   Use the TQS cursor to place the target within the crosshairs on the WPN format, then press TMS forward to designate the target. The crosshairs will close on the target. Confirm that the missile is tracking the correct target, the pointer cross is not flashing, and that the target is in range.



4. **Fire the missile.**

Fire the missile with the weapon release button.

Employment using BORE mode

BORE (boresight) delivery mode is intended for quick reactive or target-of-opportunity shots. Missiles can be launched against any target in BORE mode without having to change the SPI. In BORE mode, the Maverick seeker head is slaved to the pointer cross on the HUD.

Summary

1. On the WPN format, set E/O sub-mode to BORE.
2. On the HUD, fly the boresight cross over the target and designate **[RCtrl]+[Up]**.
3. Fire the missile **[RAlt]+[Space]**.

1. **On the WPN format, set E/O sub-mode to BORE.**

On the WPN format, set the delivery mode to BORE using cursor enable or OSB 2. SOI will move to the WPN format. Confirm that seeker head video is available. SOI will move to the WPN page and missile seeker head position will be displayed on the HUD as a cross. Seeker head position will initially be boresight.

2. **On the HUD, fly the boresight cross over the target and designate.**

Fly the pointer cross near your target, then use the TQS cursor to slew the pointer cross over the target. Reference both the HUD and the WPN format to correctly place the pointer cross, then press TMS forward to designate.

Confirm that the missile is tracking the correct target, the pointer cross is not flashing, and that the target is in range.

3. Fire the missile.

Fire the missile with the weapon release button.

Employment using TGP handoff

The TGP can hand-off targets to the MBC, which will correlate the seeker head video with the TGP video and attempt to automatically track the TGP target. To improve the likelihood of a successful handoff, perform the steps listed in Missile Boresighting, above, prior to entering the target area.

You should have the TGP format active on one MFD and the WPN format active on the other.

Summary

1. On the WPN format, set the delivery mode to PRE or VIS using cursor enable **[Enter]** or OSB2. Confirm that seeker head video is available.
2. Using the DMS, move SOI to the TGP format **[RAlt]+[.]**.
3. Using the RDR CURSOR/ENABLE switch, slew to the target. For a moving target, use TMS forward **[RCtrl]+[Up]** to switch to POINT track. (See Litening II Targeting Pod for more information.)

While the TGP is slewed, the MBC will command the seeker head to match slew and automatically attempt a track. During the attempt, HANDOFF IN PROGRESS will be displayed on the WPN format. The amount of time to complete correlation is reduced if the missile boresight procedure was completed prior to weapon employment.

If handoff succeeds, a "C" (correlated) will be displayed over the active pylon number. There is no need to switch SOI away from the TGP format. Confirm that the missile is tracking the correct target, the pointer cross is not flashing, and that the target is in range, then press the weapon release button to fire.

If the handoff cannot succeed, "I" (impossible) is displayed above the pylon number instead.

Ripple Fire

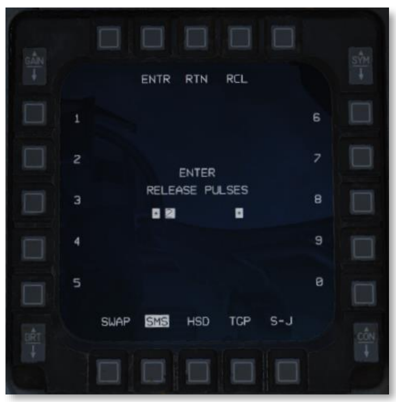
Up to two Mavericks can be queued with separate targets for a ripple fire (a.k.a. "quick-draw") attack. When more than one Maverick is tracking a target, two 10-mr LOS circles will appear on the HUD, labeled "1" and "2". The AGM-65s must be loaded on LAU-117 pylons for ripple fire to be available.

Summary

1. On the SMS format, set RP to 2 (optional).
2. Using one of the delivery modes above, designate a target for the first Maverick **[RCtrl]+[Up]**.
3. Press the Missile Step button **[S]** to step to the next missile.
4. Designate a target **[RCtrl]+[Up]** for the second Maverick.
5. Fire both missiles.

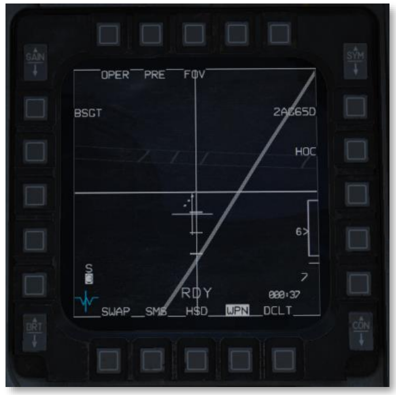
1. On the SMS format, set RP to 2 (optional).

Optionally, set the release pulses to two. To do this, from the SMS page, press OSB 8 (labeled RP). Use the MFD to set the releases pulses to 2, then press ENTR (OSB 2).



2. Using one of the delivery modes above, designate a target for the first Maverick.

Using one of the delivery modes above, locate and designate a target for the first Maverick. Confirm that the missile is tracking the correct target. Do not fire the missile.

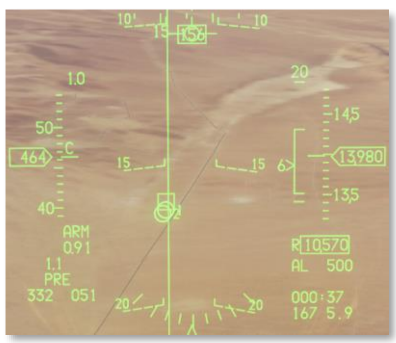


3. **Step to the next missile.**

   Press the Missile Step button to step to the next missile.

4. **Designate a target for the second Maverick.**

   Using the same procedure, locate and designate a target for the second missile. Confirm that the missile is tracking the correct target, the pointer cross is not flashing, and that the target is in range. On the HUD, LOS circles labeled "1" and "2" will indicate missile LOS and the order the missiles will fire in.



5. **Fire both missiles.**

   If you set releases pulses to two, press and hold the weapon release button until both missiles have come off the rail. If not, press and hold the weapon release button once for each missile (twice total).

Force Correlate

The AGM-65G and -H models can be launched in force-correlate mode. This mode does not use the normal centroid tracking algorithm suitable for targeting vehicles, instead using an image-correlation algorithm suitable for tracking elements within a picture. Force-correlate mode is useful when launching Mavericks against static targets such as buildings and structures, when it is desired that the Maverick impact a specific part of that structure. Instead of tracking the target centroid, the Maverick will strive to impact the exact part of the image that was targeted (e.g., the base of an antenna).

Summary

1. Using one of the delivery modes above, locate a target.
2. Set the polarity mode to AREA.
3. Designate the image feature you wish to target **[RCtrl]+[Up]**.
4. Fire the missile. **[RAlt]+[Space]**

1. **Using one of the delivery modes above, locate a target.**

   Select either PRE, VIS, or BORE mode and locate your target.

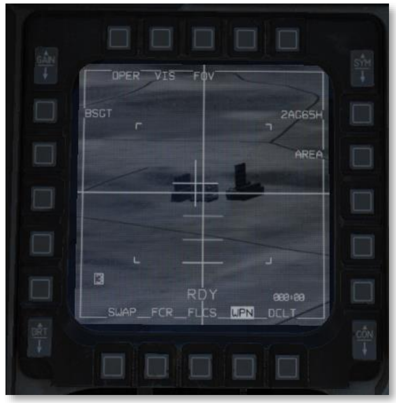
2. **Set the polarity mode to AREA.**

   Press OSB 6, use the cursor enable button, or (if the WPN page is SOI) press TMS right to cycle between polarity modes until AREA is shown next to OSB 6.

3. **Designate the image feature you wish to target.**

   Press DMS aft until the WPN page is SOI.

   Using the TQS cursor, slew the targeting gate to the image feature you wish to target, then press TMS forward to designate it. Confirm that the missile is tracking the correct portion of the image, the pointer cross is not flashing, and the target is in range.



4. **Fire the missile.**

   Fire the missile with the weapon release button.

DEFENSIVE SYSTEMS

USAF Photo
by MSgt Cecilio Ricardo

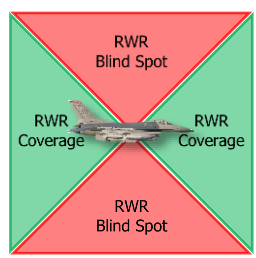
RADAR WARNING RECEIVER

The F-16C is equipped with the AN/ALR-56M Advanced Radar Warning Receiver system. The ALR-56M includes a series of passive radar receiver antennas mounted to the exterior of the airframe, internal signal processors, a threat warning azimuth indicator, and associated cockpit control panels.

AN/ALR-56M Advanced RWR Antenna Locations

When radar signals are detected by the external receiver antennas, the signal characteristics are analyzed and processed by the ALR-56M electronics to determine the specific type of radar that has been detected, what mode the radar is currently operating within, and its relative bearing from the aircraft. When these characteristics have been processed, a corresponding symbol is displayed on the Threat Warning Azimuth Indicator and corresponding audio feedback is provided to the pilot's helmet.

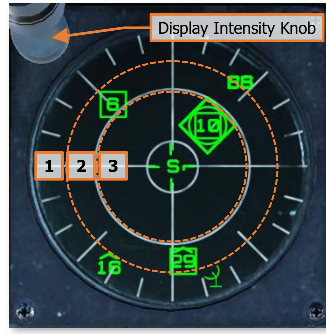
Antenna coverage of the ALR-56M is 360° in azimuth but only ±45° in elevation. As a result, the F-16C cannot detect radar signals that are directly above or below the fuselage centerline. This should be considered when performing defensive maneuvers at high pitch or roll angles, which could result in placing hostile radars in an RWR blind spot. When this occurs, radar lock and missile launch warnings will be lost.



When employing the CMDS in Semi-automatic or Automatic modes, this will also cause the ECM pod to cease emitting, which may increase the aircraft's vulnerability to attack for the duration the hostile radar signals are within the RWR blind spot.

It is important to note that the RWR does not indicate when a threat radar can see your aircraft, nor does it indicate whether a threat radar is actually tracking your aircraft. The RWR only detects the presence of radar signals and the operating mode of the radar based on those signals. It is possible that the radar may not be tracking your aircraft specifically but is locked on to another aircraft along the same bearing as your aircraft. Prudence should be taken when analyzing the information the RWR is providing, and weighing that with the other sensors on board your aircraft to produce an accurate assessment of the tactical situation.

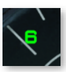
Threat Warning Azimuth Indicator



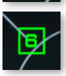
The Threat Warning Azimuth Indicator is a circular-shaped display mounted in the upper left portion of the Instrument Panel. The Azimuth Indicator is a plan-form layout with the center of the display representing the aircraft, and threat symbols displayed 360° in azimuth around it. The Azimuth Indicator includes a display intensity knob on the top left corner of the panel that can be used to brighten or dim the display itself.

If a threat symbol is displayed at the top of the display, the associated radar is directly in front of the aircraft. If the threat symbol is displayed at the bottom of the display, the associated radar is directly behind the aircraft.

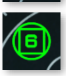
The distance from the center of the display at which the threat symbols are positioned correspond to the relative lethality of the threat radar. Radar symbols that represent more lethal threats to the aircraft are shown closer to the center of the display, within one of three concentric bands. As a threat radar progresses from a search/acquisition mode, to target tracking, and then to missile guidance, the symbol will be incrementally moved toward the center of the display to symbolize its increasing lethality against the aircraft.



Radar Threat in Search/Acquisition mode. The detected radar is operating in a search or target acquisition mode, with the symbol positioned along the outside of the display.

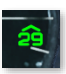


Radar Threat in Tracking mode. The detected radar is operating in a target tracking mode, with the symbol positioned just outside the solid white circle and enhanced by a box.



Radar Threat in Missile Guidance mode. The detected radar is operating in a missile guidance mode, with the symbol positioned inside the solid white circle and further enhanced by a flashing circle.

Some symbols may be enhanced with additional symbology as shown below:



Air-to-Air Radar Threat. Detected radars that correspond with airborne platforms, such as a fighter or other aircraft, are enhanced with a chevron over the symbol.

Highest Priority Radar Threat. The radar threat that is determined to be the highest priority threat is enhanced by a diamond. The highest priority threat is continuously evaluated, which may cause the diamond to be reassigned to a different threat symbol at any given time based on detected radar activity and relative lethality.

When performing defensive maneuvers, the symbols that are closer to the center of the display (especially those with missiles inbound toward the aircraft) should take priority consideration over those along the outer area.

A complete list of all RWR symbols and their corresponding threat systems can be found in Appendix B.

Any time a new threat symbol is displayed on the Azimuth Indicator, an audio tone will be played over the THREAT audio channel, which can be adjusted on the AUDIO 1 control panel. Additional, distinctive audio tones are played to indicate to the pilot when a radar has been detected that is in track or missile guidance modes.

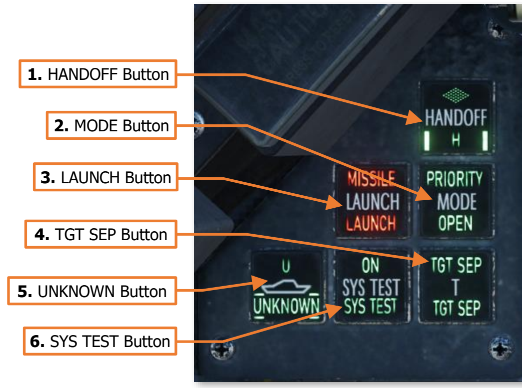
Several sub-modes are available on the THREAT WARNING AUX control panel which alter the presentation of threat symbols on the Azimuth Indicator. When these sub-modes are enabled, a letter symbol is displayed in the center of the display. If both are enabled, the display will alternate, or "mipple", between the two letters.

Search Mode. Threat radars that do not pose a direct threat are displayed, such as early warning or surveillance radars that cannot perform target tracking or missile guidance.

Low Altitude Mode. Short-range, low-altitude air defense systems and fighter aircraft are prioritized as higher threats over long-range, high-altitude air defense systems.

Threat Warning Prime Control Panel

The Threat Warning Prime control panel is mounted to the left of the Azimuth Indicator and includes several buttons for controlling the Azimuth Indicator display as well as several indicator lights.



1. **HANDOFF Button.** Not implemented.
2. **MODE Button.** Toggles the Azimuth Display between OPEN and PRIORITY modes.
   - **OPEN.** "OPEN" is displayed on the lower portion of the button and the 16 highest priority radar threats are displayed on the Threat Warning Azimuth Indicator.
   - **PRIORITY.** "PRIORITY" is displayed on the upper portion of the button and the 5 highest priority radar threats are displayed on the Threat Warning Azimuth Indicator.
3. **LAUNCH Button.** When a threat radar is detected to be in missile guidance mode, "MISSILE LAUNCH" flashes on the button.
4. **TGT SEP Button.** When pressed, "TGT SEP" is illuminated in the upper portion of the button and any threat symbols that are overlaid on top of each other are separated radially outward to aid in reading their symbol labels. Target separation is enabled for 5 seconds following the press of the TGT SEP button, after which all threat symbols will return to their original positions on the Azimuth Indicator.
5. **UNKNOWN Button.** Enables/disables the ALR-56M UNKNOWN mode. When enabled, "U" is illuminated in the upper portion of the button and any radars that cannot be identified by the ALR-56M will be displayed on the Azimuth Indicator with a "U" symbol. When disabled, any such radar signals that are detected by the ALR-56M are not displayed on the Azimuth Indicator, but the "U" in the upper portion of the button will flash to indicate the presence of unknown radar signals.
6. **SYS TEST Button.** When pressed, "SYS TEST" is illuminated in the upper portion of the button while a system self-test is performed. The Azimuth Indicator will display a series of diagnostic status messages and a series of audio alert tones will be heard. When the self-test is complete, "SYS TEST" in the upper portion of the button will extinguish.

   NOTE: The self-test may be manually aborted by pressing the SYS TEST button a second time.

Threat Warning Auxiliary Control Panel

The THREAT WARNING AUX control panel is mounted to the left of the CMDS control panel on the Left Auxiliary Console. The panel includes buttons for powering and controlling the operation of the ALR-56M.

1. **SEARCH Button.** Enables/disables the ALR-56M SEARCH mode. When enabled, "S" is illuminated in the upper portion of the button and any radar signals that are determined to be early warning, surveillance, or non-lethal target acquisition radars by the ALR-56M will be displayed on the Azimuth Indicator. When disabled, any such radar signals that are detected by the ALR-56M are not displayed on the Azimuth Indicator, but the "S" in the upper portion of the button will flash to indicate the presence of such radar signals.

2. **ACT/PWR Button.** When the ALR-56M is powered, "POWER" will illuminate in the lower portion of the button. If the ALR-56M detects any radar signals operating in a target tracking or missile guidance mode, "ACTIVITY" will illuminate in the upper portion of the button.

3. **ALTITUDE Button.** Toggles the ALR-56M between High Altitude and Low Altitude modes.

    - **High Altitude Mode.** "ALT" is illuminated on the lower portion of the button. Long-range, high-altitude air defense systems and fighter aircraft are prioritized as higher threats over short-range, low-altitude air defense systems. This mode may be appropriate for fighter sweeps, CAP patrols, or precision air strikes that are normally performed at high altitudes.

    - **Low Altitude Mode.** "LOW" is illuminated in the upper portion of the button in addition to "ALT". Short-range, low-altitude air defense systems and fighter aircraft are prioritized as higher threats over long-range, high-altitude air defense systems. This mode may be appropriate for low-level strikes, interdiction, or close air support operations that are normally performed at low altitudes.

4. **POWER Button.** Enables/disables power to the ALR-56M radar warning receiver. When the ALR-56M is powered, "SYSTEM POWER" will illuminate on the button.

5. **DIM knob.** Rotating the knob clockwise increases the brightness intensity of the indicator lights on the panel as well as those on the Threat Warning Prime control panel.

COUNTERMEASURES DISPENSING SET

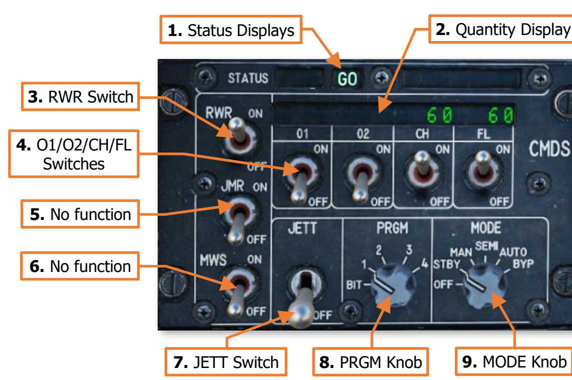
The F-16C is equipped with the AN/ALE-47 Airborne Countermeasures Dispensing Set (CMDS) for protection against radar-guided and infrared-guided threats. The ALE-47 includes four expendable countermeasure dispensers mounted to the exterior of the airframe, internal processors, and a control panel within the cockpit. The cockpit-mounted CMDS control panel allows the pilot to review expendable countermeasure quantities, configure CMDS modes of operation, and manage individual countermeasure programs.

AN/ALE-47 Airborne Countermeasures Dispenser Locations

The main interfaces with the CMDS are through the CMDS Control Panel and the CMDS DED page. The primary controls for countermeasure employment are on the Side Stick Controller (SSC).

CMDS Control Panel

The CMDS control panel is located on the Left Auxiliary Console and powers the ALE-47 countermeasure dispensers and configures the CMDS Manual programs and modes of operation.



1. **Status Displays.** Indicates status of the countermeasures dispensing set.
   - **NO GO.** The CMDS is powered but has malfunctioned and cannot dispense countermeasures.
   - **GO.** The CMDS is powered and ready to dispense countermeasures.
   - **DISPENSE RDY.** The CMDS is ready to dispense countermeasures in reaction to a threat but requires consent from the pilot when CMDS MODE is set to SEMI. This will be accompanied by a "COUNTER" voice message (if enabled on the CMDS DED page).

2. **Quantity Display.** Displays the remaining quantity of each countermeasure type on board the aircraft. System failure messages are also displayed in these display fields when applicable. "LO" is displayed when the countermeasure quantity is at or below the BINGO quantity as set on the CMDS DED page. This will be accompanied by a "LOW" voice message (if enabled on the CMDS DED page).
3. **RWR Switch.** Enables the CMDS to use threat indications detected by the ALR-56M Radar Warning Receiver to determine appropriate countermeasure programs when CMDS MODE is set to SEMI or AUTO.
4. **O1/O2/CH/FL Switches.** Enables the dispensing of the respective countermeasure type: O1/Other 1, O2/Other 2, CH/Chaff and FL/Flares. Placing these switches to ON will enable the corresponding countermeasure type's quantity to be displayed on the Quantity Display above the respective switch.
5. **JMR Switch.** No function.
6. **MWS Switch.** No function.
7. **JETT Switch.** Jettisons all expendable countermeasures on board the aircraft. This switch remains functional regardless of the CMDS MODE knob position.
8. **PRGM Knob.** Selects the CMDS program to be manually dispensed using CMS Forward on the SSC when the CMDS Mode is in Manual, Semi-automatic, or Automatic.
    - **BIT.** Initiates a BIT of the CMDS. (N/I)
    - **1.** Selects Manual Program 1.
    - **2.** Selects Manual Program 2.
    - **3.** Selects Manual Program 3.
    - **4.** Selects Manual Program 4.
9. **MODE Knob.** Selects the operating mode of the CMDS.
    - **OFF.** The CMDS is not powered and dispensing is not possible, except for jettison using the JETT switch. ECM pod emissions are disabled.
    - **STBY.** The CMDS is powered but dispensing is not enabled, except for jettison using the JETT switch. Changes to the CMDS settings and programs may be made using the CMDS DED page while in this mode. ECM pod emissions are disabled.
    - **MAN.** The CMDS is powered and Manual programs may be dispensed. Manual ECM pod emissions are enabled and disabled manually by the pilot.
        - CMS Aft will activate ECM pod noise jamming signals if ECM XMIT switch is in position 3.
        - CMS Right will deactivate ECM pod noise jamming signals.
        - Manual Programs 1-4 may be dispensed based on the position of the PRGM knob.
        - Manual Programs 5 and 6 may be dispensed.
    - **SEMI.** The CMDS is powered and determines the appropriate Automatic program to be dispensed based on the threat; and will dispense a single Automatic program if consent is provided by the pilot. Manual programs may still be dispensed. ECM pod emissions require pilot consent but will only occur when the aircraft is actively being engaged by a hostile radar threat.
        - CMDS selects the appropriate Automatic Program against the current radar threat. The pilot is prompted by DISPENSE RDY Status Display on the CMDS panel and a "COUNTER" voice message to provide consent to dispense a single Automatic program, or dispense a Manual program.

  - Once an Automatic or Manual program has completed, the pilot will be prompted again to provide consent to dispense a single Automatic program, or dispense a Manual program.
  - CMS Aft will dispense a single Automatic Program and will enable the ECM pod to emit deception jamming signals any time the aircraft is locked by a hostile radar threat if ECM XMIT switch is in position 1 or 2.
  - The Automatic program will not be dispensed if the chaff is in LO status. Manual dispensing can still be performed.
  - CMS Right will disable the ECM pod from emitting.
  - Manual Programs 1-4 may be dispensed based on the position of the PRGM knob.
  - Manual Programs 5 and 6 may be dispensed.
- **AUTO.** The CMDS is powered and determines the appropriate Automatic program to be dispensed based on the threat; and will repetitively dispense the selected Automatic program if consent is provided by the pilot. Manual programs may still be dispensed. ECM pod emissions *do not* require pilot consent and will occur any time the aircraft is actively being engaged by a hostile radar threat. Manual programs may still be dispensed.
  - CMDS selects the appropriate Automatic Program against the current radar threat. If consent has already been given to dispense Automatic programs, the selected Automatic program will be repetitively dispensed any time the aircraft is locked by a hostile radar threat, until the aircraft is no longer locked by a hostile radar threat or the chaff reaches the BINGO quantity entered via the CMDS DED page.
  - CMS Right will revoke consent for dispensing Automatic programs and will interrupt any Automatic or Manual programs that are currently in progress.
  - If ECM power switch is set to OPR, the ECM pod will override XMIT switch position and emit deception jamming signals until the aircraft is no longer being locked by a hostile radar threat. The ECM will operate in ECM Priority mode, unless the current weapon profile is AIM-120, in which case the ECM pod will operate in Avionics Priority mode.
  - The Automatic program will not be dispensed if the chaff is in LO status. Manual dispensing can still be performed.
  - Manual Programs 1-4 may be dispensed based on the position of the PRGM knob.
  - Manual Programs 5 and 6 may be dispensed.
- **BYP.** Bypass mode can be used if the other modes have malfunctioned or failed in any way. Manually dispenses one chaff cartridge and one flare cartridge when CMS Forward is pressed. Manual Programs 1 through 6 will be unavailable, as well as any other CMS functions. If the ECM pod is currently emitting in deception jamming mode, it will continue to emit until the current threat is no longer present, after which it will be placed in a standby state.

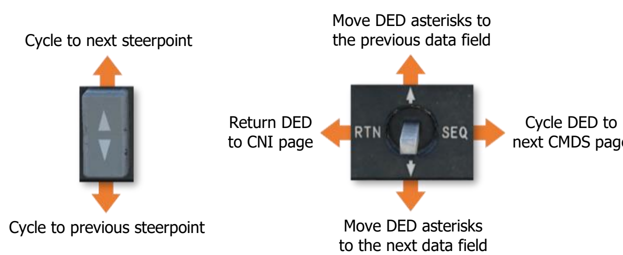
CMDS DED Settings

Prior to making any changes to the CMDS settings, the CMDS MODE knob should be set to the STBY position on the CMDS control panel. Failing to perform this step may result in erroneous data entry into the CMDS settings. The CMDS DED page may then be accessed to modify CMDS settings and Manual programs.

CMDS BINGO Page

The Countermeasures Dispensing Set DED page is accessed by pressing **7/MARK** button on the ICP keypad when the LIST DED page is displayed on the DED. This page is used to modify the CMDS Manual programs 1 through 6, adjust the expendable countermeasure "BINGO" quantities, and toggle individual CMDS voice message alerts.

The first CMDS DED page displayed is the CMDS Bingo page, which allows the pilot to edit the "BINGO" quantity values for each expendable countermeasure type and toggle voice message alerts regarding countermeasure dispensing.

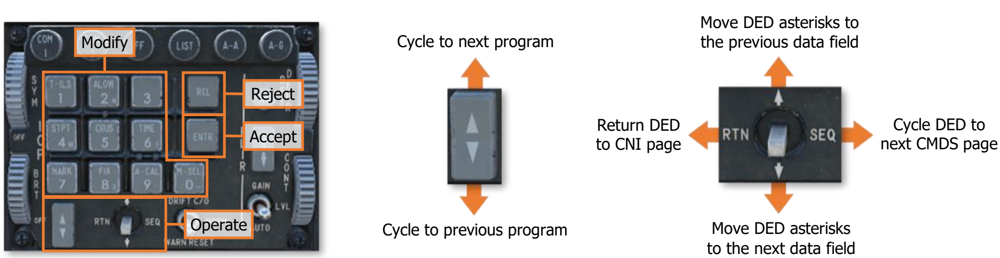


1. **DED Asterisks.** If a data field on the DED is bracketed by these symbols, the ICP keypad may be used to enter a different value, or the 0/M-SEL button may be used to enable it in some cases. A data field that has been modified but has not been accepted will be highlighted. When the modified data is accepted (ICP ENTR button) or rejected (ICP RCL button) the data field will be returned to normal, de-highlighted text.
2. **Chaff Bingo Quantity.** When the chaff quantity reaches this value, "LO" will be displayed on the CMDS control panel Quantity Display next to the chaff quantity, and the dispensing of Automatic programs containing chaff will be disabled. Manual programs may still be dispensed. Valid entries range from 0 to 99.
3. **Flare Bingo Quantity.** When the flare quantity reaches this value, "LO" will be displayed on the CMDS control panel Quantity Display next to the flare quantity, and the dispensing of Automatic programs containing flares will be disabled. Manual programs may still be dispensed. Valid entries range from 0 to 99.
4. **Other 1/Other 2 Bingo Quantity.** No function.

5. **Selected Steerpoint.** Displays the selected steerpoint. The ICP Increment/Decrement rocker may be used to cycle to a different steerpoint while this page is displayed on the DED.
6. **Feedback Voice Message.** When set to ON, a "CHAFF FLARE" voice message will be played when a countermeasures program has begun dispensing. Note that this voice message will remain the same even if the selected program does not include both countermeasure types. May be changed by placing the DED asterisks around the data field and pressing any ICP keypad button 1-9 to toggle between ON and OFF.
7. **Request Countermeasures Voice Message.** When set to ON, a "COUNTER" voice message will be played when the CMDS MODE is set to SEMI and pilot consent is requested to dispense an Automatic program selected by the CMDS. May be changed by placing the DED asterisks around the data field and pressing any ICP keypad button 1-9 to toggle between ON and OFF.
8. **Bingo Voice Message.** When set to ON, a "LOW" voice message will be played when a countermeasure type has reached its BINGO quantity as set on the CMDS DED page, and an "OUT" voice message will be played when a countermeasure type has been depleted. May be changed by placing the DED asterisks around the data field and pressing any ICP keypad button 1-9 to toggle between ON and OFF.

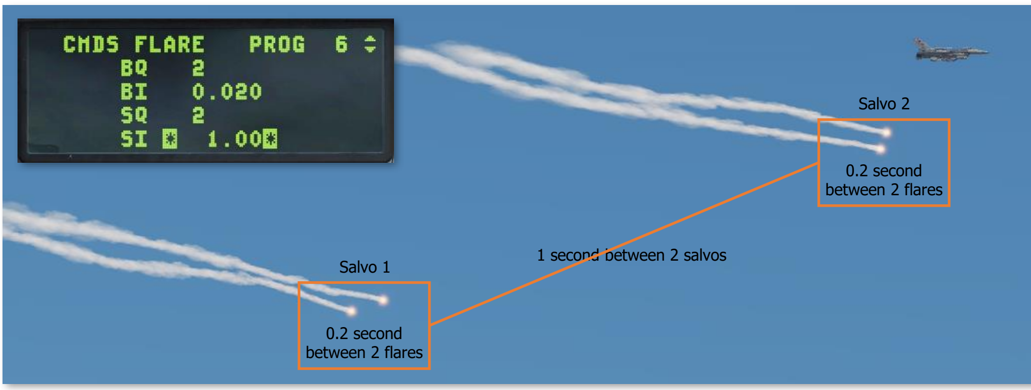
CMDS CHAFF & FLARE Page

The second and third CMDS DED pages are the CMDS Chaff and CMDS Flare pages respectively. These pages are used to edit how chaff and/or flares are dispensed within each Manual program. Setting the Burst Quantity or Salvo Quantity to 0 will prevent the respective countermeasure type from being dispensed during that program. This can be used to configure chaff-only or flare-only programs. The CMDS CHAFF and FLARE pages function identically.



1. **Burst Quantity.** Number of cartridges dispensed within each salvo. Valid entries range from 0 to 99.
2. **Burst Interval.** Time interval between cartridges dispensed within a salvo. Valid entries range from 0.020 to 10.000, in 0.001 increments.
3. **Salvo Quantity.** Number of salvos dispensed within the program. Valid entries range from 0 to 99.
4. **Salvo Interval.** Time interval between each salvo dispensed within the program. Valid entries range from 0.50 to 150.00 in 0.01 increments.
5. **Manual Program Number.** Identifies which Manual program is being edited. To edit the settings for a different program, use the ICP Increment/Decrement rocker to cycle through the Manual programs.

- **Manual Program 1-4.** Dispensed by pressing CMS Forward on the SSC when the CMDS Mode is in Manual, Semi-automatic, or Automatic, based on the position of the CMDS PRGM knob.
- **Manual Program 5.** Dispensed by pressing the CHAFF/FLARE Dispense Button, located on the left cockpit wall above the throttle, when the CMDS Mode is in Manual, Semi-automatic, or Automatic.
- **Manual Program 6.** Dispensed by pressing CMS Left when the CMDS Mode is in Manual, Semi-automatic, or Automatic.



Countermeasure Program Quantities & Intervals

CMDS OTHER1 & OTHER2 Pages

The CMDS OTHER1 and OTHER2 pages have no function. The only expendable countermeasures used by the F-16C variant that is simulated by DCS: F-16C Viper are chaff and flares.

Use the DCS SEQ position to cycle through these sub-pages and return to the CMDS BINGO sub-page.

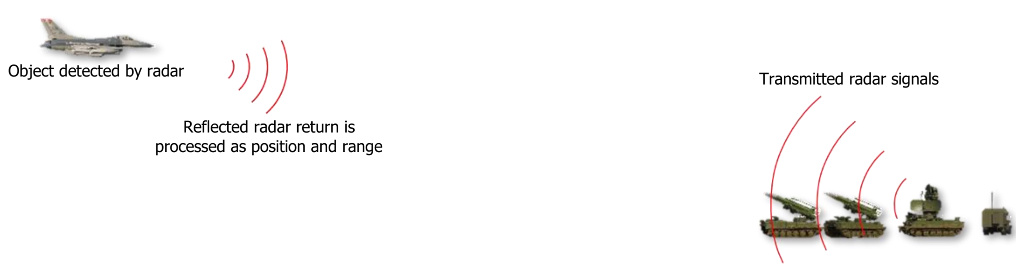
ELECTRONIC COUNTERMEASURES

Electronic countermeasures (or ECM) pods can be carried to provide an additional layer of protection against radar threats such as surface-to-air missile (SAM) batteries. Depending on the sophistication and range of the radar system that is attempting to acquire and track the aircraft, ECM pods can be used to deny, degrade or delay an attack so that the pilot can escape the engagement envelope of the threat system, evade incoming weapons, or gain additional time to execute their mission before being forced to take evasive maneuvers.

The F-16C can be equipped with either the AN/ALQ-131 or AN/ALQ-184 electronic countermeasures pods.

Radar Jamming

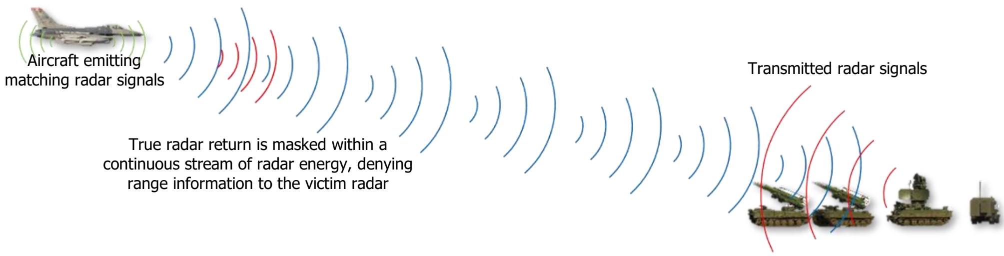
A radar system relies on its ability to receive reflections of its own radio signals off an object, and that these reflections (called "radar returns") are strong enough to be processed among other noise and clutter within the electromagnetic environment. Radar jamming is a type of electronic attack that intentionally radiates radio signals back to a radar system in order to confuse or degrade the radar's ability to calculate range and position using its own radar signals. By matching the victim radar's signal characteristics, a radar jammer can effectively send false information into the victim radar. This can be done using "noise jamming" or "deception jamming".



Radar Detection

Noise Jamming

Noise jamming is accomplished by saturating a victim radar with radio signals that match the frequencies transmitted by its own radar antenna. This is primarily performed to deny ranging data by interfering with the radar's ability to accurately measure the elapsed time between transmissions and reflected radar energy.

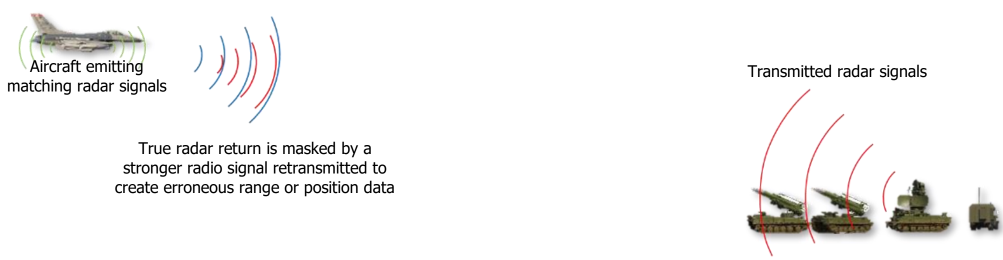


Noise Jamming

Unfortunately, since noise jamming relies upon the continuous transmission of high-power radio signals, often across multiple frequencies (known as "barrage jamming"), it can also highlight the presence of the aircraft to hostile radar systems before the aircraft itself would have been detected.

Deception Jamming

Deception jamming is accomplished by analyzing a radar signal, and then retransmitting a signal that precisely matches the signal characteristics in order to generate false targeting information. In contrast to noise jamming, deception jamming can either produce false target returns or introduce errors into automatic target tracking techniques within certain radar systems.



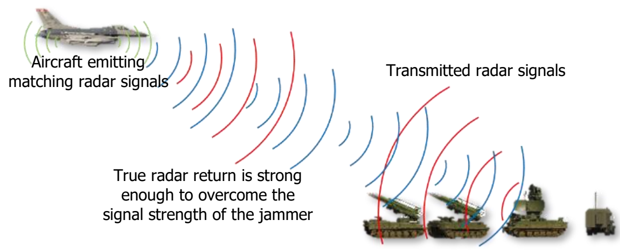
Deception Jamming

The advantage of deception jamming is that the jammer itself can be employed intermittently so as to avoid highlighting the position of the aircraft until necessary. However, depending on the specific radar system, the effectiveness of these jamming techniques may vary.

Burnthrough

"Burnthrough" may occur when the radar return of the aircraft is strong enough that it exceeds the power of the jammer's radio signal when received by the victim radar.

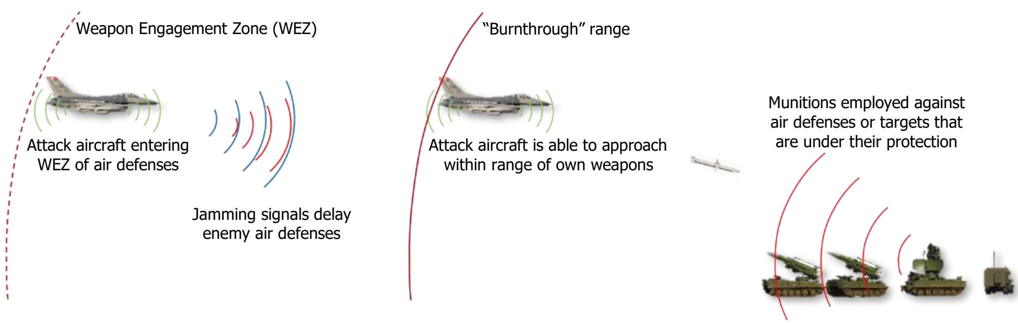
Burnthrough commonly occurs when the aircraft is at closer ranges to the victim radar, which will produce a stronger radar return. As such, the range at which burnthrough occurs will vary between different types of radar systems.



Radar "Burnthrough" of Jamming Signals

Application of Electronic Countermeasures

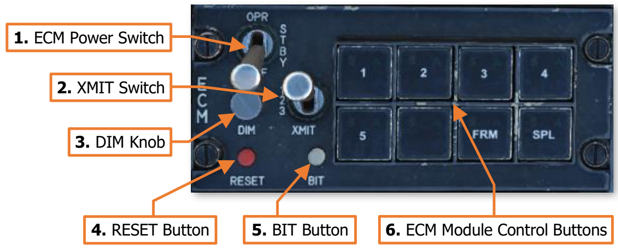
Although ECM does not provide a guarantee against enemy air defenses, when properly employed during a mission ECM can provide additional time to determine the best way to counter enemy air defenses, or allow an attack aircraft to sufficiently reduce their range to target in order to employ their own weapons.



Electronic Countermeasures Against Enemy Air Defenses

ECM Control Panel

The ECM control panel is located on the Left Console and controls the operation of the ALQ-131 or ALQ-184 ECM pod (if installed).



NOTE: Each ECM pod available to the DCS: F-16C Viper functions identically within DCS World. The selection of a specific pod may provide other benefits such as different weight and drag impacts, emulating the inventory of a specific country's military, or simulating a specific conflict or time period.

1. **ECM Power Switch.** Controls the ECM pod operation.
   - **OPR.** ECM pod is powered and operating. Threat signals are processed, and the pod's transmitters operate in accordance with the settings on this panel and the Hands-On Controls.

     NOTE: If the pod has not completed the warm-up prior to moving the switch from STBY to OPR, the pod will not emit jamming signals until the warm-up is complete.
   - **STBY.** ECM pod is powered and begins warm-up (approximately 3 minutes) but will not process threat signals or emit jamming signals.
   - **OFF.** ECM pod is not powered.
2. **XMIT Switch.** Determines the operational mode of the ECM pod.
   - **1 – Deception jamming mode (Avionics Priority).** The ECM pod will reactively emit jamming signals if the ECM system determines the aircraft is being actively tracked or engaged by a threat radar system. The FCR will continue to operate, however the FCR detection and lock ranges will be reduced.

     The CMDS MODE knob must be set to SEMI or AUTO to enable ECM emissions when set to this mode.
   - **2 – Deception jamming mode (ECM Priority).** The ECM pod will reactively emit jamming signals if the ECM system determines the aircraft is being actively tracked or engaged by a threat radar system. The FCR will be placed in a standby state, unless the current weapon profile is AIM-120, in which case the ECM pod will operate in Avionics Priority mode.

     The CMDS MODE knob must be set to SEMI or AUTO to enable ECM emissions when set to this mode.
   - **3 – Noise jamming mode (ECM Priority).** The ECM pod will continuously transmit jamming signals in a preemptive manner. The FCR will be placed in a standby state.

     CAUTION: Continuously broadcasting jamming signals in position 3 will increase the likelihood your aircraft's presence will be detected by hostile aircraft or air defense units.

     The CMDS MODE knob must be set to MAN to enable ECM emissions when set to this mode.
3. **DIM Knob.** Controls the brightness of the ECM panel indicator lights on the module control buttons.
4. **RESET Button.** No function.
5. **BIT Button.** Performs a Built-In Test of the ECM pod. (N/I)
6. **Manual Band Control Buttons.** Selectively enables emissions from individual modules within the ECM pod. Each button is latched in that the buttons are pressed down and held in place to enable that module; or pressed down and popped out to disable that module.
   - **1.** Enables/disables Band 1 module.

- **2.** Enables/disables Band 2 module.
- **3.** Enables/disables Band 3 module.
- **4.** Enables/disables Band 4 module.
- **5.** Enables/disables Band 5 module.
- **(Blank).** Enables/disables an un-marked module for growth within the system.
- **FRM.** No function.
- **SPL.** No function.

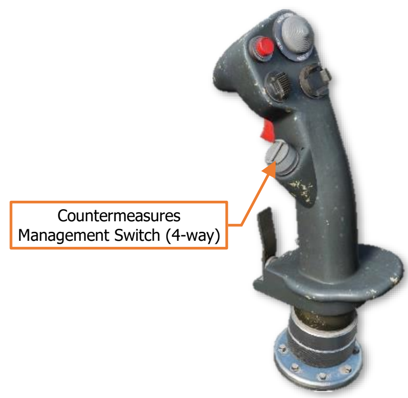
  Four status lights on each button provide an indication as to the operational state of the ECM modules.

  - **S.** Standby. The ECM module is powered but not enabled for transmission.
  - **A.** Active. The ECM module is powered and enabled for transmission.
  - **F.** Failed. The ECM module has malfunctioned or failed.
  - **T.** Transmitting. The ECM module is powered and is currently transmitting.

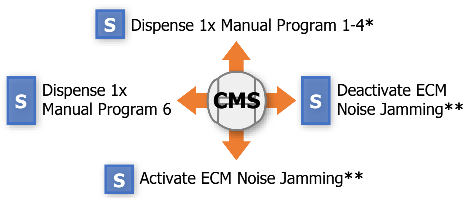
NOTE: The Manual Band Control Buttons in the DCS: F-16C Viper function identically within DCS World. The selection of different ECM modules will not produce different effects on a given threat system.

HANDS-ON CONTROLS

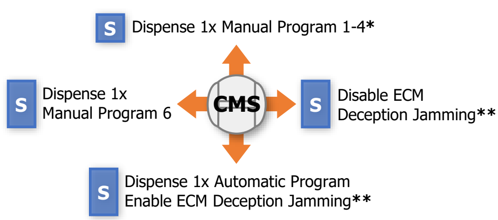
The Countermeasures Management Switch (CMS) on the Side Stick Controller (SSC) is the pilot's primary control over the F-16C's defensive systems. The CMS is a 4-way switch which controls the deployment of countermeasures and operation of the ECM pod (if installed).



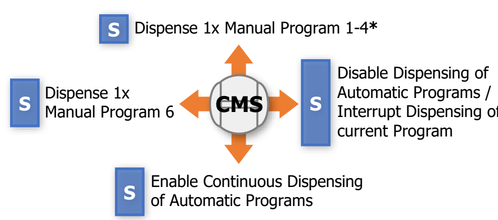
CMDS MODE – MAN. The following CMS actions are performed when the CMDS Mode is set to Manual.



CMDS MODE – SEMI. The following CMS actions are performed when the CMDS Mode is set to Semi-automatic.



CMDS MODE – AUTO. The following CMS actions are performed when the CMDS Mode is set to Automatic.



S Short press (<0.5 sec)

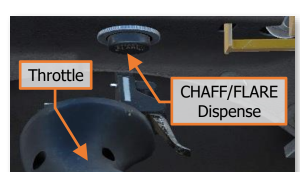
* CMS Forward will dispense the Manual Program selected by the CMDS PRGM knob, unless another Manual or Automatic program is already in progress.

** XMIT Switch on ECM Panel must be set to positions 1 or 2 to enable Deception jamming in Semi-automatic CMDS mode, or position 3 to activate Noise jamming in Manual CMDS mode.

CHAFF/FLARE Dispense Button

The CHAFF/FLARE Dispense button is located on the left cockpit wall outboard and above the throttle, and immediately aft of the canopy locking lever.

The button is used to dispense Manual Program 5 when the CMDS Mode is set to Manual, Semi-automatic, or Automatic. This button operates independently of the CMS functions on the Side Stick Controller (SSC).



APPENDICES

APPENDIX A – ABBREVIATED CHECKLISTS

Procedures

The following procedures outline the steps necessary in performing an engine start, initial INS alignment, taxi, takeoff, landing, engine shutdown, and aerial refueling operations.

Before Engine Start

1. MAIN PWR switch – BATT.
2. Verify light:
   - ACFT BATT "FLCS RLY" – On.
3. FLCS PWR TEST switch – TEST and hold.
4. Verify lights:
   - "FLCS PMG", ACFT BATT "TO FLCS", FLCS PWR "A, B, C, D" – On.
   - ACFT BATT "FLCS RLY" – Off.
5. FLCS PWR TEST switch – Release.
6. MAIN PWR switch – MAIN PWR.
7. Verify lights:
   - "ENGINE" and "HYD/OIL PRESS" warning lights – On.
   - "ELEC SYS" and "SEC" caution lights – On.
   - ACFT BATT "FLCS RLY" – On.
   - "EPU GEN" and "EPU PMG" – Off.
8. Communications – Established with ground crew and ATC as required for engine start.
9. Canopy – As desired.
10. Chocks – In place.
11. Ground crew – Clear of intake and other danger areas.

Engine Start

1. JFS switch – START 2.
2. "SEC" caution light – Off.
3. Throttle – Advance to IDLE.
4. "ENGINE" warning light – Off (approximately 60% RPM).
5. Verify lights:
   - "SEAT NOT ARMED" caution light – On.
   - Three green WHEELS down lights – On.
6. JFS switch – Confirm OFF; manually set to OFF if necessary.

7. "HYD/OIL PRESS" warning light – Off.
8. FUEL FLOW – 700-1700 PPH.
9. Engine OIL pressure – 15 PSI (minimum).
10. Engine NOZ POS – above 94%.
11. Engine RPM – 62%-80%.
12. Engine FTIT – 650° C or less.
13. HYD PRESS A & B – 2850-3250 PSI.

After Engine Start

1. TEST panel – Check.
2. AVIONICS POWER panel – Set.
3. INS – Align.
4. SNSR PWR pane – Set.
5. HUD – As desired.
6. C & I knob – UFC.
7. Secondary (SEC) engine control mode – Check.
8. Flight controls – Cycle to ensure maximum deflection of flight control surfaces.
9. FLCS BIT – Initiate and monitor.
10. ECM panel – As required.
11. SPD BRK switch – Cycle to extended position and then retract.
12. WHEELS down lights – Three green.
13. Standby Attitude Indicator – Uncage and set.
14. FUEL QTY SEL knob – Check and set.
15. EPU FUEL quantity – 95-102%.
16. Avionics, MFD's, and VHF radio – Configure as required.
17. DBU – Check (after FLCS BIT is complete).
18. TRIM – Check.
19. MPO – Check.
20. Operate controls – Verify all surfaces respond normally and no FLCS lights illuminate.
21. Air refueling system (if required) – Check.
22. "EPU GEN" and "EPU PMG" lights – Confirm off.
23. EPU – Check.

Before Taxi

1. Canopy – Close and lock.
2. Backup UHF radio – Set and check as required.
3. Altimeter and altitude indications – Set and check.
4. Exterior lights – As required.
5. INS knob – NAV.
6. Chocks – Remove.

Taxi

1. Throttle – Advance.
2. Brakes and NWS – Check.
3. Heading – Check.
4. Flight instruments – Check for proper operation.

Before Takeoff

1. ALT FLAPS switch – Verify NORM.
2. Trim – Check.
3. ENG CONT switch – Verify PRI (guard down).
4. Speedbrakes – Verify closed.
5. Canopy – Verify closed and locked.
6. IFF – Set and check. (N/I)
7. External fuel tanks – Verify feeding.
8. FUEL QTY SEL knob – NORM.
9. STORES CONFIG switch – As required.
10. OXYGEN SUPPLY lever – PBG (if high-G maneuvers are expected immediately following takeoff).
11. PROBE HEAT switch – PROBE HEAT (if required).
12. Ejection safety lever – Down (Armed).
13. Flight controls – Cycle.
14. Engine OIL pressure – 15-65 PSI.
15. Warning and caution lights – Verify no unexpected conditions.
16. Targeting pod – Stow (if installed).

Takeoff

1. Brakes – Hold.
2. Parking Brake – Verify disengaged.
3. Throttle – 90% RPM. Check for normal engine indications:
    - HYD/OIL PRESS warning light – Off
    - OIL pressure – 25-65 PSI
    - FTIT – 935° C or less
    - HYD PRESS A & B – 2850-3250 PSI
4. Brakes – Release.
5. Throttle – Advance to desired thrust.
6. NWS – Disengage at 70 knots.
7. Pull back on the stick 10 knots below takeoff speed for MIL power or 15 knots below takeoff speed for AB and establish takeoff attitude (8–12°).

TAKEOFF SPEED BASED ON AIRCRAFT GROSS WEIGHT

GROSS WEIGHT (GWT)	20,000 lbs.	24,000 lbs.	28,000 lbs.	32,000 lbs.	36,000 lbs.	40,000 lbs.	44,000 lbs.
TAKEOFF SPEED (KCAS)	128 kts	142 kts	156 kts	168 kts	178 kts	188 kts	198 kts

8. LG Handle – UP; after a positive rate of climb is established.

    NOTE: Ensure landing gear is fully retracted with the gear doors closed before exceeding 300 KCAS.

Descent/Before Landing

1. Fuel – Check quantity/transfer/balance.
2. Landing Light – On.
3. Altimeter – Set and check.
4. Attitude References – Check.
5. ANTI ICE switch – As required.
6. Targeting pod – Stow (if installed).

After Landing

1. PROBE HEAT switch – Verify OFF.
2. ECM Power switch – OFF.
3. Speedbrakes – Close.
4. Ejection Safety Lever – Safe (Up).
5. IFF MASTER knob – STBY.
6. LANDING/TAXI Light switch – As required.
7. MASTER ARM and LASER ARM switches – OFF.

Engine Shutdown

1. C & I knob – BACKUP.
2. HUD SYM knob – Minimize.
3. SNSR PWR panel – Set.
4. AVIONICS POWER panel – Set.
5. Throttle – OFF.

   NOTE: Wait at least 10 seconds after INS knob has been moved to OFF before shutting down the engine.
6. JFS RUN light – Confirm off.
7. "EPU GEN" and "EPU PMG" – Confirm off.
8. MAIN PWR switch – OFF.

   NOTE: Delay placing MAIN PWR switch to OFF until after engine rpm decreases through 20 percent.
9. OXYGEN SUPPLY lever – OFF.
10. OXYGEN Diluter lever – 100%.
11. Canopy – Open.

Pre-refueling Checklist

1. MASTER ARM switch – OFF.
2. LASER ARM switch – OFF.
3. CMDS MODE knob – STBY.
4. Emitters – Off or Standby.

   NOTE: Emitters should be disabled prior to reaching the Pre-contact position.
5. AIR REFUEL switch – OPEN. (3-5 minutes prior to refueling if equipped with external fuel tanks)
6. AR Status Light – Verify RDY.
7. HOT MIC/CIPHER switch – HOT MIC.
8. Exterior Lights – As required. For night refueling set:
    - POSITION WING/TAIL switch – DIM.
    - POSITION FLASH/STEADY switch – STEADY.
    - ANTI-COLL knob – OFF.

Post-refueling Checklist

1. AIR REFUEL switch – CLOSE.
2. HOT MIC/CIPHER switch – OFF.
3. Fuel quantity – Check. Verify proper transfer and balance.
4. AR Status Lights – All off.
5. Exterior Lights – As required.
6. Emitters – As required.
7. MASTER ARM – As required.
8. LASER ARM – As required.
9. CMDS MODE knob – As required.

Navigation

The following procedures outline the steps necessary in performing navigation, editing steerpoints within the navigation database, tuning navigation aids (TACAN or ILS), and performing navigational fixes and calibrations to maintain INS position accuracy.

Selecting a Steerpoint for navigation

Text.

Adding or Editing a Steerpoint (Steerpoints 1-30)

To add a new steerpoint using Lat/Long entry, select a steerpoint with empty coordinate data fields (all zeroes).

1. Use the **DCS Up/Down** positions to place the DED Asterisks over the LAT data field.

2. Press **2** on the ICP keypad to enter N (North).

or

2. Press **8** on the ICP keypad to enter S (South).

3. Use the ICP **keypad** to enter the Latitude. DD° MM.MMM' format is the only format that is accepted, which are entered as DDMMMMM in a continuous string of 7 characters without decimals.

4. Press **ENTR** to accept the new Latitude coordinates into the data field or press **RCL** twice to reject it.

5. Use the **DCS Up/Down** positions to place the DED Asterisks over the LNG data field.

6. Press **6** on the ICP keypad to enter E (East).

or

6. Press **4** on the ICP keypad to enter W (West).

7. Use the ICP **keypad** to enter the Longitude. DDD° MM.MMM' format is the only format that is accepted, which are entered as DDDMMMMM in a continuous string of 8 characters without decimals.

8. Press **ENTR** to accept the new Longitude coordinates or press **RCL** twice to reject it.

9. Use the **DCS Up/Down** positions to place the DED Asterisks over the ELEV data field.

10. Use the ICP **keypad** to enter the elevation in feet.

11. Press **ENTR** to accept the new elevation data or press **RCL** twice to reject it.

Convert MGRS to Lat/Long format (Steerpoints 21-25 only)

1. Use the **DCS SEQ** position to toggle the STPT page to MGRS format.

2. Use the **DCS Up/Down** positions to place the DED Asterisks over the GRID data field.

3. Use the ICP **keypad** to enter the two numerical digits of the Grid, and press **ENTR** to accept the data or **RCL** to reject it.

4. Use the **Increment/Decrement rocker** to change the final Grid character to the correct letter, and press **ENTR** to accept the data.

5. Use the **DCS Up/Down** positions to place the DED Asterisks over the SQUARE data field, and press **ENTR** to enable editing of the data field.

6. Use the **Increment/Decrement rocker** to change the first Square character to the correct letter, and press **ENTR** to accept the data or **RCL** to reject it.
7. Use the **Increment/Decrement rocker** to change the second Square character to the correct letter, and press **ENTR** to accept the data or **RCL** to reject it.
8. Use the **DCS Up/Down** positions to place the DED Asterisks over the EAST/NORTH data field.
9. Use the ICP **keypad** to enter the Easting/Northing in a continuous string of ten characters, and press **ENTR** to accept the data or **RCL** to reject it.
10. Use the **DCS Up/Down** positions to place the DED Asterisks over the ELEV data field.

    NOTE: Elevation data is not required for the conversion process to successfully complete, and can be entered separately or not at all.
11. Use the ICP **keypad** to enter the elevation in feet, and press **ENTR** to accept the data or press **RCL** to reject it.
12. Use the **DCS Up/Down** positions to place the DED Asterisks over the CNVRT data field, and press **ENTR** to initiate the conversion to Lat/Long coordinates. When the conversion is complete, the DED Asterisks will automatically be placed around the steerpoint data field. At this point, the STPT page can be sequenced back to Lat/Long format.

Storing a Markpoint (HUD sensor option)

1. Use the **DCS SEQ** position to select HUD in the Sensor Option data field on the MARK DED page.
2. Use the throttle's **RDR CURSOR/ENABLE** switch to slew the Mark Cue to the desired location within the HUD field-of-view.
3. Press **TMS Forward-Short** on the SSC to ground stabilize the Mark Cue.
4. Use the throttle's **RDR CURSOR/ENABLE** switch to make any final adjustments to the Mark Cue's ground stabilized position, as necessary.
5. Press **TMS Forward-Short** on the SSC to designate the location as a markpoint.

   or

5. Press **TMS Aft-Short** to cage the Mark Cue to the HUD FPM without designating the markpoint.

Storing a Markpoint with HMCS (HUD sensor option)

1. Use the **DCS SEQ** position to select HUD in the Sensor Option data field on the MARK DED page.
2. Press **TMS Forward-Long** to select the HMCS as SOI.
3. Place the HMCS Aiming Cross over the desired location by head movement.
4. Press **TMS Forward-Short** on the SSC to ground stabilize the Mark Cue.
5. Use the throttle's **RDR CURSOR/ENABLE** switch to make any final adjustments to the Mark Cue's ground stabilized position, as necessary.
6. Press **TMS Forward-Short** on the SSC to designate the location as a markpoint.

   or

6. Press **TMS Aft-Short** to cage the Mark Cue to the HMCS Aiming Cross without designating the markpoint.

Storing a Markpoint with HMCS (TGP sensor option)

1. Use the **DCS SEQ** position to select TGP in the Sensor Option data field on the MARK DED page.
2. Press **DMS Down-Short** to select the TGP as SOI on the applicable MFD format.
3. Use the throttle's **RDR CURSOR/ENABLE** switch to slew the TGP crosshairs to the desired location.
4. Press **TMS Forward-Short** on the SSC to switch the TGP to Point Track.
5. Press **TMS Forward-Short** on the SSC to designate the Point Track location as a markpoint.

   or

5. Press **TMS Right-Short** on the SSC to switch back to Area Track without designating the markpoint.

Storing a Markpoint with HMCS (FCR sensor option)

1. Use the **DCS SEQ** position to select FCR in the Sensor Option data field on the MARK DED page.
2. Press **DMS Down-Short** to select the FCR as SOI on the applicable MFD format.
3. Use the throttle's **RDR CURSOR/ENABLE** switch to slew the FCR cursor to the desired location.
4. Press **TMS Forward-Short** on the SSC to switch the FCR to Fixed Target Track (FTT).
5. Press **TMS Forward-Short** on the SSC to designate the FTT location as a markpoint.

   or

5. Press **TMS Aft-Short** on the SSC to reject the Fixed Target Track (FTT) without designating the markpoint.

Storing a Markpoint with HMCS (OFLY sensor option)

1. Use the **DCS SEQ** position to select OFLY in the Sensor Option data field on the MARK DED page.
2. Maneuver the aircraft as necessary to ensure the flight path will take it over the intended markpoint location.
3. Press **TMS Forward-Short** on the SSC to designate the location as a markpoint as the aircraft passes directly overhead the intended location.

Tuning a TACAN station

Text.

Selecting TACAN navigation

Text.

Tuning an ILS station

Text.

Selecting ILS navigation

Text.

Performing a Navigational Fix

Text.

Performing an Altitude Calibration

Text.

Performing an In-flight INS Alignment

Text.

Radio Communications

The following procedures outline the steps necessary in managing the UHF and VHF voice radios.

Editing a Preset UHF/VHF frequency (Upfront Controls)

1. Press **COM 1** to access the UHF DED page or press **COM 2** to access the VHF DED page.
2. Use the **Increment/Decrement** rocker to cycle to the desired preset to be edited.

   or

2. Use the **DCS Up/Down** positions to place the DED Asterisks over the Preset Channel Number, use the ICP **keypad** to type the desired preset channel to be edited, and press **ENTR**.
3. Use the **DCS Up/Down** positions to place the DED Asterisks over the Preset Channel Frequency.
4. Use the ICP **keypad** to enter the new frequency for the displayed Present Channel, in a continuous string of 5 numbers.
5. Press **ENTR** to accept the new frequency or press **RCL** twice to reject it.

Tuning a Preset UHF/VHF frequency (Upfront Controls)

1. Press **COM 1** to access the UHF DED page or press **COM 2** to access the VHF DED page.
2. Use the ICP **keypad** to enter a 1- or 2-digit number between 1-20, corresponding with the desired preset channel to be tuned.
3. Press **ENTR** to accept the new frequency or press **RCL** twice to reject it.

Tuning a Manual UHF/VHF frequency (Upfront Controls)

1. Press **COM 1** to access the UHF DED page or press **COM 2** to access the VHF DED page.
2. Use the ICP **keypad** to enter a 5-digit number corresponding with the desired frequency to be tuned.

3. Press **ENTR** to accept the new frequency or press **RCL** twice to reject it.

Tuning a Preset UHF frequency (UHF Backup control panel)

1. Ensure the **Function** knob is set to **MAIN** or **BOTH**.
2. Set the **Mode** knob to **PRESET**.
3. Rotate the **CHAN** knob until the desired preset channel is displayed within the CHAN Display indicator.
4. The frequency assigned to the currently tuned preset channel may be verified by pressing the **STATUS** button and observing the FREQUENCY STATUS/DISPLAY indicator.

Tuning a Manual UHF frequency (UHF Backup control panel)

1. Ensure the **Function** knob is set to **MAIN** or **BOTH**.
2. Set the **Mode** knob to **MNL**.
3. Rotate the **A-3-2** and **Manual Frequency** knobs until the desired frequency is displayed in the FREQUENCY STATUS/DISPLAY indicator.

APPENDIX B – ALIC CODES & RWR SYMBOLS

The Aircraft Launcher Interface Computer (ALIC) codes listed under the "ID" column in the Air Defense and Naval Radar Systems tables can be used on the HARM DED page or HTS DED page to program custom threat tables for the AGM-88 HARM or HARM Targeting System radar signal scans.

The threat radar codes under the "RWR" column correspond with how the threat radar will appear on the ALR-56M Threat Warning Azimuth Indicator, the MFD HARM Attack Display (HAD) format, or the MFD Weapon (WPN) format when the AGM-88 weapon profile is selected.

Air defense radar systems are further identified by their type. The table below lists the definition of each "Type" abbreviation to identify the radar's function within their respective air defense units.

TYPE	DESCRIPTION	TYPE	DESCRIPTION
CWAR	Continuous-Wave Acquisition Radar	**STR**	Search and Tracking Radar
EWR	Early Warning Radar	**TAR**	Target Acquisition Radar
FCR	Fire Control Radar	**TI**	Target Illumination
RR	Ranging Radar	**TTR**	Target Tracking Radar
SR	Surveillance Radar		

Air Defense Radar Systems

ID	RWR	NATO SYSTEM	SYSTEM	RADAR DESIGNATION	TYPE
-				1L13 "BOX SPRING"	SR / EWR
-				5G66 "TALL RACK"	SR / EWR
122	S	SA-2 / SA-3 / SA-5	S-75 / S-125 / S-200	P-19 "FLAT FACE B"	SR / TAR
126	2	SA-2 "GUIDLELINE"	S-75	SNR-75 "FAN SONG"	TTR
	U	SA-2 "GUIDLELINE"	S-75	RD-75 "Amazonka"	RR
123	3	SA-3 "GOA"	S-125	SNR-125 "LOW BLOW"	TTR
130	TS	SA-5 "GAMMON"	S-200	ST-68U "TIN SHIELD"	TAR
129	5	SA-5 "GAMMON"	S-200	5N62 "SQUARE PAIR"	TTR / TI
108	6	SA-6 "GAINFUL"	2K12 Kub	1S91 "STRAIGHT FLUSH"	TAR / TI
117	8	SA-8 "GECKO"	9K33 Osa	"LAND ROLL"	TAR / TTR
104	BB	SA-10 "GRUMBLE"	S-300PS	64N6E "BIG BIRD"	TAR
103	CS	SA-10 "GRUMBLE"	S-300PS	5N66M "CLAM SHELL"	TAR
110	10	SA-10 "GRUMBLE"	S-300PS	30N6E "FLAP LID"	TTR
107	SD	SA-11 "GADFLY"	9K37M Buk-M1	9S18M1 "SNOW DRIFT"	TAR
115	11	SA-11 "GADFLY"	9K37M Buk-M1	9S35 "FIRE DOME	TTR
109	DE		PPRU-M1	9S80M1 "DOG EAR"	TAR
118	13	SA-13 "GOPHER"	9K35 Strela-10M3	9S86 "SNAP SHOT"	RR
119	15	SA-15 "GAUNTLET"	9K331 Tor-M1	"SCRUM HALF"	TAR / TTR

120	19	SA-19 "GRISON"	2S6M Tunguska	1RL144 "HOT SHOT"	TAR / TTR
131	FC		S-60 / KS-19	SON-9 "FIRE CAN"	FCR
121	A		ZSU-23-4 Shilka	RPK-2 "GUN DISH"	FCR
128	HQ	CSA-7 / HQ-7B	Hóng Qí-7	HQ-7 ACU	TAR
127	7	CSA-7 / HQ-7B	Hóng Qí-7	Type 345	TTR
-				AN/FPS-117 "SEEK IGLOO"	SR / EWR
203	HK	MIM-23B I-Hawk		AN/MPQ-50	TAR
204	HK	MIM-23B I-Hawk		AN/MPQ-46	TTR
206	HK	MIM-23B I-Hawk		AN/MPQ-55	CWAR
202	P	MIM-104C Patriot PAC-2		AN/MPQ-53	STR
209	NS	NASAMS 2		AN/MPQ-64F1 "Sentinel"	STR
208	A	M163 Vulcan ADS		AN/VPS-2	RR
124	RP	Rapier FSA		DN 181 "Blindfire"	TTR
125	RT	Rapier FSA		Rapier PU	SR
205	RO	Roland TÜR		MPDR-3002S	SR
201	RO	Marder Roland		MPDR-16 / DOMINO-30	TAR / TTR
207	A	Flakpanzer Gepard		MPDR-12 / Albis	TAR / FCR

Naval Radar Systems

ID	RWR	SHIP CLASS	TYPE	DESIGNATION
301	SW	Kuznetsov class	Heavy Aircraft Cruiser	Project 1143.5 (Admiral Kuznetsov)
320	SW	Kuznetsov class	Heavy Aircraft Cruiser	Project 1143.5 [2017 SC revision]
313	HN	Kirov class	Guided Missile Cruiser	Project 1144.2 (Piotr Velikiy)
303	T2	Slava class	Guided Missile Cruiser	Project 1164 (Moskva)
319	TP	Neutrashimy class	Guided Missile Frigate	Project 11540 (Neutrashimy)
309	TP	Krivak II class	Frigate / Guard Ship	Project 1135M (Rezky)
306	HP	Grisha class	Anti-Submarine Corvette	Project 1124.4 (Grisha)
312	PS	Tarantul III class	Missile Corvette	Project 1241.1 (Molniya)
321	SC	Ropucha I class	Large Landing Ship	Project 775
410	HN	Luyang II class	Guided Missile Destroyer	Type 052C (PLAN)
409	MR	Luyang I class	Guided Missile Destroyer	Type 052B (PLAN)
411	MR	Jiangkai II class	Guided Missile Frigate	Type 054A (PLAN)
408	PS	Yuzhao class	Amphibious Transport Dock	Type 071 (PLAN)
403	SS	Nimitz class	Aircraft Carrier	CVN-71 (USS Theodore Roosevelt)
404	SS	Nimitz class	Aircraft Carrier	CVN-72 (USS Abraham Lincoln)
405	SS	Nimitz class	Aircraft Carrier	CVN-73 (USS George Washington)

406	SS	Nimitz class	Aircraft Carrier	CVN-74 (USS John C. Stennis)
413	SS	Nimitz class	Aircraft Carrier	CVN-75 (USS Harry S. Truman)
	U	Forrestal class	Aircraft Carrier	CV-59 (USS Forrestal)
407	40	Tarawa class	Amphibious Assault Ship	LHA-1 (USS Tarawa)
315	AE	Ticonderoga class	Guided Missile Cruiser	CG (USS)
412	AE	Arleigh Burke class	Guided Missile Destroyer	DDG (USS)
401	49	Oliver Hazard Perry class	Guided Missile Frigate	FFG (USS)
	U	Invincible class	Light Aircraft Carrier	R05 (HMS)
	U	Leander class	Frigate	F12, F57, F72 (HMS)
	U	Castle class	Patrol Class	P258, P265 (HMS)
	U	Condell class	Frigate	PFG-06, PFG-07 (CNS)

Airborne Radar Systems

RWR	AIRCRAFT	RWR	AIRCRAFT	RWR	AIRCRAFT
19	MiG-19	JF	JF-17	F4	F-4
21	MiG-21	29	J-11	F5	F-5
23	MiG-23	50	KJ-2000	14	F-14
24	Su-24			15	F-15
25	MiG-25	F1	Mirage F1	16	F-16
29	MiG-29	M2	Mirage 2000	18	F/A-18
29	Su-27	F2	Tornado GR4	E2	E-2
29	Su-33	U	Tornado IDS	E3	E-3
30	Su-30	U	AJS37		
31	MiG-31				
34	Su-34				
50	A-50				

Other Threat Symbols

RWR	TYPE	THREATS
M	Missile radar seeker detected	Active radar-homing missiles (ARH)

APPENDIX C – HAD / WPN THREAT TABLES

The threat radar codes under the "HAD" column correspond with how the threat radar will appear on the MFD HARM Attack Display (HAD) format if the corresponding threat class is enabled within the HTS scan cycles.

The HAD Manual threat Class is programmable via the HTS DED page and can include up to eight threat radar types. This can be used to better tailor the HTS scan cycles to the radar signals that are anticipated to be encountered during the mission.

HARM Attack Display (HAD) Threat Classes

HAD	HAD CLASS 1	HAD	HAD CLASS 2	HAD	HAD CLASS 3
TS	SA-5 "TIN SHIELD"	S	P-19 "FLAP LID B"	DE	PPRU-M1 "DOG EAR"
BB	SA-10 "BIG BIRD"	2	SA-2 "FAN SONG"	19	SA-19 "HOT SHOT"
CS	SA-10 "CLAM SHELL"	3	SA-3 "LOW BLOW"	FC	SON-9 "FIRE CAN"
10	SA-10 "FLAP LID"	5	SA-5 "SQUARE PAIR"	A	ZSU-23-4 "GUN DISH"
SD	SA-11 "SNOW DRIFT"	6	SA-6 "STRAIGHT FLUSH"		
11	SA-11 "FIRE DOME"	8	SA-8 "LAND ROLL"		
15	SA-15 "SCRUM HALF"	13	SA-13 "SNAP SHOT"		
HQ	HQ-7 ACU				
7	HQ-7 Type 345				

HAD	HAD CLASS 4	HAD	HAD CLASS 5	HAD	HAD CLASS 6
		SW	Kuznetsov-class	P	MIM-104C Patriot PAC-2
		HN	Kirov/Luyang II-class	NS	NASAMS 2 "Sentinel"
		T2	Slava-class		
		HP	Neutrashimy/Grisha-class		
		TP	Krivak II-class		
		MR	Luyang I/Jiangkai-class		
		PS	Tarantul III/Yuzhao-class		
		SC	Ropucha I-class		

HAD	HAD CLASS 7	HAD	HAD CLASS 8	HAD	HAD CLASS 9
HK	MIM-23B I-Hawk	A	M163 Vulcan ADS		
RO	Roland TÜR	A	Flakpanzer Gepard		
RO	Marder Roland				
RP	Rapier FSA "Blindfire"				
RT	Rapier FSA				

HAD	HAD CLASS 10	HAD	HAD CLASS 11	HAD	HAD MANUAL CLASS
SS	Nimitz-class				
AE	AN/SPY-1 “Aegis”				
49	Oliver Hazard Perry-class				
40	Tarawa-class				

The emitter codes under the “WPN” column correspond with how the threat radar will appear on the MFD Weapon (WPN) format when the corresponding threat table is selected.

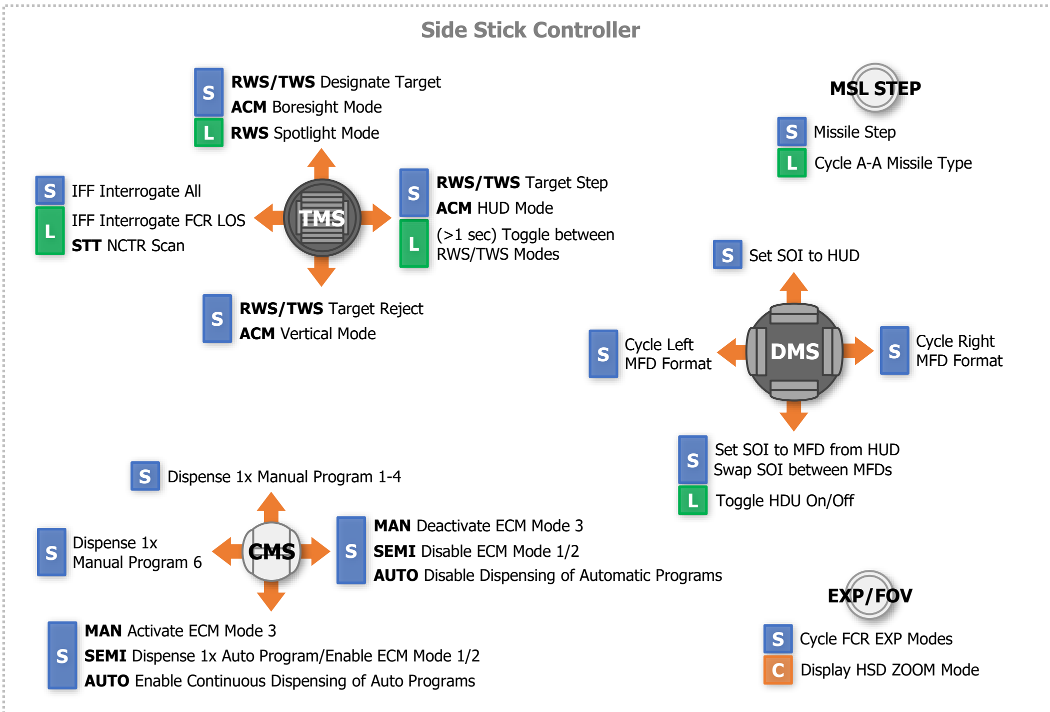
Each HARM threat table can be modified using the HARM DED page. This can be used to better tailor the AGM-88 scans to the radar signals that are anticipated to be encountered during the mission.

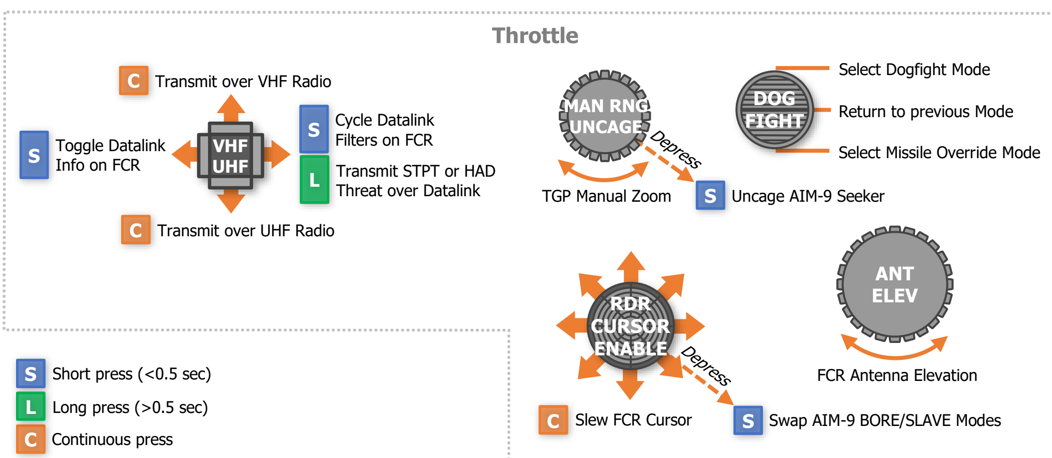
AGM-88 Weapon (WPN) Threat Tables

WPN	TBL1	WPN	TBL2	WPN	TBL3
10	SA-10 “FLAP LID”	19	SA-19 “HOT SHOT”	3	SA-3 “LOW BLOW”
BB	SA-10 “BIG BIRD”	15	SA-15 “SCRUM HALF”	S	P-19 “FLAP LID B”
CS	SA-10 “CLAM SHELL”	8	SA-8 “LAND ROLL”	6	SA-6 “STRAIGHT FLUSH”
11	SA-11 “FIRE DOME”	A	ZSU-23-4 “GUN DISH”	2	SA-2 “FAN SONG”
SD	SA-11 “SNOW DRIFT”	DE	PPRU-M1 “DOG EAR”	13	SA-13 “SNAP SHOT”

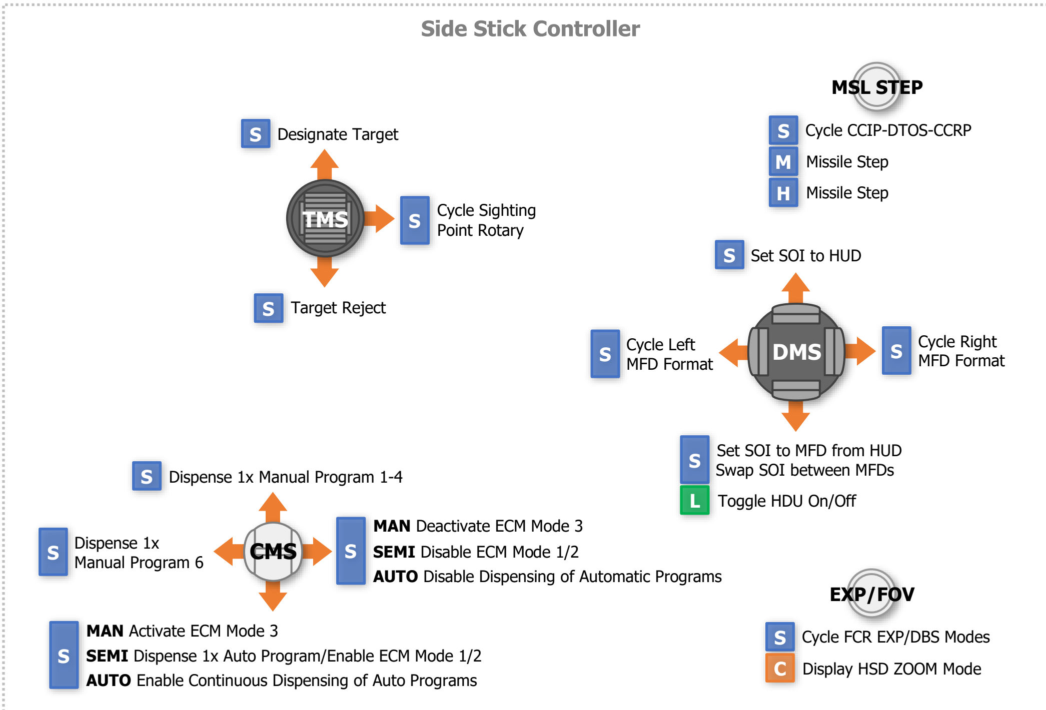
APPENDIX D – HOTAS QUICK REFERENCES

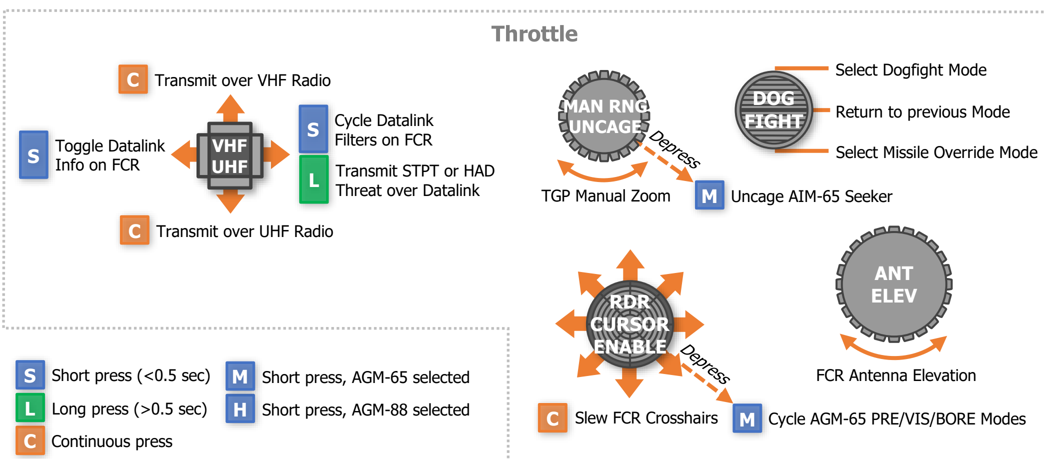
A-A, MSL ORIDE, DGFT Master Modes / SOI set to FCR



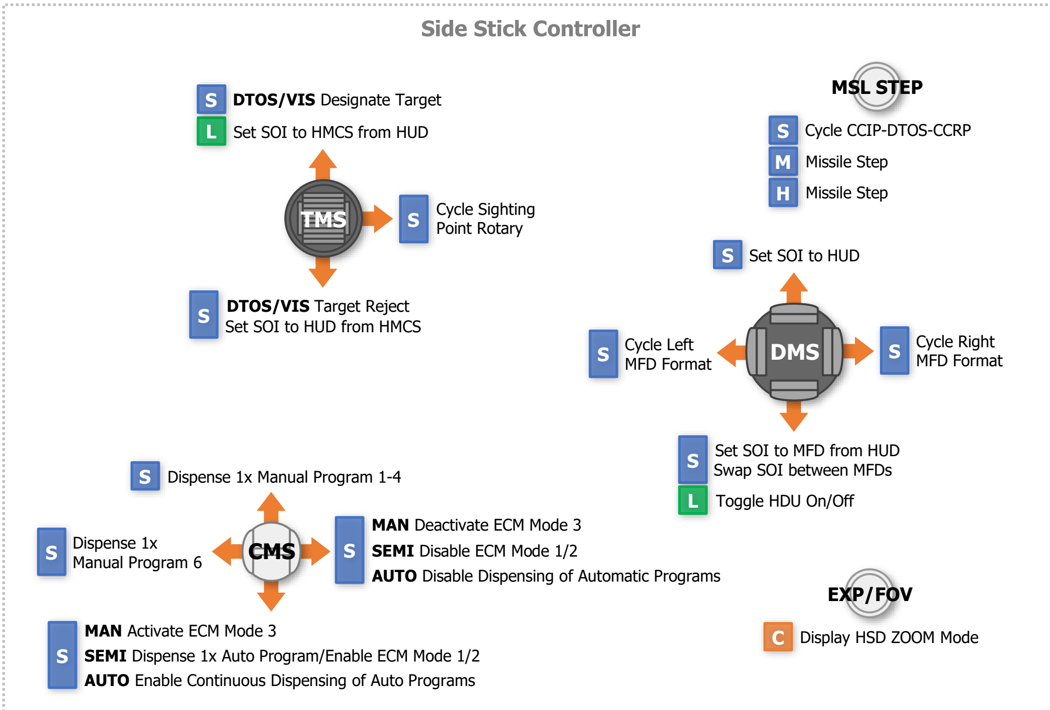


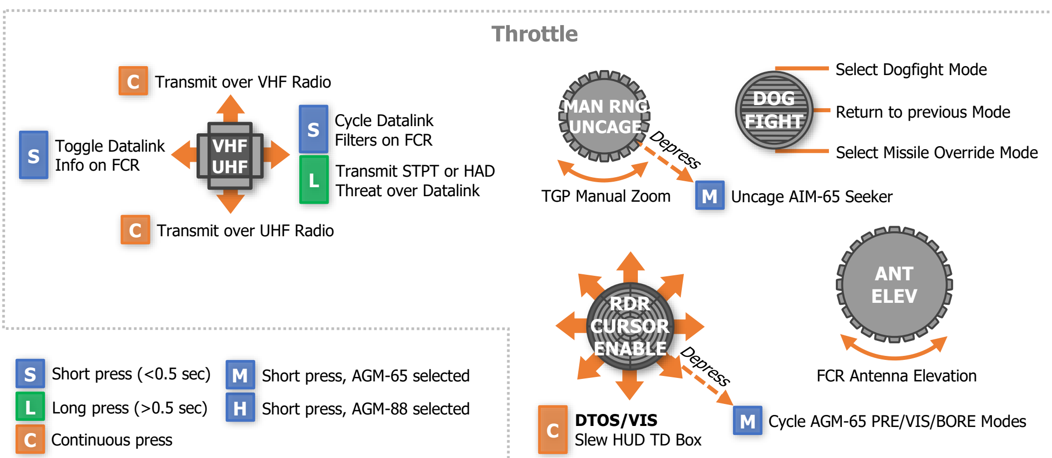
A-G Master Mode / SOI set to FCR



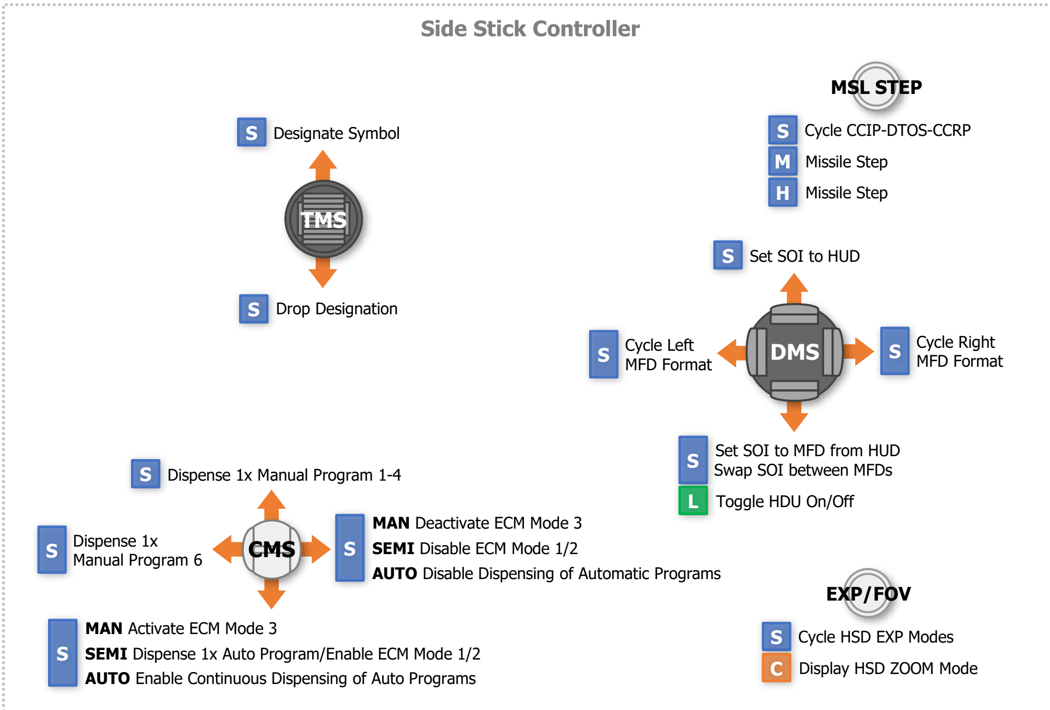


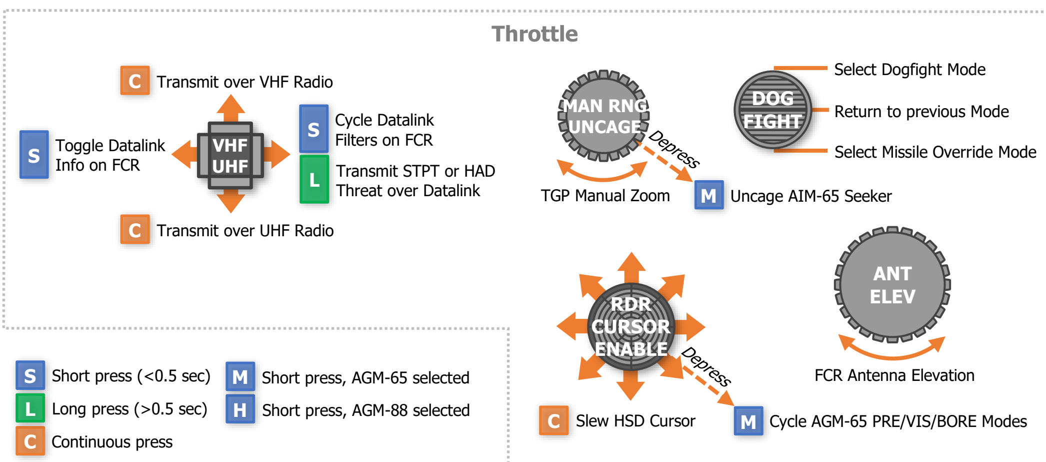
A-G Master Mode / SOI set to HUD



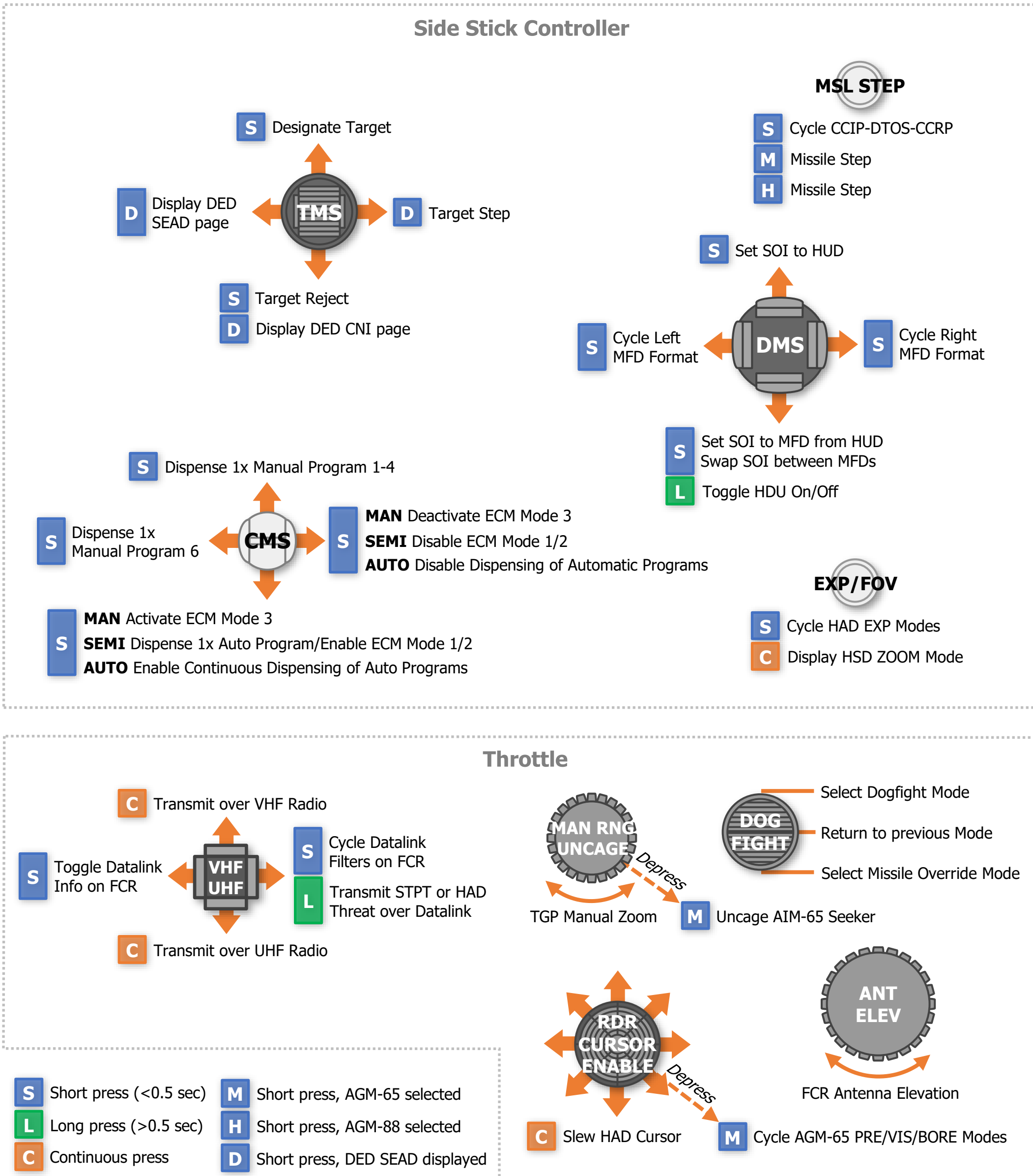


A-G Master Mode / SOI set to HSD

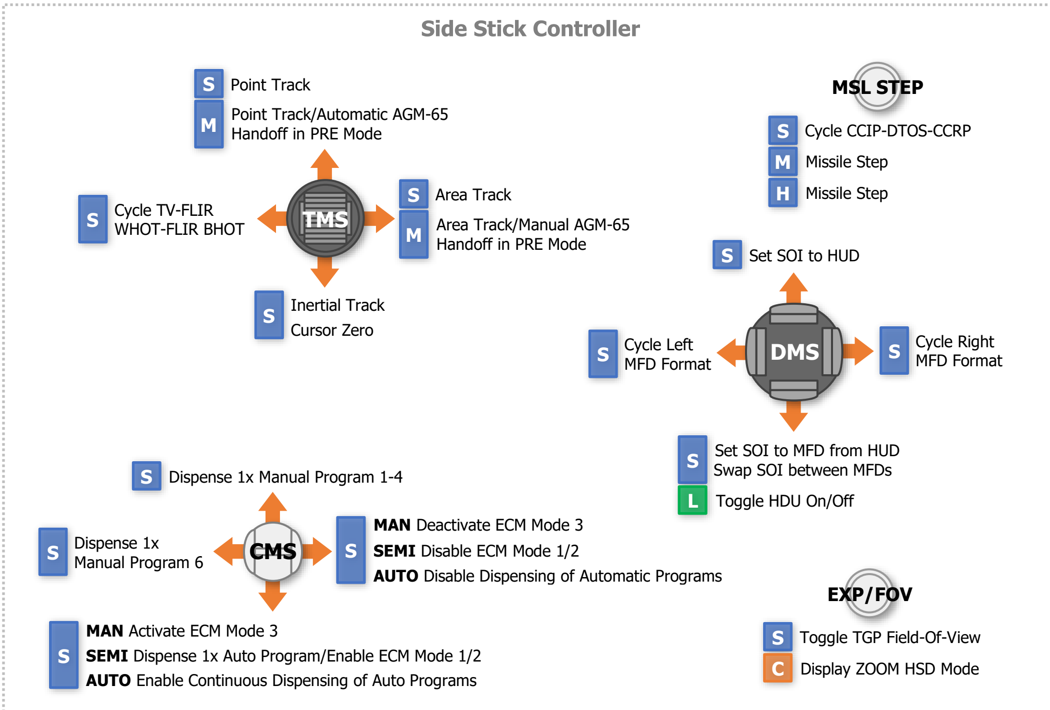


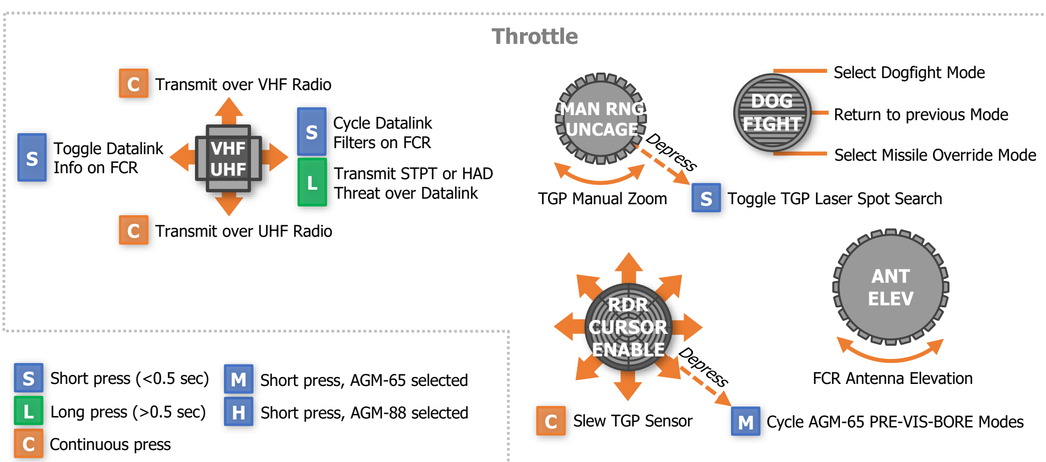


A-G Master Mode / SOI set to HAD

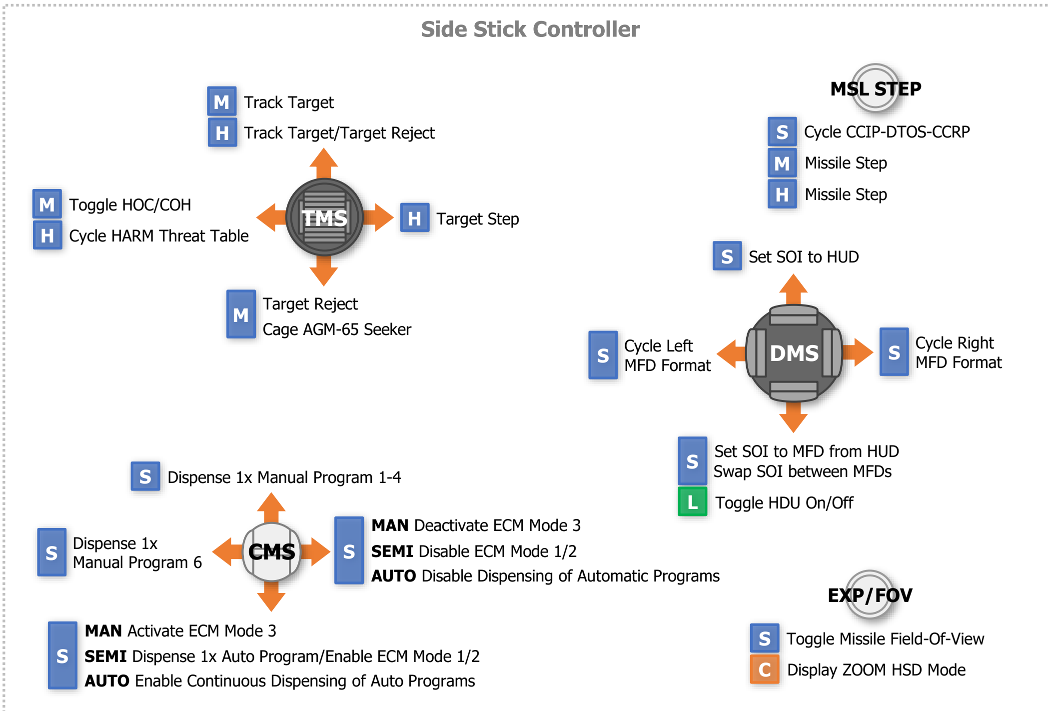


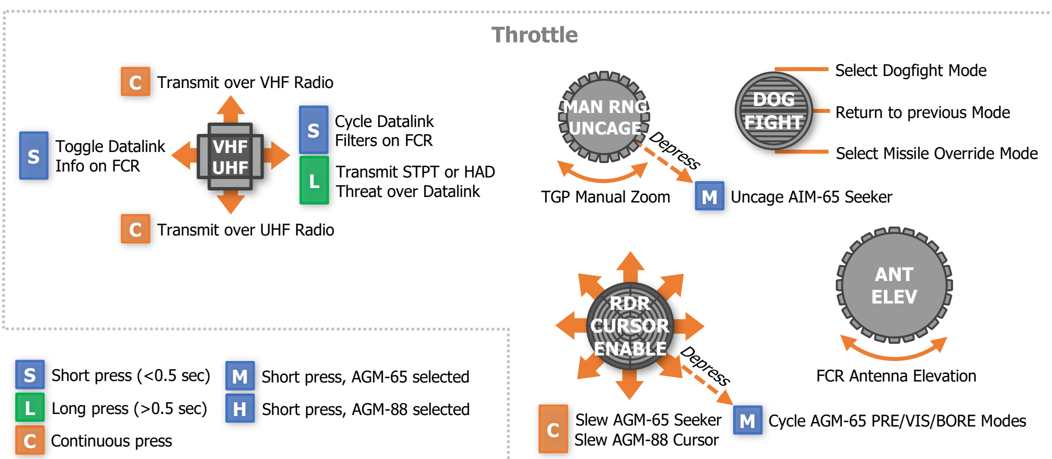
A-G Master Mode / SOI set to TGP





A-G Master Mode / SOI set to WPN





APPENDIX E – GLOSSARY OF TERMS

Definitions of acronyms, abbreviations, labels, and terms.

A-A, A/A	Air-to-Air
AAA	Anti-Aircraft Artillery
A-CAL	Altitude Calibration
ACM	1. Air Combat Mode; 2. Air Combat Maneuvers
ADI	Attitude Director Indicator
A-G	Air-to-Ground
AGL	Above Ground Level
AGM	Air-to-Ground Missile
AGR	Air-to-Ground Ranging
AIM	Air Intercept Missile
ALIC	Aircraft Launcher Interface Computer
ALOW	Altitude Low
ALT	1. Altitude; 2. Alternate
AMRAAM	Advanced Medium Range Air-to-Air Missile
AOA	1. Angle-Of-Attack; 2. Angle-Of-Arrival
AR	Aerial Refuel
ATC	Air Traffic Control
ATT	Attitude
AUTO	Automatic
AZ	Azimuth
BFM	Basic Fighter Maneuvers
BHOT	Black Hot
BI	Burst Interval
BIT	Built-In Test
BNGO	Bingo
BORE	Boresight
BQ	Burst Quantity

BULL	Bullseye
BUP	Backup
BVR	Beyond Visual Range
BYP	Bypass
CBU	Cluster Bomb Unit
CCIP	Continuously Computed Impact Point
CCRP	Continuously Computed Release Point
CH	Chaff
CMDS	Countermeasures Dispenser Set
CMS	Countermeasures Management Switch
CNI	Communications/Navigation/IFF
CNTL	Control
COM1	Communications radio 1; the ARC-164 UHF-AM radio
COM2	Communications radio 2; the ARC-222 VHF-AM/FM radio
CORR	Correction
CRM	Combined Radar Modes
CRUS	Cruise
CTR	Center
CZ	Cursor Zero
DBS	Doppler Beam Sharpening
DEC	Decrement
DED	Data Entry Display
DEFOG	De-Fog
DEPR	Depression
DEST	Destination
DLNK, DL	Datalink
DMS	Display Management Switch
DRNG	Delta Range
DTC	Data Transfer Cartridge

DTE	Data Transfer Equipment
DTOS	1. Dive/Toss; 2. Delta Time-Over-Steerpoint
DTT	Dual Target Track
DTU	Data Transfer Unit
ECM	Electronic Countermeasures
ECS	Environmental Control System
EDR	Endurance
EEGS	Enhanced Envelope Gun Sight
EHSI	Electronic Horizontal Situation Indicator
E-J	Emergency Jettison
ELEV, EL	Elevation
ENG	Engine
ENTR	Enter
EO	Electro-Optical
ETA	Estimated Time of Arrival
ETE	Estimated Time Enroute
EOM	Equations Of Motion
EPU	Emergency Power Unit
EXP	Expand
FCR	Fire Control Radar
FDBK	Feedback
FL	Flight Lead
FLCC	Flight Control Computer
FLCS	Flight Control System
FLIR	Forward Looking Infrared
FLT	Flight
FOV	Field-Of-View
FPM	Flight Path Marker
FTT	Fixed Target Track

FT	Feet (unit of measurement)
FZ	Freeze
G	G-force (unit of measurement)
GBU	Glide Bomb Unit
GM	Ground Mapping
GMT	Ground Moving Target
GPS	Global Positioning System
GRD	GUARD
GS, G/S	1. Ground Speed; 2. Glide Slope
HAD	HARM Attack Display
HARM	High-speed Anti-Radiation Missile
HAS	HARM As Sensor
HDG	Heading
HMCS	Helmet-Mounted Cueing System
HOTAS	Hands-On Throttle and Stick System
HOB	High-angle Off-Boresight
HSD	Horizontal Situation Display
HSI	Horizontal Situation Indicator
HTS	HARM Targeting System
HUD	Heads-Up Display
HYD	Hydraulic
IAS	Indicated Airspeed
ICP	Integrated Control Panel
ICS	Inter-Communication System
IDENT	Identification
IDM	Improved Data Modem
IFF	Identification Friend or Foe
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions

IN	Inches (unit of measurement)
INC	Increment
INFLT	In-Flight
INS	Inertial Navigation System
INSM	Inertial Navigation System Memory
INTG	Interrogate
INV	Inventory
JDAM	Joint Direct Attack Munition
JETT	Jettison
JFS	Jet Fuel Starter
JHMCS	Joint Helmet-Mounted Cueing System
JSOW	Joint Stand-Off Weapon
KM	Kilometer (unit of measurement)
DL16	Datalink 16
LADD	Low Altitude Drogue Delivery
LASR	Laser
LAT	Latitude
Lat/Long	Latitude/Longitude
LB	Pound (unit of measurement)
LGB	Laser-Guided Bomb
LO	Low
LONG	Longitude
LRFD	Laser Rangefinder/Designator
LSS	Laser Spot Search
LST	Laser Spot Tracker
Mach	
MAGV	Magnetic Variation
MAN	Manual
MFD	Multi-Function Display

MGRS	Military Grid Reference System
MIDS	Multifunction Information Distribution System
MISC	Miscellaneous
M-SEL	Mode Select
MSL	1. Missile; 2. Mean Sea Level
NAV	Navigation
N/I	Not Implemented
NM	Nautical Mile (unit of measurement)
NORM	Normal
NWS	Nose Wheel Steering
NVG	Night Vision Goggles
OAP, OA1, OA2	Offset Aimpoint, Offset Aimpoint 1, Offset Aimpoint 2
OFP	Operational Flight Program
OPR	Operation
PB	Pre-Briefed
PFLD	Pilot Fault List Display
POS	Position
PRE	Pre-planned
PRF	Pulse Repetition Frequency
PRGM, PROG	Program
PSI	Pounds per Square Inch (unit of measurement)
PTT	Push-To-Talk
PUP	Pull-Up Point
PWR	Power
QTY	Quantity
RCL	Recall
RDY	Ready
REC	Receive
REQCTR	Request Countermeasures

RNG	Range
RTN	Return
RUK	Range Unknown
RWR	Radar Warning Receiver
RWS	Range While Scan
SAI	1. Standby Attitude Indicator; 2. Situational Awareness Indicator
SAM	1. Surface-to-Air Missile, 2. Situation Awareness Mode
SEAD	Suppression of Enemy Air Defenses
SEMI	Semi-automatic
SEQ	Sequence
SI	Salvo Interval
S-J	Selective Jettison
SMS	Stores Management Set
SNSR	Sensor
SOI	Sensor-Of-Interest
SP	Snowplow
SPI	System-Point-of-Interest
SQ	Salvo Quantity
SQL	Squelch
SSC	Side Stick Controller
STBY	Standby
STN	Source Track Number
STOR	Store
STP, STPT	Steerpoint
STR	Steer
STT	Single Target Track
SYM	Symbology
TACAN, TCN	Tactical Air Navigation
TAS	True Airspeed

TBL	Table
TGP	Targeting Pod
TGT	Target
THRT	Threat
T-ILS	TACAN/Instrument Landing System
TMS	Target Management Switch
TOF	1. Time Of Flight; 2. Time Of Fall
TOT	Time Over Target
T/R	Transmit/Receive
TWS	Track While Scan
UFC	Upfront Controls
UHF	Ultra High Frequency
UTM	Universal Transverse Mercator
VAH	Velocity/Altitude/Heading
VHF	Very High Frequency
VIP	Visual Initial Point
VIS	Visual
VMC	Visual Meteorological Conditions
VRP	Visual Reference Point
VV	Vertical Velocity
VVI	Vertical Velocity Indicator
WCMD	Wind-Corrected Munition Dispenser
WHOT	White Hot
WPN	Weapon
WVR	Within Visual Range
XMIT, XMT	Transmit

APPENDIX F – FORMULAS

Use these calculation and conversion formulas for pre-mission planning or while in flight. Desired resultants are bolded.

Fuel/Endurance Calculations

Bingo Fuel (lbs) = (Time of Flight ÷ 60) × Fuel LB/HR

Objective Time (mins) = ([Total Fuel − Bingo Fuel] ÷ Fuel LB/HR) × 60

Speed/Time/Distance Calculations

Ground Speed Required (knots) = (Distance ÷ Minutes) × 60

Time of Flight (mins) = (Distance ÷ Ground Speed) × 60

Fuel/Range Calculations

Specific Range Factor = Ground Speed ÷ Fuel LB/HR

Flight Range (NM) = Specific Range Factor × Total Fuel

Distance Conversion

Nautical Miles (NM) to **feet (ft)** = [NM] x 6,076

Feet (ft) to **Nautical Miles (NM)** = [ft] ÷ 6,076

Nautical Miles (NM) to **Kilometers (Km)** = [NM] × 1.85

Kilometers (Km) to **Nautical Miles (NM)** = [Km] ÷ 1.85

Altitude/Elevation Conversion

Feet (ft) to **Meters (m)** = [ft] ÷ 3.281

Meters (m) to **Feet (ft)** = [m] × 3.281

Latitude/Longitude Conversion

DDD-MM-SS.SS to **DDD-MM.MMM**

SS.SS ÷ 60 = .MMM

DDD-MM.MMM to **DDD-MM-SS.SS**

.MMM × 60 = SS.SS

Good hunting!

The Eagle Dynamics SA team

USAF Photo
by SSgt Deana Heitzman