Aerosoft F-14A/B

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Avionics

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Revision	Issue date	Release	Description
0	Nov 25, 2014	1.0	Initial Release

CONTENTS

Pilot cockpit

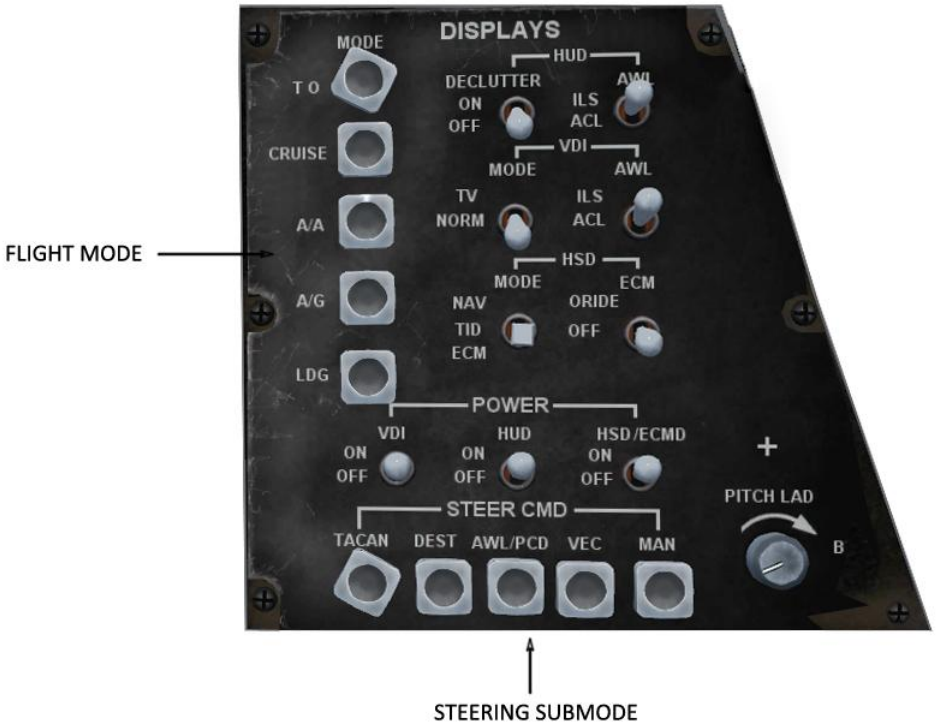
RIO cockpit

PILOT DISPLAY CONTROL PANEL

The information displayed on the HUD, VDI and HSD displays depends on the selected flight mode and steering submode. The pilot has the option of selecting any one of the five display formats, depending on the flight phase, to provide him with the data necessary to accomplish that particular flight phase. These five flight modes are arranged as five vertical, mutually exclusive pushbuttons on the pilot display control panel (PDCP) located on the right vertical console in the pilot cockpit. The five modes are takeoff (T.O.), cruise (CRUISE), air-to-air (A/A), air-to-ground (A/G) and landing (LDG).

In addition to the essential data such as altitude, vertical speed, etc., the HUD and VDI displays also provide steering cues. In each of the flight modes, the pilot has the capability of displaying several types of steering commands. Altogether there are five distinct steering submodes: tacan (TACAN), destination (DEST), all-weather landing/precision course direction (AWL/PCD), vector (VEC), and manual (MAN). The five selections are arranged horizontally along the bottom of the display control panel. The HSD follows the five submodes when the pilot places the HSD-MODE switch on the PDCP to NAV.

PILOT DISPLAY CONTROL PANEL



STEERING SUBMODES

1. TACAN - Provides tacan steering and deviation from the selected tacan radial.
2. DEST - Provides steering to preselected waypoint (*not implemented*).
3. AWL/PCD - Provides ILS glideslope information (ILS needles).
4. VEC - Provides GPS steering (flight plan).
5. MAN - Displays manually selected course and heading.

The entire Pilot Display Control panel is duplicated as a 2D panel that opens with Shift+3

VERTICAL DISPLAY INDICATOR GROUP

The Vertical Display Indicator Group (VDIG) provides the pilot symbolic takeoff, cruise, air-to-air (A/A), air-to-ground (A/G), landing and test information. Electronically generated symbology is displayed on a projected Heads-Up Display (HUD) and on a TV-like display called Vertical Display Indicator (VDI), which is a heads-down display (this is the upper CRT in the pilot's cockpit).

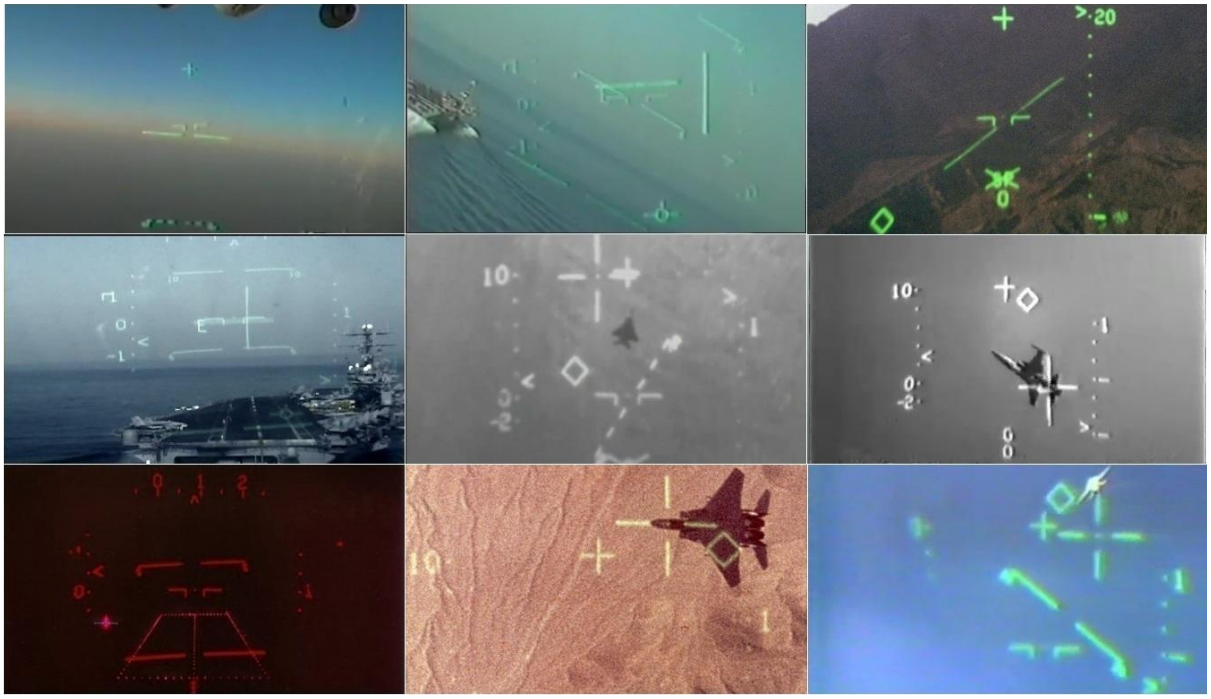
HEADS-UP DISPLAY (HUD)

The heads-up display (HUD) provides a combination of real-world cues and flight direction symbology. The display is collimated (focused at infinity), thereby creating the illusion that the symbols are superimposed on the real world (and so that visual cues received from outside the aircraft are not obscured).

Early F-14As were equipped with a HUD that was projected directly on the front windscreen. The absence of any combiner support structure improved the pilot's general field of view but required both the combiner and the windshield to be precisely aligned and the combiner to be perfectly flat. Any curvature would contribute to error. The Navy discovered that as the aircraft gained speed, the high-velocity airflow caused the windshield to flex, distorting the image reflected in the combiner. The Navy tried to solve the problem by using a thicker windshield, which instead caused multiple reflections and “ghost” images.

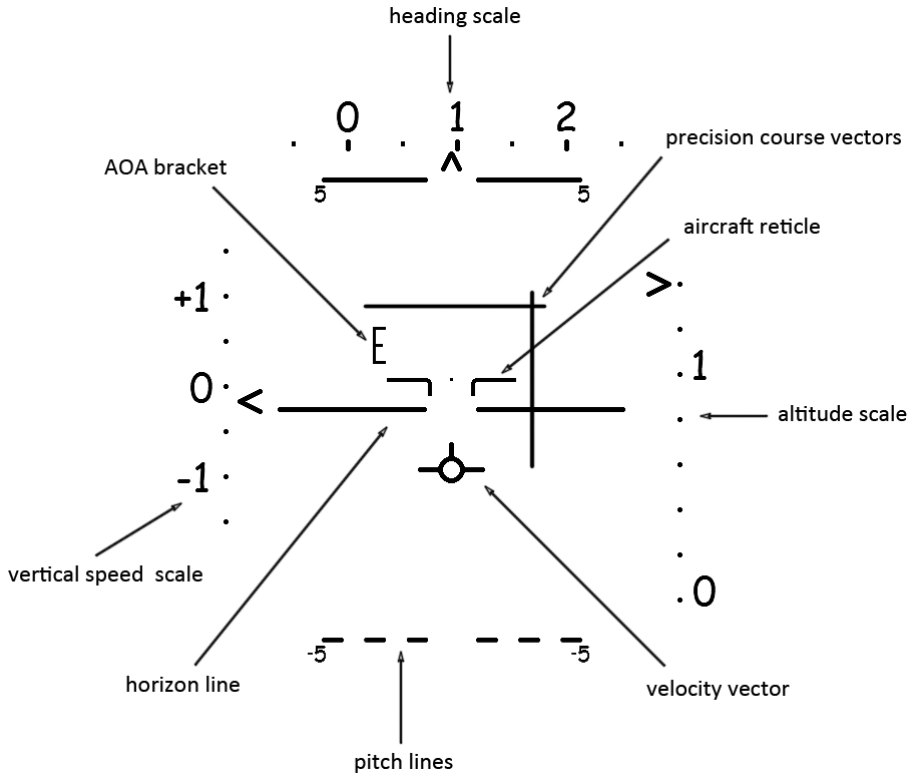
A program to refit the F-14B with a modern HUD was initiated in 1997, using a Flight Visions SparrowHawk HUD. The SparrowHawk integral combiner allowed the Navy to replace the heavy F-14B windshield with the thinner night-vision-compatible windshield used on the F-14D. The symbology on the SparrowHawk is similar to the symbols used on the F-14D. The SparrowHawk included an integral combiner, which is a flat piece of glass situated between the pilot and the windshield and reflects the HUD image into the pilot’s field of vision.

F-14A HUD (WINDSHIELD PROJECTED)



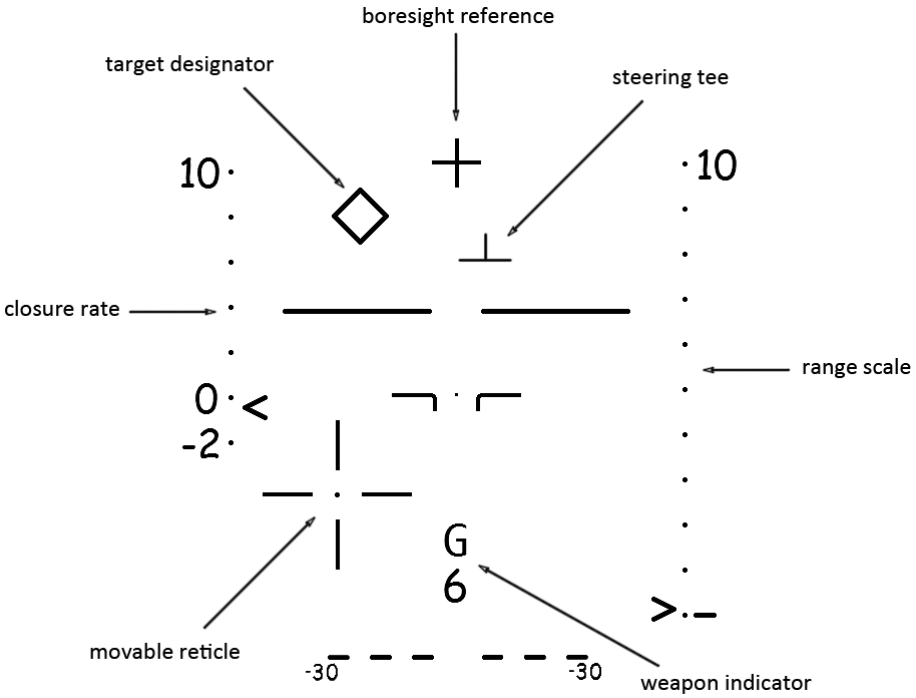
The HUD on the F-14A was projected directly onto the windscreen

F-14A HUD COMMON SYMBOLOGY



1. **Heading scale.** The heading scale shows the gyro heading of the aircraft. Each number must be multiplied by ten to arrive at the actual heading, for example “1” means 10°, “22” means 220° etc.
2. **Aircraft reticle.** Depicts the aircraft waterline. When lined up with the horizon, the aircraft pitch is zero.
3. **Altitude scale.** Shows radar altitude from 0 to 1,400 ft in 200 ft increments (when valid) in takeoff and landing mode, and barometric altitude from 0 to 14,000 ft in 2,000 ft increments in A/G mode.
4. **Velocity vector.** Indicates flight path direction (where the aircraft is going, not where it's pointed).
5. **Pitch lines.** The pitch ladder indicates the pitch attitude with respect to the aircraft reticle symbol. Solid lines indicate positive pitch, dotted lines indicate negative pitch. In cruise and A/A mode the pitch lines have a 4:1 compression ratio with 30° increments, i.e. they are no longer conformal to the outside world - for example the 30° pitch line is positioned only 7.5° above the horizon line so the pilot can see both the pitch line and the horizon line.
6. **Horizon line.** Part of the pitch ladder. When the velocity vector is on the horizon line the aircraft is in straight and level flight.
7. **Vertical speed scale.** Indicates rate of altitude change. Scale is from -1,500 to +1,500 ft/min in 500-foot increments. Appears on the left side of the HUD in takeoff and landing modes.
8. **AOA bracket.** Its position relative to the aircraft reticle indicates true angle-of-attack (AOA). When the small center horizontal bar is aligned with the reticle, the aircraft is flying at the optimal AOA of 15 units. If below the reticle, AOA is too high; above the reticle indicates AOA is too low. Displayed in landing mode only.
9. **Precision course vectors.** With AWL/PCD selected on the PDCP and valid ILS signal, the horizontal vector shows elevation glideslope deviation and the vertical vector shows azimuth lineup deviation. The vectors are referenced to the aircraft reticle.

F-14A HUD ATTACK SYMBOLOGY



1. **Boresight reference.** Symbol is a set of crosshairs fixed on the HUD and used to represent the armament data line (ADL) of the aircraft.
2. **Steering Tee.** Provides elevation and azimuth steering in the air-to-air modes when single-target-track exists.
3. **Range scale.** Appears on the right side of the HUD during A/A modes. A range caret (V-shaped symbol lying on its side) is located on the left side of the scale and indicates range to target. Two tick marks extend from the right side of the range scale. The upper tick mark represents the weapon's Rmax, the maximum effective range of the weapon in priority. The bottom tick mark represents the weapon's Rmin, the minimum effective range of the weapon in priority.
4. **Weapon indicator.** Number indicates rounds remaining in hundreds (6, 5, 4, 3, 2, 1, 0) or number of missiles ready for launch. 'G' - GUNS, 'SW' - Sidewinder, 'SP' - Sparrow, 'PH' - Phoenix, and 'ORD' - bombs or rockets. If the MASTER ARM switch is in the OFF position, an X is superimposed over the weapon indicator.
5. **Movable reticle.** Serves as an optical sight for A/A gunnery and A/G weapons delivery. In A/A gunnery indicates director solution (with target lock in PSTT) or instantaneous LCOS 1,000 foot solution (all other cases). With SW selected, indicates AIM-9 seeker head position. In A/G modes indicates instantaneous weapon impact point. Must overlay the target at the moment of release.
6. **Closure rate.** Indicates closing velocity from -200 to 1,000 knots between aircraft and target.
7. **Target designator.** Indicates radar single-target-track line of sight (LOS).

You can change the type of HUD being used on the Aerosft F-14 by pressing the 'H' key.

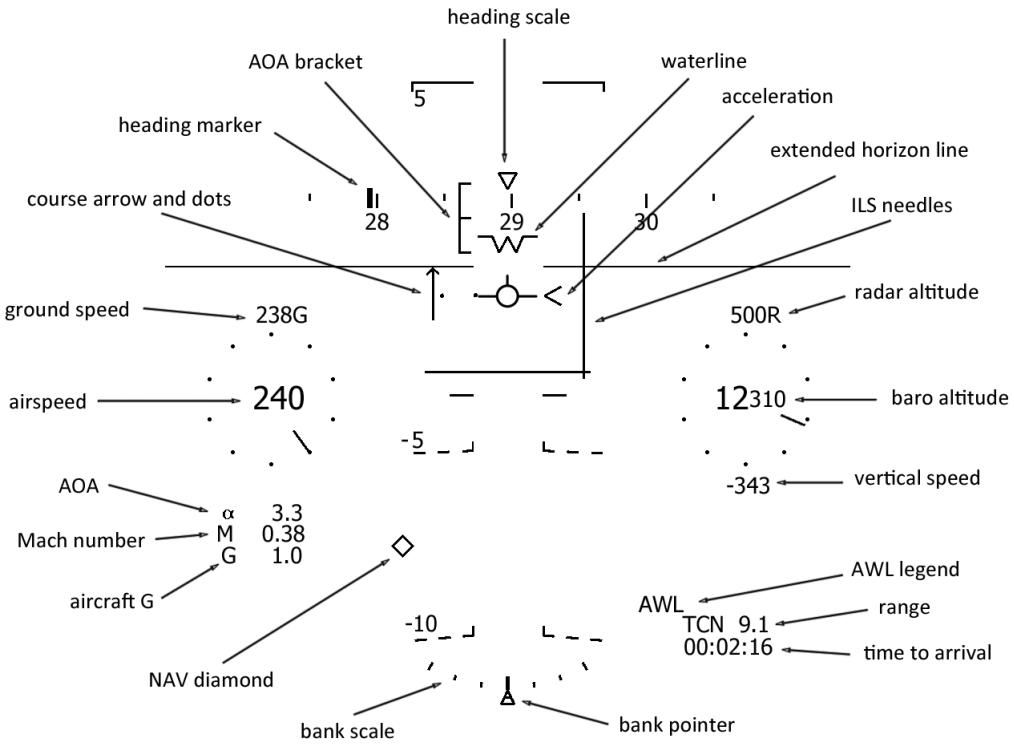
F-14B HUD (SPARROWHAWK HUD)

The SparrowHawk HUD by Flight Visions provides pilots a 25-degree total field of view. In comparison to the previous windscreen projection system in the F-14B, the new HUD's dual combiner glass doubles the field of view, provides more accurate symbol placement, and gives the pilot an improved working velocity vector and the flexibility to more easily change functions. In March 2003 F-14Bs from VF-103 were the first to get the SparrowHawk HUD. VF-11 got the new HUDs in mid-late 2004. VF-101 # 101, 102, 103, 104, 113, and 114 also had the SparrowHawk HUD installed on them.

F-14B's were equipped with a SparrowHawk HUD projected on a dual combiner glass

SparrowHawk HUD symbology

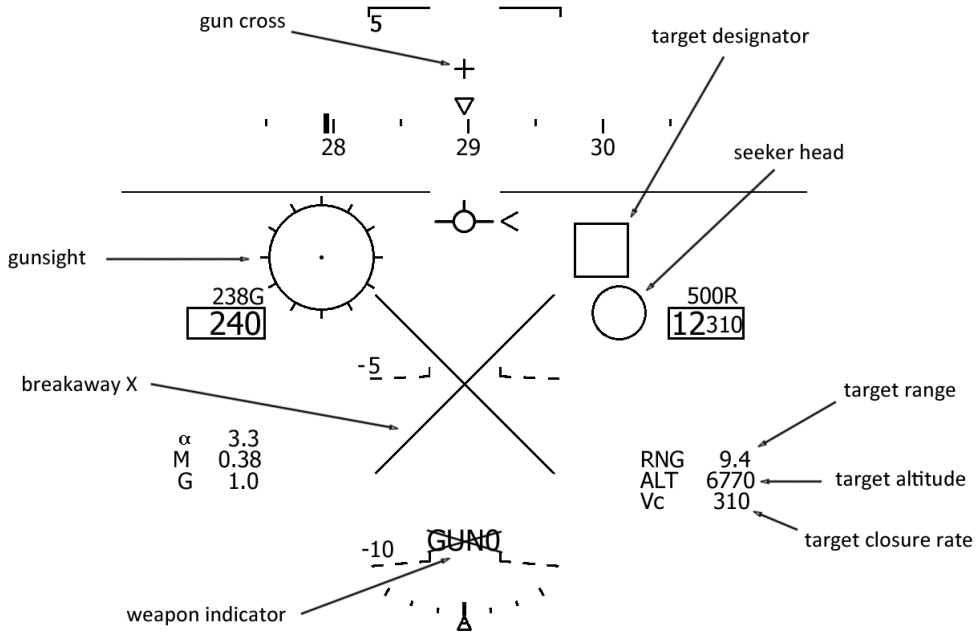
SPARROWHAWK HUD COMMON SYMBOLOGY



1. **Heading scale.** Aircraft gyro heading. Major divisions are numbered every 10°. With gear down the heading scale remains 2° above the position of the velocity vector.
2. **Waterline.** Indicates fuselage reference line (FRL). Displayed when gear down or the velocity vector is outside the HUD FOV.
3. **Acceleration caret.** Indicates positive acceleration when above the velocity vector, and negative acceleration – when below the velocity vector.
4. **AWL legend.** This message indicates that the all weather landing steering mode has been selected.
5. **Target designator.** Indicates radar single-target-track line of sight (LOS).
6. **Range.** Depending on the format this message will indicate either the range to the NAV station (VOR/TACAN/ILS) or distance to waypoint destination (GPS). The legend 'TCN' will appear when tracking a tacan station.
7. **Bank pointer.** The pointer is divided into two sections: a triangle shaped upper section and a trapezoid shaped lower section. The upper section indicates the magnitude and roll when read against the bank scale. The lower section indicates the magnitude and direction of aircraft sideslip when read against the upper section.
8. **Bank scale.** Provides indication of bank angle with tick marks 0°, ±10°, ±20°, ±30° and ±45°.
9. **NAV diamond.** Overlaid on the line-of-sight to the currently tuned NAV station.
10. **AOA.** Indicates angle of attack in units. With gear down, the AOA readout is removed when AOA is between 14 and 16 units (optimum approach angle of attack is 15 units).
11. **Course arrow and dots.** The course arrow represents the selected course to the station. Two dots will appear on the side of the velocity vector toward the course arrow and perpendicular to the arrow. The dot closest to the vector represents a half scale deflection of 4° off course, while the outermost dot represents full scale deflection of 8° off course. Velocity vector centered over the course arrow indicates being on course. For tacan bearings aft of ±90°, the arrow will be dashed.

12. **Heading marker.** This symbol indicates the heading towards the current waypoint or to the current VOR or tacan station.
13. **AOA bracket.** The bracket indicates the deviation of the current AOA from the optimum approach AOA. The center tick of the bracket represents the optimum approach AOA of 15 units when parallel to the velocity vector's "left wing". The bracket moves lower with respect to the velocity vector as AOA increases, and it moves higher as AOA decreases. The length of the bracket represents 2 units of AOA. Displayed with gear down.

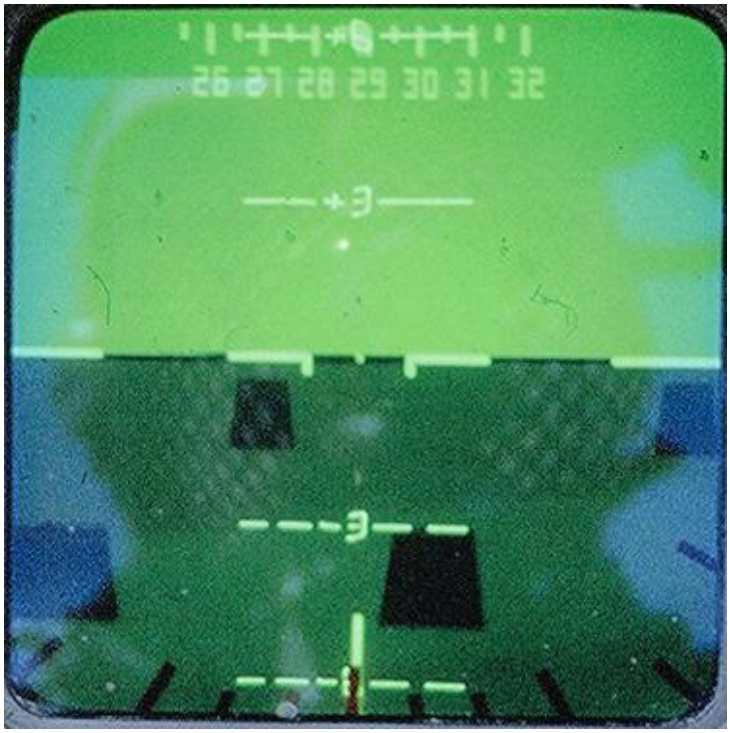
SPARROWHAWK HUD ATTACK SYMBOLOGY



1. **Gun cross.** This is the gun boresight cross which shows the departure line of the bullets as they initially leave the gun and provides a fixed aiming point. It is positioned above the waterline because the gun has a built-in upward slant. This gives a slight advantage in air-to-air gunnery, but is a disadvantage in air-ground strafe.
2. **Target designator.** Identifies the radar line of sight to the target in STT mode.
3. **Seeker head.** With sidewinder selected, indicates the missile seeker head position.
4. **Target range.** Distance to target in nmiles.
5. **Target altitude.** Altitude of the current target in feet.
6. **Target closure rate.** Closing velocity of the current target in knots (positive if the target is getting closer, negative if the target is getting further away).
7. **Weapon indicator.** Displays missile type and quantity, if selected or gun and rounds remaining in hundreds. If no weapon is selected, displays A/A or A/G depending on the flight mode. If the MASTER ARM switch is in the OFF position, an X is superimposed over the weapon indicator.
8. **Breakaway X.** A large flashing X will appear to indicate either a pull-up warning or target distance smaller than missile's Rmin.
9. **Gunsight.** With valid STT target displays the position of the LCOS (lead computing optical sight). In all other cases shows the projected bullet impact point at 1,000 feet range if fired at that instant.

VERTICAL DISPLAY INDICATOR (VDI)

The Vertical Display Indicator (VDI) provides an in-the-cockpit vertical display. The VDI replaces the mechanical attitude direction indicator of older aircraft systems as an aircraft attitude instrument providing pitch, roll and heading. TV video can also be presented in the VDI from the television camera set (TCS), when installed.

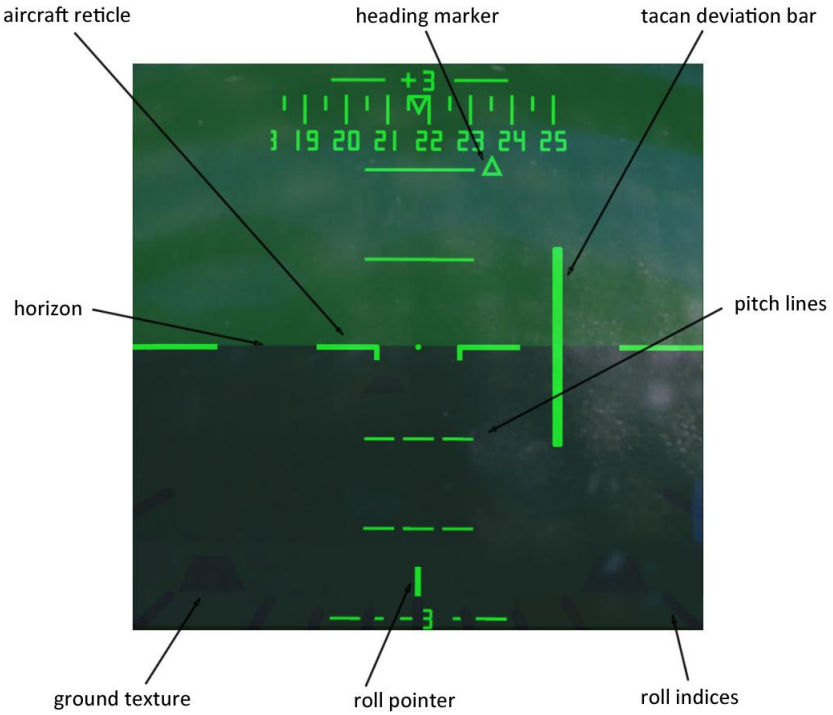


Vertical Display Indicator (VDI)

Attitude information. Attitude information is displayed on the VDI by an aircraft reticle, a horizon line, ground and sky texture, and a pitch ladder. The aircraft reticle is fixed at the center of the display, and the horizon line and pitch ladder move about it in accordance with the aircraft pitch and roll attitudes.

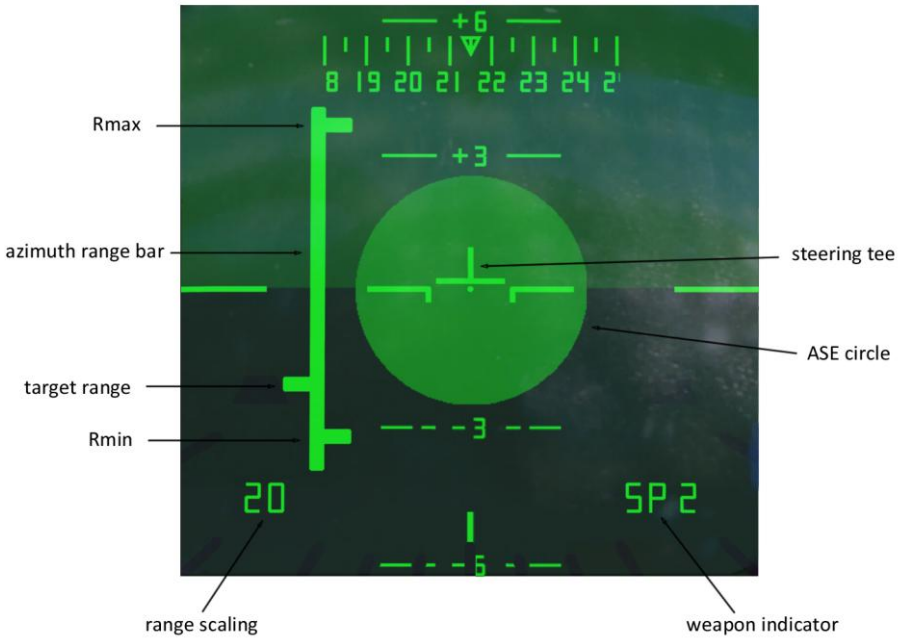
At certain pitch attitudes, the horizon line will not be displayed on the VDI. The remaining display will consist of background, pitch lines and the roll pointer. When this occurs, the roll pointer should be referenced to assist in determining aircraft attitude.

VERTICAL DISPLAY INDICATOR (T.O./CRUISE)



1. **Aircraft reticle.** Depicts own aircraft wings. When lined up with the horizon, the aircraft pitch is zero.
2. **Heading marker.** Positioned relative to the heading scale to show heading towards the current waypoint or to the current VOR or tacan station.
3. **Tacan deviation bar.** Indicates difference between bearing to tacan and selected tacan radial. Deviation limited to ±5.625° tacan deviation. When flying TO the station the bar is light green, and when flying FROM the station - dark green.
4. **Pitch lines.** The pitch ladder indicates the pitch attitude with respect to the aircraft reticle symbol. Solid lines indicate positive pitch, dotted lines indicate negative pitch. For A/A and A/G, 130° of pitch is displayed with the pitch lines every 30°. Takeoff, cruise and landing display a total of 65°.
5. **Roll pointer and indices.** Indicates roll position. Indices fixed at 0°, ±10°, ±20°, ±30°, ±45° and ±60°.
6. **Ground texture.** Simulated ground patterns to give better relationship between sky and ground. Consists of dark green trapezoids on a lighter background. Sky texture is a uniform green. Size and spacing of ground texture are arranged to give perspective to the display. Ground texture moves toward the pilot and emanates from the horizon to simulate motion. The trapezoids remain in motion even if the aircraft is stopped.
7. **Horizon.** Demarcation point between ground and sky textures.

VERTICAL DISPLAY INDICATOR (A/A MODE)



1. **Steering tee.** Provides elevation and azimuth steering in the air-to-air modes when single-target-track exists.
2. **ASE circle.** Allowable Steering Error - indicates steering error allowed for launching a Sidewinder, Sparrow or Phoenix in the normal mode. Size of ASE circle is determined by the magnitude of the allowable error.
3. **Weapon indicator.** Armament ready legend - indicates missile type selected ('SW' - Sidewinder, 'SP' – Sparrow, 'PH' - Phoenix) and the number (0 to 6) indicates number of missiles ready for launch. If the MASTER ARM switch is in the OFF position, an X is superimposed over the weapon indicator.
4. **Azimuth range bar.** This bar is used to determine whether or not a target is within range of the weapon system currently in priority. The number located beneath the azimuth range bar represents its maximum range (in nm). Range is estimated by comparing the location of the marks on the bar to the maximum range of the bar as indicated.
5. **Rmin, Rmax, target range.** The range marks are read relative to the azimuth range bar. For example, a target range mark located halfway up a 20 nm bar would indicate that the target is approximately 10 nm away. If the outside tick mark (target range) is between the inside tick marks (Rmin and Rmax range), and the steering tee is within the limits of the ASE circle, a good firing solution may exist.

MULTIPLE DISPLAY INDICATOR GROUP

The Multiple Display Indicator Group (MDIG) provides the pilot and RIO with navigation, tactical, or ECM data. The MDIG is composed of the pilot Horizontal Situation Display (HSD) and the RIO Electronic Countermeasures Display (ECMD). Both displays can show navigation data (NAV mode) and ECM data (ECM mode). In addition, the HSD can act as a repeater of the RIO TID display (TID mode). Although the ECMD and HSD operate from a common display processor, the pilot and RIO can each select any desired mode.

HORIZONTAL SITUATION DISPLAY (HSD)

The HSD is the pilot primary navigation display. It is also capable of displaying ECM information and repeating the RIO's TID presentation. The display format is dependent on the position of the HSD MODE switch (NAV, TID or ECM). When NAV mode is initiated, any of the four navigation submodes (tacan, destination, vector or manual) can be selected from the pilot display control panel (STEER CMD pushbuttons).

Horizontal Situation Display (NAV)

1. **Compass rose.** Navigation compass rose in 5° increments, numerics at 30° increments and cardinal points at 90° increments. Appears in all navigation modes.
2. **Lubber line.** Represents the nose and tail of the aircraft. Shows gyro heading of aircraft with respect to the compass rose.
3. **Course arrow.** Head and tail symbol depicting selected tacan course during tacan steering; the GPS desired track to waypoint during destination steering; or the autopilot selected heading during manual steering.
4. **Heading symbol.** Displays the GPS waypoint bearing during destination steering.
5. **ADF bearing.** Shows direction of the nearest Automatic Direction Finding Station (ADF).
6. **Aircraft symbol.** Fixed aircraft symbol centered in navigation compass rose (only in tacan mode).
7. **Tacan deviation bar.** The symbol shows selected tacan course. Moves relative to the deviation ticks.

8. **Deviation ticks.** Positioned 6° apart. The deviation bar moves relative to the ticks to indicate the deviation off course.
9. **Tacan bearing.** Head and tail tacan bearing symbol shows direction of selected tacan station. Arrowhead shows course TO station.
10. **Range.** Shows range to destination in n.m. or range to tacan station.
11. **Course.** Shows tacan selected course.
12. **HDG control.** Enables pilot to rotate autopilot selected heading.
13. **CRS control.** Enables pilot to set the tacan selected course (inhibited for aircraft carrier tacan).

HSD destination steering

HSD ECM mode

ELECTRONIC COUNTERMEASURES DISPLAY (ECMD)

The ECMD displays navigation and ECM data to the RIO. The ECMD navigation and ECM display modes use the same format as the pilot HSD modes. The ECMD controls are on the ECM DISPLAY control panel on the RIO right side console. The ECM mode displays aircraft threats that can consist of SAM activity, radar-controlled antiaircraft gun emplacements or any enemy aircraft. The aircraft threats are displayed as three coded strobes, individually or in combination thereof, and alphanumerics. ECM circles provide reference to gauge received ECM source signal strength - the stronger the signal, the longer the strobe.

AWG-9 RADAR

A view of the tactical information display (TID).

The F-14A carries the AWG-9 radar, one of the most powerful US military aircraft radars for detecting multiple air targets approaching at long range. The radar was designed specifically for fleet defense. Before its introduction, flight crews were forced to interpret the cluttered analog returns on the screen in an attempt to distinguish real targets from the background noise. One of the first radars to feature a signal processor, excess clutter could be filtered out, leaving the crew with a much clearer picture of the airspace before them. In addition, the AWG-9 signal processor is able to remove the surface clutter of the Earth's surface, providing the radar with a look-down, shoot-down capability against low flying aircraft.

The AWG-9 aircraft weapon control system can simultaneously track up to 24 targets and guide missiles to 6 of them. Developed to control the AIM-54 Phoenix air-to-air missile, the AWG-9 can be used with AIM-7 Sparrow and AIM-9 Sidewinder, as well as for the F-14's M61 20-mm Gatling gun. Its transmitter can generate Continuous Wave, pulse, and pulse-Doppler beams.

The AWG-9 radar can detect targets as low as 50 ft and as high as 80,000 ft at ranges over 115 nm, and across a front more than 150 nm wide. The RIO can select a radar range of 5 nm, 10 nm, 20 nm, 50 nm, 100 nm, and 200 nm. The antenna can search 65° to the right or left of the aircraft centerline or a total of 130°. The search area is subdivided into horizontal slices called bars, the number of bars describing the particular scan pattern. The F-14 radar can scan in 1-bar, 2-bar, 4-bar and 8-bar patterns. Each bar represents about 2.3° of vertical scan. Azimuth scan patterns are 10°, 20°, 40° and 65° (to either side). The minimum scan pattern of the antenna is 1 bar/10° for 0.25 seconds and the maximum is 8 bar/65° for 13 seconds. TWS pattern (2bar/40° or 4bar/20°) takes 2 seconds to scan the entire volume.

Target information is presented in both cockpits, though it is the back-seat RIO who really takes care of the proceedings, using his superior displays and systems management skills. He talks his pilot onto new headings or heights (the basics of which are also duplicated on the pilot's instruments and HUD). The two primary displays used by the radar scanning, back-seat RIO, surrounded by knobs and push-buttons, are a 10-inch radarscope known as the tactical information display (TID), and a much smaller tube above it, designated the detail data display (DDD). Once some target has been acquired by the radar, the DDD shows a selected contact's relative bearing and velocity by means of a rectangular blip on a two-axis grid. The TID presents the targets in a computer-generated, synthetic, clutter-free God's eye view format featuring a large 'V' which denotes the radar scan limits from the nose.

Detail Data Display Panel (DDD Panel)

RADAR MODES

The AWG-9 has seven basic modes of radar operations: five are pulse-Doppler, two are pulse only. The modes are:

- ◊ Pulse-Doppler Search (PD SRCH)
- ◊ Range while Search (RWS)
- ◊ Track While Scan Auto (TWS AUTO)
- ◊ Track While Scan Manual (TWS MAN)
- ◊ Pulse-Doppler Single Target Track (PDSTT)
- ◊ Pulse Search (PULSE SRCH)
- ◊ Pulse Single Target Track (PULSE STT)

Pulse-Doppler Search (PD SRCH): This mode is for basic long range detection, and is the maximum range mode of the unit. PDSRCH provides you with rudimentary target information only. It alerts you to the presence of other aircraft but does little to aid your situational awareness. For example, PDSRCH never provides target range information. The information is displayed on the Detailed Data Display (DDD) as raw radar data in azimuth, elevation and range-rate (rate of closure). Targets appearing on the DDD could be 100 nm away or as little as 10 nm. As long as you remain in PDSRCH mode, you'll never know. Therefore, once a target is detected, it is recommended that you quickly switch to another radar mode.

Range While Search (RWS): This mode yields the greatest surveillance volume, and also returns absolute range in addition to closure rate. Maximum range in this mode is slightly less than in the PDS mode. Information can be displayed on the DDD or on the Tactical Information Display (TID), although this mode does not provide heading, speed, or altitude information. Target icons show up on the TID that allow the RIO to determine a target's approximate range by comparing the position of the target within the display.

Track While Scan (TWS AUTO, TWS MAN): TWS mode (pronounced "Twiz" by those in the know) is capable of tracking 24 targets simultaneously. The radar sweeps every two seconds, stores the targets position and vectors, and estimates where the target will appear next. This mode is used mainly for the launch of AIM-54 missiles. This mode tracks 'virtual' targets while it continues to scan for new ones. However, if the target is maneuvering violently, it is possible for the radar to lose track on that target. This is why radar data in TWS needs to be updated more frequently (every two seconds), which means using either an 80° wide, two-bar scan (40°/2b), or a 40°, four-bar scan (20°/4b). Either will enable the AWG-9 computer to store look angles, range, and closure rate for each contact in a separate track file, for possible hand off to an individual Phoenix missile, while all the time searching for fresh targets.

In TWS mode you do not receive the same level of information about specific targets that you get with PDSTT, but you can look over the entire battlefield, inspecting and engaging many aircraft simultaneously instead of having to lock them up one at a time. Another advantage is that the enemy is not alerted - you can fire on targets in TWS mode and they may not even see it coming. This makes TWS the radar mode of choice when launching missiles at BVR (beyond visual range) targets.

In TWS AUTO mode, targets are automatically assigned a position on the launch sequence. The radar determines which targets pose the greatest danger and directs your missiles accordingly. Targets nearest to your aircraft are usually fired upon first. The firing order is displayed on the TID by placing a number directly to the right of the target's icon. Numbers to the left of target icons indicate the target's altitude. As you fire your Phoenix missiles, targets move up in the firing order.

Track While Scan Manual (TWS MAN): TWS MAN mode functions exactly the same as TWS AUTO, with one important difference. Whereas TWS AUTO designates targets for you and assigns them a position in the firing sequence, TWS MAN mode makes you responsible for prioritizing the targets, hence the term "manual". *Note that in the F-14X, TWS MAN functions exactly the same as TWS AUTO*. Alternate priority targets are assigned by selecting them on the TID and entering Single Target Tracking mode.

Pulse-Doppler Single Target Track (PD STT): PDSTT allows you to track and engage one target at a time. This mode locks the radar's antenna onto a single target continuously illuminating that target. When the radar is in PDSTT, the TID provides you with targeting information specific to the target you have locked-up. All three missiles (Sidewinder, Sparrow, and Phoenix) can be fired using PD-STT for guidance (for AIM-7 Sparrow you must keep the radar focused on the target until the missile hits). In this mode, the radar can be slaved to the aircraft's electro-optical sighting unit.

Pulse Search (PULSE SRCH): A non-Doppler mode used for air-to-air search and ground mapping. In this mode there is no range-rate information, only range versus azimuth.

Pulse Single Target Track (PULSE STT): This is another non-Doppler mode, used primary during close-in combat where Doppler information is not of much value.

AUTO ACQUISTION MODES

Three auto acquisition modes could be activated by the pilot – PLM, VSL and PAL. These modes are also called transitional modes as they automatically put the radar in STT mode as soon as a target is acquired.

Pilot Lockon Mode (PLM): This mode (also called Pilot Rapid Lockon or PRL), uses a 2.3° radar pencil beam centered on the ADL (aircraft datum line). PLM is designed specifically to aid the pilot in the fast paced environment of modern air combat. The mode allows the pilot to lock up an enemy without going through normal step-by-step radar procedures. It is a close-quarter dogfighting mode that allows the pilot to instantly get a radar lock on any target that is directly in front of the aircraft. The nearest aircraft within 5 nm and within the boresight circle is automatically locked-up on the radar. When the pilot places the nose on a target, lock-on follows and a Sidewinder can be squeezed off rapidly and let loose for the kill.

Vertical Scan Lockon (VSL): Like PLM, Vertical Scan Lock-On mode is another radar mode used almost exclusively in the tight turning confines of a high G dogfight. VSL causes the radar to sweep in an up and down motion rather than in the normal left to right fashion. The gimble limits of the radar in VSL are -15° down and +55° up. In a turning dogfight, with the aircraft in a high G bank, being able to sweep at +55° almost gives the pilot the ability to see around corners. Like PLM mode, when VSL sweeps across an eligible target, it automatically "locks" that target. The only drawback to VSL mode is that the beam width is very narrow and the risk of overlooking targets on either side is great. VSL is range restricted to 5 nm or less and 4.8° azimuth. The Tomcat driver can select VSL HI [+15°; +55°] and VSL LO [-15°; +25°], covering a sector of sky above, through and below the HUD aiming area.

Pilot Aided Lockon (PAL): Alternatively, the pilot might employ the PAL mode, which provides a 40°, one-bar scan, to acquire a target at a similar altitude, but off-axis.

Failing all three transitional modes, the RIO can use Manual Rapid Lock-on (MRL), which works much like PAL except that the RIO has to manually acquire the target in the beam using the sidestick control, in the 'frightened fly' supersearch mode.

TACTICAL INFORMATION DISPLAY (TID)

Individual contacts on the TID are presented as little tadpole-like symbols. IFF interrogation sorts them out into their various categories, and assigns them a little hat: an inverted 'u' means that the target remains unidentified, while an inverted 'V' denotes that it is hostile. Some of this IFF data may have been data-linked to the Tomcat by the E-2C Hawkeye carrier borne AWACS, which uses its screw top antenna to track and interrogate targets out to much longer range.

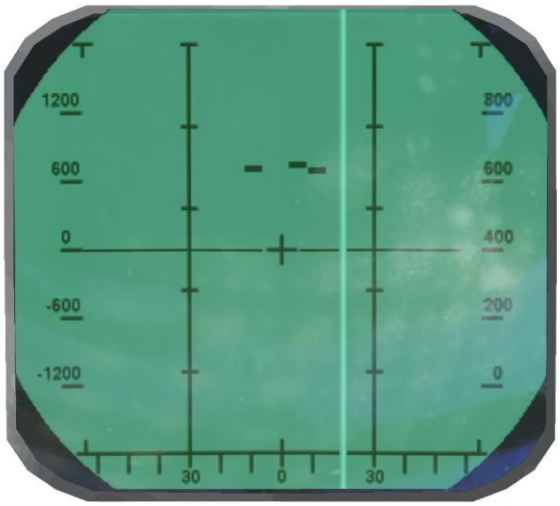
Tactical Information Display

Radar blips on the TID have "aspect markers" attached to them only when in TWS AUTO, TWS MAN and PDSTT modes. These little line segments stick out from blips to show the direction that the targets are heading, with the angle at which the line segment leaves the blip being equal to the target's aspect angle. When any target comes within AIM-54 range while in TWS mode, the aspect marker will begin to flash.

The TID default mode of operation is aircraft stabilized. In this mode the tactical display presents the radar information in heading-oriented range versus azimuth (PPI) coordinates stabilized about the aircraft. Own aircraft is shown at the bottom, headed up, with lines indicating the available engagement zone. The TID is also used to show television video.

DETAIL DATA DISPLAY (DDD)

The DDD shows azimuth (the horizontal location of the target in relation to the aircraft) and target closing velocity (closure rate). Target closure is displayed on the DDD vertically. The nearer to the top of the screen a target blip is located, the faster it is moving toward the aircraft. Running down both sides of the display are five tick marks (the tick marks are directly underneath the tiny T symbols in upper corners). The uppermost tick mark (directly under the T symbol) represents a closure rate of 1200 knots. The next tick down represents a closure rate of 600 knots. The center tick mark indicates no closure (distance to the target does not change). Target blips located below the center tick mark are actually moving away from your aircraft. The range of the DDD is adjustable from the range buttons just above the display. Note that changing the range will not change the position of the target blips on the screen as their azimuth and closure rate does not change. However, some targets may disappear if the range is reduced, and more targets may appear if it is increased.



The two vertical bars in the center of the monitor (each has 4 horizontal tick marks) are positioned at 30° left and right of the ADL. Radar blips outside these bars, therefore, represent aircraft that are 30° or more to the left or right of the aircraft nose. The full display width equals 130°. The tiny tick marks along the bottom edge are positioned at 10° azimuth away from each other. The symbology on the DDD changes when the radar is in STT mode. Because the radar beam is now focused (locked) on one particular target, only that target's blip appears. The radar beam stops its sweeping motion and remains fixated on the locked target.

RADAR CONTROLS

Detail Data Display Panel

The RIO controls the basic functions of the AWG-9 radar from the Data Display Panel (DDD panel) and the Sensor Control Panel (SCP). The range pushbuttons on the DDD panel allow the RIO to set a maximum radar range of 5 nm, 10 nm, 20 nm, 50 nm, 100 nm, and 200 nm. The seven MODE pushbuttons are also located on the DDD panel. As the mode is selected, the mode readout window next to the buttons shows the following indications: PD (for PD SRCH and PD STT), RWS, TWS AUTO, TWS MAN, PULSE (for PULSE SRCH and PULSE STT). The scan pattern is selected form the sensor control panel on the RIO left side panel. The AZ SCAN switch sets the azimuth scan pattern to 10°, 20°, 40° and 65°, and the EL BARS switch can set the elevation pattern to 1-bar, 2-bar, 4-bar and 8-bar. In FSX when the radar is in TWS mode, only two possible patterns are allowed - 2bar/40° or 4bar/20°, which ensure the 2 seconds scan interval.

Sensor Control Panel

TELEVISION CAMERA SYSTEM (TCS)

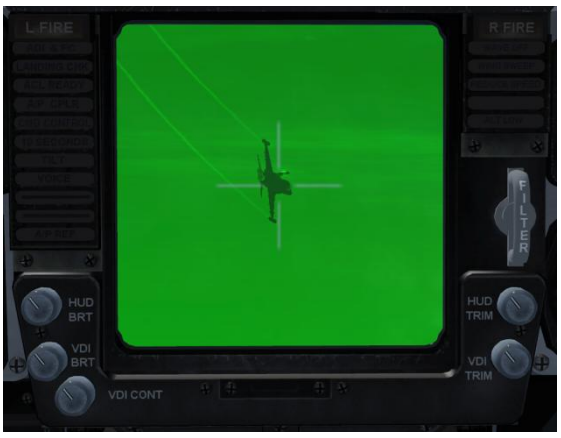
A Northrop AN/AXX-1 Television Camera System (TCS) is used for visual target identification at long ranges. Mounted on a chin pod, the TCS is a high resolution closed circuit television system which provides sharp close-up images of hostile aircraft outside of visual range. Typical identification ranges quoted are: DC-10 at 85 miles, F-111 at 40 miles, C-130 at 35 miles and F-5 at 10 miles.

The TCS image can be viewed on both the pilot's VDI display and on the RIO TID radar display. The maximum zoom of the system is 20x times, but zoom can be reduced at smaller ranges to fit the target inside the field of view.

On the Aerosoft F-14, the TCS does not need to be manually loaded, it is always available by default on **TacPack** enabled aircraft. The camera is automatically slaved to the AWG-9 and when there is a target selected on the radar, the camera is tracking that target. When there is no selected target, the camera is generally focused forward along the waterline. The zoom factor is controlled automatically as well.

Note: The TCS may not be compatible with DX10!

To display the TCS image on the VDI, put the TV/NORM switch on the Pilot Display Control Panel to 'TV'. To see the TCS in the RIO cockpit, press the IR/TV pushbutton on the RIO center console. To exit the IR/TV mode – press the RDR pushbutton.



TCS on the pilot's VDI display

TCS on the RIO TID display

TACAN SYSTEM

The TACAN system provides continuous indications of slant range to 0.1 nm and bearing of 0.5° to any surface station selected. Bearing, distance and deviation from the selected course is displayed on the BDHI indicator, the HUD, HSD and ECMD. In **Flight Simulator X** this system can be used to tune the **NAV1 radio** to track **VOR** stations and **carrier TACAN** stations, as well as the **ILS**.

Entering the TACAN channel tunes the FSX NAV1 radio

The tacan channel is entered from the TACAN CHAN switch on the tacan control panel (located on the pilot left side console). The switch consists of two rotary switches. The top (inner) rotary switch controls the last digit of the channel taking values from 0 to 9. The bottom (outer) rotary ring controls the first two digits taking values from 00 to 12. In the virtual cockpit you need to precisely place the mouse pointer next to the switch you need. The mode (X or Y) is selected by the MODE switch. With the TACAN CHAN switch you can select any TACAN channel from 17X to 126Y, which corresponds to NAV1 radio VOR frequencies from 108.00 MHz to 117.95 MHz. You can also enter the VOR frequency in MHz directly from the Cessna Radio Stack panel (Shift+6) – you will see the TACAN CHAN switch automatically select the corresponding channel (if you hover with the mouse over the switch you can see the channel in the tooltip). A list of TACAN channels and their corresponding frequencies is given at the end of this section.

TACAN Control Panel

AIRCRAFT CARRIER TACAN/ILS

Both TACAN and ILS are tuned by a single frequency specific to each aircraft carrier. The TACAN channel and its corresponding frequency in MHz are given in the table below. For example, to tune the NAV radio to the TACAN/ILS of the USS Kitty Hawk, you can either enter the TACAN channel (58X) from the tacan control panel or the frequency (112.10 MHz) from the Radio Stack panel (Shift+6). The common frequency approach and the individual frequencies are specific to the Aerosoft F-14 because carrier nav aids are not supported in FSX.

TACAN	Freq. (MHz)	Aircraft carrier
47X	111.00	Acceleration carrier
57X	112.00	USS Nimitz by Javier Fernandez
58X	112.10	USS Kitty Hawk by Aerosoft
77X	113.00	Clemenceau by Sylvain Parouty
78X	113.10	Charles de Gaulle by Sylvain Parouty

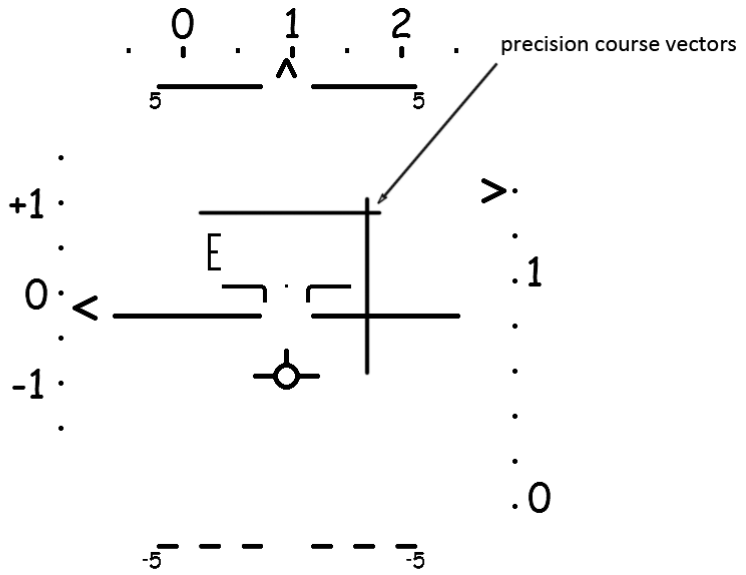
Once you have tuned the NAV1 radio to the carrier frequency, you can see navigation symbology for just one of the systems – either TACAN or ILS. The selection is done from the steering submode pushbuttons arranged at the bottom of the display control panel. Pressing the TACAN pushbutton puts the navigation system in tacan steering submode, and pressing AWL/PCD (all-weather landing/precision course direction) will show the ILS steering cues. The steering symbology will show up on the HUD, VDI and HSD (in NAV mode).

The ILS information is presented by two precision course vectors. A vertical vector (deviation bar) is used for azimuth steering, while the horizontal vector (glideslope needle) is for elevation. The pair forms a crosspointer and is displayed on the HUD and VDI simultaneously.

The TACAN information is presented by a vertical tacan deviation bar, similar to the ILS vertical bar. The bar changes when the aircraft is flying TO or FROM the station - on the HUD the bar is solid (TO) and dashed (FROM). On the VDI it changes from bright to dark.

The selected TACAN radial is automatically set to the Basic Recovery Course (BRC) of the carrier – the heading of the carrier. At night, the radial will be set to the runway heading because the aircraft goes straight for the runway instead of making a break. The selected course cannot be altered from the CRS control on the HSD.

In daylight approaches, the pilot would be tuned to the carrier frequency in tacan steering submode. This is extremely useful during the break as the pilot can judge his heading relative to the carrier heading, and nail the reciprocal course. Once abeam the carrier on the downwind leg, he would switch to AWL/PCD so he can intercept the ILS needles at the 90°.



F-14A HUD – AWL/PCD steering

TANKER TACAN

When you spawn a tanker from the TacPack in-game menu, you can tune the NAV1 radio to the tanker TACAN channel. This will show the tanker ID (TNKR) and range in the lower right corner of the HUD (B model) and the tanker bearing on the heading tape. When you see the tanker, you can switch to A/A and acquire it on the radar (use PLM for auto-acquisition). This will bring up additional data, such as altitude and closing velocity.

TACAN CHANNEL DESIGNATION AND PAIRED FREQUENCIES

TACAN	Freq.	TACAN	Freq.	TACAN	Freq.	TACAN	Freq.	TACAN	Freq.
17X	108.00	37X	110.00	57X	112.00	87X	114.00	107X	116.00
17Y	108.05	37Y	110.05	57Y	112.05	87Y	114.05	107Y	116.05
18X	108.10	38X	110.10	58X	112.10	88X	114.10	108X	116.10
18Y	108.15	38Y	110.15	58Y	112.15	88Y	114.15	108Y	116.15
19X	108.20	39X	110.20	59X	112.20	89X	114.20	109X	116.20
19Y	108.25	39Y	110.25	59Y	112.25	89Y	114.25	109Y	116.25
20X	108.30	40X	110.30	70X	112.30	90X	114.30	110X	116.30
20Y	108.35	40Y	110.35	70Y	112.35	90Y	114.35	110Y	116.35
21X	108.40	41X	110.40	71X	112.40	91X	114.40	111X	116.40
21Y	108.45	41Y	110.45	71Y	112.45	91Y	114.45	111Y	116.45
22X	108.50	42X	110.50	72X	112.50	92X	114.50	112X	116.50
22Y	108.55	42Y	110.55	72Y	112.55	92Y	114.55	112Y	116.55
23X	108.60	43X	110.60	73X	112.60	93X	114.60	113X	116.60
23Y	108.65	43Y	110.65	73Y	112.65	93Y	114.65	113Y	116.65
24X	108.70	44X	110.70	74X	112.70	94X	114.70	114X	116.70
24Y	108.75	44Y	110.75	74Y	112.75	94Y	114.75	114Y	116.75
25X	108.80	45X	110.80	75X	112.80	95X	114.80	115X	116.80
25Y	108.85	45Y	110.85	75Y	112.85	95Y	114.85	115Y	116.85
26X	108.90	46X	110.90	76X	112.90	96X	114.90	116X	116.90
26Y	108.95	46Y	110.95	76Y	112.95	96Y	114.95	116Y	116.95
27X	109.00	47X	111.00	77X	113.00	97X	115.00	117X	117.00
27Y	109.05	47Y	111.05	77Y	113.05	97Y	115.05	117Y	117.05
28X	109.10	48X	111.10	78X	113.10	98X	115.10	118X	117.10
28Y	109.15	48Y	111.15	78Y	113.15	98Y	115.15	118Y	117.15
29X	109.20	49X	111.20	79X	113.20	99X	115.20	119X	117.20
29Y	109.25	49Y	111.25	79Y	113.25	99Y	115.25	119Y	117.25
30X	109.30	50X	111.30	80X	113.30	100X	115.30	120X	117.30
30Y	109.35	50Y	111.35	80Y	113.35	100Y	115.35	120Y	117.35
31X	109.40	51X	111.40	81X	113.40	101X	115.40	121X	117.40
31Y	109.45	51Y	111.45	81Y	113.45	101Y	115.45	121Y	117.45
32X	109.50	52X	111.50	82X	113.50	102X	115.50	122X	117.50
32Y	109.55	52Y	111.55	82Y	113.55	102Y	115.55	122Y	117.55
33X	109.60	53X	111.60	83X	113.60	103X	115.60	123X	117.60
33Y	109.65	53Y	111.65	83Y	113.65	103Y	115.65	123Y	117.65
34X	109.70	54X	111.70	84X	113.70	104X	115.70	124X	117.70
34Y	109.75	54Y	111.75	84Y	113.75	104Y	115.75	124Y	117.75
35X	109.80	55X	111.80	85X	113.80	105X	115.80	125X	117.80
35Y	109.85	55Y	111.85	85Y	113.85	105Y	115.85	125Y	117.85
36X	109.90	56X	111.90	86X	113.90	106X	115.90	126X	117.90
36Y	109.95	56Y	111.95	86Y	113.95	106Y	115.95	126Y	117.95

COMMUNICATIONS

The ARC-159(V)1 radio provides air-to-air and air-to-surface voice communications. The radio is a solid state, self-contained unit with an average RF output of 10 watts. All controls for operation are on the front panel of the radio on the pilot left console. Flight Simulator X does not support UHF frequencies (above 225 MHz), so we allowed the ARC-159 to operate as a VHF COM1 radio.

Four frequency tuning controls are used to tune the transceiver when the tuning selector switch is set to MANUAL. The left knob controls the hundreds and tens digits, the second knob controls the units, the third controls tenths, and the right knob controls the hundredths. The mode selector switch has four positions - GUARD, MANUAL, PRESET and READ. The GUARD position tunes the radio to the guard frequency of 121.500 MHz. In the MANUAL mode the frequency tuning controls are used to tune the main transceiver to any frequency within the range of the set. The frequency selected is displayed in the readout window. PRESET is used to tune the transceiver to any of 20 preset channels, using the PRESET channel selector. The selected channel is displayed on the readout window. The READ mode permits the operator to read the frequency of the selected preset channel in the readout window.

AN/ARC-159(V)1 UHF 1 Control Panel

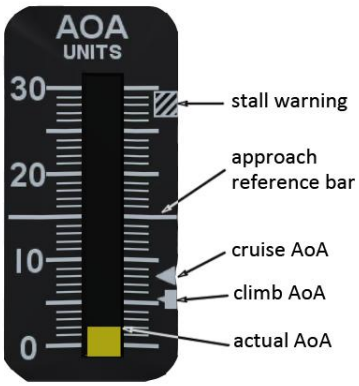
FLIGHT INSTRUMENTS

ANGLE-OF-ATTACK SYSTEM

The angle-of-attack system measures the angle between the longitudinal axis of the aircraft and the relative wind. This is used for approach monitoring and to warn of an approaching stall. Optimum approach angle of attack (AoA) is not affected by gross weight, bank angle, density altitude, or load configuration.

ANGLE OF ATTACK INDICATOR

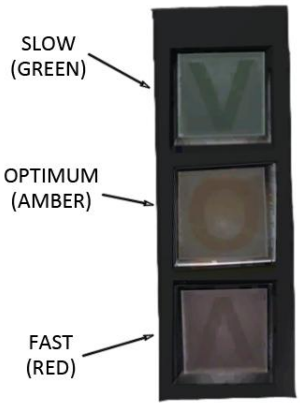
This indicator displays the aircraft AoA, provides a small warning reference marker, a climb bug, cruise bug, and an AoA approach reference bar for landing approach. AoA is displayed by a vertical tape on a calibrated scale from 0 to 30 units. The approach reference bar is provided for approach (on speed) angle of attack of 15 units. The climb reference marker is set at 5.0 units, the cruise marker at 8.5 units, and the stall warning marker at 29 units. These markers cannot be changed by the pilot.



Angle-of-Attack Indicator

APPROACH INDEXER

The approach indexer on the pilot glareshield has two arrows and a circle illuminated by colored lamps to provide approach information. The upper arrow is for high angle of attack (green), the lower arrow is for low angle of attack (red), and the circle is for optimum AoA (amber). When both an arrow and a circle appear, an intermediate position is indicated.

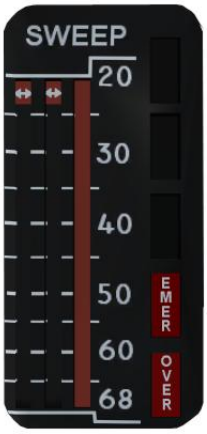


Approach Indexer

INDEXER	ANGLE-OF-ATTACK UNITS	AIRSPEED
	16 TO 30	SLOW
	15.5 TO 16	SLIGHTLY SLOW
	14.5 TO 15.5	OPTIMUM ON SPEED
	14.0 TO 14.5	SLIGHTLY FAST
	0 TO 14	FAST

WING SWEEP INDICATOR

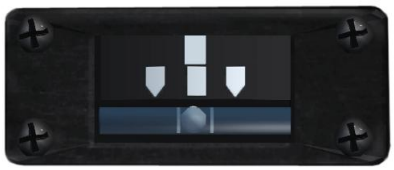
The wing sweep indicator displays actual wing sweep position from 20° to 68°. The indicator window shows the operating mode: oversweep (OVER), emergency (EMER), manual (MAN), auto (AUTO) and OFF.



Wing Sweep Indicator

TURN-AND-SLIP INDICATOR

The turn-and-slip indicator on the pilot instrument panel gives information on rate of turn of aircraft around its vertical axis and turn coordination. A needle-width deflection of pointer will initiate a 360° turn in 4 minutes. The inclinometer position of the instrument contains a damping fluid and a ball that moves from center in an uncoordinated turn.



Turn-and-Slip Indicator

AIRSPEED-MACH INDICATOR

The airspeed and Mach indicator on the instrument panel is a pitot-static system instrument that displays indicated airspeed from 80 to 850 knots on a fixed dial and Mach number from 0.4 to 2.5 on a rotating dial.

Airspeed-Mach Indicator

RADAR ALTIMETER

The radar altimeter system is a low-altitude (0 to 5,000 feet), pulsed, range-tracking radar that measures the surface or terrain clearance below the aircraft. The radar altimeter on the pilot instrument panel displays radar altitude above Earth's surface on a single-turn dial that is calibrated from 0 to 5,000 feet in decreasing scale to provide greater definition at lower altitudes. The system will operate normally in bank angles up to 45° and in climbs and dives. If radar altitude is unreliable, an OFF flag will appear.

SERVOPNEUMATIC ALTIMETER

The servoed barometric altimeter consists of a pressure altimeter combined with a servomechanism. Altitude is displayed in digital form by a 10,000-foot counter, a 1,000-foot counter, and a 100-foot drum. Also, a single pointer indicates hundreds of feet on a circular scale.

Radar Altimeter

Servopneumatic Altimeter

BEARING DISTANCE HEADING INDICATOR (BDHI)

A bearing distance and heading indicator is on the right side of the pilot and RIO instrument panels. It displays aircraft heading with navigation bearing and range information. Two servo-driven bearing needles indicate bearings to selected ADF and TACAN stations. The No.1 (single bar) needle indicates aircraft bearing to ADF station selected. The No.2 (double bar) needle indicates course to selected tacan station. The distance counter indicates slant range (nautical miles) to tacan station.

BDHI Indicator

FUEL QUANTITY INDICATOR

The white vertical tapes on the fuel quantity indicator show fuselage fuel quantity. The left tape indicates fuel quantity in the left feed and aft fuselage; the right tape indicates fuel quantity in the right feed and forward fuselage. The TOTAL readout indicates total internal and external fuel. The L and R labeled counters display either feed group (default), wing tank, or external tank fuel quantity on the side selected using the 3-position QTY SEL switch on the fuel management panel (pilot left vertical console). The QTY SEL switch positions are:

- WING - Fuel quantity in each wing is displayed on L and R counter of the fuel quantity indicator
- FEED - Feed group fuel quantity displayed on L and R counter (default position).
- EXT - Fuel quantity in each external tank displayed on L and R counter.

Fuel Management Panel

TANKS	APPROXIMATE USABLE FUEL	
	GALLONS	POUNDS*
FORWARD FUSELAGE	691	4700
AFT FUSELAGE	648	4400
RIGHT FEED GROUP	235	1600
LEFT FEED GROUP	221	1500
TOTAL FUSELAGE	1795	12,200
INTERNAL WINGS	590	4000
TOTAL INTERNAL	2385	16,200
EXTERNAL TANKS	534	3600
TOTAL CAPACITY	2919	19,800

*WEIGHT BASED ON JP-5 FUEL