MODULE 05

FOR B2 CERTIFICATION

DIGITAL TECHNIQUES ELECTRONIC INSTRUMENT SYSTEMS

Aviation Maintenance Technician Certification Series

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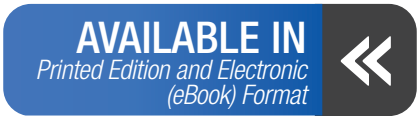

AVIATION MAINTENANCE TECHNICIAN CERTIFICATION SERIES

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We wish you good luck and success in your studies and in your aviation career!

REVISION LOG

VERSION	EFFECTIVE DATE	DESCRIPTION OF CHANGE
001	2015 01	Module Creation and Release
002	2017 02	Format Update
002.1	2019 11	Corrections to Figures: 3-5, 5-14, 8-4, 9-4

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Figure 1-2. Airbus A380 EIS with 8 large LCD displays.

Figure 1-3. Equivalent Electromechanical Flight and Navigation Instruments on the left.

ELECTRONIC DISPLAYS

The early EIS displays mimicked the analog display formats for ease in pilot training as the crew transitioned from older analog displays to digital displays that were driven by aircraft data computers, known as display processors or symbol generators.

Figure 1-3 depicts an early model Boeing 737 instrument panel with an analog Attitude Direction Indicator (ADI) and analog Horizontal Situation Display (HSI) in the left picture, and a later model B737 instrument panel with electronic ADI (EADI) and electronic HSI (EHSI) displays shown in the right picture.

The ADI or EADI is an artificial horizon with lateral bars superimposed to display computer-generated pitch, roll and bank steering commands from the Flight Director computer. The HSI or EHSI is similar to a heading indicator, except that it combines navigation commands from the VHF Omni-Range (VOR) or

Global Positioning System (GPS) receivers which are used for en-route guidance, or from the Instrument Landing System (ILS), which is used for terminal guidance. Besides heading, the HSI/EHSI also provides actual track, desired track, track angle error, drift angle, cross-track deviation, and distance to destination information from the Distance Measuring Equipment (DME) or Inertial Navigation System (INS). (***Figure 1-4***)

The pilot and the co-pilot not only have independent EADI and EHSI displays, but they also have independent Display Processor Units, also known as Symbol Generators, to drive their displays (***Figure 1-5***). Display formats are produced by the Symbol Generators that receive inputs from the crew and various on-board systems. The Flight Director Systems, Navigation Systems, Air Data Systems, and Weather Radar provide inputs to the Symbol Generators, along with commands from the each crewmember's display control panel. The Symbol Generators produce the graphics for the EADI, EHSI, and an optional Multi-Function Display (MFD) that is mounted in the center instrument panel. The MFD, which is physically identical to the EADI and EHSI, is typically used to display weather radar information; however, it can also be used to display either flight information or navigational information in the event of an EADI or EHSI failure. The following section will discuss the Boeing 777 EIS, which is a more advanced example of the one just covered.

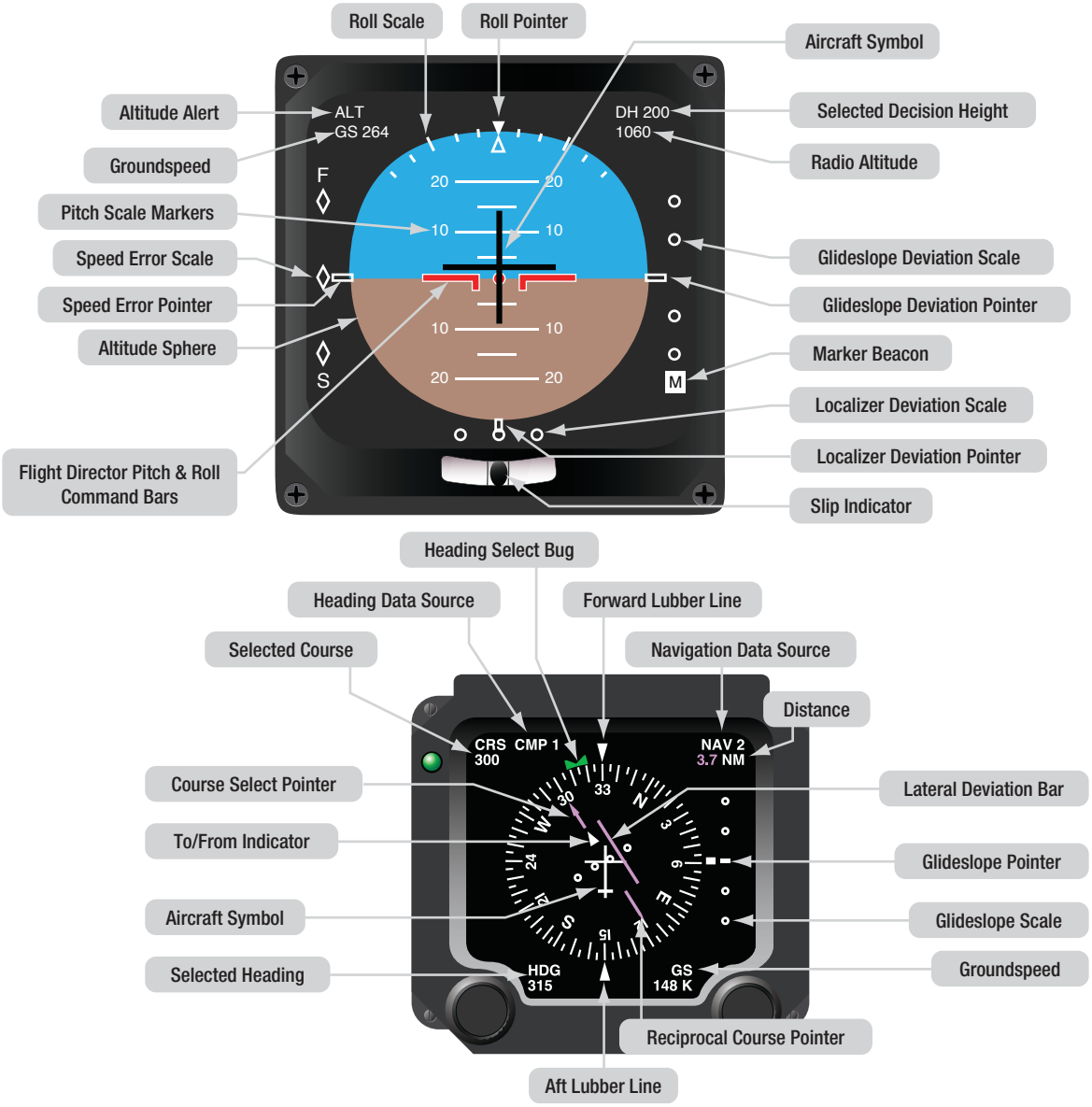

Figure 1-4. Typical EADI (top) and EHSI (bottom) Display Symbology.

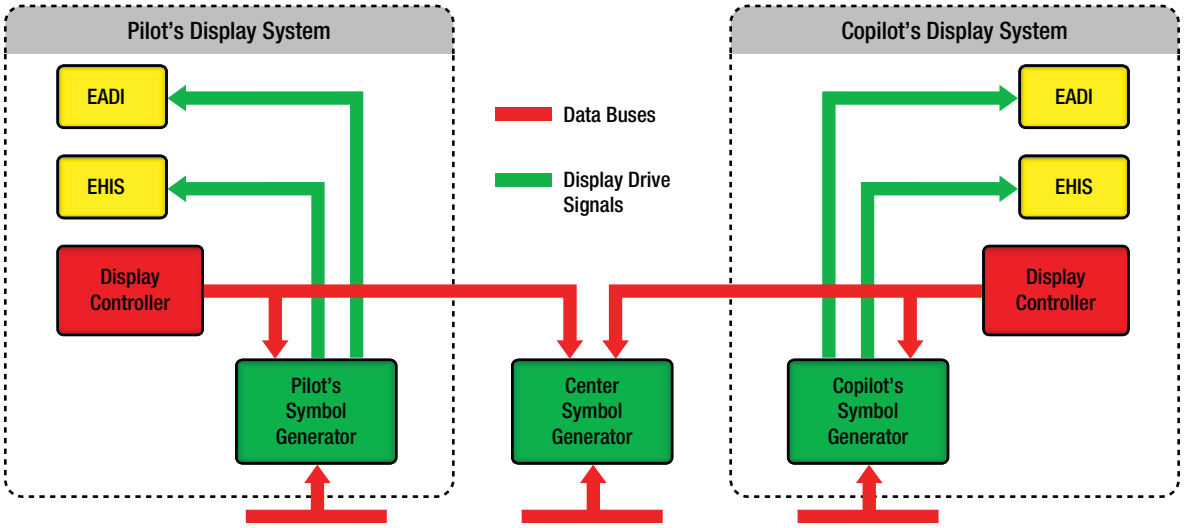

Figure 1-5. Electronic Displays are driven by Symbol Generators.

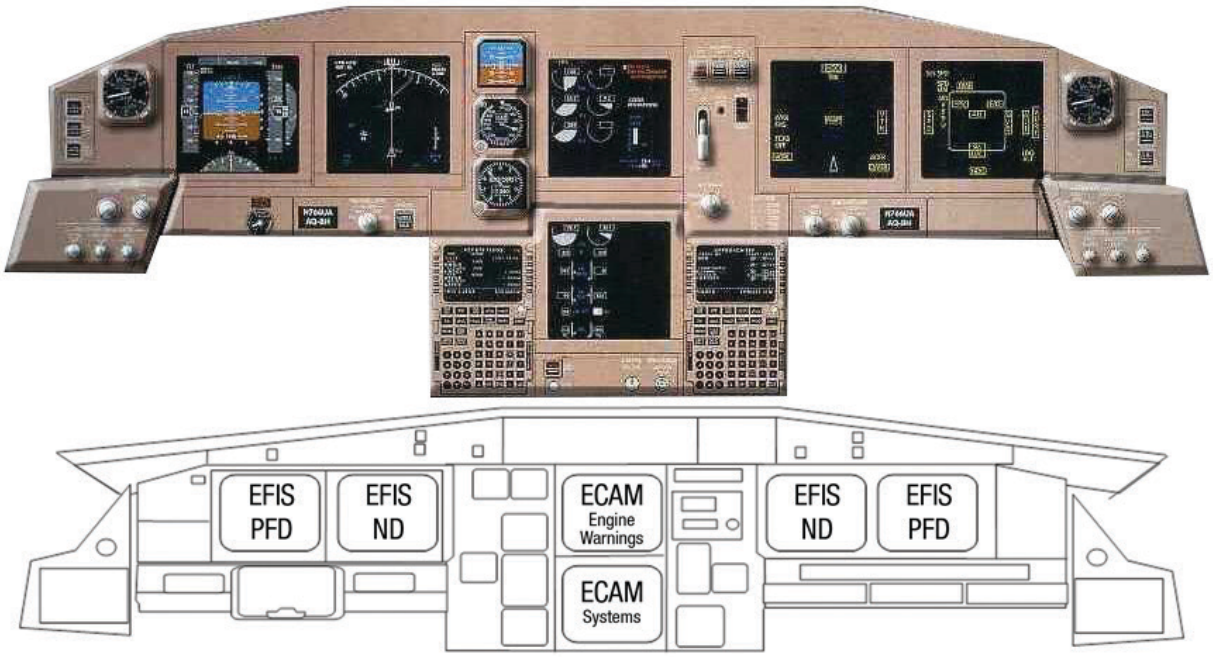

Figure 1-6. Boeing 777 Electronic Instrument System has 6 LCD Displays.

ELECTRONIC FLIGHT INSTRUMENT SYSTEM

The Boeing 777, which first entered service in 1995, has six 8' × 8" multi-color LCD displays as shown in ***Figure 1-6***. The B777 EIS consists of a dual-redundant Electronic Flight Instrument Systems (EFIS) and Engine Indication and Crew Alerting System (EICAS). On the left side of the instrument panel is the Captain's EFIS, consisting of a Primary Flight Display (PFD) located outboard and a Navigation Display (ND) located inboard. The Co-Pilot's EFIS located on the right instrument panel has an identical PFD and ND, located outboard and inboard respectively. All the displays are interchangeable to reduce the number of required spares. The information shown on each display, whether for flight or navigation, is determined by what each crew member selects on their individual display control panels.

The PFD takes the place of the EADI and displays all the information critical to flight, including attitude, airspeed, barometric altitude, vertical speed, heading, flight modes, radio altitude, ILS data, and Traffic Alert and Collision Avoidance System (TCAS) resolution advisory. The PFDs are designed to increase the

crew's situational awareness by integrating all of this information into a single composite display instead of the crew having to monitor several independent analog instruments. Also, the colors on the display change to alert the crew to potentially hazardous flight conditions, such as low airspeed, high rate of descent, etc.

Figure 1-7 is a typical Primary Flight Display format showing the artificial horizon in the center of the display, airspeed on the left side, altitude on the right side, heading on the bottom, and flight modes on the top of the display. Notice how the moving ladder format used for altitude and airspeed provide both absolute and relative information so the crew knows not only the exact numeric value, but also the rate that the altitude and airspeed is changing.

The Navigation Display, shown in ***Figure 1-8***, takes the place of the EHSI display to show the requisite information to navigate the aircraft, including heading, VOR, GPS, and ILS guidance. The ND has the ability to overlay additional information on the navigation page

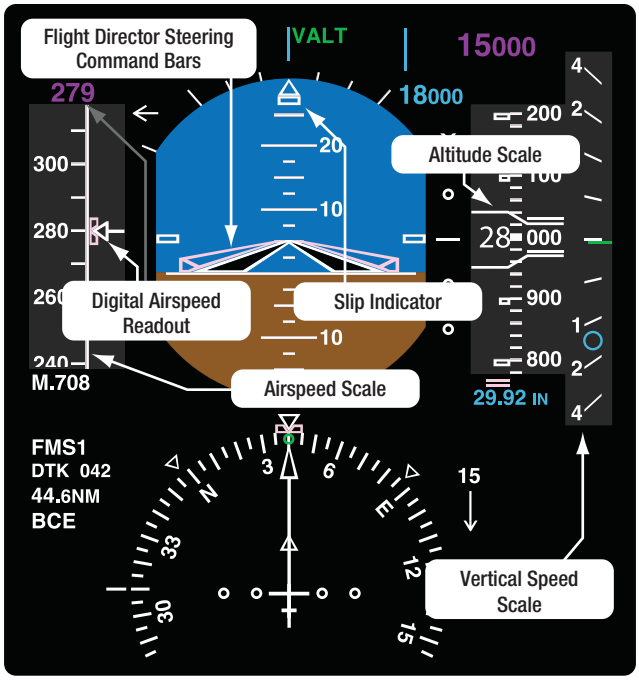

Figure 1-7. Primary flight display format.

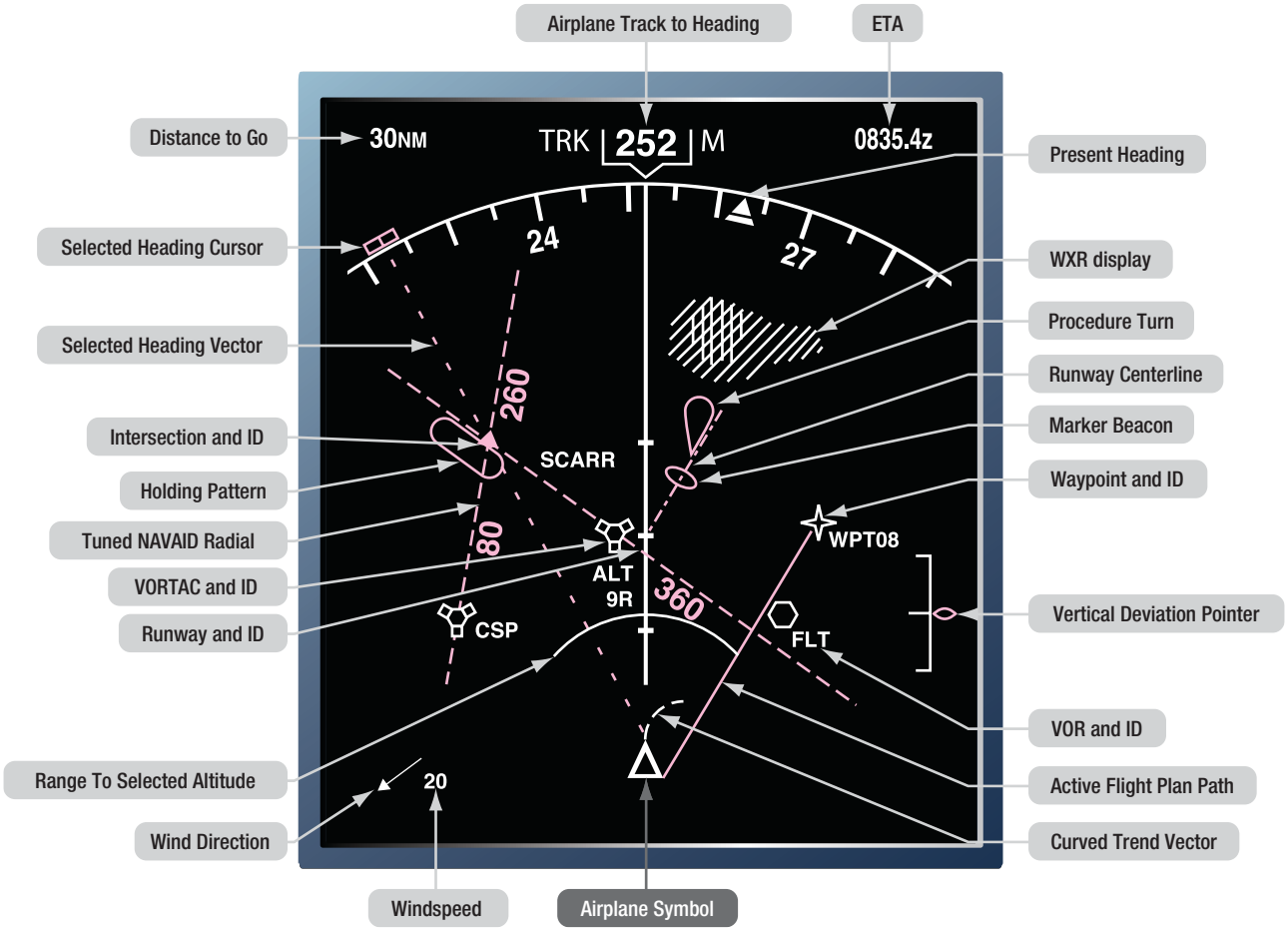

Figure 1-8. Navigation map display format.

to eliminate the need for separate dedicated displays. Some examples of information that is typically overlaid on the ND include weather information from either the onboard weather radar (WXR) or ground based sensors, and digital maps showing pre-programmed routes and waypoints from the Flight Management System.

ENGINE INDICATION AND CREW ALERTING SYSTEM

The Boeing® Engine Indication and Crew Alerting System (EICAS), also called an Electronic Centralized Aircraft Monitor (ECAM) on Airbus aircraft, performs the monitoring of aircraft systems that was previously performed by the Flight Engineer in three crew member cockpits. As previously shown in ***Figure 1-6***, the two EICAS displays on the B777 are located in the center instrument panel. The upper EICAS display shows engine performance data, such as pressure ratio, N1 rotor speed, exhaust gas temperature, total air temperature, thrust mode, etc., in addition to cabin pressure, flat/slat position, landing gear position, and crew status alerts. (***Figure 1-9***)

The EICAS engine display format mimics the round analog instruments, while also providing digital readouts of the parameters. EICAS improves situational awareness by allowing the crew to see systems operation in graphical format and alerting them to any failures or impending failures. For example, if low oil pressure is detected, the EICAS will provide an aural alert and show to the oil pressure page on a lower display with a red box outlining which engine has low oil pressure.

The Airbus ECAM system provides the crew with the following levels of warning along with detailed messages as to the nature of the problem and suggested courses of action.

- **Level 3**: An overspeed, fire, or stall condition will cause a repetitive chime aural warning with a bright red flashing light.
- **Level 2**. A system failure, but not a safety of flight issue, will result in a single chime aural warning and a steady amber light.
- **Level 1**: Failure leading to system degradation results only in an amber light.
- **Mode or System Status**. If everything is normal, a green light will illuminate.

Figure 1-9. EICAS engine display format.

The lower EICAS display is called a Multi-Function Display because it provides auxiliary information to the flight crew and maintenance crew. The MFD can be used as a secondary engine display, status display, communications display, maintenance page, or electronic checklist. The MFD formats also include synoptic displays that provide system status diagrams for the fuel, electrical, hydraulic, flight control, and environmental control systems, in addition to showing door and landing gear positions. On some aircraft, the MFD is also used to display images from the ground maneuvering camera system.

Figure 1-10 is a schematic diagram of an Engine Indication and Crew Alerting System with all its associated components. The display select panel allows the crew to choose which computer is actively supplying information. It also controls the display of secondary engine information and system status displays on the lower monitor.

EICAS has a unique feature that automatically records the parameters of a failure event to be regarded afterwards by maintenance personnel. Pilots that suspect a problem may be occurring during flight can press the event record button on the display select panel. This also records the parameters for that flight period to be studied later by maintenance. Hydraulic, electrical, environmental, performance, and Auxiliary