ECLIPSE 500

Avionics

Do Not Use For Flight

2. Avionics

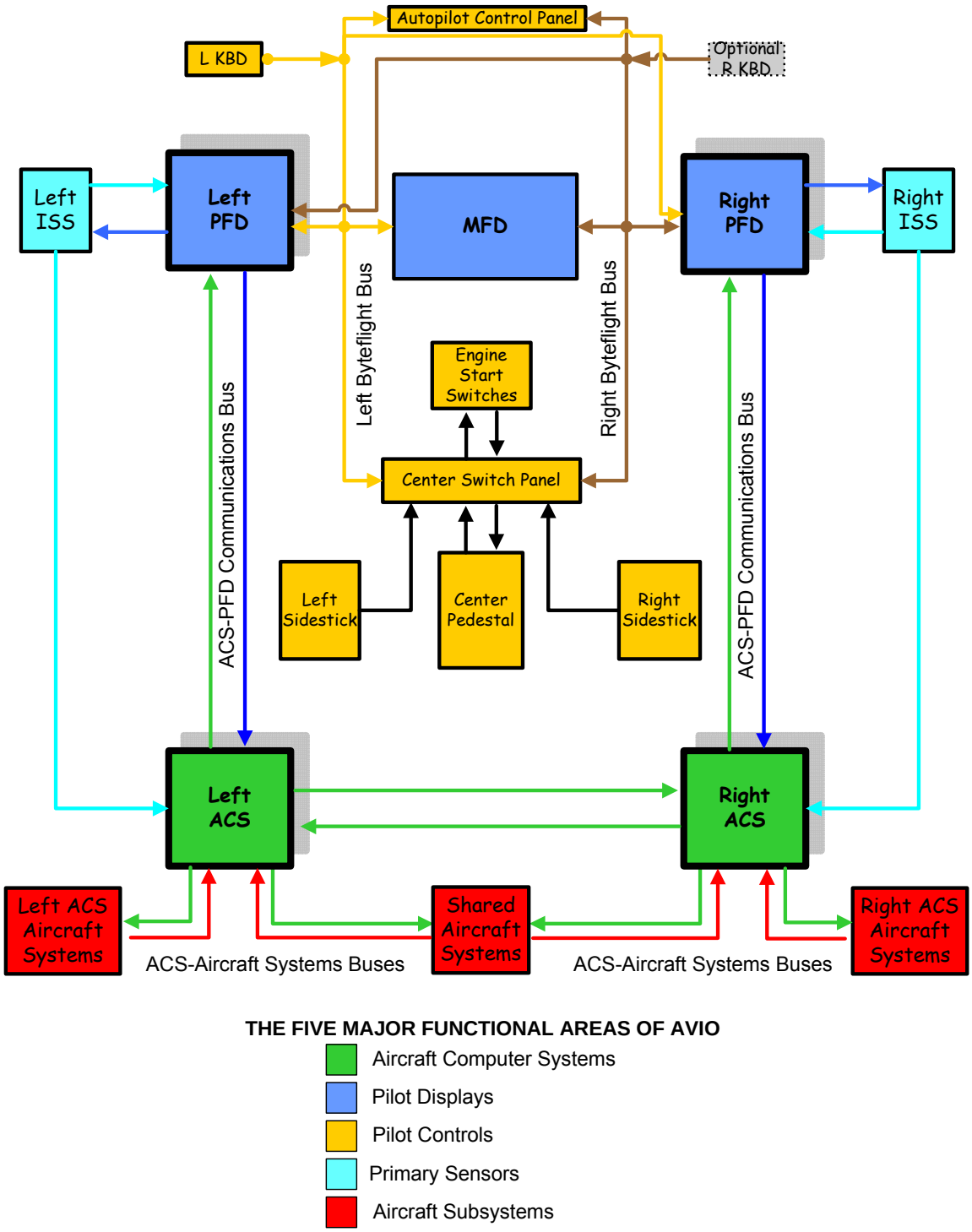
2.1 General

The Avio Avionics Suite is a highly integrated avionics system that serves as the basic systems architecture and interfaces with almost every aircraft function. Avio is divided further into five functional areas.

1. Aircraft Computer Systems
2. Pilot Displays
3. Pilot Controls/Interfaces
4. Primary Sensors
5. Aircraft Subsystems (Electrical Power Generation/Distribution)

While there are five functional areas, the two Primary Flight Displays (PFDs) and two Aircraft Computer Systems (ACS') are considered the pillars of the avionics system. Through a series of 30 data busses that interconnect all components of the avionics, many of the operations of the aircraft are routed through a combination of these four components. Data busses are electrical paths used to transfer data and instructions back and forth between two computers and can be thought of as the pipes through which information flows. It is along these data busses that commands are sent to the aircraft and systems status information is then returned to the pilot.

Cockpit Layout



THE FIVE MAJOR FUNCTIONAL AREAS OF AVIO

- Aircraft Computer Systems
- Pilot Displays
- Pilot Controls
- Primary Sensors
- Aircraft Subsystems

Avionics Architecture

2.2 Aircraft Computer Systems

The Aircraft Computer System (ACS) consists of two identical ACS computers. Each ACS unit is co-located with one of the aircrafts two Full Authority Digital Engine Controller (FADEC) units in a Line Replaceable Unit known as an Avio Processing Center (APC). The left Avio Processing Center is located along the left aft fuselage wall, while the right Avio Processing Center is located underneath the baggage compartment floor.

while these units are physically the same, each individual (left or right) ACS will perform slightly different operations. The ACS has three primary functions

- Command and Control of Systems- activation, deactivation, load shedding
- Performs Pilot Commands
- Monitors and Reports- Fault Sensing

2.2.1 Command and Control of systems

The command and control of systems capability of the ACS allows the pilot the primary means of systems control on the Eclipse 500. Unlike aircraft cockpits of the past, the Eclipse 500 is devoid of many of the various switches levers and other manual controls for aircraft systems. In its place, the pilot's interface takes place primarily through the use of line select key controls on various aircraft systems synoptic pages normally located on the MFD.

There are two types of automation that the Eclipse 500 utilizes. One type of automation involves decisions that require speed that is faster than a pilot can make. This type of automation is exemplified by the engine control system (FADEC- Fully Automated Digital Engine Control). The engine demands that fuel control decision to the engine must be made many times per second, each time taking into account a range of aircraft parameters such as outside air temperature, air speed, and altitude. In cases like this, the pilot is informed of overall performance (Indicated Turbine Temperature (ITT), N1 and N2 turbine speeds and oil pressure) to verify that the engine is performing within its design limits

The other kind of automation is aimed at reducing pilot workload. In many cases functions that are routine or unnecessarily burdensome have been automated. An example of this is the command of the electric fuel pumps. For most normal operations, the electric fuel pumps are in the automatic (AUTO) mode of operation. This means the ACS automatically activate for start, fuel crossfeed, and low fuel pressure. Notification of the pilot that this is occurring takes place through a STATUS level CAS message; this assures that the pilot is always kept aware of the current state of systems components.

Automatic electrical load shedding is also provided by the ACS. When the ACS detects a loss of electrical power, i.e. the loss of a single or the loss of both generators; it has the capability of automatically load shedding the necessary electrical equipment to maintain sufficient power and systems functionality for the pilot to safely manage the aircraft.

2.2.2 Performs Pilot Commands

While several systems have automatic controls, the pilot has the capability to override or manually control systems components from the synoptic pages. Commands from these synoptic pages are sent to the ACS upon which the individual components are activated.

Examples of control and command of systems include:

- Engine System Control- Ignition control Engine dry motoring
- Fire Suppression
- Fuel system control- electric fuel pumps, fuel crossfeed
- Flight Controls- primary flap and trim control, secondary trim control
- Electrical- control of electronic circuit breakers
- Environmental- fan activation and speed, temperature control
- Pressurization- aircraft pressurization settings
- Ice Protection- anti-ice and de-ice controls
- Primary landing gear control
- Exterior Lighting- command of ECB's to activate and deactivate lighting

2.2.3 Systems Monitoring and reporting

The systems monitoring and reporting capability of the ACS' allow reporting of various systems status to the pilot through the Primary and Multi-Function Displays (PFD & MFD). Examples of system monitoring and fault sensing include:

- Electrical system monitoring
- Fuel System monitoring- (fuel gauging probes, fuel pumps, valves)
- Secondary engine parameter monitoring- (fuel flow, oil temperature, oil pressure)
- Engine fire detection
- Pressurization and climate control system monitoring (temperature sensors, valves)
- Trim monitoring- (trim motor the current state and position of primary and secondary flight controls: flaps, trims, control surfaces)
- Landing gear monitoring- (gear position, actuator operation)
- Ice Protection monitoring- (operation of anti-ice and deice system components)
- Door indication monitoring- (state of main cabin door)
- Brake system monitoring- (brake fluid level)
- Oxygen system monitioring- (oxygen pressure)

Control monitoring is often attached to various Crew Alerting System Messages (CAS), (ex. PARKING BRAKE status message indicates that the PARKING BRAKE handle is pulled out).

As a compliment to monitoring of systems, the ACS also provides fault sensing capability for the various systems components and their associated sensors. Failure monitoring is provided for various systems, some examples include the failure of: flap actuators; control valves, such as the fuel shutoff valve; sensors, such as the climate control temperature sensors. Should a component or sensor fail a CAS message is displayed to the pilot to indicate that a failure has occurred. Due to the built in redundancy of aircraft systems, many of these failures do not result in a complete loss in system functionality, but only a loss in a redundant component.

2.3 Pilot Displays

The Electronic Flight Instrument System (EFIS) is the primary component of the integrated avionics suite contained on the Eclipse Model 500. The primary components of the EFIS are two 10.4 inch active matrix liquid crystal Primary Flight Displays (PFD) and one 15.3 inch active matrix liquid crystal Multi Function Display (MFD). The EFIS displays all primary flight information including aircraft system synoptic pages that allow control of most aircraft functions.

2.3.1 Primary Flight Displays (PFD)

The PFDs are two of the primary components of the integrated avionics. They are an information center in that they route pilot commands to the ACS, as well as receive aircraft status information and route it to the MFD for display. In addition the PFDs provide the following display and control functionality. The PFDs are outlined in detail in the PFD chapter of this manual:

1. Airspeed/Mach Display
2. Altitude and Vertical Speed Display
3. Autopilot/Yaw Damper Mode Display
4. Baro-Correction Display
5. Autopilot Targets Display
    a. Airspeed
    b. Attitude-Flight Director Command Bars
    c. Altitude
    d. Vertical speed
    e. Heading
6. Localizer and Glideslope Deviation
7. Attitude Direction Indicator (ADI)
    a. Pitch Attitude
    b. Roll Attitude
    c. Slip/Skid Indication
8. Airspeed & Altitude Indications
9. Magnetic Heading
10. VOR & ILS
11. Communications and Navigation Radio Tuning
12. Transponder Control (Mode S)
13. Composite Mode (used during MFD failure)

2.3.2 Multi-Function Display (MFD)

The MFD is the primary interface for the pilot to the aircraft systems and their status. While this display is the center of the displays and a focal point for the pilot, it is considered to be a ‘dumb’ display in the context of avionics system architecture. All

information to and pilot commands from the MFD is routed through both of the PFDs to the ACS'.

The MFD is divided into upper and lower portions. The upper portion of the MFD is continuously displayed, while the lower portion is considered configurable. Primary control of most system functionality is provided through several systems synoptic pages presented on the MFD. Each system synoptic page contains a schematic of the selected system displaying the status of primary system components. A synoptic page contains only information that the pilot needs to be aware of or that he/she has control over. Less significant information such as vent lines, and other data not required to diagnose system state or performance is excluded to prevent clutter. System synoptic layouts are designed around operational control of the system and while similar are not representative of actual system layout.

The MFD provides the following display and control functionality and is outlined in detail in the MFD chapter of this manual:

UPPER PORTION

1. MFD ADI
2. Aircraft Systems Information
    a. Engine
    b. Landing Gear
    c. Flight Controls
        - Flaps
        - Trim
    d. Cabin Pressurization
    e. Fuel
3. Crew Alerting System (CAS)

LOWER PORTION

1. Aircraft Systems Synoptics
    a. Engine
    b. Fuel
    c. Electrical
    d. Electronic Circuit Breakers
    e. Environmental
    f. Pressurization
    g. Ice Protection
    h. Flight Controls
    i. Aircraft Operations
    j. Sensor Status
    k. Setup
2. Audio Pages

2.4 Pilot Controls

In addition to the PFD and MFD, there are several switch/control panels that allow direct pilot inputs to the aircraft.

a. Center Switch Panel

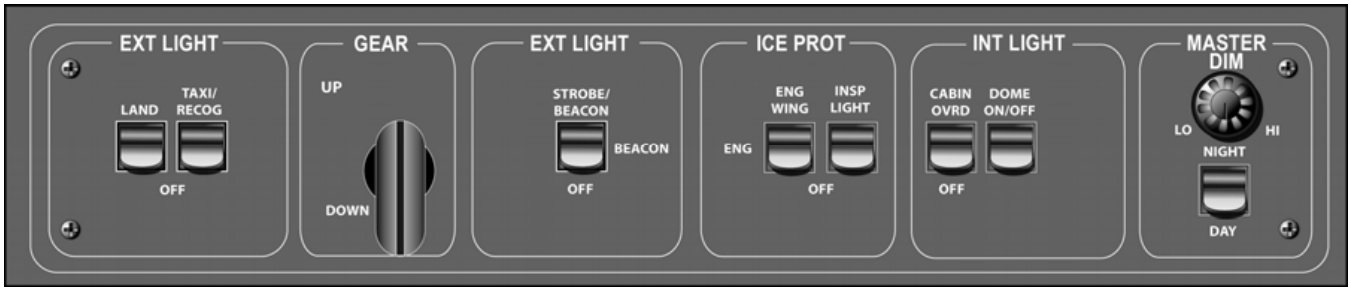
The Center Switch Panel serves as both a pilot control interface to aircraft systems and as a means of routing commands from other pilot control interfaces to the ACS'.

Direct pilot controls include:

- Landing Light
- Taxi/Recognition Lights
- Landing Gear
- Strobe/Beacon Lights
- Ice Protection- (Engine Anti-Ice & Wing Deice)
- Ice Inspection Light
- Cabin Lights
- Dome Light
- Footwell Lights (Optional)
- Cockpit Dimming
- Night/Day Switch

Command Routing

- Autopilot Control Panel
- Engine Start Switch Panel
- Left and Right Sidesticks
- Center Pedestal (Rudder Trim Switch and Flap Selector Inputs)

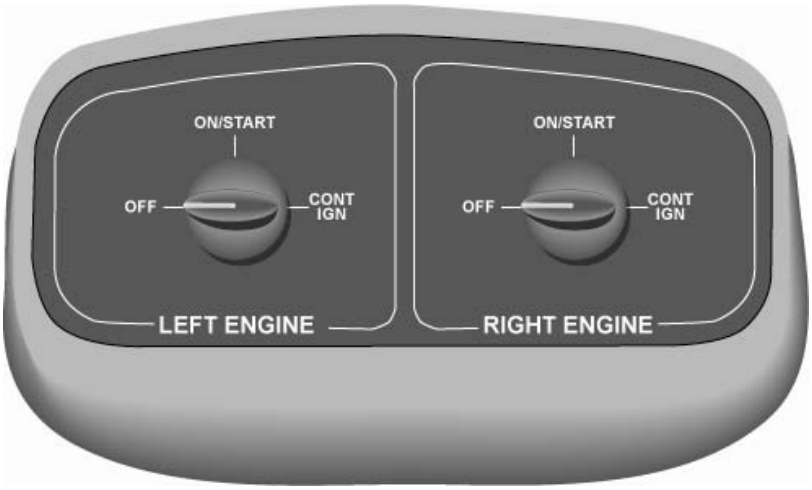


Center Switch Panel

b. Engine Start Switch Panel

Commands from the engine start switch panel are routed through the center switch panel to the PFD, then on to the ACS. The Engine Start Switch panel has three positions:

- OFF- Commands engine to off
- ON/START- Initiates Start Sequence, position for normal operations
- CONT IGN- Manually activates igniters



Engine Start Switch Panel

c. Autopilot Control Panel

Autopilot Control Panel inputs are routed through the center switch panel to the PFD and on to the ACS. The Autopilot Control Panel allows control of the following functions:

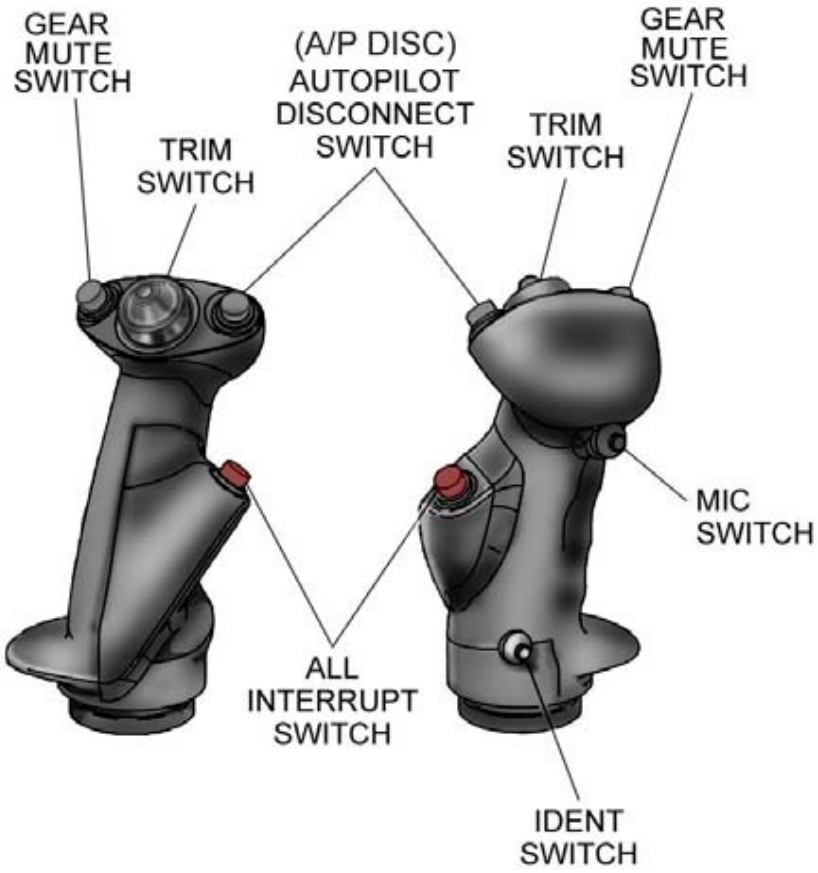
- Autoflight mode and pre-select bug control
- Barometer Setting (BARO Set)
- Map Lights (Left and Right)
- Caution/Warning Flights (Left and Right)
- Fire Warning and Suppression (Left and Right)

Autopilot Control Panel

d. Sidestick (Left and Right)

With the exception of the push-to-talk switch that is directly wired its respective PFD, switch inputs from each sidestick are routed through the center switch panel to the PFD and on to the ACS. The left and right sidesticks allow for the following functionality:

- All Interrupt Switch
- Autopilot Disconnect
- Transponder IDENT
- Microphone push-to-talk
- Pitch and Roll Trim

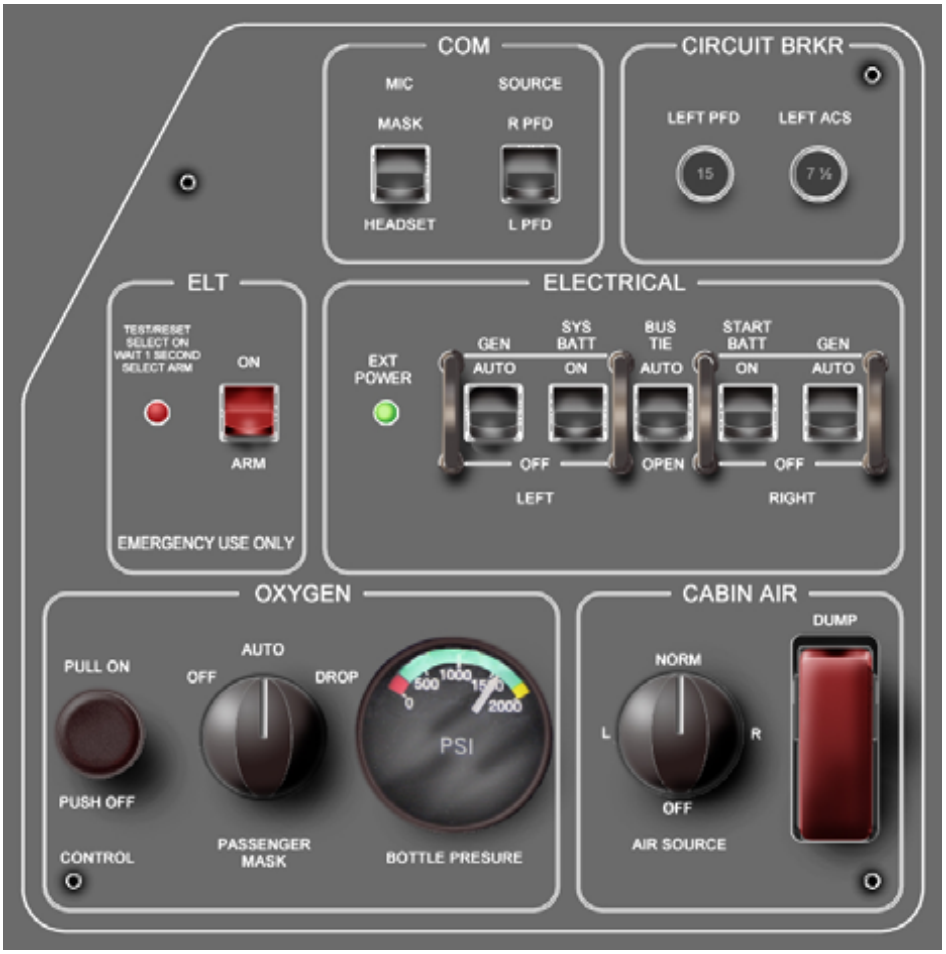


Sidestick

e. Left Switch Panel (Essential Switch Panel)

The left switch panel is also considered the essential switch panel, as many of the switches and controls on this panel have direct connections to the associated component and do NOT require ACS control to function. The item that requires ACS functionality to operate is the CABIN AIR SOURCE switch that controls the position of the flow control valves. Left switch panel functionality includes:

- Communications selections (headset/mask, Left or Right PFD)
- Mechanical Circuit Breakers (Left PFD, Left ACS)
- ELT Switch and Annunciation
- Five Electrical Contactor Switches (Generators, Batteries, Bus Tie)
- Oxygen Control and Pressure Display
- Cabin Air Control (Air Source and Cabin Dump)



Left (Essential) Switch Panel

f. Right Switch Panel (Optional)

The right switch panel contains the same communications selections available on the left switch panel.

- Communications selections (headset/mask, Left or Right PFD)

Right Switch Panel

g. Keyboards

The keyboards are an alternate means from inputting data, entering and controlling functions. Keyboard inputs are routed directly to the PFDs. All control functions, with the exception of some PFD composite mode functionality can be accessed elsewhere on the flight deck. The keyboard supports the following:

- Audio Selection and Control
- Communication Radio Selection and Control
- Flight Management System (FMS) Functions- (Future Functionality)
- Alphanumeric Entry of waypoints and Radio Frequencies
- Synoptic Page Selection on the MFD

Keyboard

h. Throttle Quadrant Switches (Flaps & Rudder Trim)

The throttle quadrant contains the two throttles, a flap position selector and a rudder trim switch. In addition there are two switches located on the left throttle, an Autothrottle Disconnect (A/T DISC) and Takeoff/Go-around (TOGA) switches.

The throttles have no direct connection to the ACS; information sensed by two position sensors for each throttle is sent directly to the FADEC Units.

Rudder trim, flap selector, autothrottle disconnect and TOGA switch position information is sent through the center switch panel to the PFDs then on to the ACS.

Throttle Quadrant

2.5 Primary Sensors

Air data, attitude and navigation information are provided to the ACS by two Integrated Sensor Suites (ISS). An ISS is comprised of three independent units working together.

1. Three Air Data Computers (ADC)
2. Two Attitude Heading and Reference Systems (AHRS)
   a. Two Magnetometers (MAGs)
3. Two Global Positioning Systems (GPS)

Information from all three of these systems is sent to the ACS for comparison and failure monitoring, to FADECs for engine control and to the PFD and MFD for display.

2.6 Aircraft Subsystems

The Eclipse 500 aircraft Subsystems include:

- Engines & Fire Protection
- Fuel
- Electrical
  - Electronic Circuit Breakers
- Climate Control

  - Environmental
  - Pressurization
- Ice Protection
- Landing Gear
- Flight Controls
- Oxygen
- Autoflight
  - Autopilot
  - Autothrottle (Future Functionality)

All aircraft subsystems have Aircraft Computer System interfaces that are outlined in the various systems chapters. For most of the aircraft systems direct pilot control is provided through MFD synoptic pages. Exceptions to this are Oxygen (controlled on the left switch panel), Landing Gear (controlled through the center switch panel), and Autoflight (controlled through the autopilot control panel).

While most aircraft systems functions are shared between the ACS units, there are some that are routed through a specific on-side ACS. Flap and landing gear actuators are controlled by the onside ACS (i.e. left ACS controls left flap actuators). Trim also functions in this manner; the left ACS controls the left pitch trim actuator as well as the roll trim actuator, while the right ACS controls the right pitch trim actuator, as well as the yaw trim.

Control of the EFIS is provided by two Aircraft Computer System (ACS) units located within the pressure vessel of the aircraft. Each ACS is collocated with a Full Authority Digital Engine Controller (FADEC). All interface inputs are routed through and processed by the ACS, with commands then sent to the various systems. In reverse, system status information is routed from the various systems to the ACS to be processed and sent back to the PFD or MFD for display.

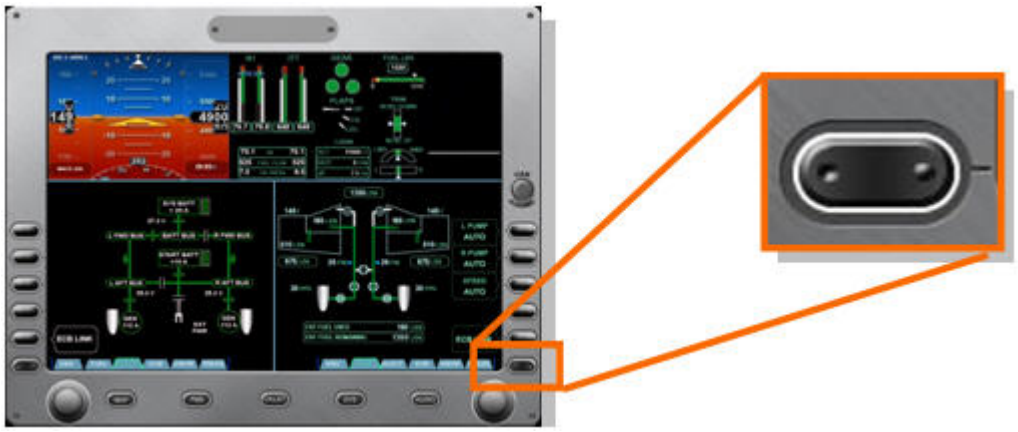
2.6.1 Line Select Keys

Line select keys on the PFD and MFD allow control of various aircraft inputs, including frequency entry and system control. Each display has 10 line select keys that correspond to different functions depending on what PFD or MFD function is enabled. Line select keys are often associated with the PFD or MFD pages within which they are used to activate or deactivate specific systems components (Ex. Fuel Pumps).

Line Select Key

2.6.2 Rocker Keys

The left and right rocker keys allow the pilot to select several pages at the bottom of the lower right and lower left tiles of the PFD and MFD. These keys can be pressed once to move the selected page left or right. Holding down the key allows slow, steady scrolling through the available pages. Scrolling is not a looping function and once the end of a particular set of pages is reached, the pilot must scroll back to return to the first page in the sequence.



Rocker Key

2.6.3 Primary Function Keys

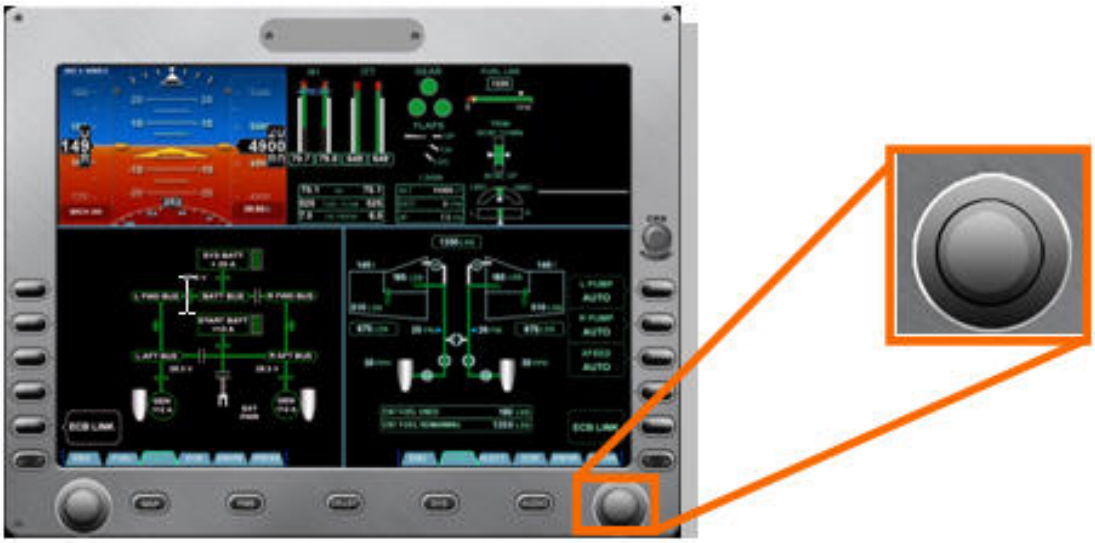
Primary Function Keys

There are five primary function keys located at the bottom of the MFD. These keys control what appears on the lower two tiles of the MFD. The pilot has five options, Map (MAP), Flight Management System (FMS), Checklist (CKLST), Systems (SYS), and Audio (AUDIO). Pressing each of these keys will configure the lower two tiles of the MFD as follows:

- MAP
  Lower left set to MAP, lower right is set to page previously on lower left.
- FMS
  Lower left tile set to FMS, lower right tile set to MAP
- CKLST
  Lower left tile set to Checklists, lower right tile set to the associated system/synoptic page.
- SYS
  Lower left set to last used systems synoptic page or if last page not known, to the first page in the tabbed list (ENG)

- AUDIO
  - Single Press
    Lower left set to PILOT AUDIO page, lower right set to page previously shown on lower left.
  - Double Press
    Lower left set to PILOT AUDIO page, lower right set to COPILOT AUDIO page

2.6.4 Concentric Knobs



Concentric Knobs

Two concentric knobs are located on the bottom portion of the PFD and MFD. The MFD knobs are shaped for pilot feel and recognition, while the PFD knobs are smooth.

Each knob corresponds specifically to the information presented on the adjacent side of the display (left knob corresponds to the left portion of the PFD or lower left tile of the MFD; right knob corresponds to the right portion of the PFD or lower right tile of MFD). Rotating the knobs clockwise moves cursor or highlight from top to bottom, left to right, or numerical values to increase. Rotating the knobs counterclockwise moves cursor or highlight from bottom to top, right to left, or numerical values to decrease.

DROP DOWN MENU SELECTION

Some display pages contain additional drop down menus for control. Within a drop down menu, rotating the outer knob moves the curser from field to field. Rotating the inner knob will scroll through drop down menu choices when shown, and selections are made by pressing the inner knob. Rotating the outer knob with the drop down menu choices displayed will cancel the drop down menu.

SEQUENTIAL CHOICE SELECTION

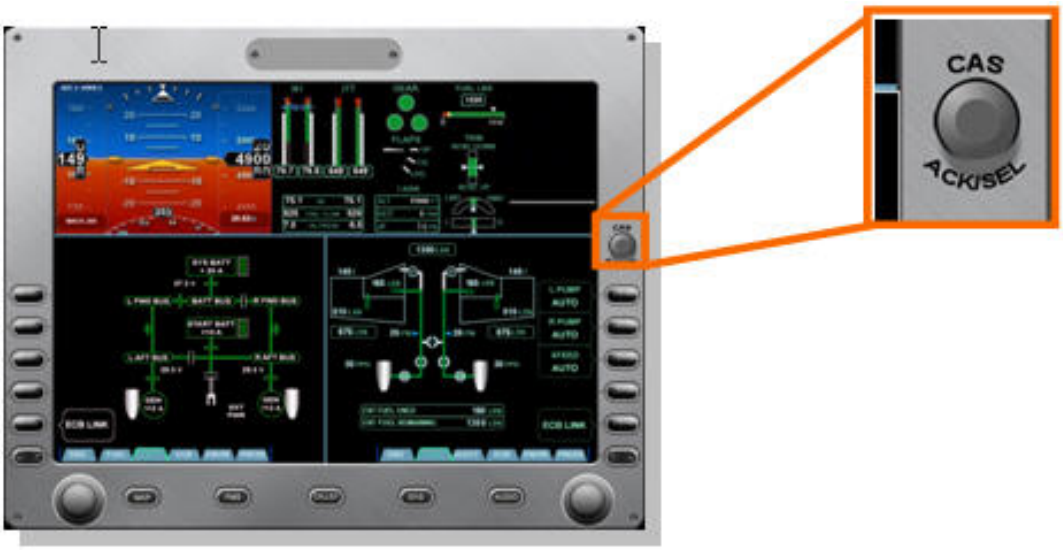
When a display allows sequential choices in a field, such as environmental fan speed settings, rotating the associated outer knob moves the cursor from field to field. Rotating the inner knob cycles through the choices for that field and pushing the inner knob will have no effect.

TEXT EDITING

If text editing is available on a page, rotating or pushing the inner knob activates the cursor for editing. Rotating the outer knob allows movement of the cursor location within the text field. Once the cursor is placed over the desired text, rotating the inner knob will change the text. When editing is complete, pressing the inner knob sets the text. While editing text, rotating the outer knob counterclockwise with the cursor on the first character will deactivate text editing.

2.6.5 Single Rotary Knobs

Single rotary knobs on the PFD and MFD provide control of pilot and copilot volume and squelch on the PFD and selection and acknowledgment of CAS messages on the MFD.



Single Rotary Knob