T.O. BMS1F-16CM-1

FLIGHT MANUAL

Combatsimchecklist series

F-16C/D BMS 4.34

Block 50 and 52

23 March 2019

CHANGE 2.00

LIST OF EFFECTIVE CHANGES

This document will be updated in accordance with BMS releases. You should consider the Dash 1 as a work in progress. It was started during BMS beta testing and updated to reflect the release version changes. It may already be outdated from the current beta BMS version but will be updated shortly after each release.

Change 2: (4.34)

(V2.00) published Feb 06th, 2019.

- 4.34 Dash1 update with many changes all around.

Change 1: (4.33)

(V1.06) published March 26th, 2016.

- Updated for 4.33 Update 1.
- Added MFL analysis

(V1.05) published Sept 5th, 2015.

- Added ILS section from BMS 4.32 Manual with relevant changes.
- Added section IV Flight Characteristics.

(V1.04) published August 9th, 2015.

- Merged AAR section from BMS Manual.

(V1.03) published July 13th, 2015.

- Proof read and 4.33RC changes.
- Updated pictures to reflect latest changes.

(V1.02) published March 31st, 2015.

- Proof read and 4.33RC changes.

(V1.01) published March 10th, 2015.

- First 4.33 Dash1 update (all systems).
- Added TFR & FLIR MFD pages.
- Added Pilot Fault List Analysis.
- Added 4.33 Callbacks.

Change 0: (4.32)

(V1.0) published March 28th, 2012.

- First released version.

(V0.8 draft) published March 24th, 2012.

- Proof read corrections.

(V0.7 draft) published January 11th, 2012.

- Changed structure of chapters.
- Added Landing chapter in Normal Procedures.

- Changed MARK POINTS section in UFC for OFLY, HUD, FCR & TGP mark.
- Added HUD Mark section in HUD chapter.
- Added training for flameout situation.

(V0.6 draft) published Dec 30th, 2011.

- Moved hotpit refuel & AA refuel to section II - normal procedure.
- Added Section III: Abnormal & Emergency procedures.
- Added Warning Light & Caution Light Analysis.
- Added Ground, Takeoff, In-flight & Landing emergencies.
- Adapted changes for 4.32 Update 1 change log.

(V0.5 draft) published August 31st, 2011.

- Various corrections from proof readers.
- Added Section2 – Normal Procedures.

(V0.4 draft) published August 29th, 2011.

- Added UFC, MFD, Engine, Fuel, ECS, Hydraulic, FLCS, EPU, Gear, Autopilot chapter
- Document formatting.
- Added BMS 4.32 callbacks.
- Added HUD chapter.
- Added Bibliography.

(V0.3 draft) published July 31st, 2011.

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SECTION I

DESCRIPTION & OPERATION

1.1 THE AIRCRAFT

In BMS you have the opportunity to fly a greater variety of F-16 blocks than ever before, many of them with country specific avionics and skins.

In the training TEs you will transition from some of the earlier blocks to more recent models with much more advanced avionics, some of them two-seaters.

Different variants all have their own unique setup, such as support for certain weapons, built-in ECM, different radar, updated RWR, support for conformal fuel tanks (CFT) and so on. All these versions have their differences so in order to keep this document simple we will concentrate primarily on one variant: the **F-16C/D block 50 with the GE-129 engine.**

Aircraft weights

The Gross Weight (GW) of the BMS F-16C (including oil, pilot, two wingtip AIM-120 missiles and a full load of 20mm ammunition is approximately 20500 lbs. With Full Internal fuel the GW is approximately 28000 lbs. The Max Take-Off weight is 42300 lbs.

Fuel Weight is 7162 lbs internally in 7 fuel tanks:

- Left wing (± 525 lbs)
- Right wing (± 525 lbs)
- Two forward fuselage F1 & F2, considered as a single F tank in BMS (± 3250 lbs)
- One aft fuselage: A (± 2810 lbs)
- And two reserve tanks: fwd reservoir and aft reservoir, each holding ± 480 lbs.

The two reserve fuselage tanks (F & A) supply fuel directly to the engine.

The D model has a smaller front fuselage (F) fuel capacity because of the second cockpit (1890 vs 3250 lbs). Fuselage fuel is therefore 4800 lbs and full internal fuel is 5900 lbs.

The F-16 can carry 3 external fuel tanks: 2 wing tanks of 370 Gallons (2516 lbs) each and a centreline 300 Gallon tank (2040 lbs) tank.

Total fuel weight with three external tanks is thus 14234 lbs (C model). We also have the capability to load 600 Gallon non-jettisonable wing tanks, though it is rarely done.

Conformal Fuel Tanks (if fitted) are considered part of the internal wing tanks for BMS fuel gauges.

Most of your flights will be done with a full load of internal fuel and 2 x 370 Gallon wing tanks.

The F-16 has no capability to vent fuel overboard. Air to Air Refuelling is provided through an AR port on top of the fuselage.

The F-16 doesn’t have a maximum landing weight. You can land the aircraft at any weight as long as the runway is long enough to accommodate the longer landing roll.

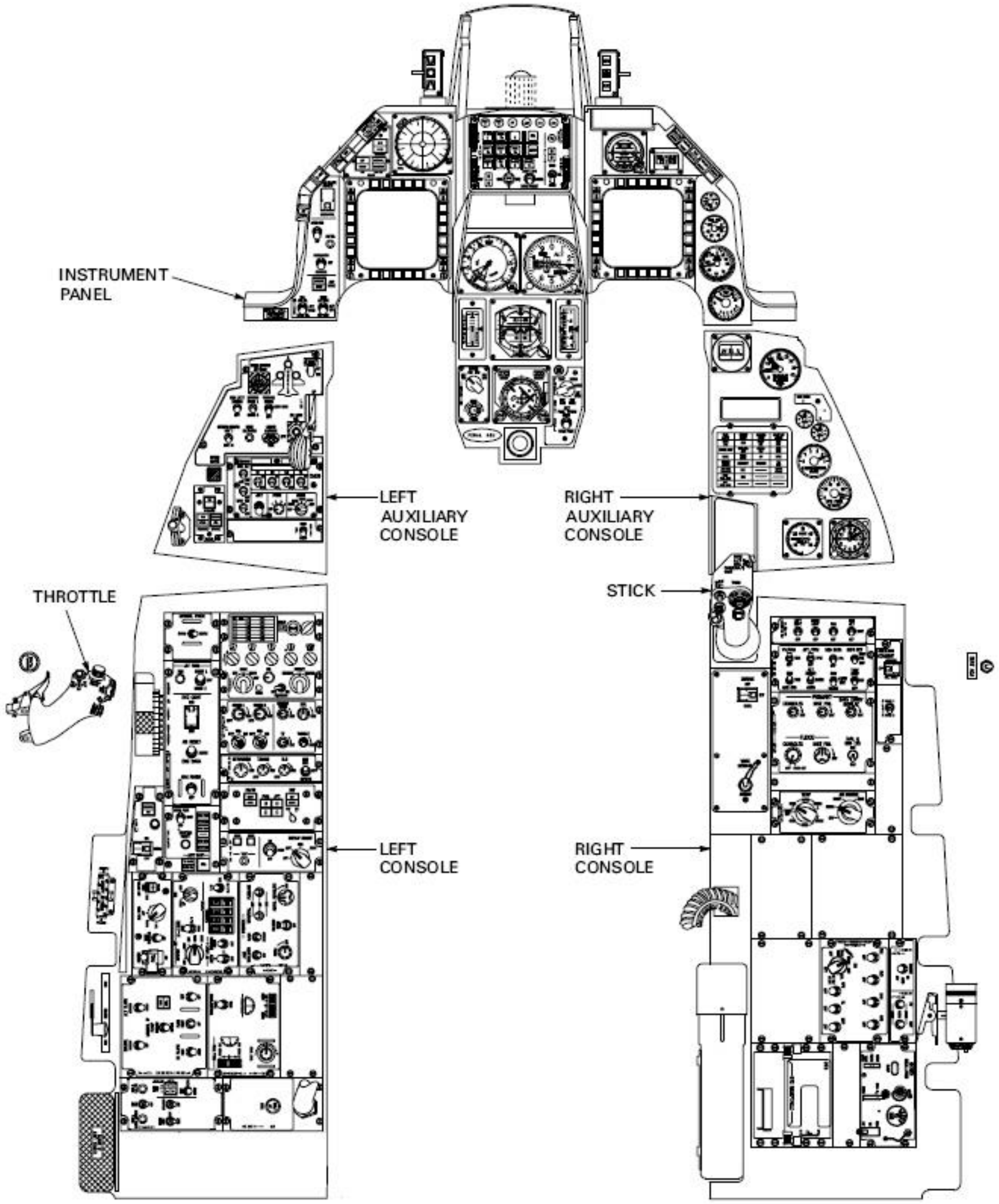
Aircraft speeds

Max Undercarriage speed is 305 knots.

The F-16 does not have a true corner velocity. It has a corner plateau from 330 to 440 knots that produces good turn rate based on available G according to altitude.

Manoeuvre speed is around 340 knots.

1.2 COCKPIT ARRANGEMENT



The F-16 cockpit is made up of the left console, left auxiliary console, centre panel, right auxiliary console and right console.

The left and right console are mainly used for start-up and ground ops, the auxiliaries and centre panels are mostly used in flight.

The heart of the onboard system is provided by the Up Front Controller (ICP & DED) and the 2 MFDs. All primary system management can be set through these.

In BMS the 3D cockpit is now our primary interface with the sim (the 2D cockpit is a thing of the past). View panning in the 3D cockpit is performed with Track IR (TIR) or similar tracking software, though you can pan around manually with a POV hat on a joystick/controller if set up properly.

Each button or knob can be interfaced with the keyboard or the mouse.

When interfacing switches with the keyboard, we use specific key callbacks for that switch. They can be toggles, full states position switches, push button press, push button release.

Callbacks are listed in the key file (\User\Config folder) where they are declared as a keystroke.
In turn these keystrokes can be programmed as HOTAS buttons, or used in full cockpit programming.

All active 3Dswitches can also be interfaced with the mouse. In this case we use the 3D button hotspot in the 3D cockpit and the mouse buttons.

Hotspots are displayed in the 3D cockpit with a change of cursor colour. When your mouse cursor reaches a hotspot it turns green, signalling the hotspot presence for the switch.

Usually moving the switch up is accomplished by depressing the left mouse button and moving it down is done with the right mouse button. The same is true for push buttons; they can be depressed with one mouse button and released with the other button.

Rotaries are usually incremented with the left mouse button and decremented with the right mouse button.

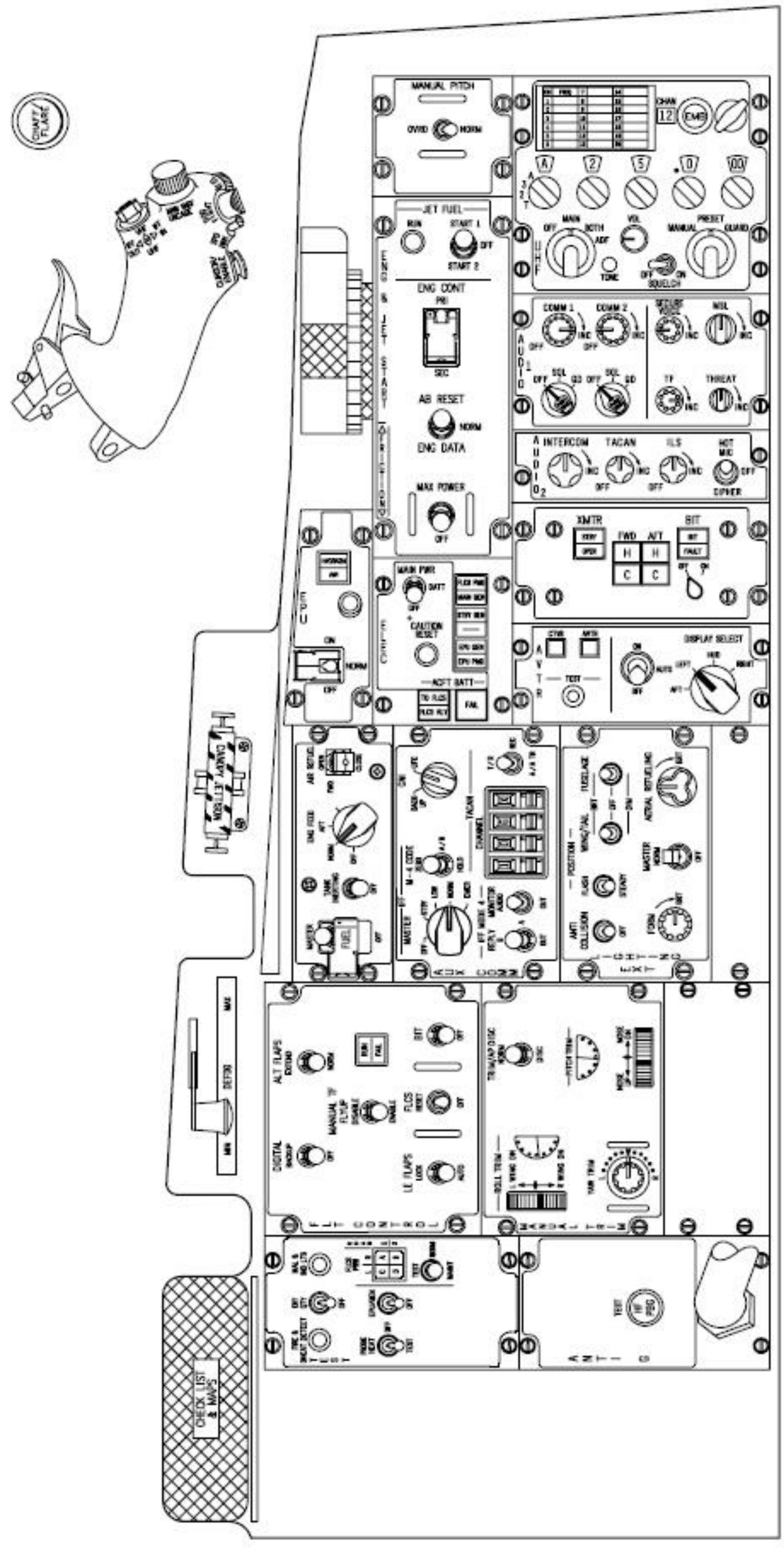
Encoders such as the CRS and HDG knobs on the HSI can be more rapidly adjusted with the mouse wheel. When the mouse is moved over a knob featuring that implementation the cursor will display a rotating effect signalling that the mouse wheel can be used. This is much faster than repeatedly clicking with the mouse button.

This chapter will review all cockpit panels and explain the functionality of each one. We will start on the far left of the cockpit and move toward the right console. A switch obscured by red shading means that this switch is not currently implemented in BMS. It thus has no key callback and no mouse hotspot.

At the end of each panel paragraph you will also find a list of the relevant key callbacks for that panel. That will hopefully help clarify the correct callbacks when a function needs to be programmed.

A more detailed explanation of callbacks can be found in the BMS-Technical-Manual.

1.2.1. LEFT CONSOLE



1.2.1.1 TEST panel

The TEST panel is used to perform tests on different systems during Ramp start. In BMS all switches and push buttons are implemented, except the FLCS TEST switch in the MAINT (Maintenance) position.

The FIRE & OHEAT DETECT button checks continuity for both engine fire and overheat detection systems. The overheat detection happens 100°C before the engine fire detection system. The overheat triggers the OVERHEAT caution light and the engine fire triggers the ENG FIRE eyebrow light. Those lights and the MASTER CAUTION light remain on as long as the button is held depressed.

The second pushbutton on the panel is MAL & IND LTS. It tests the illumination of all warning, caution, indicator lights, the warning horn and all voice messages in sequence.

The OXY QTY is a momentary switch and tests the OBOGS (On Board Oxygen Generating System). When depressed the OXY LOW eyebrow light should illuminate for 10 seconds if no faults are present and remain on if a fault is detected. Please note in newer blocks this switch should be labelled OBOGS BIT.

The PROBEHEAT switch is a three-position switch: PROBE HEAT, OFF and TEST.
The pitot, fuselage air data, AOA and the total temperature probe heaters are on anytime the aircraft is airborne regardless of the TEST panel switch position.
The PROBEHEAT position allows the probes to be heated on the ground. OFF de-energizes all systems on the ground. TEST (on the ground and in-flight) performs a functional test of the PROBEHEAT monitoring system. The PROBEHEAT caution light flashes for a successful test. Failure of the PROBEHEAT caution light to illuminate or flash indicates a failure of the probe heat monitoring system.

The EPU/GEN test switch is spring loaded to the OFF position and provides a means to test the EPU generator and EPU PMG output to FLCS on the ground without using hydrazine. Hydrazine is highly toxic for ground personnel and special procedures have to be followed when the EPU has run on hydrazine.

The quad indicator labelled FLCS PWR is the indicator of the 4 redundant digital systems (ABDC) of the FLCS (Flight Control System). In BMS they are considered as one and always light up together.

The FLCS PWR TEST switch is a momentary switch to TEST. With the MAIN PWR switch in BATT it closes the FLCS relay and allows verification of power output to the FLCC (Flight Control Computer) with the aircraft battery as the power source.

BMS Key Callbacks for the test panel:
SimOverHeat
SimOBOGSBit
SimMalIndLights
SimMalIndLightsOFF
SimProbeHeatMoveDown
SimProbeHeatMoveUp
SimProbeHeatOn
SimProbeHeatOff
SimProbeHeatTest
SimEpuGenTest
SimFlcsPowerTest

1.2.1.2 FLT CONTROL Panel (FLCP)

Refer to the FLCS chapter for a full overview of the FLCS system.

The panel is made of 6 switches and 1 dual indicator light.

The DIGITAL BACKUP switch is a two-position switch allowing the pilot to manually select a backup software state of the FLCS for digital FLCS equipped aircraft. When DBU is engaged the FLCS MFD page and the DBU ON warning light report the DBU condition. A HUD WARN message is also displayed.

The ALT FLAPS EXTEND/NORM switch controls the trailing edge flaps. In NORM they are controlled automatically by the FLCS. To extend them manually place the switch in EXTEND.

The LE FLAPS LOCK/AUTO switch commands the leading edge flaps. They can be automatically controlled by the FLCS in AUTO position (as a function of Mach, altitude and AOA) or locked in their current position in LOCK. When in LOCK the FLCS warning light illuminates and the PFLD reports a >FLCS LEF LOCK< warning message.

The FLCS RESET switch is a momentary switch to RESET and allows the FLCS fault to be reset. The MASTER CAUTION reset doesn’t clear FLCS related faults so the only way to reset the indicators, warning lights and PFL is by using the FLCS RESET switch. FLCS faults may be reset in BMS to exit the FLCS standby gains activated on any FLCS fault (see FLCS section). Not all faults can be reset.

The MANUAL TF FLYUP switch is a two-position toggle switch. It allows you to disable or enable FLYUP protection in MANUAL TF (Terrain Following) mode. Only aircraft fitted with the AN/AAQ-13 navigation pod (NVP), part of the LANTIRN (Low Altitude Navigation and Targeting Infrared for Night) system, will have Terrain Following Radar (TFR) capability.

The BIT switch is a magnetically held switch in BIT. It performs the FLCS built in test if the weight on wheel switch is on. BIT takes about 45 seconds, during which the RUN green indicator light is illuminated. During the BIT all flight control surfaces move in sequence (these movements are visible in multiplayer). If the BIT is successful the switch snaps back to the OFF position and the RUN light goes off.
In case of failure the switch returns to OFF and the yellow FAIL light illuminates. The PFL displays FLCS BIT FAIL and the status of the FLCS BIT is also shown on the FLCS MFD page. A failed BIT is not resettable and a new BIT needs to be run. During that second BIT both the FAIL and RUN lights will remain illuminated and upon successful completion the FAIL light will go off.

BMS Key Callbacks for the FLCS panel:

SimDigitalBUPBackup
SimDigitalBUPOff
SimDigitalBUP (new toggle)
SimAltFlaps (toggle)
SimAltFlapsExtend
SimAltFlapsNorm
SimManualFlyupDisable
SimManualFlyupEnable
SimManualFlyup (toggle)
SimLEFLockSwitch
SimLEFLock
SimLEFAuto
SimFLCSReset
SimFLTBIT

1.2.1.3 MANUAL TRIM panel

The Manual TRIM panel provides an additional method for the pilot to trim the aircraft. Primary trims (roll & pitch) are on the stick. The wheels and indicators on the MANUAL TRIM provide a backup way to set the trims by using the relevant wheel or knob.
Rudder trim can only be set on the MANUAL TRIM panel via the YAW TRIM knob.
In the F-16 trim is often required, especially in asymmetric load conditions. The 2 indicators move with stick trim input (when energised) and/or manual trim input. The wheels have a white line marking their centre position.

The TRIM/AP DISC switch is a two-position toggle switch. In NORM the stick trims are energized and AP operation is possible.
In DISC the stick trims and the autopilot are inhibited. Manual trim remains operative.

The MANUAL TRIM wheels and knobs can be interfaced through keystrokes, mouse clicks or analogue hardware such as potentiometers. The latter solution gives much better and smoother results. A little warning about mouse clicks: the way they are implemented is almost impossible to manage correctly in flight and should be avoided. Left click starts the trim movement and right click stops the trim action and starts the action in the opposite way. If you need to use the manual trims do it with keystrokes or analogue devices, not the mouse. Note that the YAW TRIM knob does not move in BMS when rudder trim is implemented and as a consequence you have no reference for the YAW TRIM position.

BMS Key Callbacks for the MAN TRIM panel:
SimTrimAPDisc (toggle)
SimTrimAPDISC (DISC switch position)
SimTrimAPNORM (NORM switch position)
SimTrimNoseUp
SimTrimNoseDown
SimTrimRollLeft
SimTrimRollRight
SimTrimYawLeft
SimTrimYawRight

1.2.1.4 FUEL panel

The FUEL MASTER switch is guarded in MASTER position. In some airforces the guard is even secured in place with a wire. This switch is not operated by the pilot in normal operations. When placed in OFF the fuel shutoff valve is closed, preventing fuel from reaching the engine.

The TANK INERTING switch is unsupported in BMS. In the real jet it reduces internal tank pressurisation**.**
The ENG FEED knob controls the way the fuel is pumped to the engine. Note that the fuel goes to the engine by gravity feed, so the engine will not starve when the fuel pumps are OFF. Use of the pumps prevents fuel starvation during negative G maneuvers and allows manual fuel balance whenever necessary.

OFF - all pumps are off.
NORM - all pumps are on, the CG (Centre of Gravity) is maintained automatically.
AFT - aft pumps are on. Fuel is transferred from the AFT tank to the engine. The CG moves forward.
FWD – forward pumps are on. Fuel is transferred from the FWD tank to the engine. CG moves back.

The AIR REFUEL switch is a two-position toggle switch. It opens or closes the Air Refuelling door. Upon opening the AR door the FLCS switches to takeoff and landing gains (if airspeed is below 400 knots). It also reduces internal tank pressurisation and depressurises external tanks, so they can be filled at air to air refuelling.

BMS Key Callbacks for the FUEL panel:
SimToggleMasterFuel
SimMasterFuelOn
SimMasterFuelOff
SimDecFuelPump
SimIncFuelPump
SimFuelPumpOff
SimFuelPumpNorm
SimFuelPumpAft
SimFuelPumpFwd
SimFuelDoorToggle
SimFuelDoorOpen
SimFuelDoorClose

1.2.1.5 IFF panel

BMS 4.34 introduced a fully implemented IFF system and the AUX COMM panel has been replaced with the IFF panel in some AIFF equipped aircraft. Backup TACAN controls have been moved to a MFD page and have been replaced by backup IFF controls. Please note, some non AIFF aircraft still have the AUX COMM panel (see below). For more information about the IFF system, please refer to Chapter 1.16 IFF.

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

The M-4 CODE switch controls how the IFF responds to mode-4 interrogations.
A/B is the normal operation position; the IFF uses the normal secret key that is either stored in A or B bank (set in UFC for normal operations and set with the Mode 4 reply switch in backup mode).
In ZERO, both code A and code B are erased from memory when the position is held for 2 seconds (keys are also erased automatically upon shutdown).
In HOLD, power-off zeroing is temporarily disabled and the Mode 4 codes are saved.

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

The IFF enable switch enables control of IFF modes in backup mode (CNI in Backup position). Normal IFF controls are set through the IFF UFC pages (more information in the UFC chapter)
M1/M3 enables Mode 1 and Mode 3 responses with the relevant codes inputted in the backup IFF digits codes.
M3/MS enables Mode 3 and Mode S responses (Mode S is not implemented in BMS 4.34).

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

The MODE 4 REPLY switch is a three-position switch that controls the Mode 4 reply in backup mode OFF: no response to mode4 interrogation. A: reply to Mode 4 interrogations with code A, B: reply to Mode 4 interrogations with code B.

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

Although not the case for block 50 & block 52 F-16, some other F-16 models may still have the AUX COMM panel installed. The main difference with the IFF panel documented above is the possibility to manage the backup TACAN controls rather than the backup IFF controls. The lower right part of the panel allows the pilot to set a TACAN channel, band and mode when the CNI switch is in BACKUP. The TACAN channel is set into the first three windows. The fourth window is used to set the X or Y band.

The T/R, A/A TR switch provides control of TACAN functions when the CNI switch is in BACKUP.
T/R is Transmit / Receive mode. The system receives signals which result in bearing and course deviation on the HSI and transmit distance interrogation to the station to get DME information.
REC (Receive) is not implemented.
A/A TR is the Air to Air Transmit and Receive mode. The system interrogates and receives signals from aircraft having air to air capability, providing slant range (Nm) distance between aircraft operating 63 TACAN channels apart. (The KC-10 also provides bearing information).

BMS Key Callbacks for the AUX COMMS panel:
SimIFFMasterOff
SimIFFMasterStby
SimIFFMasterLow
SimIFFMasterNorm
SimIFFMasterEmerg
SimIFFMasterInc
SimIFFMasterDec
SimIFFCodeSwitchZero
SimIFFCodeSwitchHold
SimIFFEnableOff
SimIFFEnableM1M3
SimIFFEnableM3MS
SimIFFEnableInc
SimIFFEnableDec
SimIFFEnableCycle
SimIFFBackupM1Digit1Inc
SimIFFBackupM1Digit1Dec
SimIFFBackupM1Digit1_0
SimIFFBackupM1Digit1_1
SimIFFBackupM1Digit1_2
SimIFFBackupM1Digit1_3
SimIFFBackupM1Digit1_4
SimIFFBackupM1Digit1_5
SimIFFBackupM1Digit1_6
SimIFFBackupM1Digit1_7

SimIFFBackupM1Digit2Inc
SimIFFBackupM1Digit2Dec
SimIFFBackupM1Digit2_0
SimIFFBackupM1Digit2_1
SimIFFBackupM1Digit2_2
SimIFFBackupM1Digit2_3

SimIFFBackupM3Digit1Inc
SimIFFBackupM3Digit1Dec
SimIFFBackupM3Digit1_0
SimIFFBackupM3Digit1_1
SimIFFBackupM3Digit1_2
SimIFFBackupM3Digit1_3
SimIFFBackupM3Digit1_4
SimIFFBackupM3Digit1_5
SimIFFBackupM3Digit1_6
SimIFFBackupM3Digit1_7

SimIFFBackupM3Digit2Inc
SimIFFBackupM3Digit2Dec
SimIFFBackupM3Digit2_0
SimIFFBackupM3Digit2_1
SimIFFBackupM3Digit2_2
SimIFFBackupM3Digit2_3
SimIFFBackupM3Digit2_4
SimIFFBackupM3Digit2_5
SimIFFBackupM3Digit2_6
SimIFFBackupM3Digit2_7

SimIFFMode4ReplyOff
SimIFFMode4ReplyAlpha
SimIFFMode4ReplyBravo
SimIFFMode4ReplyInc
SimIFFMode4ReplyDec
SimIFFMode4ReplyCycle
SimIFFMode4MonitorOff
SimIFFMode4MonitorAud
SimIFFMode4MonitorToggle

SimToggleAuxComMaster
SimAuxComBackup
SimAuxComUFC
SimCycleLeftAuxComDigit (cycle = move up)
SimDecLeftAuxComDigit (dec= move down)
SimCycleCenterAuxComDigit
SimDecCenterAuxComDigit
SimCycleRightAuxComDigit
SimDecRightAuxComDigit
SimCycleBandAuxComDigit
SimXBandAuxComDigit
SimYBandAuxComDigit
SimTACANTR
SimTACANAATR
SimToggleAuxComAATR (toggle)

1.2.1.6 EXT LIGHTING panel

All exterior lights except the taxi light are controlled from this panel.
The panel has been updated with 4.34 but functionalities remain the exact same as before.
The ANTI-COLLISION switch has been replaced by an anti-collision knob. But only two positions are implemented: OFF (Left-most position and ON (Right-most position corresponding to C.
It toggles the white anti-collision strobe situated on top of the tail.
The AC light is always flashing at the same frequency in BMS.
The POSITION FLASH/STEADY switch is a two-position toggle switch as well and is relevant only to the position lights (wingtips and fuselage) in BMS. In FLASH the wingtip and fuselage lights flash at a set frequency. In STEADY the lights remain on constantly.

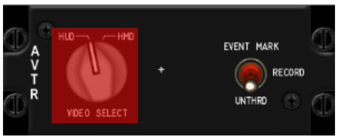
In BMS the fuselage (intake), wingtips and tail position lights are considered a single entity and as such one switch drives them all. In the cockpit both the WING/TAIL and FUSELAGE switches move together. Normally the FUSELAGE switch refers to the tail floodlights but those are not implemented in BMS. The DIM position is also not implemented and we only can set them OFF or BRT (bright).

The MASTER light switch has also been replaced by a MASTER knob of which only 2 positions are implemented (OFF & NORM). The COVERT options (IR) are not implemented either.
As its name implies is the main switch for all lights. Toggling this one OFF will switch off all lights except the taxi light. Conversely, this switch needs to be in NORM for exterior lights to work as set (except the taxi light).

Both the FORM and AERIAL REFUELING knobs are not implemented.

BMS Key Callbacks for the EXT LIGHT panel:
SimExtlMasterNorm
SimExtlMasterOff
SimExtlPower (toggle)
SimExtlAntiColl (toggle)
SimAntiCollOn
SimAntiCollOff
SimExtlSteady (toggle)
SimLightsSteady
SimLightsFlash
SimExtlWing (toggle)
SimWingLightBrt
SimWingLightOff

1.2.1.7 AVTR panel



This panel is used to toggle the ACMI on and off.
As you can see this panel has been updated since 4.33.
But unfortunately not for the best. The very useful green AVTR indicator light has been removed and the switch used to turn the ACMI ON is mislabelled and does not follow the common direction of all other cockpit switches. The VIDEO Select switch is not implemented. The old ON/AUTO/OFF switch has been replaced by a 3-position switch labelled UNTHRD, RECORD & EVENT MARK.
UNTHRD means OFF and is the default position.
EVENT MARK is mislabelled in BMS as in real life this is used to mark a specific point on the tapes (index) but in BMS it is the old AUTO position where the ACMI will turn ON for 30 seconds upon a gun trigger or a weapon pickle action.
RECORD is the old ON position where the ACMI is turned ON manually.

The problem is that this 3-position switch does not follow the common logic of all the rest of the 3D cockpit. To place the switch out of UNTHRD, you must click left as usual. But this action doesn't move the switch (as logic would dictate) to ON but straight to EVENT MARK. To move to record, you still must left click with the switch on EVENT MARK to move the switch down to RECORD. Normally a move down should be a right click.
So basically, to record an ACMI with the mouse, click twice with the left mouse button. And to place it back to OFF, click twice with the right mouse button.

Note that an option in *Falcon BMS.cfg* (in the *\User\Config* folder) lets you choose whether to display the ACMI RECORDING message on screen or not. Back in 4.33 we advised not to use it and use the green AVTR indicator light instead? Unfortunately, with 4.34 that ACMI message might be unrealistic but it is your sole option to indicate ACMI status.

BMS Key Callbacks for the AVTR panel:
SimAVTRSwitch (cycle)
SimAVTRToggle (toggle)
SimAVTRSwitchOff
SimAVTRSwitchAuto
SimAVTRSwitchOn
SimAVTRSwitchDown (step down)
SimAVTRSwitchUp (step up)

1.2.1.8 ECM panel

Due to its nature and the fact that most ECM systems are classified, this panel is not implemented. The only switch used in BMS is the main toggle switch, labelled OPR, STBY, OFF.
BMS only uses the ON/OFF position and that switch needs to be placed in OPR for the ECM pod to be energized (if carried).

BMS Key Callbacks for the ECM panel:
SimEcmPowerOn
SimEcmPowerOff
SimECMPower (toggle)

1.2.1.9 ELEC panel

The real electrical system of the F-16 is quite complicated with a main AC power system distributing current to the non-essential, essential and emergency buses, a standby AC power system distributing power to the essential and emergency buses, an emergency AC power supply distributing power to the emergency buses and a DC power and FLCS power supply.

The main power switch is a three-position switch.
In OFF no electrical system receives power from the main generator, standby generator or battery. All systems are cold.
In BATT the aircraft battery is connected and the battery bus is powered.
In MAIN the MAIN generator and standby generator provide power to the aircraft systems.

The CAUTION RESET push button is the only way to reset an ELEC fault, displayed as the amber ELEC SYS caution light. It also resets the main and standby generators.

FLCS PMG indicator light: when it lights up it means that none of the FLCS branches are receiving power from the FLCS PMG (Permanent Magnet Generator). Basically that means the primary power source for the FLCS has failed.

When the MAIN GEN indicator comes on it means that the main generator is not connected to the non-essential AC buses. In all likelihood the main generator has failed.

Likewise, when the STBY GEN indicator light up it means that standby generator power is not available.

When the EPU GEN indicator light comes on it means the EPU has been commanded ON but the EPU generator is not providing power to the emergency buses. Be aware that the light does not function with the EPU in OFF (WOW) and the engine running.

When the EPU PMG indicator light comes on it means that the EPU has been commanded ON but the EPU is unable to provide power to the FLCS branches (normally through the EPU PMG).

The two lower indicators refer to the aircraft battery.
When the TO FLCS indicator lights up it means that the battery power is going to one or more FLCS branches. Basically the battery is powering the FLCS and will deplete fast.

When the FLCS RLY indicator light comes on it means that one or more FLCS branches aren’t getting adequate voltage from the battery.

When the FAIL indicator light comes up it means that the aircraft battery has failed or is failing to charge (on the ground).

BMS Key Callbacks for the ELEC panel:
SimMainPowerOff
SimMainPowerBatt
SimMainPowerMain
SimElecReset
SimMainPowerInc (step up)
SimMainPowerDec (step down)

1.2.1.10 EPU panel

The EPU is a self-contained system that simultaneously provides emergency hydraulic pressure to system A and emergency electrical power to the emergency buses. The EPU automatically activates (unless the EPU safety pin is installed) when both main and standby generators fail or when hydraulic pressure falls below 1000 psi.

The EPU uses engine bleed air and/or hydrazine to operate. If engine bleed air is sufficient to maintain operating speed the EPU doesn't use hydrazine. Hydrazine is only used as a booster when bleed air is not sufficient.

The main switch for the EPU is a double guarded three-position switch. With the guard down the switch is locked in NORM.

OFF - the EPU is prevented from running.
NORM - the EPU is armed for automatic start upon failure of the main and standby generators, if the throttle is out of the CUTOFF position. The EPU will not start on shutdown (WOW and throttle in CUTOFF). On engine start the EPU pin prevents the EPU from starting up. The EPU pin should be removed via the ATC menu > Ground page prior to the EPU test.
ON - the EPU is commanded to RUN regardless of failure conditions.

As you see on the panel the switch is guarded, but any mouse click on the switch lifts the guard and operates the switch at the same time. In other words the guard has no effect in BMS.

The EPU RUN green light comes on whenever the EPU turbine runs within the proper range and the EPU hydraulic pressure is above 2000 psi.

The top indicator is telling the pilot if the EPU runs on engine bleed air and/or hydrazine.
When the yellow AIR indicator lights up (bottom light) the EPU is running on bleed air which is sufficient to maintain operating speed. If possible when the EPU runs, engine RPM should be maintained between 82 & 90% to prevent the EPU using hydrazine. Unfortunately in Falcon when the EPU needs to run it's usually because we've lost the engine.
When the yellow HYDRAZN (top light) comes on, the bleed air is not sufficient to maintain operating speed and is being augmented by hydrazine. In that case both indicator lights will be on.
Hydrazine is limited and usually depletes in 10 minutes under normal load requirements. Increased flight control movement reduces this operating time further. Also bear in mind that if the EPU is your sole source of hydraulic pressure and power, when the hydrazine is depleted you lose everything. As a consequence when you start running on hydrazine, plan to be on the ground within the next 10 minutes or tighten your straps ready for an ejection. For more information about the EPU and which systems are powered by the emergency bus please refer to the Electrical and EPU section later in this manual.

BMS Key Callbacks for the EPU panel:
SimEpuToggle
SimEpuOff
SimEpuOn
SimEpuAuto
SimEpuUp (step up)
SimEpuDown (step down)

1.2.1.11 AUDIO 2 panel

The AUDIO 2 panel provides control to the less frequently used communications system. The intercom volume knob is used to control the volume of all sounds normally heard in the pilot's helmet. It allows the user to set the respective individual volumes to a desired 'mix' level and then turn it up or down relative to the rest of the background sounds (those normally not heard in the pilot's headset).
The TACAN volume is normally used to get the morse code of the emitting station in the headset but this is not implemented in BMS, so that volume control is not implemented. There is not even a need to switch to knob out of OFF for the TACAN to work, it's coded always on. Likewise there is no ILS audio but this time the knob can be turned ON and OFF to power the ILS system. Unlike BMS 4.32 where the ILS was always on the pilot now needs to power the ILS to be able to see ILS symbology. Finally, the HOT MIC switch is not implemented.

BMS Key Callbacks for the AUDIO2 panel:
SimILSOn
SimILSOff
SimILS (toggle)
SimStepIntercomVolumeUp
SimStepIntercomVolumeDown

1.2.1.12 AUDIO 1 panel

The AUDIO 1 panel controls the primary communication systems. Unless otherwise specified, the controls are active regardless of the position of the CNI switch on the AUX COMM panel.

The COMM1 power knob has an ON/OFF switch and when rotated past the ON position increases volume for the COMM1 radio (UHF). This control can be set through an analogue potentiometer via the advanced setup, or with regular keystrokes.

The COMM1 mode knob has three-position: OFF, SQL and GD.
In OFF squelch mode is disabled (though squelch is not implemented in BMS).
In SQL the squelch mode is activated helping reduce background noise in normal operations.
In GD the main receiver and transmitter are tuned to the guard UHF frequency (243.000). Please note GD position is not functional when the CNI is in BACKUP (guard is then selected from the backup UHF panel).The push function is not implemented in BMS.

The COMM2 power and mode knobs have the same functions, but for the second radio (VHF).
GD position tunes to VHF guard (121.5).

The secure voice and TF knobs are not supported in BMS.

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

The THREAT knob is used to set the TWS (Threat Warning System) sound level. This control can be set either with an analogue potentiometer via the advanced setup or with regular keystrokes.
The knob has no ON/OFF position and at ramp and during your FENCE check you should check its position unless you use a potentiometer to interface it. In that case the volume is set at whatever position the pot was left during the last flight.

BMS Key Callbacks for the AUDIO1 panel:
SimStepComm1VolumeUp
SimStepComm1VolumeDown
SimComm1PowerOn
SimComm1PowerOff
SimStepComm2VolumeUp
SimStepComm2VolumeDown
SimComm2PowerOn
SimComm2PowerOff
SimStepMissileVolumeUp
SimStepMissileVolumeDown
SimStepThreatVolumeUp
SimStepThreatVolumeDown
SimAud1Com1Sql
SimAud1Com1Gd
SimAud1Com1 (toggle)
SimAud1Com2Sql
SimAud1Com2Gd
SimAud1Com2 (toggle)

1.2.1.13 ENG & JET START panel

The main purpose of this panel is to start the engine. This is done using the JFS (Jet Fuel Starter) switch. The JFS is an independent gas turbine and is started by 2 JFS/brake accumulators which are charged automatically by hydraulic system B.

The JFS is used to start the engine on the ground and to assist in engine airstarts. The switch is a magnetically held 3-position switch, magnetically held in START1 or START2. Currently in BMS we only use the START 2 position with a RIGHT mouse click (down is always right click).

When placed in START 2 the JFS spools up and drives the main engine turbine shaft RPM to 20-25%. If you have a suitable throttle (with a strong idle detent) and have the Idle Cutoff option box checked in *Falcon BMS.cfg* the throttle can then be moved out of its CUTOFF position to IDLE, which starts the main engine as it does in the real jet. In BMS this can also be done with the throttle detent key callback.

The JFS/brake accumulator starts to recharge past 12% engine RPM with HYD B pressure and takes between 40 and 60 seconds to regain a full operating pressure charge. The JFS automatically shuts down when the engine RPM passes 55%. The switch then snaps back to OFF.

Since BMS 4.33 the green JFS run light no longer comes on as soon as the JFS is activated but illuminates around 15 seconds later once the JFS has attained nominal operating speed.
In 4.34 the JFS light state will indicate JFS status: a JFS light flashing once every second will indicate a JFS overheat and a JFS light flashing twice per second will indicate a JFS failure.

The ENG CONT PRI/SEC is a two-position switch guarded in PRI, which is the normal (primary) engine operating mode. The engine transfers automatically to SEC mode in the case of any failure of the Digital Electronic Control (DEC). It can manually be transferred to SEC by placing the ENG CONT switch in SEC. Transfer is indicated by the SEC caution light on the warning panel. When operating in SEC the engine exhaust nozzle remains closed and afterburner is inhibited (nozzle is now visible in multiplayer).

The AB RESET and MAX POWER switches are not implemented in BMS.

BMS Key Callbacks for the ENG & JET START panel:
SimJfsStart (toggle)
SimJfsStart_Start2
SimJfsStart_off
SimEngCont (toggle)
SimEngContPri
SimEngContSec

1.2.1.14 Backup UHF panel

The only backup radio available in the F-16 cockpit is the UHF radio. There is no backup mode for the VHF radio. For the UHF backup radio to operate, the C&I switch on the IFF (or AUX COMM) panel needs to be in the BACKUP position.

With the right mode knob in MNL (manual) any valid frequency is selectable using the frequency control knobs.

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

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

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

The tiny volume knob has been implemented (with analogue values as well) to balance IVC volume against AI volume. It is not the real function of that knob, but quite useful in Falcon where AI comms do not follow the same logic as IVC humans comms on UHF & VHF.

BMS Key Callbacks for the BACKUP UHF panel
SimCycleRadioChannel
SimDecRadioChannel
SimBupUhfOff
SimBupUhfMain
SimBupUhfBoth
SimBupUhfPreset
SimBupUhfGuard
SimBupUhfManual
SimBupUhfFuncDec
SimBupUhfFuncInc
SimBupUhfModeDec
SimBupUhfModeInc
OTWBalanceIVCvsAIUp
OTWBalanceIVCvsAIDown
SimBupUhfFreq1Inc
SimBupUhfFreq1Dec
SimBupUhfFreq1_2
SimBupUhfFreq1_3
SimBupUhfFreq2Inc
SimBupUhfFreq2Dec
SimBupUhfFreq2_0
SimBupUhfFreq2_1
SimBupUhfFreq2_2
SimBupUhfFreq2_3
SimBupUhfFreq2_4
SimBupUhfFreq2_5
SimBupUhfFreq2_6
SimBupUhfFreq2_7
SimBupUhfFreq2_8
SimBupUhfFreq2_9
SimBupUhfFreq3Inc
SimBupUhfFreq3Dec
SimBupUhfFreq3_0
SimBupUhfFreq3_1

SimBupUhfFreq3_2
SimBupUhfFreq3_3
SimBupUhfFreq3_4
SimBupUhfFreq3_5
SimBupUhfFreq3_6
SimBupUhfFreq3_7
SimBupUhfFreq3_8
SimBupUhfFreq3_9
SimBupUhfFreq4Inc
SimBupUhfFreq4Dec
SimBupUhfFreq4_0
SimBupUhfFreq4_1
SimBupUhfFreq4_2
SimBupUhfFreq4_3
SimBupUhfFreq4_4
SimBupUhfFreq4_5
SimBupUhfFreq4_6
SimBupUhfFreq4_7
SimBupUhfFreq4_8
SimBupUhfFreq4_9
SimBupUhfFreq5Inc
SimBupUhfFreq5Dec
SimBupUhfFreq5_00
SimBupUhfFreq5_25
SimBupUhfFreq5_50
SimBupUhfFreq5_75

1.2.1.15 MANUAL PITCH override panel

The MPO switch is a two-position switch momentary in OVRD. It provides a means for the pilot to override FLCS pitch and give direct control of the elevators to the pilot. There is a stable trim point around 60° AOA which allows the aircraft to enter a deep stall. In this configuration the FLCS will always command maximum elevator pitch down angle, but in this configuration the aircraft will remain in the deep stall.

In such a deep stall the pilot needs to override the FLCS and pitch-rock the aircraft to exit the stall condition. The MPO can be tested at ramp. Simply move the elevator to its fullest extent and hold the MPO switch in OVRD. Notice the increased elevator angle as long as the switch is held in the override position (this is also now visible in multiplayer).

BMS Key Callbacks for the MPO panel
SimMPO
SimMPOToggle

1.2.1.16 Throttle grip and left side wall

The left sidewall has two important hotspots. Hotspots are areas where the mouse turns into a selective zone where a switch can be clicked.
The first one is the canopy area. Normally the canopy switch is hidden inside the left sidewall and protected with the yellow spider. The spider is just a switch guard. But in BMS it is the switch itself if you are using the mouse to operate it. Click on the spider hotspot to open or close the canopy. Alternately you can use the keystroke callback. The mission starts with the canopy open at Ramp start in BMS.

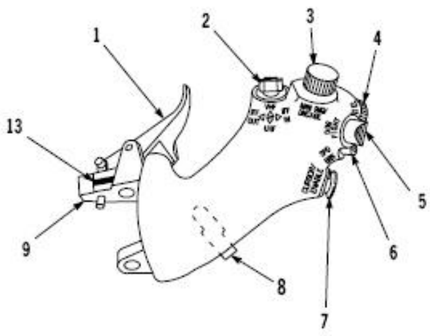
With the Idle Cutoff option disabled (in *Falcon BMS.cfg*) the idle detent needs to be depressed when the JFS has spooled up the engine to 20% RPM in order to start the engine. It was done so to simulate moving the throttle from the vertical CUTOFF position to the horizontal idle position. Likewise to shut the engine down the idle detent needs to be depressed when the throttle is idle for the engine to spool down. This was done to simulate lifting the throttle out of the idle position to the vertical CUTOFF position. Note that the idle detent only works when your throttle is all the way back (at its minimum).

There is a third feature on the left side wall that may be of interest: the SLAP switch. This is a pushbutton programmed to drop countermeasures program 5. The pilot usually slaps it in the real jet (don't try in the sim!) It does however give you a third countermeasures program immediately available without switching the PGRM knob on the CMDS. There is no mouse hotspot for the SLAP switch in the 3D cockpit so you will have to use the key callback which you can assign to any hardware button.

Not on the side wall but close to the left console you will find the seat arm lever on the left edge of the seat. This lever safes/arms the ejection seat. The lever in the UP position safes the seat and the lever in the DOWN position arms the seat.

BMS Key Callbacks for the left side panel:
AFCanopyToggle
AFCanopyOpen
AFCanopyClose
SimSlapSwitch
SimSeatOn
SimSeatOff
SimSeatArm (toggle)
SimEject

1. Cutoff release (wrongly called idle detent in BMS)
2. Comms switch (L & R = IDM, Up & Down = radio)
3. MAN RNG knob
4. ANTENNA knob
5. DOGFIGHT / MRM mode switch
6. SPEEDBRAKE switch
7. Cursors
8. HOBO switch (not implemented in F4)



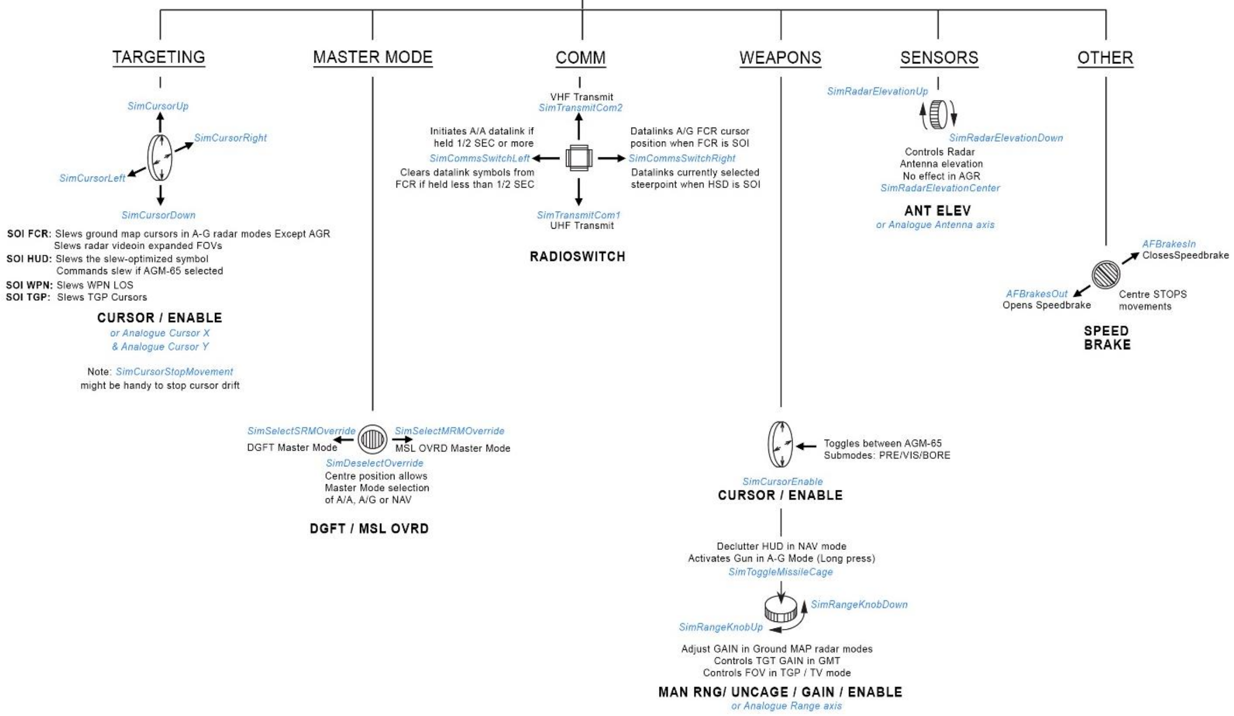
Flying a simulator you can choose how you program your HOTAS. We do advise you to use a program as close as possible to the real F-16 HOTAS.

The two following images illustrate the relationship between the real throttle functions (A-G and A-A) and the BMS callbacks (taken from the BMS -34)

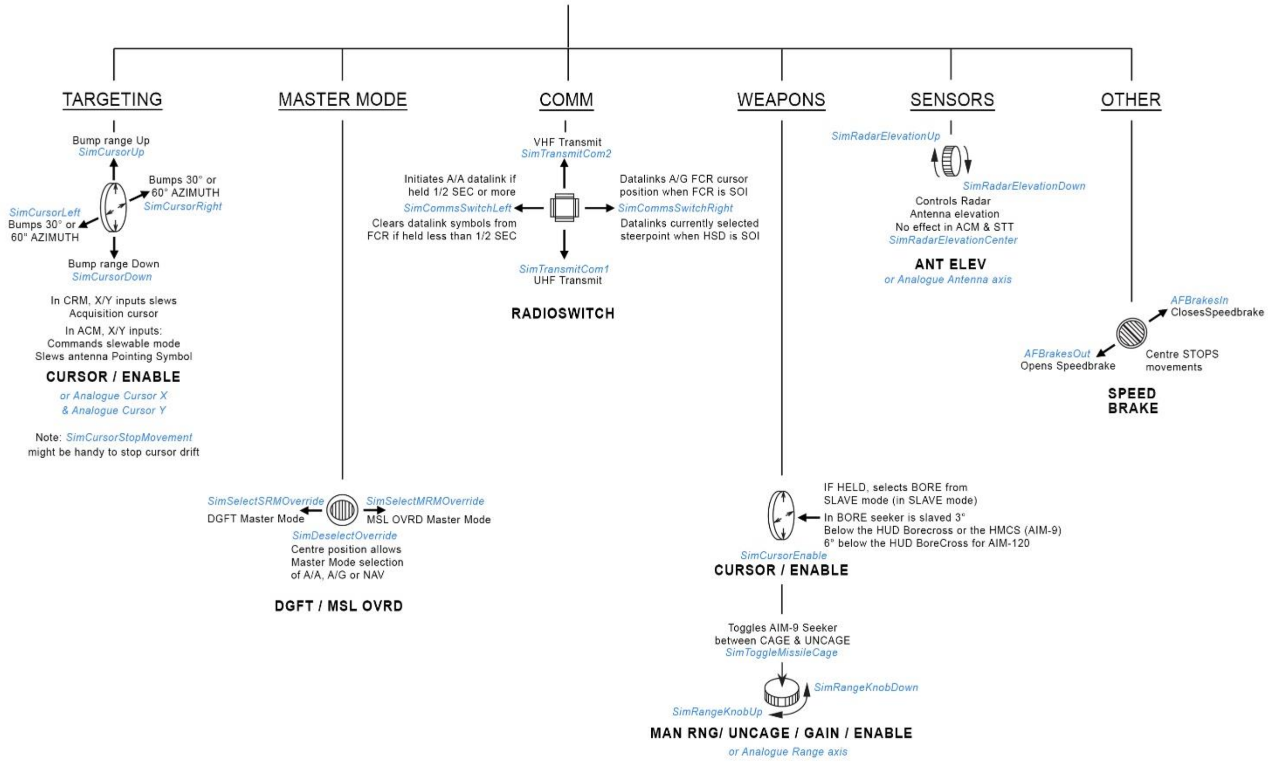
BMS Key Callbacks for the throttle:

SimThrottleIdleDetentForward
SimThrottleIdleDetentBack
SimThrottleIdleDetent
SimTransmitCom1
SimTransmitCom2
SimCursorEnable
SimToggleMissileCage
SimSelectSRMOverride
SimSelectMRMOverride
SimDeselectOverride
AFBrakesOut
AFBrakesIn
AFBrakesToggle
SimCommsSwitchLeft
SimCommsSwitchRight
SimRadarCursorZero
SimCursorUp
SimCursorDown
SimCursorRight
SimCursorLeft
SimRangeKnobUp
SimRangeKnobDown
SimRadarElevationUp
SimRadarElevationDown
SimRadarElevationCenter

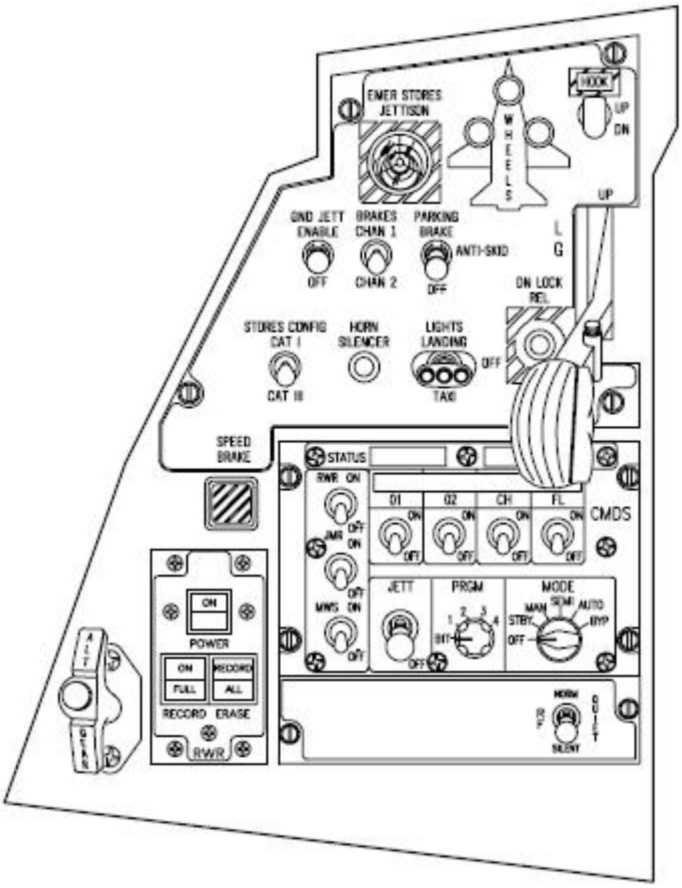
HANDS-ON CONTROLS
AIR TO GROUND MISSION
THROTTLE
A-G (& NAV) MASTERMODE



HANDS-ON CONTROLS
AIR TO AIR MISSION
THROTTLE
A-A, MSL OVRD, DGFT MASTERMODE



1.2.2. LEFT AUXILIARY CONSOLE



1.2.2.1 ALT GEAR HANDLE

This handle is used to extend the landing gear when normal extension is not possible (in case of hydraulic failure due to engine flameout for instance). Pulling the handle provides enough pneumatic pressure to open the gear doors and extend the landing gear. Please note you can lower the gear with the alternate handle only once as the pneumatic pressure cannot be recharged in flight.
The ALT GEAR RESET button (white button in the centre of the handle) allows retraction of the landing gear after an alternate extension if hydraulic pressure is available.

BMS Key Callbacks for the ALG GEAR handle
AFAlternateGear
AFAlternateGearReset

1.2.2.2 TWA panel

The Threat Warning Aux panel is part of the EWS suite. It is made up of 4 indicators (3 with pushbuttons): SEARCH, ACT/PWR, ALTITUDE & POWER.

The POWER button applies and removes power to the EWS suite. The green indicator comes on when the EWS is powered.

The ACT/PWR button is a dual indicator and has no button. The top indicator labelled ACTIVITY comes on if the EWS is powered and detects a radar painting the aircraft.
The bottom indicator labelled POWER is on whenever the EWS suite is powered.

The SEARCH button allows ‘S’ search radar symbols to be displayed on the RWR display if the EWS is powered and detects a search radar; by default they are not. With SEARCH enabled a SAM radar in search mode will display as an ‘S’, well before you would expect to see its acquisition symbol if SEARCH was not enabled, giving you an early warning in most cases.
With the SEARCH option not active the green ‘S’ indicator on the TWA will blink at 4 Hz whenever the EWS detects a search radar painting the aircraft. In that configuration ‘S’ symbols are not displayed on the RWR.
The green ‘S’ indicator on the TWA will remain lit as long as the SEARCH option is active. A further press of the button deactivates the SEARCH option.

ALTITUDE is both a pushbutton and a dual indicator.
The pushbutton toggles between HIGH & LOW altitude threat assessment biasing. The EWS is able to categorize the SAM threat according to their lethality at low or high altitude.
The top indicator labelled LOW comes on if the EWS is powered when the LOW option is selected.
The bottom indicator labelled ALT comes on whenever the EWS suite is powered.

BMS Key Callbacks for the TWA panel:
SimRwrPower (toggle)
SimRwrPowerOn
SimRwrPowerOff
SimRWRSetGroundPriority
SimRWRSetSearch

1.2.2.3 HMCS panel

The Helmet Mounted Cueing System displays weapon, sensor and flight information to the pilot through the helmet visor providing off-boresight missile capability. It is an extension of the HUD and considered as one SOI (HUD & HMCS).
The panel bears a single knob featuring and ON/OFF switch and a clockwise motion for increased brightness. The knob can be interfaced with an analogue device as well.
Refer to the HMCS section for further discussion of the HMCS.

BMS Key Callbacks for the HMCS panel:
SimHmsSymWheelUp
SimHmsSymWheelDn
SimHmsOn
SimHmsOff

1.2.2.4 CMDS panel

The CMDS panel is part of the EWS suite and mainly manages all countermeasures. It is used in conjunction with the CMS switch on the sidestick (see stick section on the right console).
The RWR and JMR switches are two state toggle switches that control automatic dispensing of chaff and flares. The RWR switch must be ON for the SEMI and AUTO modes to function. The JMR switch needs to be ON for the EWS to be able to release countermeasures coordinated with the use of the Jammer pod.

The MWS switch is not implemented in the USAF latest block inventory jets and this is therefore not implemented in BMS.

The panel provides four categories of expendables, only two are supported in the F-16. They are on the right side of the panel and labelled CH for chaff and FL for flares. Category 01 & 02 are not implemented and can remain OFF. When the switch is OFF the display above remains blank. Needless to say both the CH and FL switches need to be ON for chaff and flares to be released. The above indicator displays the number of expendables remaining and when bingo level is reached (set through the DTC or UFC) LO is displayed with the number remaining. When a category is exhausted 0 is displayed.

The MODE knob selects the CMDS operating mode: OFF, STBY, MAN, SEMI, AUTO and BYP. Depending on the mode selected the countermeasures released correspond to the selected program (position of the PRGM knob).
OFF - the CMDS is not powered and countermeasures cannot be released.
STBY - the release parameters and programming can be manually changed using the UFC. It is the only mode allowing reprogramming. The CMDS cannot release countermeasures in this mode.
MAN - only programs 1 to 5 can be released manually by the pilot by using the CMS on the sidestick. CMS forward releases whatever program is selected (1 to 4) through the PRGM knob. Program 5 can also be released with the slap switch on the left side panel.
SEMI - release is not automatic but the EWS will prompt the pilot through the VMS (“COUNTER”) whenever the system feels countermeasures should be employed. The pilot then can give consent to release by depressing CMS aft. The selected program will be then released once. If the threat persists the EWS will prompt for consent again (“COUNTER”). Consent must be given each time. Please note that for the SEMI mode to work the RWR switch on the CMDS panel needs to be ON.
AUTO - Consent must be given once (CMS aft) and is assumed until it is explicitly cancelled with a CMS right. Deployment of countermeasures is thus automatic and can deplete your stores very fast depending on the program selected.

BYP - is a Bypass mode and is used when the CMDS fails. BYP allows the pilot to release one chaff & one flare only at each CMS forward command. BYP is always manual; no SEMI or AUTO functions are active while in BYP.

The PRGM knob allows the pilot to select one of the 4 pre-programmed countermeasure sequences. When CMS forward is depressed the selected program is activated. There are a total of 6 programs but only 1 – 4 can be selected through the PRGM knob. PRG 5 is always activated by the slap switch on the left sidewall and PRG 6 is always activated by depressing CMS left. All 6 programs can be programmed through DTC, or the UFC whenever the CMDS mode in is STBY.
The BIT position is the CMDS self-test and is not implemented in BMS.

The JETT switch dumps all remaining flares at once (no visual effect implemented).

The top row indicators simply provide GO, NO GO, DISPENSE RDY messages.
GO means all system are in the green and the CMDS is ready.
NO GO means the system is not ready (one of the systems is not powered or has failed).
DISPENSE RDY comes ON whenever the CMDS is ready to dispense but consent is required.

BMS Key Callbacks for the CMDS panel:
SimEWSRWROn
SimEWSRWROff
SimEWSRWRPower (toggle)
SimEWSJammerOn
SimEWSJammerOff
SimEWSJammerPower (toggle)
SimEWSMwsOn
SimEWSMwsOff
SimEWSMwsPower (toggle)
SimEWSChaffOn
SimEWSChaffOff
SimEWSChaffPower (toggle)
SimEWSFlareOn
SimEWSFlareOff
SimEWSFlarePower (toggle)
SimEWSO1On
SimEWSO1Off
SimEWSO1Power (toggle)
SimEWSO2On
SimEWSO2Off
SimEWSO2Power (toggle)
SimEWSModeOff
SimEWSModeStby
SimEWSModeMan
SimEWSModeSemi
SimEWSModeAuto
SimEWSModeByp
SimEWSPGMInc
SimEWSPGMDec
SimEWSProgOne
SimEWSProgTwo
SimEWSProgThree
SimEWSProgFour
SimEWSProgDec
SimEWSProgInc
SimEwsJett (toggle)
SimEwsJettOff
SimEwsJettOn

1.2.2.5 Speedbrake indicator

A square mechanical indicator reports the speedbrake position to the pilot. Speedbrakes are activated with the speedbrake switch on the throttle. Switch backwards extends the speedbrakes (momentarily) and switch forwards closes the speedbrakes. The speedbrakes stop their motion once the switch is replaced in the centre. The indicator with 9 dots indicates a speedbrake OPEN and when it’s closed the indicator displays CLOSED. Diagonal lines signify lack of power to the indicator.

1.2.2.6 Gear panel

The landing gear (LG) and its doors are operated by hydraulic system B. It has two main gears (MLG) and one nosewheel (NLG).

The gear handle commands LG retraction or extension. A red warning light in the top of the handle illuminates when the LG and doors are in transit or have failed to lock in position. The light also comes on below 10000 feet when all LG are not down and locked, airspeed is less than 190 knots and rate of descent is greater than 250 feet per minute.

In real aircraft the handle is locked in the up position to prevent inadvertent lowering of the gear. To lower the gear the pilot has to depress the white pushbutton located on the landing gear handle. This is not implemented in BMS.

The DN LOCK REL button is not implemented either in BMS. In the real jet it allows the pilot to retract the LG on the ground by depressing this yellow button and moving the LG handle up. Indeed once WOW is activated, the landing gear cannot be retracted unless this safety button is depressed.

What is implemented though is the WOW switch (Weight On Wheels). Once weight is on the gear struts the WOW switch is activated allowing or terminating various system functions.

The three green wheels down indicators come on whenever the respective landing gear is down and locked. A full gear down and locked indication is given when all three lights are green and the red lollipop handle light is off.

The hook shaped switch above the LG handle is a two-position toggle switch operating the emergency arrestment system. While it is implemented on the BMS F-16 there is unfortunately no arrestment gear on any Falcon airbase yet, so it can currently be considered procedural only.
When the hook is down the HOOK caution light located on the caution panel (right aux) is illuminated.

The LIGHTS LANDING/TAXI light also has a specific shaped cap and operates the landing/taxi lights. The real jet has a three-position switch because of the distinction made between the landing light and the taxi light. In BMS we have no such distinction and the switch is a two-position toggle: up for light on and down for off. Please note: the Per-Pixel Lighting option (on by default in *Hardware > Shaders > Lighting Effects*) must be checked in Falcon BMS.cfg for the lights to be correctly visible.

The HORN SILENCER white pushbutton when depressed silences the VMS low speed/gear horn. The horn becomes audible when the following conditions are met: below 10000ft, less than 190 knots, gear not down and locked, sink rate greater than 250 fpm.

The STORES CONFIG CATI/CATIII switch is a two-position toggle switch: CATI and CATIII. CATIII position should be selected when the aircraft is configured with a category III loading; AOA limiter is then provided. Please refer to the FLCS chapter for further discussion.

The GND JETT switch is a two-position toggle switch: ENABLE and OFF. In ENABLE it allows the pilot to jettison his load on the ground. Obviously in OFF this jettison is not possible.

The BRAKES channel switch is not implemented in BMS. We only have one channel brake and aircraft braking is provided by the toebrakes. For those not having 3-axis rudder pedals the toebrakes can also be implemented with a keystroke. It is strongly advised to use toebrake pedals in BMS as differential braking is implemented. Please refer to the brakes chapter for further discussion about the F-16 braking system.

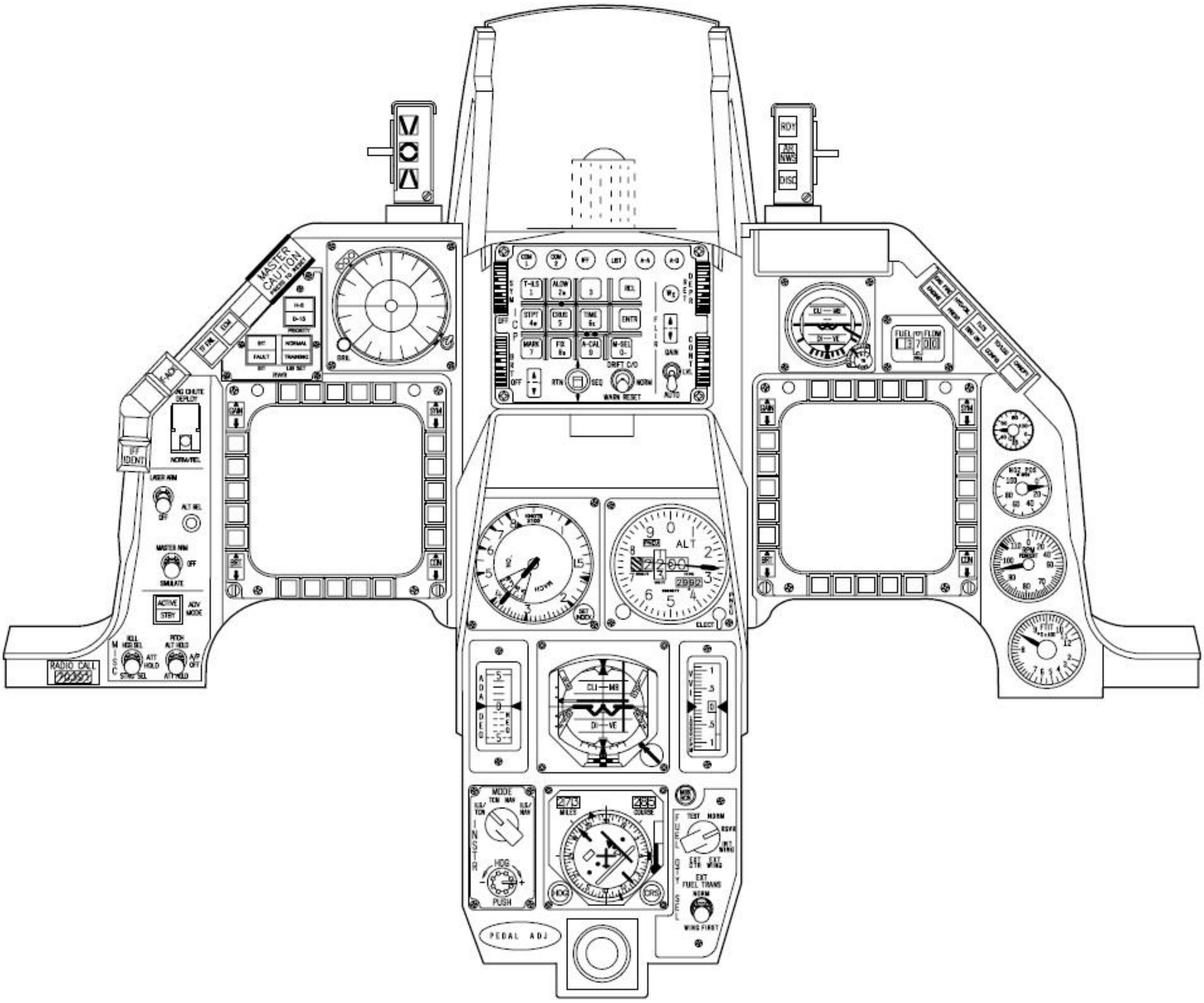
The PARKING BRAKE switch is a magnetically held switch. In the real jet it has three positions but the ANTI-SKID functionality is not implemented in BMS and thus it is a two-position switch in the BMS cockpit.

The parking brake when engaged holds the aircraft stationary without the use of wheel brakes. Considering that a lightly loaded jet in BMS can move at idle power it is important to use parking brakes to relieve the wheel brakes and their tendency to develop heat which decreases performance and may present hazardous situations.
In the real jet the parking brakes are automatically de-energised when the throttle handle moves one inch past the idle point. In BMS the parking brakes disengage automatically (that's why it is a magnetic switch) above 80% RPM. There is no parking brake status indicator aside from the position of the switch.

The EMER STORES JETTISON when depressed for more than 1 second jettisons all A-G stores and external fuel tanks. A-A weapons and any HTS, TGP and ECM pods remain on board. While the emergency jettison is depressed the MFD displays the SMS Jettison page.

BMS Key Callbacks for the GEAR panel
SimGndJettOn
SimGndJettOff
SimGndJettEnable (toggle)
SimCATI
SimCATIII
SimCATSwitch (toggle)
SimSilenceHorn
SimLandingLightOn
SimLandingLightOff
SimLandingLightToggle
SimParkingBrakeOn
SimParkingBrakeOff
SimParkingBrakeToggle
AFGearUp
AFGearDown
AFGearToggle
SimEmergencyJettison
SimHookUp
SimHookDown
SimHookToggle

1.2.3. CENTRE CONSOLE



1.2.3.1 MISC panel

The MISC panel may be different from one aircraft to another. BMS uses the Block 50/52 MISC panel featuring Autopilot, TFR, MASTER ARM, Laser, and RF switches.

The two lower Autopilot switches are the ROLL switch (left) and the PITCH switch (right). Both are three-position switches.

The PITCH switch is the master switch and is magnetically held in either the ALT HOLD or ATT HOLD position. Both engage Pitch and Roll autopilot. Roll depends on the ROLL switch position. The centre position A/P OFF disengages the autopilot.
ALT HOLD - the autopilot will strive to maintain the altitude determined by the INS at the time the PITCH mode switch was set.
ATT HOLD - the autopilot will strive to maintain the attitude/pitch determined by the INS at the time the PITCH mode switch was set.

The ROLL switch is functional only when the PITCH switch is engaged in ALT HOLD or ATT HOLD. When the PITCH switch is centred in A/P OFF the ROLL switch is inoperative.
The HDG SEL position turns the aircraft to capture and maintain the heading selected by the heading marker on the HSI.
In ATT HOLD the autopilot maintains ROLL attitude by INS at the moment the ROLL switch was set.
In STRG SEL the autopilot steers the aircraft to the selected steerpoint.

The autopilot can be engaged only if **all** the following conditions are met:

- Gear up,
- Air refuelling door closed,
- No FLCS fault present,
- AOA must be less than 15°,
- DBU not engaged,
- MPO switch not in OVRD,
- ALT FLAPS not in EXTEND,
- TRIM/AP DISC switch not in DISC,
- Stall Horn is silent.

When the autopilot is engaged and any of the above conditions are no longer met the autopilot disconnects automatically. The PITCH switch then snaps back to the A/P OFF position and a WARN message is displayed in the HUD.
The pilot can override the autopilot by depressing the stick paddle lever. While keeping the lever depressed he can change PITCH and ROLL input. Upon releasing the paddle the AP will re-engage in the mode it was set. If the autopilot is in ATT HOLD there is no need to press the paddle, a new reference is now taken in ATT AP when stick is moved and released.
Note that the Stick TRIM buttons are inoperative when the autopilot is engaged.
For further information about the autopilot system refer to the autopilot chapter later in this manual.

The ADV mode pushbutton indicator is used with the Terrain Following Radar (TFR) system which is set through the TFR MFD page. The indicator has a pushbutton that turns AUTO TFR on/off. The top part of the indicator is labelled ACTIVE in green and illuminates when AUTO TFR is enabled. The lower part of the indicator is labelled STBY in yellow and indicates that the TFR system is in STBY (manual mode or blended mode). Automatic TFR is only available if you are carrying the AN/AAQ-13 navigation pod (NVP).

The MASTER ARM switch is a three-position toggle switch labelled ARM, OFF and SIM.

The ALT REL is a pushbutton that works exactly like the pickle button on the HOTAS SSC/stick.

The LASER ARM switch is a two-position toggle switch. In ARM it enables the targeting pod laser. The laser needs to be fired to allow Laser Guided Bombs to guide on its reflected energy. The laser can be fired manually (stick trigger first detent) or automatically a few seconds before impact. Placing the switch in ARM doesn't fire the laser, it readies the system so the laser can be fired depending on the settings in the LASER DED page (LIST 0 0 5).

The RF switch is a three-position toggle switch and controls electromagnetic emissions from the aircraft as follows:
NORM is the default position and is used for normal operation of the aircraft.
QUIET reduces the level of EW emissions by turning the radar and IFF transponder to standby.
SILENT shuts down all EW emissions from the aircraft: RADAR, TFR, RALT, ECM, IFF.

BMS Key Callbacks for the MISC panel:
SimLaserArmToggle
SimLaserArmOn
SimLaserArmOff
SimRightAPSwitch
SimLeftAPSwitch
SimLeftAPUp
SimLeftAPMid
SimLeftAPDown
SimLeftAPInc
SimLeftAPDec
SimRightAPUp
SimRightAPMid
SimRightAPDown
SimRightAPInc
SimRightAPDec
AFDragChute
SimToggleTFR
SimStepMasterArm
SimArmMasterArm
SimSafeMasterArm
SimSimMasterArm
SimMasterArmDown
SimMasterArmUp
SimPickle
SimRFSwitch
SimRFSwitchUp
SimRFSwitchDown
SimRFNorm
SimRFQuiet
SimRFSilent

1.2.3.2 Left EYEBROW

The left eyebrow is made of a stack of pushbuttons and a stack of lights. Only one pushbutton is implemented: F-ACK.
Depressing F-ACK acknowledges or recalls faults on the PFL display on the right AUX console (see RIGHT AUX section below).

The IFF IDENT pushbutton is not currently implemented although we now have a fully implemented IFF system in BMS.

The lights are made up of a red warning light for the TFR system that comes on when TFR fails and the very important amber MASTER CAUTION light. This light comes on (with a slight delay) when the system detects a fault or failure. The light is coupled with a pushbutton that allows it to be reset once the fault is acknowledged or solved. It is of paramount importance to understand that the proper way to extinguish the MASTER CAUTION light is not to reset it but to clear the fault that caused it to light up.

Example: during flight you are CAT III and you jettison your load. The system senses the change but the pilot has to manually switch to CAT I, else the jet will still be limited to CAT III. The STORES CONFIG and the MASTER CAUTION lights come on. Obviously resetting MASTER CAUTION would extinguish it, but the STORES CONFIG PFL light would stay on and the fault wouldn't be cleared. The pilot by switching the CAT switch to CAT I clears the fault, which extinguishes the STORES CONFIG and MASTER CAUTION lights.

BMS Key Callbacks for the LEFT eyebrow:
SimICPFAck
ExtinguishMasterCaution

1.2.3.3 Left MFD & Right MFD

Both MFDS are main displays giving invaluable information to the pilot. They each have 20 pushbuttons and four 2 position rockers in each corner. Out of those 4 only two are implemented: the Brightness and Gain rockers on the left of the MFD.

The 20 pushbuttons arranged in 4 rows of 5 are called OSBs (Option Selection Buttons) and labelled from 1 to 20 starting at the left button on the top row and going in a clockwise direction. The top row is thus made up of OSB #1 to OSB #5.

The displays have many different pages and subpages, which are explained later in the MFD chapter. As such the function of each button changes according to the active page and is always displayed just next to the button.

BMS Key Callbacks for the LEFT& RIGHT MFDs:

SimCBEOSB_1L	*SimCBEOSB_1R*
SimCBEOSB_2L	*SimCBEOSB_2R*
SimCBEOSB_3L	*SimCBEOSB_3R*
SimCBEOSB_4L	*SimCBEOSB_4R*
SimCBEOSB_5L	*SimCBEOSB_5R*
SimCBEOSB_6L	*SimCBEOSB_6R*
SimCBEOSB_7L	*SimCBEOSB_7R*
SimCBEOSB_8L	*SimCBEOSB_8R*
SimCBEOSB_9L	*SimCBEOSB_9R*
SimCBEOSB_10L	*SimCBEOSB_10R*
SimCBEOSB_11L	*SimCBEOSB_11R*
SimCBEOSB_12L	*SimCBEOSB_12R*
SimCBEOSB_13L	*SimCBEOSB_13R*
SimCBEOSB_14L	*SimCBEOSB_14R*
SimCBEOSB_15L	*SimCBEOSB_15R*
SimCBEOSB_16L	*SimCBEOSB_16R*
SimCBEOSB_17L	*SimCBEOSB_17R*
SimCBEOSB_18L	*SimCBEOSB_18R*
SimCBEOSB_19L	*SimCBEOSB_19R*
SimCBEOSB_20L	*SimCBEOSB_20R*
SimCBEOSB_BRTUP_L	*SimCBEOSB_BRTUP_R*
SimCBEOSB_BRTDOWN_L	*SimCBEOSB_BRTDOWN_R*
SimRadarGainUp	
SimRadarGainDown	

1.2.3.4 TWP panel

The Threat Warning Prime panel is located right next to the RWR (Radar Warning Receiver) display and manages the information displayed on the ALR-56 RWR. The TWP is made of 6 square lights all featuring a push button.

Each indicator has multiple lights (top and bottom) the bottom light comes on when the system is powered and the top light comes on depending on the status of the relevant system, except for the Missile LAUNCH indicator.

Here is a rundown of each indicator/ button:

- HANDOFF - used to set the mode of operation of the RWR. The 4 modes are: Normal, Diamond Float, Transient and Latch. These modes will be explained in more detail in the Electronic Warfare System section of this manual. For now you should simply know that the mode giving the best Situational Awareness is the Diamond Float mode where the diamond floats to the highest priority symbol. That mode is entered with a short push (less than one second) on the HANDOFF button.
  The bottom light of the indicator is on as soon as there is power and the top indicator comes on only when a handoff mode is engaged (Diamond Float, Transient, Latch).

- LAUNCH - this indicator flashes at 4Hz as soon as the EWS (Electronic Warfare System) detects a radar missile launched at ownship. The indicator is backed up by audible warning tones. The indicator features a pushbutton to test the launch warning. Press the button to check the audio tone and indicator light.

- PRIORITY (MODE) - enables some declutter of the RWR display by displaying only the 5 most important symbols instead of the usual 12 symbols (16 when UNKNOWN mode is selected). When the priority MODE button is depressed the RWR enters PRIORITY mode, the top light comes on and the bottom light OPEN goes off, as both lights are mutually exclusive.
  When PRIORITY mode is enabled the top PRIORITY light will flash if the EWS detects more than 5 threat emitters.
  The RWR remains in this mode until the pilot exits PRIORITY MODE by depressing the button again. At that time the top light extinguishes and the bottom OPEN light illuminates.

- UNKNOWN (SHIP SYMBOL) - When depressed the top (U) light illuminates and the RWR displays U symbols (unknown radar). It can then also display 16 symbols instead of the usual 12. The pilot can deselect this mode by depressing the pushbutton again. The top light then extinguishes.

- SYS TEST – The bottom light of the indicator will be on whenever the EWS is powered. The top light will come on whenever the system test is running. Depressing the push button will initiate the test sequence that will run for a few seconds. During that time all TWP lights and modes will be tested. Some alphanumeric codes will also be displayed on the RWR.

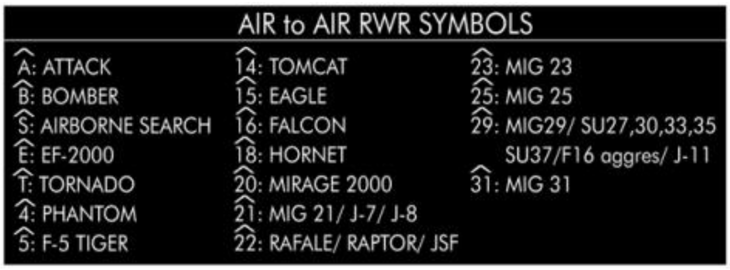
- TGT SEP (T) - Depress this indicator when you want to have a better view of two emitters which are close to each other. When depressed the top TGT SEP light illuminates and the symbols on the RWR are spread out for 5 seconds. After that time the RWR reverts to normal and the top light extinguishes. The bottom light is on as soon as power is applied.

BMS Key Callbacks for the TWP:
SimRWRSetPriority
SimRWRSetTargetSep
SimRWRSetUnknowns
SimRWRSetNaval deleted
SimRWRHandoff
SimRWRLaunch
SimRWRSysTest

1.2.3.5 ALR-56 RWR

The ALR-56 RWR displays threat emitters depending on their azimuth relative to your aircraft. It does not give distance information. The display is made of two concentric circles: inner and outer. The threats are categorised by order of importance; the more lethal threats are placed in the inner circle, while the secondary threats are left in the outer.
The RWR scope also consists of four noise bars located around the centre circle at 6, 9, 12 and 3 o'clock. They indicate the status of noise in the bands 0, 1, 2, and 3 respectively; however this is not implemented and is graphical only. There is a cycle timer on the left end of the band 3 noise bar. This is a vertical bar that moves up and down. As the RWR becomes saturated with signal activity the cycle timer moves progressively slower. With no signal activity, it moves up and down once per second. With full RWR activity it moves up and down every 2.6 seconds.

The symbols displayed on the RWR depend on their radar type, as seen below. Airborne symbols are displayed with an inverted V on top of them to differentiate them from the ground emitters. Other RWRs may be installed in other F-16s. For further information refer to the TO-BMS1F-16CM-34-1-1.



AIR to AIR RWR SYMBOLS		
A: ATTACK	14: TOMCAT	23: MIG 23
B: BOMBER	15: EAGLE	25: MIG 25
S: AIRBORNE SEARCH	16: FALCON	29: MIG29/ SU27,30,33,35 SU37/F16 aggres/ J-11
E: EF-2000	18: HORNET	31: MIG 31
T: TORNADO	20: MIRAGE 2000	
4: PHANTOM	21: MIG 21/ J-7/ J-8	
5: F-5 TIGER	22: RAFALE/ RAPTOR/ JSF	

AIR to GROUND RWR SYMBOLS

EWR/FCR: TYPE	EWR/FCR: TYPE	Radar Type
F/2: SA-2	U: Unknown	F: Flat Face (EWR)
F/3: SA-3	S: SEARCH	L: Long Track (EWR)
L/4: SA-4	A: HB AAA	B: Bar Lock B (EWR)
B/5: SA-5	A: LB AAA	D: Snow Drift (EWR)
L/6: SA-6	A: AAA	O: Dog Ear (EWR)
8/8: SA-8	C: KSAM	10: Big Bird (EWR)
10/10: SA-10	P: PATRIOT	2: Fan Song (FCR)
D/11: SA-11	P: SKYGUARD	3: Low Blow (FCR)
-/15: SA-15	N: NIKE	4: Pat Hand (FCR)
D/17: SA-17	H: HAWK	5: Square pair (FCR)
19/19: SA-19		6: Straight Flush (FCR)
		8: Land Roll (EWR+FCR)
		9: Dog Ear (FCR)
		10: Flap Lid (FCR)
		11: Fire Dome (FCR)
		17: Chair Back (FCR)
		19: Hot Shot (EWR+FCR)

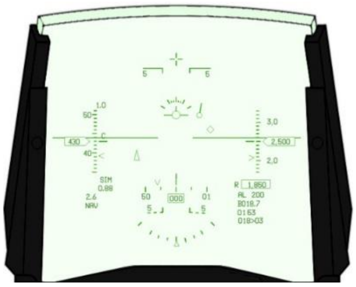
BMS Key Callbacks for the RWR:
SimRWRBrightnessUp
SimRWRBrightnessDown

1.2.3.6 Left INDEXER

The left indexer is made of three lights relevant to the Angle of Attack and is located to the left of the HUD. It is a repeater of the AOA instrument on the centre console and the HUD AOA tape.
The AOA is sensed by two conical sensors on each side of the nose of the F-16. AOA indication is valid for two point landing.

The top light points down and comes on when the AOA is above 14° (on speed AOA too slow).
The centre light featuring a green doughnut comes on if the AOA is between 11 and 14° (13° = on speed AOA for landing).
The bottom light points up and comes on when the AOA is below 11° (on speed AOA too fast for approach).
These lights are always on even when the gear is retracted, allowing the pilot to quickly check his AOA in every flight situation.

1.2.3.7 HUD



The HUD (Heads Up Display) displays a variety of flight information through a collimating system. A more in depth explanation of the HUD can be found in the relevant chapter later in this manual. The HUD is powered on using the SYM wheel on the left of the ICP. That wheel features a switch at the beginning of its course which toggles the HUD on/off. Once the HUD is enabled the wheel adjusts HUD brightness. Many settings on the HUD can be changed by the pilot through the UFC or the HUD control panel on the right console (see right console section).

1.2.3.8 ICP & DED

The ICP (Integrated Control Panel) is the primary interface between the pilot and the aircraft systems. It is part of the UFC (Up Front Controller) made up of the ICP and the DED (Data Entry Display) with the ICP as the keyboard and the DED as the display.

As a complicated system the UFC has its own chapter with detailed information later in this manual.

BMS Key Callbacks for the ICP:
SimICPCom1
SimICPCom2
SimICPNav
SimICPAA
SimICPAG
SimICPIFF
SimICPLIST
SimICPTILS
SimICPALOW
SimICPTHREE
SimICPStpt
SimICPCrus
SimICPSIX
SimICPMark
SimICPEIGHT
SimICPNINE
SimICPZERO
SimICPCLEAR
SimICPEnter
SimICPPrevious
SimICPNext
SimICPResetDED
SimICPDEDUP
SimICPDEDDOWN
SimICPDEDSEQ
SimDriftCO
SimDriftCOOn
SimDriftCOOff
SimWarnReset
SimSetWX
SimFlirLevelUp
SimFlirLevelDown
SimBrtWheelUp
SimBrtWheelDn
SimSymWheelUp
SimSymWheelDn
SimHUDPower
SimHUDOn
SimHUDPOff
SimRetUp
SimRetDown

1.2.3.9 MACHMETER

The Mach meter is a primary flight instrument giving indicated airspeed in both knots (nautical miles per hour) and Mach number. The indicated airspeed is given by the outer needle on the scale from 60-80 to 800 knots and the Mach number is given by the inner needle and the inner scale.
The Mach meter has two indicators: a red triangle illustrating the VNE (Velocity Never Exceed) speed which cannot be set and the green triangle which is a simple pilot selectable caret. It does not work in the 3D cockpit of BMS but cockpit builders can have it implemented through the Mach meter knob when using MFDE, a software tool that extracts instruments & displays.
It is used as a visual aid to maintain the assigned speed when flying IFR for instance.

1.2.3.10 ALTIMETER

The altimeter gives altitude in feet. The needle reads from zero to one thousand feet on the outer scale and the large instrument window gives altitude rounded to the nearest hundred feet. To derive the current altitude, use the drum number and needle in combination.

For the example shown left, the drum reads 2500 feet tending to 2600 feet and the needle reads 540 feet, so in combination they show the present aircraft altitude as 2540 feet on QNH 3059 in Hg.

The smaller window on the right allows the pilot to input the local altimeter setting in millibars (HectoPascal) or in inches of mercury depending on the options set in *Falcon BMS.cfg* to compensate the instrument for the current atmospheric conditions.
The pressure is changed through the altimeter knob on the bottom left of the instrument.
The instrument is flagged PNEU when it receives only pneumatic pressure and no electrical power. In this case the instrument behaves as a standard pressure altimeter.

BMS Key Callbacks for the Altimeter:
SimAltPressInc
SimAltPressDec
SimAltPressIncBy1
SimAltPressDecBy1

1.2.3.11 AOA

The AOA indicator, located on the instrument panel, displays actual AOA in degrees. The indicator has a vertically moving tape display indicating an operating range of -32° to approximately +32°.

The tape is colour coded from 9° to 17° to coincide with the colour coded symbols on the AOA indexer.

The instrument is flagged OFF when there is no power available.

1.2.3.12 ADI

The ADI (Attitude Direction Indicator) is the main attitude flight instrument and gives ownship attitude along pitch, roll and yaw axis supplied by the EGI/INS. The F-16 ADI is mainly used for IFR flying and also features an ILS localiser and glideslope when the ILS modes are activated.

The knob on the bottom right of the instrument is not implemented in Falcon BMS due to the fact that it is used in reality to centre the instrument along the fixed horizontal reference (according to the seating position of the pilot).

The ADI also has 4 flags, one in each corner of the instrument: OFF, LOC, GS and AUX.
The red OFF flag is displayed when the instrument does not receive power or the INS has failed.
The red LOC flag is displayed when the LOCaliser needle is unreliable.
The red GS flag is displayed when the Glide Slope needle is unreliable.
The yellow AUX flag is displayed while the heading value of the INS is not reliable. During ramp starts the AUX flag remains displayed until status 90, 60 seconds into the initial INS alignment. When the heading value of the INS becomes reliable the flag disappears. In BMS that is your cue for a short ramp start; as long as the GPS switch is on, the INS will remain fully reliable.

1.2.3.13 VVI

The VVI (Vertical Velocity Indicator) located on the instrument panel displays vertical velocity in thousandths of feet per minute.

The instrument features a vertically moving tape indicating an operating range from -6000 to +6000 feet/min.

The instrument is flagged OFF when there is no power available.

1.2.3.14 INSTRUMENT MODE panel

This panel has been replaced by a blank panel in later blocks where the HSI has been replaced with the EHSI. On the EHSI modes are changed with the M button.

The bottom knob is not implemented in BMS. In reality it is used to correct INS heading deviation, which never happens currently in our sim. The top knob is a four-position knob setting the instrument mode: ILS/TCN – TCN – NAV – NAV/ILS.

- **ILS/TCN -** one of the two modes used to display the ILS needles. It activates the ILS symbology in the HUD, the ADI and the HSI. The course deviation indicator on the HSI gives the localiser deviation. The TO/FROM indicator is not displayed and the bearing pointer points at the active TACAN station. The range value in the DME window of the HSI is from the active TACAN station and not the ILS.
- **TCN -** the HSI displays course deviation and distance from the active TACAN station. ILS symbology is not displayed. All HSI indicators point to the TACAN station. The TO/FROM indicator is displayed.
- **NAV -** the HSI displays course deviation and distance from the steerpoint of interest (active UFC Steerpoint) and not the TACAN. The TO/FROM indicator is displayed.
- **ILS/NAV -** ILS symbology is displayed as in the other ILS mode in the HUD, ADI and HSI. The course deviation indicator on the HSI gives the localiser deviation, the TO/FROM indicator is not displayed, the range in the DME window is given to the steerpoint of interest (and not the ILS) and the bearing pointer on the HSI points to the steerpoint of interest as well.

BMS Key Callbacks for the INSTR MODE panel:
SimStepHSIMode
SimHSIIlsTcn
SimHSITcn
SimHSINav
SimHSIIlsNav
SimHSIModeInc
SimHSIModeDec

1.2.3.15 EHSI

Block 50 and Block 52(+) have been updated with the electronic version of the Horizontal Situation Indicator. The EHSI is the primary flight instrument for navigation. It features a top down view with your aircraft in the centre and a compass rose all around it. Its use is fully explained in the BMS Comms and Nav book that explains basic and advanced radio-navigation.
The instrument features two knobs and one M button on the bottom, the left knob labelled HDG for Heading is used to set a heading caret on the compass rose to a heading of your choice (as a visual cue).
The right knob labelled CRS for Course is used to enter a course value manually which will be reflected on the course deviation indicator. That value is displayed on the top

right window of the instrument. The top left window displays the range in Nautical miles to the selected destination, according to the EHSI mode. Please note the DME is now displayed in tenths of nautical miles. The M button toggles the available Mode. Available modes are TCN, PLS (Precision Landing system = ILS) PLC/NAV & PLS/TCN.
The instrument is flagged with an OFF when no power is available.
For a full in-depth review of EHSI use please refer to the BMS-Comms-Nav-book *in your Docs folder*. We cannot explain the EHSI without explaining radio navigation.

BMS Key Callbacks for the HSI:
SimStepHSIMode
SimHsiCourseInc
SimHsiCrsIncBy1
SimHsiCourseDec
SimHsiCrsDecBy1
SimHsiHeadingInc
SimHsiHdgIncBy1
SimHsiHeadingDec
SimHsiHdgDecBy1

1.2.3.16 FUEL QTY SEL panel

The Fuel Quantity panel is made of one 6-position knob and one 2-position switch. The top knob controls the fuel quantity displayed on the fuel QTY gauge on the RIGHT AUX console.

- TEST - AR & FR needles each point to 2000, the totalizer displays 6000 and both fuel low caution lights illuminate on the caution panel (right AUX console).
- NORM - AL needle displays the quantity of fuel contained in the AFT (LEFT) reservoir and A-1 fuselage tanks. FR needle displays the quantity of fuel contained in the FORWARD (RIGHT) reservoir and F-1, F-2 fuselage tanks. The Totalizer displays the total fuel on board.
The NORM position is the only position that enables the automatic forward fuel transfer system, trapped fuel warning and BINGO fuel computation based on fuselage fuel.
- RSVR - AL and FR needles point to fuel quantity left in the aft and forward reservoir tanks. The Totalizer displays the total fuel on board.
- INT WING - AL needle points to the fuel quantity remaining in the left internal wing tank. FR needle points to the fuel quantity remaining in the right internal wing tank. The Totalizer displays the total fuel on board. Please note, the fuel contained in the internal wings does not influence the fuel imbalance as they empty first into the fuselage tanks and the CG doesn't move as long as the fuselage tanks remain full.
- EXT WING - AL/FR needles point to the quantity of fuel left in the left and right external fuel tanks. The Totalizer displays the total fuel on board.
- EXT CTR - AL needle points to zero. FR needle points to the quantity of fuel remaining in the centre external tank. The Totalizer displays the total fuel on board.

The EXT FUEL TRANS switch is used to control the priority of fuel transfer from external fuel tanks.
NORM (default position) - the centreline external tank transfers first.
WING FIRST - will drain the external wing tanks first.
For further information check the Fuel System chapter later in this document.

BMS Key Callbacks for the FUEL QTY panel:
SimExtFuelTrans (toggle)
SimFuelTransNorm
SimFuelTransWing
SimIncFuelSwitch
SimDecFuelSwitch
SimFuelSwitchTest
SimFuelSwitchNorm
SimFuelSwitchResv
SimFuelSwitchWingInt
SimFuelSwitchWingExt
SimFuelSwitchCenterExt

1.2.3.17 MARKER BEACON

The marker beacon is located to the right of the HSI above the FUEL QTY panel. Unlike general aviation, where the markers are colour coded, in the F-16 it is only green but blinks at a different frequency (with varying sound cues), according to the marker overflown.
Marker beacons are short range transmitting devices placed alongside ILS approaches and provide visual and audio cues when overflown. There are normally three markers: inner, outer and middle markers along an ILS track. In BMS we only have outer (OM) and inner markers (IM) implemented. They provide range information to the runway.
Outer markers are usually placed between 4 and 7 Nm (usually 6 Nm) from the runway threshold and are at the point where the glideslope should be intercepted.
Inner markers are placed closer to the runway, usually 3500 feet and should be heard and seen in the cockpit around 200ft above the ground, usually near the minima.
In BMS both markers light up the MRK BCN indicator making it flashes at different frequencies: (low frequency for outer marker and higher frequency for inner marker). See the BMS-Comms-Nav-book *in your Docs folder* for further information.
Please note: when the approach track is over water (e.g. Kunsan) the beacons are not installed.

1.2.3.18 FUEL FLOW indicator

Located above the RIGHT MFD this gauge displays the current fuel flow being consumed by the engine (including in Afterburner) in pounds per hour (pph).
The gauge has a range from 0 to 80000 pph and is powered by the emergency bus.

1.2.3.19 Backup ADI

The backup ADI is located above the RIGHT MFD and is the primary attitude backup instrument.

It does not need power and will function even when the main ADI is flagged OFF.

1.2.3.20 Right INDEXER

The RIGHT indexer features three coloured indicators arranged vertically.
The top one is blue and labelled RDY. It is relevant to the air-refuelling (AR) system and comes on whenever the system is ready for air to air refuelling. In BMS this indicator comes on as soon as the AR door is opened.
The centre indicator is green and labelled AR/NWS.
AR is only relevant when the aircraft is in the air and comes on whenever the boom is inserted and has good contact with the AR receptacle on the back of the F-16.
NWS is relevant only when the aircraft is on the ground. It comes on when the Nose Wheel Steering system is engaged, allowing the pilot to steer the aircraft using the rudder pedals to control direction. It is recommended that nose wheel steering only be engaged below 70 knots on landing and takeoff rolls and during taxiing.
The Bottom indicator is amber and labelled DISC. It is also relevant to the AR system and illuminates when the pilot commands a disconnect from the boom.

1.2.3.21 Right EYEBROW

On the edge of the right glareshield you will find a few more red warning lights. All these lights are powered by the emergency bus.

- **ENG FIRE / ENGINE** - a split face indicator with two separate illuminated cells. The top part (ENG FIRE) comes on whenever the system detects a fire in the engine. The ENGINE warning light illuminates when RPM and FTIT indicator signals indicate that an engine over temperature or flameout has occurred. Illumination also occurs for an engine alternator failure and may occur as a result of an RPM or FTIT indicator failure. The warning light illuminates when the rpm decreases below idle, or approximately 2 seconds after FTIT indication exceeds 1100°C. The warning light goes off when the condition that turned it on is eliminated.

- **HYD/OIL PRESS** - serves as a monitor of engine oil pressure and hydraulic system pressure. For engine oil pressure the warning light illuminates when oil pressure has been below approximately 10 psi for 30 seconds (time delay minimizes warning light illuminating for false warnings during manoeuvring).The light goes out when oil pressure exceeds approximately 20 psi. For hydraulic pressure, the warning light illuminates when either A or B system pressure decreases below 1000 psi. The light goes out when both system A and B pressures are above 1000 psi. During engine start the warning light usually goes off before reaching idle rpm; however acceptable operation is indicated if the warning light goes off before exceeding 70 percent rpm and remains off when the throttle is retarded to idle.

- **FLCS / DBU ON -** The middle light is also a split face indicator and refers to the FLCS and the Digital Backup (DBU) The FLCS warning light illuminates to indicate a dual malfunction in the FLCC electronics, including the processors, power supplies, input commands or sensors, AOA, or air data inputs. The FLCS warning light also illuminates if the LEFs are locked or FLCS BIT fails. The FLCS warning light remains illuminated until FLCS reset action is successful in clearing the failure. If an active warning fault exists and a subsequent warning level malfunction occurs the FLCS warning light goes off momentarily to retrigger HUD WARN and voice warning. The DBU ON light in BMS is eye candy only and comes on whenever the DBU switch is activated on the FLCS panel.

- **TO/LDG CONFIG -** illuminates in flight whenever pressure altitude is less than 10000 feet, airspeed is less than 190 knots, rate of descent is greater than 250 fpm and either of the following conditions exists:
  1. TEF's not full down.
  2. NLG or either MLG not down and locked (accompanied by LG warning horn).

- **CANOPY / OXY LOW** - a split face indicator with the top part referring to the canopy and the bottom one to oxygen.
  The CANOPY light is lit up whenever the canopy is not locked in place.
  The OXY LOW light comes on whenever the regulator pressure has dropped below 5 psi or when the bit has detected a fault.

1.2.3.22 Right INSTRUMENT stack

The right instrument stack has 4 gauges all relevant to the engine. The top one is the OIL pressure indicator, the second one is the NOZzle POSition indicator, the third one is the RPM and the last one is the FTIT (Fan Turbine Inlet Temperature).

Please note in BMS you can fly the block 50 F-16 with a GE 129 engine or a block 52 model with a PW 229 engine. Other blocks with different engines can be flown but are outside the scope of this manual.

- The OIL Pressure indicator displays engine oil pressure from 0 to 100 psi and is powered by emergency buses. There is a very small chance of an oil pressure fault being triggered during engine start now in 4.34. If oil pressure remains below 15 psi with the HYD/OIL warning light lit you will need to shut down and restart the engine. Pay attention to this dial during ramp start.

- The NOZ POS indicator is a display of actual nozzle position ranging from 0 % (closed) to 100 % (full open). The indicator is powered by emergency buses.

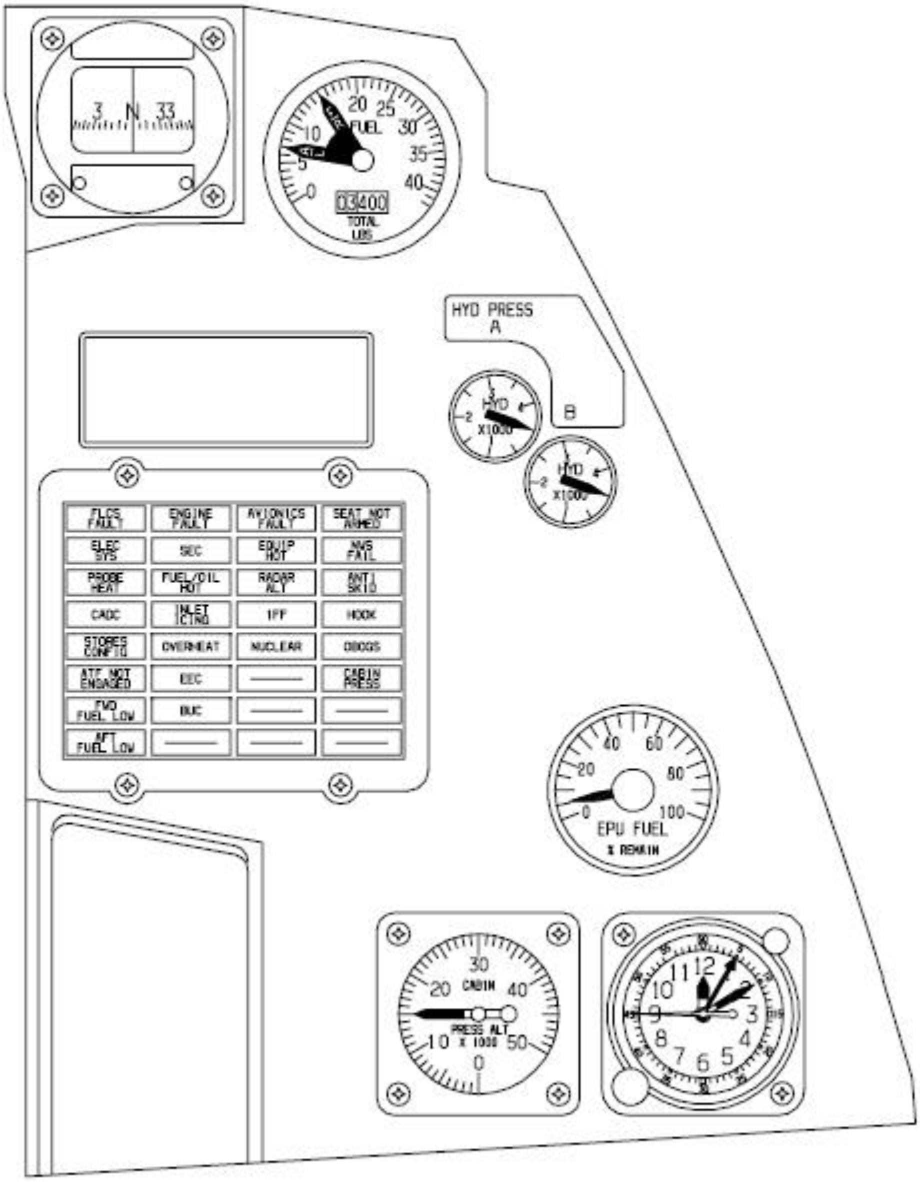
- The RPM indicator has a pointer display expressed in percent rpm from 0-110 % (on Ge129 engine) or 0-100 % (for PW229 engine). The indicator is powered by the battery bus.

- The FTIT indicator displays the Fan Turbine Inlet Temperature in degrees Celsius.

  The indicator has a range from 200°C to 1200°C in major increments of 100°C and is powered by the battery bus.

  This gauge also became much more important in 4.34 with the implementation of hot-start and hung-start in both ground and air operations. You must now pay considerable attention to this gauge during engine start to prevent engine damage in case of the FTIT going over the temperature limit (800 °C for a ground start). See the Abnormal Procedures section for further information.

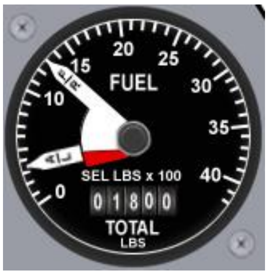
1.2.4. RIGHT AUXILIARY CONSOLE



1.2.4.1 Compass

The magnetic compass is completely autonomous and doesn't need any system power to work. It is your ultimate backup navigation instrument. All four cardinal directions are displayed as well as all 30° marks.

1.2.4.2 FUEL Quantity indicator



The FUEL QTY indicator gives your total fuel remaining on board (totalizer) and its distribution in the internal forward/aft tanks or right/left tanks (needles). Two needles labelled F/R & A/L display fuel quantity. The F/R needle indicates the amount of fuel in the FRONT tank or RIGHT tank depending on the position of the FUEL QTY SEL knob. The A/L needle indicates the amount of fuel in the AFT tank or LEFT tank depending on the position of the FUEL QTY SEL knob.
The A/L needle has a red centre portion that is visible only when a fuel imbalance condition exists. For further information please refer to the Fuel System chapter later in this manual.

1.2.4.3 Pilot Fault List Display

The Pilot Fault List Display (PFLD) is the same type of screen as the DED and provides a list of faults detected in aircraft systems mainly related to the FLCS, engine and avionics. The display is blank until a fault is detected. The PFLD needs UFC power to work.

The fault list is acknowledged page by page by the pilot via the F-ACK (fault acknowledge) button on the left glareshield. The F-ACK button also provides fault recall on the PFLD. Unlike previous versions of BMS pressing F-ACK when there is no active fault will not display NO FAULTS - ALL SYS OK on the PFLD; the screen will remain blank, just like the real jet.
See chapter 3.4 PFL analysis for further information about the PFLD.

1.2.4.4 HYD PRESS system A & B gauges

The hydraulic system is a dual redundant system labelled A & B. You will find 2 hydraulic pressure gauges accordingly.

Normal operation pressure is around 3100 psi (needles at 12 o'clock on the gauges).

Critical systems are served by both systems A and B and thus will fail only when both hydraulic systems have run out of pressure. The EPU provides emergency hydraulic pressure to system A only when required, but is limited in autonomy. Refer to the EPU & Hydraulic chapter for further information.

1.2.4.5 CAUTION light panel

The caution light panel features 26 amber caution lights. Each of them will illuminate when a fault in the relevant system is detected. For a full overview of each caution light please refer to the Caution light analysis chapter.

One additional note: the ELEC SYS light can only be reset with the ELEC CAUTION RESET button on the ELEC panel (left console). The FLCS caution light is reset with the FLCS reset switch.

1.2.4.6 LIQUID OXYGEN gauge

The liquid oxygen gauge points to the remaining oxygen in litres remaining in the liquid oxygen tank.
Later versions of the F-16 do not have a liquid oxygen tank anymore and oxygen relies on electrical power and engine bleed air to keep the supply going.
So this gauge may not be in your aircraft. When the oxygen is supplied by engine bleed air the caution light OXY LOW is replaced by the OBOGS caution light**.**

1.2.4.7 EPU FUEL gauge

The EPU gauge indicates the quantity of EPU fuel (hydrazine) remaining. Hydrazine is used if insufficient engine bleed air is available for running the EPU. The gauge displays the percentage of EPU fuel remaining and depletes fast when hydrazine is used. In normal operations you have an EPU operating time of approximately 10 minutes. Use the following rule of thumb: 100 % = 10 minutes; 50% = 5 minutes. If the main and standby generators have failed the EPU is out of fuel and the hydraulic system is depleted, so no flight controls inputs are possible. Your only remaining option at this point is to eject.

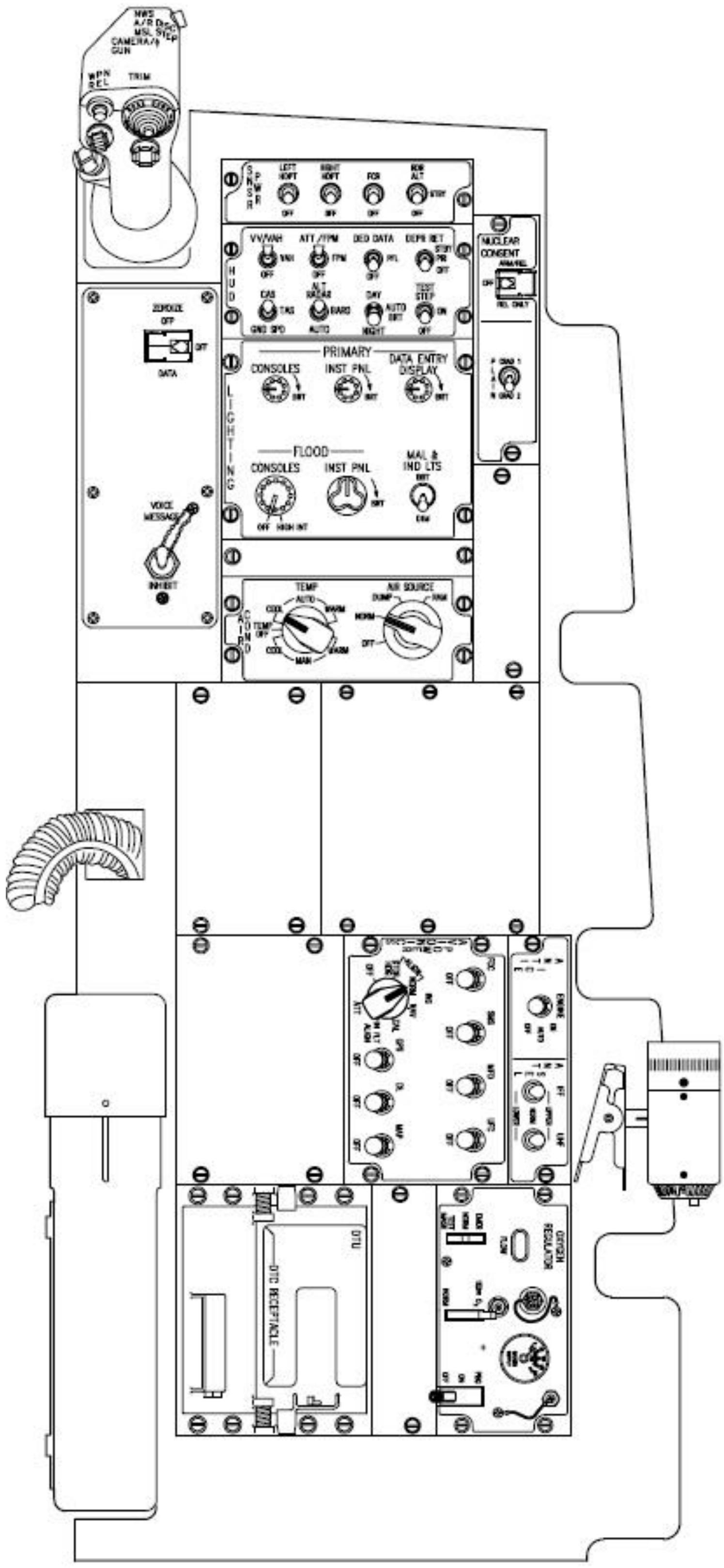
1.2.4.8 CABIN PRESS ALT gauge

The cabin pressure gauge indicates cockpit pressure altitude from 0 to 50000 feet.

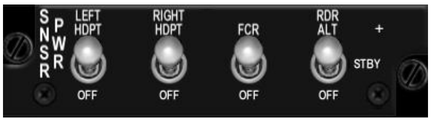
1.2.4.9 Clock

The clock, located on the right auxiliary console, is an 8 day, manually wound clock with provisions for an elapsed time indication up to 60 minutes. In BMS it is automatically set to mission time and does not take the day into account.

1.2.5. RIGHT CONSOLE



1.2.5.1 SNSR PWR Panel

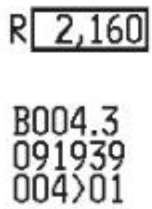


The SENSOR panel features 4 toggle switches. The two left most are power switches for the two chin intake pylons (LEFT HDPT and RIGHT HDPT).

These pylons can carry pods (SNIPER, LANTIRN, HTS) and need power to function properly. With the switches in OFF the pods get no power and will not work. Note also that some of these pods need time after powering them up to be operational, so power up the pylons early enough in your flight.

The FCR switch is a two-state switch that powers up the Fire Control Radar (FCR). When powered up the FCR enters a Power ON Built-In Test (PO BIT) mode, visible on the MFD. The BIT lasts about 3 minutes after which the radar is set to standby, unless previously set to a specific mode. The PO BIT can't be interrupted in the middle of the test. The only way to 'truly' interrupt it is to turn the radar off. Since the FCR is off at Ramp the FCR PO BIT has to be run completely when starting the jet from cold for the FCR to function properly.

The PO (3 minute) BIT is performed whenever the radar power is switched to OFF for more than 4 seconds and then back on. A shorter Manual BIT lasting about 30 seconds can also be performed through the MFD TEST page (OSB #19 FCR) or by switching the FCR switch to OFF for less than 4 seconds and then back on.



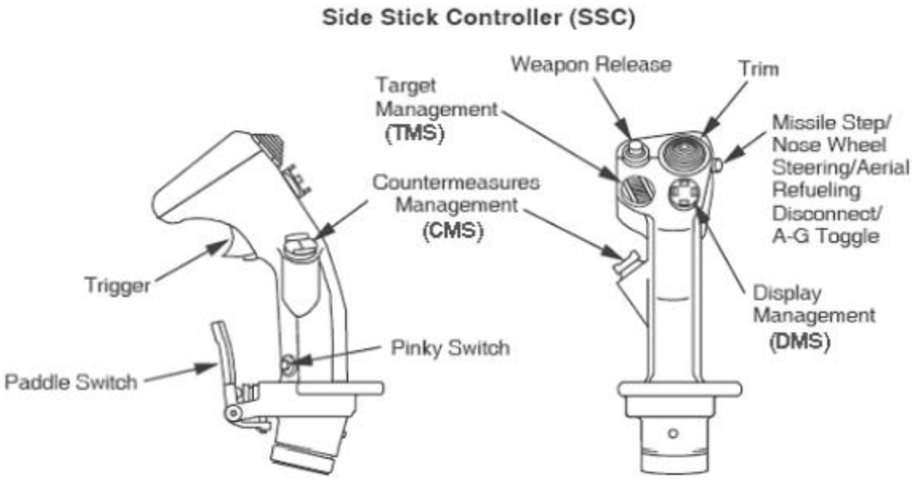
The RDR ALT switch is a three-position switch used to operate the radar altimeter. With the switch in OFF the radar altimeter is inoperative. In STBY the radar altimeter is placed in standby mode (used on the ground to avoid frying your crew-chief). In RDR ALT the radar altimeter is fully operative.

RALT BIT is implemented and visible from the MFD TEST page (OSB 7). When the radar altimeter is active the radar altitude can be read in the HUD in the box preceded by the letter R.

Certain conditions must be met for the Radar altitude to be displayed. Those conditions depend on altitude:
Low level the RALT will blank past 30° pitch and approximately 90° bank.
High altitude the RALT will blank above 10° pitch and approximately 75° bank.
Note the comma that remains displayed, even when the altitude is blanked.

BMS Key Callbacks for the Sensor panel:
SimLeftHptPower (toggle)
SimLeftHptOn
SimLeftHptOff
SimRightHptPower (toggle)
SimRightHptOn
SimRightHptOff
SimFCRPower (toggle)
SimFCROn
SimFCROff
SimRALTSTDBY
SimRALTON
SimRALTOFF
SimRALTUp
SimRALTDown

1.2.5.2 SIDESTICK CONTROLLER (SSC)

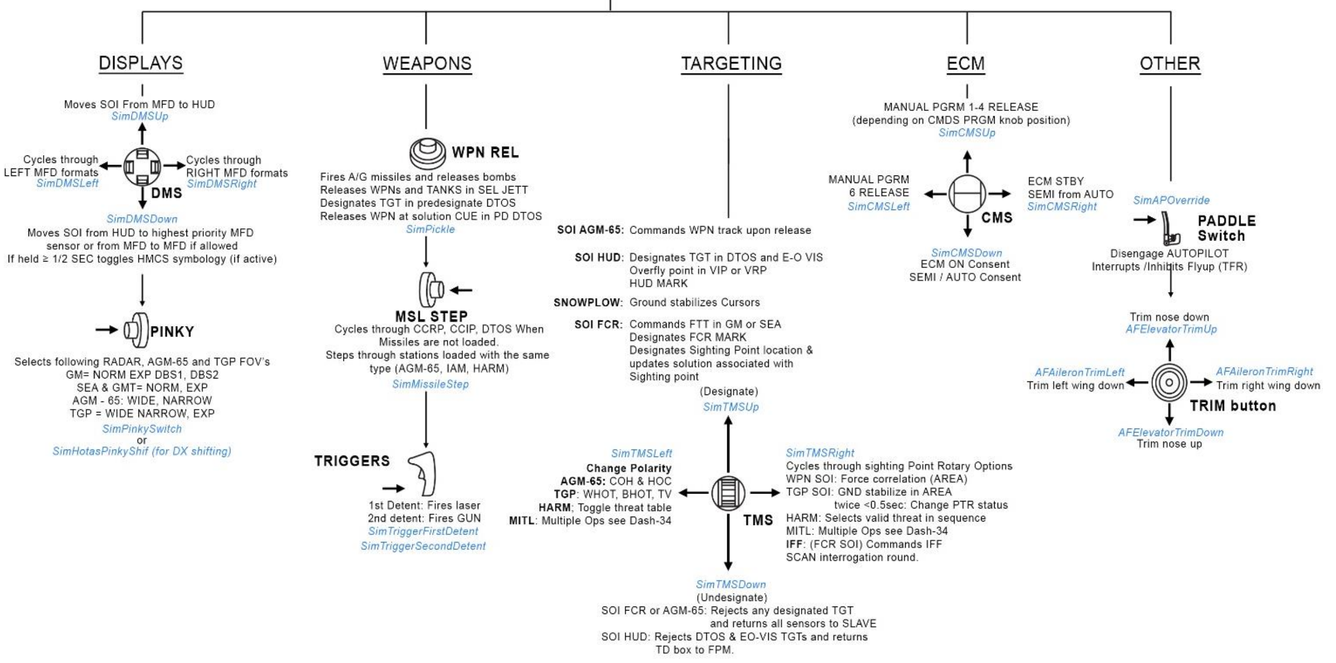


The stick in the real F-16 is a force sensing unit which contains transducers in both pitch and roll axes, moves approximately 1/4 inch in both axes and is rotated slightly clockwise.

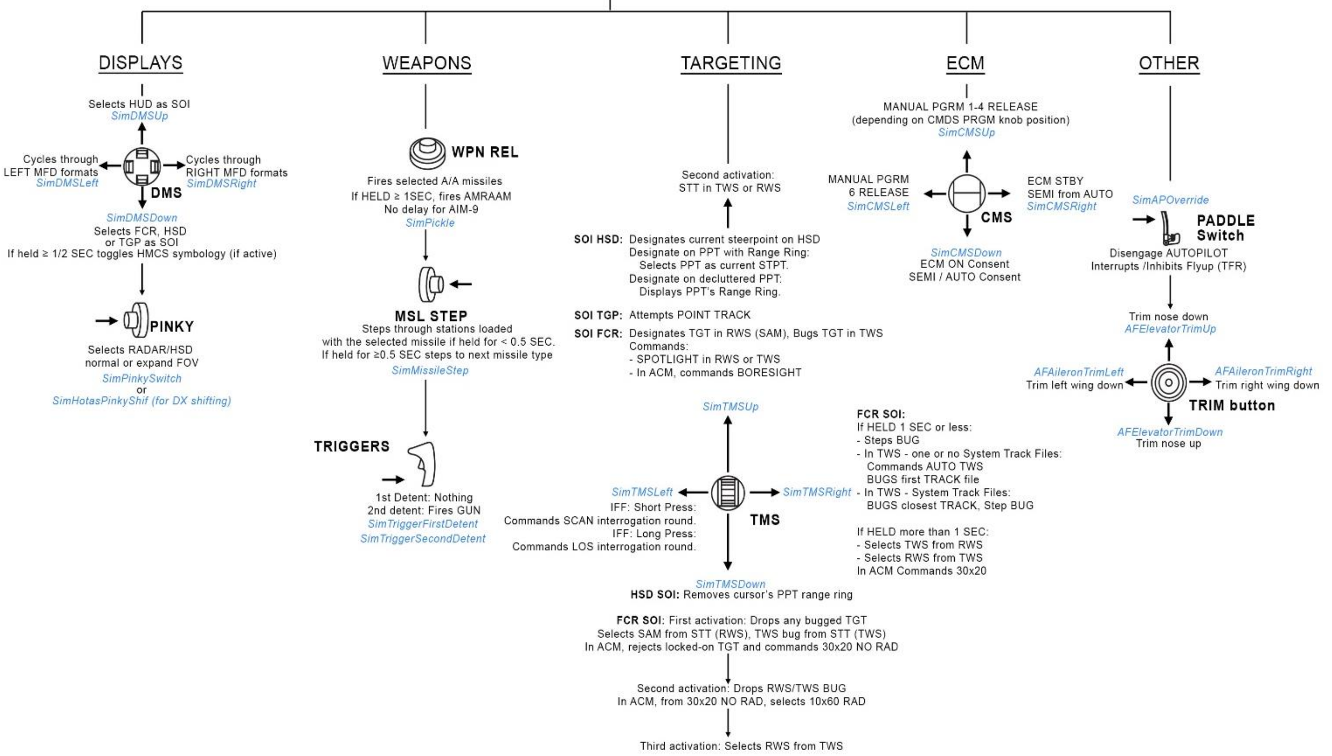
Refer to the diagrams on the two following pages for the function of each button.

BMS Key Callbacks for the Sidestick:
SimTMSUp
SimTMSDown
SimTMSLeft
SimTMSRight
SimDMSUp
SimDMSDown
SimDMSLeft
SimDMSRight
SimCMSLeft
SimCMSUp
SimCMSDown
SimCMSRight
SimPinkySwitch
SimHotasPinkyShift (DX callback)
SimAPOverride
SimTriggerFirstDetent
SimTriggerSecondDetent
SimMissileStep
SimPickle
AFAileronTrimLeft
AFAileronTrimRight
AFElevatorTrimUp
AFElevatorTrimDown
AFResetTrim

HANDS- ON CONTROLS
AIR TO GROUND MISSION
SIDE STICK CONTROLLER
A-G (& NAV) MASTERMODE



HANDS- ON CONTROLS
AIR TO AIR MISSION
SIDE STICK CONTROLLER
A-A, MSL OVRD, DGFT



1.2.5.3 HUD panel

The HUD panel allows the pilot to customise the Head Up Display. The panel is arranged in 2 rows of 4 toggle switches:

- The VV/VAH – VAH – OFF switch refers to the vertical velocity scales found on the HUD.
  In VV/VAH in addition to the vertical velocity scale there is also a bank angle (15°/30°/45°/60°) indicator on the FPM. In VAH there is a roll indicator below the heading tape (unless you have chosen to display the DED or PFL in the HUD) with 10°/20°/30° and 45° cues. In OFF no scales or bank/roll indication is displayed.

- The ATT/FPM – FPM – OFF switch refers to the pitch ladder and flight path markers (FPM). In ATT/FPM, both the pitch ladder and flight path marker are displayed. In FPM only the flight path marker is displayed. In OFF neither pitch ladder nor FPM is displayed.

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

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

- The CAS –TAS – GND SPD switch controls display of the speed scale on the left of the HUD.
  When CAS is selected the speed tape shows the Calibrated Airspeed. CAS is Indicated airspeed (IAS) corrected for position & instrument error.
  When TAS is selected the speed tape shows the True Airspeed. TAS is CAS corrected for pressure altitude, so it is the airspeed in the air mass at this altitude.
  When the switch is set to GND SPD, the HUD tape shows the speed over the ground. Groundspeed is TAS corrected for winds.
  In GND SPD a caret is also displayed on the heading tape. The caret means the system is now in wind corrected ground track as opposed to showing heading as magnetic track.
  Please note that whenever the landing gear is lowered the HUD airspeed automatically reverts back to CAS, irrespective of the switch position.

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

More information can be found in the HUD chapter.

BMS Key Callbacks for the HUD panel:
SimHUDVelocityCAS
SimHUDVelocityTAS
SimHUDVelocityGND
SimHUDVelocity
SimHUDVelocityUp
SimHUDVelocityDown
SimHUDAltRadar
SimHUDAltBaro
SimHUDAltAuto
SimHUDRadar
SimHUDAltUp
SimHUDAltDown
SimHUDBrtDay
SimHUDBrtAuto
SimHUDBrtNight

SimHUDBrightness
SimHUDBrightnessUp
SimHUDBrightnessDown
SimReticleSwitch
SimReticleSwitchUp
SimReticleSwitchDown
SimReticlePri
SimReticleStby
SimReticleOff
SimHUDFPM
SimPitchLadderOff
SimPitchLadderFPM
SimPitchLadderATTFPM
SimPitchLadderUp
SimPitchLadderDown
SimScalesVVVAH
SimScalesVAH
SimScalesOff
SimHUDScales
SimHUDScalesDown
SimHUDScalesUp
SimHUDDEDDED
SimHUDDEDPFL
SimHUDDEDOff
SimHUDDED
SimHUDDEDDown
SimHUDDEDUp

1.2.5.4 NUCLEAR panel

Currently not implemented.

1.2.5.5 ZEROIZE panel

Currently not implemented.

1.2.5.6 VMS panel

The Voice Messaging System (VMS) panel includes a single toggle switch. When placed in the INHIBIT position VMS will be inhibited (Bitchin' Betty remains silent). When placed in the UP position VMS is operational.

BMS Key Callbacks for the VMS panel:
SimInhibitVMS
SimVMSOn
SimVMSOFF

1.2.5.7 Internal LIGHTING panel

Internal lighting is not fully implemented in BMS.
Only 2 knobs are available to control cockpit lighting: the PRIMARY INST PANEL for instrument backlighting and the FLOOD CONSOLES knob for cockpit flood lights.
The third knob implemented controls DED brightness.
Each knob has three-position: OFF, DIM, BRIGHT, which cannot be assigned to an analogue value.

BMS Key Callbacks for the INT LIGHT panel:
SimInteriorLight
SimInteriorLightCW
SimInteriorLightCCW
SimInstrumentLight
SimInstrumentLightCW
SimInstrumentLightCCW
SimSpotLight
SimDedBrightness
SimDedBrightnessCW
SimDedBrightnessCCW

1.2.5.8 AIR COND panel

The AIR COND panel is made of two large knobs. The first one for TEMP is not implemented, but the second labelled AIR SOURCE is.
OFF - the engine bleed air valves close. All air conditioning, cooling and pressurizing functions shut off, meaning no cockpit pressurisation, system cooling or external fuel tank pressurisation (preventing fuel transfer from external tanks).
NORM - the air conditioning system sets for automatic temperature and pressure regulation. Cockpit and fuel tanks are pressurized and avionics are cooled.
DUMP - cabin pressurisation is terminated and the cockpit is vented to outside air pressure. This means cockpit pressure altitude will increase above 8000 feet MSL. The CABIN PRESS caution light will illuminate if cockpit pressure altitude exceeds 27000 feet. All other ECS functions such as external fuel tank pressurisation are unaffected.
RAM - engine bleed air valves close. Cabin pressurization is terminated and the cabin is vented to outside air pressure as above. RAM air valves are opened to ventilate the cockpit and avionics. All other ECS functions such as external fuel tank pressurisation & cooling are disabled.

BMS Key Callbacks for the AIRCOND panel:
SimIncAirSource
SimDecAirSource
SimAirSourceOff
SimAirSourceNorm
SimAirSourceDump
SimAirSourceRam

1.2.5.9 KY 58 panel

Currently not implemented.

1.2.5.10 ANTI ICE panel

Currently not implemented.

1.2.5.11 AVIONICS POWER panel

As the name implies, the AVIONICS POWER panel is used to power up avionic systems. It is made of 6 locking toggle switches and two knobs.
MMC - enables power to the Modular Mission Computer (old FCC).
ST STA - enables power to the Store Stations (old SMS).
MFD - enables power to the Multi-Function Displays.
UFC - enables power for the Up Front Controls.
MAP – is not wired, has no function but can be moved.
DL - enables power to the data link receiver.

The INS has been replaced by EGI (Embedded GPS/INS) in our block 50/52. That explains the deletion of the GPS switch on the old Avionic panel. The following positions are implemented in BMS: OFF, ALIGN NORM, NAV, IN-FLT ALIGN. The position ALIGN STOR HDG and ATT are not implemented.
OFF positions terminates all INS functions.
Place the knob to ALIGN NORM to start a normal alignment. The EGI is usable after 90 seconds when it has heading information. At that point the AUX yellow flag on the ADI disappears and a steady RDY is displayed in the HUD and DED. Those are your visual cues for performing a short ramp procedure. Full alignment takes approximately 4 minutes rather than the old 8 minutes with the INS. At that point RDY flashes in the HUD and on the DED to indicate full alignment.

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

In case of EGI failure or problem an IN FLIGHT alignment can be performed. The EGI is then realigned according to GPS data provided by the GPS system. During in-flight alignment straight, level and un-accelerated attitude should be maintained until the EGI reports a state at or above 8.1. Normally the magnetic heading should be entered manually in the DED, but that is not required in current BMS code

The MIDS LVT knob is not implemented. It is a digital TACAN system. The knob is supposed to turn the TACAN transmitter/receiver ON and OFF. IN BMS, TACAN is always ON

BMS Key Callbacks for the AV Power panel:
SimINSInc
SimINSDec
SimINSOff
SimINSNorm
SimINSNav
SimINSInFlt
SimSMSPower
SimSMSOn
SimSMSOff
SimFCCPower
SimFCCOn
SimFCCOff
SimMFDPower
SimMFDOn
SimMFDOff
SimUFCPower
SimUFCOn
SimUFCOff
SimGPSPower
SimGPSOn
SimGPSOff
SimDLPower
SimDLOn
SimDLOff
SimMAPPower
SimMAPOn
SimMAPOff

1.2.5.12 OXYGEN REGULATOR panel

The Oxygen panel is not implemented in BMS but the green lever can be used to toggle on or off the sounds of the pilot breathing through the oxygen mask.

BMS Key Callbacks for the Oxygen panel:
SimOxySupplyToggle
SimOxySupplyOn
SimOxySupplyOff

1.2.5.13 DTU panel

Currently not implemented.

1.2.6. MISCELLANEOUS

There are a few controls that are accessible to the pilot but not from cockpit controls. We will cover them in this small section.

1.2.6.1 NVG

Night vision googles are normally powered from the helmet, hence there is no cockpit control (thus no mouse hotspot) for them. You will have to activate them with the relevant callback associated to a keystroke (“n” by default). it’s a toggle so it can be easily activated or deactivated.

NVGs in BMS are restricting the pilot field of view and try to simulate tunnel vision.

The resolution of your main screen might impact the NVG as the DDS masks by default is made for 1920x1080 resolution. If you use other screen resolution, it is best to adapt the NVG mask DDS for a matching resolution, or use one of the NVGs mask made by the community.

BMS Key Callbacks for NVG:
SimNVGModeOn
SimNVGModeOff

1.2.6.2 HELMET VISOR

For a long time the lack of contrast of the HUD against the clear blue sky created readability issues for many of us. BMS 4.34 introduced a visor mask that increases the contrast by lowering the brightness of the sky. Exactly like a pilot lowering his flying helmet dark visor in front of his eyes.

Just like the NVG it is a toggle and there is no hotspot in the cockpit for this as it is initiated on the helmet itself. You will therefore have to use the relevant new callback associated to a keystroke (default ALT v), which can be mapped to a spare HOTAS button to allow convenient access in flight.

BMS Key Callbacks for Visor:
SimVisorToggle

1.2.6.3 PILOT MODEL

Before 4.34 the F-16 cockpit was empty. Harpoon’s popular pilot model has been added by default into the cockpit with two kneeboards where relevant dynamic flight information can be displayed. These DDS files can be manually edited or created very easily with Weapon Delivery Planner. This pilot model can block some panel views, so can be deactivated either through UI options (SETUP > GRAPHICS) or in 3D with a keystroke associated with a callback (default ALT c then p).

BMS Key Callbacks for Pilot model:
SimPilotToggle

1.3 UP FRONT CONTROLS

The UFC is made up of a display called the Data Entry Display (DED) and a keyboard known as the Integrated Control Panel (ICP).
Both work together to provide the pilot with an easy way to interface with the avionics system of the aircraft. Every press on an ICP button opens a page or changes information on the DED. The DED needs UFC power to work. Please note it will not turn on immediately at UFC power up (during ramp start) but requires a few seconds for the display to come online.

Fig1: The ICP

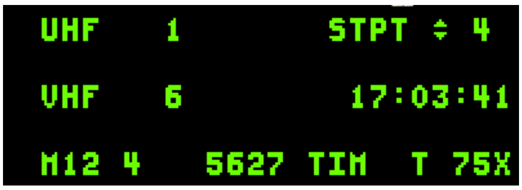
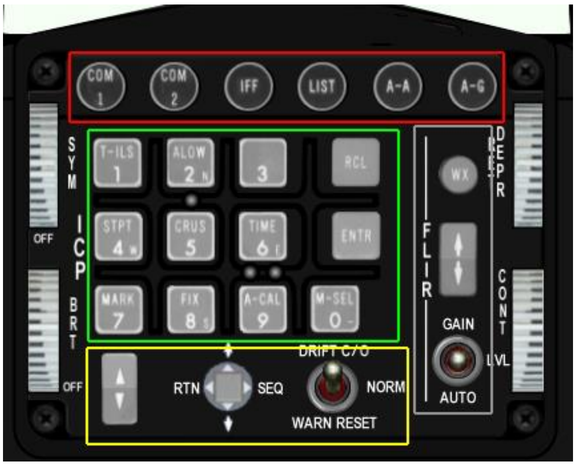


Fig 2: The DED

The ICP is arranged into 5 different areas:



The top row with round pushbuttons (red), the entry pad with square pushbuttons (green) the FLIR zone (grey), the bottom part (yellow) with switches and the 4 outboard wheels.

More importantly, we can classify the ICP buttons in other more relevant categories:

- Master Modes
- Override Modes
- Priority buttons.

The F-16 avionics system has the following components controlled from the ICP:

7 Master Modes

1. Air to Air (A-A ICP button)
2. Air to Ground (A-G ICP button)
3. NAV (when none of the A-A or A-G modes are engaged)
4. DGFT - Dogfight (toggle switch on the throttle)
5. MRM/SRM – Missile Override (toggle switch on the throttle)
6. S-J Selective Jettison (SMS page on MFD)
7. E-J Emergency Jettison (while the E-J button is depressed)

Master Mode buttons automatically configures the system for specific actions. They can change MFD pages, DED pages and HUD pages all at once.

5 Override Modes

1. COM1 (ICP button)
2. COM2 (ICP button)
3. IFF (ICP button)
4. LIST (ICP button)
5. F-ACK (left glareshield pushbutton)

Override modes provide direct access to the functions of the corresponding button. You can revert back to the initial page by pressing the override mode button again.
In addition to the 5 override modes there is a special override mode that returns the UFC to CNI (Communication, Navigation & Identification) page on the DED. That mode is accessed by moving the DCS (Data Command Switch) to the left (RTN position).

8 Priority/secondary buttons:
These are the ICP square buttons labelled T-ILS, A-LOW, STPT, CRUS, TIME, MARK, FIX and A-CAL. The two last are not implemented in BMS.
These buttons have a dual function; they are used to input numerical data into the UFC/DED or to enter UFC/DED subpages according to the labelling listed above.
Numerical values can be entered in the scratchpad. The scratchpad is the area between two asterisks displayed in the DED. Anytime you see the scratchpad active the numerical value of the ICP button from 0 to 9 will be used when you press these buttons. Note that the numerical zero is entered using the M-SEL 0 button, this button has no secondary page call up function.

1.3.1. Data Command Switch (DCS) & scratchpad

The DCS is a four way momentary switch situated on the bottom row of the ICP, next to the DRIFT C/O – WARN RESET switch.
The LEFT position is labelled RTN and allows exit from the current DED page or return to the CNI DED page.
The top position is labelled with an up arrow and cycles the DED cursors to editable functions (scratchpad) moving upward.
The bottom position is labelled with a down arrow and cycles the DED cursor to editable functions downward.
The right position is labelled SEQ and is used to enter extra subpages or options of the current priority function.

1.3.2. ENTR and RCL button

Those two buttons have no priority functions and only serve to confirm or cancel the entered data. After entering data in the scratchpad the ENTR button must be depressed to submit the changed data. The system checks if the data is valid and if it is enters it, then moves on to the next editable area. If the data is invalid the inputted data will flash and the pilot will have to correct any errors.
The RCL (Recall) will clear the last data entry. If pushed twice in succession the entire scratchpad will be cleared.

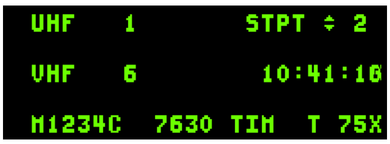
1.3.3. DED scratchpad

The scratchpad is an editable area receiving alphanumeric values from the ICP keys. The scratchpad area is displayed in the DED between two asterisks.
The scratchpad area on the left picture is around the Laser Start Time, which is initially set to 20 seconds before weapon impact.

Any press on the ICP buttons will change the numerical value. For instance, if we press 1 then 6 the laser time will change to 16 seconds when the ENTR key is pressed and the scratchpad is moved automatically to the next area (if the data is valid) or manually by moving the DCS switch up or down.

To return to the default DED (CNI) page, move the DCS to the RTN (left) position.
Anytime the scratchpad is not active a press of a priority button will enter the relevant subpage.
Each of them is covered later in this section.

1.3.4. CNI page



The Communication, Navigation and Identification DED page (CNI) is the default page for the DED.
It displays information about the current radio settings for both COM1 & COM2 radios, the active steerpoint, current time, IFF mode & codes and active TACAN or DME when A/A TACAN is active.

The CNI page is only accessible when the CNI switch on the AUX COMMS panel is set to UFC. When placed in BACKUP the UFC is inoperative and all backup systems are active and controlled from the side consoles.
Note the up and down arrow on the steerpoint on the CNI page. This shows that the current steerpoint can be incremented or decremented with the PREV/NEXT button of the ICP (the rocker switch located left of the DCS) without leaving the CNI page. As with the scratchpad, the arrows can be cycled through the fields that can be edited by moving the DCS up and down.

Moving the DCS right to SEQ in the CNI page will display the current wind speed and direction on the DED but valid data is only available once sufficient airflow is feeding data to the probes. There is no wind indication on the ground in BMS as in the real aircraft, so ask the ATC for a wind check or get the ATIS.
The system time is displayed and if a hack time is activated, the hack clock will be displayed below the system time. (see TIME subpage).

1.3.5. T-ILS page (1)

This page refers to the TACAN and ILS settings. You can access it through the T-ILS ICP button.

The first line of the DED gives the TCN and ILS status (ILS is turned on/off with the ILS knob on the AUDIO2 panel).

The scratchpad is on the left between the two asterisks and that is where the TACAN & ILS frequencies are entered. The system is able to differentiate a valid TACAN channel (0-126) from a valid ILS freq (VHF 4 or 5 digits). The next line gives the current and active TACAN and ILS frequencies respectively and the last line displays the TACAN band (X or Y) and the CRS set for the ILS approach.

To enter a new TACAN channel or an ILS frequency simply input the relevant numbers within the asterisks and hit ENTR.
To change the TACAN band: input 0 (zero) in the scratchpad and press ENTR. That toggles from X to Y to X and so on.
To change the TACAN from T/R (ground domain) to A/A TR (air domain) use the DCS SEQ button.

ILS CMD STRG can be inhibited or activated by placing the scratchpad over it and mode selecting it with the M-SEL 0 ICP pushbutton. The CMD STRG line in the DED is highlighted when command steering is active.
To change the ILS course place the scratchpad on the CRS field using DCS up/down and enter the correct runway heading for the active ILS. Press ENTR to input the data into the system.

1.3.6. A-LOW page (2)

The Altitude-LOW page lets the pilot set different values for the altitude advisory system.
It is made up of three lines but before we get to that, please note the top right number with the arrows on the right. This is the active steerpoint; the arrows mean that the active steerpoint can be changed with the PREV/NEXT buttons of the ICP without leaving the A-LOW page.

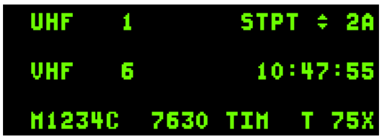
Move the scratchpad up and down with DCS up and down to select a field to edit.

CARA ALOW is the altitude in feet where you want an advisory altitude warning. It is mainly used for low altitude flying. The inputted value is repeated in the HUD next to the AL notation and flashes when the actual altitude goes below that CARA ALOW. If the gear is up VMS will also produce an aural ALTITUDE call.
A caret is placed at the ALOW height on the AUTO altitude HUD scale.
The CARA ALOW function will work only if the radar altimeter is operating.

MSL FLOOR is your Minimum Safe Level floor. It is DTC loadable and one typical approach is to set this to 14000 feet to correspond with the transition altitude in Korea. That ensures that when descending below 14000 VMS calls ALTITUDE, reminding the pilot to switch to local QNH for the altimeter calibration setup.

TFR ADV is an advisory altitude below which the red CHECK ATTITUDE box will flash. It's usually set at MSA (Minimum Safe Altitude). See the TFR MFD page for further information, or the TFR chapter in the TO BMS1-F16CM-34-1-1 manual.

1.3.7. STPT page (4)



The Steerpoint page gives the pilot information about the INS steerpoint.
The first line allows the pilots to toggle the active steerpoint with the NEXT/PREV ICP buttons (notice the up & down arrows) and the MAN or AUTO steerpoint function, which can be toggled with DCS SEQ. MAN means that the new steerpoint has to be manually selected. AUTO will increment to the next steerpoint automatically when the INS detects the proximity of the current waypoint. In AUTO mode an “A” symbol is displayed on the CNI page next to the steerpoint, as seen in the screenshot on the left.

The second line is the LATITUDE of the currently selected steerpoint. Placing the scratchpad there will let the pilot enter the latitude for this particular navigation point. The latitude must start by inputting NORTH by pressing ICP #2 key (notice the small N on that key) then the relevant numbers can be input. The scratchpad will not respond until the cardinal key is pressed.

The third line is the LONGITUDE of the selected steerpoint. It can also be changed by placing the scratchpad accordingly and entering new coordinates. The longitude must start by inputting EAST by pressing ICP #6 key (notice the small E on that key) then the relevant numbers can be input. The scratchpad will not respond until the cardinal key is pressed.

The fourth line is the elevation of the steerpoint (the altitude at which you are supposed to overfly the steerpoint according to your INS flight plan). This is different from the real jet that has the ground spot height for steerpoint in this field (it is quite relevant to TGP mechanisation and finding the target).

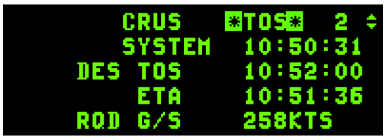
The fifth line is the TOS (Time Over Steerpoint) which gives you the local time the steerpoint will be reached, if you are following the route of flight as planned.

1.3.8. CRUS page (5)

The Cruise page provides access to 4 submodes: TOS, RNG, HOME and EDR and gives relevant information for navigation, time and fuel while cruising.
Each submode **must** be mode selected to become active and supply accurate information and cues. Remember mode-selecting is done with the M-SEL 0 button and when active highlights the area.

The submodes of the CRUS page are accessed sequentially with DCS SEQ or by pressing any secondary ICP button.

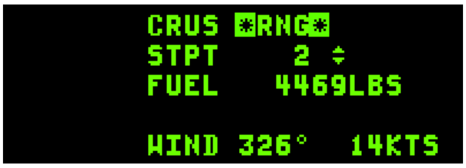
When first entering the CRUS page it defaults to the first subpage: TOS (Time Over Steerpoint).



When TOS is mode selected a caret is displayed on the HUD speed tape. To ensure that you reach the steerpoint on time for TOS match your airspeed with the caret. The ETA (Estimated Time of Arrival) to the steerpoint is also displayed in the HUD.
When TOS is not mode selected (it no longer is by default since 4.33 just like in the real jet) no caret is active on the HUD speed tape and ETE (Estimated Time Enroute) is displayed in the HUD.

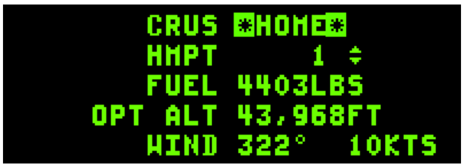
You can change your TOS and assign a new one by simply inputting a new value in the scratchpad when the asterisks are around the DES TOS.
Further information on the TOS page includes the current system time, ETA at steerpoint and required ground speed to get there at the indicated DES TOS.

The next Submode is RNG for Range.



When RNG is mode selected a caret is displayed on the HUD speed tape to pinpoint the best conserve fuel speed at this altitude. Optimum speed for fuel conservation changes with altitude.
When RNG is not mode selected there is no caret displayed on the HUD speed tape. Please note on the picture RNG mode is NOT mode selected. Only the active steerpoint can be toggled on this subpage. Additional information given on this page shows fuel remaining when reaching the active steerpoint, wind direction and speed.

A further press of DCS SEQ brings up the HOME subpage.



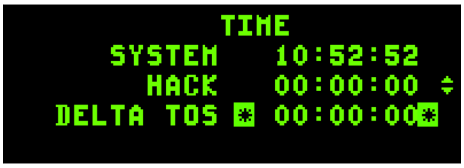
When HOME is mode selected 2 carets are displayed in the HUD on the speed tape and on the altitude tape. Following these 2 carets will establish the best profile to reach Home Plate (or any steerpoint designated as HMPT).

The procedure to fly this profile is to select full military power, reach the speed caret first then pitch to reach the altitude mark while maintaining the speed on the caret. Altitude may vary according to fuel burned. Please note, optimal altitude is given in radar altitude on the DED, but may be different on your HUD scale depending on the altimeter setting. Check the picture on the right, both carets are followed and the optimum altitude in the DED matches the HUD radar altimeter. If you follow both carets you will reach the home point at the selected optimum altitude.
The altitude caret will disappear once you can start your descent.
Further information displayed on this page indicates home point (can be changed to any INS steerpoint (e.g. alternate)), onboard fuel quantity remaining when reaching active steerpoint, optimum altitude for the HOME profile, wind direction and speed.

The last subpage of the CRUS page is the Endurance mode (EDR)

When EDR mode is mode selected a speed caret is placed on the HUD tape to give a reference speed for best endurance at this altitude. This is very useful for holding patterns or maximum endurance cruise for instance. Further information given is time to bingo, optimum Mach number and wind direction and speed.
It is important to realise that when toggling from one submode to another you **must always** mode select the new mode. If you don't do so the caret may be relevant to the previous CRUS submode. So to avoid any confusion make sure you always mode select the submode!

1.3.9. TIME page (6)



The TIME page allows the pilot to set a HACK timer and a DELTA TOS for ROLEX calls. The first line gives the current system time. The second line is the hack timer. As the arrows indicate, pressing the ICP NEXT rocker button will start/freeze/resume the timer and ICP PREVIOUS rocker button will reset the hack timer to zero.
When the HACK timer is running it is also visible on the CNI page. ROLEX calls are initiated when TOS for all steerpoints need to be adjusted. This is done through the TIME page by changing the DELTA TOS. Place the scratchpad on the DELTA TOS line and input the ROLEX value. If a minus is required start your input with the 0 (zero) ICP key for the minus sign.
For instance: “Mamba flight Rolex +2” => TIME, DCS down to DELTA TOS: 2, 0, 0, ENTR
Another example: “Mamba flight Rolex -3” => TIME, DCS down to DELTA TOS: 0, 3, 0, 0, ENTR

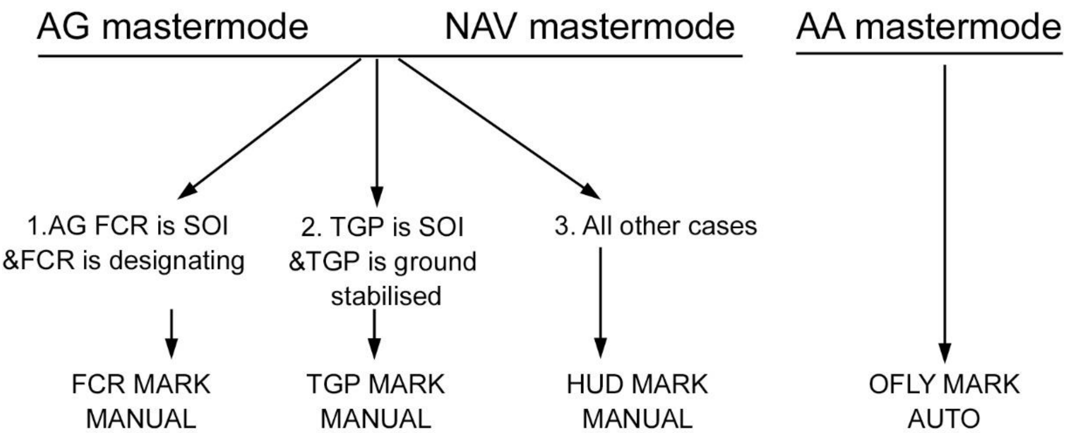
1.3.10. MARK page (7)

The MARK page is used to create markpoints. Ownship markpoints are stored in steerpoints 26-30. Mark points can be made from 4 different systems. OFLY (Overfly GPS/INS), FCR (Fire Control Radar), HUD (Head Up Display) or TGP (Targeting Pod). There are thus 4 submodes in the MARK page. To toggle between the submodes use DCS SEQ. The system defaults to a specific subpage according to master mode and Sensor of Interest (SOI) and may enable automatic markpoint recording.

- If master mode is NAV or A-G mode and the FCR is SOI & designating entering the MARK page will default to FCR MARK. The first markpoint will remain blank until TMS is moved up. At that point, the markpoint is created.
- If master mode is NAV or A-G mode and the TGP is SOI and ground stabilised entering the MARK page will default to TGP MARK. As with FCR, TMS up will create the markpoint.
- If master mode is NAV or A-G mode and the FCR or TGP are not SOI & designating or ground stabilised entering the MARK page will default to HUD MARK. A markpoint must be created manually by moving the HUD mark cue (HMC – a small slewable circle appearing near the FPM in pre-designate) with the cursor (HUD SOI) and moving TMS up. The first press of TMS up will ground stabilise the HMC and the second TMS up will save the markpoint. HMC must be on the ground for correct implementation, pointing at the sky will not work obviously.
- If master mode is A-A entering the MARK page will default to OFLY MARK and an automatic markpoint will be created.

Please note: the ICP ENTR key is no longer used to create markpoints – TMS forward (TMS up) creates markpoints.

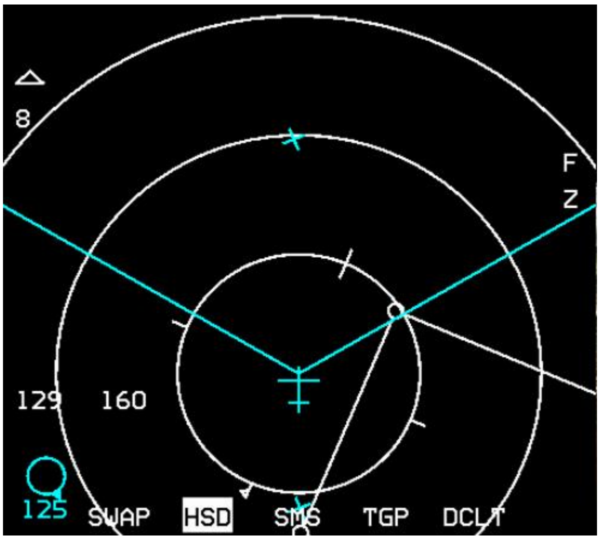
Mode selecting (M-SEL 0 button) any valid markpoint will make it the active steerpoint.



As with any type of steerpoint markpoints can be sent over the IDM - Refer to the IDM chapter in the TO-BMS1F-16CM-34-1-1 for further information.

Markpoints are visible on the HSD page once created as a cyan cross.

In any MARK mode manual markpoints can be created by setting the correct MARK subpage according to active sensor. Move the cursor to the desired spot and move TMS up once or twice depending on MARK mode. If previous automatic markpoints were recorded the markpoint rotary will increment and the next available steerpoint in the MARK bank will be selected. Ownship markpoints are stored in steerpoint 26 to 30. Once #30 is filled, the next markpoint will overwrite #26 and so on.



1.3.11. FIX page (8)

Not implemented.

1.3.12. A-CAL page (9)

Not implemented.

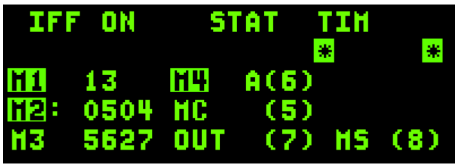
1.3.13. COM1 page

Pressing the COM1 ICP button brings up the UHF radio page. The first line gives the status; in this case it's set to BOTH (Preset & Guard) and the frequency is 292.650 MHz. The scratchpad is ready to receive a new frequency or the new preset. Presets are set in the UI.
Another way to change the UHF radio is to use the ICP NEXT/PREV ICP button to directly change the preset (note the double arrows next to the 4).
Note that the UFC UHF radio is able to listen to GUARD while transmitting and receiving on the preset if set to BOTH. By moving the DCS to the right BOTH will be replaced by MAIN and the UHF will not receive GUARD unless tuned to 243.0 MHz. Please refer to the BMS-Comms-Nav-book for more information.

1.3.14. COM2 page

The COM 2 ICP button brings up the VHF radio page.
The first line gives the status of the radio, in this case it's ON and the set frequency is preset 15. The UFC VHF radio cannot listen to GUARD while on a preset. It must be tuned to 121.5 MHz.
The scratchpad is ready to receive the new frequency or the new preset.

1.3.15. IFF page



IFF transponder operations are managed through 3 IFF UFC pages: STAT (Status), TIM (Time) and POS (Position).

The default IFF page is the STAT page. Subsequent pages are accessible with DCS right (SEQ).

IFF status can be OFF, STBY, ON, or DEGR (degraded) if the system has failed.

The last item on the first line is the TIM or POS criteria, whichever is active (see TIM and POS IFF pages below). If both criteria are active P/T will be displayed. If neither criterion is active, nothing will be displayed.

Active modes are highlighted. In the picture above Mode1, Mode2 and Mode4 are active; Mode3 and ModeC and ModeS are inactive. IFF codes are given in regard to their respective mode: Mode1 code is 13, Mode2 code 0504, Mode3 code is 5627 and Key A is currently in use for Mode4.

Selecting a mode is made through the scratchpad: enter 1 to toggle Mode1 on and off, enter 2 for Mode2 toggling, 3 for Mode3, 4 for Mode4, 5 for Mode C and 8 for Mode S (currently not implemented) Codes can also be entered manually with the scratchpad as follows:

Two digit encoding defaults to a Mode1 code if it's a valid code: first digit never above 7, second digit never above 3.
Three or Four digit encoding defaults to Mode3 provided the code is valid (between 0000 and 7777 – no digit above 7).
The F-16 can change Mode2, unlike other aircraft. Change the Mode2 code by prefixing the 4-digit code with a 2. For example: "2 – 4 - 6 – 5 – 0 – ENTR" will input 4650 as the M2 code.
Mode4 is encrypted and cannot be changed but can be switched between key A and key B. This is done by entering "6 – ENTR" in the scratchpad.

Mode4 interrogation visual/audio feedback can be set with "7- ENTR" in the scratchpad. It will toggle between OUT (no feedback when Mode4 interrogated by another aircraft), LIT (the "4" will be highlighted on the CNI DED page – and enlarged if repeated on the HUD - when interrogated by another aircraft) and AUD (includes LIT plus in addition an audio tone is played in the pilot's headset if a Mode4 interrogation not matching the set key is received).

The next two IFF subpages are used to change the IFF settings automatically according to time or position criteria:

Press DCS SEQ to switch to the IFF POS subpage:
The IFF position page allows you to activate or deactivate certain modes according to the position of your aircraft.
You can set 2 different position criteria by using the up and down UFC arrow to toggle between page 1 and 2 (top right number).This would allow you to set a different IFF setting at fence in and at fence out for instance).

For the position criteria to be activated POS must be highlighted. Move the scratchpad to POS with DCS up and hit 0 (M-SEL). POS will then highlight and the criteria are activated.
Position criteria do not include code changes but only toggle the different modes on/off. This is why you do not see codes displayed on the POS page.

It is important to understand that toggling modes will depend on the current state of the mode in the STAT page. You determine a position where modes will be toggled. Once the aircraft reaches this position, the mode will be toggled. So if mode1, 2 and 3 are currently on and mode 4 is off as reported by the STAT page, and you set mode1, 2, 3 and 4 to toggle in the POS subpage, then upon reaching that position, the system will turn off mode 1, 2 & 3 and turn on mode4.

In the POS subpage you select which mode will toggle by typing "1-ENTR" to toggle Mode1 in the scratchpad position illustrated by the picture above, type 2 to select the Mode2, type 3 for Mode 3, 4 for Mode4, 5 for ModeC and 8 for ModeS (always confirm your entry with ENTR). In the picture above, Mode1, 2, 3 & 4 are set to toggle. As you notice ModeC and ModeS are not highlighted and therefore their state will not change upon reaching the position.

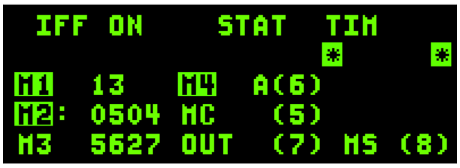
The actual position is set with the next scratchpad entry. DCS down to put the asterisks around the “OF“. Positions are given in relation to cardinal direction and INS steerpoints. Cardinal directions are on the ICP keypad 2 for North (the one on top), 6 for East (right), 4 for West (left) and 8 for South (bottom). Once the scratchpad is correctly placed input first the cardinal direction with 2, 6, 4 or 8 and then input the steerpoint number. In the left picture I inputted “6 3” for EAST OF steerpoint 3 (EOF3). Steerpoints are limited to 2 digits maximum but inputting one digit is perfectly fine. Remember you can set a second position criterion by selecting page 2 of the POS subpage with the up and down arrow.

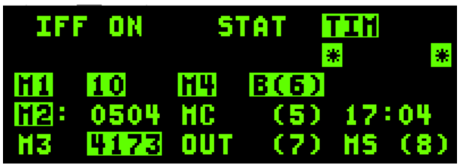
With the above configuration, the modes 1, 2, 3 & 4 will be toggled when reaching a line EAST of steerpoint 3.

The next IFF subpage is the Time criteria accessible with a further DCS right (SEQ). Rather than setting position criteria to change IFF settings, the time subpage allows pilots to set 12 different criteria based on time. Time criteria do not impact modes, only codes for the relevant modes. Only Mode1, Mode3 and Mode4 codes/keys can be changed with time criteria.

As with the POS subpage, time criteria are activated only when the TIM subpage is mode-selected. Move the scratchpad to TIM with DCS up and hit 0 (M-SEL). TIM will then highlight.

Pilot can set 12 different time criteria: use the up and down arrow on the ICP to toggle between the different criteria pages. The top right number will be updated accordingly. For instance you could set time criteria for each hour during the next 12 hours.





Codes are inputted in the same manner as on the STAT page: 2 digits for Mode1, 4 digits for Mode3 and toggling between key A and key B is done by inputting “6” in the scratchpad.

The time at which the IFF codes should change is input in the next scratchpad position (00:00 in the picture above) which you can select by moving the scratchpad with DCS down.

Time format must be inputted in hh:mm for 24hours. If you want the criteria to change at 17:04 local, input “1 – 7 – 0 – 4 – ENTR”. At 17:04 local, the STAT page will report a code change for the modes you set on the TIM page and will display the last event change (in this case 17:04).

As you can see in the sequence of pictures on the left, the IFF was set to change at 17:04 from Mode1:13, Mode3: 5627 and Mode4: A key to Mode1: 10; Mode3: 4173 & key B for Mode4. Notice the code highlights on the STAT page that notify an event took place.

This all sounds complicated but bear in mind that IFF data comes preloaded into your DTC for typical usage scenarios and pilots will not have to specify POS and TIME events from the cockpit, unless they want to. The IFF system is set up just like the real thing though, so there is huge scope for mission creators who want to explore its full potential.

For further information about IFF, please refer to the IFF chapter 1.16 later in this manual.

1.3.16. LIST page

The LIST page is used to access additional subpages. Each page can be accessed by pressing the relevant ICP button: 1 for DEST, 2 for BNGO, etc. Please note: RCL, ENTR and M-SEL 0 buttons are also used to enter INTG, DLINK and MISC subpages respectively.

Once again note the 4 and double arrows in the top right corner, allowing the pilot to change the current steerpoint without exiting the LIST page. It is not the case on the picture but if VIP or VRP are mode selected they will appear highlighted in the LIST page.

1.3.16.1 DEST page (1)

The DESTination page looks similar to the STPT page. The main difference is that you can change any steerpoint coordinates without direct effect on the HSD. When you change a steerpoint with the STPT page the effects are immediate since that particular steerpoint is active. Not so the DEST page, which is quite handy for making steerpoints more precise or simply for adding new steerpoints.
Please note: as with the STPT page any entered coordinate must start with the cardinal ICP key N(2), E(6), W(4) or S(8). The scratchpad will not respond until the cardinal key is pressed.

Depressing DCS to SEQ with any steerpoint selected enters the Offset Aimpoint 1 & 2 subpages. This lets the pilot set up two offset aimpoints for each INS steerpoint. Since BMS 4.33 you can change from FT to KM or NM on the RNG line. DCS up until you see *FT* (scratchpad asterisks around FT) then press any number key to rotate through FT to KM to NM.
More information about offset aimpoints can be found in the TO-BMS1F-16CM-34-1-1 manual.

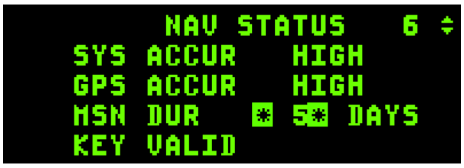
1.3.16.2 BNGO page (2)

The BINGO page is where you input your briefed Joker/Bingo settings. It is made up of two lines: the first one is where you enter your Joker or Bingo setting and the second line is the total fuel remaining on board. If the FUEL QTY knob is in NORM the VMS will call “BINGO” upon reaching the value set in the first line. It is good practice as a mission begins to input the Joker value. You can then reset it to the briefed Bingo value once Joker fuel is reached.
Note the arrows next to the active steerpoint allowing you to change it as usual with the NEXT/PREV button of the ICP.

1.3.16.3 VIP page (3)

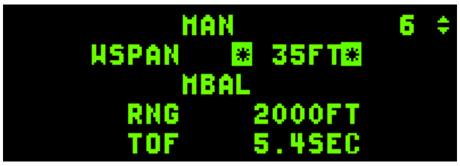
This page is used to enter VIP settings. VIP can be calculated manually but it is advisable to enter data given by a tool like WDP. This data is DTC loadable and WDP can set your DTC automatically as well. Nevertheless, should you need to input the data manually it is possible using this page. The VIP page must be mode-selected with the 0 (M-SEL) button for the VIP symbology to be visible in the HUD (the text between the asterisks is then highlighted). Moving the DCS to the right (SEQ) will enter the VIP-to-PUP page. Since BMS 4.33 you can change between FT, KM & NM on the RNG line by moving DCS up until you see *FT* and then pressing any key as shown above.

1.3.16.4 NAV page (4)



The NAV page is eye candy as it refers to the accuracy of the navigation system which is always very good in BMS and does not drift.

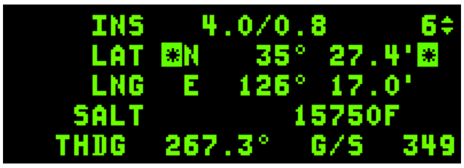
1.3.16.5 MAN page (5)



The MAN page is used to adjust the GUN EEGS funnel width setting for cannon firing. The setting is entered in feet and should match the wingspan of the expected target. The default is 35 feet and is DTC settable (and also in WDP). On the right is a table from the SP3 manual with the most common aircraft wingspan values.

Aircraft	*Span (ft)*
A-10	58
F-111	48
F-14	51
F-15	43
F-16	31
F-18	38
F-4	39
F-5	27
MiG-21	24
MiG-23	37
MiG-25	46
MiG-29	36
MiG-31	46
Su-24	44
Su-25	51
Su-27	42

1.3.16.6 INS page (6)



The INS page relates to the Inertial Navigation System. It is made up of 5 lines. The first one gives status of the INS (status 10 means fully aligned) and as always the active steerpoint can be changed without leaving this page with the NEXT/PREV ICP buttons. The second line gives your current latitude and the third your current longitude. The next line gives your barometric altitude and the last line your true heading and groundspeed. This last bit of information is very useful when taxiing as it is the only way to see information about your taxi speed.

1.3.16.7 EWS page (7)

The Electronic Warfare System page is where you setup your EWS.
Normally all these settings are in your DTC but you can also reprogram them on the fly through this page. Programming is only possible when the CMDS mode knob is placed in STBY.

The main section of the EWS page allows changes to the chaff and flare bingo settings and to enable or disable the REQCTR (request to counter), FDBK (feedback) and “BINGO” VMS calls.
Moving DCS to SEQ displays the expendable category (chaff then flares) for manual programming (programs 1 to 6). The arrows now designate the possibility to toggle among the 6 available CMDS programs to reprogram them. You toggle from the chaff page to the flare page using DCS SEQ. For each program and each expendable type you are allowed to set the Burst Quantity (BQ), Burst Interval (BI), Sequence quantity (SQ) and Sequence Interval (SI) just like in the DTC. For further information, please refer to the TO-BMS1F-16CM-34-1-1 ALE-47 COUNTERMEASURES DISPENSER SET chapter.

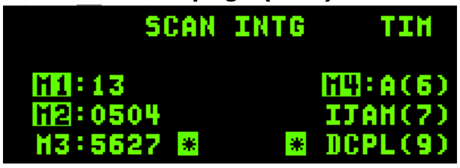
1.3.16.8 MODE page (8)

The MODE page provides an alternative way of changing the Master Mode without using the ICP buttons. Move the DCS to SEQ to toggle the Master Mode and mode select it with the M-SEL 0 key to make it active. NAV mode defaults when none of the others (A-A or A-G) are mode selected.

1.3.16.9 VRP page (9)

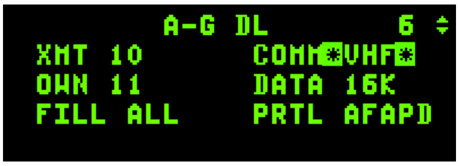
This page is used to enter VRP settings. VRP can be manually calculated but it is advisable to enter data given by a tool such as WDP. This data is DTC loadable and WDP can set your DTC automatically as well. Nevertheless, should you need to input the data manually it is possible to do so using this page. The VRP page must be mode selected (with the M-SEL 0 button) for the VRP symbology to be visible in the HUD (the data between the asterisks is then highlighted). Moving DCS to the right (SEQ) will enter the VRP-to-PUP page. DCS RTN exits back to the CNI page.

1.3.16.10 INTG page (RCL)



The INTG pages (now active in 4.34) are relevant to IFF interrogator settings. There are two subpages, both with the same structure yet independent from each other. One is for SCAN and one for LOS (Line of Sight).
SCAN and LOS page can be toggled with DCS right (SEQ). They display the active interrogator mode (active modes are highlighted) and the corresponding code for each mode. In modes 1/2/3 the interrogator does not send any data, it compares the received codes with the one inputted and if they match, the returned answer is considered friendly.
Codes can be changed with the same method as in the IFF STAT page: 2 digits for Mode1, 4 digits for Mode3 and 5 digits (always starting with 2) for Mode2. Mode4 has no code but it is important that the active key is valid as a transponder will not respond to an invalid key query.
Modes can be enabled or disabled in the same way as the STAT page as well, 1 toggles M1, 2 M2, …
IJAM is not implemented and is relevant to IFF jamming.
Entering “9 – ENTR” in the scratchpad couples or decouples the SCAN/LOS interrogator code to/from the transponder codes. When coupled, all changes made manually or through the change criteria (POS/TIM) to the IFF transponder pages will be automatically copied to the IFF interrogator pages.
If decoupled, interrogator pages will not reflect any changes made on the transponder pages.

1.3.16.11 A-G DL page (ENTR)



The Data Link pages are used to set your in-flight data-link settings. You can change the XMIT (transmit) address, the OWN address, the FILL and the COMM options.
The XMIT address is your ownship IDM address category. OWN is your specific address within that category.
The FILL option determines whether the system stores (ALL) or ignores (NONE) all received data-link steerpoints. When the FILL option is set to ALL the received steerpoints are stored in the steerpoint databank between #71 & #80. When more than 10 IDM steerpoints are received position #71 is overwritten and so on.
When option NONE is selected the system doesn’t store received markpoints and the pilot gets no HUD or VMS messages. The COMM option toggles (with any ICP number key) between VHF or UHF for A-G datalink (Intraflight will always use the opposite radio to A-G DL).
If DCS is moved right to SEQ the INTRAFLIGHT subpage is displayed. This is where other flight IDM addresses can be entered to enable A-A data-link with them.

Ownship (#1) can now be changed, though you will typically use the first column for your own flight and the second column for extra flights in your package. Simply enter the IDM addresses of flight members you wish to add. Example below: Your flight IDM is 20 (21-22-23-24), Strike flight IDM is 10 (11-

12), SEAD IDM is 30 (31-32-33-34).
The first column is already full with your flight IDM and you only have 4 slots free in the second one. One possible compromise could be to enter the Strike flight (11-12) in positions #5 & #6 and enter the Lead and Element Lead of the SEAD flight (31-33) in positions #7 and #8. This is left to the pilot's discretion but it is important to set multi-package IDMs correctly to maintain good SA during COMAO.
Please note A-A IDM radar tracks are only received from IDM addresses in the first (left) column.
For further information please refer to the TO-BMS1F-16CM-34-1-1 IDM chapter.

1.3.16.12 MISC page (0)

The MISC page leads to yet another list of submodes. The principles of operation are the same as the LIST page: depress the corresponding button listed on the MISC page to access the subpage.

1.3.16.12.1. CORR page

Correction page is not implemented.

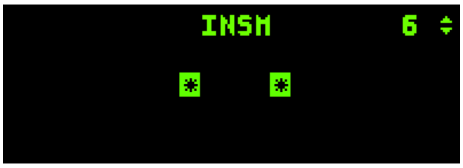
1.3.16.12.2. MAGV page

Displays the actual Magnetic Variation at this aircraft location. It would be used to correct INS navigation errors should they happen in BMS. At the moment this is done automatically by the code.

1.3.16.12.3. OFP page

Operational Flight Program page is not implemented.

1.3.16.12.4. INSM page



Inertial Navigation System Memory page is not implemented.

1.3.16.12.5. LASER page

This page is used to set up the Laser system. It is made of 4 lines.
The first sets the TGP code which must match the targeting laser pulse code of the weapon (set in the UI LOADOUT screen). If the TGP CODE does not match the weapon code the GBU will not guide and will fall ballistically. It is therefore possible to conduct buddy lasing by inputting the weapon code of your wingman's bombs. The second line sets the Laser Spot Track code. The third line toggles the laser from Training to Combat mode with any ICP button. The fourth line sets the laser timer. The targeting laser is fired for final weapon guidance automatically before impact and is DTC loadable. It's also more realistic in 4.34; you are now advised to set it to 10 or 12 seconds for Paveway II bombs and perform manual lasing for Paveway III bombs and moving targets as necessary. For further information please refer to the TO-BMS1F-16CM-34-1-1 SNIPER XR ADVANCED TARGETING POD chapter.

1.3.16.12.6. GPS page

Displays information about the GPS system.

1.3.16.12.7. DRNG page

Not implemented.

1.3.16.12.8 BULLSEYE page

This is where you manage system Bullseye.
Bullseye is by default assigned to STPT #25 but you can change it to any steerpoint (up to #25) by using the PREV/NEXT ICP button.

Display of Bullseye information changes depending on whether BULLSEYE is mode selected or not. Mode selection is toggled by pressing M-SEL 0 when the scratchpad asterisks surround the ‘BULLSEYE’ text and is on by default.

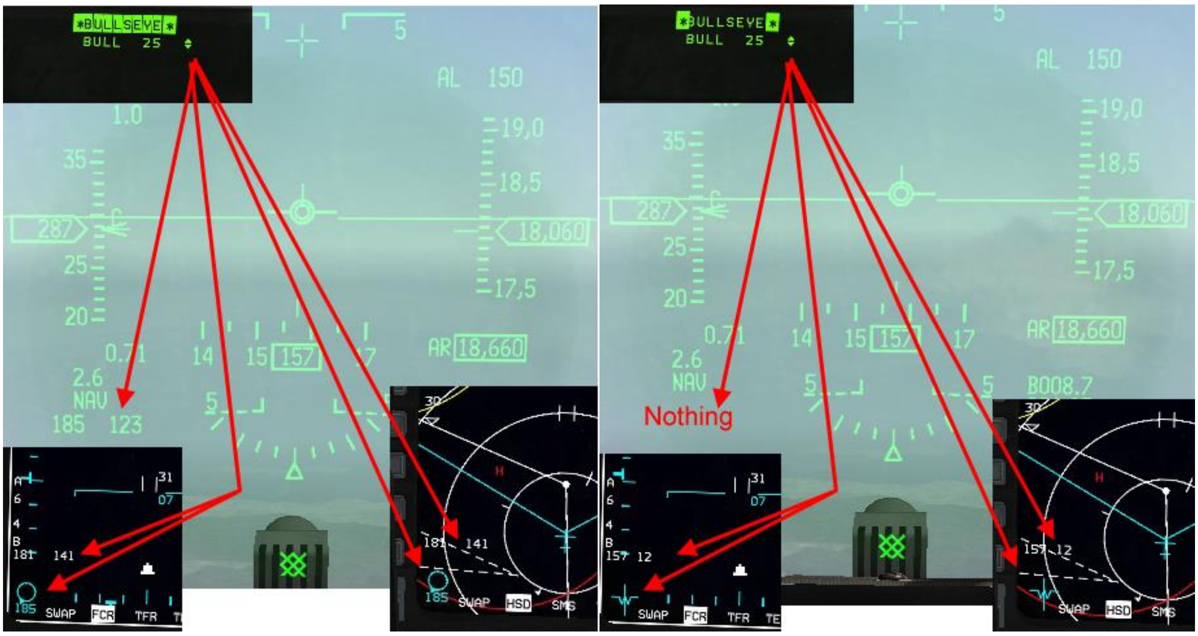
Bearing and range to Bullseye is displayed in the bottom left corner of the HUD when Bullseye is mode selected. When it is not mode selected you will have no bearing and range indication to Bullseye in the HUD.

In the MFDs (FCR and HSD pages) bearing and range information of the cursor position is shown relative to the Bullseye position when BULLSEYE is mode selected and relative to the active steerpoint when BULLSEYE is not mode selected. This may vary according to block, with newer blocks always displaying the flight director symbol, even with BULLSEYE mode selected.

The Bullseye symbol & circle is not displayed on the MFDs when BULLSEYE is not mode selected. Instead a waterline flight director symbol relative to the current active steerpoint is displayed.

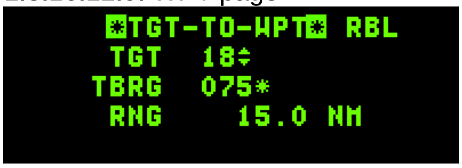
Please note: when distance to Bullseye is more than 99Nm the distance is not displayed inside the Bullseye circle (two digits only) on the MFD page.

So, to be able to maintain good Situational Awareness when calling out contacts with Bullseye bearing and range you need to have BULLSEYE mode selected, which is the default setting.



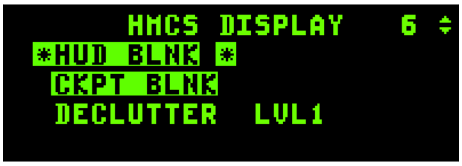
The left picture shows the HUD, FCR and HSD Bullseye symbols when BULLSEYE is mode selected; the right picture shows the same elements when BULLSEYE is not mode selected.

1.3.16.12.9. WPT page



The TGT-TO-WPT page is made to control Harpoon waypoints in RBL mode. Settings can't be changed when accessed from the LIST page.

1.3.16.12.10. HMCS page



The HMCS (Helmet Mounted Cueing System) display page allows the pilot to control the HMCS (on supported aircraft). The first line enables HUD blanking when mode selected. The HMCS will not be displayed when looking at the HUD. The second line enables blanking the HMCS when the pilot looks inside the cockpit.
The third line allows a selection of three levels of de-clutter for the HMCS displays. Highlight that line with DCS down and hit any ICP secondary button to change from level 1 to level 2 to level 3 to level 1.

If you depress the DCS to SEQ while in the HMCS display page another subpage will be displayed, though it is not implemented at this time.
Refer to the HMCS chapter in the TO-BMS1F-16CM-34-1-1 for further information about the HMCS displays & capabilities.

1.3.17. DRIFT C/O switch

The DRIFT C/O switch is a three-position switch with a momentary position to WARN RESET. Upper and middle positions manage the DRIFT of the flight path marker according to winds. The centre position, labelled NORM takes winds into account and lets the FPM drift to the side according to crosswinds, giving you a visual cue of beta angle (sideslip crabbing into the wind).

In the NORM position the FPM indicates where in 3D space the aircraft will fly towards with the current flight conditions and no additional control inputs. In other words if you hold what you have on the controls the FPM will show you where the jet will ultimately end up.
This is particularly useful for landing because it lets you picture the wind visually so you can compensate automatically.

On the other hand it may be an annoyance at high altitude with strong winds (which may throw the FPM off the edges of the HUD) and the upper position labelled DRIFT C/O maintains the FPM in the centre of the HUD regardless of winds. The switch should be placed to NORM before landing.

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

1.3.18. The ICP Thumbwheels

The top left is labelled **SYM** and used for HUD brightness. The wheel has an ON/OFF switch at the beginning of its travel, which is where the HUD is powered up.

The one **labelled DEPR RET** (top right) lets the pilot manage the backup bombing mode.

The brightness (**BRT**) wheel (bottom left) controls FLIR brightness on the HUD. Use this wheel to display the FLIR image on the HUD. Its effect will only be noticed when the FLIR is operational.

The bottom right wheel (**CONT**) is not implemented at this time.

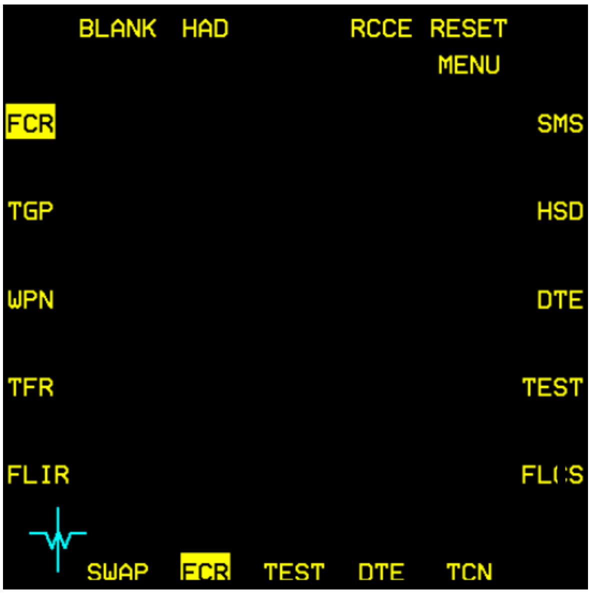
It is possible to control the implemented wheels with the mouse, keystrokes or an analogue axis.

1.4 MULTI FUNCTION DISPLAYS

The MFDs are the two displays situated on the front dash featuring 20 pushbuttons and four rocker switches on each. Both displays are independent. MFDs are powered by the MFD switch on the AVIONICS POWER panel on the right side console.
The push buttons are called Option Selection Buttons (OSB) and are numbered from 1 to 20, starting at the left button of the top row and moving clockwise to the top button of the left row.
The function of the button changes according to the displayed page and the button's legend is displayed next to the button.
The top, left and right rows of buttons are typically assigned customized functions depending on the page being displayed. By contrast, the bottom row (OSB 11 to 15) operates more or less the same way regardless of page format:

- OSB #15 is always a SWAP button that will swap over the left and right displays. OSB #11 is usually a declutter option. The only page where OSB #11 is not used for declutter is the SMS page where OSB #11 selects the S-J (Selective Jettison) master mode.
- The three centre OSBs (#12, #13, #14) are Direct Access (DA) buttons and provide direct access to the DTC saved MFDs displays according to master mode. Up to three pages for each MFD may be assigned to the DA buttons for each master mode. The displayed page format has its DA mnemonic highlighted. These are easily toggled by pressing the corresponding direct access OSB button or they can be cycled even faster with the HOTAS buttons: DMS right for the right MFD and DMS left for the left MFD. Please note you cannot have the same page displayed on both MFDs at the same time, so if you try to display the FCR on the right MFD while it is already being displayed on the left MFD the FCR will simply be taken from the left MFD leaving an empty DA slot where it was originally assigned.

1.4.1. Menu page



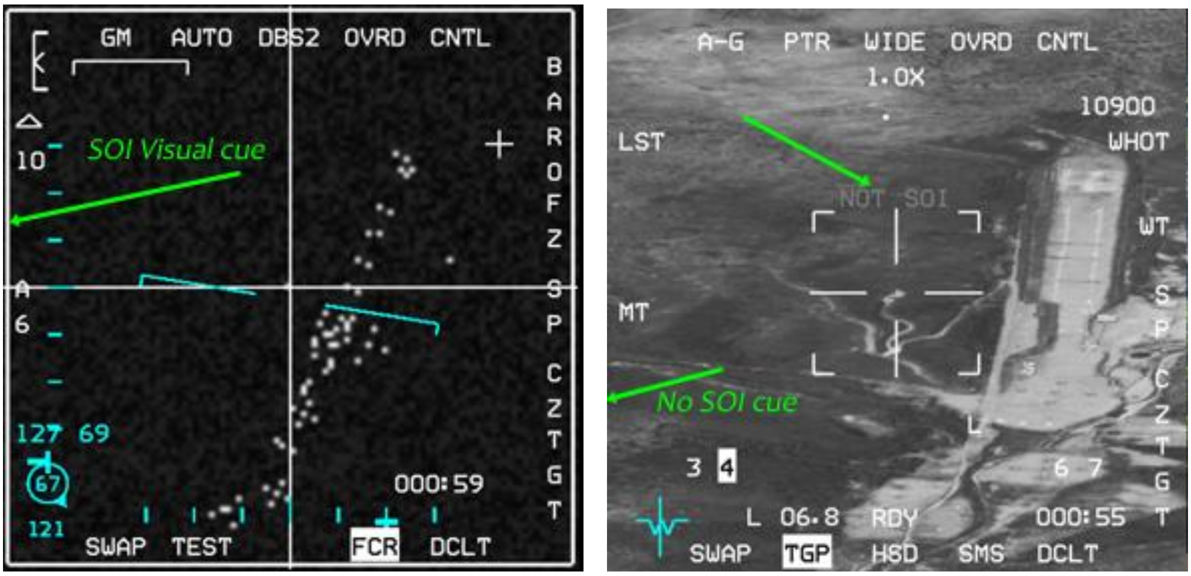
Although it is advised to set the three most required MFD pages for each master mode in the DTC it is also possible to set them in the cockpit by modifying the direct access button setting, while the desired master mode is engaged.
To do so, first set the desired master mode, then display the page you want to change (its mnemonic is highlighted). Press the DA button that is highlighted and the MFD displays the MENU page. From there simply select the new page you want to have accessible and the new page mnemonic appears on the direct access row, replacing the previous one. You can now easily toggle it with the DMS HOTAS button.
As you can see from the left image, the default MFD colours changed on some aircraft in 4.34 (though you can customise them with the Avionics Configurator). Note also the new entry: the backup TACAN page (see § 1.4.17 TACAN page).

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

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

1.4.2. Sensor of Interest (SOI)

You will need to work on one MFD rather than the other one sometimes. To let the system know where you are focusing your attention you need to use the Sensor of Interest mechanisation. Imagine the following example: the FCR is SOI and set on the left MFD and the HSD is on the right. You would like to delete a threat ring on the HSD but if you move your cursor the captains bar moves both in the HSD and the FCR. To tell the system that you want to work specifically on the HSD, you need to make the HSD SOI. To do so, simply move the DMS (Display Management Switch) on your HOTAS down. The SOI toggles from one MFD to the other. The visual cue for MFD SOI is the big square box drawn outside the OSB labels. If a MFD is not SOI the text NOT SOI is displayed in the centre, reminding the pilot that this display is not the Sensor of Interest.



Above, the FCR on the left MFD is the SOI and displays the large square SOI cue around the edge of the display. The TGP on the right MFD does not display the SOI cue and instead shows the NOT SOI cue in grey in the middle. Only one MFD can be SOI at a time.
DMS up selects the HUD as SOI (if the HUD is in a mode allowing SOI). In this case the SOI cue is an asterisk shown in the top left corner of the HUD. DMS down toggles SOI from one MFD to the other.

Since BMS 4.33 slewing your ground cursor position (System Point of Interest or SPI) will effectively slew your current steerpoint by adding a system delta to all steerpoints. All NAV and weapon delivery steering and symbology, including the great circle steering cue (tadpole) will be referenced to the amended steerpoint(s). The CZ mnemonic will be highlighted in aircraft with the Nav EGI upgrade if a system delta exists (i.e. SPI slew).

Pilots should use the following routine to revert the system solution back to the original navigation solution if cursor slews have been made: **TMS down - Cursor Zero - Wide Field of View** (OSB#3). This habit should be developed after each cursor slew phase and at each IP if cursor slews have been made.

Please see the chapter on SPI Management in the TO-BMS1F-16CM-34-1-1 for more details.

1.4.3. HSD page

The Horizontal Situation Display page provides a god's eye view around your aircraft with information such as your radar cone, concentric range circles, radar cursor position, bullseye position (or bearing and range), INS flight plan with steerpoints, lines, PPTs (Pre-Planned Threat points) and their programmed range rings, IDM information and so on.

OSB #19 and #20 are used to change the HSD range. In the image on the right only OSB #20 is available to increase the range. Note the absence of a down arrow next to OSB #19 as the HSD is at its minimum decoupled range of 8 Nm.

The concentric ranges circles are dependent on the current range but you will always have three of them in depressed mode, with the last one being at the set range shown at the upper left. The closest one is thus at 1/3 of that range and the middle one at 2/3 of the range.

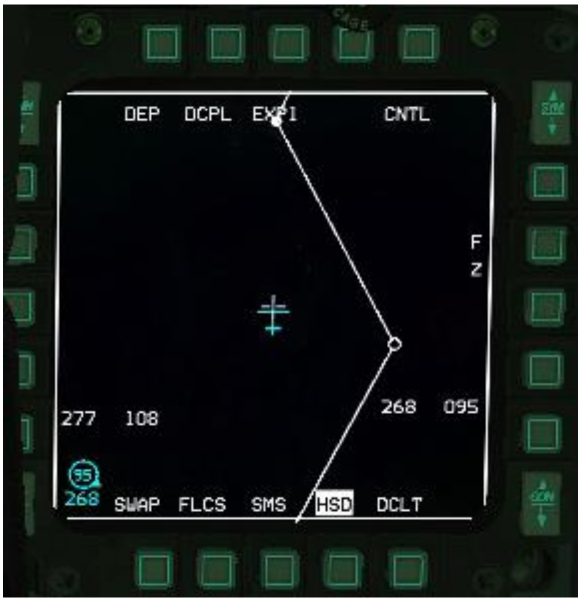
The inner HSD ring is divided by 4 cardinal marks. The small flag indicates North. The longer line indicates South and the two smaller lines point to East and West. These cardinal directions are useful to determine your direction from the HSD itself. They are also very helpful with bullseye situation awareness. By joining the North and South pointer you draw a reference line that can be used to quickly identify bearing from the bullseye calls. In the right example, ownship position is 158°from bullseye 16Nm and the radar cursor position is 271°, 7Nm from Bullseye.

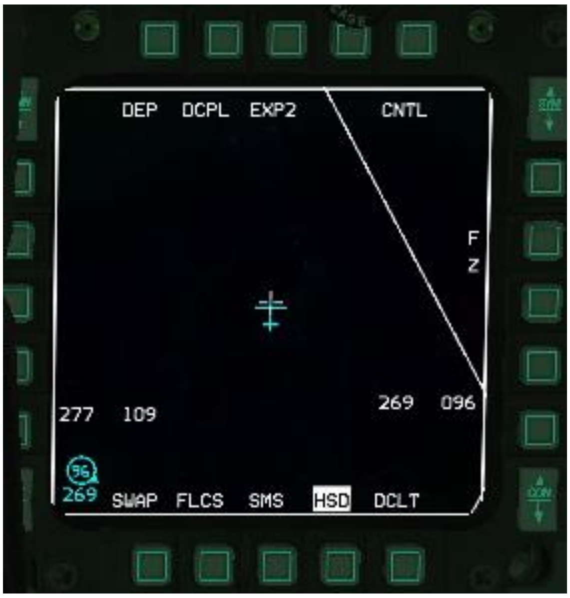
OSB #1 is labelled DEP (Depressed) and when pressed toggles to CEN for Centred.
In DEP ownship is pictured below the centre of the MFD one quarter of the way up from the bottom and visibility is better in front of the aircraft than to the rear. When CEN is selected ownship is placed in the middle of the display and the visibility is equal to the front or behind own ship. Please note, ranges are also different in DEP or CEN. The minimum range for DEP is 8Nm, while you can go as low as 5 Nm in CEN. CEN mode also matches the FCR ranges better.

OSB #2 is labelled DCPL (Decoupled) and when depressed toggles to CPL (Coupled) which ties the HSD to the FCR range. In CPL mode OSB #19 and #20 are inhibited (no arrows displayed) and the HSD will change scale according to the FCR scale (range).

To maintain a good correspondence between the HSD and the FCR (which helps SA) it is advisable to work with the HSD in CPL and CEN modes. This ensures that both ranges are the same and move together according to the FCR range.

OSB #3 is labelled NORM/EXPAND and changes the FOV of the HSD when the HSD is SOI. This can also be done using the HOTAS pinky switch. This option is invisible when the HSD is not SOI. The EXP mode has two levels: EXP1 and EXP2





OSB #5 is the CNTL (Control) page for the HSD. When depressed a series of options are displayed on most buttons. Highlighted options are currently active and therefore will be displayed on the HSD. When the corresponding OSB is depressed the option becomes inactive (not highlighted) and the related symbology is blanked from the HSD.

Display (on/off) options are:
FCR: FCR cone and ghost radar cursors
PRE: pre-planned steerpoints and their threat rings
AIFF: IFF response symbols (now implemented)
LINE1: DTC line 1 (steerpoints 31 to 36)
LINE2: DTC line 2 (steerpoints 37 to 42)
LINE3: DTC line 4 (steerpoints 43 to 48)
LINE4: DTC line 4 (steerpoints 49 to 54)
RINGS: concentric range rings from ownship
ADLINK: Air to Air datalink information
GDLINK: Air to Ground datalink information
NAV1, 2 & 3: INS flight plan but only NAV1 is implemented in BMS for the whole INS flight plan

Exit the Control page by pressing OSB #5 CNTL. Please note the direct access buttons are displayed as usual OSB #11 remains the DCLT option and OSB #15 remains the SWAP option.

OSB #7 is labelled FZ on the main HSD page format and freezes the display at the current world position and orientation of the ownship.
The aircraft now moves around with the world position fixed on the MFD (ownship is free to fly around and off the HSD) instead of the world moving with reference to the aircraft. Pressing the FZ button again unfreezes the HSD world position.

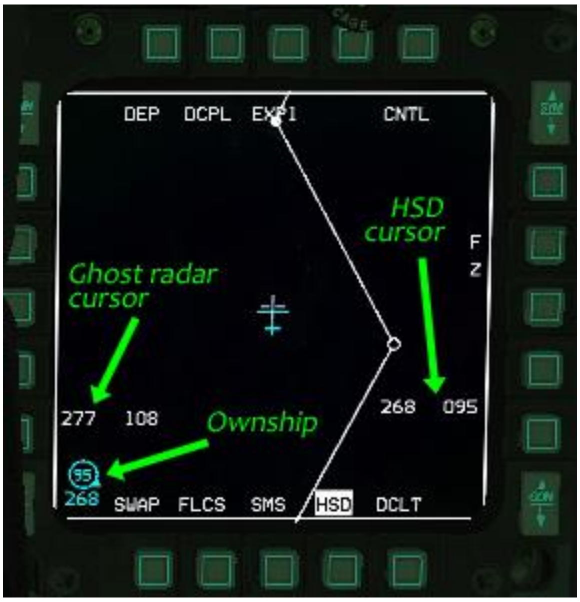
BOTTOM ROW is displayed as usual with declutter and swap buttons (#11 & #15) and the direct access buttons between them.

HSD cursor
When the FCR and the HSD are both displayed and the FCR is SOI the HSD displays the ghost radar cursors moving within the radar scan zone depicted on the HSD.
When the HSD is made SOI the ghost radar cursor is replaced with the HSD cursor which is shown as a cross. Any subsequent cursor movement will then move the HSD cursor and not the radar cursor. The HSD cursor can be used to select new steerpoints of interest and toggle on/off specific threat rings on PPTs displayed on the HSD. TMS up over a HSD steerpoint makes that steerpoint the new steerpoint of interest, TMS down on a PPT will deactivate the associated threat ring. This cursor has its own bullseye reading on the right side of the HSD, between OSBs #9 and #10.

Cursor bumping
To change the range of the HSD you can use OSBs#19 & #20 in DCPL mode or change the FCR range in CPL mode.
There is a third way to change the HSD range (which is also valid for the FCR) that is called cursor bumping. It is done by moving the cursor towards the upper or lower edge of the display. When the cursor gets close the range will automatically change up or down accordingly. This is done mainly on the FCR because most of the time the FCR is SOI, but it also works on the HSD when it is SOI.
If the HSD is in CPL mode the first hit on any top or bottom edge will switch the HSD to DCPL mode and subsequent hits will change the range.

Bullseye symbols
There are many different bullseye symbols on the HSD page.
You can find bearing and range information from Bullseye for your ownship, the ghost radar cursor, and the HSD cursor when it is displayed.

Ownship bullseye information is always displayed in the bottom left corner of the HSD. It is the same information that is displayed in the bottom left corner of the HUD when Bullseye is mode selected in the UFC (LIST-MISC-BULL page). If Bullseye is not mode selected this symbol is replaced by a mini flight director relative to the active steerpoint.

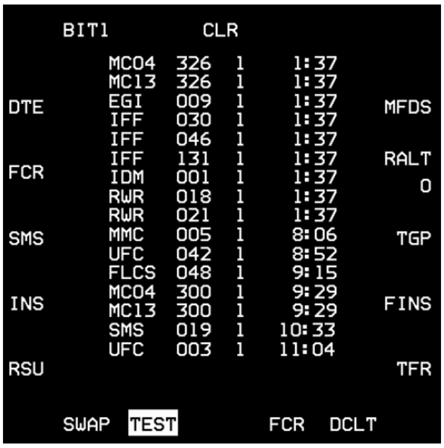


Ownship Bullseye is coloured cyan with the bearing below the circle and the distance in the circle. Distance is limited to 2 digits, so if Bullseye is further away than 99 Nm the circle is empty.

Ghost radar cursor Bullseye information is displayed in white on the left side of the MFD. The first number is bearing in degrees and the second number is distance in Nm.

HSD cursor Bullseye readout if displayed (HSD SOI) is on the right side of the screen and has the same structure as the ghost radar cursor information, i.e.: bearing then distance.

1.4.4. TEST page



The TEST page shows various Built-In Tests (BIT). BIT1 and BIT2 display the maintenance fault list (MFL) encountered during a flight. Each fault encounter logs the following:
1. Subsystem (same as on PFL) where the fault occurred
2. Test number that failed
3. Number of failures of that subsystem
4. Time (since FCC power up) the first fault occurred

Two pseudo-faults are always recorded; the take-off time (TOF) and landing time (LAND). TOF is recorded whenever the airspeed reaches 120 kts with the gear up. LAND is recorded whenever the gear is down and airspeed is less than 80 kts.

Pressing the CLR button will clear the fault list and launch a fault survey. A maximum of 17 faults (including the two pseudo-faults) may be recorded. If more than 17 faults are present the oldest (which occurred first) will be replaced by the newest one. After the flight pilots can review the full MFL from the flight in the DTC file. All MFLs are recorded in the dtc_last_flight_faults.txt file (*User**Logs*\\ folder) at the end of each flight. It is overwritten with each new flight.

It is normal to have faults displayed on the TEST page during Ramp Start. Those faults will clear as the systems come online. In the event of a real problem it may be necessary to clear the MFL with OSB #3 to launch a fault survey. After having cleared the MFL if a system is still malfunctioning the fault will display again on the MFL, allowing the pilot to take appropriate action to solve it.

PAGE 1
OSB #1 BIT1 Indicates BIT1 tests. Pressing this button changes to the BIT2 page
OSB #3 CLR Clears the Maintenance Fault List (MFL) if displayed in the centre of the MFD
OSB #6 MFDS MFD Self-Test (N/I)
OSB #7 RALT Radar Altimeter test
OSB #8 TGP Targeting Pod test (N/I)
OSB #9 FINS Fixed Imaging Navigation Set (N/I)
OSB #10 TFR Terrain Following Radar Test (N/I)
OSB #16 RSU Rate Sensor Unit (N/I)
OSB #17 INS Inertial Navigation System test (N/I)
OSB #18 SMS Stores Management System test (N/I)
OSB #19 FCR Fire Control Radar test switches the MFD to the FCR page and starts the FCR BIT
OSB #20 DTE Data Test Loading (N/I)

PAGE 2
This page contains additional built-in tests. OSB 1 (BIT2) indicates that these are the BIT2 tests. Pressing this button again will change to the BIT1 page.
OSB 3 CLR Clear fault list (N/I)
OSB 6 IFF1 IFF1 self-test (N/I)
OSB 7 IFF2 IFF2 test (N/I)
OSB 8 IFF3 IFF3 test (N/I)
OSB 9 IFFC IFF Mode C test (N/I)
OSB 10 TCN TACAN Test (N/I)
OSB 19 TISL Target Identification Set, Laser (N/I)
OSB 20 UFC Up-Front Controls (N/I)

1.4.5. SMS page

The SMS page will be different depending on the Master Mode you are in when it is selected:

1.4.5.1 SMS in NAV mode:

The SMS page will display the system inventory, graphically depicting the loading of your aircraft with all its stores and pylons.

In the real jet this page is fully programmable but in BMS it always reflects the pre-loaded stores perfectly.

Please note the usual DCLT option on OSB #11 is replaced by the S-J page access. Pressing the S-J button enters the Stores Jettison Master Mode and associated MFD subpage, which is documented later in this manual.

1.4.5.2 SMS in A-G mode:

When SMS is selected and the Master Mode is A-G the SMS page displays only information relevant to A-G weapons.

The information displayed in the centre is the current weapon arming setting from the CNTL page.

- OSB #1 displays the current Master Mode and if depressed selects the A-G strafe gun mode and its associated SMS subpage.
- OSB #2 is used to toggle delivery mode CCIP – CCRP – DTOS – LADD & MAN. Each has an associated subpage.
- OSB #4 is labelled INV and displays the Inventory page, should it be needed outside of NAV mode.
- OSB #5 (CNTL) is the Control page for the currently selected weapon (see below).
- OSB #6 shows current active weapon, type and quantity aboard. When depressed the next different A-G weapon type is selected in sequence. Please note the MSL STEP button on the sidestick does not perform the same function - it switches to the next pylon loaded with the same type of A-G ordinance. This allows the pilots to pre-program two missiles differently if needed such as in the case of HARM missiles for POS EOM shots.
- OSB #7 is labelled as the currently loaded profile for freefall A-G stores. The SMS is able to save two different weapon profiles PROF1 and PROF2. By default CNTL settings refer to PROF1 but if you depress OSB #7 and select PROF2 all settings made will be recorded for the second weapon delivery profile. This allows the pilot to save two weapon settings and toggle easily from one to another depending on the situation.
- OSB #8 is SinGLe or PAIR release for A-G stores. Pressing the button will toggle between SGL and PAIR.
- OSB #9 is the set spacing for A-G ripple stores. When pressed the SMS enters a specific page where a new spacing value in feet can be input. This is relevant when dropping more than one weapon to correctly space out the weapon hits.
- OSB #10 is the ripple value for A-G stores. This is the number of weapons that will be released each time you pickle. When depressed the SMS enters a specific page where the new value can be input.
- OSB #18 is the fusing option for A-G stores. When depressed it toggles between NOSE, TAIL and NSTL (both nose and tail) fuses.

SMS A-G Control page

While the CNTL page is displayed OSB #5 remains highlighted.

The top & bottom OSB lines are the same as the main SMS page. What is of interest is the left line of OSB buttons (#16 to 20) and OSB #6 to the right, which give access to 5 different weapon settings: C1, C2, C3, C4 and LADD.

C1 (OSB #20) is relevant to General Purpose weapons or Laser guided weapons and provides two different arming delays. One for the NOSE fuse and the second for the TAIL fuse. Depress OSB #20 to enter a subpage where both timings can be set.

C2 is relevant to Cluster Bomb Units or any weapon requiring a Burst Altitude (BA). Pressing OSB #19 will enter a SMS subpage where both the arming delay and the burst altitude can be set.

C3 is an additional setting for CBUs, with the same Arming Delay (AD) and Burst Altitude (BA) options as C2.

C4 is specifically for double fused CBUs. On this page AD1, AD2 and BA can be set.

LADD stands for Low Altitude Drogue Delivery and although OSB #6 has a profile for it, it is currently not implemented in BMS.

OSB #10 is the setting for the planned release angle. This value is required by the computer to calculate the correct symbology for DTOS deliveries.

Most of the time C1 and C2 are used if you deploy GP/LGBs or CBUs.

The way settings are input is always the same:
Depress the relevant OSB (C1 to C4) and the subpage is displayed with the settings in the middle of the page.
The current active setting is displayed between the scratchpad asterisks and numbers 0 to 9 are displayed next to the left and right rows of OSB buttons.
To enter a new value simply use the OSB next to the number you want until the correct value is set, then use OSB #2 ENTR to confirm the value and the next line of setting will be selected for change. If there is no next line available the ENTR button will exit the CNTL page and return to the SMS base page.
OSB #3 (RTN) returns to the previous value or page.
OSB #4 (RCL) deletes the last alphanumerical value input.

1.4.5.3 SMS in A-A mode:

The AAM SMS base page has the same structure as the A-G SMS page.

- OSB #1 displays the current Master Mode and if pressed selects the A-A gun SMS subpage.
- OSB #3 is active when infrared weapons are carried and is displayed SPOT. It changes the AIM seeker from SPOT to SCAN.
- OSB #4 is labelled INV and displays the Inventory page, should it be needed.
- OSB #5 (CNTL) is the Control page for the currently selected weapon.
- OSB #6 shows the current active weapon, type and quantity aboard. When depressed the next different A-A weapon loaded hardpoint is selected in sequence. Please note: the MSL STEP button on the sidestick performs the same function if held for more than half a second. If held for less than half a second it switches to the next hardpoint carrying the same type of A-A missile. You can see the hardpoint configuration in the picture above. Station 1 is currently selected and carrying an AIM-120B. Station 9 carries the same type of weapon and stations 2, 3, 7 and 8 carry medium range missiles (M)
- OSB #8 (WARM/COOL) is displayed when infrared weapons are carried and shows the status of the IR seeker on the missile. Pressing WARM allows you to cool the seeker. This is done automatically in DGFT mode with MASTER ARM in ARM or SIM.
- The bottom row has the usual functions including S-J available.
- OSB #18 is dependent on missile type.
  For radar missiles it sets the PRF range and toggles between unknown, large, medium and small targets. Large is used for bombers, medium is used for fighters and small is used to intercept missiles (not implemented).
  For IR missiles it toggles from BP (Bypass) to TD (Threshold Detection). When set to TD the missile will automatically uncage. When set to BP the missile needs to be uncaged manually.
- OSB #19 toggles SLAVE or BORE.
  Radar missiles can be set to SLAVE or BORE. When set to SLAVE the missile is slaved to the FCR and when set to BORE the missile is pointed six degrees below the gun cross and will fire without command guidance. It will switch on its own radar and go autonomous right after launch. That's a MADDOG shot as it will go after the first thing it 'sees'.

Depressing OSB #1 selects the A-A gun and the A-A gun SMS subpage is displayed:

OSB #1 displays GUN
OSB #2 sets the A-A Gun mode (EEGS etc.) through a subpage
OSB #4 displays the Inventory page
OSB #6 displays the amount of ammo remaining for the gun. 51 means 510 rounds. Each burst is 10 rounds by default.
The bottom row has the usual functions.
OSB #20 is labelled SCOR and toggles ON or OFF.
When ON it allows the BATR circle to be displayed in the HUD when the gun is being fired as well as the FEDS markers.

The BATR (Bullets at Target Range) circle for EEGS is a 6-mil circle displayed after the trigger is squeezed and the bullets have travelled to the target. It disappears after the last bullet passes through the target range (it actually disappears 1 second after the trigger is released; which is good enough for the time being). The BATR is nothing more than a record of where the gun cross has been pointed (corrected for gravity drop).

Depressing OSB #5 enters the CNTL page:

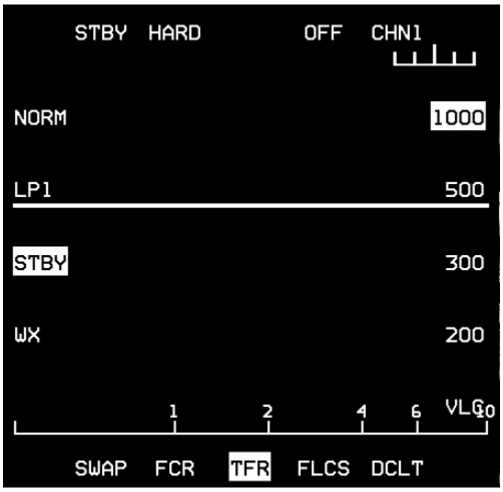
When the A-A CNTL page is selected OSB #5 CNTL is highlighted.

There is not much to set here, except perhaps the MSL ID which should match your flight # ID. It is good practice to set your MSL ID to #2 for instance if you fly as wingman in a two ship.
This would serve the FCR datalink should it be implemented one day. For the moment it is not implemented in BMS.

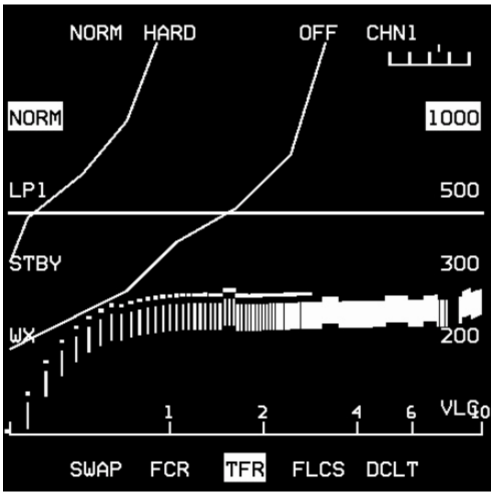
1.4.5.4 Selective Jettison (S-J) page:

The S-J page is accessible in NAV, A-G and A-A modes from the SMS base page OSB #11.
Selective Jettison is a Master Mode.
This allows the pilot to jettison weapons and racks unarmed or unguided from selected aircraft stations. Only jettisonable stores will be displayed for selection. The pilot presses the OSB adjacent to the station displayed on the S-J page. The selected station's bottom-most store is highlighted on the S-J page, indicating that it is selected. If a jettisonable rack is also loaded it may also be selected with a second press of the OSB. A third press will then deselect all stores on that station. The pilot can preselect a selective jettison configuration while in S-J Master Mode, which will be remembered during Master Mode transitions. The stores are jettisoned using the pickle button when the MASTER ARM switch is in ARM. After the stores are released the highlighted stations are removed from the S-J page and the associated weapon quantity reads zero. The S-J mode also bypasses any other weapons settings.

1.4.6. TFR page

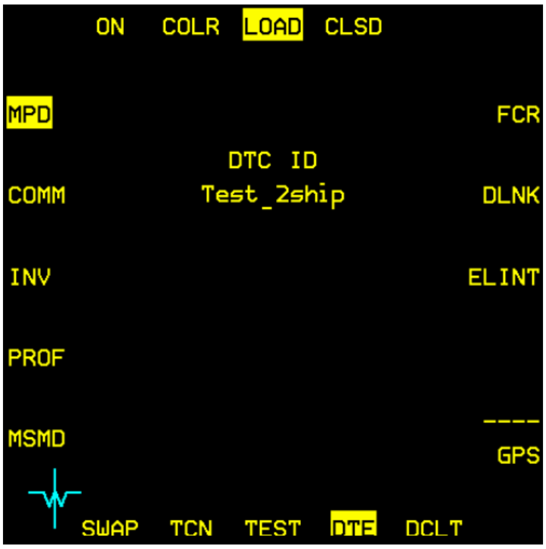


The Terrain Following Radar was completely updated in 4.33 and is now fully operational.
TFR is only available on F-16s carrying an AN/AAQ-13 LANTIRN navigation pod (on the left chin station).
The TFR is a short range (36000ft) forward and down radar that allows you to follow the terrain at very low altitude with automatic fly up protection.
The TFR page can be reached from the menu page by depressing OSB #17. As with all pods / systems the TFR needs a certain amount of time to become operational. This time starts when the TFR is placed out of OFF to STBY. The TFR is ready when the NOT TIMED OUT message disappears. Obviously the chin hardpoints must be powered and the radar altimeter must be operational.
The TFR has 7 modes of operation: **OFF – BIT – STBY – NORM – LPI – WX – VLC**
OFF: the TFR is not powered.
BIT: (N/I) is accessed from the MFD TEST page.
STBY: the pod is in standby mode and not operative (see picture above).
NORM: is the normal mode of operation and accessed with OSB #20. It has 3 submodes:
MAN TF: the pilot receives FPM cueing (MAN TF box) in the HUD to maintain a selected altitude above ground level. He hand flies the jet but the TFR offers automatic fly-up protection if the MANUAL TF FLYUP switch is in ENABLE. The ADV light on the MISC panel is unlit.
AUTO TF: the flight control computer uses the vertical acceleration commands generated in the LANTIRN pod to maneuver the aircraft to maintain the selected SCP (Set Clearance Plane) altitude. In AUTO TF the ADV light on the MISC panel has the top indicator (ACTIVE) lit and a horizontal line is shown near the FPM on the HUD. The pilot can override the TFR (just like the autopilot) by depressing the paddle switch on the stick. While the paddle is depressed the STBY (bottom part of the ADV) light on the MISC panel is illuminated.
Blended TF: the autopilot is engaged to hold a specific barometric altitude (or attitude). If the LANTIRN pod detects the aircraft violating the selected minimum AGL the system will automatically maneuver the aircraft to maintain the minimum AGL until the terrain has dropped away. A/P PITCH switch is in ALT or ATT HOLD. STBY ADV light is on. Horizontal line is visible.
LPI: is Low Probability of Intercept. It allows minimal TFR use with the RF switch placed in the QUIET position. It is activated by pressing OSB #19 or automatically upon placing the RF switch in QUIET. Please note: placing the RF switch in SILENT places the TFR in STBY.
WX: is used in bad weather (rain) to minimize uncommanded fly-ups due to conflicting radar returns in rain or fog. It is activated with either the MFD TFR page OSB#17 or the ICP WX button.
VLC: is Very Low Clearance (100ft SCP) and accessed from OSB #10. This mode is to be used only on relatively flat terrain or over water.



The TFR has 3 Ride options: HARD - SOFT - SMTH (smooth) available on the OSB#2 rotary.
Activate the TFR by placing it in NORM and select the desired SCP. Both options highlight on the TFR page. In this example we set 1000 feet. The A-LOW in the DED should be set to SCP-10% (in this case 900 feet). The TFR E-scope display will start displaying a visual representation of the terrain ahead. The pilot can then decide if he wants MAN TF or AUTO TF. AUTO TF is engaged by depressing the ADV indicator/pushbutton on the MISC panel.
Automatic fly-up protection is provided in AUTO TF; in MAN TF you must have the MANUAL TF FLYUP switch in ENABLE.
Refer to Avionic Checklists for TFR checks (*in your Docs folder)*. More detailed information on the TFR is available in the TFR chapter of the TO-BMS1F-16CM-34-1-1.

1.4.7. DTE page



The DTE page is accessed from the menu page by depressing OSB #8.
It is used to load the Data Cartridge prepared during mission planning in the UI into the aircraft computer. Loading is done (usually at ramp start right after or just before switching the CNI to UFC) by depressing OSB #3.

Each displayed system (MPD, COMM etc) is highlighted in sequence during loading and the DTC changes should be visible in the DED (presets for VHF and UHF amongst others).

The DTE page has been updated for 4.34. Each system is now loaded as it is highlighted in a counter-clockwise sequence from the LOAD button. Some systems take longer than others to load, just as they do in the real jet.

COLR is used to manually load any colour profile you have set up using Avionics Configurator and saved to your [callsign].ini file, for example to turn yellow MFDs back to white, or change any other aspect of the symbology to your preference, just as you can do in the real aircraft. (See the Avionics configurator chapter in the BMS Technical Manual)

1.4.8. FLCS page

The FLCS page is accessed from the menu page by depressing OSB #10.

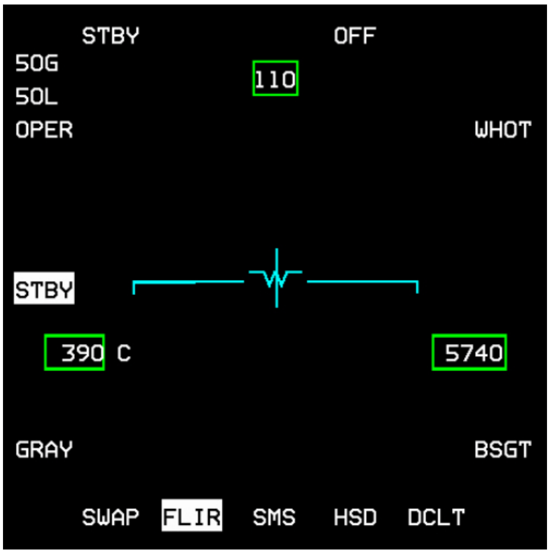
The FLCS page provides an overview of anything related to the FLCS. The page provides a backup display for the FLCS faults by showing up to 5 FLCS faults or warnings. As with the PFL the warnings are displayed within ><. When more than 5 faults are present they can be reviewed by pressing OSB #20 labelled MORE.
This can be very helpful in case of UFC failure that will blank both the DED and the PFL and will prevent the pilot from seeing any faults. On the FLCS page at least the FLCS related faults can be reviewed.
The FLCS page content can be reset by switching to DBU (digital backup) mode and back for digital FLCS equipped jets. The FLCS RESET switch will also clear the FLCS page.

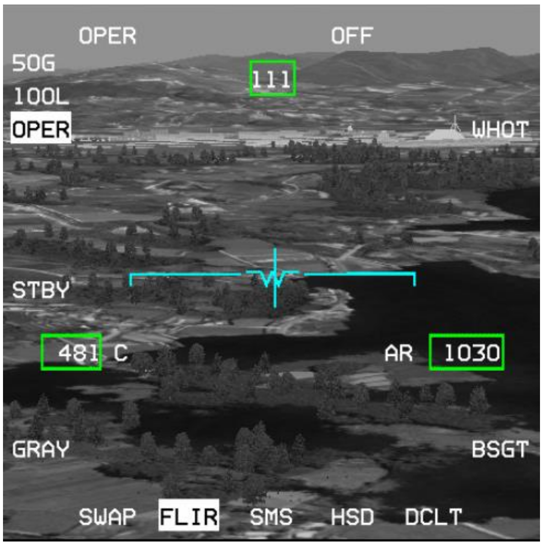
The FLCS page will also report the status of the FLCS BIT and status of the DBU if the jet has a digital FLCS.

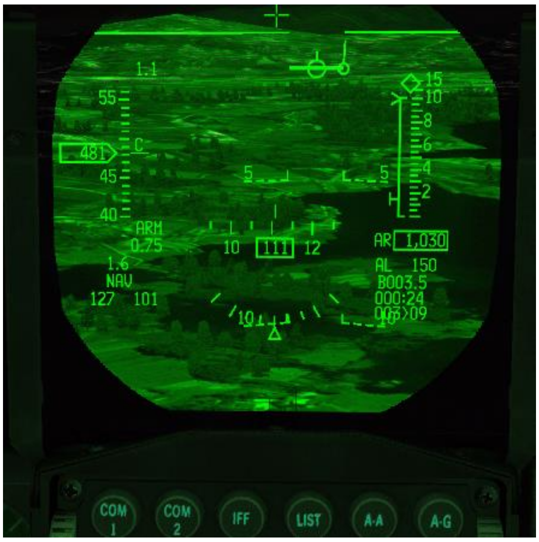
When the FLCS suffers from a BUS FAIL the FLCS page will show OFF and cannot be used to review FLCS faults.

If the jet is equipped with digital FLCS the maintenance functions and addresses are displayed in the middle and bottom part of the MFD when the jet is on the ground. Once in flight the maintenance functions are deleted and the FLCS page is usually blank unless FLCS malfunctions are present.

1.4.9. Forward Looking Infrared (FLIR) page







The FLIR page is only available on F-16s carrying an AN/AAQ-13 LANTIRN navigation pod (on the left chin station). The FLIR is a forward looking infrared camera used for low level night navigation. The FLIR is housed in the navigation pod of the LANTIRN system mounted alongside the TFR system. Obviously chin hardpoints must be powered up for the FLIR to be operational.

The FLIR needs between 8 and 15 minutes to cool down before use, so start the process as soon as possible during ramp start for missions requiring FLIR. The FLIR will be ready to operate as soon as the NOT TIMED OUT message disappears from the MFD.

OSB #18 places the FLIR in standby. OSB #20 places the FLIR in operational mode (OPER). Once operational the FLIR page will display the infrared view in front of the pod. The image can be repeated on the HUD by rotating the BRT ICP wheel upwards. The FLIR level can be changed with the ICP up and down FLIR arrows. The current gain and level values are displayed on the top left corner of the FLIR MFD.

OSB #10 is the boresight option. On the ground the FLIR camera is boresighted on top of the HUD. It may induce parallax errors. The boresight is used to better match the image in the HUD with the image from the FLIR camera at a certain range. Depress OSB#10 and the BSGT mnemonic highlights. The HUD FLIR image can then be slewed with the cursors. Do not boresight on close objects. It is advised to boresight in flight on large objects such as the edge of a mountain or a road for instance. Once both images are superimposed correctly depress OSB#10 again and the BSGT mnemonic will return to its initial state.
Once the FLIR image is displayed on the HUD the MFD page does not need to be active, though it is advisable to have it on one of the DA buttons for easy access to boresighting.

LOOK-INTO-TURN (LIT) and SNAPLOOK capabilities are available on the HUD.
LIT: when the bank angle is above 5° holding DMS UP will shift the FLIR view slightly into the turn to provide lead obstacle clearance. The FLIR image reverts to forward looking when DMS UP is released.
SNAPLOOK: The view can be shifted further in flight by holding DMS UP and moving the cursors in any direction, even in a turn. The view will revert to forward looking when DMS UP is released.
When LIT or SNAPLOOK are active the FPM is dashed.

More information can be found in Avionic Checklists and the TO-BMS1F-16CM-34-1-1 LANTIRN chapter *(in your Docs folder)*.

1.4.10. WPN page

The WPN page is accessed from the menu page by depressing OSB #18.
It gives the pilot access to onboard weapons sensors.

Some weapons such as AGM-65 Mavericks and the AGM-88 HARM have onboard sensors that may be used to acquire and lock targets. Since the sensor is onboard the missile it should be obvious that once the missile is away the MFD can no longer display the sensor image.

HARMs
POS EOM is displayed on the WPN page when the HARM is selected and ready.
See weapon specific documentation for HARM deployment.

Mavericks
The IR image from the missile head is displayed in the WPN MFD page once the IR head has been uncaged (and any dome covers removed). See weapon specific documentation for Maverick deployment.

- OSB #1: reports status
- OSB #2: toggles PRE-VIS-BORE modes
- OSB #3: sets the Field of View
- OSB #5: accesses the Control page
- OSB #6: displays the type of weapon currently selected
- OSB #7: toggle polarity
- Bottom row has the usual DCLT, Direct Access and SWAP buttons
- OSB #20: selects the SLAVE options

For further information on specific weapon employment please refer to the relevant chapter in the TO-BMS1F-16CM-34-1-1.

1.4.11. TGP page

The TGP page is accessed from the MENU page by depressing OSB #19.

The TGP is active when either a LANTIRN or SNIPER pod is carried on the chin pylon and powered up.
This is done on the SNSR PWR panel with the RIGHT HDPT switch. The TGP needs to cool down after powering up and the TGP page will display NOT TIMED OUT until the pod is ready.

See the TO-BMS1F-16CM-34-1-1 for more information about the LANTIRN and SNIPER TGPs.

1.4.12. HAD page

The HARM Attack Display is selected from the MENU page by pressing OSB #2 (if you have a HTS pod fitted and the LEFT HDPT powered up).
The HAD may be selected in any Master Mode and shares many common display features with the HSD. HAD cursor movement and expanded FOV (OSB #3 or pinky switch) options are similar to the HSD as well.
The pilot may select the HAD range (with HAD as SOI) by slewing the cursors up and down the display to bump range or by pressing OSBs #19 and #20.
The HAD is not the only way to deploy AGM-88s. POS and HAS modes are accessible through the WPN MFD page with HARMs loaded (as long as HAD is not SOI).
The HARM WEZ footprint is based on Rmax of the AGM-88 and will increase or decrease in size according to your speed and altitude. If the HARM WEZ is greater than the selected display range the lines will be dashed.

Detected emitters are coloured as follows:
Green = emitter not active
Yellow = emitter active
Red = emitter tracking
Flashing Red = emitter launching

1.4.13. BLANK page

It is possible to turn off one MFD by selecting the BLANK page with OSB #1 on the MENU page.

Although you may think that it is completely pointless it can be helpful when you need only one MFD page active from the Direct Access row for a specific Master Mode. For example if you only want FCR to be displayed on the left MFD in A-A Master Mode you would simply program: FCR - BLANK - BLANK in the DTC.

1.4.14. RCCE page

The RCCE page (OSB #4 from the menu page) is intended for interfacing with reconnaissance pods, but is not implemented in BMS. Even the low altitude camera in the weapon inventory does not use it.

1.4.15. RESET MENU page

The RESET menu is accessed via OSB #5 of the MENU page but has no purpose in BMS. None of its functionality is implemented.

1.4.16. FCR page

The Fire Control Radar page is accessed from the menu page by depressing OSB #20.
The radar is now fully documented in the TO-BMS1F-16CM-34-1-1 AN/APG-68(V)5 FIRE CONTROL RADAR chapter. Here is a short introduction which hopefully will meet your immediate needs.
Obviously this page displays a visual representation of what the radar detects. It can be set to A-A radar and its submodes, or A-G radar depending on Master Mode.

1.4.16.1 FCR in A-A modes

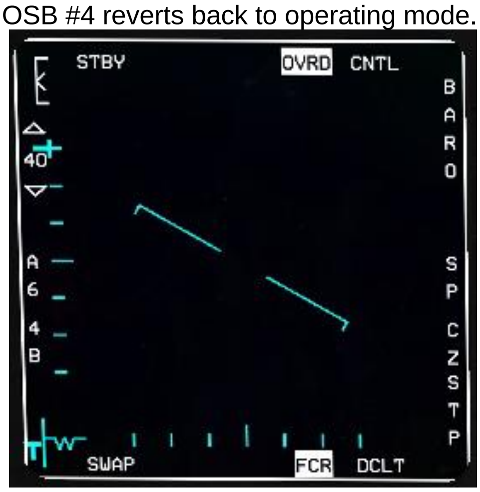
The FCR is switched on by the FCR switch on the SNSR panel and once powered enters a BIT (Built In Test) that may last a few minutes. If the FCR is switched off in flight for longer than 4 seconds the BIT will be reinitialised.
Once the BIT is complete the FCR becomes available and usually defaults to A-A CRM (Combined Radar Modes).

OSB #1 states the current mode the FCR is in and if depressed displays a page where all other modes can be chosen from the side MFD buttons: CRM and ACM (Air Combat Maneuvering) on the left and on the right GM (Ground Mapping), GMT (Ground Moving Target), SEA (Anti-Ship) and STBY (Standby). Depressing any of the corresponding OSBs will enter that mode. Please note: BCN (Beacon) mode is not implemented.

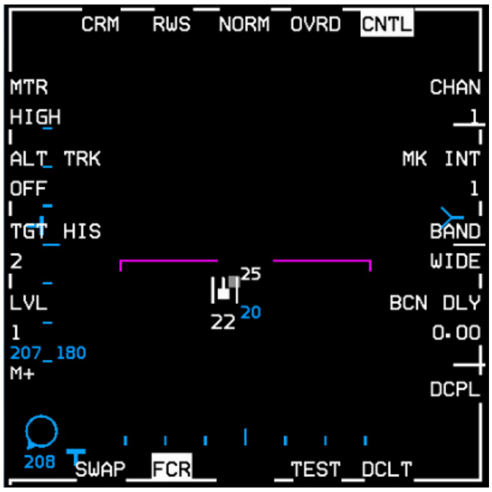
OSB#2 selects the corresponding submode.
If the FCR is in CRM the submodes are RWS (Range While Search), ULS (=LRS Long Range Scan), VSR (=VS Velocity Search), TWS (Track While Scan).
If the FCR is in ACM the submodes are 20 (HUD), Slew, Bore, 60 (Vertical).

OSB #3 is FOV and is not available in all modes. It is displayed only when available and will toggle between NORM and EXP. This can also be done with the pinky switch (S3) on your stick. When toggled to EXP the area around the cursor is expanded and illustrated by the blue square drawn on the MFD. The EXP label also flashes.

OSB #4 places the FCR in standby mode. All symbology is deleted from the MFD and OVRD is highlighted. A further press on OSB #4 reverts back to operating mode.



OSB #5 enters the FCR control page. The left and right rows of OSBs can set different options but most of those are not implemented yet and are eye candy only. The exception is TGT HIS which sets the number of toned down contacts you see after the main contact and Advanced IFF (AIFF) CPL/DCPL adjacent to OSB 10. Selection couples the AIFF Interrogator FOV to the FCR FOV in the AIFF scan mode. The control page is the same in both A-A and A-G FCR modes and is detailed in the A-G FCR section further down this chapter.

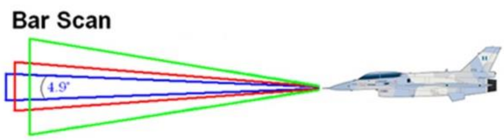


OSB #6 is the IDM mode. It defaults to ASGN (Assign) but can be toggled to CONT (Continuous) or DMD (Demand).

OSB #7, #8, #9 & #10 are labelled 1, 2, 3 and 4 and correspond to your flight members. These are used to select a specific flight member to send IDM data to. Please refer to the IMPROVED DATA MODEM chapter of the TO-BMS1F-16CM-34-1-1 for further information on A-A IDM.

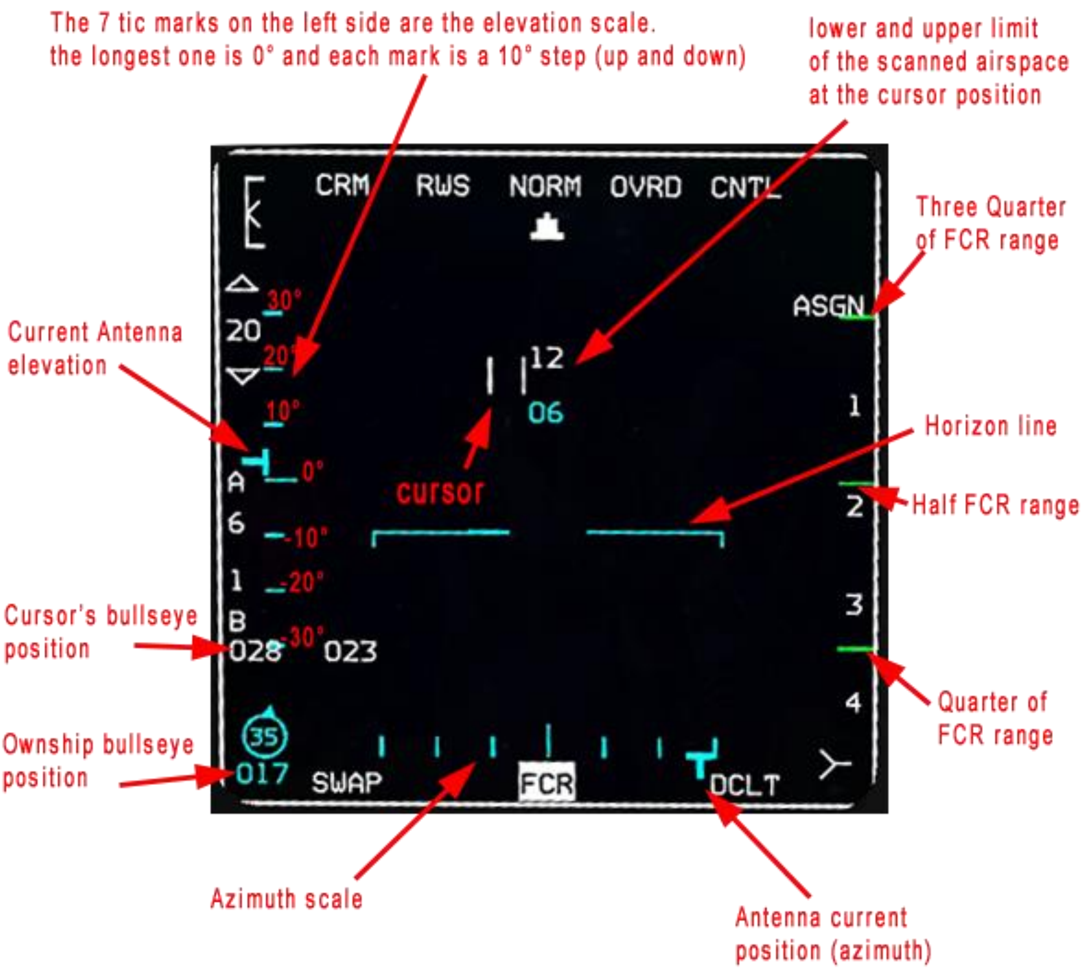
The bottom row has the usual Direct Access buttons with DCLT on OSB #11 and SWAP on OSB #15.

OSB #17 is the bar scan and can be toggled from 1 bar to 4 bar.
The FCR scans the horizon by physically moving the antenna. The beam that the antenna normally emits is not able to scan more than 4.9° in the vertical. So with this set to 1 the radar will scan just the single 4.9° slice of airspace. Set to 2 the radar will scan 2 bars of airspace, set to four it will scan four bars. It takes 2.5 seconds to scan one bar and another 0.5 seconds to move the antenna up and start on the next bar, so a full 4 bar scan will take 12 seconds, whereas a 1 bar scan will take just 2.5 seconds. Obviously decreasing the bar scan will quicken the scan but will reduce the search area. Regardless of the bar scan setting the radar can always be tilted up or down with the ANTENNA elevation control on the throttle.



OSB #18 is the azimuth setting and toggles between a cone of 60° (A6), 30° (A3) and 10° (A1). Blue vertical lines are drawn on the FCR to illustrate the reduced search area and it is displayed similarly on the HSD. The obvious advantage is that the smaller the search area the quicker the scan happens. The disadvantage is that it becomes easier to miss a contact that might be outside your search area. When the azimuth is less than 60° the search area is slewable using the cursors.

OSB #19 & 20 are used to set the FCR range when the mode allows it. Depressing OSB#19 decreases range and OSB#20 increases range. Another way to set the range is by cursor bumping (if the FCR is SOI) whenever the cursors hit the top or bottom edge of the FCR.



1.4.16.2 FCR in A-G modes

The FCR will switch automatically to A-G FCR upon entering A-G Master Mode. If you need to set the FCR to a specific mode you can use the menu page to select any submodes. The left side OSBs show the A-A modes and the right side OSBs access the Ground submodes:

GM: Ground Map
GMT: Ground Moving Target
SEA: for naval targets
BCN: Beacon (not implemented in BMS)

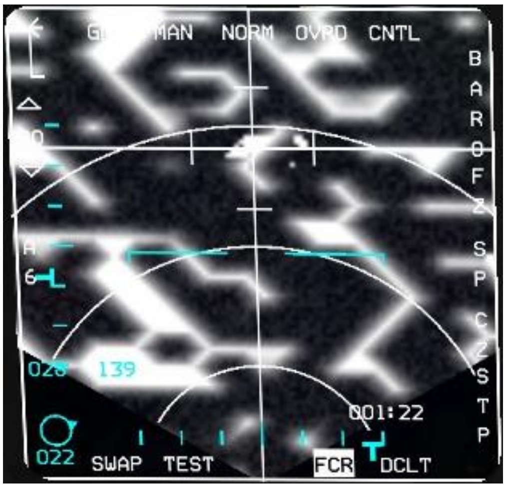
Mechanisation of the A-G FCR is the same for all different A-G submodes, only sensitivity towards different targets changes.

We will use Ground Map (GM) mode to illustrate the A-G FCR in this chapter.

Upon first entering GM mode the FCR is scanning ahead and is pointing at the current active System Point of Interest (SPI). The time needed to reach the SPI is displayed in the bottom right corner of the FCR, in this case 33 seconds. This timer may be specific to other things such as pull up cue and bomb impact for LGBs. It depends on Master Mode, SOI and SMS.

As with the A-A FCR the cursor’s bullseye position or bearing and range from the current steerpoint is displayed near OSB#17 according to Bullseye being mode selected or not. In this case bearing and range is displayed (189 00) as bullseye is not mode selected. Ownship bullseye position will be displayed in the bottom left corner of the MFD if Bullseye is mode selected in the DED (LIST 0 8 BULL page). In the picture on the right Bullseye is **not** mode selected and thus the MFD displays the aircraft reference symbol (W) and the azimuth steering bar. In BMS this may vary according to block or export variants, with some aircraft always displaying the flight director symbol, even with BULLSEYE mode selected.

The A-G radar is able to paint the terrain in different colour depths. Contact returns appear as bright white dots. The A-G FCR gain can be set with the throttle RNG knob or by using the GAIN rocker switch (top left corner). The gain changes the intensity of the terrain and is indicated with the Gain marker displayed in the top left corner of the MFD. The two pictures below illustrate the A-G FCR gain set to maximum (left picture - notice the gain meter set to the highest point) and set to minimum (right picture - notice the gain meter all the way to the bottom of the scale). Please note the gain meter is displayed both in A-A & A-G FCR modes.



OSB #1 is the current submode. If pressed the FCR will show other submodes as in the STBY page above.

OSB #2 sets the option to have AUTO or MANUAL range switching. This switching is available in GM, EXP, DBS1, DBS2, GMT & SEA. In MANUAL range must be manually changed with OSB 19 & 20.
In AUTO the range switches automatically when the cursor position enters the next available range setting of the FCR. It defaults to AUTO.

OSB #3 is Field of View and has 4 levels: NORM, EXP, DBS1 and DBS2 (Doppler Beam Sharpening). When the A-G FCR is SOI the pinky switch on the stick toggles through the available FOV settings. EXP mode expands the radar display around the cursors and centres it on the scope. DBS1 refines the EXP mode, providing more detail but no more magnification. DBS2 is the highest level of magnification.
EXP is available in GM, GMT & SEA. DBS1 & 2 are only available in GM. They are not available in GMT and SEA.

OSB #4 is the Override mode. When pressed the radar goes into standby and the FCR MFD goes blank. OVRD is highlighted. To resume radar operation the OVRD button has to be pressed again.

OSB #5 enters the Control page
Please Note the FCR CNTL page is the same for A-G and A-A FCR modes.
The display remains (and keeps being updated) but the OSBs change to CNTL options. Currently none of these Control options are enabled in BMS for the A-G FCR. The options can be toggled but the consequences are nil in the code.
In the real aircraft OSB #6 (NI) changes the radar channel to avoid interference from other aircraft,
OSB #7 is the Marker intensity button and ranges from 1 to 4. This allows a different intensity for the range markers than the overall symbol intensity set through the SYM rocker (NI).
OSB #8 is bandwidth select from narrow to wide (NI).
OSB #9 is an option to set the beacon delay from 0.00 to 99.9 through the data entry display (NI).
OSB #10 is Power management and alternates between PM ON & PM OFF (NI).
OSB #17 toggles between ECCM level 1 and level 2 (NI).
OSB #18 sets target history and that is the only option working for A-A FCR. History can be set from 1-4 providing a trail for radar targets in A-A.
OSB #19 is Altitude Liner blanker option ON or OFF (NI).
OSB #20 is the level declutter option on A-G & A-A radar, rejecting targets below certain radial velocities (NI).

OSB #6 is BAROMETRIC but this is not implemented in BMS.

OSB #7 is FZ for Freeze. When pressed the A-G FCR image is frozen and the coordinates of the ground stabilized point are displayed in the top right part of the MFD. The azimuth and distances are displayed in the bottom left part of the MFD.
FZ mnemonic remains highlighted as long as FREEZE mode is active.
It is particularly useful for zooming in and creating an accurate lock on a specific target easily recognizable on the radar. To unfreeze it press OSB #7 again and the FCR will radiate again. Changing FOV will also cancel freeze mode.

OSB #8 is SP for SNOWPLOW. As mentioned above the FCR points at the current Steerpoint of Interest (SPI) by default. In some situations you may need to have the FCR scanning a point ahead of you and not near any navigation steerpoints. Snowplow mode does just that, placing the FCR cross dead ahead of your trajectory at half the range of the A-G FCR range.
In Snowplow mode the terrain moves under the radar designating cross and thus is not ground stabilized until you press TMS up. The mnemonic SP remains highlighted as long as Snowplow mode is active. To revert to STPT mode press OSB #8 again.

OSB #9 is CZ for Cursor ZERO. Since BMS 4.33 slewing your ground cursor position (System Point of Interest or SPI) will effectively slew your current steerpoint by adding a system delta to all steerpoints. CZ will zero out or erase any previously created system deltas and so will return all STPTs to their original position and will naturally return SPI position to the current STPT position. The CZ mnemonic will be highlighted in aircraft with the Nav EGI upgrade if a system delta exists (i.e. SPI slew).

Pilots should use the following routine to revert the system solution back to the original navigation solution: **TMS down - Cursor Zero - Wide Field of View** (OSB#3). This habit should be developed after each cursor slew phase and at each IP if cursor slews have been made.

Please see the chapter on SPI Management in the TO-BMS1F-16CM-34-1-1 for more details.

OSB #10 is the sighting point rotary. It will be STP in NAV mode, TGT in A-G Master Mode, OA1 or OA2 if data has been entered for the applicable SPI, RP if VRP is mode selected and IP if VIP mode has been selected. Please note: TMS right changes the sighting point rotary selection as well.

As usual OSBs #11-15 at the bottom are the Direct Access buttons and the usual DCLT (OSB#11) and SWAP buttons (OSB#15).

OSB #17 allows azimuth setting of 120°, 60° and 20°. 6, 3 & 1 stand for 60°, 30° and 10° either side of the longitudinal reference line, giving you a total scan of 120° when A6 is selected, 60° when A3 is selected and 20° when A1 is selected. As with the A-A modes the smaller the azimuth setting the quicker the radar updates.

OSB #19 & 20 are used to set FCR range. OSB #19 decreases range. OSB #20 increases range. Range varies from 10 to 80 Nm in A-G mode. Optimal efficacy is usually obtained under 20 Nm though.

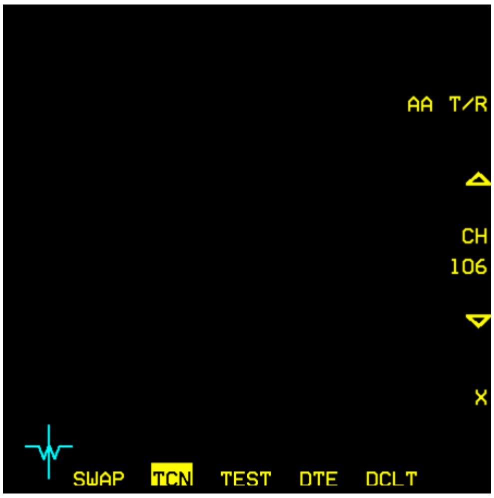
There is much more to learn about the FCR, but it goes outside the scope of this section and will be covered in other chapters as well as in the TO-BMS1F-16CM-34-1-1.

1.4.17. TACAN page

A new MFD page has been implemented in 4.34 for aircraft with an IFF panel on the left console instead of an AUX COMM panel. The TCN MFD page is the only way to manage the TACAN in BACKUP mode in these aircraft.

This page manages TACAN in BUP mode only; the T-ILS UFC page is still the primary way to edit TACAN settings.

Aircraft with an AUX COMM panel on the left console still use that to change TACAN settings in BUP and do not have this MFD page available.



BUP TACAN operations are managed with OSB #6 to #10.

- OSB #6 toggles AA T/R and T/R.
- OSB #7 increases by 1 the channel displayed next to OSB #8.
- OSB #8 opens an MFD page where the TACAN channel may be entered manually to avoid scrolling all the way to the relevant channel.
- OSB #9 decreases by 1 the channel displayed next to OSB #8.
- OSB #10 toggles X and Y band.

If increasing or decreasing the channels require too many button presses, just press OSB #8 and enter the correct channel with the OSB button in the scratchpad.
Confirm your entry with OSB #2 ENTR.

It is recommended to set up backup TCN to your home airbase during ramp start in case you take damage and have to switch to BUP with no functioning MFDs, as you might not be able to change TACAN settings in case of MFD failure.

1.4.18. Setting the MFDs according to Master Mode (DTC)

As you have noticed the 3 centre buttons on the bottom row of the MFDs are the Direct Access buttons and remain visible whatever page is displayed.

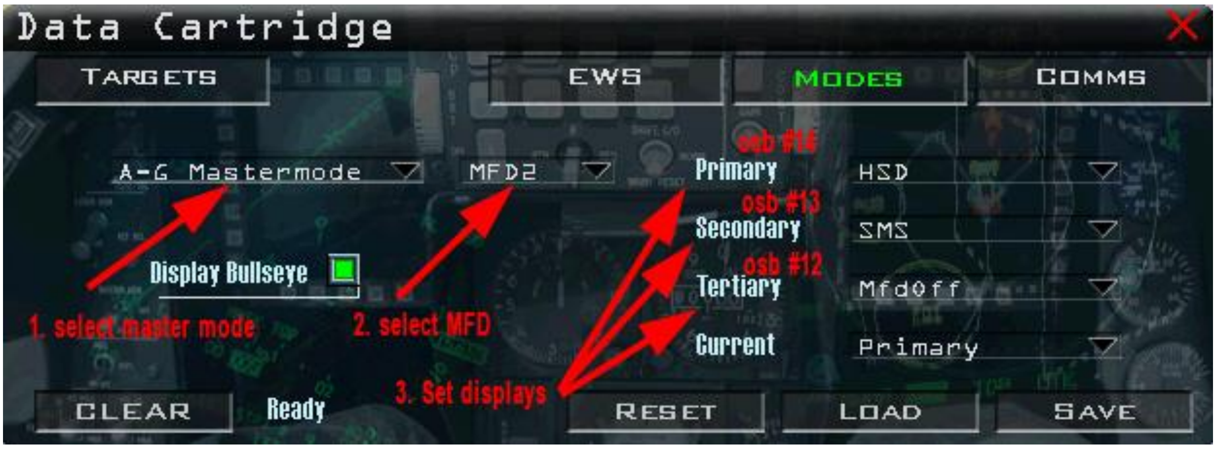
Each Master Mode has 3 MFD slots available for Direct Access: OSBs #12, #13 & #14.
They need to be programmed through the DTC and then can be toggled with DMS left for the left MFD and DMS right for the right MFD in flight. Of course the relevant MFD button can also be pressed instead of using DMS.

Programming can also happen in flight. To change the DTC programming press the Direct Access button twice to enter the menu page and from there another page can be selected for the current Master Mode. This selection is saved by the system and will be recalled when the same Master Mode is selected again.

It is advisable to build your own MFD configuration at least once from the DTC, which is saved in your *callsign.ini* file and will be remembered. You will not have to redo it for each TE through the DTC.
Common DTC settings are saved in the *callsign.ini* file.
TE specific DTC settings are saved in the *TEname.ini* file.

Making your own MFD configuration:

Open any TE and select the DTC button. Select the MODES tab to set your MFDs.



The first menu is used to select Master Mode. The second menu is used to select the MFD (MFD1 is left MFD, MFD2 is right MFD, MFD3 & MFD4 used to be in 1 view but are now disabled. They might still be required for other aircraft needing more than 2 MFDs.
Primary is used to select the left Direct Access button on OSB #14.
Secondary is used to select the middle Direct Access button on OSB #13.
Tertiary is used to select the right Direct Access button on OSB #12.
The Current option sets which of the three is displayed by default when the Master Mode is entered.

Please note, each Master Mode needs to be programmed and you need at least to program MFD1 and MFD2 for each Master Mode.

On the image above you may notice that the Tertiary mode shows MfdOff. That means there will be only two pages available on Direct Access buttons for that MFD in that Master Mode. You do not need to always have 3 pages set and having 2 or even 1 may be less confusing or provide faster toggling from one page to another.

Once you are satisfied with the configuration you can save your DTC. The MFD settings will be saved in your *callsign.ini* file and will be available to you (from the moment the DTC is loaded in the 3D cockpit) as long as you use the same logbook.

You can also setup your DTC using Weapon Delivery Planner http://www.weapondeliveryplanner.nl/.

Recommended DTC settings for the MFDs
Here is a suggestion on how to set the MFDs. You are free to use your own configuration or use this as a base to build your own:

A-A:
Left MFD (1): **FCR** – blank – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)

You don't risk losing the FCR on the left MFD with an inadvertent press of DMS left thanks to the two empty pages.

A-G:
Left MFD (1): **FCR** – TGP – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)

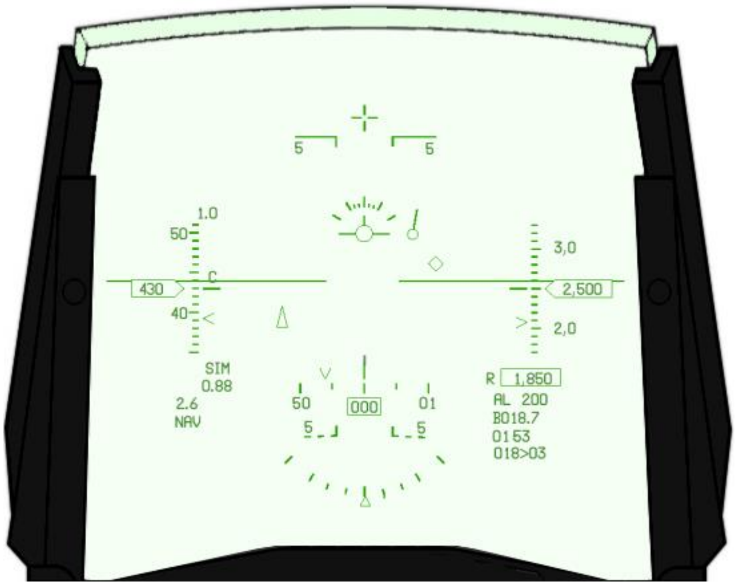
NAV:
Left MFD (1): **FCR** – TEST – blank (current = primary for FCR)
Right MFD (2): **HSD** - SMS – blank (current = primary for HSD)

MRM:
Left MFD (1): **FCR** – blank – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)

DGFT:
Left MFD (1): **FCR** – blank – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)

1.5. THE HEAD UP DISPLAY (HUD)

The HUD is a combining glass that provides information for essential aircraft data such as airspeed, altitude, heading, the flight path marker etc. It also provides flight symbols relating to Master Modes.



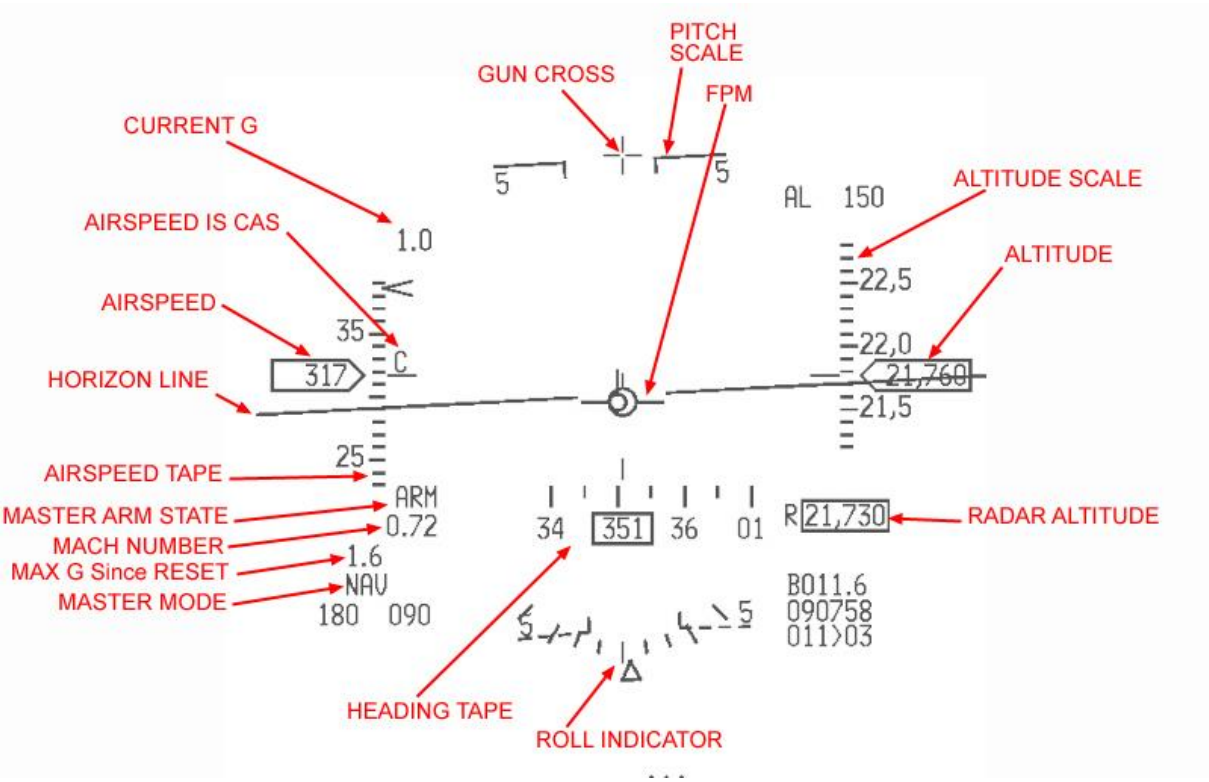
The HUD is switched on using the SYM wheel on the ICP. Brightness can also be set through the SYM wheel or by assigning an analogue axis in the advanced controller menu.

1.5.1. HUD SETTINGS

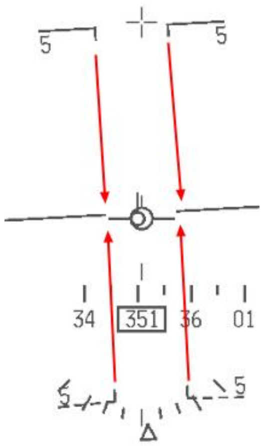
In all Master Modes Velocity or airspeed is always displayed on the left, Altitude on the right and Heading on the top or the bottom (VAH).

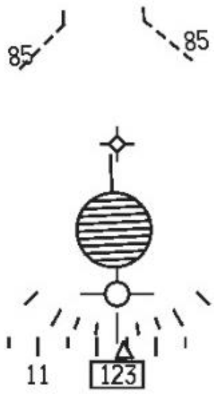
Some HUD features can be set using the HUD panel on the right console (see cockpit arrangement section: 5.3 HUD panel).

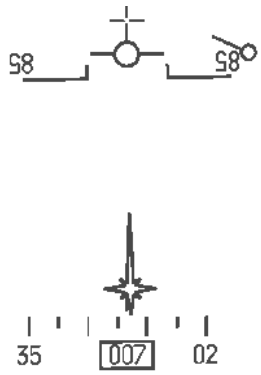
Airspeed can be displayed as CAS (Calibrated), TAS (True) or GND SPD (Groundspeed).
The FPM and pitch scale lines can be removed.
The DED or PFL can be displayed on the bottom of the HUD.
Brightness can be auto adjusted for day/night.
A vertical velocity indicator can be displayed (see below VV/VAH).
Altitude scales can display BAROmetric, RADAR or AUTO altitude (see below).



The centre of the HUD usually features the horizon line with pitch scales every 5° up (solid lines pointing to horizon) and down (dashed lines pointing to the horizon). When the horizon line is outside the HUD Field of View it is replaced by a dashed ghost horizon line.
The pitch bars are also bent incrementally when the aircraft is in a dive. The bend varies between 8 and 45°. There are two specific symbols at +90° (zenith) and at -90° (nadir) pitch as seen on the pictures below:





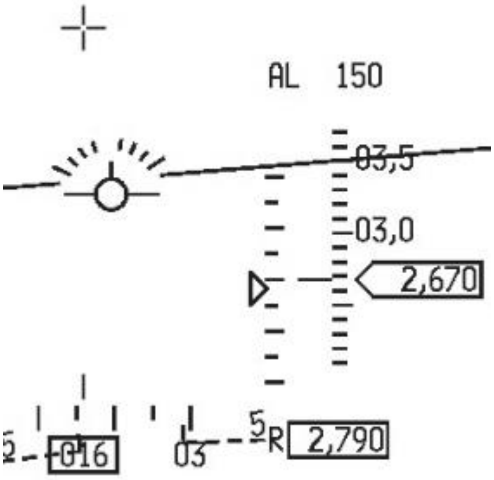


The FPM is an invaluable cue when flying the aircraft. It represents your instantaneous flight path vector and is not affected by AOA. It is represented by an aircraft viewed from behind symbol.
The FPM can drift according to the wind and may be pushed by it outside the HUD FOV. In this case a cross is superimposed on the FPM to indicate that it is not to be used.
The wind drift can be cancelled out with the DRIFT C/O switch on the ICP. The FPM is then anchored in the middle of the pitch scale bars.

Near the top of the HUD you will find the Gun Cross or Boresight Cross which represents the fuselage reference line. It displays zero degree azimuth in all modes. It is therefore a very important HUD cue.

The Roll indicator is located on the bottom of the HUD. Each tick mark represents 10° of roll except the last ones which are set at 45°. The roll indicator is not displayed when the DED/PFL is displayed, when the pitch bars are de-cluttered or if the INS data is invalid.

Vertical velocity scale (VV/VAH)

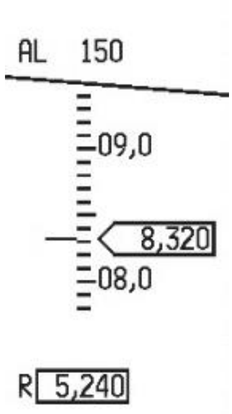


Moving the top left switch of the HUD CNTL panel to VV/VAH displays the Vertical Velocity, Velocity, Altitude and Heading on the HUD.
The vertical velocity is placed inboard of the altitude tape. The VV scale features 500 feet interval marks and a moveable triangular caret displaying the actual vertical velocity (the same as the VVI).
When the vertical velocity is displayed the roll indicator usually found on the bottom of the HUD is replaced by a smaller roll indicator located just above the FPM.

When the switch is placed to VAH the HUD displays Velocity, Altitude and Heading information only. This is the default display of the HUD

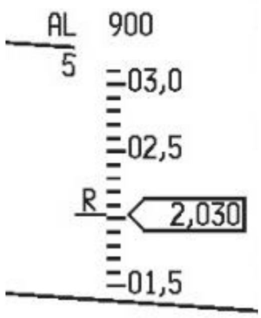
Placing the switch to OFF turns off display of the HUD scales.
The current values for velocity and altitude are then displayed in boxes. Heading is not displayed.

Altimeter scales (ALT)



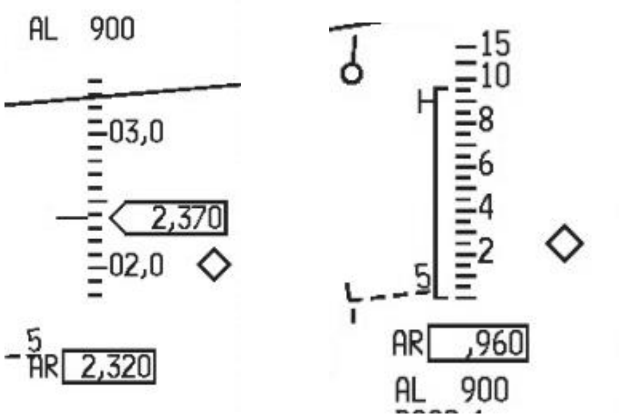
There are three possibilities for the altimeter scale according to the position of the corresponding switch on the HUD panel: RADAR, BAROmetric or AUTO.

The default setting is BARO which displays barometric altitude changing with local altimeter setting. It displays altitude in hundredths of feet with 100 feet marks (20 feet marks when the gear is down).The radar altitude (CARA) is also displayed below the altitude scale in a boxed window with the letter R in front of it if the CARA is active and within operating limits.



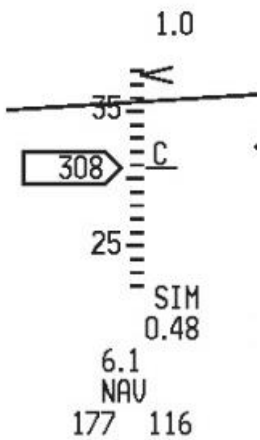
When the ALT switch is placed in the RADAR position the altimeter scale displays RADAR altitude. To avoid confusion the mnemonic R is added next to the fixed index mark on the altimeter tape.
The marks are the same as the barometric scale: 100 feet scaling and 20 feet when the gear is down.
The radar altimeter box usually placed below the airspeed tape is not displayed in this mode.

The last position of the switch is labelled AUTO and is an automatic scale using barometric altitude above 1500 feet and switching to radar altitude under 1200 feet.
Above 1500 feet the radar altitude is displayed in its usual box but with the mnemonic AR (Automatic Radar) instead of the usual R. When descending below 1200 feet the radar scale will replace the barometric altitude. A T-bar is displayed next to the tape showing the A-LOW setting. In the example below it is set at 900 feet. Note the AL line has switched to the bottom of the HUD, right under the AR window. When climbing the radar scale remains displayed up until 1500 feet AGL, when it is replaced by the barometric scale.



Airspeed scales

On the ground the airspeed tape cannot display airspeeds (CAS) at speeds lower than 60 knots.
The displayed airspeed may change according to the position of this HUD panel switch. In all modes the airspeed is marked every 10 knots and labelled in 50 knot increments.
In CAS the airspeed tape displays Calibrated Airspeed.
A mnemonic C is placed next to the HUD speed tape.

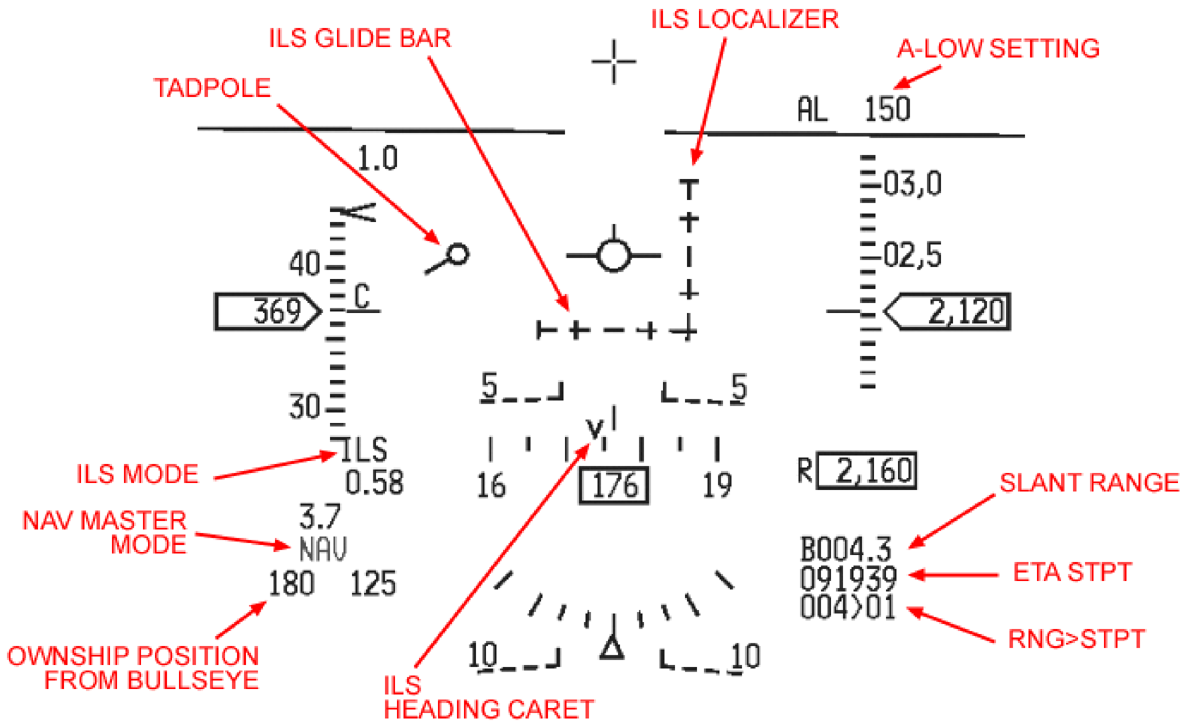


Moving the switch to the TAS position switches the airspeed tape to True Airspeed. In this case the T mnemonic is displayed.

Ground Speed can also be set and the mnemonic then is G. When GND SPD is selected a ground heading track caret is displayed as an inverted triangle on the heading tape.

When the landing gear is lowered the airspeed scale automatically reverts to CAS regardless of the position of the HUD panel switch. The heading track caret will remain displayed though if the switch remains in the GND SPD position.

1.5.2. HUD in NAV mode



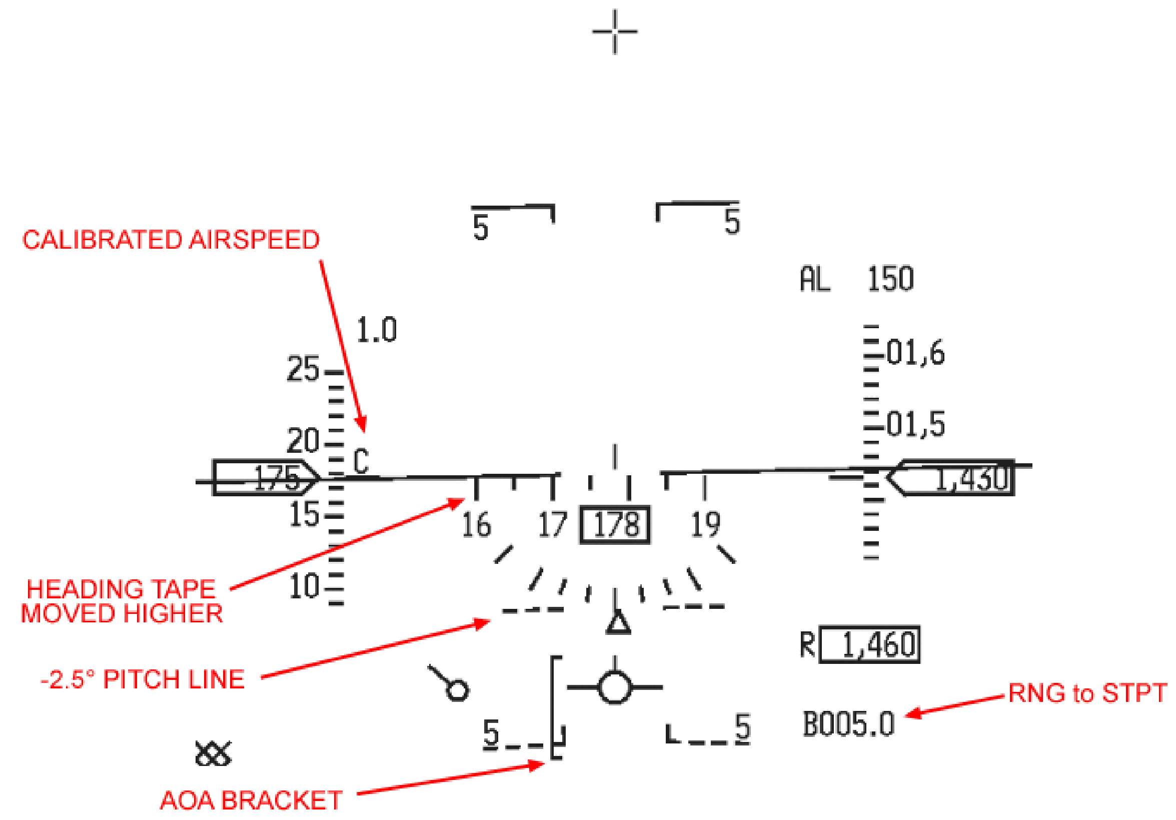
Most of the displayed features are not specific to NAV mode but are active in all Master Modes.

- The Great Circle Steering Cue (tadpole) points to the currently selected steerpoint (SPI). The SPI is also displayed on the HUD with a diamond. When outside the HUD field of view a cross is superimposed on the diamond and the crossed diamond remains on the edge of the HUD, towards the direction of the SPI (which is why you do not see it on the picture above).
- The A-LOW setting on top of the altitude scale corresponds to the first line (CARA) set in the UFC A-LOW page.

As always, different information can be displayed according to the way various subsystems are set up:

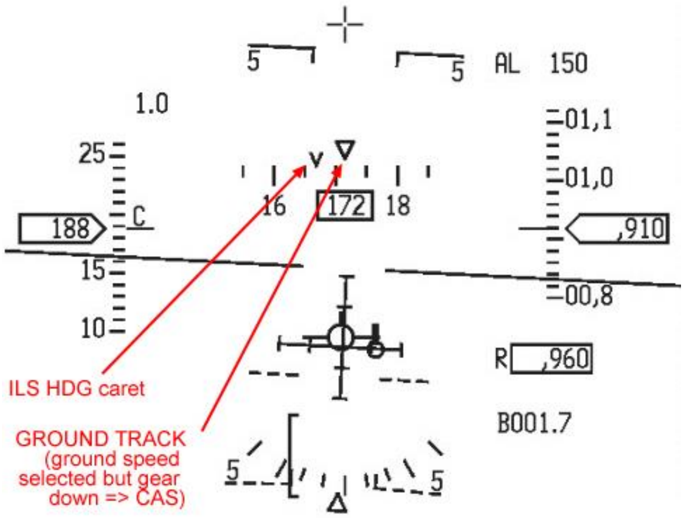
- If the HSI is switched to NAV/ILS or TCN/ILS the HUD will display the ILS localizer and glide slope and the CMD STRG cue if activated in the UFC T-ILS page.
- The ETA to STPT can be replaced by ETE (Estimated Time Enroute) according to the UFC CRUS TOS page settings.
- Different carets can be displayed around the tapes to give visual cues for airspeed, altitude and heading, again according to UFC subsystems.
- Ownship position from Bullseye can be displayed or not depending on Bullseye being mode selected in the UFC BULL page (LIST 0 8).
- Radar altitude will blank if you are outside of its attitude and altitude limits.
- The inverted V on the heading tape is displayed whenever the ILS mode is selected and represents the ILS heading caret. It is the wind corrected heading required to maintain the selected ILS approach course.

1.5.3. HUD with GEAR DOWN



When the landing gear is lowered some specific items are displayed or changed:

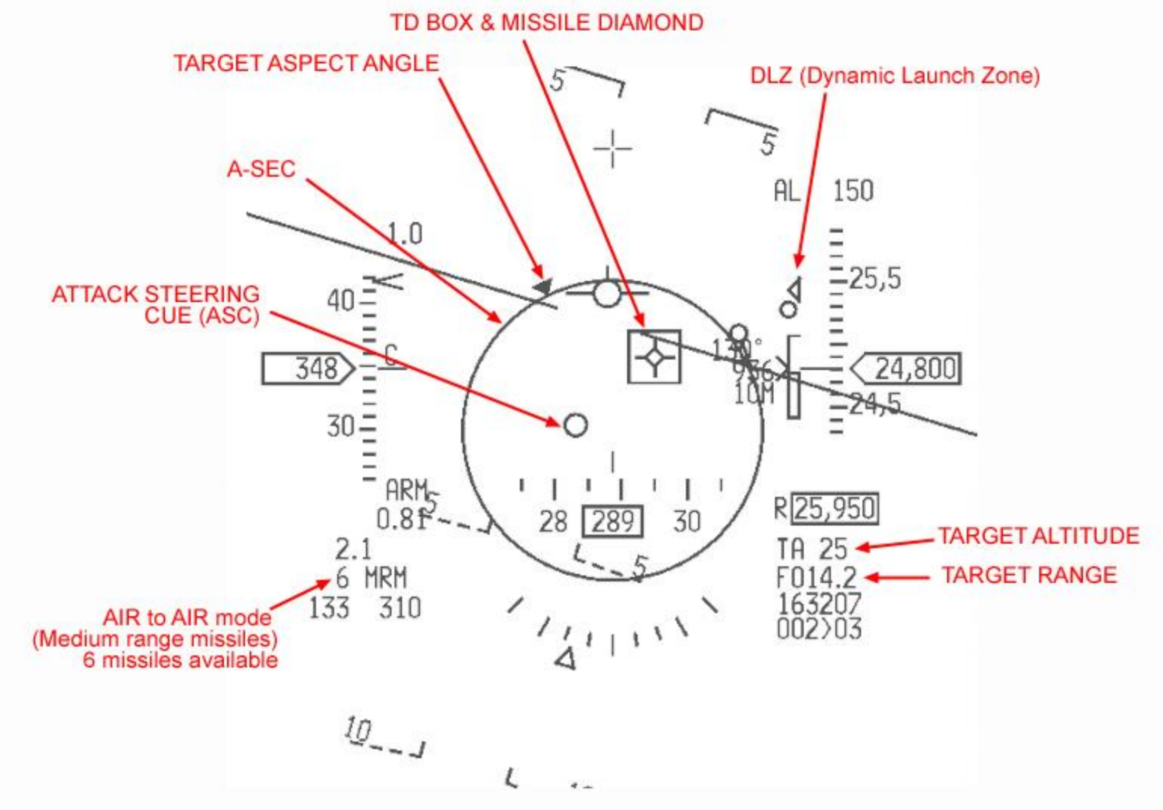
- The Heading tape is moved higher in the HUD. It will go to 50 milliradians above the FPM or on top of the HUD whichever is lower.
- The AOA bracket is displayed and represents optimal AOA for landing. The top mark is 11° AOA and the lower mark 15° AOA. The two marks correspond to the yellow and red chevrons on the AOA indexer, just to the left of the HUD. On speed AOA for landing is obtained by placing the FPM in the middle of the AOA bracket as pictured above, thus maintaining an AOA around 13° (corresponding to the green doughnut on the AOA indexer).
- A dashed pitch line is also displayed between the horizon line and the -5° pitch line. It is the -2.5° pitch line that represents the glideslope for landing.
- When the gear is down the displayed airspeed is always CAS, even if the Speed switch on the HUD panel is set to TAS or GND SPD. The ground heading track (inverted triangle on the HUD heading tape displayed with GND SPD) is still displayed when the gear is down. With ILS enabled you might have two different carets on the heading tape: the inverted V for the ILS heading and the inverted triangle for the ground heading track.

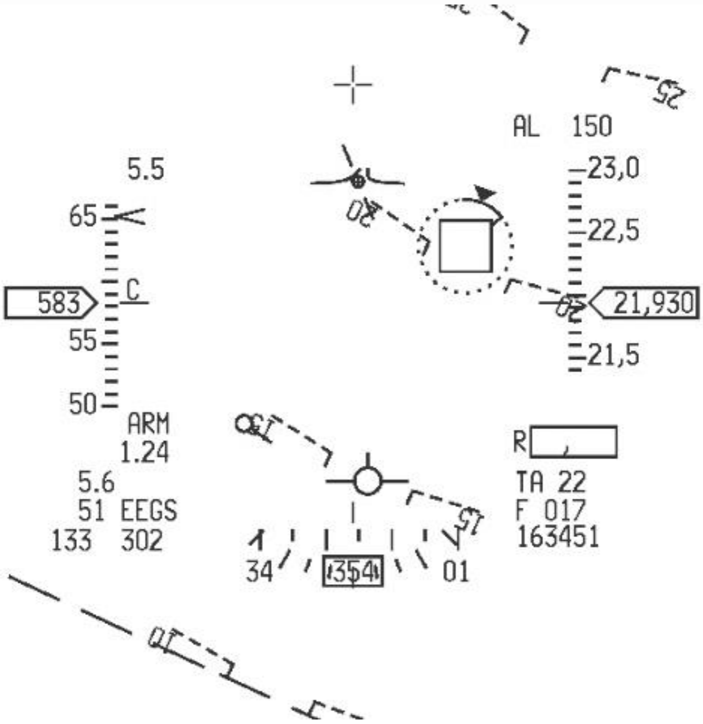


- Some data blocks usually displayed on the bottom of the HUD are blanked to allow better visibility of the critical HUD landing symbology.

1.5.4. HUD in AIR to AIR mode

The HUD will display different information depending on the active weapon in A-A mode.
A-A weapon parameters are displayed in the HUD repeating the cues on the MFDs (usually A-A FCR).

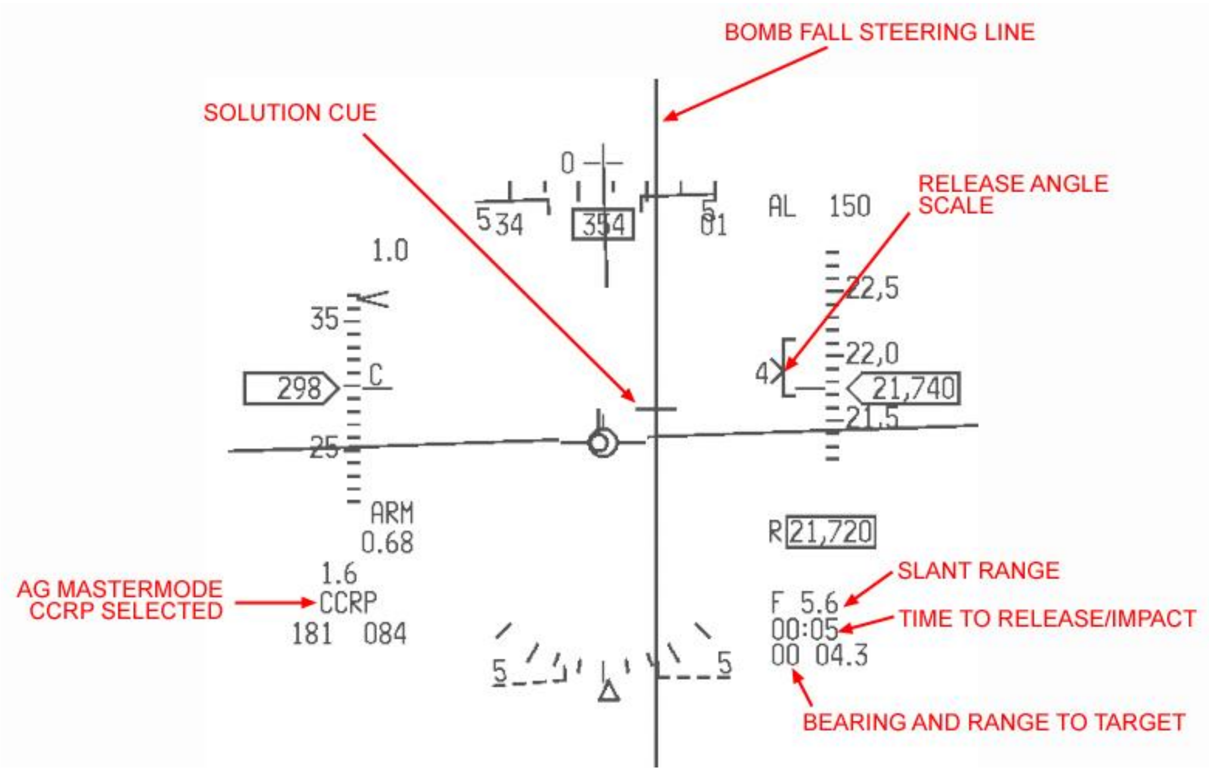




In the image above the A-A gun has been selected in EEGS mode. Note the inverted attitude and the radar altimeter which is blank.

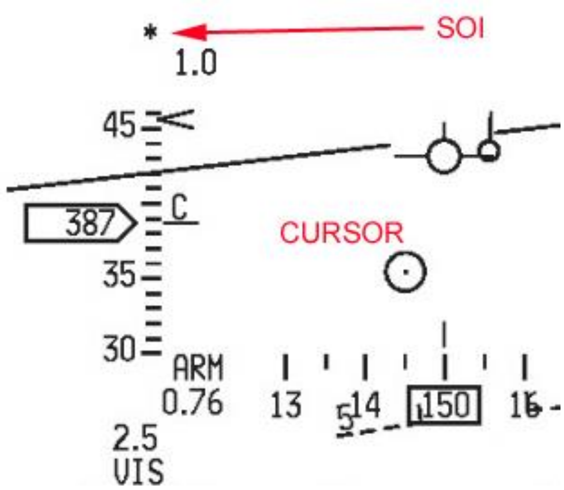
1.5.5. HUD in AIR to GROUND

As in A-A mode weapon and release mode cues are displayed in the HUD in A-G Master Mode.



The HUD can display many different cues in A-G modes depending on release solutions (e.g. CCRP, CCIP, DTOS) or even weapons (e.g. STRAFE, HARMs and other A-G missiles).
Please refer to the TO-BMS1F-16CM-34-1-1 for weapon employment specifics.

1.5.6. HUD as SENSOR OF INTEREST (SOI)

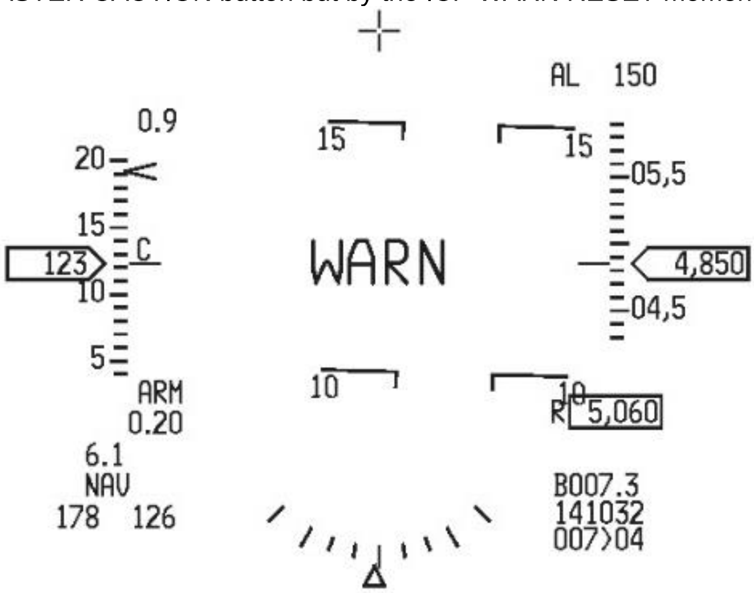


As with the left or right MFD the HUD can be selected as Sensor of Interest (SOI)
This is done with DMS up on the sidestick. When the HUD is SOI an asterisk is displayed in the top left corner of the HUD.

The HUD is used as SOI for creating HUD mark points and A-G missile employment in VIS mode. When the HUD is SOI a slewable cursor or target designator box is displayed on the HUD which can be moved with the cursor switch on the throttle and ground stabilised/designated with TMS up on the sidestick.

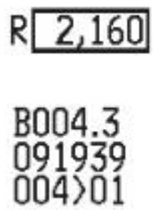
1.5.7. HUD WARNING

When a relevant malfunction occurs the HUD may display a flashing WARN message in its centre. VMS provides an audible “WARNING – WARNING” message. The flashing WARN in the HUD cannot be reset with the MASTER CAUTION button but by the ICP WARN RESET momentary switch instead.



Other smaller warnings may accompany the WARN HUD message such as a flashing FUEL message in the middle of the HUD, although smaller and below than where the WARN message is displayed or a steady TRP FUEL on the left of the HUD for instance replacing the NAV mode indication.
Please note: the TFR when out of Standby mode will also trigger a lot of TFR specific warnings in the HUD. Refer to the TFR system documentation in the TO-BMS1F-16CM-34-1-1 for details.

1.5.8. HUD CARA



The Combined Altitude Radar Altimeter provides accurate reading of aircraft altitude above ground level (AGL).
Radar altitude is displayed on the HUD below the altitude tape, in a box preceded by the letter R.

The CARA is controlled by the radar altimeter switch on the SNSR PWR panel, located on the right console. When the switch is placed in RDR ALT the CARA is functional. Radar Altitude advisory is provided by the A-LOW page of the UFC that is used to set the CARA A-LOW (1st line).
The set altitude is then repeated on the HUD above the altitude tape. When altitude goes lower than the CARA A-LOW the VMS calls “ALTITUDE – ALTITUDE” and the HUD A-LOW flashes.
When the gear is down VMS altitude calls are inhibited but the HUD CARA A-LOW still flashes.

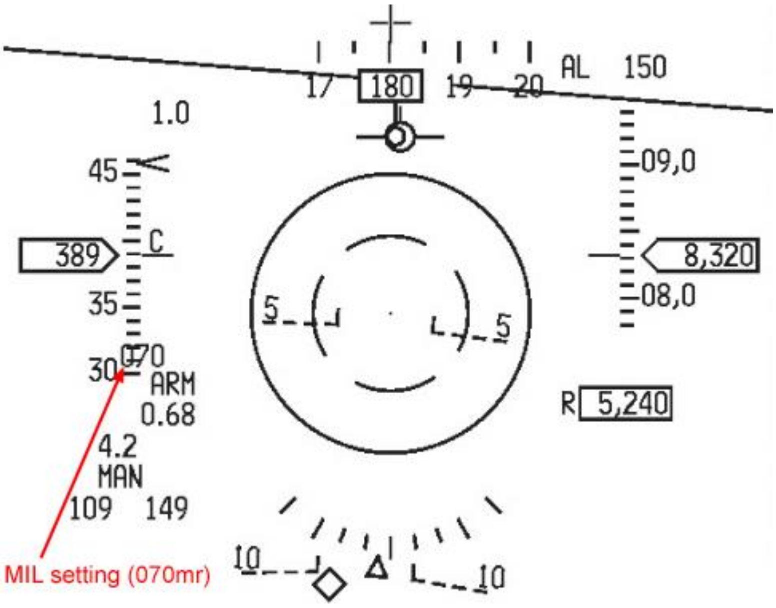
The CARA has limitations depending on altitude and pitch roll (bank angle).
Pitch or roll angle limits are 10° at 50000 feet, 15° at 25000 ft, 25° at 10000 ft, 30° at 5000 ft and 30° in pitch and 60° in roll at 3000 ft.
A combination of pitch and roll angles further reduces CARA altitude capability.
When outside the specification of the CARA altitude the HUD CARA display is blanked.
CARA is therefore most useful at low altitudes below 3000 feet.

1.5.9. DEPRESSIBLE RETICLE SWITCH

MANUAL bombing mode selected through the SMS A-G MFD (OSB #16) uses a backup bombing reticle that is normally used when the primary systems and avionics have failed.

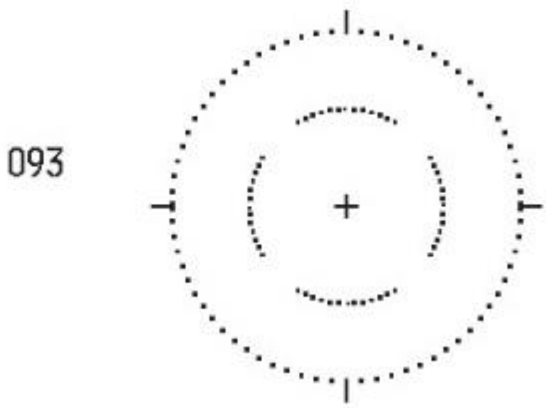
The manual bombing reticles are controlled by the DEPR RET switch on the HUD panel. The switch has three positions and features a primary (PRI) and standby (STBY) reticle. The reticles are comparable in use to old WWII aiming devices.

The Primary reticle does not change actual HUD symbology (except for the bombing mode symbols) and consists of a centre pipper with a dashed inner circle (50mil) surrounded by a solid outer circle (100mil).



The reticle can be moved UP and DOWN in the HUD by using the DEPR RET ICP wheel (top right wheel). The depression is displayed on the left of the HUD in milliradians.

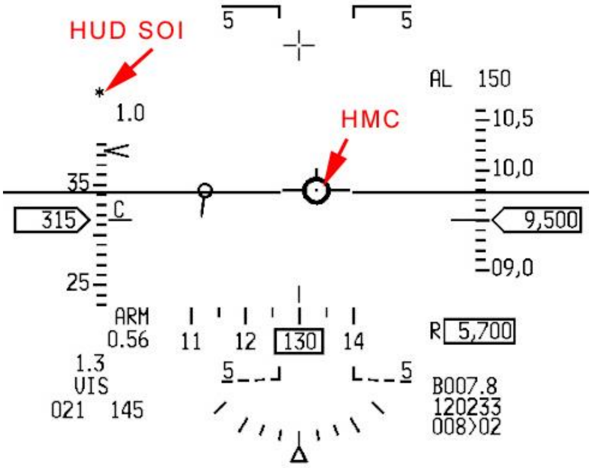
The standby reticle is a centre cross with a dotted inner circle (50 mils) surrounded by another dotted circle (100mil). The STBY reticle blanks out all other HUD symbols except the mil setting set by the ICP DEPR RET wheel. The standby reticle is visible even with the HUD damaged.



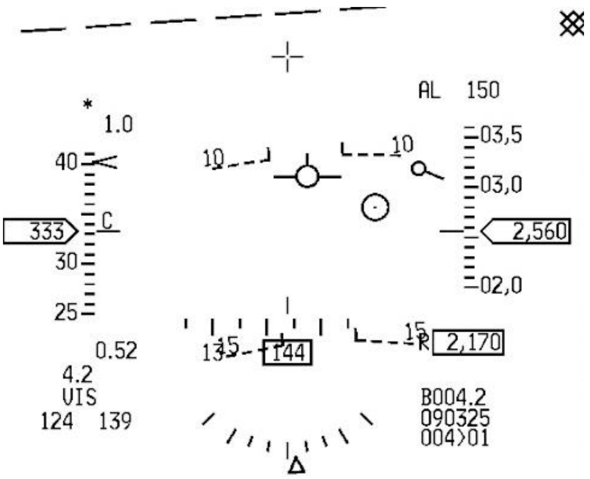
1.5.10. HUD MARK

Manual markpoints can be created on landmarks within the HUD field of view by using the HUD MARK page. Whenever the Master Mode is set to A-G or NAV and the FCR or TGP is not SOI and designating or ground stabilized, pressing the ICP #7 button will default the markpoint mode to HUD.

The HUD will display a HUD Mark Cue (HMC) consisting of a small 12 milliradian pipper with a dot in the centre. There are 2 states for HUD MARK mode, pre-designate and post designate.
In pre-designate mode the HMC pipper is placed on the FPM.



The HUD is automatically made SOI and the HMC pipper can be moved within the HUD field of view. A first TMS up will ground stabilize the pipper which can then be moved into position. The coordinates in the MARK UFC page will remain blank as the markpoint is not saved yet.
TMS down at this point will cancel ground stabilisation and return the HMC to pre-designate position.



A further press of TMS up will store the markpoint in the steerpoint bank. A small cross will be displayed on the HSD at the location of the markpoint. Depressing the M-SEL 0 button on the ICP with the newly made markpoint still showing on the DED will select it as the active steerpoint (SPI).

1.6 THE ENGINE

The BMS F-16 is powered by a single afterburning turbofan engine. The engine control system is composed of two major components: the Fuel Control (see Fuel chapter), and the Digital Electronic Engine Control (DEEC). The engine has two modes of operation: Primary (PRI) and Secondary (SEC).

1.6.1. Primary (PRI) and Secondary (SEC) engine control

PRI mode is the nominal mode of operation where the engine receives fuel as a function of throttle inputs and the DEEC controls ignition, engine operation, AB operation and nozzle actuation.
SEC mode prevents AB operation and is used in the event of a DEEC failure or malfunction. SEC is manually selected by the ENG CONT switch on the ENG & JET START panel or automatically by the DEEC during SEC operation the SEC caution light illuminates and the nozzle remains closed.

1.6.2. Exhaust nozzle

The exhaust nozzle is variable and controlled by the DEEC as a function of throttle input.
In PRI with the LG handle down, the nozzle is greater than 80% open at IDLE. As the throttle is advanced the nozzle closes. With the LG handle up the nozzle is near minimum except near MIL power when the nozzle controls engine pressure according to fan speed.
When the throttle is advanced in the AB range the nozzle is opened to compensate for increasing AB fuel flow.
In SEC the nozzle is closed to 0% and AB operation is inhibited.

1.6.3. Engine Oil system

Lubrication of the engine is done with a self-contained oil system. In BMS 4.34 oil issues may arise as during ramp start, or as a result of battle damage. Pilots should ensure that oil pressure is always within operating limits. A loss of oil pressure will lead to engine seizure. See SECTION III ABNORMAL & EMERGENCY PROCEDURES for further information.

1.6.4. Engine Anti-Ice system

No component of this system is currently implemented in BMS 4.34.
The Anti ice switch and the INLET ICING caution light are eye candy.

1.6.5. Jet Fuel Starter (JFS)

The JFS is a gas turbine which uses aircraft fuel. The JFS receives fuel at all times regardless of the FUEL MASTER Switch position. The JFS is started from two accumulators, used either singly (START 1) or together (START 2). In BMS we only have the START 2 option.

If you do not succeed in starting the engine after JFS discharge you now have the option to ask your crew chief to manually recharge the accumulator with a hand pump. This option is available through the ground page of the ATC menu (you must be on the ground frequency) and will make you very unpopular with your crew chief. Recharging the JFS will take about 3 minutes, during which a status message is displayed in the top right corner of the screen. Once the message disappears you can give START 2 another try. Remember to buy your crew chief a case of beer.

As well as starting the engine on the ground without any external aid the JFS can be used to assist in engine air-start. This is explained in the ABNORMAL & EMERGENCY PROCEDURES section later.
In flight the accumulators are charged automatically by hydraulic system B in about 60 seconds.

JFS status can now be determined by the JFS light, which is implemented realistically in 4.34:

- Steady: JFS operating normally (light on happens when JFS reaches nominal speed).
- 1 Hz flashing (once per second): JFS overheating after running for 4 minutes on the ground.
- 2 Hz flashing (twice per second): JFS failure due to running for over 8 minutes on the ground.

Please note, max operating time of the JFS is 4 minutes. Using it for longer time may induce overheating conditions.

1.6.6. Engine Warning & Caution lights

The ENGINE FAULT caution light indicates a PFL (Pilot Fault List) item listed. The caution light will go off when the fault is acknowledged.
The SEC caution light illuminates when the engine is operating in SEC (Secondary) mode of operation.
The EEC and BUC caution lights are deactivated (may come on during tests) but bear no real significance.
The HYD/OIL PRESS warning light (right eyebrow) is used to monitor the engine oil and hydraulic system pressure. For engine oil pressure the light comes on when the pressure has been below 10 psi for 30 seconds (this delay minimizes false warnings due to manoeuvring). The light goes off when pressure exceeds 20 psi.
For hydraulic pressure the light goes on when either A or B system decreases below 1000 psi.
At ramp start the light usually goes off before reaching idle RPM but it is within acceptable limits if the light goes off before exceeding 70% RPM.
The ENGINE warning light illuminates when RPM and FTIT indicate an engine over temperature or a flameout has occurred. It could also light in the case of RPM and/or FTIT indicator failure. The warning light illuminates when the RPM decreases below 55% or approximately 2 seconds after FTIT exceeds 1100°C.

1.6.7. Engine instruments

The RPM indicator expresses RPM in percent and is powered by the battery bus.
The NOZ POS indicator gives the position of the exhaust nozzle in percent (0%=closed 100%=open). This indicator is powered by the emergency bus.
The FTIT indicator displays average FTIT temperature in degree Celsius from 200 to 1200°C. It is powered by the battery bus.
The fuel flow indicator displays the total fuel flow to the engine, including AB. This indicator has a range of 0 to 80000 pph. It is powered by the emergency buses.
The OIL pressure indicator displays oil pressure from 0 to 100 psi and is also powered by the emergency buses.

1.6.8. Throttle

The engine is controlled by the throttle with detents at OFF, IDLE, MIL and AB.
The OFF (CUTOFF) position terminates engine ignition and fuel flow.
The IDLE position commands minimum thrust (which may be enough to move a lightly loaded jet).
From IDLE to MIL the throttle controls the output of the engine.
Past MIL the throttle modulates the use of the afterburner.

Normally the real jet does not need to depress an idle detent to be started or shut down.
In CUTOFF the throttle is lifted vertically and advancing and lowering the handle to the idle point starts the engine, once the JFS has increased the RPM to 20%. The idle detent was invented in Falcon to overcome the lack of CUTOFF position on most hardware throttles.
To shut down the engine the handle is simply brought over the idle detent and lifted vertically, shutting down the ignition and starving the engine of fuel.

1.6.9. Ground operations

Ground idle provides the lowest level of idle thrust. Be aware that it may be enough to move a lightly loaded jet, so be sure to use the chocks (ask the crew chief to fit and/or remove them by using the ATC menu if you are on an airbase frequency) or use parking brakes.

With chocks fitted you can increase RPM up to 80-85% but chock jumping is a real possibility, so beware while performing your ramp start checklists. Always back up the chocks with toe brakes when performing checks needing higher power settings (EPU, SEC, etc).

Parking brakes are usually automatically deactivated around 83-85% RPM as well (The real value is when the throttle goes further than one inch past the IDLE point, but that is not easily quantifiable in the simulator).

Do not exceed 80% RPM for taxiing. A small increase of RPM is usually enough to start rolling and then RPM can be decreased to maintain a constant speed on the ground. Beware not to speed up past 25 knots and 15-10 knots in turns. You can see your ground speed in the INS UFC page (LIST 6).

1.7 FUEL SYSTEM

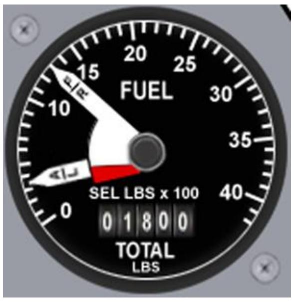
DISCLAIMER: This chapter refers only to the single seat F-16 Block 50 / Block 52 in BMS. Block 52+ with their conformal fuel tanks and F16D two seat variants of the block 50 & 52 are not documented in this manual but are now coded correctly in BMS.

The F-16 block 50 and block 52 in BMS are able to carry 7162 lbs of JP5/8 fuel internally.

The amount of fuel carried externally differs from one variant to another.
Wing tanks can be 370 gallon or 600 gallon but the latter are hardly used. We will work on the assumption that the normal external fuel load consists of two 370 gallon wing tanks (capacity 2516 lbs each) and one 300 gallon centreline tank (capacity 2040 lbs).
In this scenario the maximum load of external fuel is 7072 lbs.
The maximum fuel load is thus 7162 + 7072 = 14134 lbs.

The internal fuel system is made of 6 tanks:

Left wing tank with a capacity of 550 ± 100 lbs.
Aft fuselage tank + Aft reservoir fuselage tank with a capacity of 2810 ± 100 lbs.
Forward fuselage tank + Forward reservoir fuselage tank with a capacity of 3250 ± 100 lbs.
(Forward fuselage tank 1 & forward fuselage tank 2 are combined in BMS to forward fuselage tank).
Right wing tank with a capacity of 550 ± 100 lbs.

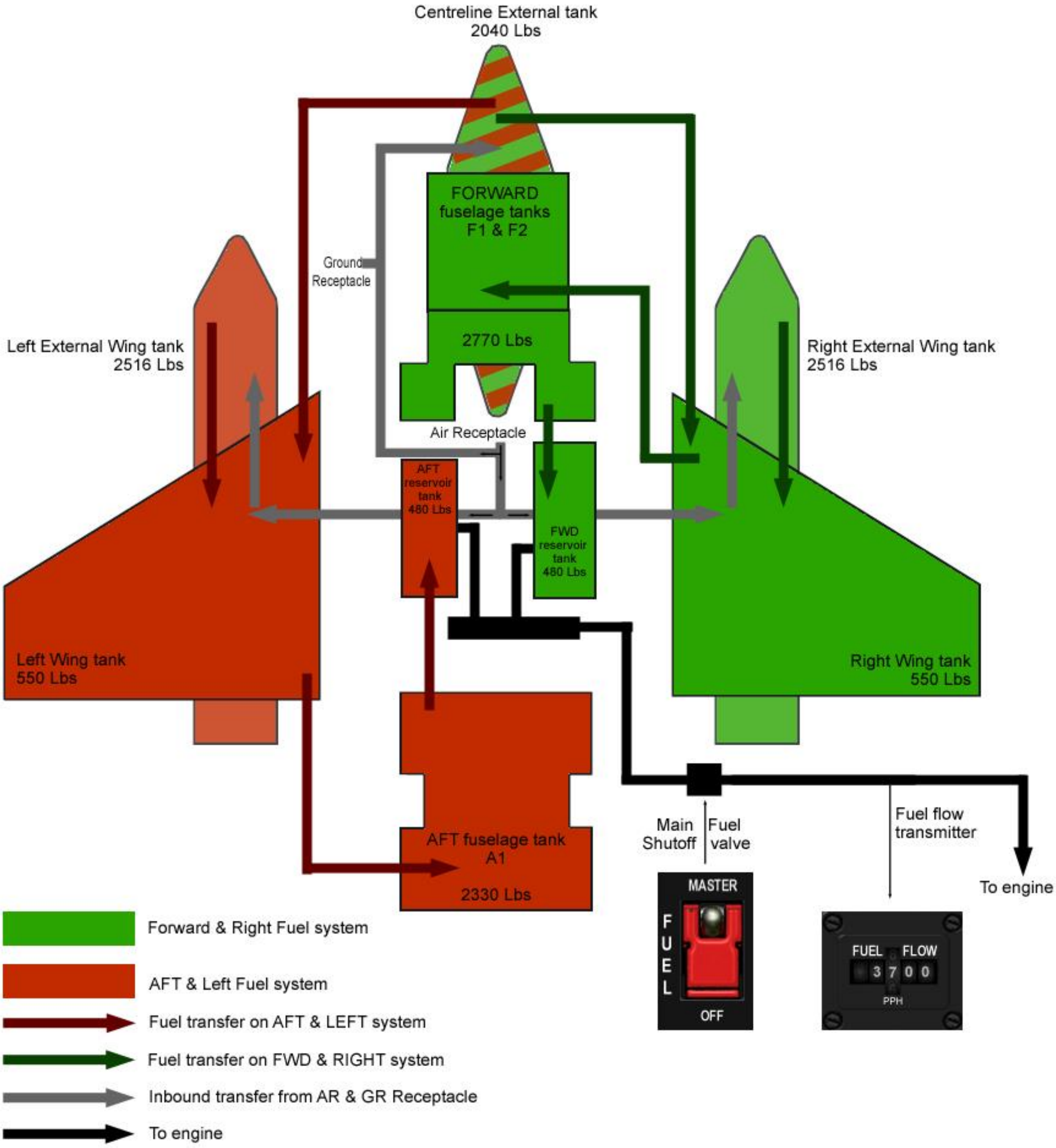


The total fuel system is divided in two parts:

- AFT & LEFT tanks (A/L) in red in the following image
- FORWARD & RIGHT tanks (F/R) green on the image

That is why you find two different needles on the fuel quantity gauge on the right aux console. One for the A/L fuel system, the second for the F/R fuel system.
We will cover this gauge at a later stage.

Please note, the centreline external tank is part of both systems as it transfers into both F/R and A/L systems.



Centreline External tank
2040 Lbs
FORWARD
fuselage tanks
F1 & F2
2770 Lbs
Ground
Receptacle
Left External Wing tank
2516 Lbs
Right External Wing tank
2516 Lbs
Air Receptacle
AFT
reservoir
tank
480 Lbs
FWD
reservoir
tank
480 Lbs
Left Wing tank
550 Lbs
Right Wing tank
550 Lbs
AFT fuselage tank
A1
2330 Lbs
Main
Shutoff
Fuel
valve
Fuel flow
transmitter
To engine
MASTER
FUEL
OFF
FUEL FLOW
3700
PPH
Forward & Right Fuel system
AFT & Left Fuel system
Fuel transfer on AFT & LEFT system
Fuel transfer on FWD & RIGHT system
Inbound transfer from AR & GR Receptacle
To engine

The normal path of a drop of fuel in either the A/L or F/R system would be:
From the external tank to the wing tank to the fuselage tank to the reservoir fuselage tank to the engine.
This path is illustrated on the image above by the dark red or dark green arrows.
So the external wing tank(s) always empty first into the relevant internal wing tank.
The wing tank transfers to the relevant fuselage tank: Right wing goes to Forward fuselage and Left wing goes to Aft fuselage tank).
Each fuselage tank transfers to its relevant reservoir tank before being fed to the engine.
The only exception to that as noted above is the centreline external tank that feeds both wing tanks at the same time.

The normal path of a drop of fuel at filling (on the ground for Hotpit refuel – or in the air during A/A refuel) would be: from the receptacle to the centreline tank (if carried) to the wing tank and to the external wing tanks if carried. This path is illustrated on the image above by grey arrows.

1.7.1. Fuel SHUTOFF valve.

The fuel shutoff valve illustrated on the image above allows the engine to be starved of fuel. That valve is driven by the MASTER FUEL switch located on the FUEL panel on the left side console.

The switch has two positions MASTER and OFF and is guarded in the MASTER position. In some air forces it is even securely wired and cannot be moved by the pilot unless in an emergency.
In BMS that switch is in MASTER at all times as well, especially at ramp start. You should never shut down the engine by shutting off the fuel valve. You would only shut it off in case of emergency to prevent a fire when crash landing for instance.

1.7.2. Fuel pumps

The primary transfer system for fuel through tanks and to the engine is by gravity and siphoning but it is also backed up by pumps as gravity wouldn't drain a tank fully and wouldn't work correctly in negative G situations. Fuel pumps therefore operate at the same time and independently of gravity feed.

Fuel is pumped from both reservoir fuselage tanks to the Fuel Flow Proportioner (FFP) which adjusts flow rates from both the F/R and A/L systems to maintain the balance of fuel and hence the centre of gravity (CG) position. The FFP is driven by the A hydraulic system.
It is thus possible to have fuel imbalance problems occurring even when pumps are operating if there is a failure on hydraulic BUS A which drives the FFP.

The fuel pumps from the fuel tanks to the FFP are operated through the ENG FEED knob located on the FUEL panel on the left console. It operates as follows:

- With the knob in OFF none of the pumps work and fuel transfer occurs only via gravity and siphoning action. During heavy manoeuvring or negative G the engine may flame out.
- The NORM position activates pumps for both systems (F/R & A/L) and maintains CG position automatically.
- When the knob is placed in AFT the AFT pump works and fuel is pumped from the AFT reservoir tank to the engine. The CG moves forward.
- When the knob is placed in FWD the FWD pump works and fuel is pumped from the FWD reservoir tank to the engine. The CG moves aft.

Please note, as the reservoir tanks start to empty the possibility of negative Gs starving the engine of fuel increases significantly. Avoid negative G loads with less than 1000 lbs. of fuel remaining.

1.7.3. Fuel pressurisation

Fuel pressurisation is only partially implemented in BMS.
For fuel to transfer from the external tanks they have to be pressurized. This is done with the AIR SOURCE knob on the AIR COND panel on the right console:

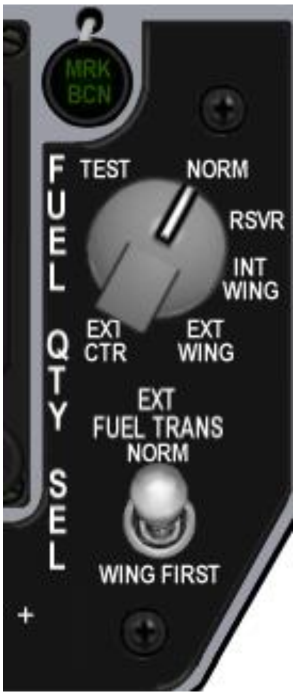
This knob controls the ECS system and thus pressurisation of the cockpit and the fuel tanks. Fuel tanks are pressurized only in NORM and DUMP position. In NORM both the cockpit and fuel tanks are pressurized, in DUMP only the fuel tanks are pressurized.
This is implemented and failure to pressurize the fuel tanks with the AIR SOURCE knob may trigger TRP FUEL conditions.

When air refuelling the fuel goes from the AR receptacle to the wing tanks and to any external tanks if carried. Normally to allow the fuel to transfer into the external tanks the pressurisation would need to be decreased.

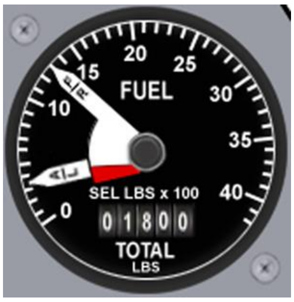
This would normally be done with the TANK INERTING switch located on the fuel panel in the left console. Unfortunately that function is not implemented in BMS and as a consequence A-A and hotpit refuelling does not require tank inerting when external tanks are carried.

That being said some depressurisation is simulated in the current code when opening the AR door. This prevents fuel from flowing from the external wing tank to the internal wing tank when the AR door is opened.

1.7.4. Fuel quantity indicating system



The main fuel quantity gauge is located on the right AUX console and indicates many different things depending on the position of the FUEL QTY SEL knob placed on the centre pedestal (right of the HSI).



1. Total usable fuel remaining onboard is given on the bottom of the gauge in pounds of fuel (numerical value) (except in TEST).
2. The F/R needle points to the amount of fuel in pounds remaining in the forward/right fuel system according to the FUEL QTY SEL knob position.
3. The A/L needle points to the amount of fuel in pounds remaining in the aft/left fuel system according to the FUEL QTY SEL knob position.

Here is a table explaining the interaction between the two instruments:

Fuel QTY SEL	Fuel Totalizer (lbs)	A/L needle (in hundredths of pounds)	F/R needle (in hundredths of pounds)
TEST	6000	20	20
NORM	**Total lbs Fuel onboard**	**Total Lbs fuel AFT FUSELAGE (max=28)**	**Total lbs fuel FWD FUSELAGE (max=32)**
RSVR	Total lbs Fuel onboard	Total lbs fuel AFT RSVR (max=4.8)	Total lbs fuel FWD RSVR (max=4.8)
INT WING	Total lbs Fuel onboard	Total lbs fuel LEFT internal wing (max =5.5)	Total lbs fuel RIGHT internal wing (max =5.5)
EXT WING	Total lbs Fuel onboard	Total lbs fuel LEFT external wing (max =25 for 370Gal)	Total lbs fuel RIGHT external wing (max =25 for 370Gal)
EXT CTR	Total lbs Fuel onboard	0	Total lbs Fuel external tank (max 2.0)

It is very important to know that the NORM position is the only position ensuring automatic fuel transfer, trapped fuel warning and Bingo fuel computation based on fuselage fuel.
As a consequence if that knob is any other position than NORM you may not get accurate BINGO or TRP FUEL warnings.

Please note that 4.34 introduced the possibility of flameout due to fuel starvation, even if the needles are reporting some fuel remaining. Fuel gauges are notoriously inaccurate in airplanes, especially with low fuel amounts, and this has been modelled in BMS to some extent.

1.7.5. External fuel transfer switch

The two-position switch located under the fuel quantity selection knob is used to invert the way the external tanks feed into the internal wing tanks. Obviously it is used only when both external wing and centreline tanks are carried.
Normally the centreline tank empties first into both the internal wing tanks. It is therefore the first tank that is emptied. This is what happens when the switch is the NORM position.
But in some cases the mission may dictate that the wing tanks are emptied first so they can be jettisoned (think CAT I). In this case the switch would be placed to the WING FIRST position so the external wing tanks empty first into the internal wing tanks and can be jettisoned. The centreline tank would then start to empty into the internal wing tanks.

1.7.6. Fuel checks

Keeping a close eye on your fuel system is paramount to mission success. Flight Leads will often request fuel state or an Ops check to ensure that no one in their flight runs out of fuel or has an imbalance problem. But you are the pilot and your fuel is your responsibility, so don’t wait for your Flight Lead to check it for you. Check it as often as possible and not only the fuel gauge, but also the fuel remaining at different steerpoints on your route particularly at home plate.

There are three types of check your lead can request from you:

1. Fuel state
2. Ops check
3. FOS (Fuel Onboard at Station)

Fuel state is simply the total fuel remaining on board. You find that one on the fuel quantity gauge, at the bottom of the instrument on the digital readout.

- Mamba flight, fuel state, Lead is 9.6
- Two is 9.4

Ops checks are much more complete.
First the call has to be acknowledged:

- Mamba flight, Ops check
- Two
- One is 28-32 10.4 feeding
- Two is 28-32 10.2 feeding

The format is:
Call sign (Number in the flight), A/L needle value, F/R needle value, Total Fuel, Feeding if external tanks are carried and feeding the internal wing tanks and Dry if the external tanks are empty.
Once Dry has been said once it does not have to be repeated.

An imbalance condition is illustrated on the fuel quantity gauge when the red portion of the needles is visible, so each pilot can check it visually at a glance. Lead on the other hand has to ensure that the difference between the A/L and the F/R needle values do not exceed 600 Pounds each way.

The FOS check is a request to check fuel reaching a specific waypoint (usually home) and it is answered by giving the fuel state in the CRUS HOME page, ensuring that the correct steerpoint is selected.

1.7.7. Fuel imbalance

It should come as no surprise that aircraft behaviour in the air is heavily influenced by the position of its centre of gravity. Obviously the centre of gravity moves according to the way the aircraft is loaded. In this way fuel load and fuel transfer will greatly impact the centre of gravity position. The CG moves along two axes depending on the load and must remain within certain limits for the aircraft to remain controllable. In the same way asymmetric weapon loadouts induce the heavy wings to drop, a fuel heavy wing will drop as well.

Fuel transfer can also induce a forward or aft shift of the CG if there is only one of the two fuselage tanks feeding the engine. In that case the fuselage fuel load does not decrease evenly in the front or rear of the aircraft and the CG will move accordingly. This CG longitudinal shift is much more subtle than left & right shift because it often goes unnoticed but may induce quicker departure at higher AOA, especially dangerous for aerobatics, approach and landing.

We can therefore define two types of imbalance and luckily the least dangerous one will probably happen before the more dangerous one, which will help you to correct it before it becomes serious.

Since the left and right side empty first into the fuselage any kind of imbalance happening soon after takeoff will probably induce a shift of the CG to the left or to the right, inducing a roll which can be neutralized with the aileron trim in the exact same way an asymmetrical loadout is compensated. That roll will be noticed before the external wing tanks are empty and if you succeed in overcoming the temptation to check the possibility of joystick drift, you will probably realise something is wrong with your load. Since your weapons haven't been dropped yet you should think about a potential fuel imbalance problem.

Furthermore as said above, when one of the wing tanks starts to empty you might get a TRP FUEL warning signalling that some fuel is trapped in the other external tank. That is your second clue. If you need a third clue you should consider playing PS3 games ☺

The second type of imbalance will happen when the wing tanks are empty (both external and internal) and concerns only the internal fuselage tanks. If they empty into the FFP unevenly the difference in weight will induce a shift of the CG forward or backward.

That imbalance is much harder to detect by simply flying the aircraft and may induce serious problems in some envelopes of the flight model: the aircraft becomes more prone to departure of controlled flight under certain AOA.

The only way to detect such a condition early is to check the needles on the fuel quantity gauges as often as possible. As long as you don't see the red portion of the needles there is no fuel imbalance problem. The red portion of the needles becomes visible when the difference between the two needles is more than 600 lbs.

Remember you may not feel this kind of imbalance before it is too late. That is why Ops checks are so important.

Aft CG saves fuel, but forward CG makes the aircraft more responsive to pilot input (when staying within the established %Mac CG loading of course).

1.7.8. Analysis of caution lights & HUD messages relevant to the fuel system

Beside the needles and the fuel totalizer there aren't many caution lights for the fuel system.

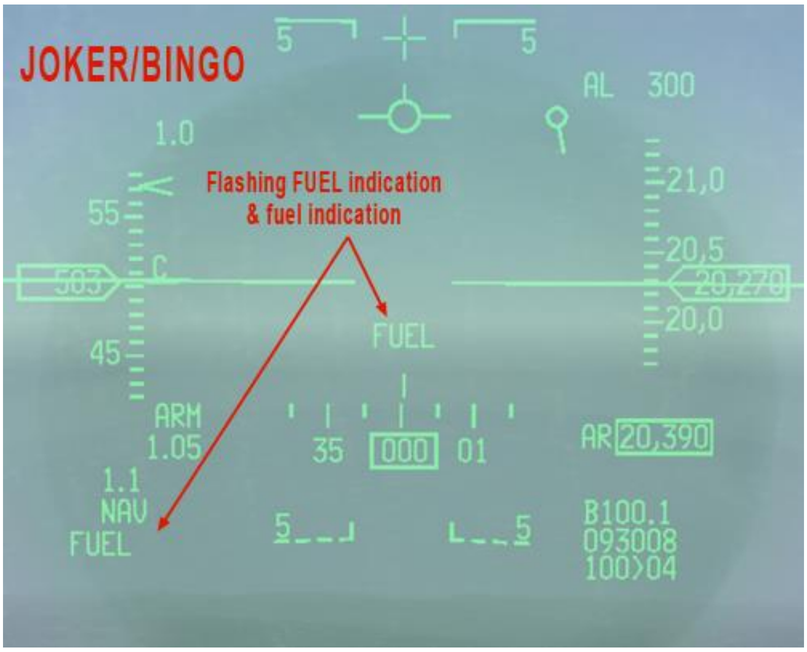
The two main ones are located on the caution panel and come on when the level of fuel in the fuselage reservoir tanks reach 400 lbs for the FWD reservoir and 250 lbs for the AFT reservoir.

Obviously the FWD caution light is relevant to the F/R fuel system (Forward fuselage reservoir) and the AFT caution light is relevant to the A/L fuel system and more specifically to the Aft fuselage reservoir. The MASTER CAUTION light will come on as well. Those lights are powered by the emergency DC bus n°1 and are independent from the fuel totalizer.

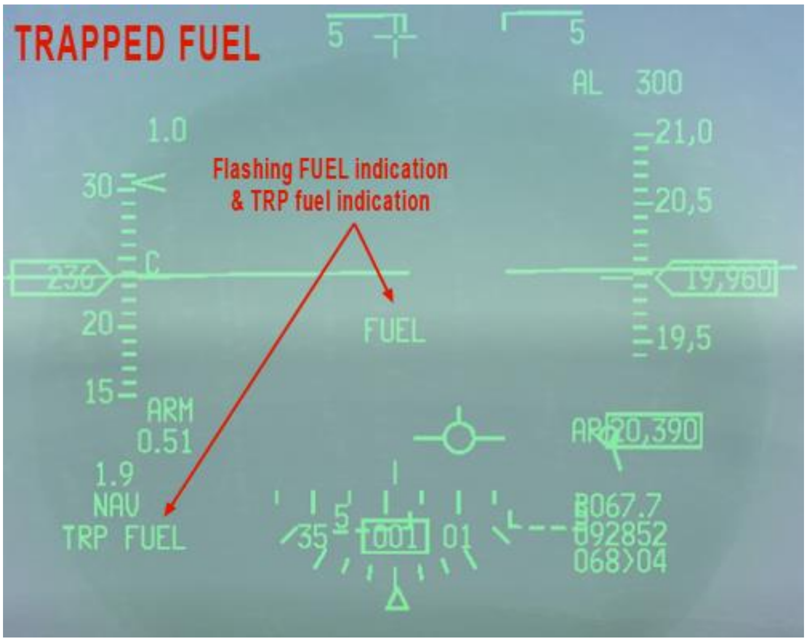
Usually when these two come on you're in trouble because you only have a few seconds of engine power left and you should land right away. Consider also that fuel gauges are notoriously imprecise. You've also busted the minimum fuel needed on board when landing which is 1200 lbs.

Effective fuel management includes setting a Joker and a Bingo setting in the UFC. This will make Betty call "Bingo – Bingo" when that fuel state is reached (if the FUEL QTY SEL knob is in NORM).

A flashing FUEL indication will also be displayed in the HUD. That warning message can be reset with the WARN RESET switch on the ICP.



Another HUD message relevant to the fuel system is the TRP FUEL, meaning a condition of trapped fuel has occurred. Again it can be reset with the WARN RESET switch (TRP FUEL will remain displayed on the left of the HUD), but it is much better to solve the problem at its source.



A trapped fuel condition may happen in abnormal situations such as:

- **Imbalance situation.** For instance if the A/L system feeds the engine alone (ENG FEED to AFT) and the aircraft carries two external wing tanks, the left wing tank will empty in the left internal wing tank but the right external wing tank will remain full. When the left external wing tank is empty and the left internal wing tank starts to empty into the aft fuselage tank a trapped fuel message will be displayed on the HUD notifying the pilot that some fuel is trapped in external tanks. In this case in the right external wing tank.
  You will get a TRP FUEL warning when fuel remains in the external tanks and the amount of fuel in any internal tank is decreasing.
- **AR door open for too long.** When the AR door is opened the external tanks depressurise a bit to allow the fuel coming from the AR door to actually be transferred to the external tanks (if carried). In this case the external tanks are not transferring fuel to the internal tanks anymore, because of the drop in pressure.
  If the external tanks are kept depressurised for too long it may be possible that the fuel left inside cannot reach the internal wing tank. In that case a TRP FUEL condition may develop.
- **AIR SOURCE to OFF or RAM**. The same is true if the AIR SOURCE knob is placed in any other position than NORM or DUMP. Both these positions, besides activating the ECS, pressurise the fuel tanks. If they are not pressurised the fuel may not transfer correctly. That being said, if you leave the AIR SOURCE knob set incorrectly the problems induced on the ECS system will happen much quicker than any fuel pressurisation problems. So chances are that you will notice these first and fix the problem before fuel pressurisation problems occur.

Five conditions must be met for a TRP FUEL warning to occur:

- FUEL QTY SEL knob is in NORM
- Aerial refuelling has not occurred within the previous 30 - 90 seconds
- Fuselage fuel has been at least 500 pounds less than fuselage capacity for 30 seconds
- Total fuel has been at least 500 pounds greater than fuselage fuel for 30 seconds
- Fuel flow has been less than 18000 pph for 30 seconds

A TRP FUEL warning may also occur with prolonged AB use if fuel flow to the engine exceeds the maximum transfer rate from the external tanks. This is not really a true TRP fuel and will clear as soon as AB is disengaged or when the fuel transfer rate decreases back to within the maximum possible transfer rate of the external tanks.

1.7.9. Managing Fuel: Joker & Bingo

As Flight Lead, you may have to set a Joker/Bingo level for the whole flight. But first let's define BINGO and JOKER.

BINGO fuel is the amount of fuel that once reached triggers an immediate return to home plate.
It takes into account the fuel needed to fly the return leg of the flight, the fuel required to fly the briefed approach, the fuel to go to the alternate (if necessary) and the emergency fuel which is not supposed to be used except in an emergency. That emergency fuel is 1200 lbs for the F-16 block 40-52 and 800 lbs for earlier blocks.

JOKER fuel is usually set above BINGO as a warning that the bingo is approaching. We usually set it 1000 lbs above Bingo to allow 1 minute of combat time in AB. That rule is not fixed in stone and can vary.

As you may understand by now the planned BINGO is dependent on many factors that need or may not need to be taken into consideration.
How is the weather? What are the chances to being rerouted to the alternate? What is the type of mission? Patrol at loiter speed or bombing or escort or SEAD tactics on multiple threats? What is the expected opposition on the return leg? The possibility of A-A intercepts? Do we fly low level or high level egress? Is there a tanker available?
All this makes BINGO computation quite mission specific but here is one way (amongst others) to compute Bingo conservatively:

1. Min fuel on landing for F-16 Block 50/52: 1200 lbs (800 lbs for earlier blocks).
2 a) If VMC (Visual Meteorological Conditions): 1 pattern = 400 lbs - so add 400 lbs just in case you screw up the overhead and need to go around.
2 b) If IMC (Instrument Meteorological Conditions): 1 STAR = 800 lbs, so add 800 lbs just in case you have to go missed approach and re-do the STAR.
3. Compute fuel needed to go the alternate. If alternate is say 70Nm from home, multiply by 10 = 700 lbs to get there.
4. Final calculation is from the furthest steerpoint of the flight plan.
Take the return leg distance (along the route, not in a straight line) into consideration and multiply it by 15 to estimate fuel needed: (so 15 lbs/Nm for mid altitude – multiply by 20 for low altitude egress)
So if the furthest point is 200 Nm away from home plate calculate 200 x 15 = 3000 lbs.

So BINGO is the sum of all that:
1200 + 400 + 700 + 3000 = 5300 for VMC.
1200 + 800 + 700 + 3000 = 5700 for IMC.

Joker is 1000 more: 6300 and 6700 respectively.

As you can see BINGO is tied to a steerpoint. If you did not reach your computed Joker or Bingo level for that steerpoint and started your egress there is no real reason to call your fuel state over the radio. The situation remains dynamic though so if something happens on the return leg you may have to recompute a Bingo. Doing this is easy, just select the CRUS page and HOME subpage and check your fuel state at home plate at any moment in your flight. Make sure that fuel is above minimum fuel (emergency + approach + alternate = 1200 + 400 (or 800) + 700 = 2300 (or 2700)) and as soon as the fuel remaining over home is equal to this value you're BINGO. Add 1000 and you're Joker.

BINGO and JOKER are entered at the same spot in the UFC: LIST 2 (BINGO) page.
Obviously you first enter JOKER and when you reach that you reset it by typing in the numbers for BINGO.

FLIGHTPLAN BINGO FUEL CALCULATION		lbs	EXAMPLE	lbs
1. FUEL FOR LANDING	A. BLOCK 40 ≤	1200	F16 BLOCK 52	1200
	B. BLOCK 40 >	800		
2. FUEL FOR GO-AROUND		+		
CONDITIONS AT HOMEPLATE:				
A. VFR (GOOD WEAHTER)		400		
B. IFR (BAD WEATHER)		800	IFR CONDITIONS	800
3. FUEL FOR GO-TO ALTERNATE		+		
[DISTANCE] FROM HOMEPLATE TO ALTERNATE:			40nm TO ALTERNATE	
		[dist.]nm x 10		40nm x 10 = 400
4. FUEL FOR EGRESS		+		
[ROUTE] FROM TARGET TO HOMEPLATE:			140nm FOR EGRESS ROUTE	
A. MEDIUM ALTITUDE (x15)		[dist.]nm x 15		110nm+30nm x 15 = 2100
B. LOW ALTITUDE (x20)		[dist.]nm x 20		
BINGO		**= .... lbs**	**BINGO**	**= 4500 lbs**
5. FUEL BUFFER		1000 +		1000 +
JOKER		**= .... lbs**	**JOKER**	**= 5500 lbs**
				by Scuby, 2015

The above table can be used for Bingo/Joker calculations.

When reaching the fuel state input in the UFC the pilot will receive visual (HUD) and audio (VMS) warnings.

Bingo fuel warning is based either on fuselage fuel with the FUEL QTY SEL knob in NORM or on total fuel with the FUEL QTY SEL knob out of NORM.

With the FUEL QTY SEL knob in NORM the bingo computation is based on the lesser of fuselage fuel weight or total fuel weight.

In other words with the FUEL QTY SEL knob in NORM a Bingo fuel warning will be triggered as soon as either fuselage fuel or total fuel decreases below the entered BINGO fuel value. With the FUEL QTY SEL knob out of NORM the warning will only be triggered when total fuel decreases below the entered BINGO value.

With trapped external fuel this could lead to fuel starvation before the Bingo warning is triggered.

It is thus very important that the FUEL QTY SEL knob is left in NORM whenever you are not doing fuel/ops checks.

1.8 ENVIRONMENTAL CONTROL SYSTEM (ECS)

The ECS provides air-conditioning and pressurisation driven by engine bleed air.

In BMS the air-conditioning system provides cooling of the avionics (you have to provide your own fresh air!) and the pressurisation system provides canopy seal, pseudo cockpit pressurisation, fuel tank pressurisation and simulated OBOGS (pressure breathing).

All of those functions are lost when the AIR SOURCE knob is placed in OFF position. Please refer to the cockpit arrangement section in this manual for an overview of the AIR SOURCE knob.

In BMS, we basically use two positions: OFF (both air-conditioning and pressurisation systems shut off) and NORM (both systems working automatically).

The TEMP knob is used for cockpit air-conditioning and is not implemented. The same is true of the defog lever (outside the left console towards the rear of the cockpit) and obviously the Anti-G system.

1.8.1. ECS PFL/Caution/Warning lights

Two caution lights are relevant to the ECS: EQUIP HOT and CABIN PRESS. EQUIP HOT comes on when cooling of the avionic systems is insufficient, which happens very quickly if you forget to put the AIR SOURCE knob in NORM. The CABIN PRESS light comes on when the cockpit pressure altitude is above 27000 feet.

There is also a warning light relevant to the ECS, the CANOPY warning light on the right eyebrow. It comes on when the canopy is not locked tight.

1.9 ELECTRICAL SYSTEM

The real electrical system in the F-16 is extremely complicated with multiple AC and DC buses. BMS has simplified things while maintaining correct behaviour for ramp starts, flight and shutdown but without the possible malfunctions. Work on the electrical system is still in progress so hopefully; this will get simpler in the future. But for now the BMS electrical system might be even harder to understand than the real one.

The biggest difference is that BMS does not differentiate AC and DC power. The next difference is that BMS does not model the actual physical routing for the bus wiring. For instance the real F-16 has multiple essential & non-essential buses scattered in different locations, BMS only has one of each electrical bus. Finally the real FLCS has a four branch power supply (ABDC) but BMS considers them a single unit.

So basically what we have in BMS is a set of generators (MAIN GEN, STBY GEN, EPU GEN) that are linked to engine output and hydrazine reserves. These feed models of the various electrical buses (battery, emergency, essential and non-essential buses).

The MAIN GEN supplies power to the non-essential, essential and emergency buses.
The STBY GEN supplies power to the essential and emergency buses and comes online whenever the MAIN GEN is not supplying power and as long as the MAIN PWR switch is in MAIN PWR.
The EPU GEN comes online when both the MAIN and STBY GEN fail, providing power to the emergency buses.

1.9.1 Electrical System Normal Operation:

Prior to engine start the MAIN PWR switch is placed to BATT to permit a check of the aircraft battery.
The ELEC SYS, MAIN GEN, STBY GEN and FLCS RLY lights come on.
The FLCS RLY light illuminates because the FLCS relays are open and the FLCC is not connected to the aircraft battery.

The FLCS PMG light is not illuminated since it requires FLCS power.
The ACFT BATT TO FLCS light does not illuminate since the FLCS relays are open.
With the FLCS PWR TEST switch held in TEST the FLCS relays close but do not latch.
The FLCS PMG and the ACFT BATT TO FLCS lights illuminate and the FLCS RLY light goes off.
The FLCS PWR lights on the TEST switch panel illuminate, indicating that the power output of the FLCC is good. With the FLCS PWR TEST switch in NORM and the MAIN PWR switch moved from BATT to MAIN PWR the lights do not change.

When the JFS switch is moved to either START position the FLCS PMG light (and the ACFT BATT TO FLCS light if the engine is started on battery power) illuminates and the FLCS RLY light goes off, indicating that the FLCS relays have closed.

During engine start the FLCS PMG light (and ACFT BATT TO FLCS light if the engine is started on battery power) goes off at approximately 30% engine rpm.
The STBY GEN light goes off at approximately 60% engine rpm.
The MAIN GEN light goes off approximately 5-10 seconds later if both generators are operating normally.

At any point after selecting MAIN PWR, including in flight, the FLCS PWR TEST switch may be held momentarily in TEST to check FLCC power output. During the EPU test the FLCS PWR lights come on to indicate that EPU PMG power is available to the FLCS.

During engine shutdown the ELEC SYS caution light and FLCS PMG, MAIN GEN, and STBY GEN lights come on as the engine spools down. The ACFT BATT TO FLCS light also illuminates.

1.9.2. Electrical caution/warning lights

FLCS PMG light: comes on whenever there is no power applied to the FLCS PMG.
MAIN GEN light: comes on when the MAIN generator is not online.
STBY GEN light: comes on whenever the STBY generator is not online.
EPU GEN light: indicates that the EPU has been commanded to run but the EPU generator is not providing power to the emergency bus. (it can’t work when EPU switch is OFF).
EPU PMG light: indicates that the EPU has been commanded to run but the EPU PMG power is not providing power to the FLCS.
ACFT BATT FAIL light: indicates an aircraft battery failure or failure to charge.
ACFT BATT TO FLCS light: indicates that the battery is powering the FLCS.
ACFT BATT FLCS RLY: indicates that the battery is not connected to the FLCS.

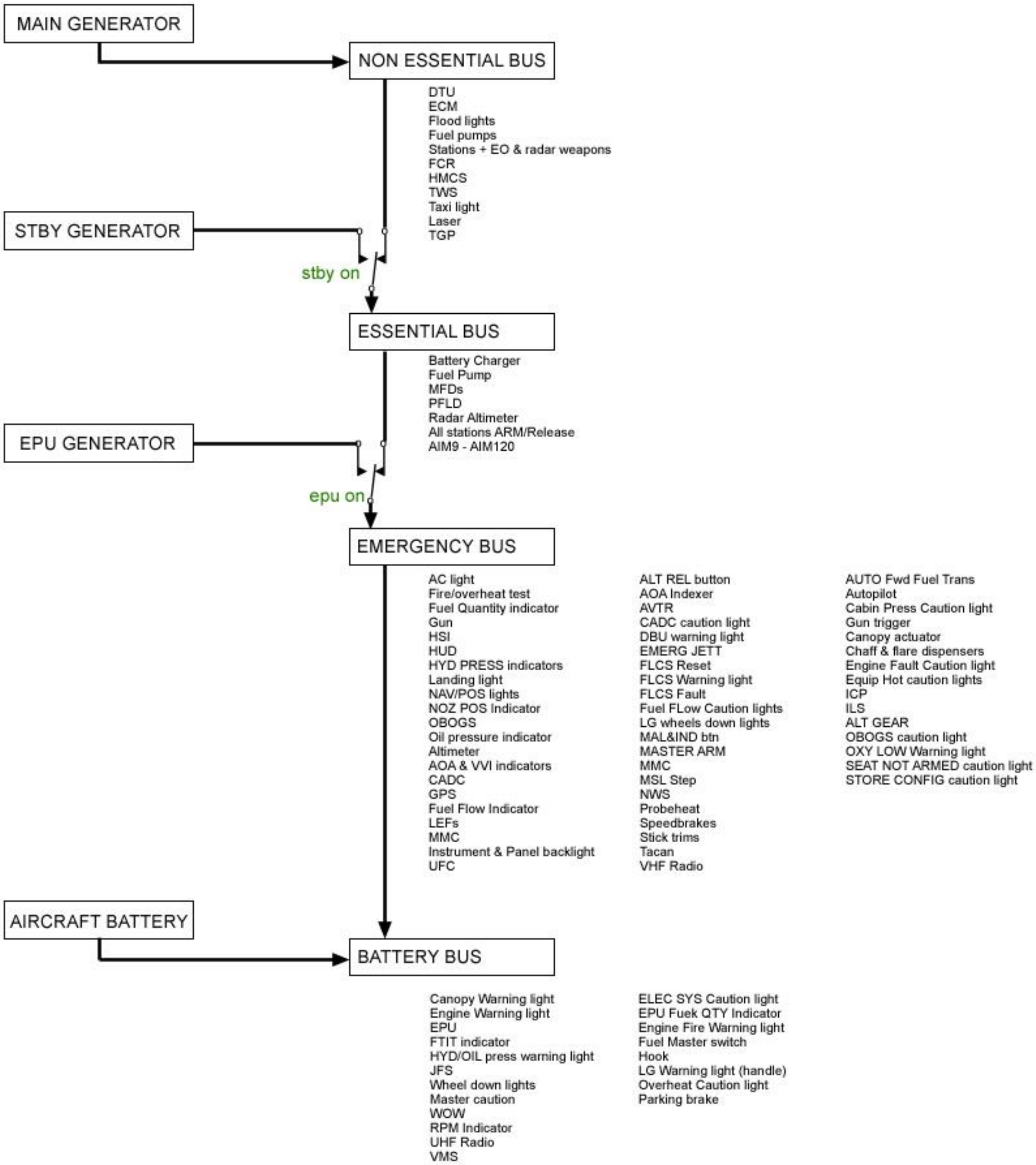
ELEC SYS caution light (CAUTION panel): comes on with any of the lights above.

FLCS PWR light (TEST panel): ABDC – a single light in BMS, as the 4 FLCS branches are considered a unique branch: illuminates to indicate proper power output of the FLCC during FLCS power test.

The white pushbutton on the ELEC panel labelled CAUTION RESET is fully implemented in BMS and resets the ELEC SYS caution light and clears the MASTER CAUTION light ready for future indications. It also resets the MAIN and STBY generators.

Inflight electrical system failure hardly ever happens in BMS though; the most likely cause of problems is if you mess up the ramp start sequence.

BMS F-16C Block 50/52 Power Distribution



1.10 HYDRAULIC SYSTEM

Hydraulic pressure is supplied by two independent, concurrently running engine driven pumps A & B. Should one of the systems fail the remaining system provides sufficient hydraulic pressure. This hardly ever happens currently in BMS. It is indeed much more common to see both systems A & B fail at the same time in BMS. In that case a third hydraulic pump driven by the EPU provides emergency hydraulic pressure for a limited time to system A.

HYD PRESS indicators
There are two hydraulic pressure indicators located on the right aux console, one each for systems A and B. They are powered by the emergency bus. In flight the normal position of the needles should be pointing at 12 o'clock (approximately 3100 psi).

HYD/OIL PRESS warning light
Located on the right glareshield the HYD/OIL PRESS light comes on whenever system A or B pressure drops below 1000 psi or when the engine OIL pressure drops below 10 psi. The light is powered by the battery bus.

1.11 EMERGENCY POWER UNIT (EPU)

The EPU is a self-contained system whose purpose is to provide emergency electrical power and hydraulic pressure. The EPU automatically activates (if the EPU switch is in NORM) whenever both MAIN & STBY GEN drop offline and/or when both hydraulic systems pressure drop below 1000 psi.

A safety pin prevents the EPU from switching on automatically during the engine start sequence. Once the engine is running and prior to testing EPU operation, the EPU pin should be removed. This is done through the ATC menu (Ground page). Failure to remove the pin would prevent proper EPU testing and proper EPU operation if need in an inflight emergency.

The EPU can also be operated manually by placing the EPU switch to ON.
When the EPU is operating power is supplied to the emergency bus (the non-essential and essential buses are unpowered). Hydraulic system A is also supplemented by EPU hydraulic pressure.

The EPU uses engine bleed-air to operate if engine RPM is sufficient. When bleed-air becomes insufficient EPU uses hydrazine to operate. Hydrazine is a highly toxic gas and is contained in a specific tank allowing around 10 minutes of EPU operation.

EPU lights
EPU RUN light located on the EPU panel: comes on whenever the EPU is running.
HYDRAZN light: comes on whenever the EPU is consuming hydrazine.
AIR light: comes on whenever the EPU is using engine bleed-air. This light remains on when the EPU is using hydrazine to augment engine bleed-air.

EPU indicators
The EPU FUEL % REMAIN indicator located on the right aux console is graduated from 0 to 100% and indicates the amount of hydrazine remaining in the tank. When this hydrazine is depleted and engine bleed-air is not sufficient to maintain EPU operation the aircraft receives no power or hydraulic pressure and the only option is ejection.

When the EPU is activated plan to land as soon as practicable, especially if engine bleed-air is not going to be sufficient to run the EPU. Remember, once you start using hydrazine you have about ten minutes of power and hydraulic pressure left.

Unfortunately when the EPU is fired up in BMS it is usually because the engine is no longer operating, so the EPU is not able to run for very long on engine bleed-air alone before you slow down too much.

1.12 FLIGHT CONTROL SYSTEM (FLCS)

The FLCS is a digital fly-by-wire system which controls the flight surfaces hydraulically. The main component of the FLCS is the Flight Control Computer (FLCC) that translates electrical signals generated at the flight controls to hydraulic pressure moving all primary and secondary flight controls, taking into account other sources of data such as AOA, air data probes, INS, etc.
Pitch motion is provided by symmetrical movement of the horizontal tails, Roll is controlled by differential movement of the flaperons and horizontal tails and Yaw is controlled by the rudder.
The FLCS provides roll coordination automatically through the ARI (Aileron Rudder Interconnect) system which is not active on the ground with WOW and until a few seconds after gear retraction.

The FLCS is meticulously coded in BMS as it is one of the main components of the BMS Advanced Flight Model. It is a combination of three modules:

- Pitch FLCS
- Roll FLCS
- Yaw FLCS

FLCS limiters are provided in all three axes to help prevent departure/spins.

The FLCS has three operational modes that are called GAINS:

- Standby gains
- Takeoff & Landing gains
- Cruise gains (normal operating mode)

The normal mode of operation is Cruise gains. Takeoff and Landing gains is activated whenever the following conditions are met:

1. Landing Gear handle in Down position.
2. ALT FLAPS switch in EXTEND position and airspeed less than 400 knots.
3. AIR REFUEL door switch in OPEN position and airspeed less than 400 knots.

The Standby gains are coded in BMS but are relatively transparent to the user. They kick in automatically when the FLCC detects a FLCS failure indicated by the FLCS FAULT caution light.

1.12.1 CRUISE GAINS

1.12.1.1 Pitch FLCS

The purpose of the Pitch FLCS is to limit requested G to control the natural pitch instability of the F-16. It is important to understand that when the pilot applies pressure on the sidestick in the pitch axis he is actually commanding an amount of G. The FLCS translates this into flight control surface motion to deliver the intended G number, taking into account other flight parameters such as AOA.

At low AOA (below 15°) the maximum positive G is 9G, but as AOA increases maximum G decreases. The limit also depends on the position of the STORES CONFIG switch. Two settings are possible: CATI and CAT III.
CAT I is the least limiting position and is intended for a clean configuration (centreline and A-A weapons can be carried). CAT III is the most limiting position to protect the aircraft from departure when carrying loads on the wing stations (fuel tanks, A-G bombs, etc).
In CAT I the pilot can request from -3G to +9G. The AOA remains a factor in the maximum possible G. At 20° AOA it will reach 7.3G and at 25°AOA the max G reachable is 1G (level flight).
In CAT III the AOA is limited from a certain angle to prevent higher G being reached. This AOA limit is around 15.5 – 15.8° AOA. That means that in CAT III below 15° AOA, the airframe might be able to pull 9G but as soon as the AOA reaches 15° the CAT III limits additional AOA increase therefore limiting the number of available G.
The CAT config does not limit G, it limits AOA which as a consequence limits maximum G available.

1.12.1.2. Roll FLCS

The main purpose of the Roll FLCS is to prevent roll-coupled departures by limiting the roll rate.
Four parameters contribute to a roll-coupled departure:
AOA (the higher it is the more critical)
Elevator position (the higher it is the more critical)
Dynamic pressure (the lower it is the more critical as dynamic pressure is lower at high altitude)
Rudder position commanded by the Yaw FLCS module

As a consequence pilots should be very aware of roll-coupled departure when performing low speed barrel rolls at high altitude, which assaults two limiters at the same time (roll and pitch).

The CAT switch also plays a part in Roll FLCS by limiting the roll rate. In CATIII the aircraft is more prone to roll coupled departure due to higher gross weight and position of the centre of gravity. The maximum commanded roll rate is thus further reduced by 40% of the maximum commanded roll rate in CAT I.

1.12.1.3. Yaw FLCS

Since the rudder is mostly controlled in flight by the FLCS through the ARI (Aileron Rudder Interconnect) the pilot should in theory have no need to use the rudder in flight. To prevent pilot induced rudder movement which can create adverse effects the FLCS automatically limits its use.
Rudder authority is reduced as a function of AOA, roll rate and CAT config to prevent departure from controlled flight.
In CAT I the maximum deflection starts to be limited around 14° AOA and reaches zero deflection possible at 26° AOA.
In CAT III the maximum deflection starts to be limited at 3° AOA and reaches zero deflection at 15° AOA.

The ARI provides automatic coordinated turns by moving the rudder along with the ailerons to compensate for aileron induced yaw effect.
Nevertheless in a crosswind take-off/landing situation the pilot may need to put the rudder and ailerons in the same direction to compensate for winds. To allow this the ARI is inactive when the main gear speed is greater than 60 knots or if AOA exceeds 35°.
When the gear is retracted the wheels slow down and thus the ARI becomes active again (usually 2 seconds after landing gear up). If the gear is kept down the ARI may take longer to become active again.

1.12.2. TAKEOFF & LANDING gains

The FLCS automatically switches to Takeoff & Landing gains whenever the following conditions are met:

- Landing Gear in the down position or
- ALT FLAPS switch in EXTEND position and below 400 knots or
- AIR REFUEL door switch in OPEN position and below 400 knots

1.12.2.1 Pitch FLCS

The Pitch FLCS operates as a pitch rate command until 10° AOA. It means that the pilot commands a pitch rate and not a G value as in Cruise gains. As a consequence when no pressure is applied the FLCS maintains a 0° pitch rate, the nose will stay steady and the FPM will move up and down according to AOA.
Above 10° AOA the FLCS commands pitch in a blended mode of pitch rate and AOA command. This was created to give more feedback to the pilot for landing; indeed constant back pressure will be required for the nose to keep its attitude, giving classic feedback for non-fly-by-wire aircraft during landing.

1.12.2.2. Roll FLCS

The roll rate is limited to half the value of the Cruise gains. It is totally independent of AOA, airspeed and horizontal tail position.

1.12.3. STANDBY gains

The FLCS Standby gains is a backup mode that automatically kicks in whenever a FLCS fault is detected (i.e. whenever the FLCS warning light and FLCS FAULT caution light are illuminated). Control response is then tailored for a fixed speed and altitude (around 600 knots for gear up and 230 knots for gear down). If the FLCS Fault can be reset with the FLCS RESET switch the FLCC will revert to its previous gains, clearing the Standby gains. This is indicated by the warning light going off.

Action of FLCS limiters in three FLCS axis (Cruise and LG gains)

	PITCH	ROLL	YAW
CAT I	Max AOA= 25° G command system till 15°AOA g/AOA command system above 15° AOA	Max roll rate command decreases with: AOA above 15° Airspeed less than 125Kts Horizontal tail deflection more than 5° down Rudder deflection more than 20°	Max deflection reduced for: AOA > 14° Roll rate > 20° /sec Note: 0° rudder available at 26° AOA
CAT III	Maximum AOA =15.5 -15.8° G command system till 7° AOA at 100 Kts to 15° AOA at 420 kts G/AOA command system above the previous value	Max roll rate command reduced by approx 40% of the max commanded roll rate of CAT I.	Max deflection reduced for: AOA>3° Roll rate > 20° /sec Note: 0° rudder available at 15 ° AOA
Notes	+9G available till 15°AOA.17:17Max G decreases as a function of AOA after 15° AOA		Above 35° AOA and under -5° AOA the yaw rate limiter provides Antispin control inputs

1.12.4. Gun compensation

The FLCS automatically compensates for the off-centre gun firing and the gun gas emissions during gun firing by moving the rudder and flaperons. Gun compensation is optimised for 0.7 – 0.9 Mach. Firing outside of those speeds may create adverse effects. Furthermore if the FLCS is damaged, firing the gun may be impossible because of the lack of compensation.

1.12.5. Leading Edge Flaps (LEF) and Trailing Edge Flaps (TEF)

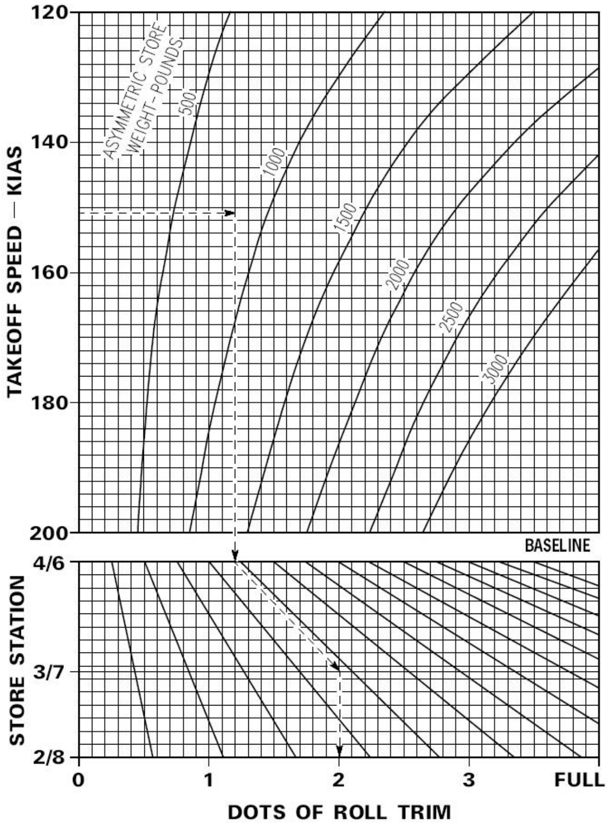
BMS also models the impact of LEF and TEF motion behaviour. Normally these flight controls are commanded by the FLCS but they can be locked in place with the FLCP (FLCS Panel) switches or by malfunctions or damage.
LEF are controlled by the FLCS as a function of MACH and AOA.
TEF are controlled by the FLCS as a function of Landing Gear handle position, ALT FLAPS switch position and airspeed.

1.12.6. Digital Backup (DBU)

The DBU provides a software backup in the event of FLCS problems. It automatically engages when the FLCC detects a majority of FLCS branches in a failed state. The DBU operation does not significantly impact the normal cruise operation or landing and as such is not coded in BMS. The DBU light and DBU switch on the FLCP are eye candy but will nevertheless disengage autopilot if engaged.

1.12.7. Asymmetrical loading

The FLCS does not provide automatic roll trim function to compensate for asymmetric loading of the wings (fuel or weapons). As a consequence the pilot will need to constantly adjust the roll trim of the F-16 when loaded asymmetrically or when fuel is draining unevenly from the wing fuel tanks.
This should normally be done prior to take-off (if necessary) or in-flight after weapon release (if the condition exists).



1.12.8. FLCS BIT

The FLCS should be tested at ramp start by using the FLCS BIT switch. In real-life it is a magnetic spring-loaded 2-position switch. When engaging the FLCS BIT a green RUN light comes on and the FLCS goes through a full series of tests lasting approximately 45 seconds. During the tests the flight controls will move and this movement will be visible over the multiplayer network. Warning light and HUD messages will be displayed during the BIT.

The test can fail and failure is indicated by the illumination of the FAIL light on the FLT CONTROL panel. A FLCS warning light, HUD WARN message and corresponding PFL will also be displayed. A failed test can only be reset by rerunning the test again until successful completion.

A successful test is indicated by the green RUN light going off and the FLCS BIT switch snapping back to the OFF position. The FLCS bit progress can also be followed on the MFD FLCS page. The BIT in progress and BIT status messages are displayed.

1.12.9. FLCS warning/caution lights

There are many caution and warning lights about the FLCS scattered on the TEST & FLCP panels, warning panel, ELEC panel etc.

The FLCS warning light located on the right glareshield illuminates to indicate a failure of the FLCS. It also comes on to indicate if the LEF are locked or with a failed FLCS BIT.

The DBU warning light comes on whenever the FLCC engages the digital backup software to replace the FLCS primary system. In BMS it comes on only when the DBU switch of the FLCP is switched to ON (eye candy).

The FLCS FAULT caution light illuminates when a FLCS PFL fault is listed. It goes off whenever the PFL fault is acknowledged or if the caution condition has been resolved.

The STORES CONFIG caution light comes on whenever the CAT switch is placed opposite to what the FLCS detects it should be for CAT loading. The light resets whenever the switch and the FLCS are synchronised again.

1.13 LANDING GEAR & BRAKES

The Landing Gear is operated by hydraulic system B and consists of two main landing gears (MLG) and a nose wheel (NLG). When hydraulic system B is inoperative the gear can be lowered once pneumatically with the alternate gear handle located outboard of the left auxiliary console. Once depleted, pneumatic pressure cannot be restored but the reset button allows retracting the gear after an alternate extension if system B hydraulic power becomes available again.

The main landing gear handle is the primary control to extend and retract the gear. A red warning light is located in the lollipop and comes on whenever the gear and doors are in transit or when the landing gear has failed (open or closed). The lollipop warning light also comes on when the TO/LDG CONFIG warning light (right eyebrow) comes on. The conditions are airspeed less than 190 knots, rate of descent greater than 250 ft/min, altitude less than 10000 feet and any gear leg is not down and locked. The gear operating limit speed is 305 knots. All gear legs must be retracted before reaching that speed to prevent gear damage or failure in flight.

On the ground the gear is locked in place mechanically and cannot be retracted (unless using the DN LOCK REL button prior to raising the handle but that is not implemented in BMS).
A switch is activated when there is weight on wheels (WOW) that activates or deactivates aircraft systems depending on if the aircraft is on the ground or in flight.

1.13.1. Nose Wheel Steering

The nose wheel can be steered on the ground when the NWS system is active. Nose wheel steering is powered by hydraulic system B and as such is not available after an alternate gear extension.
The NWS A/R MSL STEP button on the stick toggles NWS on and off when there is WOW. A green NWS light illuminates on the right indexer when the NWS is engaged. Nose wheel steering is automatically disengaged when the nose landing gear strut is extended but the NWS should be manually disengaged above 70 knots to avoid uncontrolled nose wheel rotation on the take-off and landing roll. Failure of the NWS is indicated by the NWS FAIL caution light.

1.13.2. Wheel brakes

BMS features two types of wheel brakes for users with or without rudder equipped toe brakes.
Users without toe brakes (or using no rudder at all) have a wheel brake implemented by a keystroke that brakes both main landing gear wheels at the same time.
Users using rudders with toe brakes can program differential brakes as axes in the UI controller setup. In this case each main landing gear wheel can brake separately, allowing steering on the ground.
Brake hydraulic power is supplied by system B. There is no emergency brake implemented in BMS. In the real jet the JFS accumulator is able to power the brakes in case of a dead stick landing. To overcome the issue BMS toebrakes remain active even when the aircraft is running on EPU.

BMS features accurate brake energy limits based on gross weight, temperature, pressure altitude and speed. Brakes generate a great deal of heat when used and uncontrolled heat build-up can lead to brake melting, tyre blow-outs, brake hydraulic pressure failure and even landing gear failure. As a consequence it is important in BMS to use the wheel brakes correctly.

Brake heat builds up not only on rejected takeoff and landing but also when taxiing. An F-16 with a low gross weight can start moving and even accelerating in idle power and brakes will be required to control taxi speed. Heavy use of the brakes when taxiing will increase brake heat energy build up.
A higher gross-weight F-16 will not move on idle power, thus requiring less braking to control taxi speed.
For comparison a 20000 lbs GW F-16 taxied at 10 knots over 20000 feet will develop around 4.3 million ft-lbs energy needing to be absorbed by the brakes. The yellow caution zone in the graph below starts at 11.5 million ft-lbs energy. If a rejected takeoff follows a heavy braking taxi, brake problems are likely to happen.

It takes about 5 to 9 minutes for the brake energy to build up after braking; that is when problems may occur. To avoid problems real life taxi procedures should be followed:

- Maximum taxi speed: 25 knots & 10 knots in turns
- Do not ride the brakes, allow speed to increase to 25 knots and then slow down moderately to 15 knots, allowing the speed to increase again to 25 knots
- Taxi speed is displayed in the INS UFC (LIST 6) subpage

The way the brakes are used during the landing roll greatly impacts the possibility of brake failure. It is best to hit the brakes hard for a shorter time than to brake early but longer as your speed will be higher and the brake will generate more heat energy doing so.
Use aerodynamic braking till the nose gear drop down around 90 - 100 knots and then use the brakes at around 90-80 knots until you reach taxi speed or come to a full stop.
Do not start braking around 110-120 knots; the heat build-up will be much higher.

Refer to chapter 3.5.5 Hot brakes for further information about hot brakes.

1.13.3. Parking Brake & Chocks

To overcome the correct behaviour of the AFM (Advanced Flight Model) of the BMS F-16 the virtual pilot will need to use the chocks at ramp start and shut down and the parking brake if a full stop is required on the taxiway or at EOR (End of Runway) checks for instance.

The parking brake is activated with the PARKING BRAKE switch on the Gear panel. The anti-skid system is not implemented in BMS. The parking brake is a magnetic switch held automatically in position as long as the throttle is not pushed further than one inch past the idle point (in BMS that translates to 83-85% RPM). Once the parking brake is no longer able to hold against the engine RPM the switch is released and the parking brake deactivated. The parking brake is powered by the battery bus and system B hydraulics.

The chocks are on by default at ramp start and they need to be removed prior to taxi. Normally this is done with the crew chief but we don’t have them in BMS so the request is done through the ATC Tower menu. Bear in mind that you need to have a correct tower frequency set on your radio. Likewise at shut down chocks can be requested to be placed through the same ATC Tower menu. Although the chocks will prevent the aircraft moving during ramp start it is possible to jump them if a high enough power setting (over 85%) is used. Be careful then during SEC and EPU checks which require higher power settings. Always back up the chocks with toe brakes. You cannot backup these checks with the parking brake as it would be deactivated with such high power settings.

1.13.4. Speed Brake system

The speed brake system consists of two pairs of clamshell surfaces located on either side of the engine nozzle, inboard of the horizontal tail and is powered by hydraulic system A.
The speed brakes open to 60 degrees with the gear not down and locked. With gear down and locked speed brake opening is limited to 43 degrees to prevent the lower surfaces from striking the runway during landing. This limit can be overridden by holding the SPD BRK switch in the open (aft) position. When the NLG strut compresses on landing the speed brakes can be fully opened and remain fully open without holding the SPD BRK switch open.

The SPD BRK switch, located on the throttle, is a thumb activated three-position slide switch.
The open (aft) position is spring loaded to off (centre) and allows the speed brakes to be incrementally opened.
The closed (forward) position locks in place, allowing a single motion to close the speed brakes.

A three-position indicator is located left of the LG control panel.
Positions are:

- CLOSED
- 9 dots symbol: the speed brakes are not closed (thus open but it is not possible to say how open they are)
- Diagonal lines: the indicator is not receiving electrical power

1.14 AUTOPILOT OPERATION

The F-16 features an autopilot system interfaced through the two 3-position switches located at the bottom of the MISC panel.
The left one labelled ROLL is a standard 3-position switch, the right one labelled PITCH is the master autopilot switch. It is a magnetic switch held in place in the up and down positions. It snaps back to the centre position when the A/P is disengaged. The left switch is operative only when the right switch is placed out of OFF.

The autopilot provides the following modes:

- ROLL Attitude hold
- Heading select (HDG SEL on ROLL switch)
- Steering select (STRG SEL on ROLL switch)
- Altitude hold (ALT HOLD on PITCH switch)
- PITCH Attitude hold

There are two more important switches relevant to the autopilot system. The TRIM A/P DISC switch on the MANUAL TRIM panel disengages the autopilot and the paddle switch on the sidestick overrides the autopilot while depressed.

1.14.1. Altitude Hold

Placing the right PITCH switch to ALT HOLD commands the aircraft to maintain a constant altitude. The reference altitude is the altitude the aircraft was at when the A/P switch was engaged +/- 100 ft. Vertical velocity above +2000 ft/min or below -2000 ft/min may prevent the correct altitude capture. The FLCS limits the pitch command from 0.5 to 2.0G when PITCH ALT HOLD is engaged.
The AOA also plays an important role in altitude capture. It remains accurate only below 5° AOA.

Stick steering & Autopilot override

If the pilot moves the stick while the A/P is engaged the aircraft will respond to pilot input, although the stick will feel slower than usual. Upon releasing the stick the autopilot will resume its previous settings. For example if you were flying 15000 feet with ALT HOLD engaged and pulled the stick back climbing slowly to 20000 feet, when you released the stick the aircraft would descend back to 15000 feet.
If you want the aircraft to remain at 20000 feet in this example you would need to depress the paddle switch when leaving 15000 feet (overriding the A/P setting), climb slowly to 20000 feet and then release the paddle switch. Upon releasing the paddle the A/P will take this new actual altitude as the reference.

1.14.2. Attitude Hold (PITCH)

Placing the right PITCH switch to ATT HOLD mode commands the aircraft to maintain the current pitch attitude. Angles above or below 60° in pitch will not be captured.

As in altitude mode stick steering is available and the pitch can be changed with stick input but there is no need to hold in the paddle, the autopilot in ATT will capture a new pitch attitude whenever the stick is moved.

1.14.3. Heading Select (ROLL)

Placing the left ROLL switch to HDG SEL will turn the aircraft towards the heading selected in the HSI through the heading bug. The heading bug is visible on the picture as white captain's bars on the HSI compass rose. It is set to 360° in the picture. You can rotate the heading bug by using the HDG knob at the bottom left of the instrument. Two key callbacks are useable: increment by 1° or by 5° if you use the keyboard, joystick programming or even encoders. It can also be done with the mouse wheel for rapid increment (this mouse behaviour is valid for all cockpit knobs (encoders)).

In this mode the FLCS limits bank angle to 45°. Stick steering remains possible but the A/P will resume following the HSI heading bug as soon as the stick is released. The paddle switch has no effect in this mode as the paddle switch cannot change the HSI heading bug and this is the sole signal that is valid for Heading Select mode.

1.14.4. Attitude Hold (ROLL)

Placing the left ROLL switch to ATT HOLD commands the aircraft to maintain the current roll attitude. Angles above or below 60° in roll will not be captured. Stick steering and paddle override remains available with the known restriction of each mode.

1.14.5. Steering Select (ROLL)

Placing the left ROLL switch to STRG SEL commands the aircraft to fly to the current steerpoint of interest. As in Heading Select mode the bank angle will be limited to 45°. If AUTO steerpoint is selected in the UFC the A/P will steer to the next waypoint when reaching the vicinity of the current steerpoint (it follows the steerpoint of interest which in AUTO is automatically switched to the next waypoint). If MANUAL is set the A/P will circle the steerpoint at a 30° bank angle. Stick steering remains useable but paddle override has no effect since the paddle is not able to change the steerpoint of interest.

1.14.6. Autopilot limits

In all modes the autopilot will refuse to engage or will automatically disengage if one of the following conditions is met:

- Gear is down
- AR door is open
- ALT Flaps switch is in EXTEND
- AOA greater than 15°
- DBU is engaged
- MPO switch is held in OVRD
- A/P failure or FLCS failure PFL message (thus STANDBY gains will be active as well)
- TRIM A/P DISC switch is placed in DISC
- Stall Horn is active

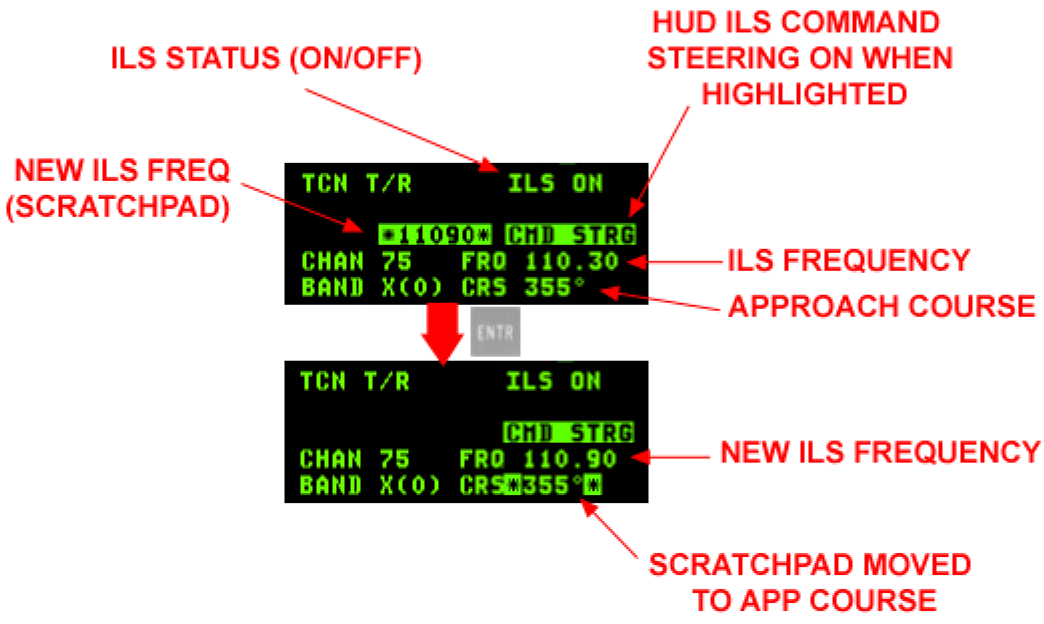
The Autopilot has a final mode beside the ones set by the roll and pitch switches: the TFR.
See the MFD chapter for further information about the TFR.

1.15 INSTRUMENT LANDING SYSTEM

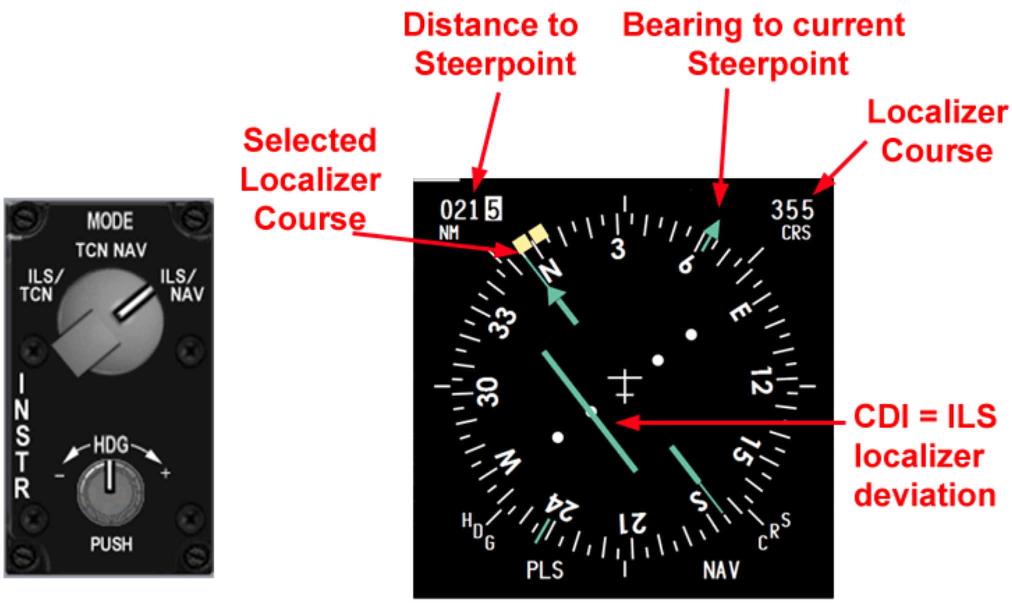
The ILS is used to perform precision instrument approaches using azimuth (localizer) and vertical (glideslope) approach cues in the cockpit independent of any airport precision radar. The system operates on VHF frequencies of 108.10 to 119.95 MHz. The ILS is turned on and off using the ILS volume control knob on the AUDIO 2 Panel on the left console. If the ILS system is left switched off ILS cues are not displayed on any flight instrument, as the receivers are offline.

The system is controlled via the T-ILS DED page, which is accessed with the T-ILS button on the ICP. Command steering (CMD STRG) behaves like a flight director and is automatically mode-selected on FCC/MMC power up, but may be deselected/selected by positioning the asterisks around CMD STRG and pressing the M-SEL 0 button.

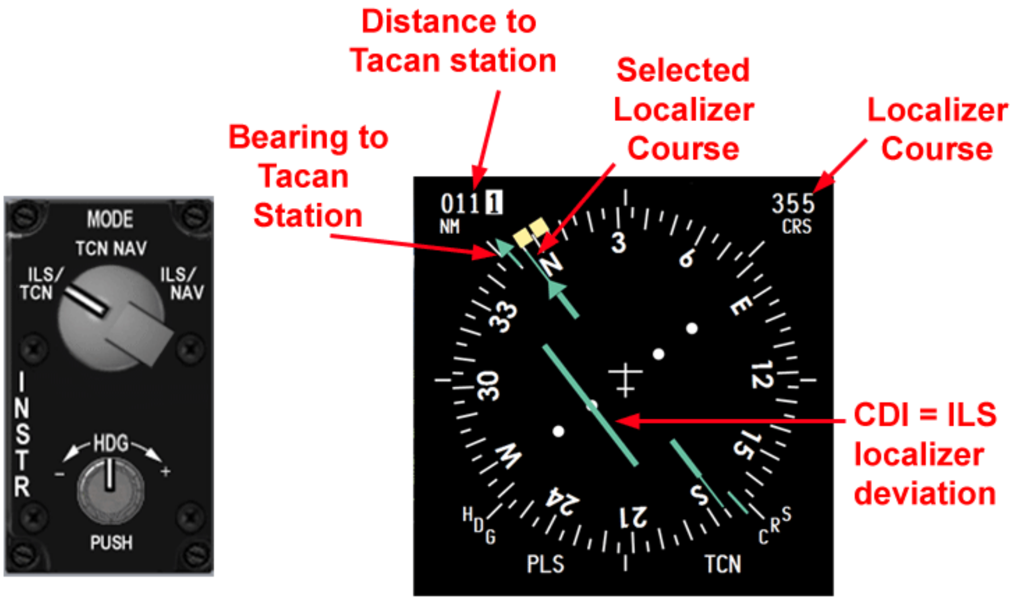
The pilot tunes the ILS by entering the desired four or five digit ILS frequency in the scratchpad and pressing ENTR. The system recognises that an ILS frequency has been entered and the asterisks step to the Course (CRS) field. The pilot then keys in the course (runway heading) with the ICP keys and presses ENTR.



ILS cueing is presented on the HUD (localizer, glideslope, command steering cue), ADI (localizer & glideslope) and the HSI (localizer only). The deviation of each ILS bar is marked with 2 dots on each side of the deviation. One dot corresponds to a deviation of 2.5°. The ILS cues are therefore able to give accurate position within 5° each side of its centreline.



When the INSTR MODE selector is positioned to ILS/NAV, ILS cues are displayed on the HUD/ADI and selected STPT distance and bearing information is shown on the HSI. The HSI CDI does show ILS localizer deviation.

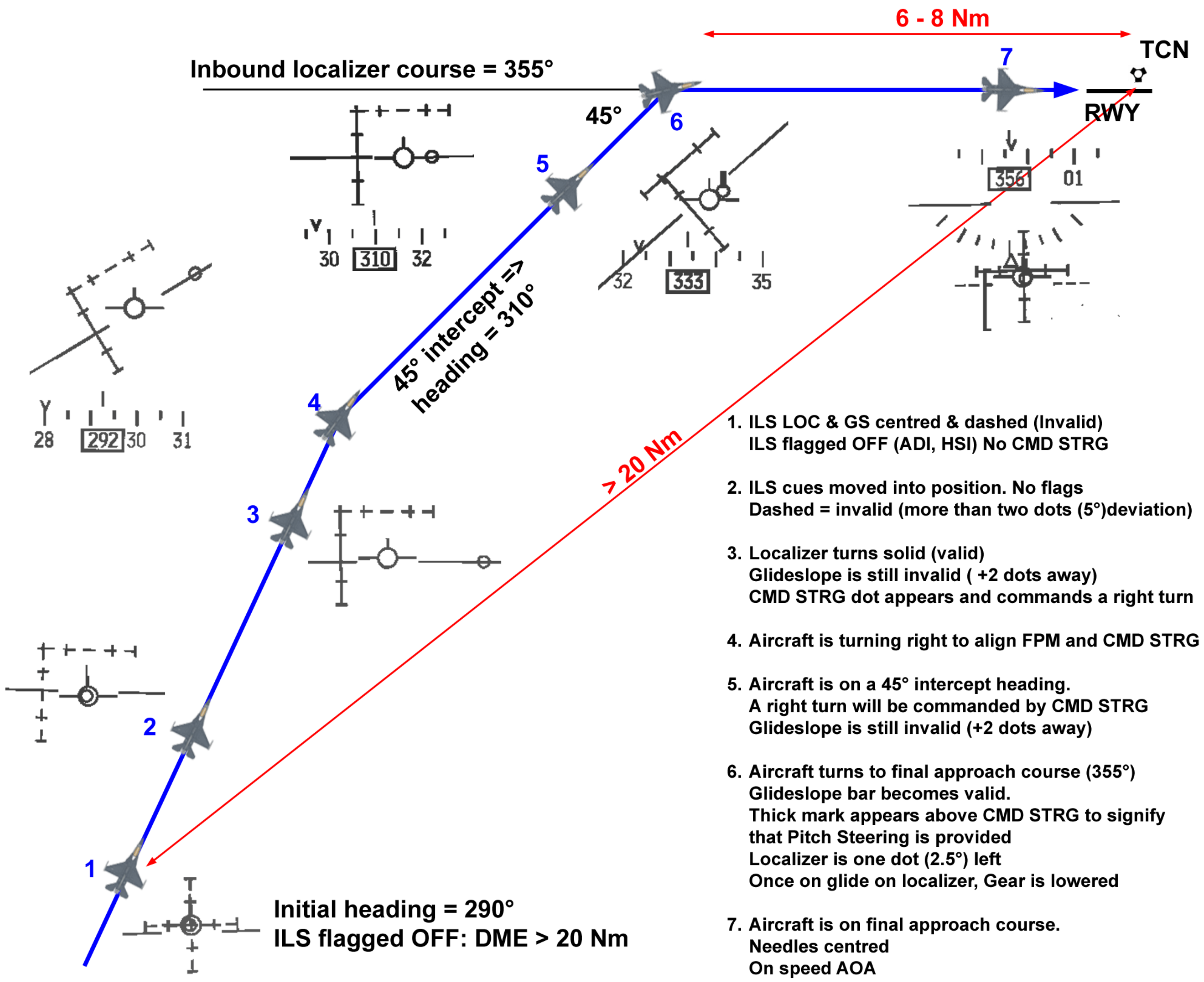


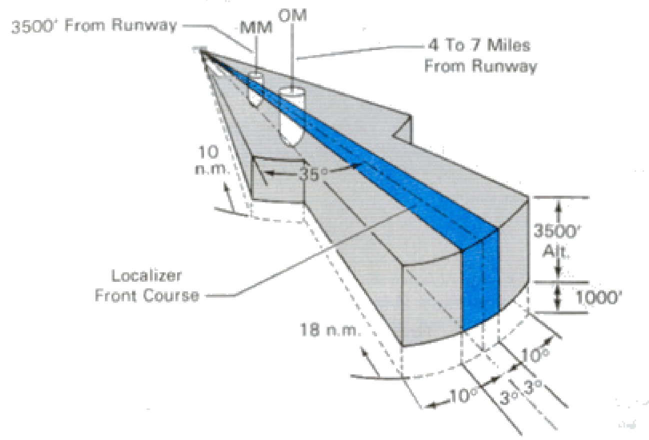
When the INSTR MODE selector is positioned to ILS/TCN, ILS cues are displayed on the HUD/ADI and TACAN distance and bearing information are shown on the HSI. The CDI always shows localizer deviation.

Noting the above difference you will realise that the DME never actually refers to the ILS. It refers to the selected steerpoint or the selected TACAN, neither of which may be at the same location as the ILS antenna. ILS approaches in BMS are therefore all ILS DME approaches.

It is important to note that ILS localizer raw data is displayed on the HUD the ADI and on the HSI, but the glideslope is displayed only on the HUD and the ADI. Command steering cueing (when selected) is only displayed on the HUD. The command steering cue is a circle similar to the great circle steering cue (tadpole), but it has no tail. When the glideslope is intercepted, a short tail appears on the command steering cue and the cue moves up and down to indicate corrections required to intercept and maintain the glideslope. The pilot flies the FPM to the command steering cue to intercept and maintain the localizer course and the glideslope for an ILS approach.

The following picture shows a typical sight picture the pilot sees when flying an ILS approach:



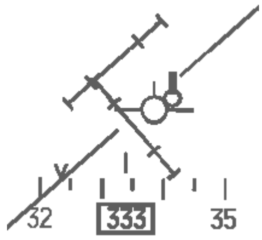


The coverage zone for the localizer mirrors the USAF instrument manual description (AFMAN 11-217 VOL 1). There's a relatively narrow 18Nm radius pie wedge shaped coverage zone centred on the extended runway centreline. There is a second fatter pie wedge of radius 10Nm similarly centred. Middle and inner markers are also positioned at specific distances from the runway threshold, unless their placement is not possible for topographic reasons (approach track over water for instance as it is the case for both Kunsan runways).

ATC vectoring procedures in real life are designed to get you roughly in the neighbourhood of the localizer at or around 2000' AGL (given roughly flat terrain in the vicinity of the base). From there you are vectored into the coverage zones as appropriate. Now, if you have the CMD STRG mode-selected in the DED page when you cross into the coverage zone, a CMD STRG cue pops up. This is a plain small circle that is tied to the HUD horizon line. It moves back and forth across that line to guide you to a 45 degree intercept of the extended runway centreline that the localizer transmits along.

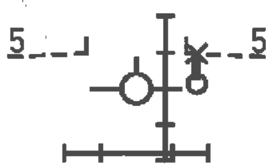
The cue is fixed to the horizon line because the idea is that you fly level at 2000' to intercept the localizer first and then the glideslope (GS) from below, usually around 6-7 Nm from the runway threshold. The GS cues will remain invalid till you are close enough to its centre (5° = 2 dots). As long as that is the case the command steering cue will not display the top thick mark and the GS bar will most likely stay dashed (HUD) on top of the instrument (ADI).

So you are flying along on the 45° intercept heading and start to get within 5 degrees (=2 dots) of the localizer centreline. At this point the localizer deviation bar (HUD, ADI and HSI) should start to come alive and the CMD STRG cue will start to swing you onto the approach course.



As you continue inbound you'll get to within 2-3 degrees of the glide slope. When you do, the GS deviation bar will start to descend. Depending on exactly where you are in the approach course, around this time or shortly thereafter you will be close enough to the GS centreline to get pitch steering. The CMD STRG cue will unglue from the horizon line and will grow a fat 'tick' on top of it (the tick mark means that pitch steering cues are provided).

The main thing now is to let the GS descend to the centre. When the glide slope is centred, you are declared on glide on loc and it's usually at the moment you overfly the outer marker. It's time to lower the gear. That will provide a slight pitch down movement that will be just enough to lower the FPM to the -2.5° dashed line and keep the glide slope centred. Maintain the CMD STRG aligned with the FPM, the cross perfectly centred and lower your airspeed to on speed AOA using the AOA bracket.



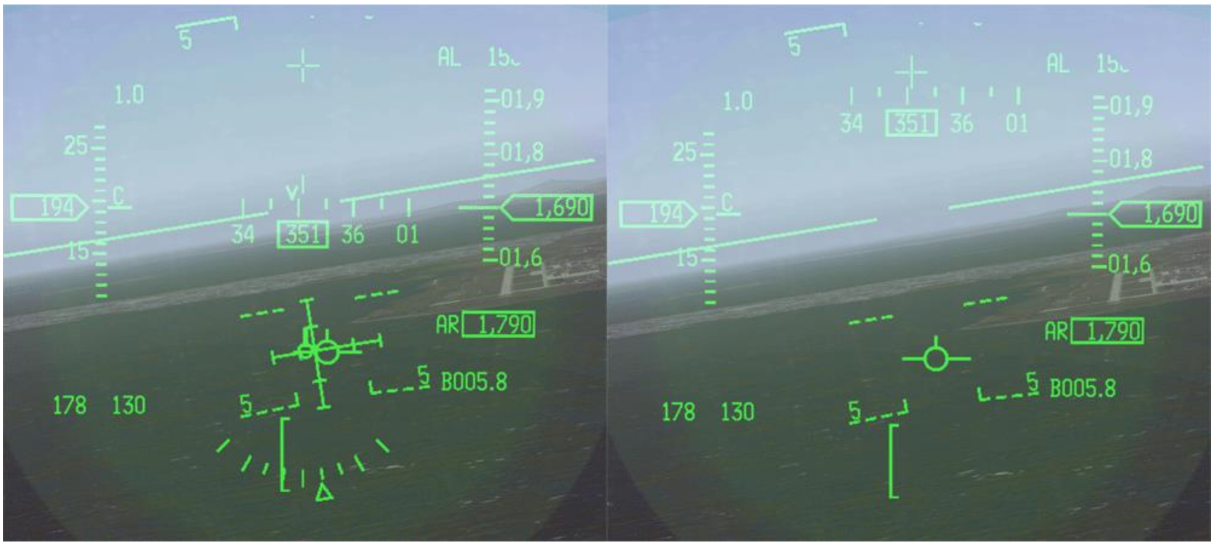
One other thing about the CMD STRG cue: if you start to drift above the GS centreline after you have intercepted it and drift to the point that you risk losing pitch steering the fat tick will have an "X" superimposed over it. This is your cue to pull back on power and/or drop the nose as appropriate.

The CRS setting can be set to the runway approach course in the T-ILS page. Normally the CRS setting must be correctly aligned for the CMD STRG cues to work correctly, but that is not yet valid in BMS. The CRS setting in the DED is totally separate from the one on the HSI. There is no relationship whatsoever in the avionics suite (it's not the case when the aircraft is equipped with the EHSI). It is advised to set both according to runway approach course, but apart from the risk of confusion when they are not set correctly it has no consequences in BMS.

With the HUD in ILS mode a V is placed on the HUD heading tape according to current winds. This cue gives you the wind corrected heading you need to steer to maintain the desired approach course.

So if you have the CMD STRG cue under the FPM and the V centred on the heading tape, your nose should be crabbed into the wind just the right amount to maintain ground track along the approach course centreline to the runway.

With the gear down and the ILS HUD up there is a declutter option that removes some of the symbology on the HUD to give you a cleaner look at your aim point on the runway. That is done with the UNCAGE button on the HOTAS throttle. If in the conditions mentioned above you press this button the ILS bars and a few other pieces declutter so you can see the FPM and the AOA staple and the runway a little more clearly. The declutter cancels with WOW, a mode change, or cycling the gear if you don't proactively toggle the declutter off again yourself. The picture below illustrates the decluttered HUD on the right.



The last thing you'll recognise, which isn't directly related to ILS but is with landing, is how various symbology in the HUD now move in coordination with the FPM. This movement was noticed during review of many HUD videos. The heading, speed, and altitude tapes, G meter, ALOW setting and radar altimeter altitude all move up and down in the HUD based on the FPM. Some symbology can fall completely off the HUD, but the airspeed and altitude boxes will always remain visible. Our logical guess is that this allows consistency in the distance between the FPM and the altitude/airspeed boxes and also serves as a visual cue of low airspeed/high angle of attack during an approach or in the pattern.

For specific ILS training please refer to training missions #4 & #6 and the relevant BMS-training document located in your *Docs* folder.

1.16. IDENTIFICATION FRIEND or FOE (IFF)

IFF or Identification, friend or foe is an identification system designed to identify aircraft as friendly.

IFF is based on an interrogator sending radio queries and a transponder replying to queries.
Currently in BMS IFF interrogation is mostly used by human, ATC and AWACS do not interrogate.
AI fighters may interrogate during BVR intercepts. All AI though respond to IFF interrogation with their transponders.

It is important to realize that despite the name, IFF can only positively identify friendly targets, not hostile ones!
If an IFF interrogation receives no reply or an invalid reply, the object cannot be identified as friendly, but is not positively identified as foe. It will therefore remain a bogey. There are in addition many reasons that friendly aircraft may not properly reply to IFF. For these reasons, do not consider IFF like the ultimate solution to prevent fratricide kills but rather another tool to help prevent such occurrences.

1.16.1 IFF modes

IFF in BMS features 5 modes and their relevant codes or cryptographic key: Modes 1, 2, 3, 4, and C**.**
Mode S can be turned on/off, but there is no support to simulate mode S reply or address entry; therefore Mode S is considered not implemented.

IFF modes available are specific to aircraft. Not all aircraft in BMS are mode 4 or mode C capable.

- **Mode 1**: military mode, non-crypto. Response is a code in a range of 32 codes between 00 and 73. The reason it is only 32 codes is that the first digit is never above 7, the second never above 3. Example: 41 and 22 are valid Mode 1 codes, 44 and 81 are not.

- **Mode 2:** military mode, non-crypto. Response is a code in a range of 4096 between 0000 and 7777. Similarly, the digits are never above 7. So 4484 is not a valid code, 4625 is.

- **Mode 3/A:** military and civilian mode, non-crypto. Most if not all aircraft must be equipped with a transponder Mode 3/A for ATC purposes in the real world. Response is again a code between 0000 and 7777.

- **Mode C:** civilian mode, non-crypto. Reports the pressure altitude of the transponder aircraft.

- **Mode 4**: military mode, crypto. The closest thing to a true « Identification Friend or Foe ». The interrogation is actually a sequence of rapid challenges, encrypted using a specific key and the transponder must reply correctly to those challenges using the same key.

- **Mode 5** is an updated version of Mode 4, not implemented.

- **Mode S** is an updated civilian transponder. Only implemented as eye-candy.

IFF in BMS can be complicated, as it closely models the real system, but in a typical usage scenario it can be as simple to use as switching the IFF Master Knob to STBY at ramp and then toggling it to NORM just before take-off. The rest (for the Transponder at least) is largely taken care of by the DTC.

It is important to understand the details though in case complicated IFF scenarios are designed for TEs or campaign missions.

Read on…

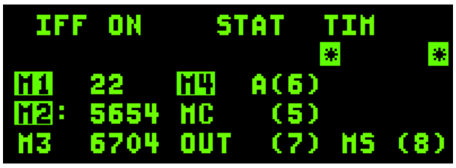
1.16.2 Cockpit controls

The F-16 block 50 & 52 in BMS 4.34 have been updated with an AIFF system and the AUX COMM panel has been replaced with the IFF panel. Note: TACAN management in backup mode, previously done on the AUX COMM panel, is now input via an MFD page accessible from the MFD menu.

The IFF MASTER switch turns on the IFF and changes its mode of operation (OFF, STBY, LOW, NORM, EMER)

With the C&I switch in C&I all IFF settings are changed through the UFC (Up Front Controller) pages.

The IFF Transponder is managed via the IFF override button, giving access to the STAT, POS and TIM pages (left DED image) and the IFF Interrogator is managed via the LIST – RCL (INTG) buttons, giving access to the interrogator SCAN and LOS pages (right DED image).



It is important to understand the difference between the IFF Transponder and the IFF Interrogator parts of the IFF system. All aircraft have transponders but not all have interrogator capabilities.

Backup control of the IFF is only done on the IFF panel when the C&I switch is in the BACKUP position.

1.16.3 IFF DTC Brief

Each mission (TE or campaign) displays an extensive IFF brief. All the parameters from that brief are automatically saved to the DTC. When the DTC is loaded, IFF parameters are copied to the relevant systems in the aircraft.
Consider two different flight briefings from the same campaign between 0900 & 1000 (Falcon Time). These aircraft are flying at the same time with take-off times before 1000 FT. It's important to compare the brief to understand the IFF policy of the campaign. Be aware that this is just an example; it might be different in a TE scenario. The important point here is to always study the brief prior to go flying.

Panther 2 flight:

IFF

GENERAL:

Initial STAT Settings: Modes Active: M124 Codes: M1: 61 M2: 7404 M3: 7354
M4 Validity Time (Until): Key A: Day2 00:00 Key B: Day3 00:00
IFF Policy: M1: per team M2: per aircraft M3: per aircraft
Code Change Setting: TIM

TIME EVENTS:

Rot/day:		10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
M1:	24	72	22	51	63	30	13	03	60	20	10	51	01
M3:	24	1004	3704	6154	4330	5504	0630	6354	0354	6554	7254	5004	3030
M4:	1	A	A	A	A	A	A	A	A	A	A	A	A

POS EVENTS:

Ingress: M124 / ----- Egress: M124 / -----

Mudhen1 flight:

IFF

GENERAL:

Initial STAT Settings: Modes Active: M124 Codes: M1: 61 M2: 3434 M3: 4610

M4 Validity Time (Until): Key A: Day2 00:00 Key B: Day3 00:00

IFF Policy: M1: per team M2: per aircraft M3: per aircraft

Code Change Setting: TIM

TIME EVENTS:

Rot/day:		10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00
M1:	24	72	22	51	63	30	13	03	60	20	10	51	01
M3:	24	2634	6110	6310	6460	6260	3510	2210	4260	5634	3134	1234	4134
M4:	1	A	A	A	A	A	A	A	A	A	A	A	A

POS EVENTS:

Ingress: M124 / ----- Egress: M124 / -----

The general section states which modes will be active upon DTC loading, i.e.: Modes 1, 2 and 4. The relevant codes are given. Please note that for Panther and Mudhen flights, their Mode 1 codes are the same, their Mode 2 and Mode 3 codes are different and their Mode 4 keys toggle at the same time.

The IFF Policy is quite important to read if you want to understand what you get as answers when you interrogate other flights in the campaign.

- **M1** is assigned to a team. All the allies share the same code, which is changed every hour as stated in the TIME events.
- **M2** is specific to each aircraft. All aircraft have a different M2 code, which does not change. Panther2 has M2 code 7404 and Mudhen1 has M2 code 3434, so if Mudhen interrogates Panther with its default M2 interrogator setting Panther will not reply positively and will be categorised as bogey.
- **M3** is specific to each aircraft as well but (unlike M2) rotates every hour. Panther2 has M3 code 7354 and Mudhen1 has M2 code 4610 until 1000 FT when the codes will switch to 1004 & 2634 respectively.
- **M4** is always assigned per team and the encryption key rotates every 24 hours.

TIME events, as explained above, detail the moment the code changes. POS (Position) events show any changes specific to ingress or egress, but in this case both are the same with Modes 1, 2 and 4 active throughout the flight.

IFF

GENERAL:

Initial STAT Settings: Modes: M124 M1: 20 M2: 4260 M3: 2710

M4 Validity Time: Key A: 12:00:00 Key B: 00:00:00

IFF Policy: M1: per package M2: per aircraft M3: per aircraft

Code Change Setting: P/T

TIME EVENTS:

Rot/day:		06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
M1:	24	22	10	11	72	02	61	11	22	71	43	03	72
M3:	24	6610	7110	0660	5560	5534	2634	4310	3610	2510	2060	6310	1734
M4:	2	A	A	A	A	A	A	B	B	B	B	B	B

POS EVENTS:

Ingress: M4 / NOF4 Egress: M124 / SOF9

The above picture comes from another campaign flight brief, not related to our first example. Notice how it is different in policy. In the briefing above you see active criteria for time changing each hour for M1 & M3, the M4 key changing at 1200 FT and two position changes (North of STPT 4 for Mode 4 and South of STPT 9 for Modes 1/2/4); thus active modes should be different during ingress and egress.

Luckily you do not have to manually input all these settings in the jet; your DTC is pre-programmed with all the briefed settings. Therefore if you do not change any IFF settings manually, the time and position criteria will be defined as per the brief and the IFF settings will change accordingly. All you have to do is turn the IFF MASTER knob to STBY at ramp and turn it to NORM upon taking off.

Nevertheless studying the IFF brief may help to prevent fratricide.

As you saw in the Panther/Mudhen example above you will never get a friendly answer in Mode 2, unless you specifically change your M2 interrogator code. A pilot who missed that information and interrogates in Mode 2 only might think that the bogey he is interrogating is a bandit.

This particular “per aircraft” policy could be useful when you want to find a specific aircraft (like a tanker for instance). All you need to do is go to his briefing page, note the aircraft specific M2 or M3 code and the possible rotation of codes (more for M3). When you want to find it, you change the M2 code in your interrogation page to his specific code and you interrogate in M2. The only friendly answer will be the aircraft you are looking for.

The question of course is how to get into that tanker briefing. Since he’s probably not in your package and originating from another airbase scenario, your only way to get that code is to read the tanker briefing. This can be done either by finding the aircraft icon on the planning map and joining that flight, or by opening up the ATO, finding the fragged tanker flight in the support flights and opening his briefing to note down the aircraft specific IFF codes. If you do that, make sure you record your own squadron, package number and flight callsign, because you will have to find your flight in the ATO after having joined the tanker flight to read its brief.

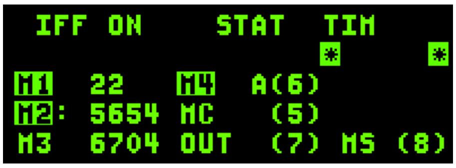
1.16.4 How to use the IFF in flight

Once the IFF system has been properly set up through the DTC (DTE load) and the system is activated (IFF MASTER Knob in NORM) the IFF will do two things in flight:

1. The transponder will answer queries from other aircraft.
2. The interrogator, when activated, will send queries to other aircraft and display the responses on both your FCR and HSD MFD pages.

<u>**1.16.4.1 Transponder**</u>

The transponder page is accessed with the IFF ICP button. This is the page where answers to IFF queries are managed.



The main page is the STATUS page and shows the modes currently active (highlighted) and their corresponding codes. Both should match the IFF policy in the briefing.

DCS right (SEQ) will change to the TIME and POSITION pages. These pages are preset via the DTC setting and will change the IFF transponder according to either the TIME or Position events stated in the briefing. Pilot can override these settings and create new criteria by using these pages.

Changing any of these settings manually may lead to incorrect responses from your IFF transponder when interrogated versus the briefed IFF policy. Therefore it should be changed with caution.

The IFF transponder is fairly transparent in use. Once set correctly (loading the DTC into the jet via the DTE page) the IFF transponder will be set up according to the briefed IFF policy and the need to deviate from that in flight should be very low.

Nevertheless to change modes in all IFF (transponder and interrogator) pages:

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

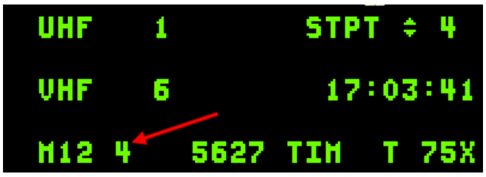
Codes can be changed as well:

- Mode 1 code can be changed by inputting a two digit valid code + ENTR in the scratchpad.
- Mode 2 code can be changed by inputting 2 then a 4 digit code + ENTR (a total of 5 digits).
- Inputting a code of 3 or 4 digits + ENTR changes the Mode 3 code.
- Mode 4 key can't be changed. You can only toggle between A and B keys by inputting ICP key 6 then ENTR
- Mode C is just a request for pressure altitude, so there is no correct answer to that interrogation.
- Mode S is not implemented.

By default pilots do not know when their jet is being interrogated by another IFF system. That information might be handy, especially when you are interrogated in Mode 4 and your jet isn't able to send the right answer. Indeed if your system didn't reply correctly to an interrogation, chances are that the contact who just interrogated you might consider you a bogey. There is a way to enable audio cues for that specific purpose.

On the IFF STAT page you can see the OUT (7) in the centre of the bottom line. Pressing ICP 7 then ENTR will toggle the IFF Mode 4 feedback between available options which are:

- **OUT**: no feedback at all (the default option).
- **LIT**: visual feedback when interrogated with the **4** symbol highlighted on the UFC CNI page whenever your jet is interrogated in Mode 4.
- **AUD**: an audio tone will be played in addition to the visual signal (LIT) if your jet is interrogated in Mode 4 and the interrogation key does not match your key.



LIT only provides a visual cue when interrogated, no matter the answer. AUD sounds the aural cue only when the jet is unable to answer the Mode 4 interrogation correctly. Setting it to AUD is therefore recommended, as you want to be warned when this happens.

1.16.4.2 Interrogator

Aircraft equipped with an interrogator have two modes of interrogation: SCAN and LOS (Line of Sight).
Each interrogation mode (SCAN or LOS) has its own DED page accessible by pressing LIST RCL. It defaults to the SCAN INTG (Interrogator) page; the LOS page can be accessed with a DCS right (SEQ). Both pages have the same format and are completely independent.

You may select different active modes and codes for both pages. These settings will be remembered, allowing pilots to have different schemes of interrogation for SCAN and LOS. We will come back later on to the INTG pages.

Please note, the transponder and interrogator are also independent from each other. Active modes may be different and set according to the IFF policy in the transponder page, but the pilot may elect to customise his interrogation sequence according to preference.

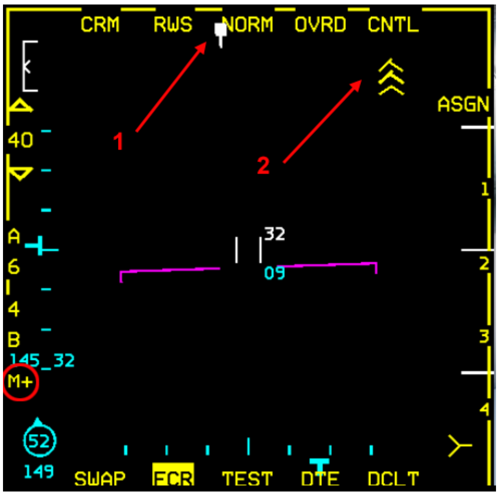
But first let's see how to initiate interrogation with a specific example:

IFF Interrogation is usually initiated on the FCR page.

OSB #16 offers the possibility to interrogate in specific single modes or all modes as set up in the Interrogation page.

Depressing OSB#16 will select either Mode 1 only, or Mode 2 only, or Mode 3 only, or Mode 4 only, or M+ (multi-mode) where all the active modes on either the SCAN or LOS (as applicable) interrogator UFC pages are interrogated.

In the FCR picture on the right, OSB #16 is set to M+. There is one radar contact 40 Nm dead ahead and jamming contacts on the right side. We will initiate IFF interrogation.



IFF interrogation is initiated with TMS left. There are two modes of interrogation:

- SCAN with a short TMS left (<1s).
- LOS with a long TMS left (>1s).

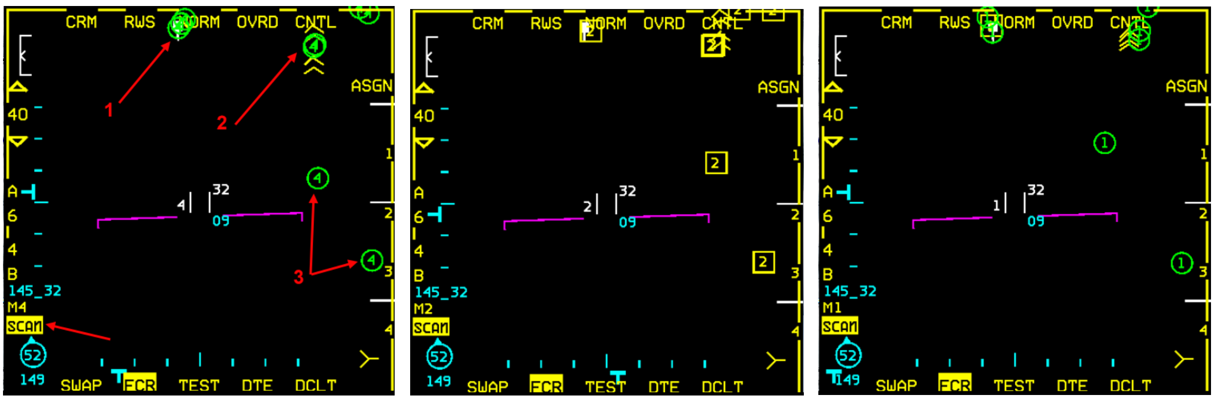
In SCAN mode the IFF scans a full cone 60° in elevation and 60° in azimuth.

With OSB #16 set to M+, the interrogation will be made with all the modes that are active in the SCAN INTG UFC page, in this case M1, M2 and M4. Mode 4 takes a bit longer than Mode 2 and Mode 1. The system first interrogates in Mode 4 and then works its way down to Mode 1.

- A green circle with the mode inside is a correct answer and therefore categorised as friendly.

- A yellow square with the mode inside is an incomplete answer and therefore categorised as unknown/bogey.

- During the interrogation the interrogation mode is displayed to the left of the acquisition cursor (captain's bars). M+ (OSB #16) is replaced by the actual mode the IFF is currently interrogating. The type of interrogation (SCAN in this case) is also displayed and highlighted below the mode mnemonic.



As you can see above, the SCAN reports responses from contacts even outside your radar scan area:

- The contact labelled **1** is in your radar scan and is reported friendly in Mode 4, bogey in Mode 2 and friendly in Mode 1.
- The contacts labelled as **2** are jamming and not detected by the radar (probably outside burn-through range), but provide the same replies.
- The contacts labelled as **3** are outside your radar scan area (probably below it) and give the correct Mode 4 response, the wrong Mode 2 reply and the correct Mode 1 answer.

One might wonder why these friendly aircraft are not answering the correct IFF mode 2 query. This is where the studying of the briefing and more specifically the IFF policy will come in helpful. The IFF policy stated that Mode 2 is aircraft dependant, so all aircraft in theatre have their own unique Mode 2 code.

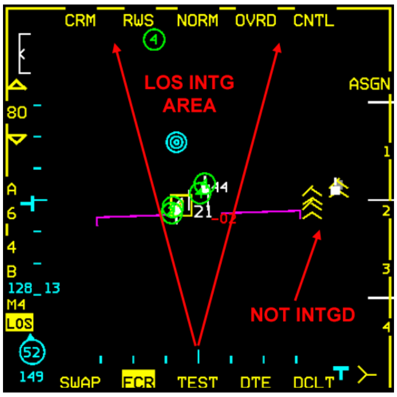
On the SCAN INTG page Mode 2 is set to our code (5654), so none of the interrogated aircraft are able to answer with a valid code since our aircraft is the only one using that code. Knowing this it is obvious why the Mode 2 queries can't categorise the aircraft friendly. Fortunately correct responses in Mode 1 and particularly the more secure Mode 4 allows the pilot to categorise them as friendly.

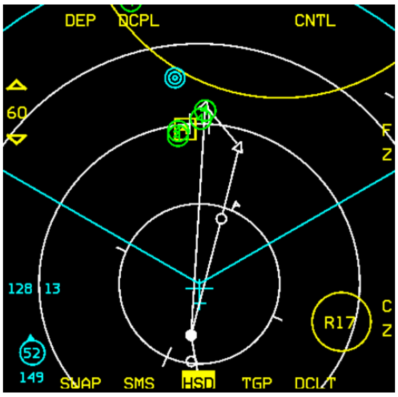
In LOS (Line of Sight) mode the IFF still scans the 60° elevation but restricts its scans in azimuth to 30° (approximately 15° either side) of the following reference:

- If there is a target track: the target area
- If there is no locked target:
  - the radar cursor in CRM.
  - the scan centre in ACM-SLEW.
  - the beam in ACM-BORE.
  - the aircraft nose line in any other case.

LOS interrogation is made according to the settings in the LOS INTG page, which may be different to the interrogation settings on the SCAN INTG page.

Response symbols and scan mechanisation are the same as in SCAN mode. Notice OSB #16 highlighting LOS mode while interrogating Mode 4.





As you can see above the jamming contacts are not interrogated this time because they are outside the interrogation cone roughly 15° either side of the ACQ cursor. On the other hand notice the friendly Mode 4 response at 80 Nm. This one is inside the interrogation cone and provides a valid response, since it's friendly.

The IFF response is also displayed on the HSD (provided AIFF symbols are enabled on the HSD CNTL page – they are on by default).That is illustrated here for LOS but it is the same in SCAN mode. IFF responses are always displayed on both the FCR and the HSD.

Mode 1, 2 & 3 interrogations more commonly provide invalid answers, illustrated by the yellow square. Only part of the code may be valid and the system therefore categorises the contact as unknown.

Mode 4 is more reliable as it is encrypted and team-based, with only two keys available. Partial responses are very rare; usually either the IFF responds correctly or it does not respond at all. This is an important consideration as you shouldn't expect a yellow square with a 4 inside. An enemy aircraft interrogated in Mode 4 will simply not answer at all and might be categorised by lack of symbol being displayed.

Yet as said in the introduction of this chapter, the lack of response isn't enough on its own to categorise a contact as a bandit. It might very well be a friendly, who for whatever reason is not able to answer Mode 4 queries. Reasons could include: battle damage, Mode 4 not active on the transponder STAT page, aircraft not equipped with Mode 4 transponder capabilities, etc.

Now that we mastered the IFF basics, let's induce the rotation of code or active modes based on TIME or POS events.

Remember that the IFF system is made of two parts: the transponder and the interrogator. The IFF policy loaded in your DTC mostly impacts your transponder. IFF policy may define both the active modes of the interrogator and the transponder, but if a code is set to change according to a TIME or POS event it will only change in the transponder side of the IFF. The interrogator side of the IFF changes are left to the pilot's discretion.

Pilots may elect to couple interrogator and transponder settings to avoid having to manually track any changes due to TIME or POS events.

On both INTG DED pages (SCAN and LOS) is a setting labelled DCPL (9) by default. DCPL stands for decoupled and signifies that the interrogator is decoupled from the transponder. That state can be changed to CPL (coupled) mode by pressing ICP key 9 then ENTR.

Available options are DCPL (decoupled), ALL (all are coupled) and SOME (some modes are coupled).

Entering ICP key 9 and ENTR sets the relevant interrogator mode (SCAN or LOS) to ALL by coupling all interrogation modes to the transponder modes.
All codes will then be highlighted and will display the same code as the transponder STAT page. Example right ALL interrogator codes are highlighted meaning they are all coupled with the transponder codes.

A further toggle of ICP key 9 and ENTR puts the relevant interrogator mode in DCPL again, where codes from the interrogator might be different than codes from the transponder. In that case, all codes will not be highlighted.

It is also possible to decouple one mode only. To do so couple them all first and then enter the code you want to decouple. Say you want to decouple Mode 1, which is currently set to 22 (same as the transponder), type 31 in the scratchpad and ENTR. The SCAN interrogator Mode 2 will then be set to 31. Doing so it is no longer coupled to the transponder M2 code (22) the code 31 un-highlights and the CPL/DCPL status changes to SOME. A colon appears next to M1 showing that this mode is decoupled.

The example above was made in the SCAN interrogator page but is equally valid on the LOS interrogator page. Both modes may be coupled or decoupled independently from one another.

IJAM (7) is IFF Jamming and is not implemented. It can be highlighted as eye-candy only.

1.16.5. IFF use in backup mode

Backup IFF operation is done with the switches on the IFF panel, when the C&I switch is in BACKUP.

It is possible to control Mode 1, 3, and S; the active modes are decided by the IFF ENABLE Switch position. It can toggle between: OFF (centre), M1 & M3 (down), and M3 & MS (up).
Remember, Mode S is only implemented as eye-candy.

With the switch out of the OFF position, the M1 code broadcasted is set with the two MODE 1 manual digits. The Mode 3 code first two digits are set with the MODE 3 digits on the IFF panel – the last two digits being 00. As an example, in the picture above, the backup Mode 1 code would be 10 and the backup Mode 3 code would be 6600.

Mode 2 and C operation is not possible in BACKUP. No reply will be transmitted to any interrogation in these modes in BACKUP.

Mode 4 operation is decided by the MODE 4 REPLY Switch, toggling between: OUT (no Mode 4 reply), A (reply with A key) and B (reply with B key). Please note it is up to you to know which key is supposed to be active according to the briefed switch time.

The MODE 4 MONITOR Switch defines the audio cue which sounds when the IFF is unable to answer a Mode 4 request. Please note for the audio cue to sound, this switch must be placed in AUDIO, even for normal operation with the C&I switch in UFC.

The M4 CODE Switch allows you to manage the secret keys for Mode 4. It is a 3-position switch labelled: ZERO, A/B and HOLD.

A/B is for normal operation of Mode 4, with the A and B keys.

ZERO when held for two seconds erases both keys from the aircraft memory (before ejecting the pilot should zero the IFF keys to avoid it falling into enemy hands but it's not critical in BMS). With no key available for Mode 4 the IFF caution light will be on and a relevant IFF PFD message will be displayed as well.

The HOLD position allows the key to be retained in memory even after a shut down.
Normally the key is automatically erased upon system shut down.

1.16.6 IFF in emergency

Emergency operation is done by turning the IFF MASTER Knob to EMERG. This automatically broadcasts emergency codes in all modes:

- 70 for Mode 1.
- 7777 for Mode 2.
- 7700 for Mode 3.
- Mode 4 uses the Backup M4 key code.

When placing the IFF in EMERG, the IFF STAT page is not manageable anymore and displays the emergency status.

1.16.7 IFF CAUTION Lights

The caution panel IFF light illuminates whenever there is a condition preventing IFF Mode 4 operation. This includes:

- IFF in STBY.
- Mode 4 disabled in UFC or on the BACKUP panel, depending on C&I switch position.
- Mode 4 keys zeroed.
- RF switch in SILENT or QUIET.

Additionally, if a Mode 4 interrogation was received on a different key than what the transponder is set to, the IFF caution light will illuminate for a few seconds. This is the second way to know if a wrong key interrogation has been received, along with the Audio monitor tone discussed in the STAT page section.

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SECTION II

NORMAL PROCEDURES

2.1. RAMP START in 3 SWEEPS

Ramp start in BMS can be overwhelming at first when transitioning from another version of Falcon. To begin you can follow the BMS checklists but you will quickly developing your own routine to start the jet. This chapter is presented to share such a routine with you.

BMS avionics are the most complete Falcon avionics around but a number of ramp start items are, at this stage, simply eye candy. Some users like to do them, yet these items are not mandatory for a fully mission capable jet.

For the sake of completeness this guide will include all of those optional steps. I will clearly identify them so they can be overlooked if you lack time, or do not wish to perform them.

Anyway let’s get back to work.

We separate the F-16 cockpit (see following page) into three main sections:

- Left console (left auxiliary + left console)
- Centre console
- Right console (right auxiliary + right console)

Mouse vs. Keystrokes

You can move cockpit switches with the relevant keystroke, or with the mouse. For keystrokes you will have to find the corresponding key for each switch state; with the mouse you will have to use left or right-click to move switches up or down and rotate knobs clockwise or counter-clockwise.

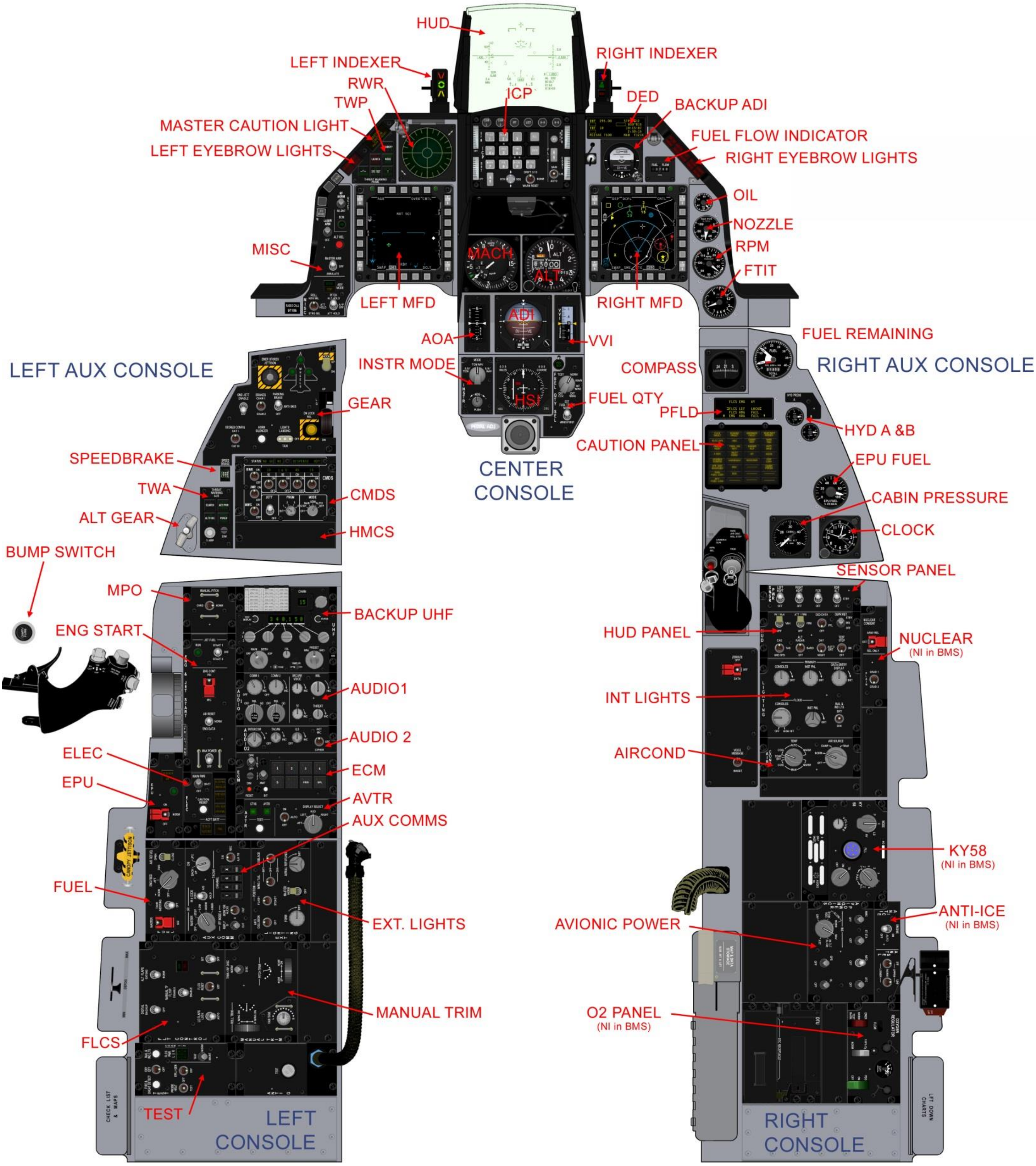
Starting the jet is done by making three consecutive sweeps from left to right beginning at the back end of the left console, moving to the centre console and around to the back end of the right console.

When you enter the pit for a ramp start your jet is cold, the canopy is open and all switches are set and ready for start-up.

1st Sweep: Before starting the engine

We start the first sweep which I call the before starting engine sweep.

Looking towards the back of the left console we start by setting the systems correctly so they begin working from the moment that power is received from the battery.



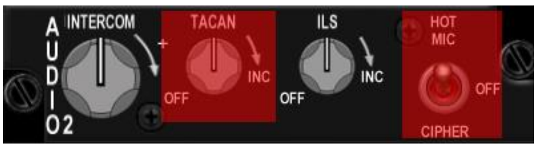
F-16 b50/52 cockpit layout and panels

1. On the EXT LIGHTS panel we set the MASTER light knob to NORM, ANTI-COLLISION to OFF, POSITION to STEADY and WING/TAIL & FUSELAGE switch to BRIGHT. Note that the WING/TAIL & FUSELAGE switches move together as they share a common callback in BMS. The FORM and AERIAL REFUELING knobs are not implemented in the current version of BMS.
Bear in mind that you won't immediately see the lights come on as the jet doesn't have power yet. The lights will only come on when the main generator comes online during engine start.

2. Moving forward we glance at the IFF panel to check that the C&I knob is in the BACKUP position. We move one step further forward and confirm that the MASTER fuel switch on the FUEL panel is positioned to MASTER and that the guard is down; these should be correctly preset at ramp. The ENG FEED knob though needs to be rotated to NORM. Failure to do so may cause fuel system malfunctions later in the flight, as the fuel pumps will be off and fuel transfer possible only by gravity.
The TANK INERTING switch is not implemented in BMS.

3. Battery power is enabled with the MAIN PWR switch to BATT on the ELEC panel. THE ELEC SYS caution light and the FLCS RLY, MAIN GEN and STBY GEN lights (ELEC panel) should come on with battery power enabled. We need to test the battery by moving down to the TEST panel and holding the FLCS PWR TEST switch out of NORM to TEST. Please note when doing this with the mouse you must keep the mouse button depressed on the hotspot. It simulates holding the switch or button in position. While doing that the FLCS PMG and the ACFT BATT TO FLCS lights illuminate and the FLCS RLY light goes out (ELEC panel). On the TEST panel the four FLCS PWR lights (ADBC) come on, indicating good power output to the FLCC. The MAIN GEN and STBY GEN lights (ELEC panel) remain illuminated during the test.
You can now release the FLCS PWR TEST switch (release the mouse button). The lights reset to their initial state. This check is eye candy and is not mandatory. Leave the MAIN PWR switch to BATT for we will start the engine shortly.

4. Let's set the comms so we're quickly ready to use the radio after engine start. Moving forward to the AUDIO 1 panel we rotate the COMM 1 (UHF) volume knob out of OFF to the fully-clockwise position and do the same for COMM 2 (VHF). Note that the first step out of the full counter-clockwise position actually represents the ON/OFF switch. Bear in mind that for the backup UHF panel to work the COMM 1 volume on the AUDIO 1 panel needs to be out of the OFF position.
The two mode knobs for COMM 1&2 should already be set to SQL and do not need to be moved for ramp start. They have no function anyway with the C&I switch in the BACKUP position. Set the MSL & THREAT volumes to fully clockwise. These two do not have ON/OFF switches at CCW position *but are very often forgotten which may cause problems later on.*
The ILS knob needs to be powered for the ILS system to work. The audio volume for ID is not implemented. It's just an ON/OFF feature for now. The INTERCOM volume is working as well and controls the level of all sounds normally heard in the pilot headset. So this one should always be set to full CW position (default).



5. Moving forward to the backup UHF panel the left function knob should be rotated from OFF to BOTH and the right mode knob set to MNL or PRESET or GRD depending on briefing. MNL configures the backup UHF panel to use the MANUAL frequency you can now set with the 5 smaller knobs. In PRESET the radio is tuned to the selected channel (#6 by default) and GRD sets the backup UHF to UHF guard (243.000). Please note that the F-16 only has a backup radio for UHF and not for VHF. The backup UHF radio only works when the C&I switch is in the BACKUP position. It is strongly advised to set the backup radio correctly as briefed such that your lead or any member of the flight is able to communicate if needed. Indeed before switching to C&I the backup UHF radio is your only means of communication.

In this case, the ground frequency (e.g. 273.52) might be entered in the manual frequency window by clicking the relevant knobs. Once set, communication with (Kunsan) ground will be available in Backup mode. Select the COM1 page of the UFC; it will display the following page: When the UFC will be powered the DED will tell you that the UHF is ON in Backup mode and 273.52 is selected in the MNL window and the active preset is channel 6.

6. Since there is nothing to set on the front panel during this sweep we move straight to the right console. If you need internal lighting you can set up the LIGHTING panel accordingly.
PRIMARY INST PANEL (backlighting) and DATA ENTRY DISPLAY (DED & PFD) and FLOOD CONSOLES (all cockpit floodlights) can be rotated fully clockwise. The highlighted knobs are not implemented. As the aircraft doesn't yet have power the lights won't come on when you move the switch but rather when the relevant buses receive power.

Note: a spotlight is also available for night ramp starts. This is available as soon as the MAIN PWR switch is moved to BATT, so for night ramp starts using the MAIN PWR switch key callback, followed by the spotlight callback will light up the cockpit, allowing you to continue your ramp start more easily

7. The final item in this sweep is to make sure that the AIR SOURCE knob is set to NORM. Failure to do so will lead to an EQUIP HOT caution light as soon as the systems are powered by the main generator, because they will not be cooled correctly.

2nd Sweep: Starting engine & systems

The second sweep is dedicated to starting the engine and getting all systems online. We start again on the left console.

1. On the ELEC panel move the MAIN PWR switch out of BATT to MAIN PWR. The lights do not change as the generators need the engine running to provide power to the buses. Please note one of the common mistakes is to start the jet in BATT which prevents the systems from coming online later as the main generator is not online and may induce engine start issues. So make sure you start this sweep with the MAIN PWR switch to MAIN PWR.

2. Moving forward you can close the canopy (spider). It is advisable to do so before engaging the JFS. Closing canopy during JFS operation may result in a failed JFS start or premature JFS shutdown due to a reduction in electrical power available to the JFS. Check your throttle for its correct position (cut-off) then move on to the ENG & JET START panel.
The JFS switch is moved to START2 with a right-click; the JFS RUN light comes ON after a few seconds and engine RPM increases steadily to 20%. At that point check that the SEC caution light is off and move the throttle forward to your IDLE detent (or click the idle detent) and monitor lights and engine gauges:

- SEC caution light goes off around 20% RPM (**before** moving the throttle).
- HYD/OIL PRESS light (right eyebrow) goes off between 30 and 35% RPM.
  If the light stays on and your oil pressure remains below 15 psi you have an oil pressure fault; shut down the engine immediately and refer to abnormal operations, chapter 3.5.4 later in this manual.
- During engine spool up, FTIT should increase to around 600-650° then decrease back to 500° at idle. FTIT should not go above 800°C. If you see FTIT rising at an alarming rate or go above 750°C you are encountering a hot start; immediately pull the throttle back to CUTOFF and let the FTIT decrease to 200°C while the JFS is running, before attempting another engine start. Refer to abnormal operations chapter 3.5.3 further in this manual.
- FLCS PMG light (ELEC panel) goes off around 40-45% RPM.
- JFS shuts off around 55% RPM (the switch automatically snaps back to OFF).
- ENGINE light (right eyebrow) and STBY GEN light (ELEC panel) go off around 60% RPM and MAIN GEN light (ELEC panel) goes off about ten seconds later.

With the engine running steadily you can check the engine gauges such as fuel flow (700-1700 PPH), oil pressure (> 15 PSI), nozzle position (> 94%), FTIT (usually below 650°C but never above 800°C) and HYD A & B pressure (at the 12 o'clock position).

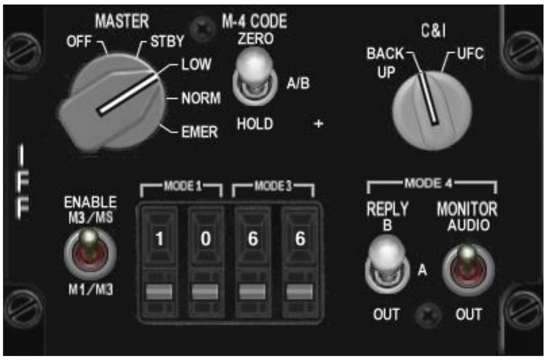
With MAIN GEN online all systems should get power and the systems you previously set should come online. You can now proceed to set the next ones.

3. Move straight to the AVIONICS POWER panel to quickly begin EGI alignment.
Power up the MMC, ST STA (SMS), MFD, UFC, DL switches. Note that the MFD & DED will need a few seconds to boot up after the UFC switch is powered. Once the DED comes online rotate the EGI knob from OFF to ALIGN NORM. Do not rotate the EGI knob before the switches or the alignment may fail. At this point, I usually sweep back from right to left instead of starting again on the left side.

4. So I move forward to the SNSR PWR panel and power the FCR and place RDR ALT in STBY. You can also power the left and right chin hardpoints if you have any (HTS, NVP, or TGP) pods fitted. There is no need to power them if you have nothing loaded on those stations. Failure to do so however can prevent any systems on pods from being powered in time as they may require a cool down before being operational, especially FLIR, which needs anything between 8 and 15 minutes to become operational. As you should check/ boresight it on the ground before take-off this needs to be a priority.

5. Moving to the centre console quickly check that the EGI has started aligning; look at the DED which defaults to the EGI page and check that the status of the EGI is increasing. You can also look at the flags on the ADI. The AUX yellow flag on the ADI should disappear 60 seconds into alignment.

6. Switch the HUD on with the ICP SYM thumbwheel (up). Click on F-ACK (left eyebrow) to review the PFLD and reset the MASTER CAUTION light so you are aware of the next time it comes on. Try to reset the MC light as soon as you acknowledge a fault so you don't miss the next one, but never reset it without knowing why it came on in the first place. Clear also the MFL (Maintenance Fault List) on the MFD TEST page via OSB #3.



7. Move to the left console and rotate the C&I switch on the IFF panel from BACKUP to UFC so you can start using the primary on-board systems. Place the IFF MASTER knob to STBY.
Your lead will soon initiate radio contact on a pre-briefed frequency and you had better be ready. With that done the Up Front Controller comes online and it is suggested that you set the radios through the UFC right away. But before doing so load the data cartridge into the system. The DTC contains all the information that was set in mission planning. In real life the pilots carry it with them and load into the DTC receptacle on the right console. In BMS we load the DTC by selecting the DTE page on the MFD and selecting the LOAD button (OSB #3). The reason we do this **before** setting the UFC radios is that since the DTC has a comms section the presets might be different than the ones pre-briefed. If you load the DTC after setting the UFC radios it will overwrite your changes and you might not be on the correct frequency anymore, although smart pilots configure their DTC with the briefed frequencies to avoid the problem altogether. For more information about the data cartridge refer to the Data Transfer Cartridge section in the BMS-Manual.

This item is often forgotten by fresh BMS pilots and can cause problems later on in the flight.

If you didn't set the comms plan in the DTC while in the UI push COM1 on the ICP and enter the pre briefed preset UHF frequency (usually the ground frequency). Push the COM2 button and enter the pre-briefed VHF frequency/preset (which is now important if you want to be able to communicate with your AI wingman (see the BMS Comms and Nav book for further information about the new BMS 4.34 radio plan). You are now ready for the initial radio contact.

That's the end of the second sweep. It's a little bit confusing toward the end but from this point the INS/EGI does its magic and you have some time to check systems, prepare the jet for the mission and set the rest of the avionics up.

3rd Sweep: The final sweep

1. The TEST panel is the first to be used in this sweep. Press and hold the FIRE & OHEAT DETECT button and check the:

- ENG FIRE warning light is on,
- OVERHEAT caution light is on,
- MASTER CAUTION light is on,
- All lights go off when the button is released.

Press and hold the MAL & IND LTS button and check correct operation of the Voice Message System (VMS) and that all lights are illuminated. If you don't hear any sounds check the INTERCOM knob.

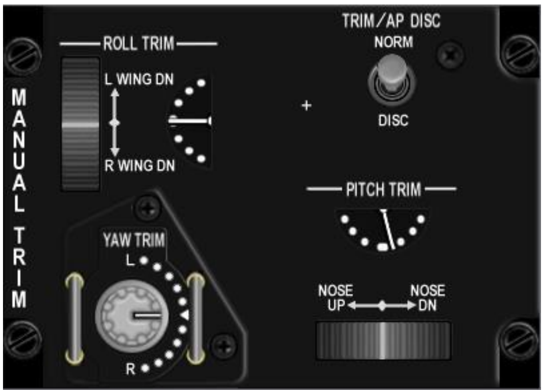
Flip the PROBE HEAT switch to the upper position and check that the MASTER CAUTION light remains off. Move the switch to the lower TEST position and check that PROBE HEAT flashes on the caution panel. Once you are satisfied that the system works as advertised you can place the switch to OFF again. We will come back later to test the EPU and the oxygen system.

The TEST panel is mostly eye candy and there are no consequences if the above checks are skipped.

2. Move one panel forward to test the FLCS. Before doing so cycle and check the flight controls (stick and rudder) to assist in warming up the hydraulic fluid and removing air from the system. Check that all switches are down prior to flip the FLCS BIT switch. It's a magnetic switch that stays in place for the duration of the bit test. The green RUN light comes on and the flight controls are tested in sequence; progress can be monitored by looking out of the cockpit at the flight controls. Members of your flight are also able to see your flight controls moving.
During the FLCS bit WARN will be displayed in the HUD and the T/O LDG CONFIG warning light may also flash.
At the end of the self-test the switch will revert back to its original position and the RUN light will go out.
In some cases the test might fail and the amber FAIL light will then be illuminated. If that happens the only way to reset is to perform the BIT again. The status of the FLCS bit is displayed in the FLCS MFD page.
The FLCS bit will initiate only if weight is on the main wheels and if groundspeed is less than 28 kts.

The next check is the Digital Backup operation, simply toggle the DIGITAL BACKUP switch up and check that DBU on the right eyebrow is illuminated. Move the flight controls and check them visually for correct operation. Once satisfied return the switch to the OFF position and check that the eyebrow light goes off. Again, the HUD WARN message will be displayed during the DBU check and the FLCS page on the MFD will display DBU.
Once all FLCS tests have been completed ensure all switches are in the DOWN position on the FLT CONTROL panel.

Both the FLCS bit & DBU are eye candy in BMS and have no consequences if you skip them.



3. Move down to the MANUAL TRIM panel. A good habit is to always check that all needles are centred, especially if you have a cockpit where knobs might not be so!
Place the TRIM/AP DISC switch in DISC and ensure that stick trim actions do not induce flight control movement or needle deviation. Return the switch to NORM and apply stick trim to check needle deviation and re-centre.
Failure to set the trims properly may induce problems during or immediately after the take-off roll.

Those checks may appear like eye candy but as asymmetric drag is implemented in BMS ensuring proper trim settings before take-off is strongly advised!

4. If your mission could include air-to-air refuelling you need to test the AR system. On the FUEL panel open the AR door by flipping the AIR REFUEL switch to OPEN and check the right indexer for a blue RDY light. Hit the stick DISC button and RDY is replaced by an amber DISC indication. After three seconds DISC goes out and the blue RDY light returns. Move the AR switch to CLOSE and the blue RDY light goes out.

BMS rarely develops a fault into the AR system so this check could be categorised as unnecessary.

5. The next item to check is the EPU but for the test to be valid we need to ask the crew chief to first remove the EPU pin. This is done after engine start through the ATC menu (Ground page). Please note you must be on the ground ATC frequency. Once the crew chief has removed the EPU pin (preventing the EPU from actually starting during your normal engine start sequence) the status message in the top right corner of your screen will disappear.
Once the EPU pin is removed, move to the EPU panel and cycle the EPU to OFF and back to NORM. With the mouse make sure you use a left-click to move it from NORM to OFF; a right-click would engage the EPU which should be avoided on the ground. The real reason is of no significance to us; hydrazine is toxic to your ground crew but we don't have them in Falcon.

Check first that both the EPU GEN and EPU PMG lights are OFF on the ELEC panel. Testing the EPU is done with the EPU/GEN switch on the TEST panel. Engine RPM needs to be around 80% and the parking brake can't be engaged so make sure your aircraft is still on chocks and back them up with toe brakes. Move the throttle to 80% RPM, toggle and hold the EPU/GEN switch on the test panel and check lights:

- EPU AIR light ON (EPU panel),
- EPU GEN and EPU PMG lights OFF (ELEC panel),
- FLCS PWR 4 lights ON (TEST panel),
- EPU RUN light (EPU panel) comes on after five second

You can then release the test switch and return the throttle to IDLE.
If the green run light fails to come on reinitiate the test with a slightly higher throttle setting.

This check can be omitted as, with the EPU switch in the NORM position, the system will run automatically whenever needed.

6. Check the ECM panel and toggle the top left switch to OPR. This is the only switch implemented on the ECM panel. While you are there check the AUDIO panels one last time for correct volumes on COMM 1, COMM 2 and INTERCOM. TACAN volume is not implemented and we set the ILS volume earlier. No further action should be required as you set COMM 1 and 2, THREAT and MSL tone volume knobs earlier.

7. SEC check is performed next to ensure that the engine can operate in secondary control mode. SEC mode will be entered automatically if there is an engine damage or malfunction. The pilot thus needs to ensure that SEC mode works correctly. Parking brakes shouldn't be engaged, ensure that the aircraft is on chocks and back them up with toe brakes. Lift the guard and move the ENG CONT switch to SEC. The MASTER CAUTION light and the SEC caution light come on. The engine nozzle closes and should indicate less than 5% on the NOZ POS indicator on the right instrument stack.
In SEC RPM might be lower than in PRI mode. Check smooth RPM operations while in SEC and when satisfied return the ENG CONT switch to PRI and close the guard. The MASTER CAUTION and SEC lights should go out and the nozzle open up to more than 94%.
In multiplayer you can check your wingman's SEC test and confirm his nozzle opening and closing.

SEC check is not mandatory to have a ready-to-go jet.

8. A good idea while in that area is to check proper speedbrake operation. Open the speedbrake with the slider on the throttle and check the SPEED BRAKE indicator on the left auxiliary console. Remember it takes about two seconds to open and six seconds to close; ensure that it's closed before taxi.

9. The defence suite power-up starts at the TWA (THREAT WARNING AUX), located on the left auxiliary console. Depress the lower right POWER button and the SYSTEM POWER green light illuminates.

You can then move to the CMDS panel and power up the RWR and JMR pod with both toggle switches to ON. The CMDS has four countermeasure banks but only the CH (chaff) and FL (flares) are used in the Korean squadron F-16. Bank 01 and 02 are not implemented in the F-16 in Korea and as such these two switches can remain OFF. You may need to power them ON with other versions of the F-16.

The PRGM knob can be set to any program (preset through DTC) you like and you should rotate the MODE knob as desired or pre-briefed. Once all is set correctly (assuming you didn't forget to move the ECM switch to OPR earlier) the GO status indicator should come on, telling you that all systems are ready to be deployed.
You may also power up and check the HMCS at this stage but it's something I personally prefer doing at FENCE in.

Moving up to the gear panel set CAT I or III according to your loadout (check the STORES CONFIG caution light) and confirm that all three gear lights are green.

Move up to the TWP (THREAT WARNING PRIME) and perform the BITs on the RWR suite. These tests might be different according to the selected F-16 variant. These are relevant to the ALR-56 RWR:
Depress the SYS TEST button and check the indication on the RWR displays. Then check the MSL LAUNCH indicator and AUDIO by depressing the indicator. Once satisfied the system is running normally, depress the Handoff button. This sets the RWR to diamond float mode.

This item is very often overlooked and if omitted will prevent the RWR suite from warning you of threats!

10. While you are busy on the centre console you can set your MFDs and UFC according to your mission. Settings include: A-LOW, ILS, A-A or ground TACAN, pre-briefed JOKER, weapons settings, SMS, Selective Jettison, Bullseye (mode selected), VIP, VRP settings. You may also have to check your pods operation according to mission SPECS (TFR, FLIR, TGP etc).

You don't have to do all this now but remember; the more you do on the ground the less you will have to do while maintaining formation with your flight in the air. Plan on being very busy once the wheels lift off the ground; make your job a little easier by performing as many tasks as you can on the ground.

Move down to the instruments and if you weren't previously notified by your lead, request the local altimeter setting and dial in the altimeter accordingly. This is done either through the ATC menu or by listening to the ATIS VHF frequency introduced with 4.34. Normally only Lead should request QNH from the Tower and make sure all flight members have received the information.
ATIS frequencies are listed on the BMS charts and more information about ATIS can be found in the BMS COMMS AND NAV book manual located with the other BMS manuals in your Docs folder.

Check the remaining instruments and ensure that no flags are visible. Red GS and LOC flags might be displayed on the ADI if the instrument mode knob is set to ILS/NAV or ILS/TCN. Place it in TCN or NAV mode. If your flight calls for an instrument departure it is a very good idea to set your navigation systems and HSI correctly (HDG and CRS) at this stage.

11. To the right of the HSI you will find the FUEL QTY SEL panel which may be used to check that your remaining fuel is displayed correctly.

- In TEST check that both needles of the fuel gauge on the right auxiliary console indicate 2000 lbs. The totalizer should read 6000 lbs and both FWD and AFT FUEL LOW lights should be illuminated on the caution panel.
- In NORM; A/L = 2675-2810 lbs, F/R = 3100-3250 lbs.
- In RSVR both needles should read 460-480 lbs.
- In INT WING both needles should read 525-550 lbs.
- In EXT WING both needles should read 2300-2420 lbs. (when carrying 370 gal wing tanks)
- In EXT CTR; A/L = 0 lbs, F/R = 1800-1890 lbs (when carrying a centreline).

Never forget to return the knob back to NORM after checks because NORM is the only position where you get proper operation of the automatic forward fuel transfer system, trapped fuel warnings and BINGO fuel warning computation based on fuselage fuel.

In other words you will not get TRAPPED FUEL or BINGO fuel warnings if the knob is not in NORM!

12. Moving to the right auxiliary console check the PFLD for any remaining faults you might not have acknowledged. Depress F-ACK and check MASTER CAUTION and the warning light panel and EPU fuel quantity, which should be between 95 and 102%.

13. The final step in this sweep is to confirm that the EGI is fully aligned by checking to see if ALIGN is flashing in the lower left corner of the HUD. If so: toggle the EGI knob from ALIGN NORM to NAV on the AVIONIC POWER panel. From that moment all navigation cues will be displayed.

You are now almost ready to taxi. Arm your seat and enable nose wheel steering; confirm NWS is illuminated on the right indexer. Apply toe-brakes or set parking brakes and ask the crew chief to remove the chocks through the ATC ground menu page.

You can now tell your flight lead you have a good jet and you are ready to taxi as per your SOPs.

That's it! The explanation may seem pretty long-winded but all steps can be covered in less than fifteen minutes in the cockpit. With a little experience you will develop your own routine and it will become second nature. Bear in mind that the procedure is quite flexible and you may develop your own routine as long as all required items are performed and at the end you have a mission-ready jet.

Of course once Lead initiates radio comms he might be busy communicating relevant information or requests, considerably shortening your ramp start routine. Don’t stay idle waiting for the EGI to align; perform as many items while you can because there are many other checks Lead may call for from his flight such as IDM checks, swing checks etc.

2.2. REFUELLING

2.2.1 Hotpit refuelling

It is possible to request a hotpit refuel in BMS. Any airbase is able to provide this feature and all you need to do is open the AR door (to depressurise fuel tanks), make sure you are on a valid ATC frequency, stop on the taxiway and request hotpit refuel via the ATC menus.

Since 4.33 it is now possible to request hotpit refuel in BUP mode through the manual frequency of the BACKUP UHF panel. Unfortunately there is no specific hotpit area coded yet so any area in any airbase will work. To observe the fuel transfer: enter the UFC BINGO (LIST 2) page.

The external fuel tanks should be depressurised to allow the fuel to transfer to them. This is normally done by opening the air refuel door on the ground and keeping it open for the duration of the refuelling process. The main BMS checklist volume includes a section entitled HOTPIT REFUEL should you need it.

2.2.2 Air to Air refuelling (AAR)

For long missions it is not uncommon to need air-to-air refuelling. This service is provided in BMS by KC-10 and KC-135 aircraft.

Where is he?

First you need to find the tanker. The easiest way is to use the DTC lines on the HSD if the mission was correctly planned and the TE designer placed a box around the tanker track.

Secondly you can use A-A TACAN. BMS uses three different TACAN systems:

- Ground beacon: provides bearing and range to a ground station.
- Airtac beacon: provides only range to an airborne station.
- Mitac beacon: provides bearing and range to an airborne station.

The Ground TACAN is self-explanatory. Airtac is used by fighters and the KC-135 and Mitac is only used by the KC-10. As a consequence only the KC-10 will provide bearing information. All other airborne stations will provide distance only and the bearing pointer on the HSI will spin around the instrument indicating lack of bearing information.

In addition the A-A FCR comes in handy for detecting the tanker at long range and practice of the bracket intercept is always welcome for rejoin.

Lastly if an AWACS is in flight, and if you are on its tactical frequency, the request vectors to tanker option from the AWACS menu will provide tanker position, AA TACAN channel you should input straight into your system and the Tanker UHF frequency.

Distance matters

Before refuelling you will need to establish radio contact with the tanker to ask for fuel. Since 4.34 it is mandatory to be on the correct frequency for the AI to interact with you. You therefore need to know the tanker UHF frequency if you want to get fuel. If there is a tanker assigned to your flight and if your flight plan has a refuel steerpoint, then the tanker's UHF channel is nominally preset #13 on the UFC, but AWACS will tell you too. Use the radio menu to establish contact (Y key for tankers).

Depending on your distance from the tanker when you make the initial contact the answer will be:

- If you are outside 10 Nm AWACS will respond with Tanker bearing, range and TACAN channel.
- If you are at or within 10 Nm you will be cleared by the Tanker directly to the pre-contact position.

Obviously you will need to open the AR door with the relevant switch on the FUEL panel on the left console. It is good practice to open it (viewable externally now) 3 to 5 minutes prior to refuelling to allow the external tanks to depressurise slightly, but no earlier due to the possibility of creating a trapped fuel situation.

The speed limit in BMS for opening the AR port is CAS 400 kts / Mach 0.85 (whichever is lower) and flying with the AR receptacle open is CAS 400 kts / Mach 0.95 (whichever is lower).

Cleared to Pre-Contact position

Before taking fuel you will need to establish a stable pre-contact position. This position needs to be held for a few seconds to be recognized by the boomer. You'll need to be 50 feet below at 30° down from the tanker.

The best method to get that position correctly is to use the gun cross and the boom. When the “request fuel” radio call is acknowledged by the tanker he lowers the boom half way. The position of the boom gives you the location of the pre-contact position. Just follow the lower part of the boom by aligning the gun cross on it.

Be advised there are no director lights at this stage. You just need to hold position a few feet behind the boom.

When the boom operator is happy with your stabilised position he will call:

“call sign, cleared to contact position”.

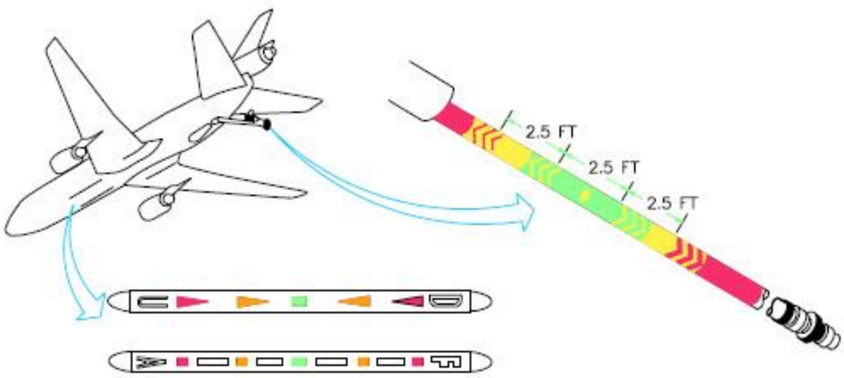
At that point the red director lights **F** (Forward) and **U** (Up) will switch on to give further positional guidance. Start to move slowly towards the boom and it will move to left or right to let you get into contact position.

Turn the lights on please

BMS uses an EMCON 2 (Emission Control) procedure. It means that no verbal directions will be given by the boom operator to guide you into the contact position. Boom operators will only use the radio for the pre-contact position, to announce contact position, disconnect and the infamous “tanker entering turn” call.

This means that you'll only have visual aids to find the right contact position; help is provided by the director lights.

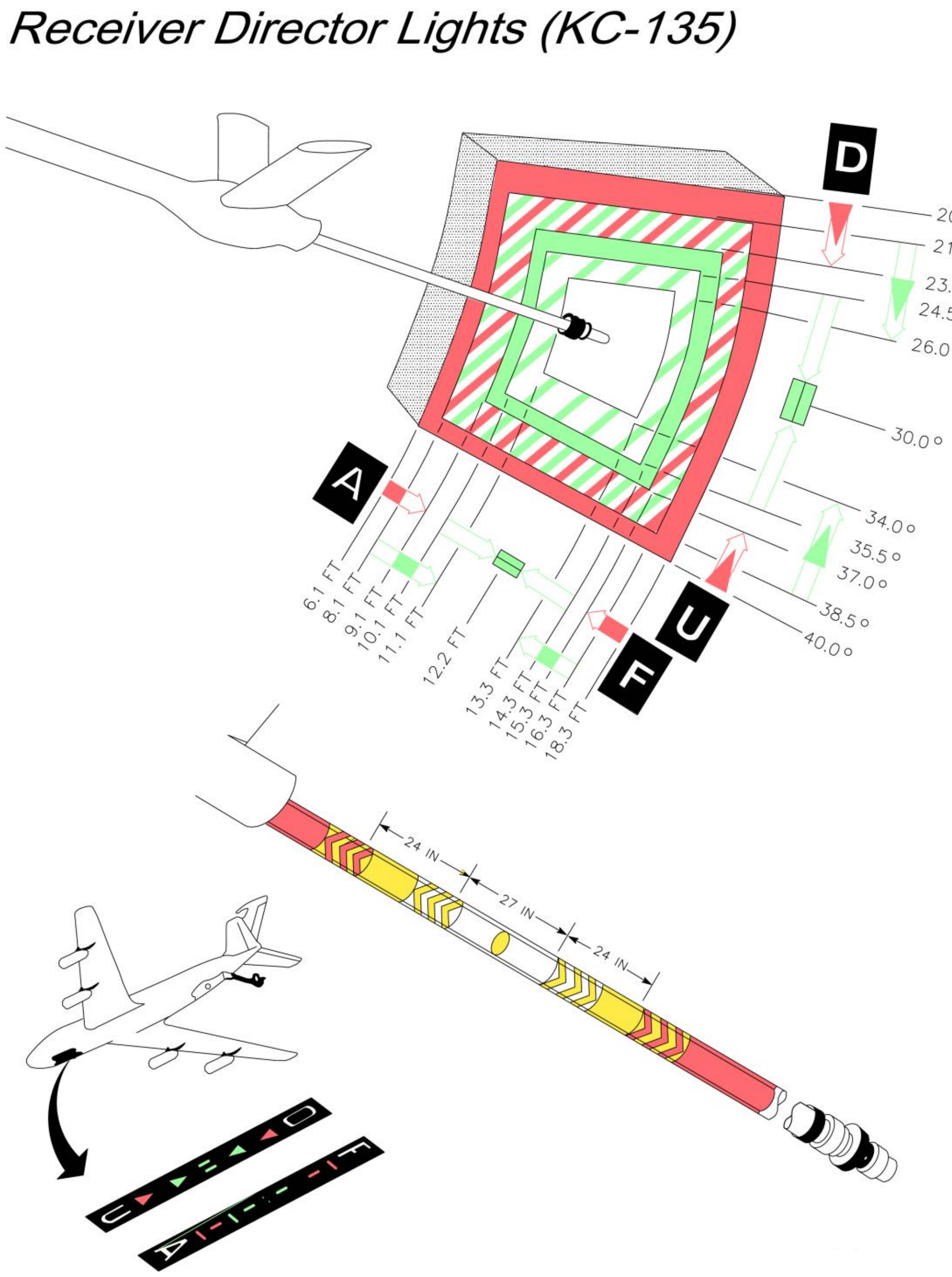
The red director lights will be switched on only when the pre-contact position has been established. If you don't see them you’re not in the correct pre-contact position, or you haven’t opened your AR door (blue indexer RDY light is not lit).



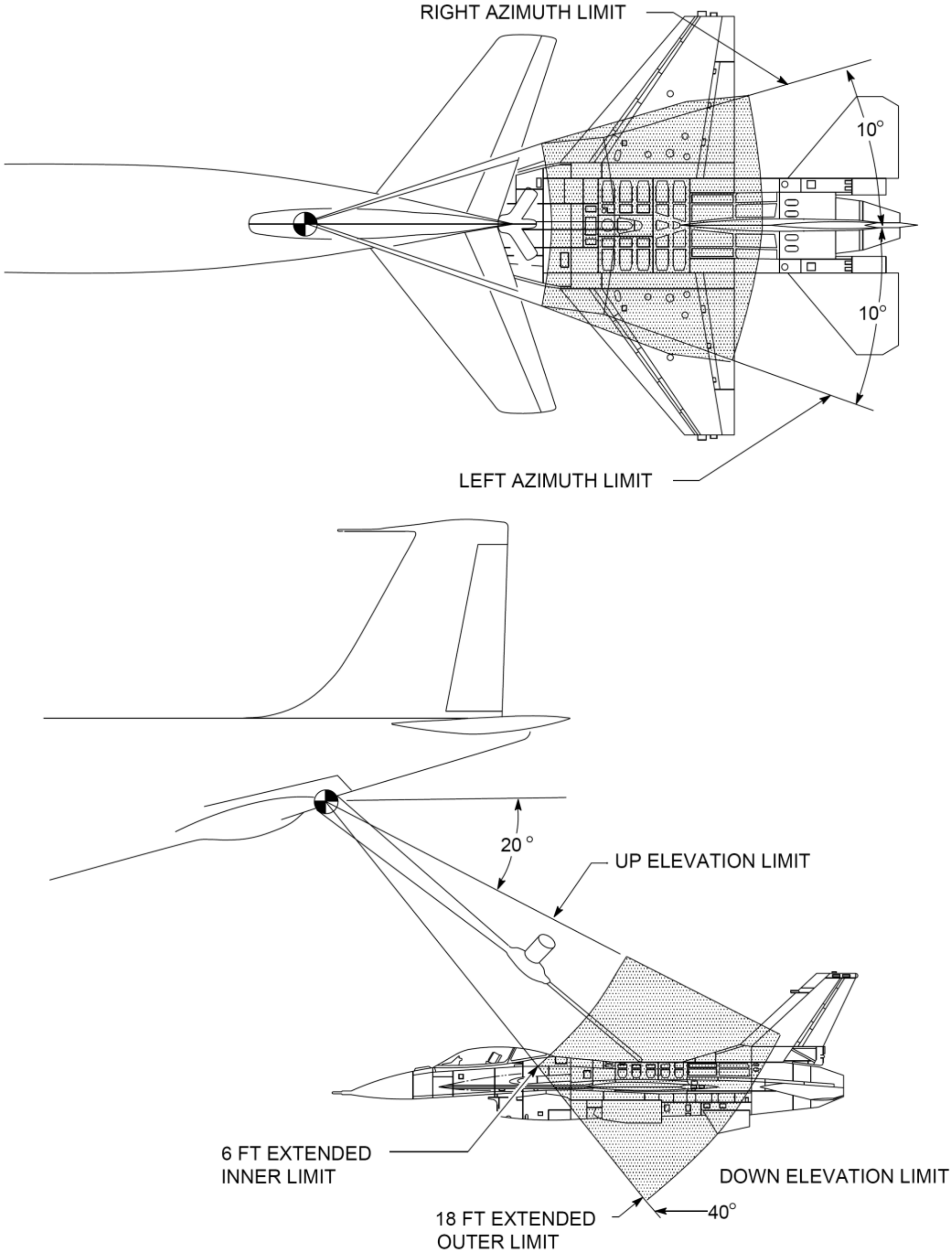
Once you have reached the pre-contact position only red director lights will be illuminated; steady for correction and blinking for fine tuning. When all the lights go out don't move! The boom operator is trying to connect. You will need to hold this position for a few seconds.

Once contact has been made the yellow and green lights will become active; these will help you to adjust your position to stay connected with the boom.
If in all older versions of Falcon you remember the boom “snapping” you in the correct position no matter what; this is no longer the case with BMS. You keep flying the aircraft. The boom will remain connected as long as you stay within its manoeuvring envelope.
When the boom connects the blue RDY light on the right indexer shuts off and the green AR/NWS light comes on signalling fuel transfer. If you enabled the BINGO DED page you can monitor the fuel flowing in.

KC-135 Diagrams

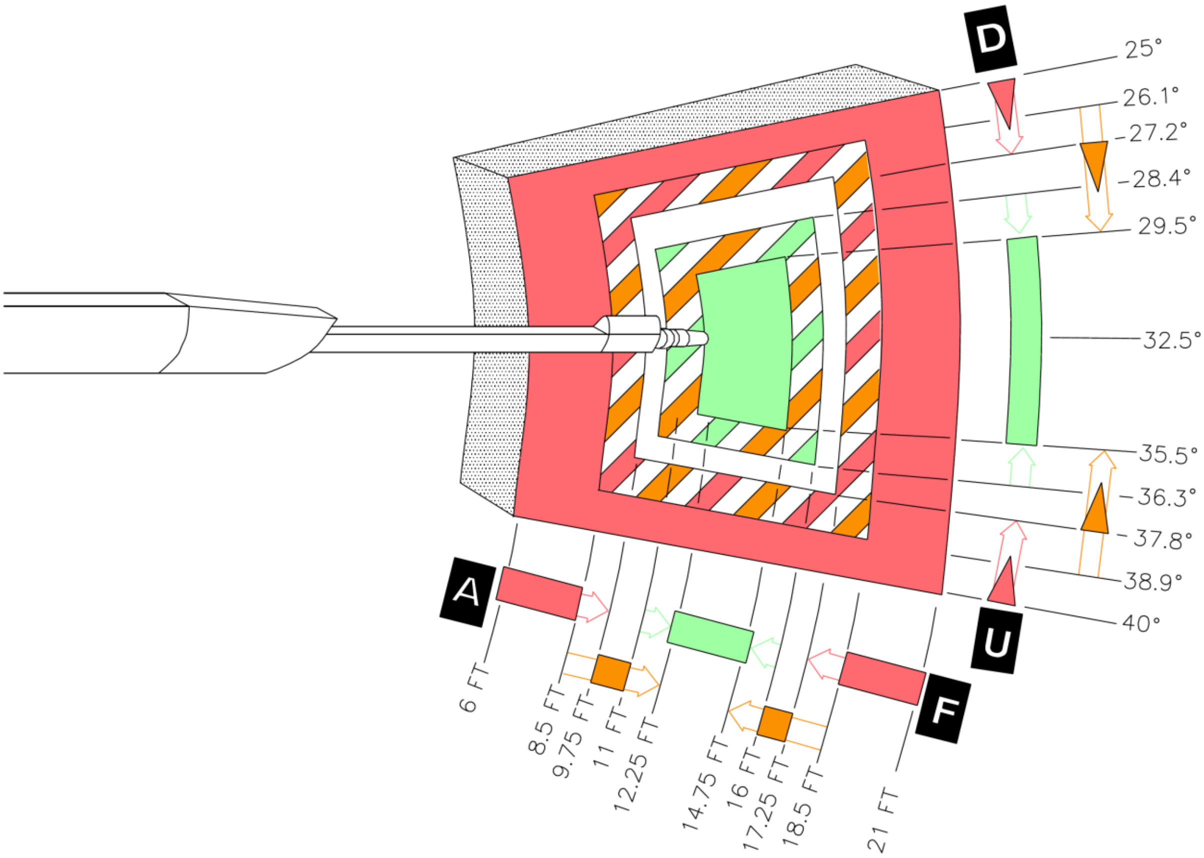


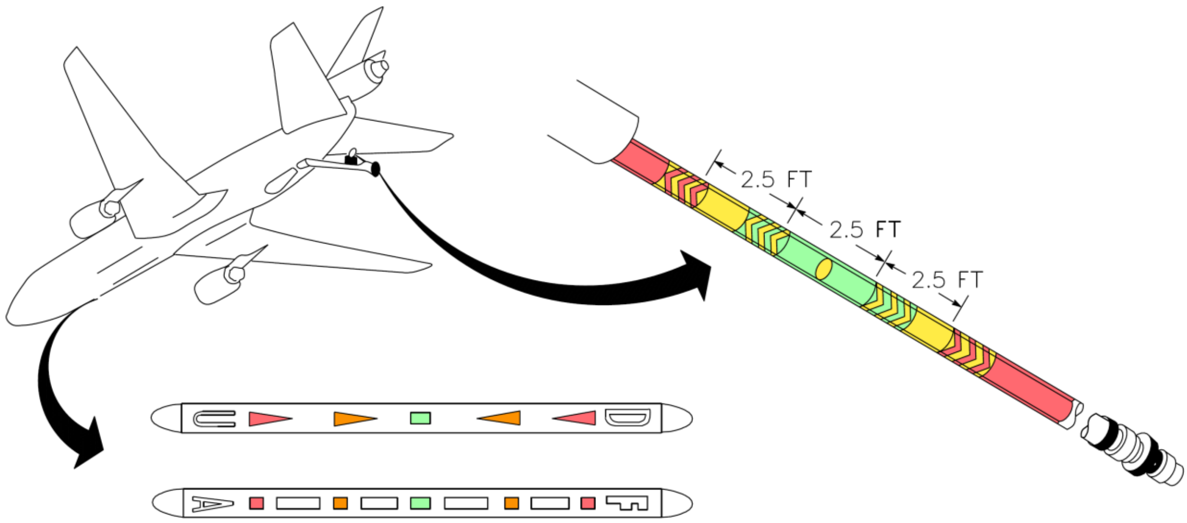
Boom Envelope Limits (KC-135)



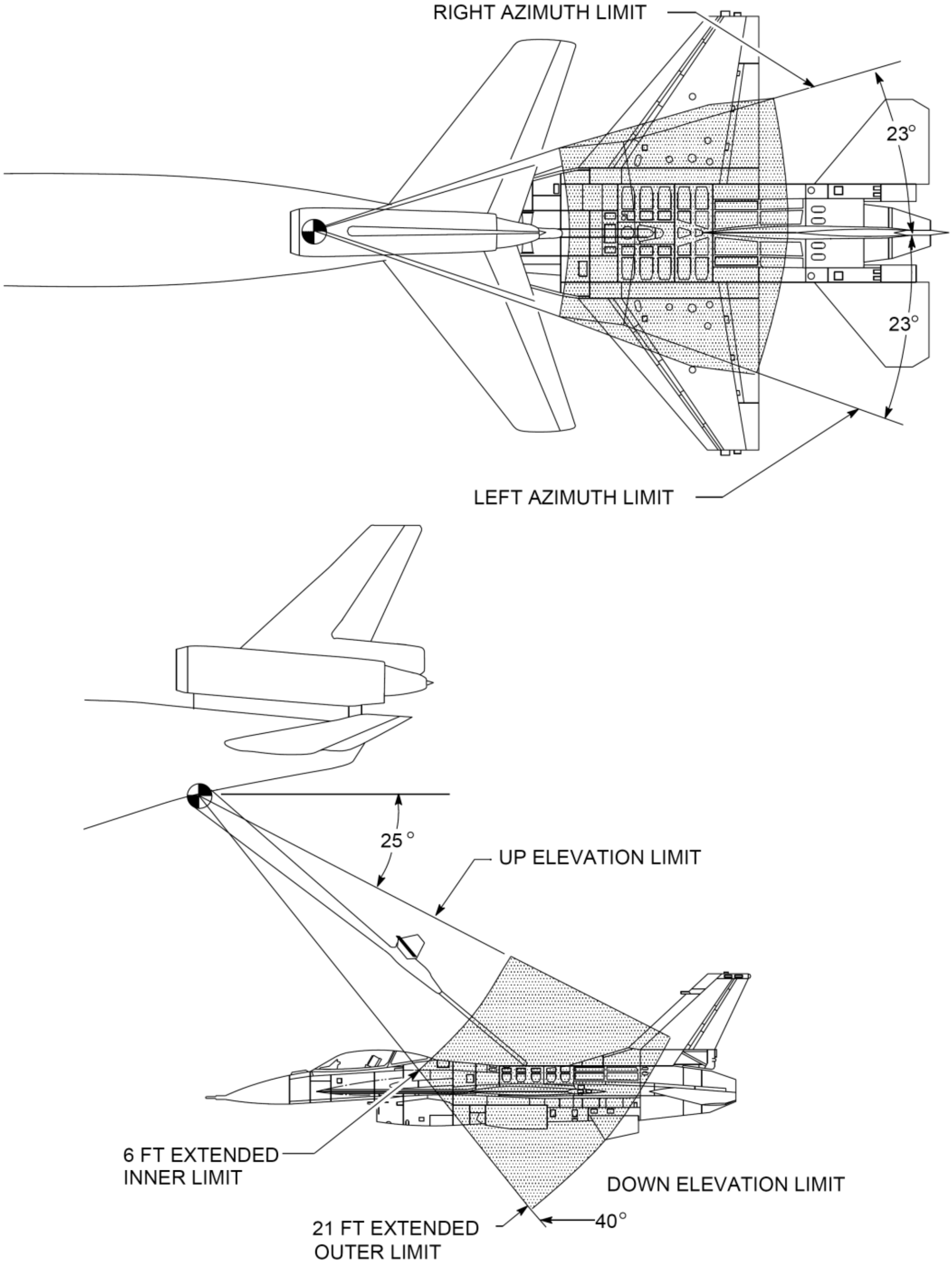
KC-10 Diagrams

Receiver Director Lights (KC-10/KDC-10)





Boom Envelope Limits (KC-10/KDC-10)



Quick-Flow Procedure

In accordance with ATP-56 B Quick Flow procedures have been implemented for both AI and humans to expedite air refuelling operations. Quick Flow allows receivers to minimise refuelling time with maximum fuel transfer. The receiver flight will join on the left of the tanker with the flight lead moving to the pre-contact position. Remaining aircraft will proceed to the left observation position. Once the flight lead commences refuelling, the second aircraft in the air refuelling sequence should move to the On-Deck position.

The On-Deck position is normally flown as a route (left echelon) formation with approximately 10 feet spacing from the refuelling aircraft. The third and fourth receivers will remain in the observation left position.
When the lead jet completes refuelling it calls done on the radio (y 3) and moves to an observation position off the tanker's right wing. Tanker ownership in multiplayer automatically transfers to the second receiver (if he is human). This can result in a noticeable 'jump' of the tanker as you take over multiplayer ownership of it.

The second receiver moves from the On-Deck position to the pre-contact or contact position as directed by the tanker (if the On-Deck formation was being flown correctly he would be cleared straight to contact).
The third receiver (if present) then moves to On-Deck and waits for the second to call done refuelling to follow the tanker direction to refuel. The left to right flow continues until all fighters have refuelled.

Additional receivers arriving prior to the first flight completing refuelling operations will remain in trail position until there is space at the left tanker observation position. There will only be a maximum of three jets waiting at left observation (including the On-Deck spot) at any one time any others waiting will be in trail until there is room for them to move up.

1. Leader in pre-contact position. #2, #3 and #4 waiting in pre-refuelling observation position.

2. Leader in contact. #2 closes up to On-Deck (echelon left). #3 and #4 stay in observation left of the tanker

3. Leader done refuelling and moves to the right tanker wing. #2 contacts, #3 closes up to echelon on #2. #4 is waiting in position.

4. #2 done refuelling and rejoins the leader on the right wing. #3 Contact with #4 closing up.

5. #3 done refuelling and rejoins on the right wing. #4 in contact.

We typically offload a certain amount of fuel which is usually briefed. You thus have to know when you reach that amount. Simply select the UFC BINGO page and monitor your total fuel load as it increases to the desired quantity.

At that point you hit the A/R DISC switch on the sidestick and take your place in the formation again. The tanker needs to be told you have “done refuelling” (y 3) for the next flight member to be cleared for refuel. The AR door can then be closed.

For departure from the tanker, the aircraft at right observation will descend 1000' and take up a loose echelon right formation with each jet stepped down 100’ progressively to allow the outside jets to maintain sight. The aim point for this clearing manoeuvre is 1000’ below the tanker's present altitude and 1 NM to the right of the tanker’s horizontal position. Once the flight is approaching this aim point they are cleared to return to waypoint mode.

Thanks to AMRAAM for his permission to reproduce part of his BMS refuelling article.

2.3. LANDING

Landing the F-16 is fairly easy; the aircraft is stable from a pilot's point of view. This chapter will go through a straight-in visual landing but the final approach steps are relevant to any type of landing.

In BMS the F-16 is able to land on any in theatre runway; airstrips included. Generic airbases always have the same length runways and only specific airbases have longer runways as in real life, i.e. Kunsan, Kimpo, Osan & Seoul in KTO. BMS does not take into account the runway conditions. Airstrips are considered short field landing.

Besides the runway length another aspect to be taken into account before landing is the weather. Visibility and winds are implemented. Crosswind landings with limited visibility may therefore happen but that is outside the scope of this chapter and is detailed in the BMS-Comms-Nav-book document. That being said, wind must always be checked before landing. This can be done with DCS right (SEQ) while displaying the CNI UFC page.

Landings should usually be performed with the DRIFT switch in NORM; this allows the pilot to visually see the effect of the wind through the offset of the HUD flight path marker. Plan to touch down on the upwind side of the runway (the side opposite the FPM) in high crosswinds.

A straight-in landing is a long, controlled descent to the runway; usually beginning at a distance between six to nine nautical miles. The landing phase will start aligned with the runway axis; you can use the airbase TACAN to do that but it can be done visually as well. Altitude should be 2000 feet and airspeed less than 300 knots for safe extension of the landing gear. Due to the low drag nature of the F-16 speedbrakes may need to be opened to reduce speed.

From this point on we will no longer refer to airspeed but instead to angle of attack (AOA). The optimal approach airspeed depends on your gross weight and the best way to be 'on speed' is to forget all about airspeed and think 13° AOA for landing.

First lower your landing gear. Doing so will automatically deploy leading and trailing edge flaps, and the FLCS will switch to Takeoff and Landing Gains. The drag induced by dirtying up your aircraft configuration will decrease your airspeed further and pitch the nose down a little.
The HUD symbology will also change; an AOA bracket will be displayed. This symbol is used in conjunction with the FPM and the Indexer lights as your main cues for controlling the approach.

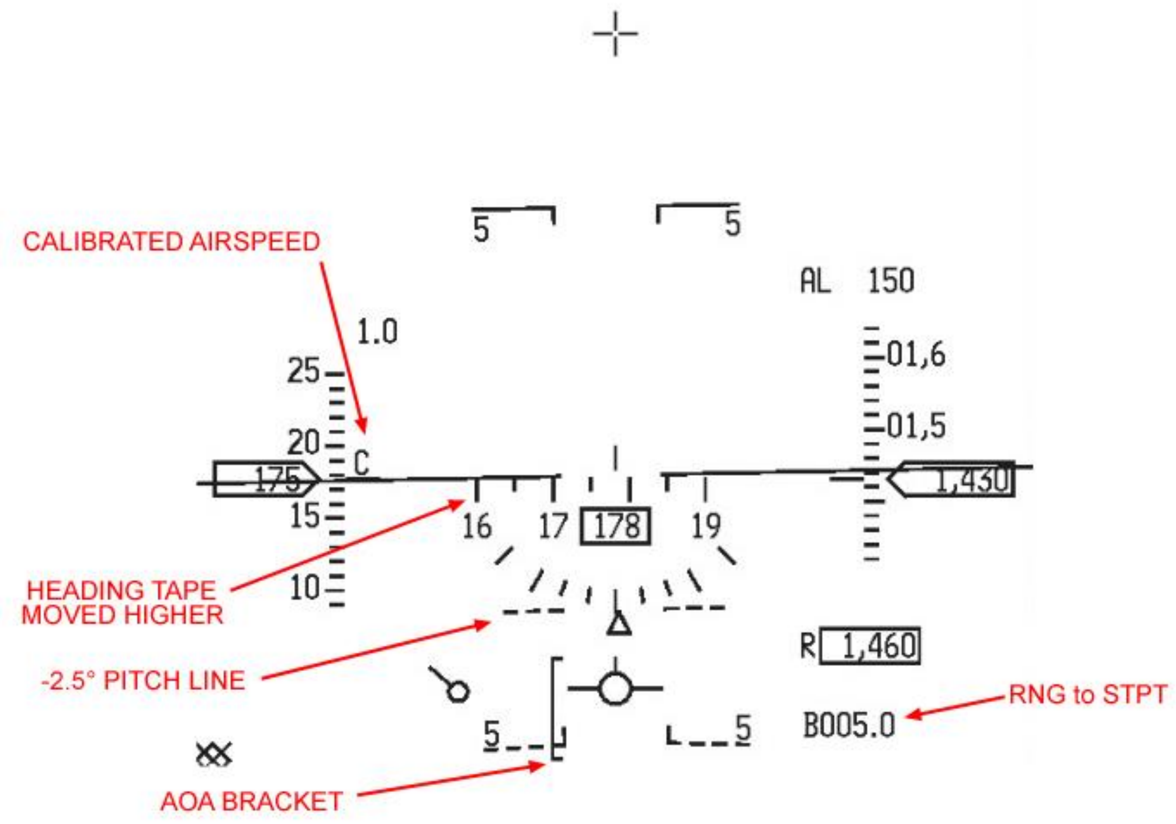
The glide slope is 3° down to the runway, with a -2.5° dashed line on the HUD. By placing the FPM on the -2.5° dashed line, or slightly below, you should fly a correct profile for your descent to the runway.

Most runways in BMS are equipped with a visual landing aid system known as Precision Approach Path Indicator or PAPI. It consists of four equally spaced lights situated to the side of the runway. The lights will be seen as white or red according to the position of the aircraft with respect to the optimal glideslope. The more red lights visible from the aircraft the lower you are below glideslope. The more white lights seen the higher you are above the glideslope.

A 13° AOA approach is flown correctly when two white and two red lights can be seen.

An 11° AOA approach will show "three red, one white".

A simple rule of thumb to remember: Red is dead!



So there you are with the runway and PAPI in sight at around 6 Nm, aligned correctly with the centreline at 2000 feet, gear down and flying around 250 knots.

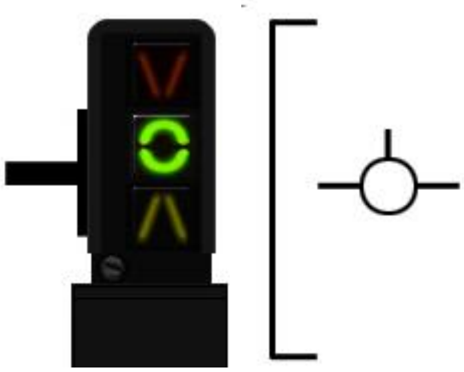
You know that you have to place the FPM on the runway threshold to land.
You also know that to maintain two red and two white lights on the PAPI you have to fly a 3° glideslope to the runway; the FPM has to be around the -2.5° dashed pitch line. This is done with the sidestick controller.

All you have left to do is to understand angle of attack and how to control it with the throttle.

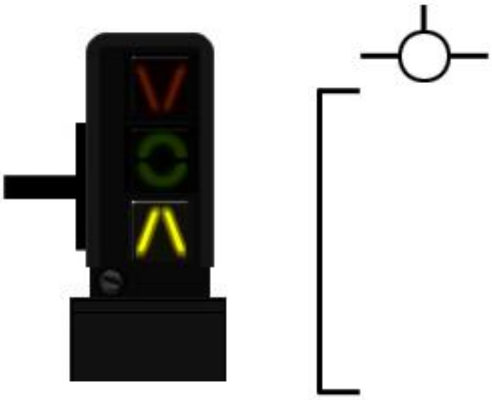
AOA is the angle between the aircraft wing chord line (equivalent here to the airframe longitudinal axis) and the relative vector of motion of the aircraft. Basically it's the angular difference between where the aircraft is pointing and where it is going.

The optimal touch down AOA for the F-16 is 13° AOA; corresponding to when the FPM is in the middle of the AOA bracket. The AOA indexer located on the left of the HUD will show the middle green doughnut illuminated.

The top of the HUD AOA bracket indicates 11° AOA and the bottom mark of the HUD AOA bracket indicates 15° AOA. The range of the AOA bracket therefore is 5° AOA: from 11° (top) to 15° (bottom).

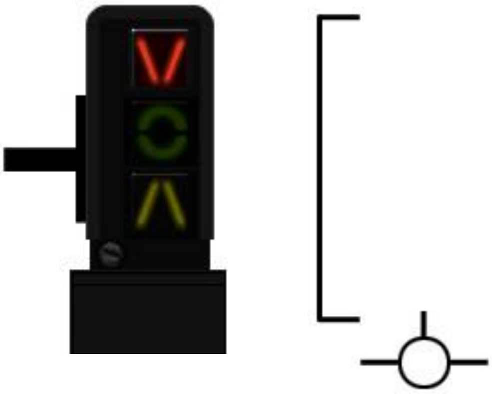


AOA is controlled by the power setting. Increasing power decreases AOA. (The FPM moves up while the nose remains steady) Reducing power increases the AOA (The FPM moves down in the HUD while the nose remain steady)



Knowing that, if the FPM is above the bracket (AOA<11°), you know you will have to decrease the power setting to increase the AOA and lower the FPM inside the bracket.

You are too fast



If on the other hand the FPM is below the bracket (AOA>15°) you need to increase power to decrease AOA and bring the FPM up inside the AOA bracket.

You are too slow

The approach is made around 11° AOA (FPM at the top of the HUD AOA bracket) on a 2.5° glideslope to the runway with speedbrakes opened and landing gear obviously deployed. The FPM should be just on the runway threshold and the PAPI should indicate two red and two white lights. The picture on the left depicts the situation although the AOA is a bit too low and fast. The throttle was then decreased to increase AOA and bring the FPM on top of the bracket.

From there the power setting is used to maintain the FPM on the runway threshold and on the top of the bracket.

The next phase will be to flare just prior to touch down. The F-16 does not require much flare. The idea here is to transition the FPM from the top of the AOA bracket (11° AOA) to the centre of the bracket (13° AOA & green doughnut illuminated on the left indexer).
Decreasing the power setting as you go over the threshold is usually all it takes to transition to 13° AOA. Once there maintain it until the wheels kiss the ground and the retard the throttle to idle. If you land with the correct on-speed AOA the aircraft will not bounce on the runway and will not want to fly again unless you increase power.

Maintain aerobraking by keeping the FPM in the middle of the AOA bracket and the green doughnut illuminated in the left indexer. Since you are rolling and not flying anymore that is done by pulling gently on the stick. Beware that pulling too much will scrape the tail and damage the aircraft.
You can maintain directional control with the rudders during the landing roll; rudder efficiency is greater at higher speed and will decrease as your speed decays.

Around 80-90 knots the nose gear will drop to the runway. Gently cushion it by pulling the stick.
Pop the speedbrakes fully open and maintain aft stick in the roll out.
Wheel braking can then be initiated as required being mindful of inducing a hot brakes condition.
Nosewheel steering can be engaged once below control speed (70-80 knots) to steer the aircraft on the ground but you shouldn't need to steer the aircraft until your ground speed is really low, usually just before turning off the active runway.

Welcome back.

SECTION III

ABNORMAL & EMERGENCY PROCEDURES

3.1. WARNING AND CAUTION LIGHT AND PILOT FAULT SYSTEM

This section covers the operation of the aircraft during abnormal or emergency situations.
When dealing with emergencies it is essential to determine the best course of action by using sound judgment. When practical your flight members should be made aware of your problems and your proposed course of action to correct them.

There are three basic rules to apply to all emergencies:

- Maintain aircraft control
- Analyse the situation and take corrective action
- Land as soon as the situation dictates

The warning/caution system is made of different subsystems:

- Warning lights (amber lights on the eyebrows)
- MASTER CAUTION (press to reset amber light on the left eyebrow)
- Caution lights (yellow lights on the right auxiliary console caution panel)
- PFLD (Pilot Fault List Display - small screen on the right auxiliary console accessed with the F-ACK button on the left eyebrow)
- Maintenance Fault List
- VMS (Voice Message System – aka Bitching Betty)
- HUD messages

3.1.1 MASTER CAUTION light

The MASTER CAUTION light illuminates shortly after any individual light on the Caution Panel illuminates. It does not illuminate in conjunction with the warning lights.

The MASTER CAUTION light can be reset by pressing it, unless the triggering caution light is the ELEC SYS light.

The light should be reset as soon as possible so that other triggering events may be more noticeable. Unless it is reset the MASTER CAUTION light will remain illuminated as long as the individual caution light is illuminated.

3.1.2 Caution lights

The caution light panel is located on the right auxiliary console. It is a placeholder for 32 indicators, of which 20 are fully supported in BMS.

The ELEC SYS caution light cannot be reset with the MASTER CAUTION light. The only way to reset it is to use the ELEC CAUTION RESET push button on the ELEC panel. The light may not be resettable in some situations.

Some lights such as the AVIONICS FAULT, ENGINE FAULT and FLCS FAULT may be reset with the F-ACK button (PFLD message).

3.1.3 Warning lights

The warning lights are located on the eyebrows, just under the glareshields.

3.1.4 Pilot Fault List Display (PFLD)

The PFLD is a small screen located on the right auxiliary console. Its purpose is to display a system code to identify the active fault.
There are two types of PFLD messages:

- Warning level
- Caution level

The warning level PFL are associated with the FLCS. When a warning PFL occurs the PFL message and the FLCS error code are displayed on the PFLD, the FLCS FAULT caution light illuminates, the HUD flashes the WARN message and VMS is activated ("WARNING – WARNING").

When a caution level PFL occurs the PFL and error code are displayed in the PFLD, the appropriate caution light panel illuminates and the MASTER CAUTION light lights up as well.

PFL are acknowledged and recalled by depressing the F-ACK button on the left eyebrow. Multiple faults can occur at the same time and it may be necessary to toggle through additional pages on the PFLD with the F-ACK button to review them all.

Acknowledging a caution level PFL clears it from the PFLD and extinguishes the relevant caution light. Acknowledging a warning level PFL clears it from the PFLD but the FLCS warning light remains ON. See chapter 3.4 PFL analysis for further information on the PFLD.

3.1.5 Maintenance Fault List

The MFL is a list of faults, which can be displayed on the MFD TEST page. The MFL contains all of the information reported by the subsystems which indicate a fault. It is in some ways more precise than the Pilot Fault List, which reports only faults of interest to the pilot. The MFL also reports faults of interest for maintenance personnel. Nevertheless the MFL can be used by the pilot to get more information about a particular component of a failed system. See chapter 3.5 for MFL analysis.

3.1.6 Voice Message System (VMS)

The VMS provides an audible warning to back up warning and caution visual cues. VMS can be turned off with the VOICE MESSAGE INHIBIT switch on the right console. The volume of the VMS can be set with the INTERCOM volume knob on the AUDIO 2 panel (all sounds normally heard in the pilot's headphones are changed according to the intercom volume knob position).

A suggested way to set volumes up is the following method by Dee-Jay:

1. Set your Windows volume and headset/speakers volume as required (outside BMS).
2. Set your UI sound volume to the default position (BMS UI).
3. Set all volume knobs to mid-range and run the MAL & IND LTS test. While the test is running set the master headset volume you want in BMS with the INTERCOM volume knob.
4. Set your COMM 1, COMM 2, MSL and THREAT volumes as you require them.

The above methods give you more fine control over the in-cockpit volumes rather than have them all at MAX volume, which is often counter-productive.
With the above method you can then decrease Betty sounds for instance with the INTERCOM volume and increase the relevant COMMS volume.

The "WARNING – WARNING" message is automatically activated 1.5 seconds after illumination of any warning light.

The "CAUTION – CAUTION" message is automatically activated 7 seconds after illumination of any caution panel light. If the MASTER CAUTION light is reset within the 7 secs the audio cue is inhibited.

Besides the WARNING and CAUTION messages the VMS provides discrete voice messages for specific conditions:

- “ALTITUDE – ALTITUDE” advises that descent is occurring after take-off, radar altitude is below the CARA A-LOW setting, or barometric altitude is below the MSL A-LOW setting.
- “BINGO – BINGO” is played when the fuel quantity reaches the set Bingo amount in the UFC, as long as the FUEL QTY SEL is in NORM.
- “JAMMER” is played if CMDS REQJAM is activated and warns the pilot that use of the jammer is advised and consent is required.
- “COUNTER” advises that a dispense command should be initiated (active in CMDS SEMI mode).
- “LOCK – LOCK” advises the pilot that the FCR has locked on a target.
- “PULLUP – PULLUP” advises that the ground proximity warning has been activated and a 4G pull is immediately required to avoid terrain.
- “CHAFF – FLARE” advises that CMDS has initiated a dispense program release (active only if FDBK is turned on in the DED CMDS page).
- “LOW” advises that expendables have reached their bingo level (if turned ON in the CMDS UFC page).
- “DATA” is played when the IDM receives data link information.
- VMS is also able to play the LOW SPEED warning tone and Landing Gear warning horn.

The VMS is inhibited with WOW, but can be tested with the MAL & IND LTS test button. During test, each word is heard once in sequence.

3.2. WARNING LIGHT ANALYSIS

3.2.1. ENG FIRE

Illumination of the ENG FIRE should be followed by immediately retarding the throttle to idle. The likely cause is engine compartment fire.
If there are other signs of engine fire such as visible smoke/flames, FTIT high, OVERHEAT light on, engine response sluggish or non-existent and if the warning light remains on eject immediately.
If there are no other signs then the cause is probably a malfunction in the fire detection system. In that case land as soon as possible.

3.2.2. TO/LDG CONFIG

This warning light refers to a wrong configuration for landing or takeoff.

On the ground with the landing gear handle up the warning light means that the Trailing Edge Flaps (TEF) are not fully down. That hardly ever happens in BMS, which is good because you should abort the aircraft.

In the air with the landing gear handle up the light comes on to warn the pilot that the aircraft is not correctly configured for landing. The light comes on when the following conditions occur:

1. Below 10000 feet.
2. Airspeed less than 190 knots.
3. 250 fpm descent or more.

The VMS warning horn will sound. To address the problem stop your rate of descent and accelerate, or lower the landing gear handle if you intend to land.

In the air with the landing handle down the light indicates a malfunction in the gear, or in the TEF. To work out where the problem lies first check the individual gear lights. If all three of them are green then the gear is fully down and locked and the problem is related to the TEF. In that case land using normal AOA (about 20 knots faster than normal).
If one of the gear lights is not green that gear is not fully down and/or locked. Refer to Landing Emergencies chapter 3.8.3 LANDING WITH GEAR UNSAFE/UP later in this section.

3.2.3. CANOPY

Illumination of this warning light indicates that the canopy hooks or locks are not secured or there has been a loss of cabin pressure. Descend below 10000 feet and land as soon as possible.

3.2.4. FLCS

The FLCS warning light comes on whenever there is a PFL warning message relating to the FLCS. Refer to the Pilot Fault List message.

3.2.5. HYD/OIL PRESS

This warning light indicates a low pressure condition in one or both hydraulic systems, or a low engine oil pressure condition. Both systems therefore need to be checked.

1. Check the oil pressure gauge. If the pressure reads normal the problem is not the oil pressure. If the pressure is below 15 psi the engine has low oil pressure. Limit throttle movement and land as soon as possible. Refer to 3.7.11 Oil Leak in the in-flight emergency paragraph later this section. If on the ground, shut down the engine immediately and let the RPM decrease below 20% before attempting a restart. Refer to 3.5.4 OIL PRESSURE.

2. Refer to the hydraulic system A & B gauges on the right auxiliary console and check pressure there.

If only system A is below 1000 psi there is a single system A hydraulic failure (refer to System A Hydraulic failure in the EP checklists).

If the system B gauge is under 1000 psi, check the EPU:
- If the EPU RUN light is off there is a single system B hydraulic failure (refer to System B Hydraulic failure in the EP checklists).
- If the EPU run light is on check the ELEC SYS caution light:
    - If ELEC SYS light is on the problem is PTO shaft failure.
    - If ELEC SYS light is off both hydraulic system A & B have failed (refer to Dual Hydraulic failure in the EP checklists).

If both hydraulic indicators show less than 1000 psi with the EPU switch in NORM or running, the aircraft has suffered a total hydraulic failure and will become uncontrollable as soon as the EPU fuel runs out. If you can’t land before that happens you will have no choice but to eject.

3.2.6. OXY LOW

The OXY LOW warning light illuminates when the OBOGS BIT has detected a fault or when regulator pressure is below 5 psi. Refer to OBOGS malfunction.

3.2.7. DBU ON

The DBU ON warning light illuminates whenever the FLCC is running in digital backup mode. This is eye candy in BMS and happens only when the DBU is tested.

3.2.8. TF FAIL

Indicates a Terrain Following Radar failure. An immediate climb to a minimum safe altitude should be initiated.

3.2.9. ENGINE

The ENGINE warning light illuminates due to other engine problems. Causes include engine flameout, alternator failure, over temperature, etc.

If RPM is abnormally low but not showing zero the engine has flamed out. Retard throttle to off and initiate an air-start. Refer to 3.7.5.1 Air Start chapter later in this section).

If RPM is low and reading zero the aircraft has suffered an alternator failure.

If RPM is not abnormally low but FTIT is abnormally high the engine is suffering from over temperature. Land as soon as possible.

If RPM is not abnormally low and FTIT not abnormally high it is an engine warning system failure, or RPM/FTIT indicator failure. Land as soon as practical.

3.2.10. GEAR HANDLE LIGHT

The red light in the gear handle (lollipop) is also considered a warning light. It refers to the landing gear or landing gear doors not being in the position commanded by the handle unless the gear is in transit.

Normal operation of this light is to be illuminated while the gears are in transit.

If the light remains on after moving the handle a failure has occurred.

If the light remains on after placing the gear handle up it indicates that one or more gears has not fully retracted or a landing door has not closed. Refer to 3.8.2 LG Extension Malfunctions later in this section.

If the light remains on after placing the gear handle down it indicates that one or more gear is not fully down and locked. Check the individual gear light to know which one and refer to 3.8.2 LG Extension Malfunctions later in this section.

3.2.11. HUD WARN

The HUD WARN message comes on whenever one of the warning lights illuminates.
Refer to the relevant warning light and reset the HUD with the WARN RESET switch on the ICP.

3.3. CAUTION LIGHT ANALYSIS

3.3.1. MASTER CAUTION

The MASTER CAUTION light comes on 3 seconds after anything on the caution light panel illuminates (except IFF). Check for the specific caution light and take relevant action. Please note: if a caution light remains on for more than 7 seconds VMS will issue a “CAUTION – CAUTION” message.

The MASTER CAUTION light can be reset by pressing the light face. It cannot be reset when the ELEC SYS caution light is illuminated; the ELEC CAUTION RESET pushbutton needs to be pressed in this situation.

3.3.2. CAUTION PANEL LIGHTS

A FLCS fault is detected. Refer to the PFL display. See 3.4. PFL Analysis.

A failure of the electrical system is detected. Check ELEC panel for illuminated light(s) and press the ELEC CAUTION RESET button.

Single generator failures are not coded for the moment in BMS, so when the ELEC SYS caution light comes on check the relevant ELEC lights and press the ELEC CAUTION RESET to try to reset the fault. If it does not reset, land as soon as possible.

Probe heater failure or monitoring system failure. Probeheat is not fully implemented in BMS and not yet necessary since there are no possible icing conditions. The system can be tested with the PROBE HEAT switch on the TEST panel. PROBE HEAT should be turned on in flight but is not mandatory in BMS. As such illumination of the PROBE HEAT caution light has no consequence and no further action is required.

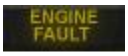
The C ADC caution light is not implemented in BMS. It does come on during the MAL & IND LTS test though.

The STORES CONFIG switch on the gear panel (left auxiliary console) is not in the correct position for the current loadout. To extinguish the caution light simply toggle the STORES CONFIG switch.

This caution light is not implemented in BMS. It refers to an Automatic Terrain Following failure. It has no consequence in BMS. It does come on during the MAL & IND LTS test.

The FWD FUEL LOW caution light comes on whenever the forward reservoir contains less than 400 pounds of fuel (C model) or 250 pounds of fuel (D model).

The AFT FUEL LOW caution light comes on whenever the aft reservoir contains less than 400 pounds of fuel (C model) or 250 pounds of fuel (D model). Note: engine flameout due to fuel starvation may happen in 4.34 even if the fuel quantity does not show empty tanks, especially with negative G pushovers. Fuel gauges are now as inaccurate as they are in real life.



Engine fault(s) detected. Refer to the PFL displayed message and press F-ACK button to reset the ENGINE FAULT caution light. Perform fault recall with a further press of F-ACK to determine if the failure condition still exists. See chapter 3.4. PFL Analysis.
Engine failures are hard to come by in BMS unless due to battle damage.

The SEC caution light illuminates whenever the engine is operating in secondary mode. Check the position of the ENG CONT switch on the ENG & JET START panel (left console). If the switch is on PRI either an automatic transfer to SEC has happened (this is not implemented in BMS), or your switch must be in SEC. In SEC the nozzle remains closed and afterburner is inhibited.

Temperature of the fuel going to the engine or engine oil is excessive.

Not used in the real F-16 Block 50 – not used in BMS.

Not used in the real F-16 Block 50 – not used in BMS.

An avionics fault was detected. Refer to PFLD message and press F-ACK button to reset the AVIONICS FAULT caution light. Perform fault recall with a further press of F-ACK to determine if the failure condition still exists. See 3.4. PFL Analysis.

Cooling of the avionics equipment is insufficient. AIR SOURCE knob position should be checked immediately. If AIR SOURCE was not in NORM place it in NORM and the fault will clear as soon as cooling becomes effective again. If AIR SOURCE was in NORM expect degraded avionic equipment performance and FCR shutdown. Retard throttle to 80% and shut down non-essential avionics. Land as soon as practical.

Malfunction of the radar altimeter. Move the radar altimeter switch to OFF. A-LOW will not be available anymore.

The IFF caution light illuminates whenever there is a condition to prevent Mode 4 operation: IFF in standby; Mode 4 disabled; Mode 4 keys zeroed, RF switch in SILENT. The IFF caution light will also illuminate briefly whenever your IFF is unable to answer a Mode 4 query. Depending on your IFF settings an audio cue may also sound at the same time. This caution light does not trigger a MASTER CAUTION light.

Malfunction in the NUCLEAR control circuitry which is irrelevant in BMS. This caution light is advisory and has no consequence in BMS.

This caution light illuminates whenever the ejection seat lever is up (system safe).
If desired simply arm the seat and the caution light will clear.

The Nose Wheel System (NWS) has failed and steering with the nose gear is not possible. Steering can be done with the rudder, but will become less effective at low speed. Differential toe brakes can be used at low speeds but beware of hot brake risks.

The anti-skid system is not implemented in BMS. This caution light has no consequence.
It does come on with the MAL & IND LTS test though.

The hook is not up and locked. Cable arrestment system is not implemented in BMS and the hook has no real purpose. Change the position of the HOOK switch on the gear panel to clear the fault.

The OBOGS caution light illuminates when the ECS air supply has dropped below 10 psi. Oxygen production has stopped (not that it really matters to us). Expect an OXY LOW warning light.

The CABIN PRESS caution light comes on when the cockpit pressurisation is above 27000 feet. Check AIR SOURCE knob for NORM position. If caution light remains illuminated descend below 25000 feet and reduce speed to 500 knots maximum. Flight can be continued below 25000 feet as oxygen is available. Hypoxia is now modelled in 4.34 and you will blackout if you don’t descend quickly enough. If you do blackout and you are descending you will recover when you get low enough, unless you hit the ground first!

3.4. FAULT ANALYSIS

All faults sent to the FCC are reported via the maintenance fault list (MFL) and accessed via the TEST page on the MFD. All MFL faults are recorded on the DTC file for access and review after the flight.

Two fault reporting schemes are used. The maintenance fault list (MFL) contains the detailed information for all reported faults, while the pilot's fault list (PFL) contains the same information only for those faults that would be of interest to the pilot. The PFL is a subset of the MFL.

Faults that require pilot action or reduce mission capabilities are reported on the pilot's fault list (PFL) and displayed on the pilot's fault list display (PFLD). The MASTER CAUTION light and avionics fault, engine fault and FLCS fault caution panel lights illuminate to indicate pilot faults. The faults are automatically displayed on the PFLD. See 3.4.2 PFLD analysis.

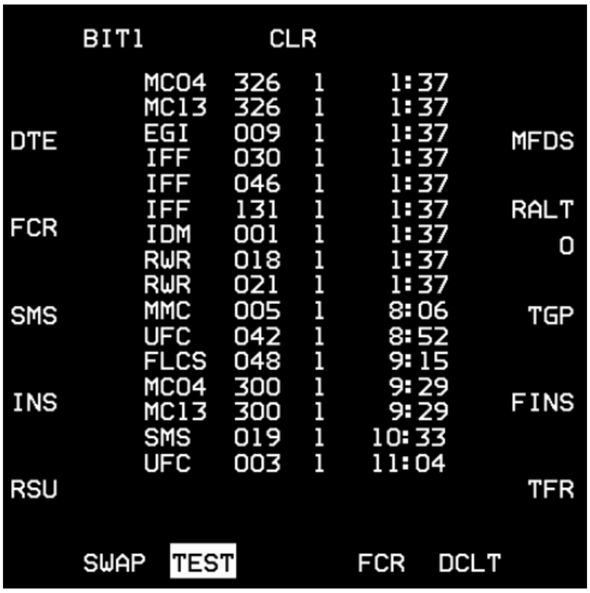
The MFL often helps isolate faults to a specific subsystem, which might not be necessary during the flight but used by maintenance afterwards. In our case, it might be used for reviewing the faults that occurred during a flight to help determine if pilot actions were appropriate.

3.4.1. Maintenance Fault List (MFL)

The Maintenance Fault List is accessed from the MFD TEST page (See 1.4.4)
MFL displays a maximum of 17 faults with the following format:

FAULTY subsystem - TEST number - Number of occurrences (up to 9) - Time of first occurrence.

MC04 326 1 1:37



The first column (PFL message) identifies the subsystem in which the fault occurred.

The second column is a test number identifying the specific subsystem that failed.

The third column states the number of times the failure occurred since FCC power-up. The maximum times recordable for one failure is nine.

The last column is a time of first occurrence of the fault since FCC power-up. Up to 17 entries can be displayed on the MFL. Included in those 17 are two events: the takeoff and the landing. The logging of these two events segments the entries into three significant parts of the mission.

If more than 17 malfunctions including takeoff and landing occur, the last one is always replaced with new.

All faults are remembered by the DTC (see later *DTC Faults recording* part). A takeoff (TOF) flag is entered when airspeed reaches 120 kts and the gear is up. A landing (LAND) flag is recorded when gear is down and airspeed is less than 80 kts.

The subsystems are identified by one of the following mnemonics:

- AMUX A-multiplex bus
- BLKR Interference blanker unit
- BMUX B-multiplex bus
- CADC Central air data computer
- CMDS Countermeasures dispensing set
- DLNK Data modem
- DMUX D-multiplex bus
- EGI Embedded Global Positioning System / Inertial Navigation Set
- ENG Engine
- FCC Fire control computer
- FCR Fire control radar
- FDR Crash survivable flight data recorder
- FLCS Digital flight control system (DFLCS)
- FMS Fuel measurement system
- GPS Global positioning system
- HUD Head-Up display
- IFF Advanced identification friend or foe
- IDM Improved Data Modem
- INS Inertial navigation set
- MC04 Modular Mission Computer
- MC13 Modular Mission Computer
- MMC Modular Mission Computer
- MFDS Multifunction display set
- MSL Missile slaving loop
- NVP Navigation Pod
- RALT Radar altimeter
- RWR Radar warning receiver
- SMS Stores management set
- TCDS Threat Adaptive Countermeasures Dispensing Set
- TCN TACAN
- TGP Targeting Pod
- UFC Upfront control set
- TOF Pseudo fault recording the take-off time.
- LAND Pseudo fault recording landing time.

When a fault occurs the PFL is displayed on the TEST page and the corresponding test number (3 digits) is displayed in the second column. The test number is the key to identify the subsystem that failed. Refer to section 3.4.3. for a list of test numbers.

In some cases the PFL might be the same and only the different test number will provide additional information about the exact cause of the malfunction.

For instance, a NVP COMM FAIL might have 2 causes: number 14 refers to a failure of the NVP due to INS, while number 15 refers to NVP failure because of a radar altimeter problem. In this particular case the pilot, knowing the exact cause of the problem, can quickly remedy it by checking the relevant system.

3.4.1.1. MFL management at ramp start

It is normal to have faults reported during the ramp start sequence. As the systems come online multiple faults will be reported until all systems are nominal. These faults will clear by themselves as the systems come online, or as the pilot powers up and checks other systems.

Once the aircraft is ready to taxi the pilot clears the MFL by pressing OSB 3 on the TEST page to reset the MFL to a clean state, which will help tracking in flight faults better if they occur.

Clearing the MFL initiates a survey of all current malfunctions and detects and reports persistent faults occurring in the system. If a fault is still present after MFL clearing, it will be displayed again on the TEST page. If the faulty system has been shut down, the system cannot report the fault and the TEST page will remain void of that fault report.

After take-off once the aircraft reaches 120 Kts with gear up the pseudo fault TOF will be created to record the take-off time. Please note, if the MFL is cleared in flight the TOF pseudo fault will be replaced by the mission time at MFL clearing.

If the flight happens without any malfunctions the next pseudo fault that will be generated will be the landing fault (LAND) that will record the landing time when the airspeed falls below 80 kts with the gear down.

3.4.1.2. DTC fault recording

All MFL faults can be reviewed after the flight by analysing the DTC_last_flight_faults file located in the *\User\Logs* folder.

This file will be overwritten every time you enter 3D, so is only available before your next flight.

The file has the following structure:

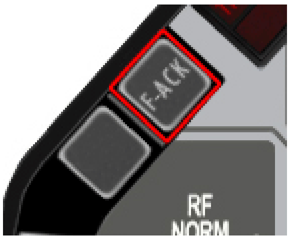
```
[ 0:00]  [ 0:00]  [SET]  [4]    [FLCS BIT PASS ]   [-1]
[ 0:24]  [ 0:24]  [SET]  [2]    [TOF ]             [4]
[ 1:21]  [ 1:21]  [SET]  [123]  [DMUX BUS FAIL]    [3]
```

[Total mission time] [Time from last MFL clear] [Action] [ID] [Fault] [Test Number]

- Total mission time indicates at which time into the mission the fault occurred.
- Time from last MFL clear will indicate the time since the MFL was cleared (if the pilot didn't clear the MFL with OSB 3, it will be equal to the first time block).
- Action can be SET or CLEAR. SET refers to a fault occurring. CLEAR refers to a fault being cleared (by pilot action most of the time).
- ID is a number internal to BMS and irrelevant for the user.
- Fault lists the system where the malfunction appeared (PFL).
- The Test number corresponds to the second column on the MFL test page and may provide further information about which subsystem failed. See 3.4.3 for a list of test numbers.

3.4.2. PILOT FAULT LIST (PFL)

BMS 4.33 introduced a fully implemented Pilot Fault List (PFL). Faults relevant to the **FLCS**, **Engine** and **Avionics** are categorised by priority and displayed on the Pilot Fault List Display (PFLD) aka PFD (Pilot Fault Display) located on the right auxiliary console. Faults are acknowledged (that does not mean solved) by pressing the F-ACK (Fault-Acknowledge) button on the left glareshield.



The PFLD displays 1 status line and a maximum 3 fault lines.

The faults displayed on the PFLD are categorized and prioritised in four categories (listed by priority):

- FLCS warning level faults – FLCS mnemonic displayed on the left side of the status line. Warning level PFL are displayed within >symbols<
- FLCS caution level faults – FLCS mnemonic displayed on the left side of the status line.
- Engine faults – ENG mnemonic displayed in the centre of the status line.
- Avionics faults – AV mnemonic displayed on the right side of the status line.

If the PFLD is blank that is a normal situation and there is no reported fault.
When the system reports faults the PFLD will display the category of fault and the type of malfunction.
When the malfunction has been acknowledged with the F-ACK button but the fault is still present the PFLD will blank except for the fault category mnemonic in the status line at the top.
When the fault is cleared (problem solved) the PFLD will revert to a fully blank display.

Below the status line the PFLD has room to display 3 faults. They are structured in the following manner:

Affected subsystem (**FLCS**) – Affected function (**LEF**) – Severity of fault (**LOCK**)

Warning level PFL are displayed within >symbols< as seen on the first two faults below:

If more than 3 failures occur consecutive faults are displayed on following pages of the PFLD. In that case page numbers and arrows pointing down signify that more faults exist. This can be seen in the above picture. The next page is accessed by pressing the F-ACK button.

3.4.2.1. Example workflow: Ramp Start with AIR SOURCE knob out of NORM

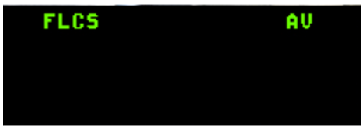
1. The first indication to the pilot will be the illumination of the MASTER CAUTION light. It is not in fact the first caution light to illuminate, but usually the first one that is noticed.

2. The pilot will then check the caution panel and identify the faulty system.
In this case both the FLCS FAULT and AVIONICS FAULT lights are illuminated.

3. Looking at the PFLD the pilot will confirm the FLCS & AV mnemonics in the status line and the type of fault present in the following lines. Pressing the F-ACK button will acknowledge each page in sequence. The button needs to be depressed as many times as they are pages present.

4. After the F-ACK press the second page is displayed. Bottom arrows are still displayed so a third page is present and needs to be reviewed with the F-ACK button.

5. The third and final page is acknowledged. A subsequent F-ACK press will clear the faults.



6. Once all faults have been acknowledged the mnemonic will remain displayed as long as the fault is present.

7. With the fault cleared the caution panel will extinguish the FLCS and the AVIONICS caution lights.

The others still remain illuminated as the source of the problem hasn't been solved yet.

The EQUIP HOT is a tell-tale sign of the real issue here if the pilot didn't get it through the PFL messages.

8. The F-ACK button can be used as a fault recall to re-evaluate the problem that has not cleared. Pressing the F-ACK again the PFL will display the image on the left. Subsequent presses will display page 2 and page 3 if still present. The way faults happen is very dynamic and in this case there is no page 3 as some of the initial faults were normal faults happening during the ramp start procedure.

9. Reviewing those faults the pilot now finally realises that the AIR SOURCE knob is not in the NORM position. He moves the knob accordingly. The FLCS status light will disappear as the FLCS faults clear.

10. The AV mnemonic will remain on. A further fault recall (pressing the F-ACK button) will show the pilot that the MMC is still degraded. Shutting down the MMC power may or may not clear the fault. The active cooling may or may not provide enough bleed-air to cool down the MMC and make it operational again, depending on how long the system was overheated.

3.4.2.2. Special considerations:

- The PFLD is powered by the UFC and will obviously blank if no power is available to the UFC or in case of UFC failure. In that case the AVIONICS FAULT caution light is disabled as well.
- If the FLCS system fails (FLCS BUS FAIL) the AVIONICS FAULT caution light will illuminate rather than the FLCS FAULT light. FLCS faults are not reported on the PFLD and the MFD FLCS page will report OFF. The only way to see the fault is through the MFD TEST page.
- ELEC faults must be acknowledged with the ELEC CAUTION RESET pushbutton on the ELEC panel (left console).
- It is normal to have to press the F-ACK button numerous times to clear and/or review faults.

3.4.3. Table of possible faults (PFL & MFL):

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
FLCS WARNING	>STBY GAIN<	14	Dual Air Data failure	FLCS in Standby Gains	FLCS RESET - Land ASAP
	>FLCS DUAL FAIL<	21	FLCS electronics, sensor or power failure	None	Not yet implemented
	>FLCS LEF LOCK<	43	LEFs locked or damaged	Possible asymmetry	Check FLCS panel LEF switch - FLCS reset
	>FLCS AP FAIL<	50	Autopilot has failed	Autopilot unavailable	Do not use Autopilot
	>FLCS BIT FAIL<	55	Failed FLCS BIT	Fault only on ground	Not resettable through FLCS reset - rerun FLCS BIT again
	>SWIM ATTD FAIL<	75	INS attitude estimator failure	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM SCP FAIL<	79		TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM NVP FAIL<	76	Navigation pod self mode failure	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	>SWIM RALT FAIL<	80	SDC monitor failure or CARA data bad	TFR Auto fly-up	Discontinue TFR ops - Refer to TFR failure
	PFL NAME		**CAUSE**	**SYMPTOMS**	**CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS**
FLCS CAUTION	FLCS ADC FAIL	13	Air data input signal failure	Second ADC fail triggers STBY GAINS and latches ADC fail against FLCS RESET attempt	FLCS RESET - Land ASAP
	ISA RUD FAIL	34	Rudder servo actuators malfunction	Rudder problems	FLCS RESET - Land ASAP
	ISA ALL FAIL	36	Controls servo actuators malfunction	Flight control problems	FLCS RESET - Land ASAP
	FLCS HOT TEMP	48	Excess temperature in FLCS branches	None	Not yet implemented
	FLCS SNGL FAIL	49	Single electronic or sensor failure in FLCS	Only on Ground	FLCS RESET
	FLCS BIT PASS		Bit passed (not real caution)		None
	FLCS FLUP OFF	54	FLCS auto fly-up is inhibited	No flyup in manual TF	Discontinue TFR ops
	FLCS MUX DEGR	71	FLCS BIT detected degradation of FLCC MUX interface when attempting FLCS BIT without FCC/MMC power	None - fault only on ground	Not resettable through FLCS reset - rerun FLCS BIT again
ENGINE	ENG AI FAIL	15	Engine anti-ice valve failed (GE129)	None	Avoid areas of suspected icing conditions (not implemented)
	ENG A/B FAIL	18	Afterburner system failure (GE129)	Afterburner not available	Go SEC mode. Land asap
	ENG AI TEMP	84	Possible engine damage (PW229)	Rough engine	Land asap
	ENG AI FAIL	85	Engine anti-ice valve failed (PW229)	None	Avoid areas of suspected icing conditions (not implemented)
	ENG A/B FAIL	87	Afterburner system failure (PW229)	Afterburner not available	Go SEC Mode. Land asap

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
AVIONICS FAULTS	FLCS BUS FAIL	3	FLCS System failure	Illuminates AVIONICS FAULT light instead of FLCS FAULT light	Can't use PFLD to review FLCS fault; use MFD TEST page
	FMS FAIL	4	Fuel Management system failure	Fuel bingo capability degraded	Monitor Fuel situation closely
	HUD BUS FAIL	3	HUD system failure	No HUD	RTB
	HMCS LBUS FAIL	3	Left Bus HMCS failure	Loss of HMCS	Pilot discretion
	HMCS RBUS FAIL	6	Right Bus HMCS failure	Loss of HMCS	Pilot discretion
	HMCS TEMP FAIL	20	Overheat of the HMCS system	HMCS will shutdown	Pilot discretion
	RALT BUS FAIL	3	Radar Altitude system failure	No Radar Altimeter	Pilot discretion
	FCC FAIL	4	FCC Failure	Fire Control Computer non-operational	Discontinue offensive operations
	FCC TEMP	132	Overheat of the FCC system	Possible damage if not shut off	Shut off FCC, check AIR SOURCE knob position
	FCR BUS FAIL	3	FCR Failure	FCR non-operational	Discontinue offensive operations
	FCR XMTR FAIL	94	FCR transmit operation failure	FCR not emitting	Discontinue offensive operations
	BLKR BUS FAIL	3	RWR system failure	RWR is blind	Discontinue offensive operations
	DLNK FAIL	5	Datalink system failure	Datalink non-operational	Pilot discretion
	UFC BUS FAIL	3	UFC system failure	DED and PFLD non-operational	Reset UFC
	UFC TEMP	42	Overheat of the UFC system	Possible damage if not shut off	Shut off FCC, check AIR SOURCE knob position
	AMUX BUS FAIL	3	AMUX BUS failure	FCC is forced to NAV	Discontinue offensive operations
	BMUX BUS FAIL	3	BMUX BUS failure	FCC is forced to NAV	Discontinue offensive operations
	DMUX BUS FAIL	3	DMUX BUS failure	HUD, HMS, MFDs non-operational	Pilot discretion
	CADC BUS FAIL	3	Loss of CADC parameters to avionics system	No Airdata Available	Pilot discretion
	EPOD SLNT DEGR	60	ECM system failure	ECM non-operational	Discontinue offensive operations
	CMDS BUS FAIL	3	CMDS bus failure	CMDS non-operational	Discontinue offensive operations
	CMDS DSPN DEGR	4	CMDS failure with chaffs	Chaff release non-operational	Pilot discretion
	CMDS INV DEGR	6	CMDS failure with flares	Flare release non-operational	Pilot discretion
	RWR BUS FAIL	3	RWR BUS failure	RWR non-operational.	Reset RWR - Pilot discretion
	RWR DEGR	21	Problem in the RWR system	All RWR quadrants inoperable	Reset RWR - Pilot discretion
	RWR DEGR (135)	6	Problem in the front left RWR (09-12)	Front left RWR quadrant inoperable	Reset RWR - Pilot discretion
	RWR DEGR (135)	7	Problem in the front right RWR (12-03)	Front right RWR quadrant inoperable	Reset RWR - Pilot discretion
	RWR DEGR (225)	8	Problem in the aft left RWR (06-09)	Aft left RWR quadrant inoperable	Reset RWR - Pilot discretion
	RWR DEGR (225)	9	Problem in the aft right RWR (03-06)	Aft right RWR quadrant inoperable	Reset RWR - Pilot discretion
	MMC TEMP	5	Overheat in the MMC system	Possible damage if not shut off	Shut off MCC, check AIR SOURCE knob position
	MMC DEGR		Mission Modular computer problem	MMC non-operational	Pilot discretion

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
AVIONICS FAULTS (CONTINUED)	MC04	326	Mission Modular computer problem	MMC restart	None
	MC04 DEGR	300	Mission Modular computer problem	MMC restart	None
	MC13	326	Mission Modular computer problem	MMC restart	None
	MC13 DEGR	300	Mission Modular computer problem	MMC restart	None
	TCN FAIL	4	TACAN system failure	TACAN non-operational	Use INS steerpoints
	IFF BUS FAIL	3	IFF system failure	IFF non-operational	Pilot discretion
	IFF INM4 FAIL	30	IFF mode4 failure	Degraded AIFF. Mode 4 not available	Pilot discretion
	MSL SLAV FAIL	4	Missile Slave failure	Missile seeker will not follow radar line of sight	Use boresight mode
	MFDS LFWD FAIL	168	MFD LEFT failure	Left MFD non-operational	Pilot discretion
	MFDS RFWD FAIL	177	MFD RIGHT failure	Right MFD non-operational	Pilot discretion
	GPS BUS FAIL	3	GPS failure	GPS non-operational	INS will drift without GPS backup
	IDM BUS FAIL	3	IDM failure	Loss of IDM	Pilot discretion
	INS BUS FAIL	3	INS failure	INS non-operational	Go backup system (CNI)
	EGI AR FAIL	9	EGI Failure	No GPS data available	Go backup system (CNI)
	EGI NAV FAIL	13	EGI failure	GPS/INS non-operational	Go backup system (CNI)
	NVP COMM FAIL	13	Invalid Air Data	CADC fault (Not implemented)	Not implemented
	NVP COMM FAIL	14	INS invalid data	Terrain following FAIL and AUTO fly-up	Check INS/EGI/GPS
	NVP COMM FAIL	15	Invalid RALT	Terrain following FAIL and AUTO fly-up	Check RALT switch position & RALT BIT not running
	NVP FLIR ALIGN	12	FLIR alignment failure	FLIR video misaligned	Reset FLIR, discontinue FLIR operations
	NVP FLIR FAIL	9	FLIR failure	FLIR inoperative	Discontinue TFR/FLIR operations
	NVP FAIL	10	Navigation pod failure	Navigation pod inoperative	Discontinue TFR operations
	NVP TFR FAIL	24	TFR failure	TFR inoperative	Discontinue TFR operations
	SMS BUS FAIL	3	SMS BUS failure	All functions lost except EJ, SJ	RTB at pilot discretion
	SMS TEMP	19	Overheat in the SMS system	None	Shut off SMS, check AIR SOURCE knob position
	SMS STA1 DEGR	103	Station 1 Remote interface degraded	Command not executed correctly	Left wingtip pylon malfunction, pilot discretion
	SMS STA1 FAIL	87	Station 1 Remote interface failed	Station operation inhibited	Left wingtip pylon malfunction, pilot discretion
	SMS STA2 DEGR	104	Station 2 Remote interface degraded	Command not executed correctly	Pilot discretion
	SMS STA2 FAIL	88	Station 2 Remote interface failed	Station operation inhibited	Pilot discretion
	SMS STA3 DEGR	105	Station 3 Remote interface degraded	Command not executed correctly	Discontinue offensive operations
	SMS STA3 FAIL	89	Station 3 Remote interface failed	Station operation inhibited	Discontinue offensive operations
	SMS STA4 DEGR	106	Station 4 Remote interface degraded	Command not executed correctly	Left wing tank pylon - monitor fuel

	PFL NAME	TEST Number	CAUSE	SYMPTOMS	CORRECTIVE ACTIONS / REMARKS / SEE EP CHECKS
AVIONICS FAULTS (CONTINUED)	SMS STA4 FAIL	90	Station 4 Remote interface failed	Station operation inhibited	Left wing tank pylon - monitor fuel
	SMS STA5 DEGR	107	Station 5 Remote interface degraded	Command not executed correctly	Centreline - monitor fuel
	SMS STA5 FAIL	91	Station 5 Remote interface failed	Station operation inhibited	Centreline - monitor fuel
	SMS STA6 DEGR	108	Station 6 Remote interface degraded	Command not executed correctly	Right wing tank pylon - monitor fuel
	SMS STA6 FAIL	92	Station 6 Remote interface failed	Station operation inhibited	Right wing tank pylon - monitor fuel
	SMS STA7 DEGR	109	Station 7 Remote interface degraded	Command not executed correctly	Discontinue offensive operations
	SMS STA7 FAIL	93	Station 7 Remote interface failed	Station operation inhibited	Discontinue offensive operations
	SMS STA8 DEGR	110	Station 8 Remote interface degraded	Command not executed correctly	Pilot discretion
	SMS STA8 FAIL	94	Station 8 Remote interface failed	Station operation inhibited	Pilot discretion
	SMS STA9 DEGR	111	Station 9 Remote interface degraded	Command not executed correctly	Right wingtip pylon malfunction, pilot discretion
	SMS STA9 FAIL	95	Station 9 Remote interface failed	Station operation inhibited	Right wingtip pylon malfunction, pilot discretion
	TGP BUS FAIL	3	TGP system failure	Total loss of TGP function	Discontinue TGP operations
	TGP HADF FAIL	9	Maverick Controller fail	No AGM-65 hand-off at Boresight	Reattempt boresight procedure or use VIS mode
	TGP HADF FAIL	10	Maverick Controller out of tolerance	Boresight error	Reattempt boresight procedure or use VIS mode
	TGP HADF FAIL	18	Missile Boresight Correlator fail	No AGM-65 hand-off	Cancel sensor lock and reattempt handoff or use VIS mode
	TGP HADF FAIL	19	Negligible Missile Boresight Correlator capability degradation	Hand-off error	Cancel sensor lock and reattempt handoff or use VIS mode
	XP NO KEYS		Mode 4 Keys have been erased	IFF not able to use Mode 4	Pilot discretion
	INT NO KEYS		Mode 4 Keys have been erased	IFF not able to use Mode 4	Pilot discretion

3.5. GROUND EMERGENCIES

3.5.1 HUNG START / NO START

A hung start happens when the RPM does not increase past 20% (with JFS running) irrespective of the idle detent keystroke or the throttle position (out of OFF). This is most likely a hardware problem with your throttle (probably not correctly calibrated) or an idle detent keystroke problem. Abort the aircraft and check your hardware / config settings.

3.5.2 ENGINE START IN BATTERY

Although not an emergency it is not uncommon to see virtual pilots trying to light up the engine on battery power. Initial indication of a battery start is the ELEC SYS light on the caution panel remaining on throughout the engine start (it will extinguish when RPM reaches 50% during a normal start). Many virtual pilots miss this though and realise the situation only when the avionics (MFDs, UFC etc) refuse to start. Unlike in 4.33 where a battery start had no consequence, in 4.34 battery start will most likely induce hot or hung start. It is now therefore mandatory to start engine in MAIN power

3.5.3 HOT START

BMS 4.34 introduced the possibility of engine start failure due to pilot error. Advancing the throttle to IDLE *before* the JFS has spun the engine up to 20% RPM may cause a HOT START with FTIT rising very quickly above the 800°C (PW) or 935° (GE) ground limits.

During engine start the pilot **must** wait for engine RPM to reach 20% **before** moving the throttle to IDLE, then closely monitor FTIT temperature. If the needle starts to move quickly to 750°C and above a hot start is occurring and the engine must be immediately shut down. Failure to interrupt the engine start will damage the engine, leading to engine fire with FTIT rising to well over 1000°C.

After moving the throttle back to the CUTOFF position (click idle detent if necessary) keep the JFS running as it helps to cool down the engine. Allow FTIT to fall to 200°C before advancing the throttle to IDLE to attempt another engine start.

In addition there is a small, random chance that even with no pilot error a HOT START could develop. It is now mandatory to closely monitor FTIT during engine start and intervene if necessary.

Note: after 4 minutes running (on the ground) the JFS will start to overheat (JFS light will flash once per second). After 8 minutes running (on the ground) the JFS will fail (light flashes twice per second) and you will no longer be able to start the engine. To avoid this you should shut down the JFS if necessary to let it cool (the lamp will stop flashing when it has cooled sufficiently), before asking your crew chief to spend 3 minutes recharging it (ATC > Ground menu page).

3.5.4 OIL PRESSURE

During ramp start oil pressure should rise to a minimum of 15 psi. If it remains under 15 psi and the HYD / OIL warning light stays illuminated as engine RPM reaches 35%, shut down the engine (throttle back to CUTOFF - click idle detent if necessary) immediately to avoid engine seizure and/or fire.

You may try to clear the fault, allow engine RPM to drop below 20%. Leave the JFS on to cool the engine at first then switch the JFS off as RPM approaches 25% to allow engine RPM to fall below 20%.

Once RPM has fallen below 20% you can recommence the engine start procedure. If the JFS will not start you will need to ask your crew chief to recharge it (ATC > Ground menu page) first.

3.5.4 EQUIP HOT CAUTION LIGHT

If the EQUIP HOT caution light illuminates during ramp start check AIR SOURCE knob position is set to NORM. If it was not in NORM the ECS cannot provide cooling to avionics. If EQUIP HOT remains on one minute after AIR SOURCE is set to NORM place all nonessential avionics to OFF and abort the aircraft.

3.5.5 FLCS BIT FAILURE

FLCS BIT fail is indicated by the FAIL light on the FLCS panel coming on, relevant information on the FLCS MFD page and PFL messages. The only way to clear a failed BIT is to run the FLCS BIT again. During that BIT both the RUN and FAIL light will be on. At the end of the new FLCS BIT the FAIL condition may clear. If FAIL did not clear execute another BIT until the condition clears. Please note, if any of the FLCS switch was not in the down position before initiating the test, the BIT will most likely fail.

3.5.6 HOT BRAKES

It is the pilot's responsibility to determine when a hot brake condition exists. BMS now features accurate modelling of the real F-16 brake energy limits. The limits are based on gross weight, temperature, pressure altitude and airspeed at which an abort (during the takeoff roll) or braking on landing was initiated.

Refer to the chart on the next page for brake energy limits.

It takes between 5 and 9 minutes (random) for the brake energy/heat to build up after braking. It is during this time period that failures due to a hot brake condition may occur, depending on how much energy was built up.

Brake energy is also continually monitored and built up during taxiing (whenever the brakes are applied). Build up from taxiing is at its greatest with low gross weights and long taxis, because the brakes must be used more often to control taxi speed. Taxiing with a gross weight of 20000 lbs at 10 knots over a distance of 20000 ft yields ~4.3 million ft-lbs of energy absorbed per brake. Heavier weight and increased speed (within reason of course) uses less energy over the same distance. Heat and energy also dissipate over time. A rejected (aborted) takeoff with maximum braking followed by another rejected takeoff will likely put the aircraft in the danger zone, or worse.

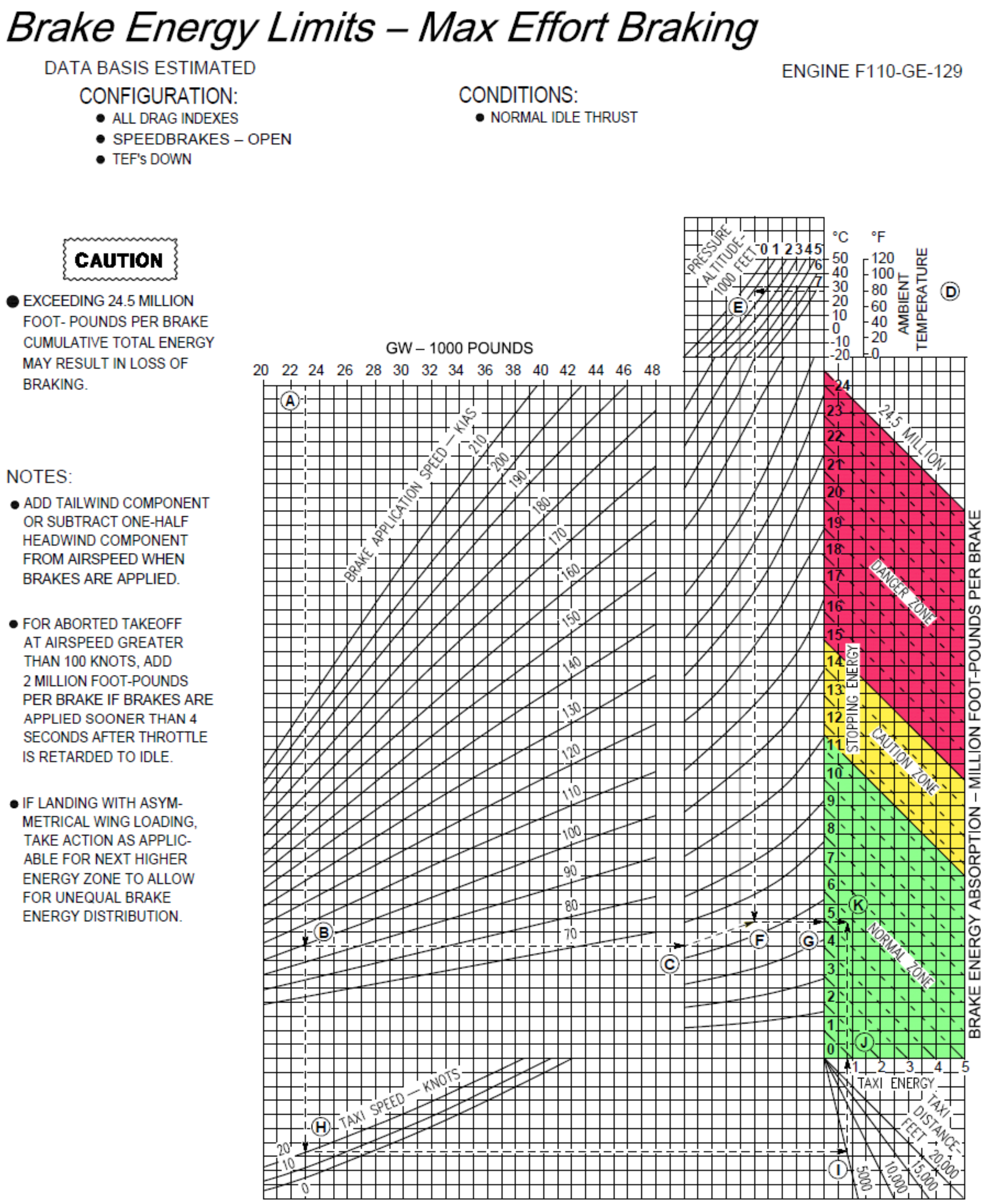
When a hot brake condition is suspected, brake use should be minimised and if possible the aircraft stopped and chocked in the nearest designated hot brakes area (do not use the parking brake). Turn EPU off, retard the throttle to OFF to shut down the engine (IRL hot brakes present a fire hazard), then turn MAIN Power switch OFF.

A BMS hot brake situation may deteriorate to the following situations depending on how much energy the brakes absorbed:

• Blowing tyre fuse plugs - tyre(s) go flat which causes much more longitudinal friction and less lateral friction. Fusible plugs in aircraft tyres are designed to melt at specific temperatures to relieve tyre pressure and thus keep them from exploding.

• Brake hydraulic pressure line failures - brake reaction is reduced or lost completely.

• Main gear tyre fire, hydraulic fluid fire, exploding tyres and gear failure - the affected gear fails completely.



Zone 1 : Green: Normal zone - 0-11.5 million ft-lbs, nothing happens
Zone 2: Yellow: Caution zone - 11.5-15 million ft-lbs, 30% chance something bad happens
Zone 3 : Red: Danger zone - 15-24.5 million ft-lbs, 90% chance something bad happens
Zone 4 : Over 24.5 million lbs: Danger zone + immediate braking failure likely

3.5.7 NWS FAILURE

NWS failure is indicated by the NWS FAIL caution light, in which case do not engage NWS; a malfunction may cause abrupt turns, tyre skidding or blowouts and departure from the paved surface. Use rudder and brakes as required to steer the aircraft on the ground. Beware of increased hot brakes risk when using differential brakes to steer the aircraft.

Remember NWS is not to be used at speeds higher than 70 knots. Doing so may cause abrupt turns, tyre skidding or blowouts and departure from the paved surface as well.

3.6. TAKEOFF EMERGENCIES

3.6.1 ABORT / REJECTED TAKEOFF

Normally with the short takeoff distance capability of the F-16 aborting should not be a problem unless directional control is a factor (blown tyre). An early decision to abort will lead to the best outcome. Aborting after rotation should not be done in Falcon as runway distances are often too short to allow it. Flying to a key position is advised instead.

When aborting, retard throttle to idle and apply maximum wheel braking (maximum pedal pressure while maintaining directional control). When the nose wheel is on the ground apply maximum braking effort (full aft stick, fully opened speedbrakes and maximum wheel braking). NWS should be engaged only if directional control becomes a problem.

You may lower the hook if you like but as there is no cable arrestment system in BMS it does nothing.

Consider following the hot brakes procedure after any abort. Taxiing after an abort will further increase the likelihood of hot brakes.

3.6.2 LG FAILS TO RETRACT

If the landing gear handle warning light remains on after the handle has been moved up, the landing gear or landing gear doors are not fully retracted. In BMS chances are that you oversped the jet with gear down (>305 knots). If this is the case reduce speed immediately to below 300 knots and replace the gear handle in the down position.

If landing gear comes down normally land as soon as possible. Do not try to retract the gear as it may cause further damage and prevent further gear extension.

If the landing gear does not indicate down reduce speed further to below 190 knots and use the alternate gear extension handle. Bear in mind that NWS is not available after an alternate gear extension.

If gear then indicates it is down and locked ask for a visual confirmation that your gear is down (if flying multiplayer) and land normally. Use differential braking for directional control (if available).

If gear still indicates it is unsafe apply alternating G forces (-1.0 to +3.0G) to try to free the landing gear. Although this does not work in BMS, it’s still cool to try.

Consider landing with LG unsafe/up or ejection.

- If possible divert to a runway with a minimum crosswind component.
- If wing fuel tanks are carried keep them but jettison all armament and centreline stations (if possible).
- Ensure wing fuel tanks are empty and decrease gross weight as much as possible (that means burning fuel since the F-16 does not have a fuel dump system). If you have no choice but to land immediately and cannot empty the wing fuel tanks, jettison them as well.
- Open the AR door to depressurise the wing tanks (once the wing tanks are emptied).
- Switch off the FCR, ST STA & HDPT power and ECM power.
- Extend ALT FLAPS.
- Place the EPU to ON.
- Fly a low angle approach at 13° AOA & place the throttle to CUTOFF immediately before touchdown.

3.6.3 BLOWN TYRE ON TAKEOFF

A blown tyre condition is difficult to recognise. The directional control loss may be confused with crosswind.

Aborting takeoff may be more dangerous than continuing, especially if speed is already high. If takeoff is continued do not retract the landing gear, reduce the gross weight and plan to land as soon as practical (refer to landing emergencies chapter 3.8.1 Landing With A Blown Tyre later in this section).

If aborting the takeoff try to maintain directional control with rudder, differential braking (if available) and NWS when at control speed. Stop straight ahead and shut down the aircraft. Do not taxi further unless in case of an emergency.

3.7. IN FLIGHT EMERGENCIES

3.7.1 COCKPIT PRESSURE MALFUNCTIONS

Illumination of the CANOPY warning light indicates a loss of cockpit pressure. It may be caused by the canopy seal or a failure or shutdown of the ECS system. If cockpit pressure exceeds 27000 feet the CABIN PRESS caution light will illuminate; descend below 25000 feet altitude and maintain a speed under 500 knots. The flight can be continued below 25000 feet.

Hypoxia is now modelled in 4.34 and you will blackout if you don't descend quickly enough. If you do blackout and you are descending you will recover when you get low enough, unless you hit the ground first!

3.7.2 EQUIP HOT CAUTION LIGHT

As always in this case the first item to check is that the position of the AIR SOURCE knob is in NORM. Reduce power to 80% RPM. Another reason why EQUIP HOT might be illuminated is flying for long periods with the gear extended at low level. Indeed flying below 8000 feet for more than 7 to 8 minutes with the gear down might shut the ECS off. If EQUIP HOT remains on shut down all non-essential avionics (the FCR will be shut down automatically) and land as soon as practical.

3.7.3 EJECTION

Since there is absolutely zero risk of death or even injury in our hobby, there should be no qualms about ejection when necessary; just pull the handle and off you go to meet the silk.

3.7.4 ELECTRICAL SYSTEM FAILURE

Electrical System failures are indicated by illumination of the ELEC SYS caution light. Refer to Chapter 1.9 Electrical System for troubleshooting. The ELEC SYS caution light cannot be reset with the MASTER CAUTION light. The CAUTION RESET pushbutton on the ELEC panel is used to reset any ELEC SYS caution light.

3.7.5 ENGINE MALFUNCTIONS

4.34 introduced more possibilities to have engine trouble in flight. Nearby explosions (AAA or SAM) may cause your engine to flameout, fuel starvation may occur when running on fumes due to unreliable fuel gauges, particularly with negative G. In most cases engine restart may be attempted with an air-start procedure.

3.7.5.1 Air-Start

Air start procedures differ depending on the setting of the Idle Cutoff option in *Falcon BMS.cfg*.
With that Config option deactivated (default) you will need the (unrealistic) idle detent keystroke.
If you have the Idle Cutoff option in *Falcon BMS.cfg* enabled then you rely on your flight controller's mechanical detent for the idle detent, making the keystroke unnecessary.

The first indications of an engine shutdown are a decrease in RPM and FTIT (and engine noise).
If the EPU is in NORM it will immediately start running to power the emergency and hydraulic buses. Depending on RPM % the EPU may also start to deplete the hydrazine. Remember an EPU running on hydrazine will only last about 10 minutes before it runs out of fuel.

When the engine flames out in flight engine RPM may still remain high enough, especially in a dive due to air flow spinning the turbine, to restart the engine if RPM is above 20-25%.Air-start can thus be initiated without use of the JFS.

JFS assisted air-starts are only necessary when engine RPM has decayed below the 20-25% limit.
Air-start efficiency in BMS is not currently dependent on altitude.

To initiate an air-start with sufficient engine RPM, place the throttle in the CUTOFF position and then move it past the idle detent (or use the idle detent keystroke) and place it mid-range (standing up). Then check for signs of engine relight, such as FTIT & RPM increasing.

If RPM alone is not sufficient to air-start the engine and if you have altitude to spare, you can dive the aircraft to windmill the turbine and provide sufficient pressure to relight the engine.

If you do not have the altitude to increase speed by diving you will need to use the JFS to assist the air-start. The JFS has an operating range and should be engaged only below 20000 feet and at airspeeds below 400 knots.

Once in the JFS envelope and with the throttle in CUTOFF switch the JFS on to help get the RPM up to 20-25%. At that point move the throttle to mid-range and monitor RPM and FTIT for engine relight. The JFS will not shut down automatically when the engine reaches 50% RPM in the air, but as it is being cooled by airflow it will not overheat like it does on the ground. Switch it off manually after successful engine restart and completion of your post-restart checks.

Be aware that just like on the ground you only have one shot at the JFS. If you fail to relight the engine the JFS cannot recharge and you will not be able to restart it. In the air the JFS recharges only when the engine is running.

After engine relight and with engine thrust sufficient to sustain level flight, set the throttle as desired and verify that both MAIN GEN and STBY GEN lights are OFF. Use the ELEC CAUTION RESET pushbutton to clear any ELEC SYS caution lights and reset the EPU to OFF, then back to NORM.

3.7.5.2. Flameout Landing

Landing the aircraft with no engine is not easy and must be carefully considered before being attempted. The current weather (visibility, wind) must be taken into consideration as well as the amount of training and the success rate the pilot demonstrated in simulated flameout (SFO) exercises. That being said failing does not bear any consequence and the BMS ejection envelope is rather large.

To perform a flameout landing turn immediately towards the nearest runway, jettison stores to decrease drag and establish best range airspeed. Sounds simple but you first need to be able to know where you are and where the closest runway is and to know what your best range airspeed is.

Solving the first issue is outside the scope of this manual and greatly depends on your situational awareness and correct flight planning. The latter depends on Gross Weight and is 200 knots for a GW of 20000 lbs and 205 knots for 21000 lbs GW. Add 5 knots per 1000 lbs of additional stores. For reference an F-16 empty of fuel and having jettisoned stores (with a centreline pod & A-A missiles) weighs around 22000 lbs, or 21000 lbs without the centreline ECM pod.

The best range speed is thus typically set to 210 knots. To find out your best range speed in any configuration just fly 7° AOA attitude. To maintain that speed the F-16 will trade approximately 1000 ft of altitude every nautical mile, giving a glide ratio of one for one. Granted it is an approximate rule but it is very handy to estimate your range when deciding which available runway to use. The real Dash 1 manual says that the F-16 will go 7nm over the ground for every 5000 ft of altitude you lose. This makes gliding calculations tricky in an emergency so just use 1:1.

Another consideration for long glides to the runway is EPU fuel for hydraulics and emergency power. Once the hydrazine is depleted the EPU will shut down and the F-16 will be as controllable as a brick. At that point your only way out is to eject. The EPU has about 10 minutes of autonomy running on hydrazine. Don't plan for a glide and flameout landing taking more than 10 minutes!

There are two basic types of flameout approaches: direct (straight-in) and overhead. The direct approach is simpler but provides no margin for error. The overhead pattern is safer, if you have sufficient altitude to execute it, as it provides good visual cues against known references (if you have practised them and know them by heart).

The Overhead Approach

The overhead flameout approach is made up of three distinctive points called HIGH KEY, LOW KEY and BASE KEY. Each key is associated with a minimum altitude ensuring that the flameout approach can be concluded with a safe landing. The pattern can be entered at any point, provided the next key altitude can be reached.

HIGH KEY: 1/3 down the landing runway at 7000 – 10000 feet.

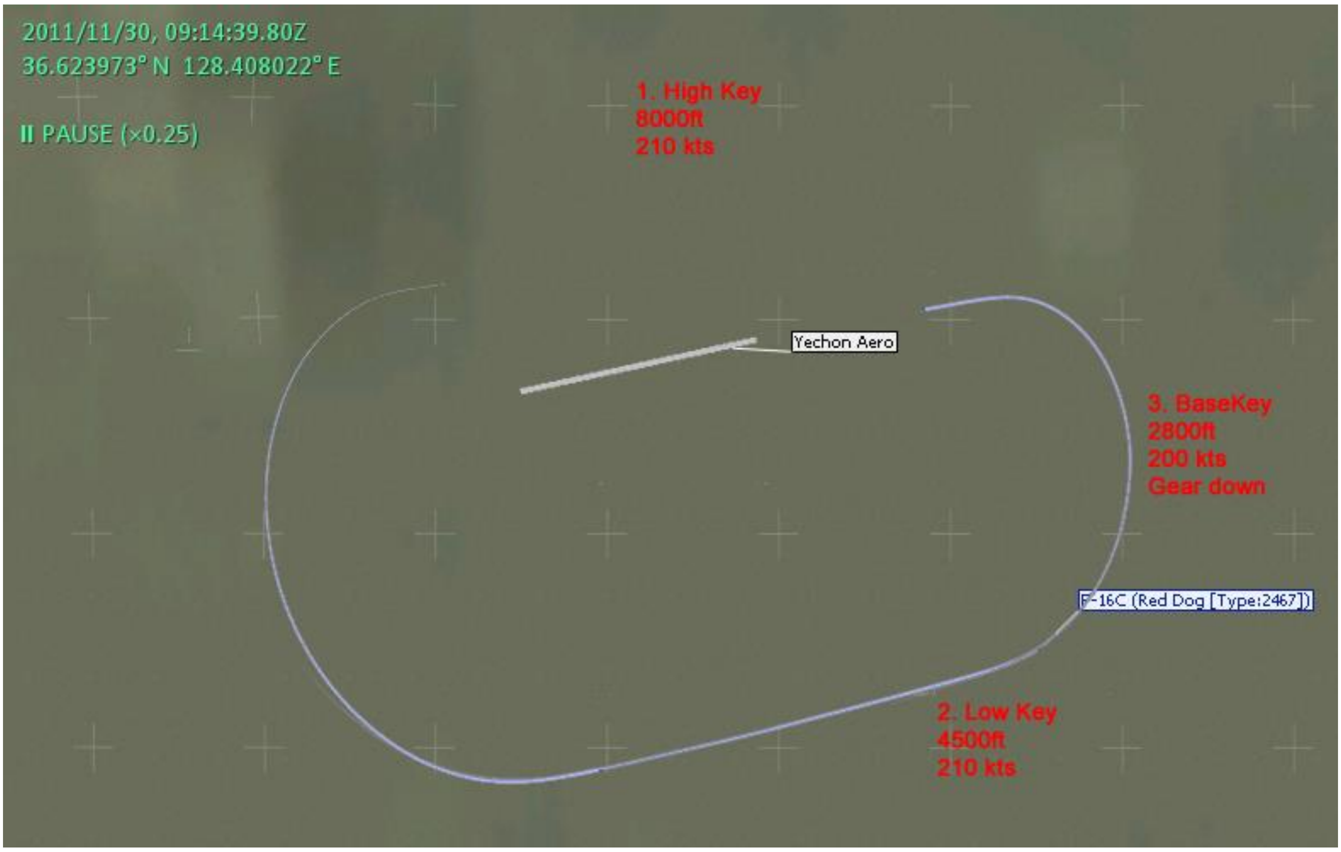
LOW KEY: abeam rollout point on final at 3000 – 5000 feet.

BASE KEY: midpoint of the turn from downwind to final no lower than 2000 AGL.

The whole approach is flown at best range airspeed (210 knots) gear up. Optimum bank angles are 50° for gear up and 55° gear down. Anything above optimum bank angle induces a significant loss of altitude per degree of turn.

The gear is only lowered when it becomes certain that BASE key altitude can be reached. Best range speed with gear down is 10 knots less than gear up best range speed (200 knots). You may need to use the alternate gear handle to lower the landing gear.

If EPU fuel is less than 25% when reaching high key you may run out of EPU fuel during the procedure, ejection will then be your only way out.



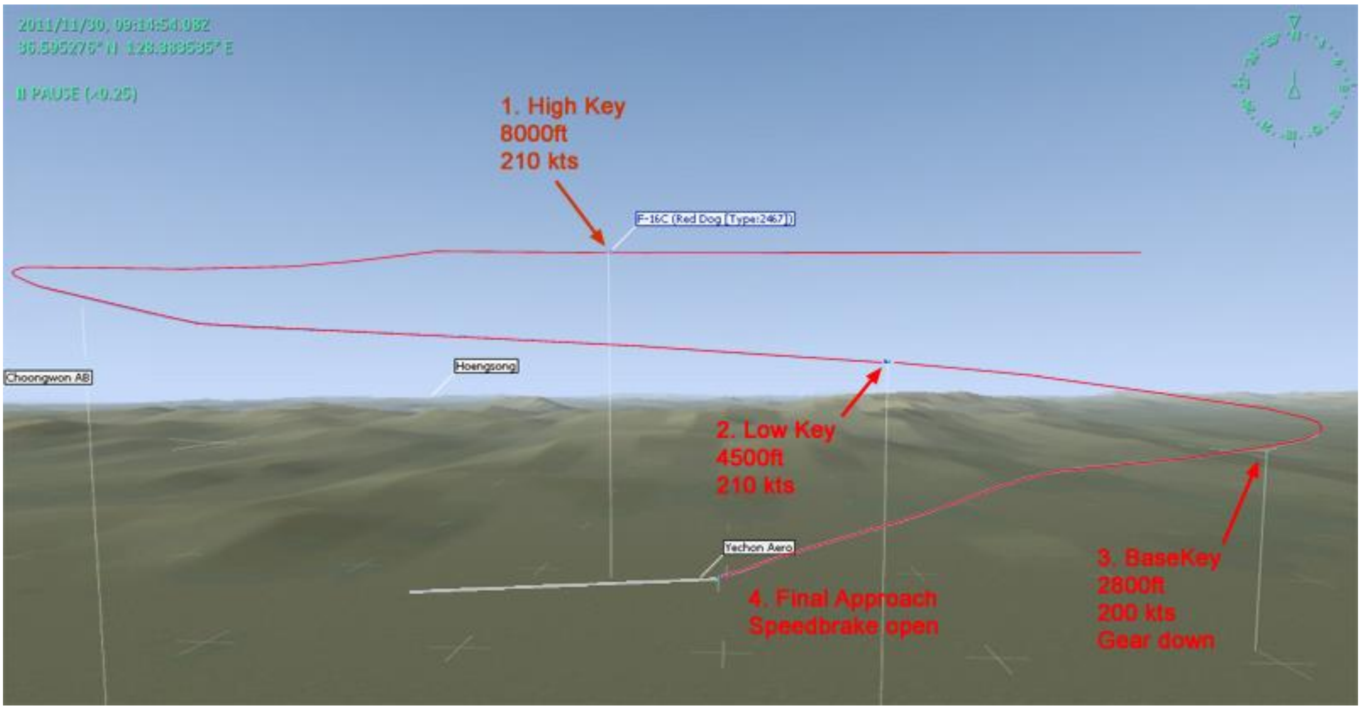
Passing High Key within the altitude limits (7000 - 10000 feet) execute a 50° bank descending turn (180° of turn) to downwind while maintaining 210 knots, aiming for Low Key.

Low Key is the point where you start your final 180° turn towards the runway and should be reached between 3000 and 5000 feet AGL. Execute a 50° bank angle descending turn towards the runway, still maintaining best range airspeed towards Base Key.

Base Key is the mid-point of the turn and should be reached no lower than 2000 feet AGL. At that point the gear should be down. Speedbrakes can be used (carefully) to bleed off excess altitude or just move the touchdown point past the runway threshold.

Maintain 11-13° AOA during final approach, flaring and using speed brakes as required. On touch down maintain aero-braking as in a normal landing and when the nose wheel is on the ground apply full aft stick, fully open the speedbrakes and engage wheel brakes.

Note: NWS will not be available if you had to use the alternate gear extension handle to lower the landing gear.

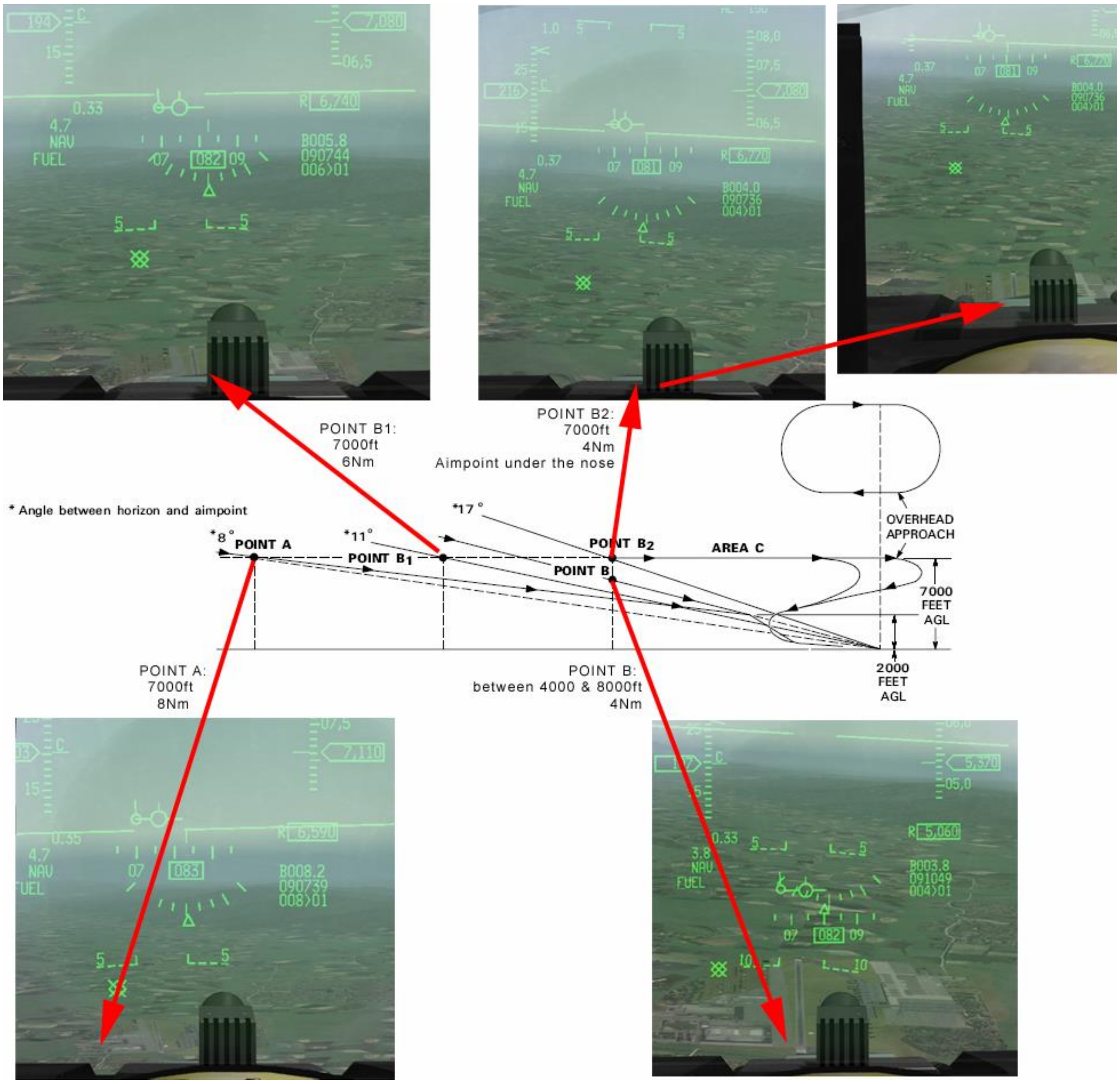


The Straight-in Approach

This procedure is comparable to a long 7° AOA glide to the runway threshold at best range speed (210 knots), with the gear up until the initial aim-point is 11-17° below the horizon. Landing gear should be lowered and the glide continued at best speed with gear down (200 knots) until the flare.

As in the overhead pattern 3 points can be defined, each with a reference altitude:

- POINT A: 8 Nm from the runway (aligned), with an altitude of 7000 feet AGL.
- POINT B: 4 Nm from the runway (aligned), with an altitude of 4000 - 6000 feet AGL.
- AREA C: between 0 and 4 Nm from the runway threshold.



Judging when the aim-point is 11-17° below the horizon to start your final descent is not easy.
A good visual cue is when the aim-point (runway touch down point) is at the bottom of the HUD.

If the altitude of 7000 feet was maintained the aim-point would disappear under the nose between 6 (point B1) and 4 Nm (Point B2) from the runway. The straight-in approach would be successful at this altitude up to point B2. Past B2 you would have too much energy to succeed in landing even with full speed brakes and landing gear deployed.

Refer to the screenshot on the left.
If a dive was initiated at point B2 the FPM, if placed on the aimpoint, would be 17° from the horizon.

Such a dive will increase your airspeed, even with gear and speed brakes deployed. The speed will be too high for a safe landing.

If you find yourself in such a situation you must bleed energy to salvage the approach. Delay landing gear extension, maintain your glide at best range speed and enter a flameout overhead pattern, shooting for any reachable key position.

If you are high, but not high enough for an overhead pattern, use the speedbrakes and a series of S-turns back and forth to get down to the proper 11-17° glide path.

As a rule of thumb for straight-in approach, maintain the aim-point in the bottom of the HUD while gliding at best range speed.

If the aim-point moves up in the HUD you are running out of energy and you will not make the runway; ejection is your only option.

If your aim-point disappears under the nose you have too much energy and should deploy speed brakes, make a series of S-turns back and forth, or enter a flameout overhead pattern.

Once at 2000 feet AGL, with the aim-point at the bottom of the HUD, lower the landing gear (alternate gear extension) and control your final descent, which will be steeper with speed brakes.

When starting a straight-in approach take the weather and the EPU fuel remaining when reaching POINT A into consideration.

IMC penetration can be performed but ideally VMC should be attained (runway visible) no later than 3 Nm from the runway at 3000 feet AGL.

EPU Fuel should not indicate less than 40% at point A, to ensure that the EPU does not run out of hydrazine before landing.

After the nose-wheel touches down open the speedbrakes fully and apply full aft-stick and wheel brakes in one single moderate and steady application.

NWS will not be available after an alternate landing gear extension, so you can only steer the aircraft on the ground after a flameout landing with the rudder. As your speed decays so will your ability to steer the aircraft. You should aim to roll slowly off the runway (avoiding any lights or signs) if you have other planes behind you needing to land. Park (chock) the aircraft when stationary.

Training for flameout landing

See BMS Training Mission 7 and the associated chapter in the BMS-Training Manual (in your *Docs* folder) for instruction about flameout procedures.

3.7.6 JETTISON

Both Selective Jettison and Emergency Jettison are Master Modes.

Selective Jettison is used to release selected stores and racks (A-A missiles and pods cannot be selected) and can be programmed in advance through the SMS S-J page.

Emergency Jettison is a one-step operation to lighten Gross Weight in an emergency situation by releasing all stores, except A-A and pods.

Selective Jettison

It is good airmanship to preselect stores that may need to be jettisoned during a flight (e.g. fuel tanks).

Access the SMS MFD page and select the S-J subpage with OSB #11.

The first press on the OSB next to a station selects the store(s) and a second press selects the rack (if available) for jettison. In the picture on the left the L117s are the Maverick racks and the L88s are the AGM-88 racks.

The pilot can preselect a selective jettison configuration while in S-J Master Mode, which will be remembered during master mode transitions.

The stores are jettisoned using the pickle button when the MASTER ARM switch is in ARM.

After the stores are released the highlighted stations are removed from the S-J page and the associated weapon quantity reads zero. S-J mode bypasses any other weapons settings.

Emergency Jettison

Emergency Jettison clears all expendable stores and racks from the aircraft. While the button is depressed the SMS page displays the E-J subpage.

Emergency Jettison does not require MASTER ARM to be activated.

Warning

While uncommon in BMS jettisoning stores with the gear down may result in collision and should be avoided. Ensure the gear is up before jettisoning.

Jettison is possible on the ground only when the GND JETT ENABLE switch located on the gear panel is set to ENABLE. But it should be used as a last resort.

3.7.7 EGI In-Flight Alignment (IFI)

Although not fully implemented in-flight EGI alignment may be performed in BMS. BMS models only the AUTO IFA to some extent. It thus relies on GPS for internal alignment and does not require a fix to be made by the pilot. If one day MANUAL IFI is implemented, then fix taking will be required.

When in-flight alignment is required fly a straight, level and non-accelerated attitude.

Place the EGI knob to OFF for 10 seconds (both OFF and AUX flags should be displayed on the ADI), then move it to in-flight ALIGN position.

The DED will display the INS page where EGI status can be followed. The HUD will display ALIGN. You cannot enter the magnetic heading manually in the UFC; the BMS process is fully automatic.

As with ground alignment all navigation data is removed from the HUD and MFDs during in-flight alignment. There is no end of alignment notification and the alignment will continue until the EGI knob is placed back to NORM.

An EGI status of 8.1 / 10 is sufficient (actually as with ground align the alignment in BMS is accurate with GPS as soon as the AUX flag disappears from the ADI). The EGI knob can then be moved back to NORM and navigation data will be displayed in the HUD and MFDs.

3.7.8 Controllability Check

A controllability check should be performed anytime structural damage or any failure impacting aircraft handling is suspected or detected. The following actions should be accomplished:

- Attain a safe altitude.
- Reduce Gross Weight.
- Lock LE FLAPS if LEF damage is observed.
- Determine the optimum configuration for landing by dirtying up to landing configuration and assess best AOA/ landing speed.
- Land using the above found settings.

If the aircraft is not controllable to a reasonable landing speed consider controlled ejection.

3.7.9 Out of Control Recovery

Recovery from most departures is usually automatic in 10-20 seconds as long as the controls are released. Recovery is detected by the nose pitching down and airspeed increasing.

To prevent another departure the pilot should wait until airspeed had reached 200 knots before moving the controls.

Refer to chapter 4.4.5 for recovery procedures according to type of departures.

3.7.10 Fuel leak

Battle damage may cause fuel leaks. Fuel leaks may be noticed visually with a sudden drop of fuel quantity at the time of battle damage and an abnormally fast needle movement (towards empty).

Fuel leak may induce fuel imbalance obviously. Afterburner use should be avoided.

As soon as a fuel leak is suspected the range should be maximised and a climb to higher altitude made to maximise the glide range. SFO should be planned for landing.

Fuel leak may be minimised by identifying the source of the leak and bypassing automatic forward fuel transfer by placing the FUEL QTY SEL knob out of the NORM position.

ENG FEED may be placed accordingly depending on the source of the leak to counter the imbalance. In any case, a fuel leak is a critical in-flight emergency and landing should be planned ASAP.

3.7.11 Oil Leak

Battle damage may lead to oil loss and the engine cannot work without oil. An oil leak may be noticed on the OIL pressure gauge. Oil pressure is dependent on throttle setting and must be minimum 30 psi at flight idle for the PW engine and minimum 25 psi at flight idle for the GE engine F-16. Any pressure below these limits should be considered as an in-flight emergency and landing should be considered as soon as possible.

Please note the HYD OIL PRESS warning light may not illuminate immediately. Oil pressure issues are usually slow to develop.

Whenever suspecting an OIL pressure loss minimise throttle movement (place throttle around 80% and try to leave it there unless absolutely required), minimise manoeuvring and plan for a SFO approach at the earliest convenience.

You may activate the EPU and monitor hydrazine consumption. If you leave the EPU OFF, be ready to turn it ON as soon as the engine seizes.

3.7.12 Battle Damage Checks

4.34 seriously increased the possibility of system failures due to battle damage. Engine stalls, fuel leaks and oil leaks are a real possibility and further emphasise the need for battle damage checks.

It is therefore advised to request a battle damage check from one of your human wingmen (if available) to visually check the extent of the damage.

Fuel leaks and oil leaks may be visible from your wingman’s perspective. Both create white smoke, but oil leaks always originate from the engine while fuel leaks may originate from either tanks (wing, fuselage, etc.)

3.8. LANDING EMERGENCIES

In case of suspected or fully developed in-flight failure the type of landing pattern should be decided according to the following factors:

- Nature of the emergency
- Weather and time of day
- Fuel
- Aircraft response to pilot inputs

A straight-in landing is recommended to minimise inputs on hydraulic, flight controls and electrical systems.

A simulated flameout pattern may be best suitable if engine failure is possible. If the engine fails the SFO pattern will provide sufficient energy to land the damaged aircraft safely.

3.8.1 LANDING WITH A BLOWN TYRE

The main danger from landing with a blown tyre is the blown tyre gear collapsing and lack of directional control on the landing run. If a blown tyre condition is suspected gross weight should be reduced to a minimum before landing. External fuel tanks should be retained if empty. In that case they should be depressurised to reduce probability of explosion. This is done by opening the AR door at the expense of the NWS in BMS. Landing with the AR door open will prevent the NWS system being engaged. Since explosion isn't really modelled NWS might be more critical.

Land on the side away from the blown tyre. Use roll control to relieve pressure on the blown tyre and NWS to maintain directional control. Brake on the good tyre (if you have differential braking).

Stop the aircraft straight ahead and shut down the engine. Do not attempt to taxi unless an emergency situation exists.

3.8.2 LG EXTENSION MALFUNCTIONS

Malfunctions in the landing gear are usually indicated by a constant illumination of the gear handle red light or by lack of corresponding green wheel down lights. The lollipop (handle) red light indicates a problem and the wheel down green lights indicate the localisation of the problem.

In BMS the landing gear handle will always move down (unlike in real life) but gear malfunction may occur nevertheless and is usually a consequence of over-speeding the aircraft above maximum undercarriage down speed, or a hydraulic failure.

Alternate gear extension provides a pneumatic 'use only once' means to lower the landing gear.
It should be accomplished at the lowest possible airspeed below 300 knots and preferably below 190 knots.

Alternate gear extension should be confirmed visually if at all possible. Any human wingman can confirm the correct position of the landing gear.

If the gear is confirmed down and locked, land normally. If any landing gear is still unsafe or up refer to LANDING WITH GEAR UNSAFE/UP below.

3.8.3 LANDING WITH GEAR UNSAFE/UP

With most gear problems on landing retain empty fuel tanks and reduce gross weight. Because of the high probability of crash you may also consider shutting down the FCR and all unnecessary avionics.

- **All landing gear indicate unsafe but appear normal:**

Be prepared for any gear failure on landing Shut down all non-critical avionics before landing (FCR, SMS). Land Normally.

- **All landing gear up:**

EPU ON.
EXTEND ALT FLAPS.

Land from a low angle approach at 13° AOA.
Throttle OFF immediately prior touch down.

- **Both main landing gear up or unsafe:**

Alternate Gear handle **in** & wait 5 seconds.
Landing Gear handle **up.**
Depress Alternate Gear reset button.

If nose landing gear does not retract consider a low angle approach at 13° AOA with empty fuel tanks (if carried).

- **Nose landing gear up or unsafe:**

EPU ON.
Consider low angle approach at 13° AOA.
Throttle OFF after touchdown.
Lower the nose to the runway before control effectiveness begins to decay.
EPU OFF once stopped.

- **One main landing gear and nose landing gear unsafe or up:**

Alternate Gear handle **in** & wait 5 seconds.
Landing Gear handle **up.**
Depress Alternate Gear reset button.

If landing gear does not retract:
Consider landing from a low angle approach at 13° AOA with empty external tanks.
If external tanks are not carried consider ejection.

Land on the side of the runway away from the unsafe gear.

- **One main landing gear unsafe or up:**

Alternate Gear handle **in** & wait 5 seconds.
Landing Gear handle **up.**
Depress Alternate Gear reset button.

If landing gear does not retract:
Consider landing from a low angle approach at 11° AOA with empty external tanks.
After touch down use roll control to hold wing up.
If external tanks are not carried consider ejection.
Land on the side of the runway away from the unsafe gear.

3.8.4 BRAKE MALFUNCTIONS

Refer to HOT BRAKES, GROUND EMERGENCIES earlier in this chapter.

3.8.5 NOSE WHEEL STEERING MALFUNCTION

Refer to NWS FAILURE, GROUND EMERGENCIES earlier in this chapter.

3.8.6 TAKEOFF & LANDING IN CROSSWINDS

The first step for managing the wind is to know the wind direction and speed.

On the ground your only information is from your briefing, by calling the ATC for wind speed and direction prior to departure, or by switching to the VHF ATIS frequency for latest conditions.

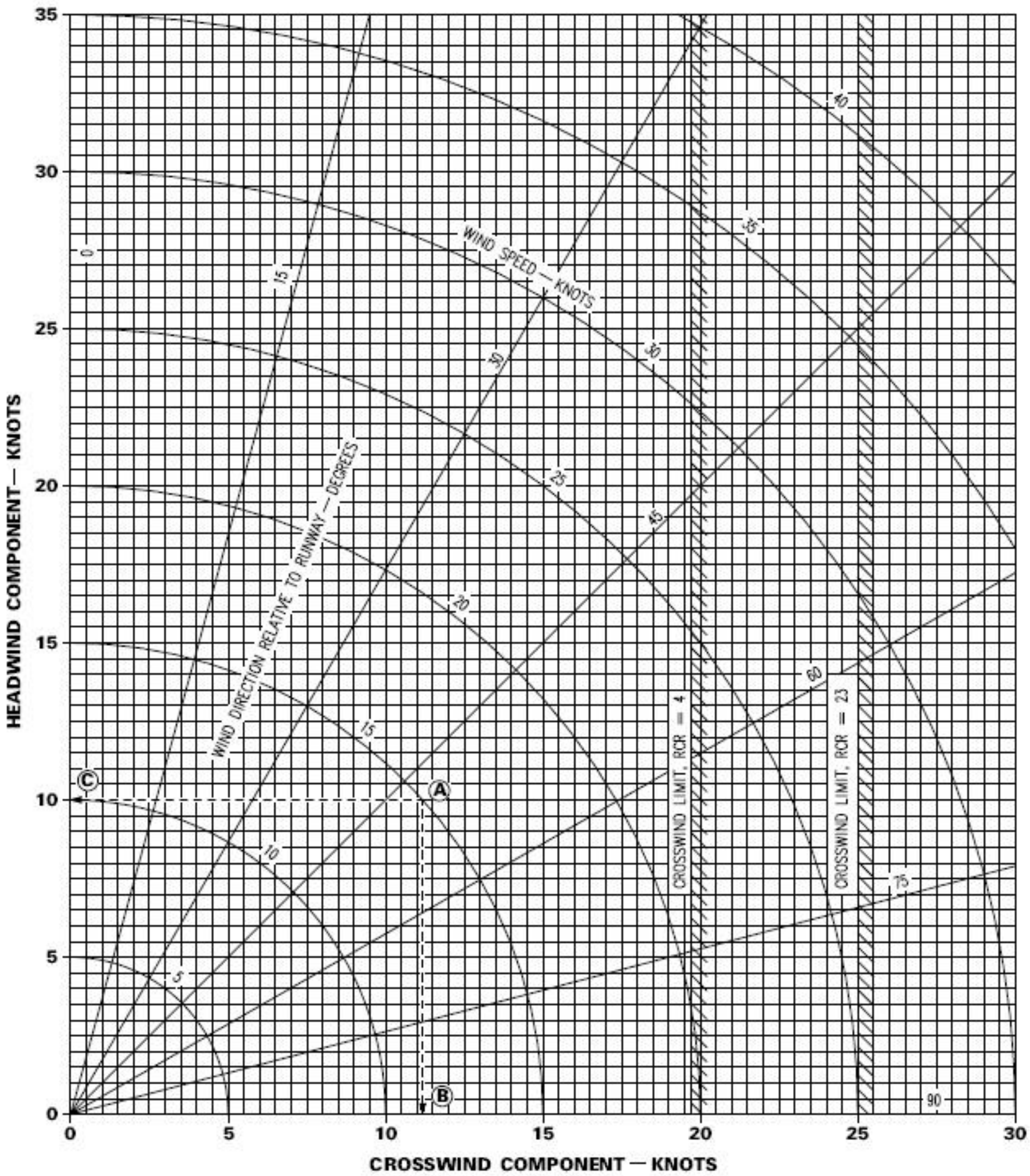
In the air you can receive wind data from the F-16 probes by moving DCS right on the UFC CNI page. The second step is to calculate the real annoying component of the wind: the full crosswind. As you know, headwind is desirable for take-off and landing.

When the wind is not fully headwind or tailwind the crosswind component will push the aircraft to the side the wind is blowing to.

The wind force can be defined in two components: the head or tail component and the full cross component.

This is done with the following graphic, knowing the wind direction relative to the runway orientation, and the wind speed. See the example on the next page.

Since BMS does not implement RCR (runway condition) we can define a crosswind limit of 25 knots for BMS from the graph below. Any crosswind situation up to 24 knots can be dealt with in BMS but anything over 25 knots means diverting to an alternate runway with more favourable wind conditions.



Let's consider the following example:

Runway heading is 360° and the wind is blowing from 330° at 20 knots.

You enter the graph on the line giving the wind direction relative to the runway, 360° - 330° = 30°.

Then find the wind speed on the left of the graph and follow the curve until you intersect the first line.

By plotting the found coordinates on the two axes you will have the full headwind and full crosswind component of this scenario, in this case 17.5 knots headwind and 10 knots crosswind.

Takeoff in crosswind should be done on the upwind side of the runway centreline and directional control should be maintained with the rudder until the ARI (Aileron Rudder Interconnect) kicks in.

In BMS the crosswind will mostly be felt once the main wheels leave the runway. The FPM will drift towards one side of the HUD.

Landing in crosswind may be a little bit more complicated. There are usually two techniques for crosswind landings in aviation. The first is to put one wing down and side slip with rudder to the runway, the second is to simply crab the aircraft wings level into the wind all the way to the runway.

Because of the ARI that connects Aileron to Rudder, the wing down sideslip is to be avoided with the F-16. The rudder should not be used when landing the F-16!

The wing level crab is the **only** technique for landing the F-16. Take your feet off the rudder pedals and point the aircraft nose into the wind. In high crosswind situations the FPM may drift outside the HUD field of view and you may have to centre the FPM with the DRIFT C/O switch and estimate your flight path.

Always plan your touch down point on the upwind side of the runway.

On touchdown the ARI switches out and undesirable yaw transients may occur if roll control is being applied at this time. The aircraft will steady itself after a short while. Refrain the urge to counter with flight controls and let the aircraft steady itself.

Maintain aerobraking and use the rudder and aileron to maintain directional control.

As airspeed decreases the amount of rudder input needed to maintain directional control increases.

Once the nose gear is firmly on the ground you can start braking and maintain directional control with the rudder, differential braking and NWS once below control speed.

Excessive differential braking may result in a hot brakes condition.

SECTION IV

FLIGHT CHARACTERISTICS

4.1 Limit Cycle Oscillation

Complex buffeting & stores flutter (Limit Cycle Oscillation) code has been added to the Flight Model. These are both based off real-world F-16 studies & technical papers.

A limited amplitude constant frequency oscillation (commonly referred to as limit cycle oscillation or LCO) may occur with certain stores loadings. LCO (typically 5 -10 cycles per second) may occur in level flight or during elevated g maneuvers. LCO may appear as buffeting or turbulence at a constant frequency, lateral acceleration from side-to-side, or in some cases vertical acceleration up and down. The magnitude generally increases with increasing airspeed and/or load factor.

Other indicators of LCO include significant vertical movement of the forward area of wing stores, especially wingtip launchers and missiles; this motion is typically up and down, but may also follow a circular pattern. In addition, cockpit instruments may become difficult to read as LCO amplitude increases from moderate to severe. LCO in BMS is not detrimental to the aircraft and mostly happens with air-to-surface configurations (external tanks and AGMs, General Purpose or Guided bombs).

If LCO is encountered and is uncomfortable or distracting, reduce airspeed.

4.2 Descent Warning Advisory

Descent Warning After Takeoff (DWAT) provides an audio warning of an unintended dive or descent during the departure phase of flight. The Voice Message Unit (VMU) descent warning advisory “Altitude, Altitude”, will occur when all the following conditions are met:

- The landing gear handle is up.
- The time from takeoff is less than 3 minutes (from WOW).
- The aircraft has climbed at least 300 feet above the runway elevation referenced to Mean Sea Level (MSL), but not yet gained 10,000 feet above runway elevation.
- There is a descent rate present such that the aircraft will descend to the runway MSL elevation within the next 30 seconds.
- The DWAT message has not previously occurred since takeoff.

If for whatever reason you want to start the 3 minute timer before takeoff selecting ENABLE on the GND JETT switch starts the DWAT timer as well.

Predictive Ground Collision Avoidance System (PGCAS)

In addition, the CARA ALOW code was rewritten in 4.32 so that it behaves more like the real one. Specifically, the ‘AL <alt>’ label will flash when you are below the selected <alt> value as measured by height AGL. If you descend through the ALOW limit, you get the VMS warning once unless and until there is a CARA reset.

Resets happen if you go back above the limit altitude, or if the RALT reading is lost (like when you roll inverted and the radar can't see the ground). A reset also occurs if your rate of climb *as measured by the radar altitude* exceeds 1200 feet per min. Note this last one means that you can hear the VMS message even when flying along in level flight or even climbing if the terrain below you has sudden significant slope. Normally though you should only hear one VMS altitude warning per trip below the limit value.

4.3 Category Loading

Unlike popular belief, the CAT config switch does not limit G. It limits AOA, which as a consequence limits maximum G available that the pilot can request according to his speed.

CAT I is the least limiting position and is intended for a clean configuration (centreline and A-A weapons can be carried). The pilot can request from -3G to +9G. AOA is limited to 25°.
AOA remains a factor in the maximum possible G. At 20° AOA it will reach 7.3G and at 25° AOA the max G reachable is 1G (level flight).
Rudder deflection is slightly limited in CAT I to limit the roll rate (induced roll). Maximum Rudder deflection starts to be limited around 14° AOA and reaches zero deflection possible at 26° AOA.

CAT III is the most limiting position and is intended to protect the aircraft from departures when carrying heavier loads on the wing stations (e.g. fuel tanks, A-G bombs, etc).
AOA is limited from a certain angle to prevent higher G being reached. This AOA limit is around 15.5 – 15.8° AOA. That means that in CAT III below 15° AOA, the airframe might be able to pull 9G, but as soon as the AOA reaches 15° the CAT III limits additional AOA increase, therefore limiting the number of available G.
In CATIII the aircraft is more prone to roll-coupled departures due to higher gross weight and position of the centre of gravity. To prevent departure the maximum commanded roll rate is thus further reduced by 40% of the maximum commanded roll rate in CAT I.
Maximum rudder deflection is also limited in CAT III and starts to be limited at 3° AOA and reaches zero deflection at 15° AOA.

Although the FLCS, through the CAT limiting switch, offers further protection against departure the pilot still has to be careful with heavier (and especially asymmetric) loads (CAT III) or at slow speeds with lighter loads (CAT I).

4.4. Departure from controlled flight

Departure from controlled flight is something any fighter pilot will strive to avoid. By nature fighter aircraft and especially F-16s are unstable (the FLCS actually provides artificial stability to the aircraft) and depending on the configuration and stores loading, recovery from departure might be impossible.
Departure (stalling) is not a direct function of speed but rather a direct function of angle of attack. When a critical angle of attack is achieved the wing doesn't generate lift anymore because the airflow is turbulent. The wing stalls and the aircraft may depart controlled flight.

The FLCS limits the potential for departure by limiting AOA, as seen in the previous chapter. Nevertheless by assaulting two limiters at the same time (maximum commanded roll coupled with either maximum aft stick, or exceeding the maximum bank angle change limits) departure from controlled flight is possible and pilots should know how to deal with the situation.

4.4.1 Rudder input

The Aileron Rudder Interconnect (ARI) automatically provides rudder input according to pilot roll input to reduce sideslip during turns. Pilot induced rudder does not improve turn performance, but actually increases departure possibility.

4.4.2 Flight with stores

Stores increase instability, inertia and gross weight. Although stores will lead to stricter limits from the FLCS (in CAT III), departure remains possible. Avoid abrupt controls commands that may assault 2 limiters at the same time; AOA & roll for instance.

4.4.3 Asymmetric loading

Asymmetric loading must be trimmed with the roll trim to lift the heavy wing. When roll trim is used the ARI adds rudder input causing a yaw away from the heavy wing. Both yaw and roll trim requirements will change according to the flight envelope.

Asymmetric stores therefore increase the chances of departure from controlled flight as increased roll commands are required to turn away from the heavy wing. G increase also will require more roll trim and consequent rudder input to maintain the heavy wing level. Therefore aft stick will increase roll requirements, which in turn will increase the yaw away from the heavy wing through the ARI.

All the roll and yaw input to maintain the aircraft in level flight further decreases the flight control action before reaching the limiters, as level flight already requires flight control inputs. It is therefore even easier to assault multiple limiters at the same time. Departure from controlled flight with asymmetrical stores may not be recoverable.

4.4.4 Type of departure

Yaw departure:
A yaw departure may occur when the sideslip increases beyond controllable range.
This may happen in CAT I with a centreline, high altitude 25000 feet, in the Mach 0.8 – 0.95 range and light asymmetric stores, or CAT III in the same conditions with heavier asymmetric stores.
Yaw departure may self-recover, or induce a pitch departure that may turn into a deep stall.

Roll departure:
Normally roll departure shouldn't be documented because more than a 360° continuous roll is forbidden with this aircraft. And 360° wouldn't be enough to induce a roll departure. Still BMS being a simulation, roll departure is a real possibility if rolls limits are exceeded. Roll departure will lead to pitch departure.

Pitch departure: upright or inverted.
Occurs when the AOA exceeds the AOA limiters.
During a pitch departure the instruments will usually report erroneous low speed (0-150kts) and AOA above positive (32°) and negative (-5°) instrument limits.
This may happen at slow speed, or as a consequence of a yaw departure, heavy stores (wing tanks) and opened speedbrakes.

A typical inverted pitch departure may be caused by flying at the top of a loop with airspeed too slow.
Pitch departure may induce deep stalls; inverted pitch departure may induce inverted deep stalls.
In a pitch departure the horizontal tails are locked in place by the FLCS to limit AOA. Pitch stick commands are ineffective without MPO (Manual Pitch Override) use.

4.4.5 Deep Stalls & Recovery

A deep stall is an out of control situation in which the aircraft stabilises at very high AOA and drops with significant sink rates. Luckily the FLCS in BMS does a really good job of preventing such conditions and the hardest thing to achieve is actually to induce the deep stall in the first place. There is a real chance that a pressure driven HOTAS sticks will get damaged trying to induce a deep stall. Deep stalls are easier to induce at slow speed in CATI and at higher speed in CATIII, especially with asymmetric loads.

During a deep stall the AOA instrument is usually glued at the maximum value of 32° for upright deep stalls and at the -5° limit for inverted deep stalls. The FLCS tries to return the AOA to normal, blocking the horizontal tail in full deflection. However, full deflection is not enough to get the AOA back into the normal range.

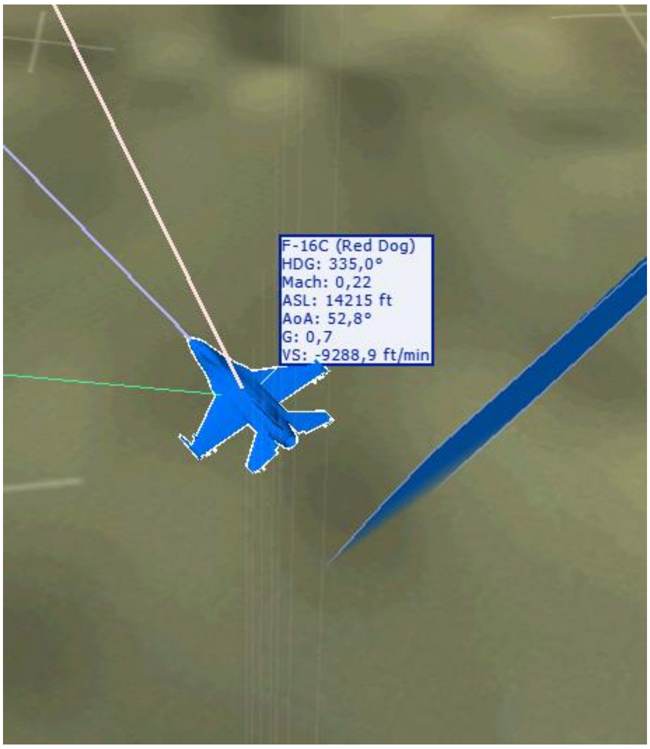
Airspeed indication is not correct and the instruments usually reports speeds between 0 and 150 kts. Sink rates are usually between 10000 and 15000 feet per minute.

During the deep stall the nose will oscillate 15° around a slight nose down pitch attitude. The aircraft may self-recover if the pilot releases the controls in the early oscillations of the generating deep stall. If it does not self-recover, pilot input will be required to rock the aircraft out of the deep stall AOA. To pitch the aircraft further the pilot must hold the MPO switch in override until recovery is complete. MPO overrides the maximum horizontal tail deflection angle, further increasing pitch authority in subsequent pitch rocking motions.

With the MPO held in override the pilot must accompany the aircraft oscillation with in-phase hard stick movement. If there is no detectable oscillation, aggressive stick input must create the oscillation, as it is by increasing the amplitude of the oscillation that recovery will become possible.

When the aircraft starts to pitch down, full forward stick should be aggressively applied and maintained until the aircraft starts to pitch back up following its deep stall oscillation. At this time stick commands should be inverted with a hard aft-stick commanded and maintained until the next oscillation. Basically you must accompany the pitching motion of the aircraft with aggressive stick inputs.

After a few oscillations with correct stick input and MPO override the down oscillation may break and the nose down attitude may be large enough for the aircraft to recover from the deep stall. AOA returns to normal range (below 25°) and the aircraft will exit the deep stall condition in a steep dive (usually 30° from vertical). Maintain MPO until speed reaches 200 kts and then recover smoothly from the nose down attitude. Releasing the MPO too soon may prevent recovery.



The left image shows the deep stall fully developed, with an AOA of 52.8° and a sink rate of 10000 ft/minute. The right image shows recovery with a significant nose down attitude and an AOA back in the normal range. MPO can be released and dive recovery initiated at this point.

Deep Stall Checks:

- Controls: Release.
- Throttle: Idle.
- MPO: Override and hold.
- Stick: Cycle in phase.
- 200 kts Initiate dive recovery and release MPO.

4.5 Operating Limits & Restrictions

JFS:

JFS start limits for air-start: less than 20000 feet, less than 400 knots.

JFS operating time: 4 minutes. Past 4 minutes of operation the JFS may overheat on the ground. Overheat is indicated by a 1 hertz (once per second) flashing JFS light. Stop the JFS to allow cooling. When JFS light stops flashing the JFS has cooled enough to be started again.

Failure to let the JFS cool may break the JFS. JFS failure is indicated by a 2 hertz flashing JFS light.

The JFS does not shut off automatically during air-start. While it will not overheat in the air the pilot should switch it off when it is no longer needed.

Moving canopy during JFS running may result in a failed JFS start or premature JFS shutdown due to a reduction in electrical power available to the JFS. Close the canopy before switching the JFS on.

ENGINE GAUGES:

ENGINE F100 PW-229 (blocks ending with a 2 (Block 32, 42, 52))				
GROUND				
CONDITION	FTIT (°C)	RPM (%)	OIL (psi)	REMARKS
START	800	-	-	If FTIT rises past 750°C, expect a hot start
IDLE	625	-	15 (min)	If Oil remains under 15 psi, expect engine failure and /or fire
MIL/AB	1070	97	30 - 95	At MIL and above, oil pressure must increase 15 psi minimum above idle oil pressure
IN FLIGHT				
AIRSTART	870	-	-	-
IDLE	-	-	15 (min)	-
MIL/AB	1070	97	30 - 95	Oil pressure must increase as RPM increases

ENGINE F110 GE-229 (blocks ending with a 0 (Block 30, 40, 50))				
GROUND				
CONDITION	FTIT (°C)	RPM (%)	OIL (psi)	REMARKS
START	935	-	-	If FTIT rises past 750°C, expect a hot start
IDLE	650	-	15 (min)	If Oil remains under 15 psi, expect engine failure and /or fire
MIL/AB	980	108	25 - 65	At MIL and above, oil pressure must increase 10 psi minimum above idle oil pressure.
IN FLIGHT				
AIRSTART	935	-	-	-
IDLE	-	-	15 (min)	-
MIL/AB	980	108	25 - 65	Oil pressure must increase as RPM increases

Negative G flight with both reservoir tanks full is limited to:

- AB thrust: 10 seconds.
- MIL thrust or below: 30 seconds.
- Negative flight should be avoided with a low fuel condition, or when the ENG FEED knob is out of NORM.

Maximum airspeed (VNE): 800 Kts sea level to 30000 feet & M2.05 above 30000 ft. Max speed may be further reduced according to stores carried.

Maximum airspeed with Gear Down: 305 Kts.

Maximum airspeed for AAR door opening: 400 Kts.

Max Gross Weight: 48000 lbs.

Centre of Gravity Limitations:

- Generally CG is always within limits unless the red portion of the AL Fuel Quantity needle is visible.
- Without external tanks the most aft CG occurs with 2000 lbs of internal fuel remaining.
- With external tanks the most aft CG happens when the external fuel tanks have just emptied.

Crosswind limits: 25 kts.

5. BIBLIOGRAPHY

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As always it's been a rough ride but we made it once again.

On to 4.35…