

Glass Cockpit Basics And The Aspen Evolution EFD1000

Hill Flying Club



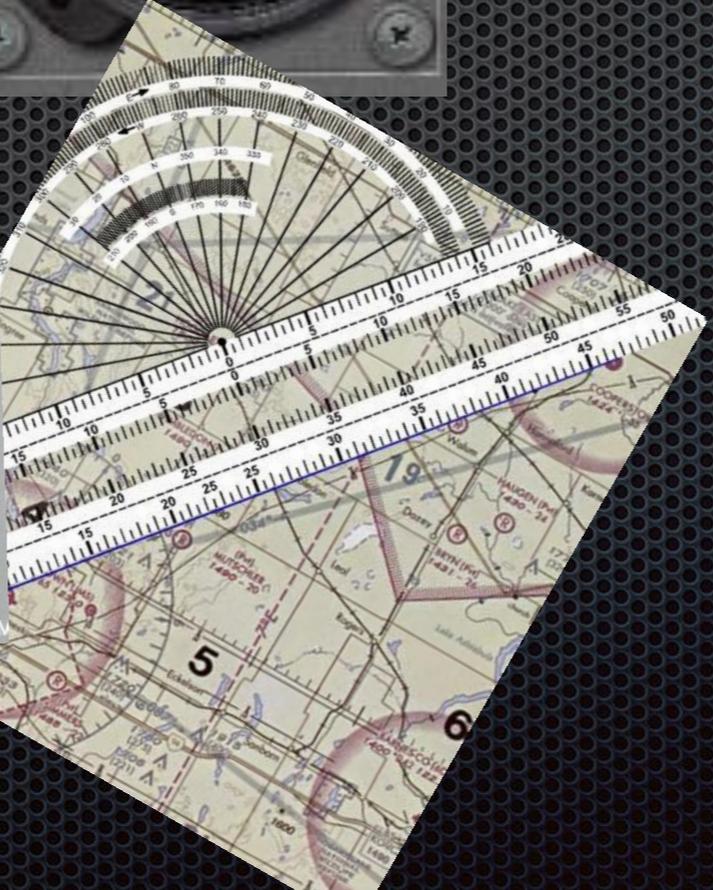
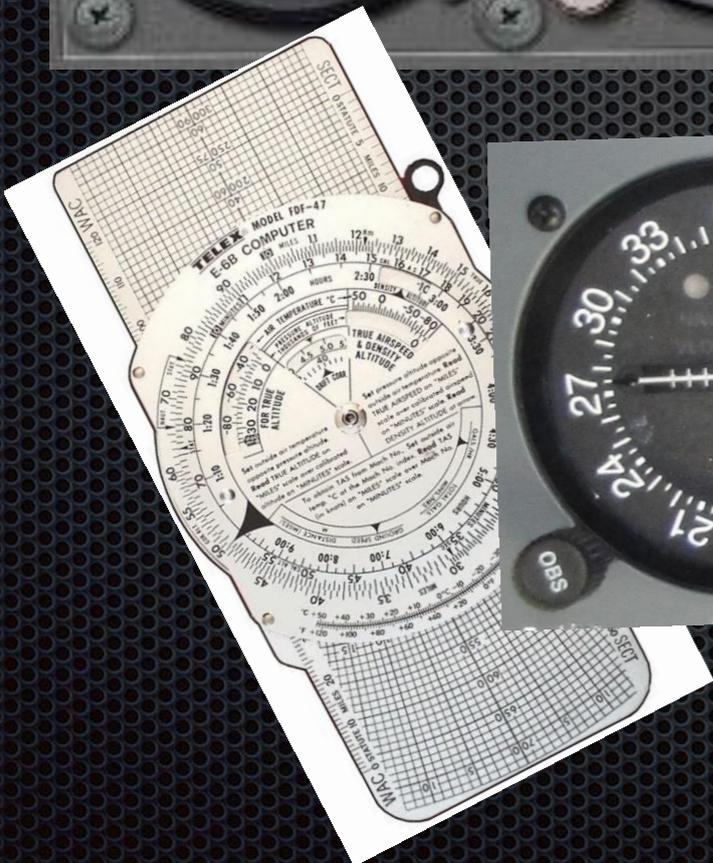


Glass Cockpit?

From this:



To this:



Your instrument scan:

From this:

To this:



The Evolution of Glass Cockpits



McDonnell-Douglas DC-9

CRT Displays





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McDonnell-Douglas MD-88



Boeing 757/767

CRT Monitor



LCD Monitor



LCD technology brought glass cockpits to general aviation.



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Embraer Legacy 500



N3524F

Conventional Cockpit vs. Glass—The Main Differences:

- The gyroscopic instruments are replaced by solid-state electronics.
- The pitot-static instruments are replaced by solid-state electronics.
- The standard cockpit instrument displays (6-pack) have been replaced by highly-reliable LCD displays augmenting and enhancing the information available to the pilot.
- Enhanced integration with other aircraft systems such as navigation systems and autopilots.
- More Acronyms!

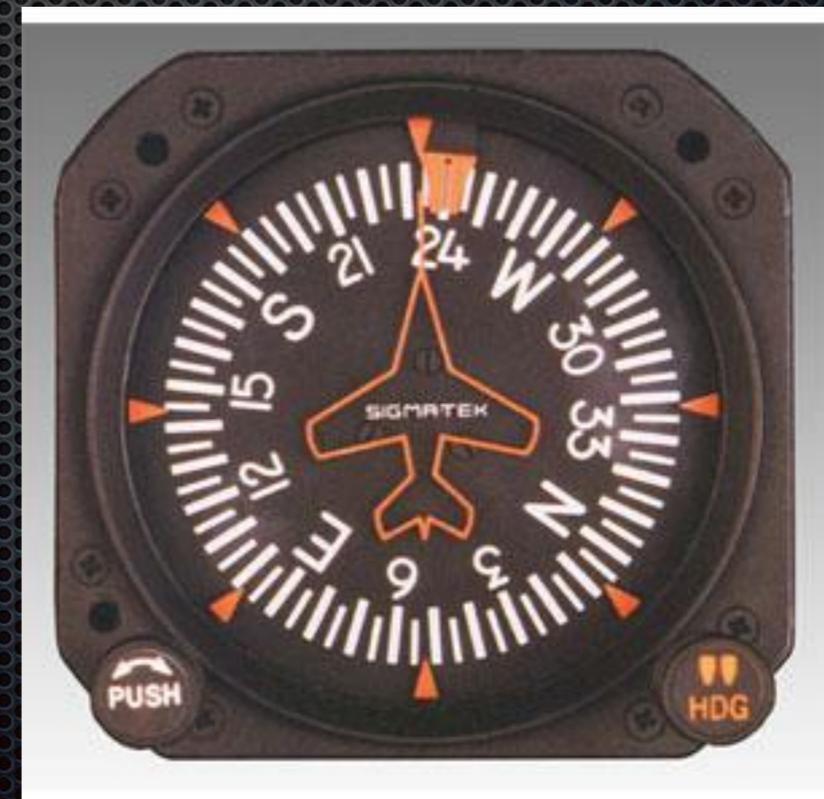
EFIS = Electronic Flight Instrumentation System



EFIS

Behind the Panel

Gyros



From this:

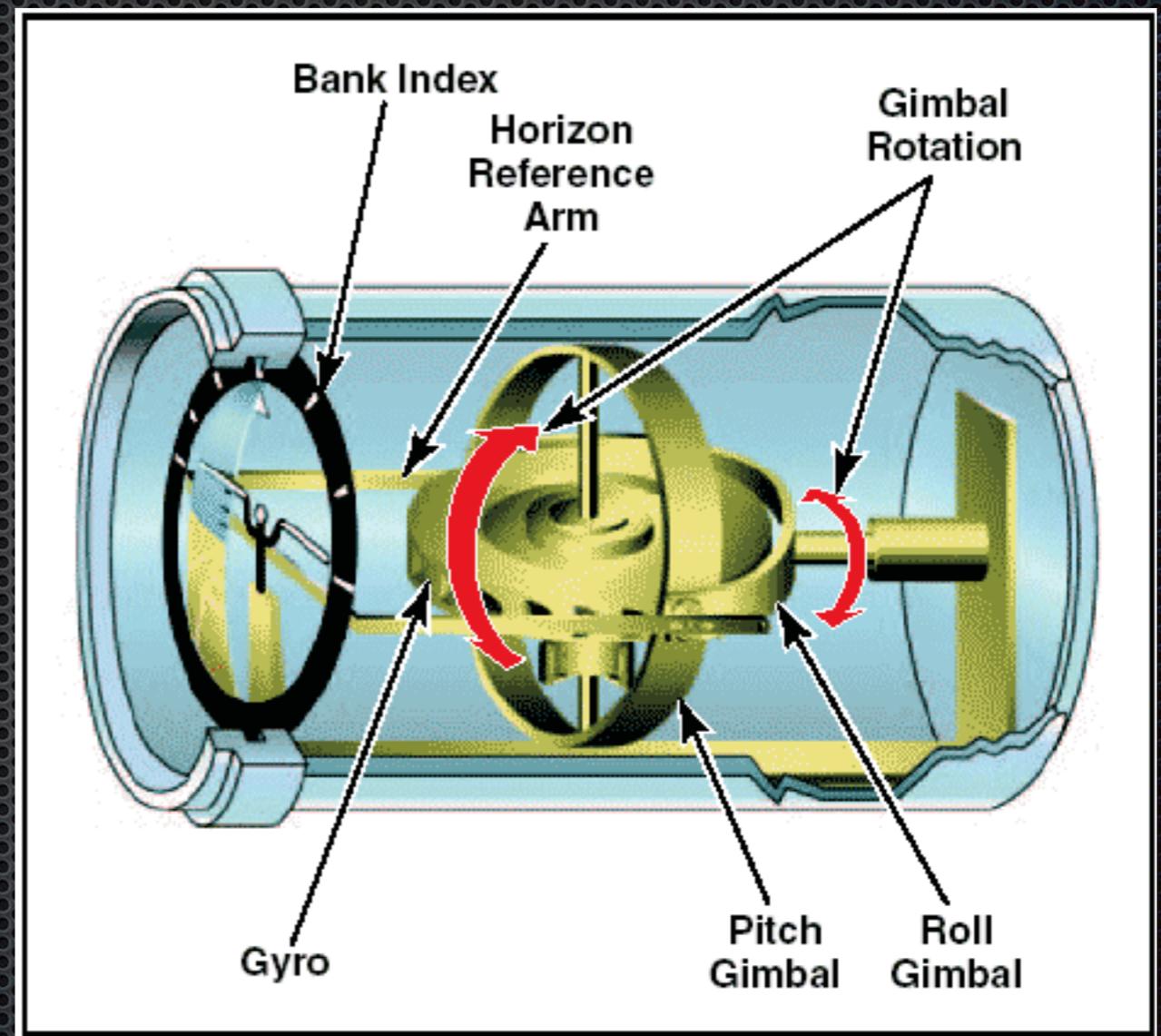


To this:



Gyro Review

- Rigidity in space.
- Vacuum or electrical system spins gyros at high speed (10-15,000 RPM.)
- System of mechanical gimbals, gears and display cards to depict information to pilot.
- Many precision, moving parts.
- Relatively heavy weight.



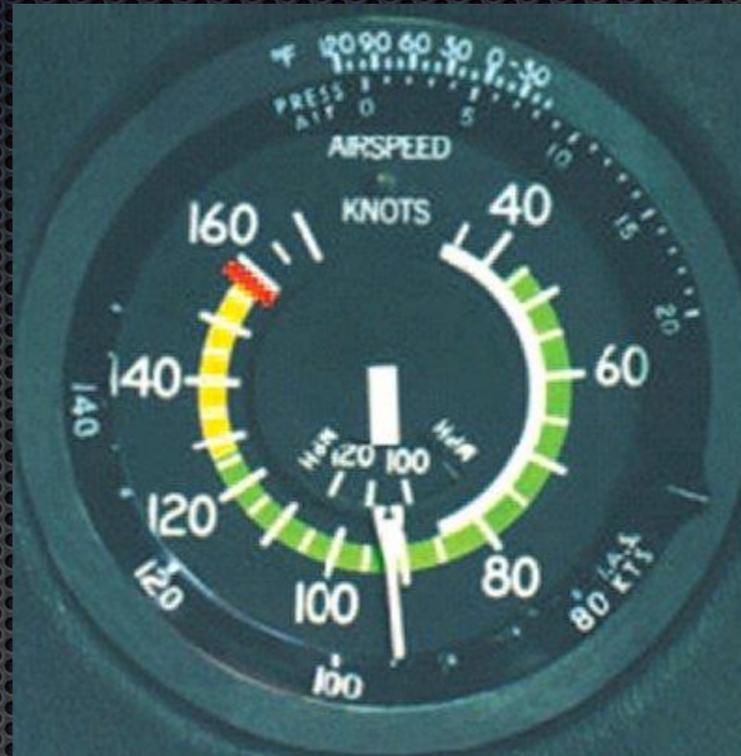
What's New?

- Solid state electronics.
- Micro-electronic mechanical gyros, accelerometers, and magnetometers.
- Less space / weight required.
- More Acronyms!
- AHRS=Attitude/Heading Reference System.



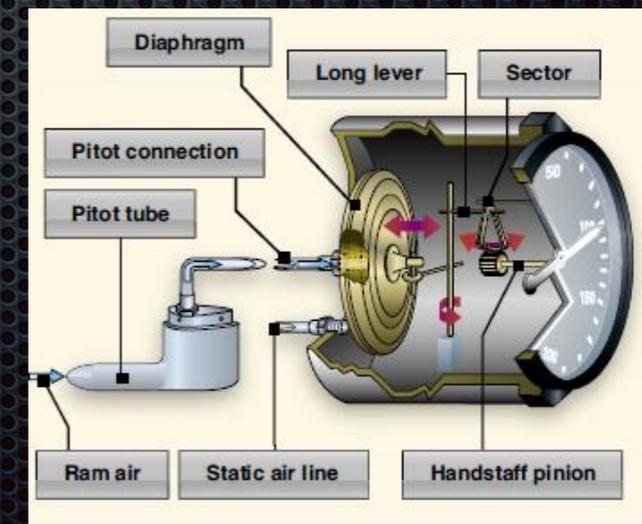
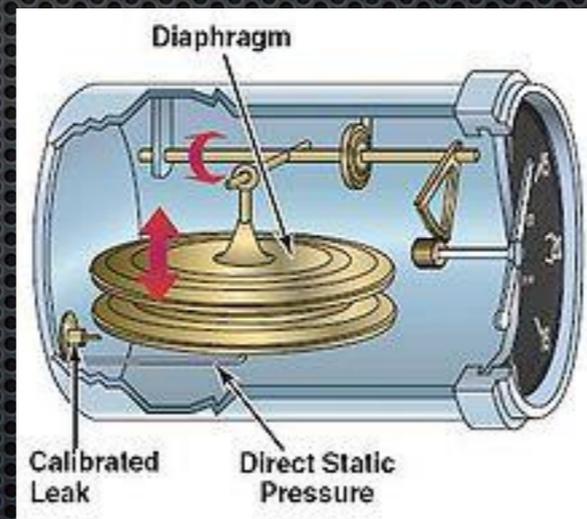
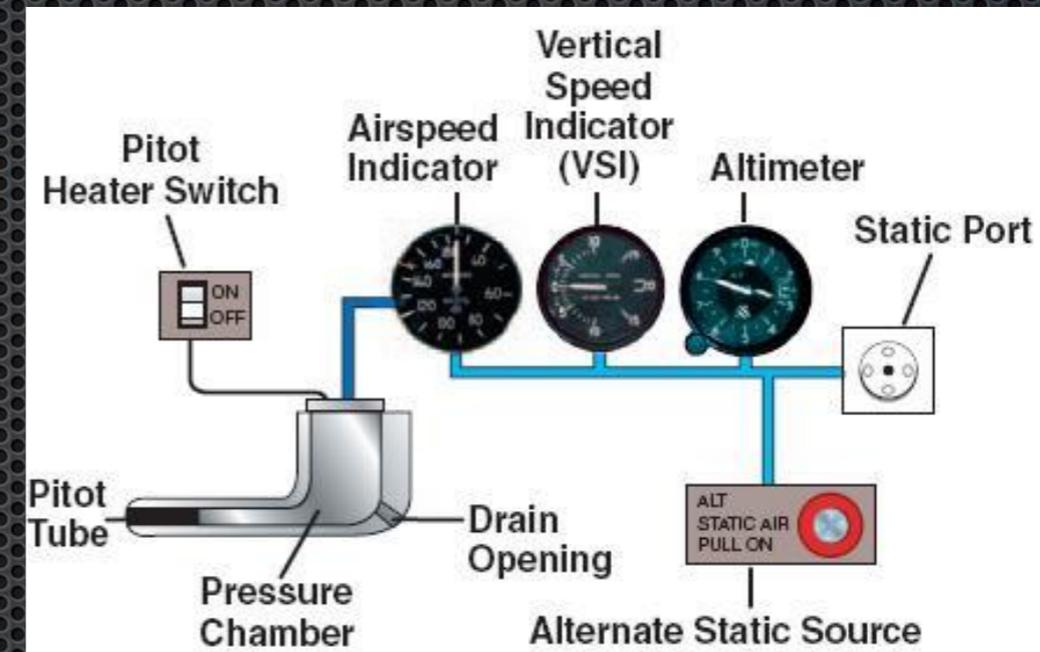
AHRS

Pitot-Static



Pitot-Static Review

- Ram (pitot) air pressure.
- Static pressure.
- System of tubes, ports and plumbing to each instrument.
- Precision hardware: pinions, gears, delicate aneroid wafers and calibrated leaks.
- Relatively complex / heavy weight.

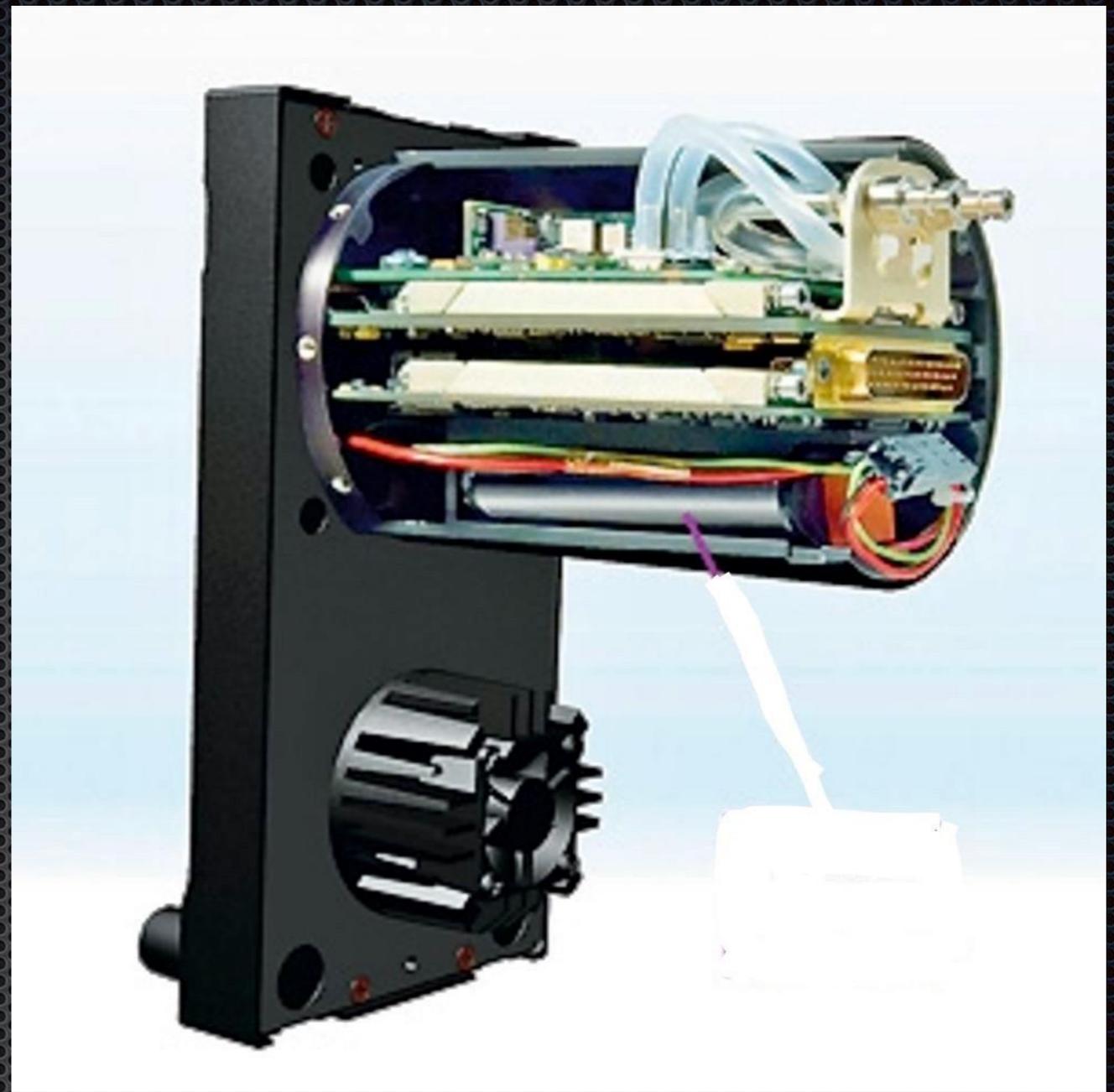


What's New?

- Uses mostly existing ports and plumbing.
- Added temperature input.
- Pressure transducers convert air pressure into voltage.
- Software algorithms compensate for errors.
- More Acronyms!
- (D)ADC=(Digital) Air Data Computer.



ADC



Aspen Evolution EFD1000

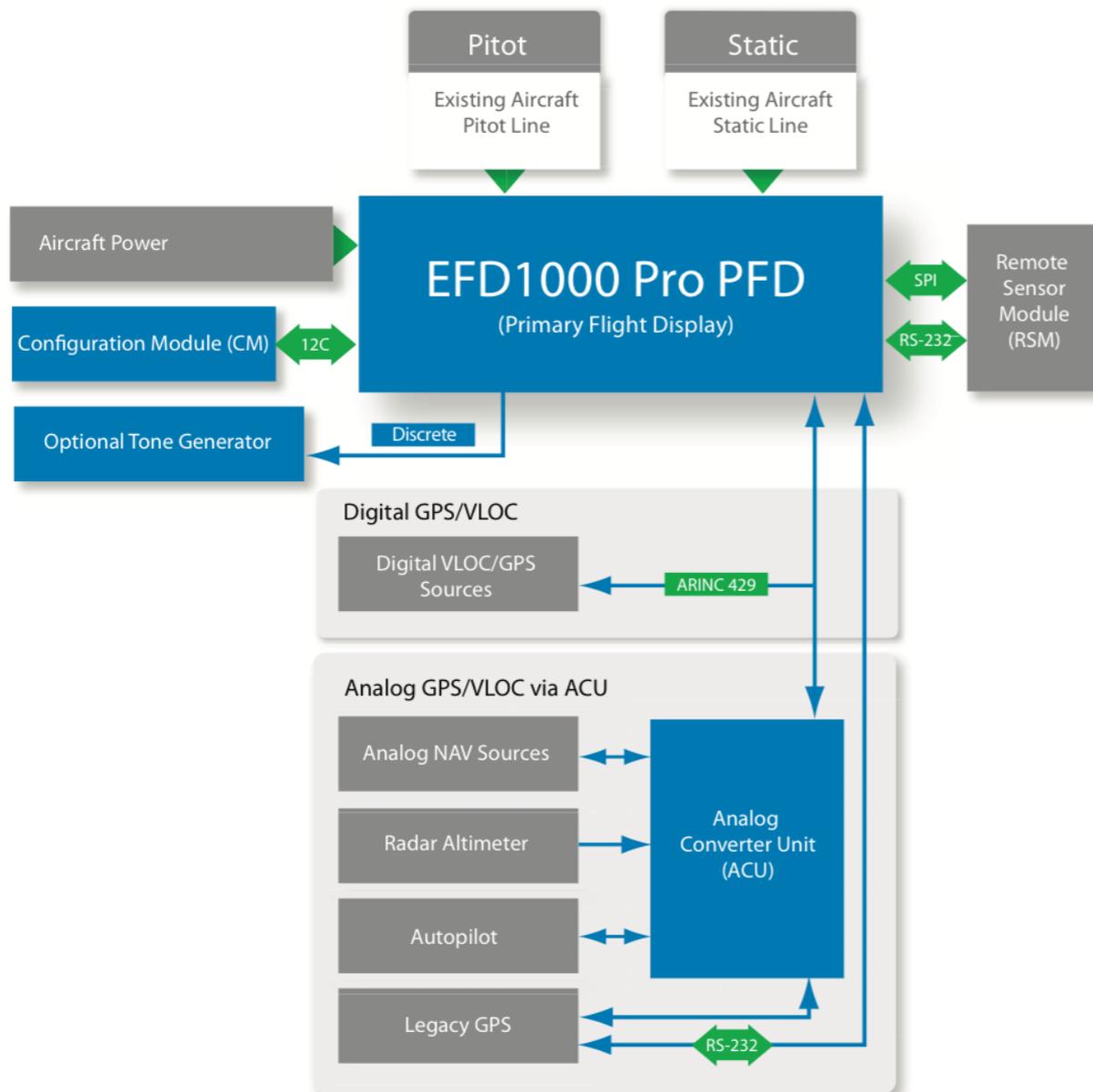


Figure 1-5
Pro PFD System Architecture

1.1. System Overview

The PFD system typically consists of four components:

1. EFD1000 Display Unit (PFD)
2. Configuration Module (CM)
3. Remote Sensor Module (RSM)
4. Analog Converter Unit (ACU)¹

The ACU converts older analog signals and interfaces to the industry-standard digital ARINC 429 interface, which is the native language of the PFD. In some installations, generally when the aircraft is not equipped with an autopilot and has only digital GPS/Nav/Comm, the ACU may be omitted.

The system architecture in **Figure 1-5** shows the relationships of the PFD, RSM, CM and ACU.

¹. Not available with the Pilot PFD

1.1.1. EFD1000 Display Unit

The EFD1000 system unit is a digital system that consists of a high resolution 6" diagonal color LCD display, user controls, photocell, and Micro SD data card slot. The three-inch diameter, four-inch deep can on the back of the display contains a non-removable electronics module which includes:

- A Sensor Board with solid-state Attitude and Heading Reference System (AHRS) and digital Air Data Computer (ADC).
- A Main Application Processor (MAP) board with Central Processing Unit (CPU), graphics processor and system memory.
- An Input-Output Processor (IOP) board for integrating communications with other aircraft systems.

Also on the rear of the unit are (**Figure 1-6**):

- An access cover for removing and replacing the built-in backup battery.
- Pneumatic connections to the aircraft's pitot and static systems.
- 44-pin D-sub connector for electrical connections to the EFD1000.
- A cooling fan, to cool the electronics and LCD backlights.

The PFD mounts to the front surface of most instrument panels.

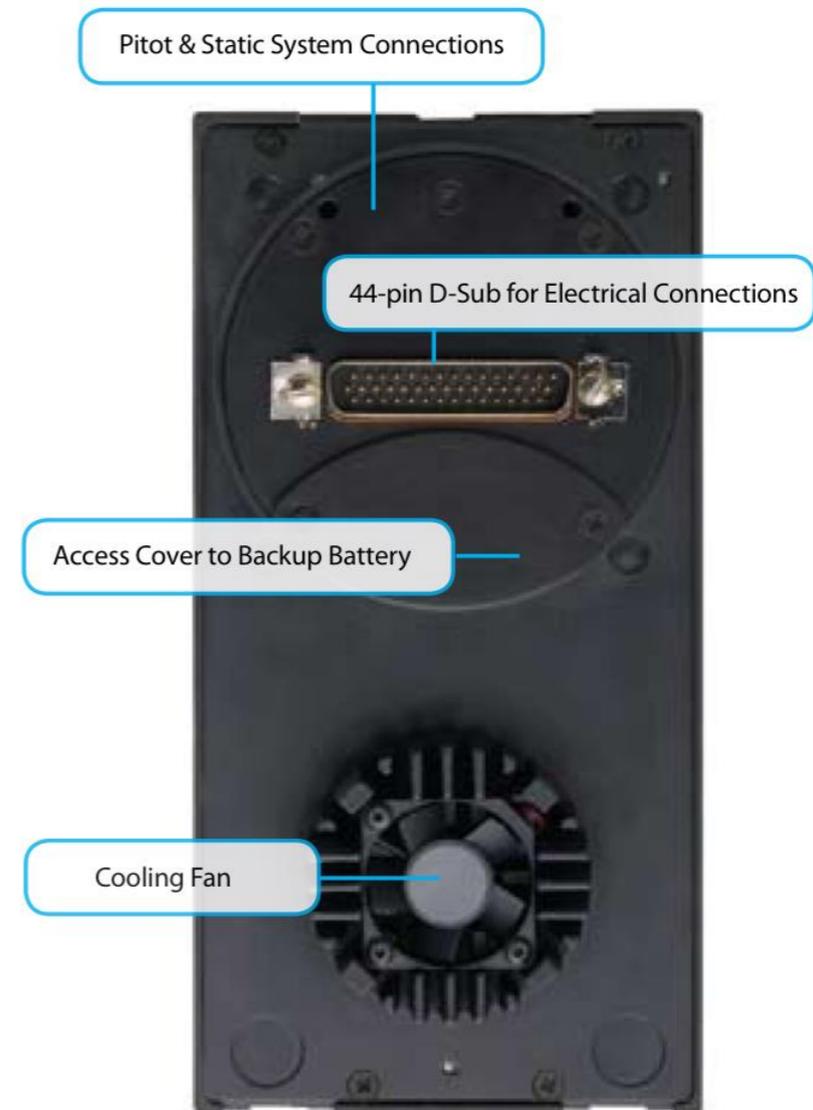


Figure 1-6 PFD Rear Connections



Figure 1-7
Configuration Module (CM)

1.1.2. Configuration Module (CM)

The Configuration Module (**Figure 1-7**), contains an EEPROM device that retains system configuration and calibration data and provides two primary functions:

- Retains aircraft-specific configuration information, calibration data, and user settings, allowing the PFD to be swapped for service purposes without re-entering or re-calibrating the installation
- Contains a license key that configures the PFD software features

The CM is typically attached to the wire bundle coming out of the D-sub connector on the display unit.

1.1.3. Analog Converter Unit (ACU)¹

The Analog Converter Unit (ACU) (**Figure 1-8**), included with most Pro PFD systems, enables the all-digital, EFD1000 System to interface with analog avionics when required. The ACU converts multiple analog interfaces to the digital ARINC 429 buses supported by the PFD. Control parameters, such as desired heading, are also sent from the Pro PFD to the ACU for conversion to analog format for autopilot support. The ACU is required when any of the following capabilities are required in a Pro PFD installation:

- Interface to supported autopilots
- Interface to conventional VHF navigation radios
- Interface to legacy (non-ARINC 429) GPS navigators
- Interface to supported radar altimeter decision height annunciations

If ARINC 429-based digital radios, such as the Garmin 400/500-series GPS/nav/comm radios are installed in the aircraft and no other aircraft interfaces are desired, the ACU is not required.



Figure 1-8
Analog Converter Unit (ACU)

1. Not available with the Pilot PFD

1.1.4. Remote Sensor Module (RSM)

The Remote Sensor Module (RSM) (**Figure 1-9**), is an integral part of the EFD1000 system and works together with the display unit sensors as part of the AHRS and ADC. The RSM looks and mounts like a GPS antenna and is mounted on the exterior of the fuselage, typically aft of the cabin.

The RSM contains the following sub-systems:

- 3D magnetic flux (heading) sensors
- Outside Air Temperature (OAT) sensor
- Emergency backup GPS engine and antenna

The RSM communicates with the PFD via a digital cable connection.



Figure 1-9
Remote Sensor Module (RSM)

1.1.5. Evolution Weather Receiver (EWR50)¹

The optional Evolution Weather Receiver, EWR50 (**Figure 1-10**) converts the XM WX Satellite Weather data into a digital format displayed on the EFD1000 Pro PFD. The EWR50 provides the ability to receive XM WX Satellite Weather data with a paid subscription to XM WX Satellite Weather service. The EWR50 consists of a receiver and antenna.



Figure 1-10
Evolution Weather Receiver (EWR50) - Optional

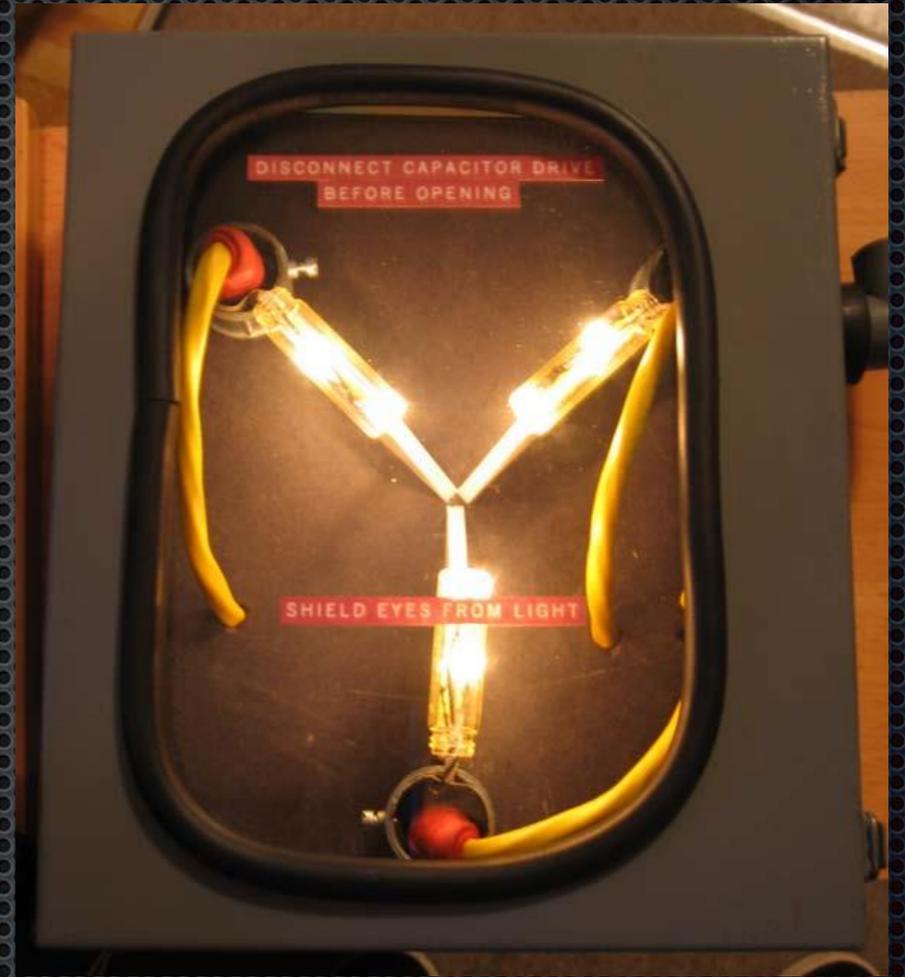
NOTE

A single EWR50 Receiver will supply data to all EFD units installed on the aircraft.

1. Not available with the Pilot PFD



Flux Sensor



Flux Capacitor

What You See

Instrument Displays



What's New?

- All six-pack instruments now displayed digitally on LCD screen.
- Similar to six-pack layout.
- Added features like airspeed and altitude tape displays, flight director integration, localizer and glideslope depiction, moving map, traffic, weather, etc.
- More Acronyms!...



PFD= Primary Flight Display



PFD

MFD= Multi Function Display



MFD=
Multi
Function
Display



Bendix-King KMD 550 MFD

Airspeed Tape Display



Airspeed Tape Display

- Current airspeed in black box, rolls like a “drum.”
- Airspeed “bug” in cyan.
- Reference speeds along right side.
- Colors correspond to conventional airspeed indicator markings. (i.e. White line=flaps, etc.)

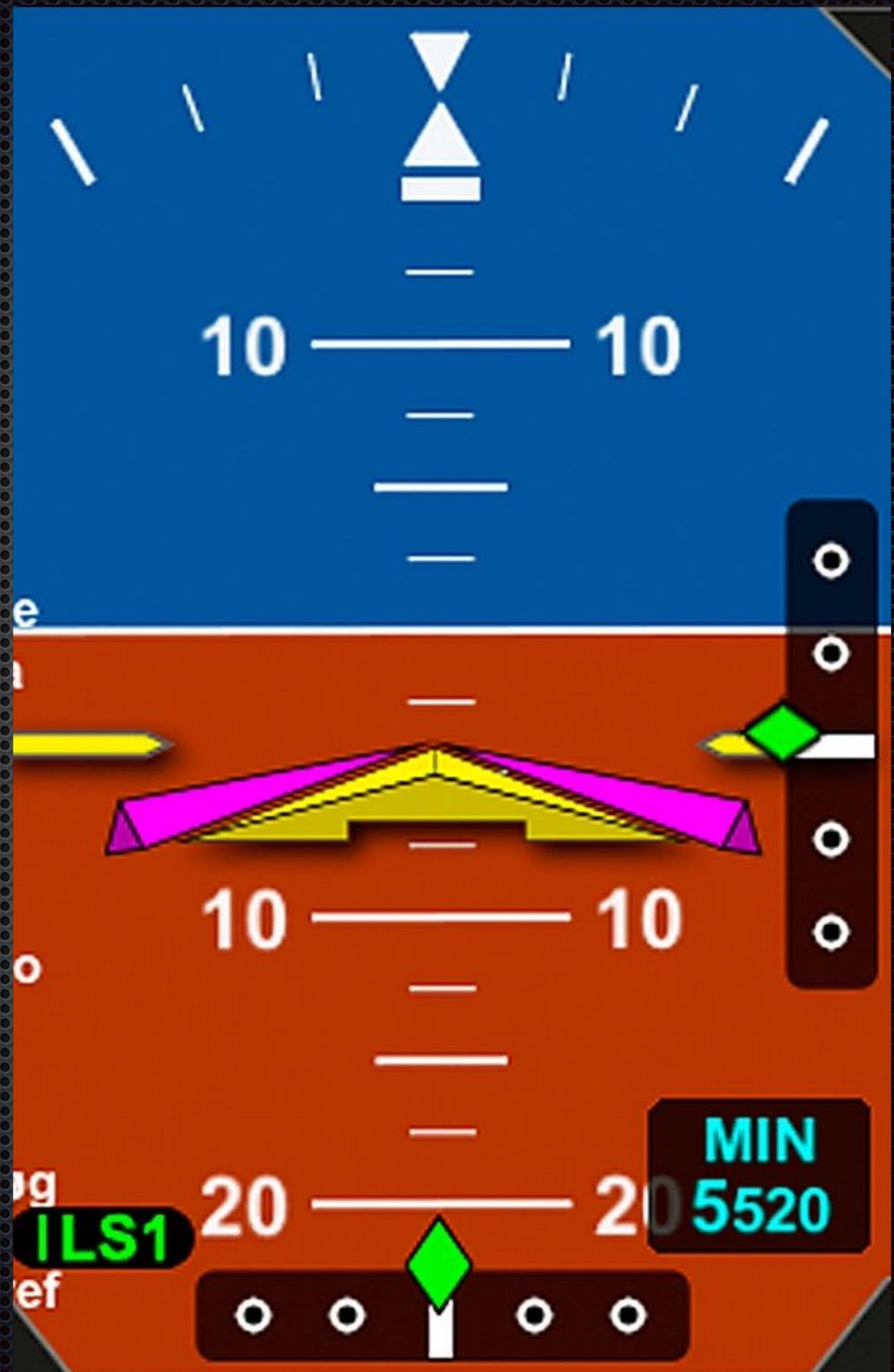


ADI Display



ADI Display

- White Horizon line and pitch and bank references lines.
- “Sky pointer” for bank angle.
- “Brick” slip / skid indicator. One rectangle width = one ball width.
- Airplane symbol and pitch bar in yellow.
- Flight Director bar in magenta.
- Localizer / Glideslope pointers & Nav source.
- Minimums window (cyan.)



Altitude Tape Display



Altitude Tape Display

- Current altitude in black box, rolls like a “drum.”
- Altitude “bug” in cyan.
- Altimeter setting lower right (cyan.)
- Magenta altitude trend vector. Shows altitude in 6 seconds @ current vertical rate.



Data Bar





- TAS.
- GS.
- OAT.
- Wind Vector, direction and velocity.
- Altimeter setting.

(E)HSI =
(Electronic)
Horizontal
Situation Indicator

-or-

ND = Navigation
Display



HSI or ND

EHSI 360° Mode



EHSI Arc Mode



EHSI 360° Mode: (Aircraft centered on compass rose.)

- Current magnetic heading in black pointer box. NDI=Numerical Direction Indicator.
- No adjustments required (slaved.) Automatically compensates for precession, turning, and acceleration errors.
- Primary Nav in green HSI format (selected CRS in cyan).
- Cyan HDG bug.
- Single and double bearing pointers (only available in 360 mode.)
- Cyan diamond = Ground Track Marker.
- Range and clutter level displayed in lower left.



EHSI Arc Mode: (Aircraft symbol near bottom of display.)

- Displays map format.
- 100° arc.
- Displays other airports, navaids and fixes depending on declutter level selected.
- Can toggle Weather (ADS?), Traffic, and Lightning on/off.



Rate Of Turn Indicator:

White arc displayed on top of compass rose in direction of turn.



Thick tick mark = standard rate.

Thin tick mark = 1/2 standard rate.

Vertical Speed Indicator (VSI):

- White scale displayed to the right of compass rose on EHSI.
- Actual vertical rate displayed numerically above.
- Scale Pegs out at 2000 fpm.
- Numeric value displayed up to 9990 fpm.



SV =
Synthetic
Vision



SV

SV Basics

Computer generated 3D view of terrain, obstacles and traffic.



SV Display Features

- Zero Pitch Line.
- Flight Path Marker.
- Aircraft reference symbol.



SV Display Features

- Distance markers.
- Airport Flags.
- Runways.
- Obstacles.

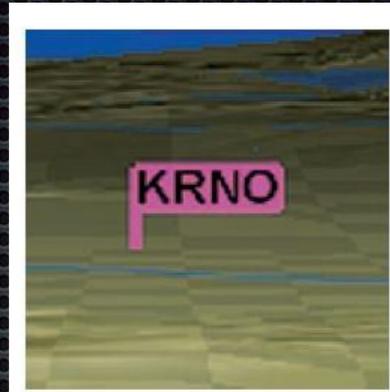


Figure 2-5 Magenta Airport Flag

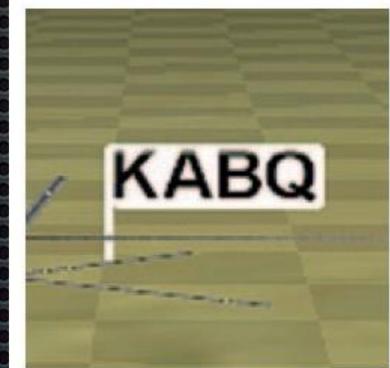
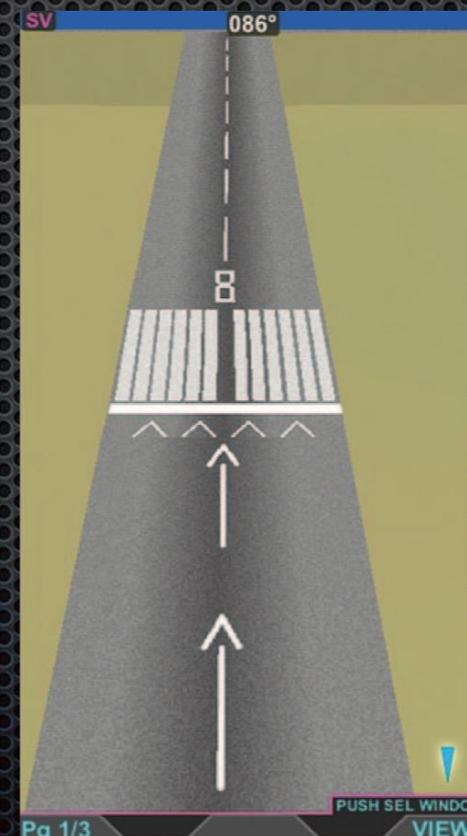


Figure 2-6 White Airport Flag



Obstacle Height < 1000' AGL		Obstacle Height > 1000' AGL	
			
			
			

TWS = Terrain Warning System

- Terrain Coloring.
- FPM Coloring.
- Caution/Warning text annunciations.
- Aural Alert.

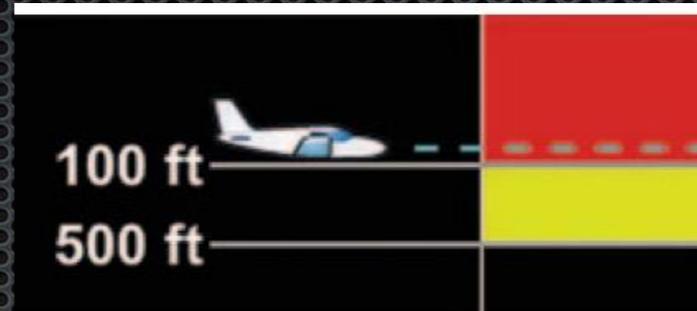


Figure 4-2 Inflight Terrain Color Legend



Figure 4-3 Green FPM

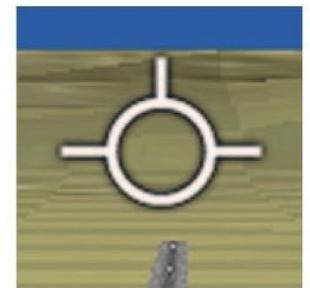


Figure 4-4 White FPM



Figure 4-5 Amber FPM



Figure 4-6 Red FPM



Figure 4-8 Amber FPM and CAUTION - Obstacle



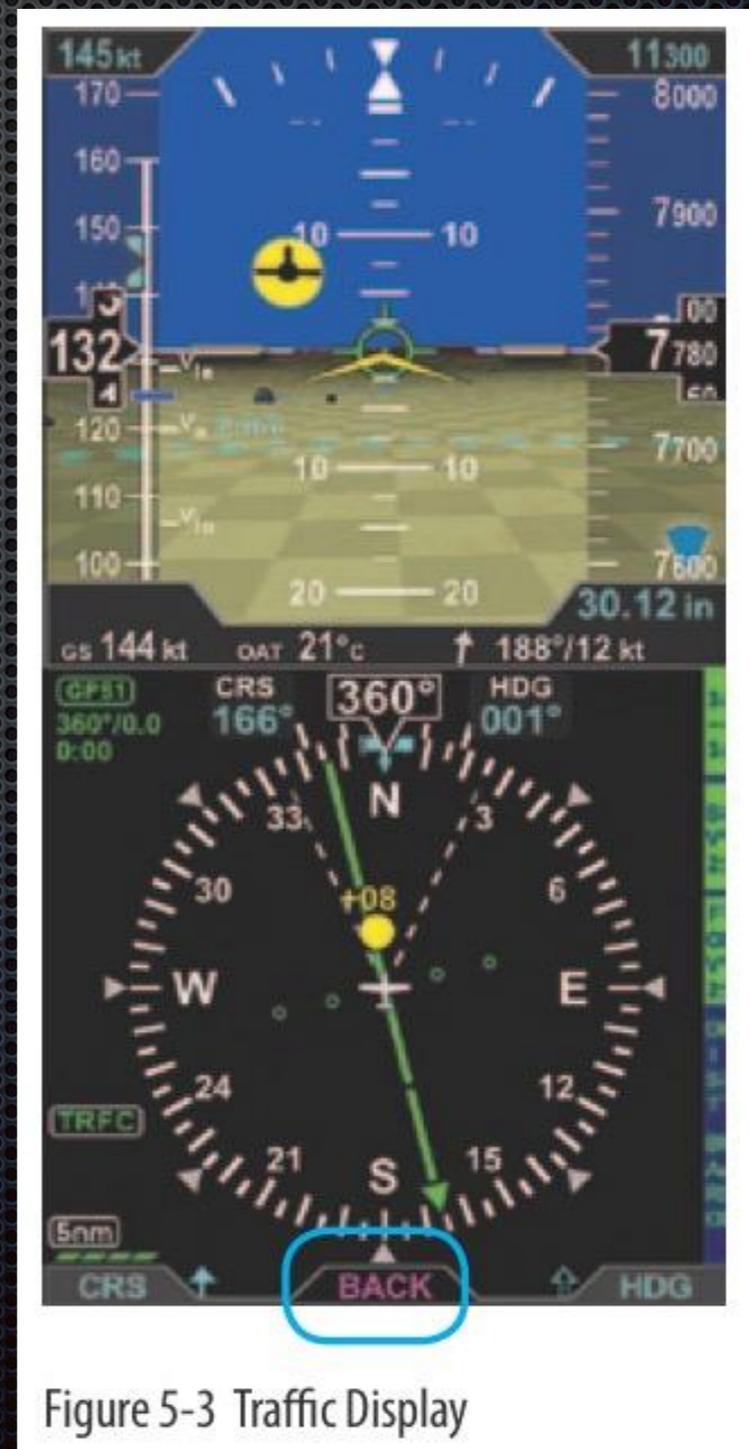
Figure 4-9 Red FPM and CAUTION - Obstacle

Traffic Symbols

- ADS B Traffic.
- Advisory only.
- Not to be used for avoidance maneuvers.
- Not all traffic is displayed.
- IOW - Keep Looking Outside.

Traffic Advisory	Proximity Advisory	Other Traffic
		

Table 5-1 ESV 3D Traffic Symbols



Controls



Reversion / Power Button

- Used mostly in multiple screen installations.
- You will likely never touch it.



Range Selector

- Selects range in arc mode.



Menu Button

- Used to change pilot selectable options.



Hot Keys

- Function labeled on screen to left of key.
- Bright green = Active
- Dark blue = Off



- CDI Nav Source Select Key (center.)
- Bearing Pointer Select Keys (Outer.)



Knobs



Left knob controls functions on left side of screen:

- Push to highlight desired function in magenta.
- Twist to change setting.
- Course Selector.
- Airspeed bug.
- Reverts to CRS (cyan) after 10 seconds.



Right knob controls functions on right side of screen:

- Push to highlight desired function in magenta.
- Heading bug.
- Selected altitude.
- Altimeter setting (BARO.)
- Minimums.
- Reverts to HDG (cyan) after 10 seconds.



AFM Supplement Notes:

Section 3: Emergency/Abnormal Procedures

- Pitot Tube Icing
- ON BAT Annunciation
- AHRS Reset
- Turn Off EFD in Flight
- Continuous System Reset

AFM Supplement Notes:

Section 4: Normal Procedures

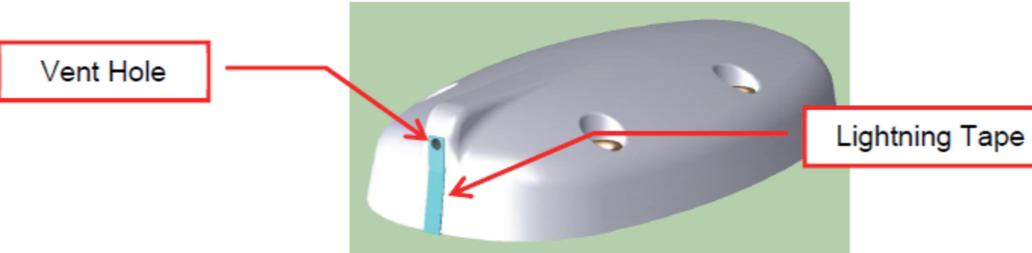
- Exterior Inspection (RSM, Vent Hole, Lightning Tape.)
- Before Takeoff (Configure for departure.)
- Before Approach (Configure for arrival.)
- Shutdown Check (Switch—OFF)

ASPEN AVIONICS *Evolution Flight Display System*

4 Normal Procedures

4.1 Exterior Inspection

1. RSM..... Check for condition and security
2. RSM Vent Hole..... Check Clear of obstructions
3. RSM Lightning Tape..... Check for condition and security



The diagram shows a 3D perspective view of a grey, oval-shaped Remote Sensor Module (RSM). A red box labeled 'Vent Hole' has a red arrow pointing to a small circular opening on the left side of the module. Another red box labeled 'Lightning Tape' has a red arrow pointing to a blue strip of tape on the right side of the module.

Figure 1 - Remote Sensor Module (RSM)

**WARNING: EFIS CAN BE
A MAJOR DISTRACTION!**

The temptation is STRONG!

Try to resist!

**WARNING: EFIS CAN BE
A MAJOR DISTRACTION!**



Fly the airplane!



Fly the airplane!



There is no substitute for experience!

- Go out and Fly!
- Bring a safety pilot.

List of New Acronyms:

ADC	Air Data Computer
ADI	Attitude Director Indicator
AHRS	Attitude and Heading Reference System
BP	Bearing Pointer
CDI	Course Deviation Indicator
EFIS	Electron Flight Instrumentation System
(E) HSI	(Electronic) Horizontal Situation Indicator
FD	Flight Director
FPM	Flight Path Marker
LDI	Lateral Deviation Indicator
MFD	Multifunction Display
ND	Navigation Display
NDI	Numerical Direction Indicator
PFD	Primary Flight Display
RMI	Radio Magnetic Indicator
SV	Synthetic Vision
TWS	Terrain Warning System
VDI	Vertical Deviation Indicator

Questions?

Hill Flying Club

