CHAPTER 31

Indicating and Recording Systems

CHAPTER 31
INDICATING AND RECORDING SYSTEMS

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

31-EFFECTIVE PAGES

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INDICATING AND RECORDING SYSTEMS

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41	May 15/2022	
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FLIGHT DATA RECORDER SYSTEM - INTRODUCTION

Purpose

The Flight Data Recorder System (FDRS) stores airplane parameters and system data for the last 25 hours of operation.

The Solid-State Flight Data Recorder (SSFDR) protects the parameters and the system data. If there is an airplane incident, these parameters supply data on flight conditions and airplane systems operation. Airline personnel can also use the data to make an analysis of system performance during airplane maintenance.

Abbreviations and Acronyms

- ac - alternating current
- A/C - aircraft
- ACARS - aircraft communications addressing and reporting system
- ACMS - aircraft conditioning monitoring system
- A/D - analog to digital
- ADC - air data computer
- ADIRU - air data inertial reference unit
- ADL - airborne data loader
- ADS - avionics data stream
- ADV - advance
- ALRT - alert
- ALT - alternate
- alt - altitude
- A/P - autopilot
- APU - auxiliary power unit
- ARINC - aeronautical radio incorporated
- A/T - autothrottle
- ATE - automatic test equipment
- BITE - built in test equipment
- CDU - control display unit
- CFast - industry standard variant of CompactFlash
- CPU - central processor unit
- dc - direct current
- DFDAU - digital flight data acquisition unit
- DFDMU - digital flight data management unit
- DFDR - digital flight data recorder
- DIP - dual inline package
- DITS - digital information transfer system
- DME - distance measuring equipment
- DMP - data management processor
- DMU - data management unit
- DPC - display processing computer
- ECU - electronic control unit
- EE - electronic equipment
- ELEC - electric
- EPROM - erasable programmable read only memory
- EVSC - engine vibration signal conditioner
- FCC - flight control computer
- FDR - flight data recorder
- FDRS - flight data recorder system
- FMC - flight management computer
- FMCS - flight management computer system
- FSEU - flap slat electronics unit
- GND - ground
- GPWC - ground proximity warning computer
- GSE - ground support equipment
- HF - high frequency
- hyd - hydraulic
- Hz - Hertz
- IDU - interactive display unit
- IFSAU - integrated flight systems accessory unit

EFFECTIVITY

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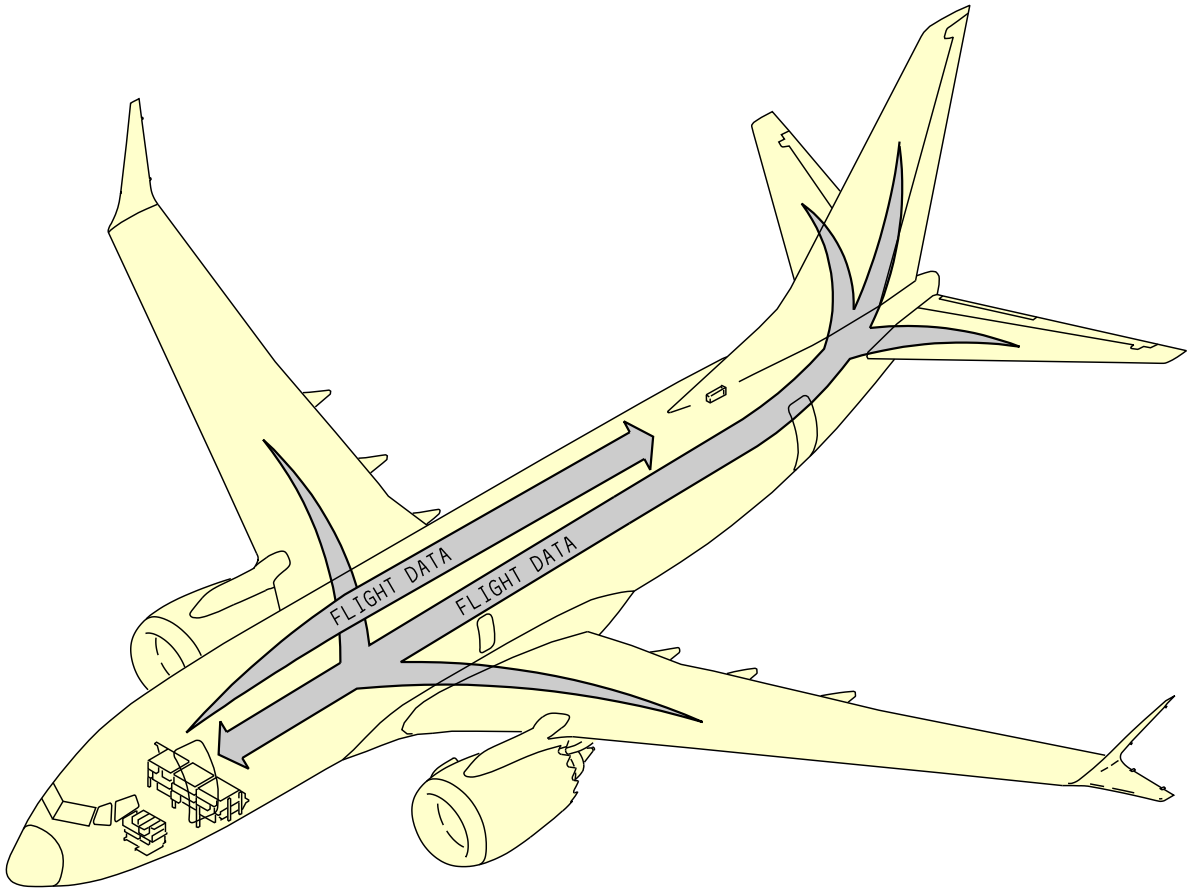
- ILS - instrument landing system
- kg - kilogram
- lav - lavatory
- LED - light emitting diode
- LRU - line replaceable unit
- MD&T - master dim and test
- MLS - microwave landing system
- MMR - multi mode receiver
- MSS - mandatory system software
- NFS - network file server
- ONS - onboard network system
- OVHT - overheat
- PCMCIA - personal computer memory card international association
- PPR - paper
- posn - position
- press - pressure
- PWR - power
- QAR - quick access recorder
- REC - recorder
- RST - reset
- SEL - select
- SRAM - static random access memory
- TCAS - traffic alert and collision avoidance system
- TSS - target system software
- ULD - underwater locating device
- V AC - volts alternating current
- V DC - volts direct current
- VOR - very high frequency omni range
- XFR - transfer

FLIGHT DATA RECORDER SYSTEM - INTRODUCTION



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FLIGHT DATA RECORDER SYSTEM - INTRODUCTION

FDRS - FLIGHT COMPARTMENT COMPONENT LOCATION

Flight Compartment

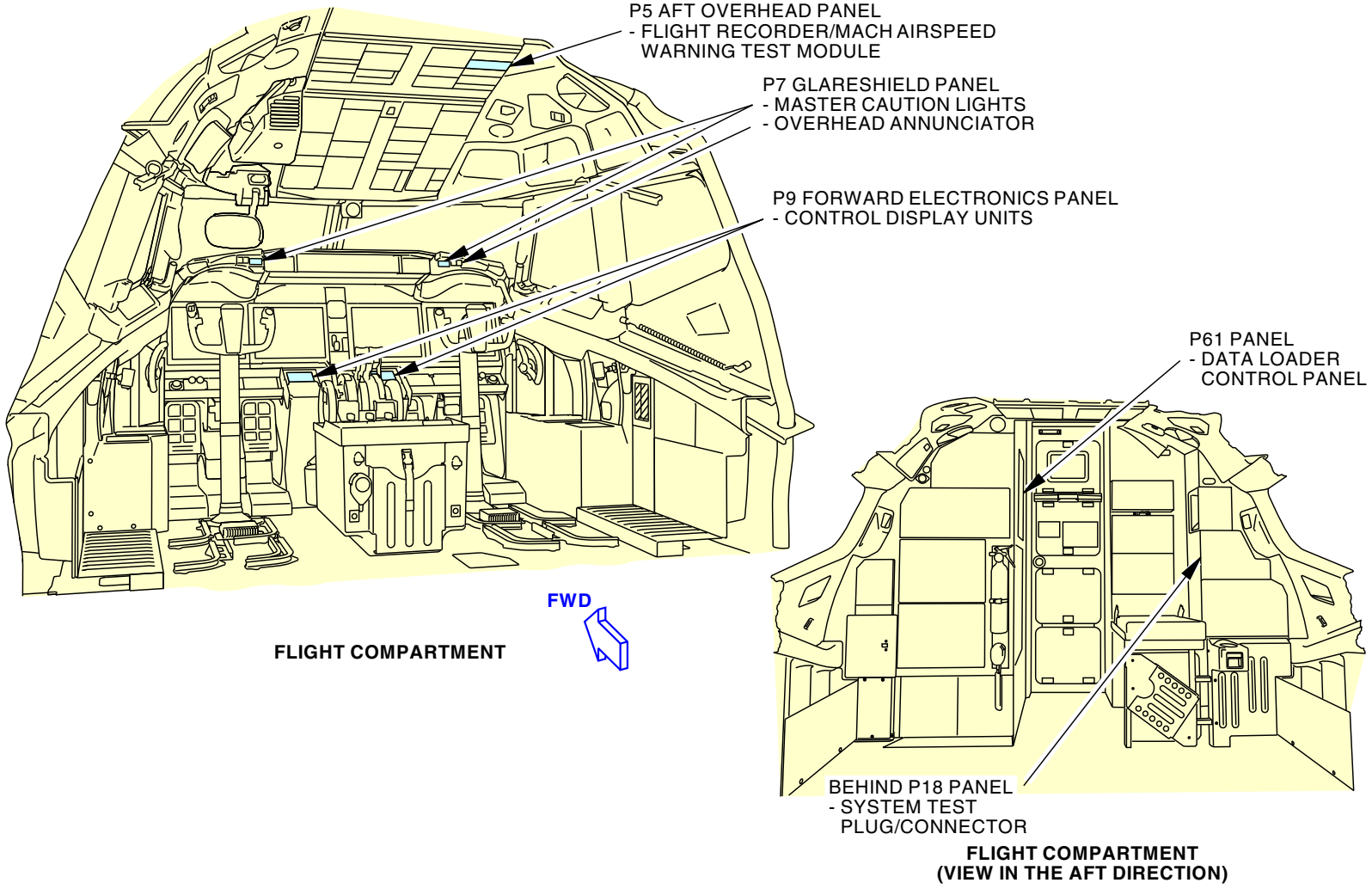
These are the Flight Data Recorder System (FDRS) components in the flight compartment:

- Flight recorder/mach airspeed warning test module on the P5 aft overhead panel
- System test plug/connector on the outer wall behind the P18 circuit breaker panel.

These are the components in the flight compartment that interface with the FDRS:

- Printer on the aft electronic panel P8.
- Control display units on the P9 forward electronics panel
- Master caution lights and OVERHEAD caution annunciator on the P7 panel
- Data loader control panel on the P61 panel.

FDRS - FLIGHT COMPARTMENT COMPONENT LOCATION



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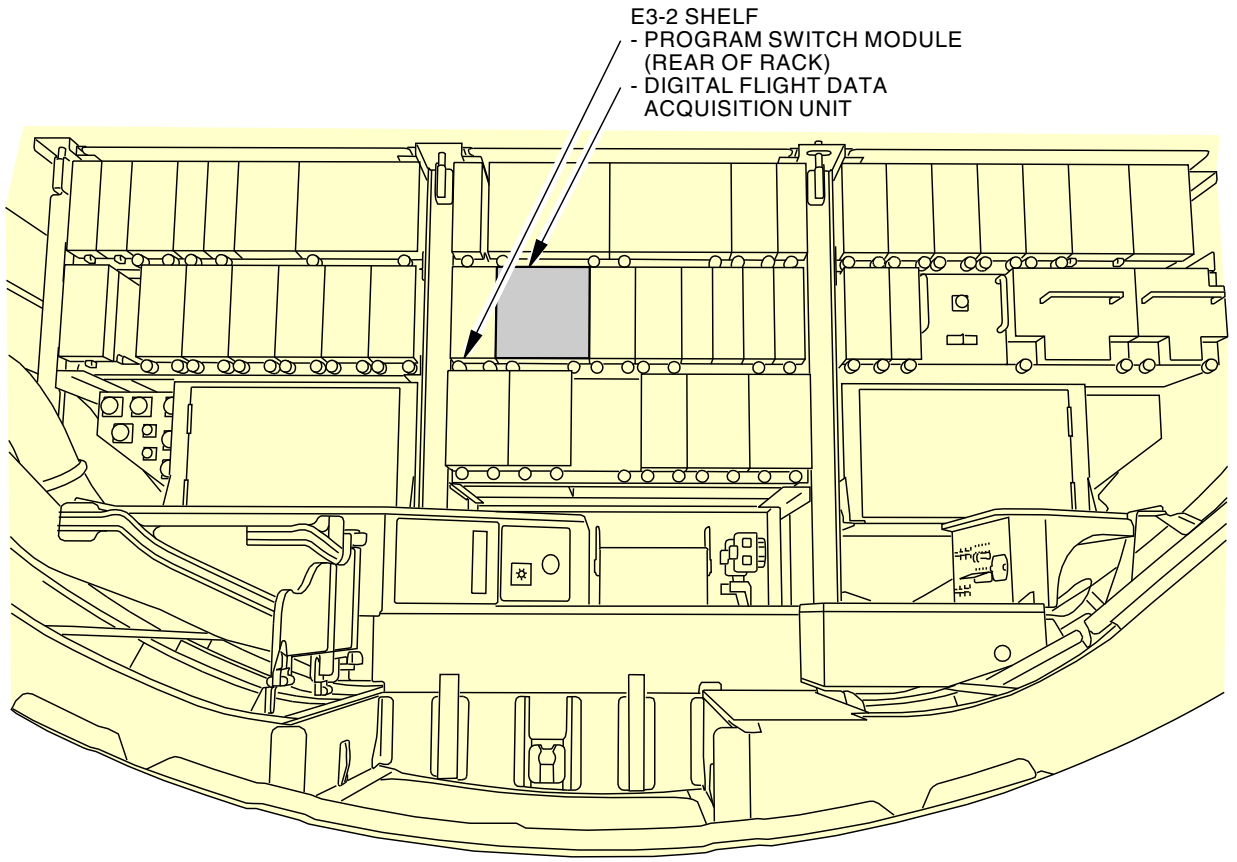
FDRS - FLIGHT COMPARTMENT COMPONENT LOCATION

FDRS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION

Digital Flight Data Acquisition Unit Location

The Digital Flight Data Acquisition Unit (DFDAU) is on the E3-2 shelf in the EE compartment. The program switch module is near the rear of the equipment rack.

FDRS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION



EE COMPARTMENT
(VIEW IN THE AFT DIRECTION)

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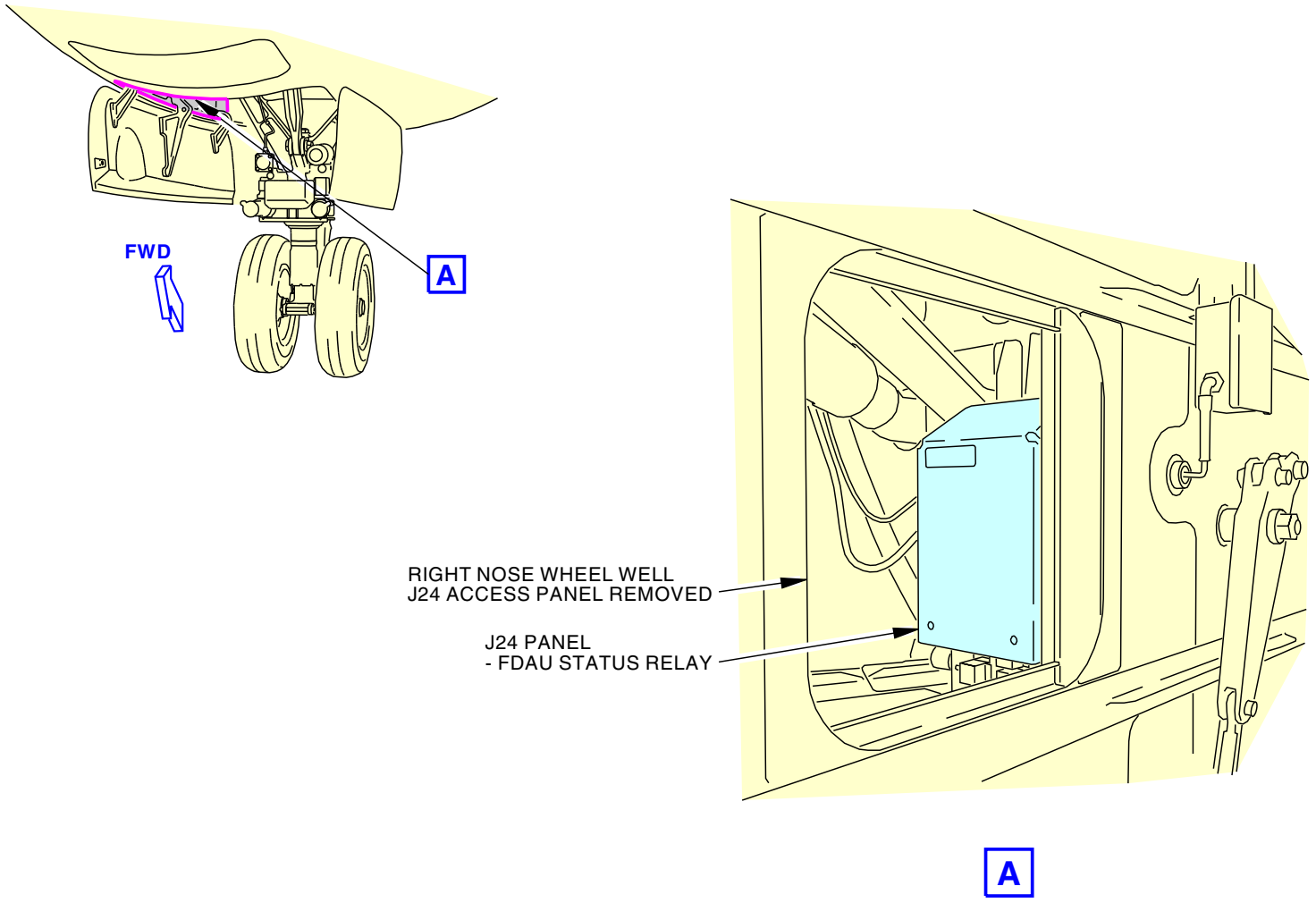
FDRS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION

FDRS - NOSE WHEEL WELL COMPONENT LOCATION

DFDAU Status Relay

The Digital Flight Data Acquisition Unit (DFDAU) status relay is on the right side of the nose wheel well on the J24 panel.

FDRS - NOSE WHEEL WELL COMPONENT LOCATION



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FDRS - NOSE WHEEL WELL COMPONENT LOCATION

FDRS - AIRPLANE COMPONENT LOCATION

Transmitter Locations

The tail area has these transmitters that have an interface with the Flight Data Recorder System (FDRS):

- Rudder position transmitter
- Left and right elevator position transmitters.

The rudder pedal force transducer is located in the horizontal stabilizer and has an interface with the FDRS.

The left and right aileron position transmitters in the wings have an interface with the FDRS.

Position Sensor Locations

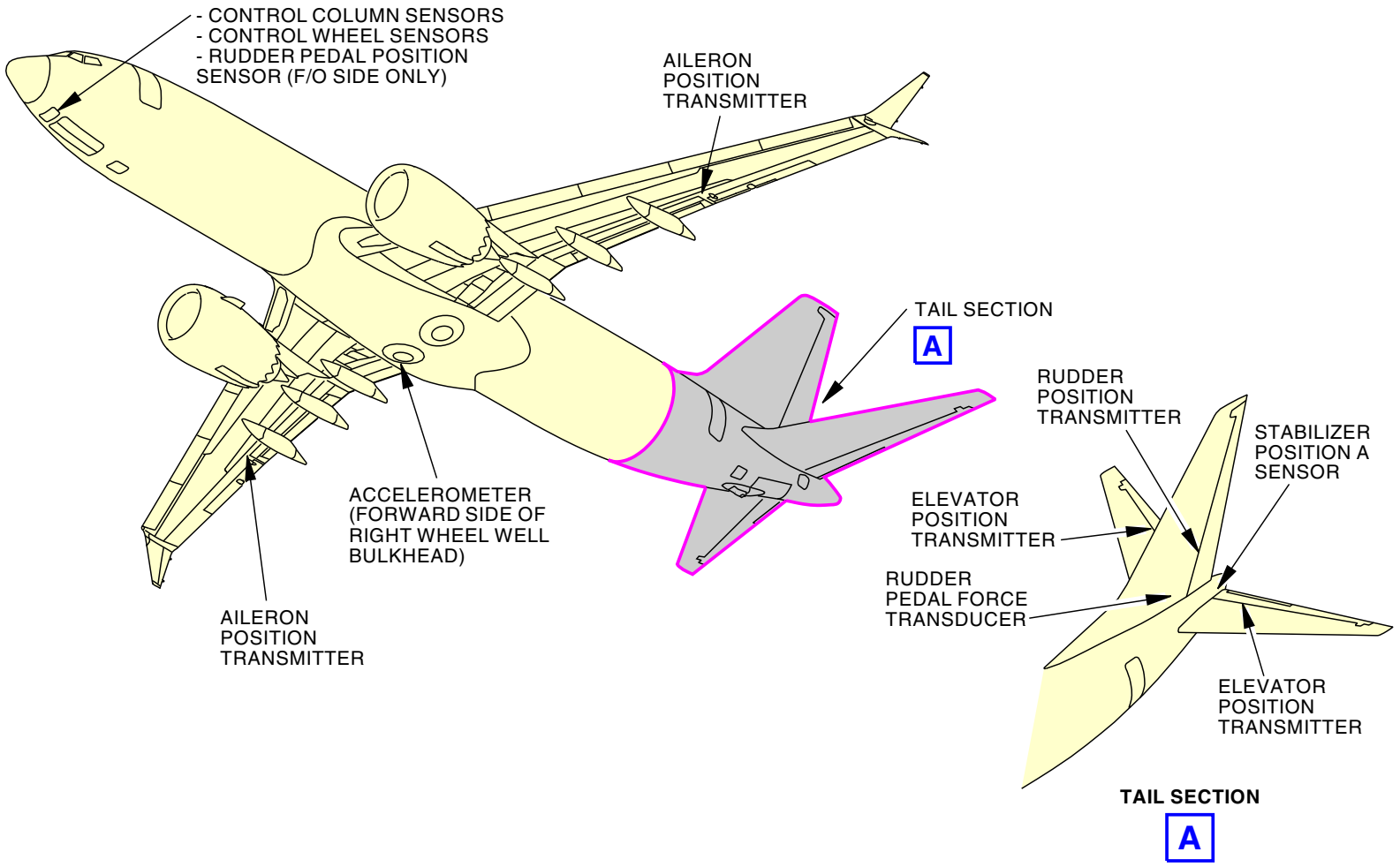
The control column (2), control wheel (2), and rudder pedal (1) sensors are in the forward equipment center under the flight compartment floor.

The stabilizer position A sensor is in the tailcone adjacent to the elevator feel and centering unit.

Accelerometer

The three-axis accelerometer is on the forward side of the right wheel well.

FDRS - AIRPLANE COMPONENT LOCATION



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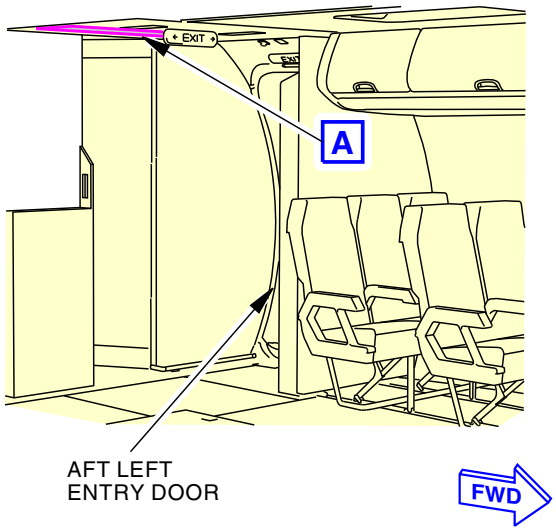
FDRS - AIRPLANE COMPONENT LOCATION

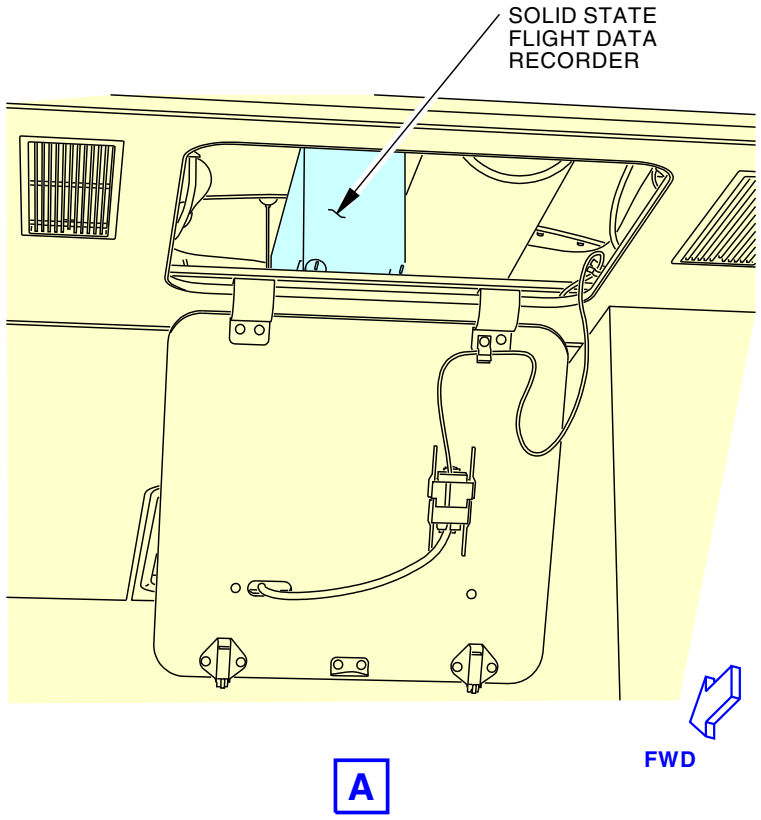
FDRS - AFT CABIN COMPONENT LOCATION

SSFDR Location

The Solid-State Flight Data Recorder (SSFDR) is in the aft cabin overhead.
Access is through a hinged ceiling panel.

FDRS - AFT CABIN COMPONENT LOCATION





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FDRS - AFT CABIN COMPONENT LOCATION

FDRS - POWER, SIGNAL, AND BITE INTERFACE

General

The Flight Data Recorder System (FDRS) collects, formats, and stores digital, discrete, and analog data. The FDR gets 115v ac power from the P18 circuit breaker panel.

Power Input

These components get 28v dc power:

- FDAU status relay
- Flight recorder/mach airspeed warning test module
- Digital flight data recorder (DFDR).

115v ac goes through a system test plug to the Digital Flight Data Acquisition Unit (DFDAU). 115v ac also goes to a relay in the flight recorder/mach airspeed warning panel to turn on the FDR. 26v ac goes to the DFDAU for reference voltage for the FDRS sensors.

DFDAU Status Relay

The DFDAU status relay controls the flight recorder OFF light. Normally, the DFDAU BITE out signal causes the DFDAU status relay to energize. This removes the ground from the flight recorder OFF light and it goes out. If the DFDAU finds a fault, the BITE out signal removes the ground from the DFDAU status relay. A ground connects to the flight recorder OFF light and the flight recorder light comes on.

Flight Recorder/Mach Airspeed Warning Test Module

The flight recorder/mach airspeed warning test module has an OFF light and a TEST/NORMAL switch. The flight recorder OFF light comes on when one of these conditions occurs:

- Airplane is on the ground and both engines are off
- DFDAU status relay is not energized because of a fault
- FDR status flag signal shows a fault.

Select TEST to connect 115v ac to the FDR. Do this to give power to the FDR on the ground for maintenance purposes.

When the switch is in the NORMAL position, the FDR gets 115v ac when the engine running relays or the ground sensing relay sends a ground to the flight recorder test module. The ground is sent for either one of these conditions:

- Engine 1 or engine 2 is running. (Engine running is when N2 > 50%)
- Airplane is in the air.

Digital Flight Data Acquisition Unit

The DFDAU gets digital, discrete, and analog inputs. The DFDAU changes the inputs to serial digital data. This data goes to the Solid-State Flight Data Recorder (SSFDR). The DFDAU gets playback data from the SSFDR and monitors for the presence of sync words. This senses if the FDR is operational.

The program switch module sends a code to the DFDAU. The DFDAU uses this code to identify the type of airplane.

The SSFDR sends a maintenance flag signal to the DFDAU. A FDR fault condition causes the flight recorder fail light on the DFDAU to come on.

System Test Plug

The system test plug sends 115v ac to the DFDAU. It can also send 115v ac to some test equipment. You can monitor FDR signals at the system test plug. The test plug gets two data inputs. The data that goes to the flight recorder also goes to the system test plug. If the data to the flight recorder is not all logic ones and not all logic zeros, the flight recorder sends the data back to the DFDAU. This data is the playback data. The DFDAU also sends the playback data from the flight recorder to the system test plug.

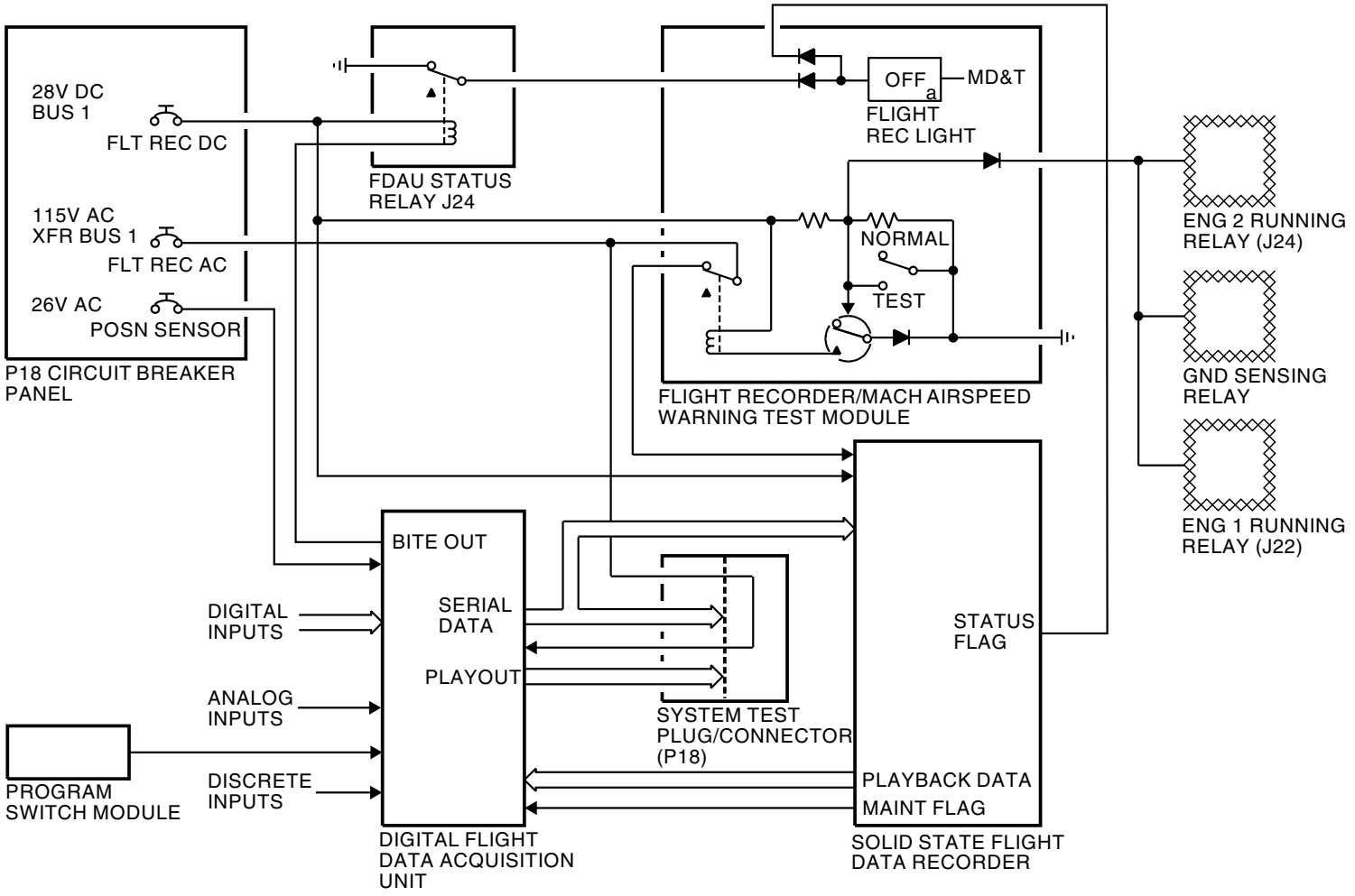
Flight Data Recorder

The flight data recorder gets the data and keeps it in a solid state memory.

BITE gives these outputs:

- Status flag - Gives fault signal to the flight recorder test module to turn on the OFF light
- Maintenance flag - Gives fault signal to the DFDAU.

FDRS - POWER, SIGNAL, AND BITE INTERFACE



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FDRS - POWER, SIGNAL, AND BITE INTERFACE

FDRS - DATA LOADER INTERFACE

General

You can transfer software from a data loader to the Digital Flight Data Acquisition Unit (DFDAU). The data loader control panel selects where the software goes.

You can also transfer data from the Airplane Condition And Monitoring System (ACMS) part of the DFDAU to a data loader.

The DFDAU connects to the data loader control panel.

Data Transfer

Two Aeronautical Radio Incorporated (ARINC) 429 data buses bring data into the data loader control panel. These buses are DATA IN 1 and DATA IN 2. DATA IN 2 sends the ACMS data to the control panel.

The data output port transfers software to the DFDAU. This software goes to the ACMS interface or the mandatory interface.

The discrete enable signals from the data loader control panel tell the DFDAU whether the software goes to the ACMS interface or to the mandatory interface.

Data Loader Control Panel Switches

The data load selector switch on the data loader control panel has three positions. The switch must be in the C SINGLE SYS (single system) position in order for the data loader to send software to the DFDAU.

The system select switch on the data loader control panel has these FDRS selections:

- NORM - Data loader can get ACMS data.
- ACMS - Software goes from the data loader to the ACMS interface in the DFDAU.
- DFDAU - Software goes from the data loader to the mandatory interface in the DFDAU.

DFDAU

The DFDAU has these sections:

- ACMS interface
- Mandatory interface
- Avionics Data Stream (ADS).

Software goes to the ACMS or mandatory interface on the data output bus. A discrete from the data loader control panel tells the DFDAU where to send the software. While the software is loading, the DFDAU sends handshake signals to the data loader. These signals give the data loader the status of the procedure.

The ADS acquires and outputs flight data and ACMS reports to the Onboard Network System (ONS).

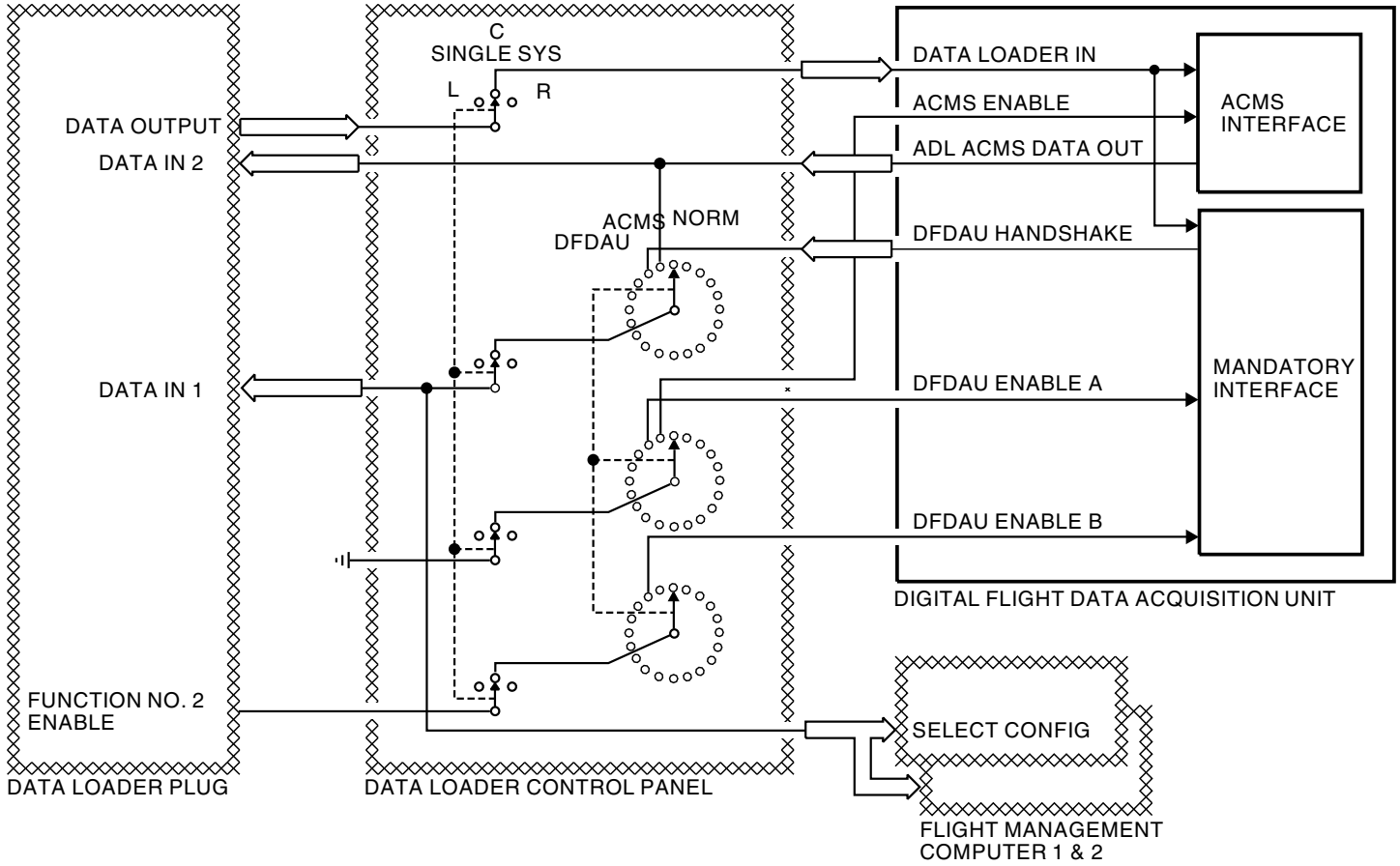
Flight Management Computer

The data loader control panel sends information from the ACMS or the mandatory processor in the DFDAU to the Flight Management Computer (FMC). The ACMS and mandatory processors send the software part number to the FMC.

The FMC shows the software part number on the control display unit (CDU). To see the software part number on the CDU you must do these things:

- Select the system on the data loader control panel
- Select the SEL CONFIG (select configuration) prompt on the INIT/REF (initialization reference) INDEX page on the CDU.

FDRS - DATA LOADER INTERFACE



(EXAMPLE)

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FDRS - DATA LOADER INTERFACE

FDRS - DFDAU DIGITAL INTERFACE

General

These Line Replaceable Unit (LRU)s send data to the Digital Flight Data Acquisition Unit (DFDAU) in Aeronautical Radio Incorporated (ARINC)429 digital format:

- Distance Measuring Equipment (DME) interrogators (1 and 2)
- Instrument Landing System (ILS) / Multimode Receiver (MMR)
- VHF Omnidirectional Range/Marker Beacon (VOR/MB) receivers
- Ground Proximity Warning Computer (GPWC)
- Radio altimeter transceivers
- Traffic Alert and Collision Avoidance System (TCAS) computer
- Air Data Inertial Reference Unit (ADIRU)
- Clock(s)
- Display Processing Computers (DPCs)
- Auxiliary Power Unit (APU) / Electronic Control Unit (ECU)
- Stall management yaw dampers
- Flight Control Computer (FCC)
- Auto throttle computer
- Engine vibration signal conditioner (EVSC)
- Flight Management Computer (FMC)
- FMC control display units (CDU)
- Flap/Slat Electronics Unit (FSEU)
- Head-Up Display (HUD).

Digital Interface

The DFDAU gets digital data from many different airplane systems. The mandatory data goes to the FDR through the DFDAU. The data that each operator records in the FDR is dependant on their aviation authority.

The DME 1 and 2 interrogators send these parameters to the DFDAU:

- DME distance
- DME failure
- Antenna failure
- DME display discrete.

The ILS / MMR(s) send these parameters to the DFDAU:

- Frequency
- Mode
- Glideslope deviation
- Localizer deviation
- Glideslope receiver failure
- Localizer receiver failure
- Glideslope antenna failure
- localizer antenna failure
- Receiver failure.

The VOR/MB1 and 2 receivers send these data to the DFDAU:

- VOR frequency
- VOR failure
- MB failure
- 3000 Hz marker
- 1300 Hz marker
- 400 Hz marker.

The GPWCs sends these parameters to the DFDAU:

- Wind shear caution
- Wind shear
- Terrain pull up
- Minimums
- Glideslope
- Too low terrain
- Too low flap
- Too low gear

EFFECTIVITY

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- Don't sink
- Terrain
- Pull up
- Sink rate
- GPWC failure.

The radio altimeter 1 and 2 transceivers send these parameters to the DFDAU:

- Radio altitude
- LRRA receiver antenna
- LRRA transmit antenna
- LRRA failure.

The TCAS computer sends these parameters to the DFDAU:

- Altitude Select
- Sensitivity level control
- SPI
- Altitude reporting
- Down advisory
- Up advisory
- vertical control
- Combined control
- Advisory rate to maintain
- RI field
- TCAS sensitivity level
- TCAS system status
- TCAS computer unit.

The left and right ADIRU sends these parameters to the DFDAU:

- AD/IR fault
- Excess motion error
- No IR initialization
- Align fault
- On DC
- IR fault
- ADC fault
- DC fail
- altitude invalid
- Set heading
- Nav mode
- Rev attitude mode
- Align mode not ready
- Auto nav realign
- IR A/C ident code invalid
- variable align select
- ADIRU select.

The clock sends these parameters to the DFDAU:

- GMT
- GMT (hrs/min)
- GMT (second)
- Date (day)
- Date (month)
- Date (year).

DPC 1 and 2 send these parameters to the DFDAU:

- Engine system parameters
- Brake system parameters
- Hydraulic system oil parameters
- Hydraulic system pressure parameters
- Fuel system parameters
- Radio altitude

- Localizer and glideslope deviation
- ADIRU parameters
- Displayed indications
- autopilot system parameters
- Electrical system parameters
- CDS display unit formats
- TCAS parameters
- VOR parameters
- ADF parameters
- FMCS parameters
- CDS EFIS control panel selections
- GPWS parameters
- CDS fault annunciations.

The APU electronic control unit sends these parameters to the DFDAU:

- N1
- Oil temperature
- EGT
- Fuel flow
- Low oil quantity
- Bleed valve open
- Any fault detected
- Bleed air switch
- Ready to load.

The stall management yaw dampers 1 and 2 send these parameters to the DFDAU:

- Rudder position
- Rudder command
- Angle of attack
- Stick shaker speed
- Minimum airspeed for flap retraction
- Minimum operating speed
- High speed buffet
- Auto slat enable
- Yaw damper engage
- Auto slat command
- Auto slat valid.

The FCC1 and 2 send these parameters to the DFDAU:

- Selected course
- Selected heading
- Selected altitude
- Selected airspeed
- Selected vertical speed
- Selected mach
- Spoiler position number 2
- Spoiler position number 7
- MCP speed
- L Nav mode oper
- CWS roll
- CWS pitch
- A/P off
- Single channel
- TO/GA
- V/S engaged
- Altitude hold
- Altitude acquire
- Heading select
- VOR/LOC engage
- G/S engage
- Flare engage

- Local limited master
- G/S deviation warning
- Localizer deviation warning
- A/T speed warning
- ILS deviation warning
- Visual altitude alert
- CWS B
- CWS A
- CMD B
- CMD A
- F/D B on
- F/D A on
- CWS warning
- Indicated airspeed display
- Vertical speed PB lite
- V Nav PB lite
- Level change PB lite
- Altitude hold PB lite
- N1 PB lite
- Speed PB lite
- Approach PB lite
- Heading select PB lite
- VOR/LOC PB lite
- L Nav PB lite
- B master light
- A master light.

The auto throttle sends these parameters to the DFDAU:

- Throttle rate command
- Throttle servo motor tachometer
- Throttle torque
- Motor power from ASM
- Auto Throttle disconnect
- ARM
- GA
- MCP speed
- A/T limit
- FMC speed
- N1
- Retard
- A/T engage
- Minimum speed.

The EVSC sends these parameters to the DFDAU:

- CN1 tracked vibration
- CN2 tracked vibration
- TN1 tracked vibration
- TN2 tracked vibration
- Fan balance angle
- Fan balance mass.

The FMC(s) send these parameters to the DFDAU:

- Distance to go
- Origin character
- Destination character
- Destination ETA hours
- Destination ETA minutes
- Gross weight
- Engine out engaged
- Flight number
- NDB effectivity day
- NDB effectivity month

- NDB effectivity year
- PMC on
- FMC valid
- N1 limit mode
- Target N1
- VREF speed
- V2 speed
- VR speed
- V1 speed
- Present position latitude
- Present position longitude
- Track angle true
- Wind speed
- Wind direction true
- Drift angle
- Flight path angle.

The HUD system sends these parameters to the DFDAU:

- Guidance cue symbol position
- Flight path symbol position
- Guidance cue and flight path deviation
- All mode capable
- No All message set
- G/S and localizer deviation
- Crosstrack rate
- Vertical deviation
- Airspeed error
- Lateral position
- Vertical speed deviation
- Flare command set
- Exceed six degrees roll angle
- Combiner position
- Active HUD mode
- APCH WARN message set
- Low visibility takeoff is set
- Flare command active
- Touchdown
- Autopilot engaged
- Autothrottle engaged
- HUD BITE fault set.

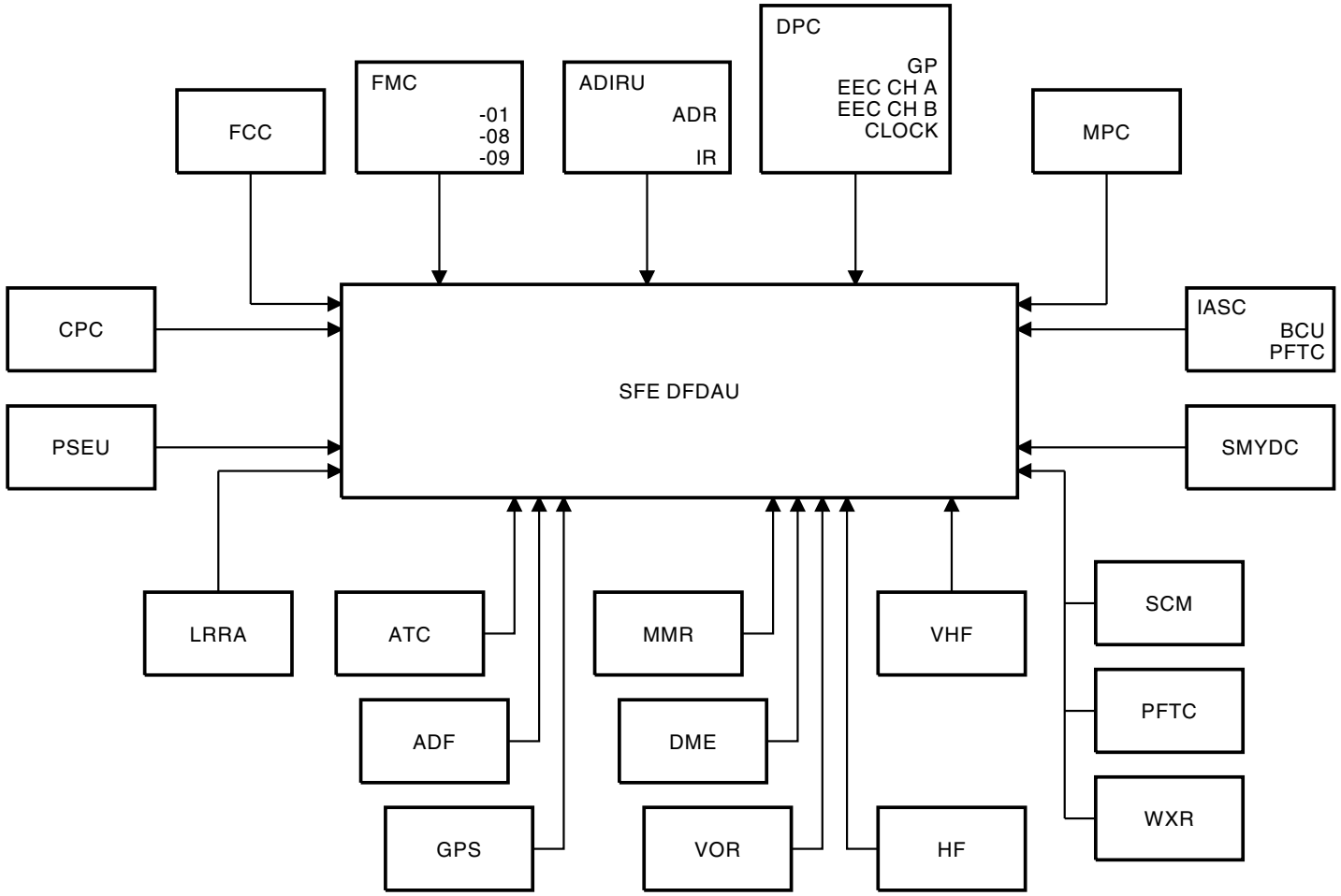
CDU Inputs

The Control Display Unit (CDU) can control the operation of the Airplane Condition And Monitoring System (ACMS) portion of the DFDAU. The CDU can call up reports and control the optional printer. You can also verify the ACMS software part numbers on the CDU.

DPC Outputs

The DFDAU sends flight surface position information to the DPCs.

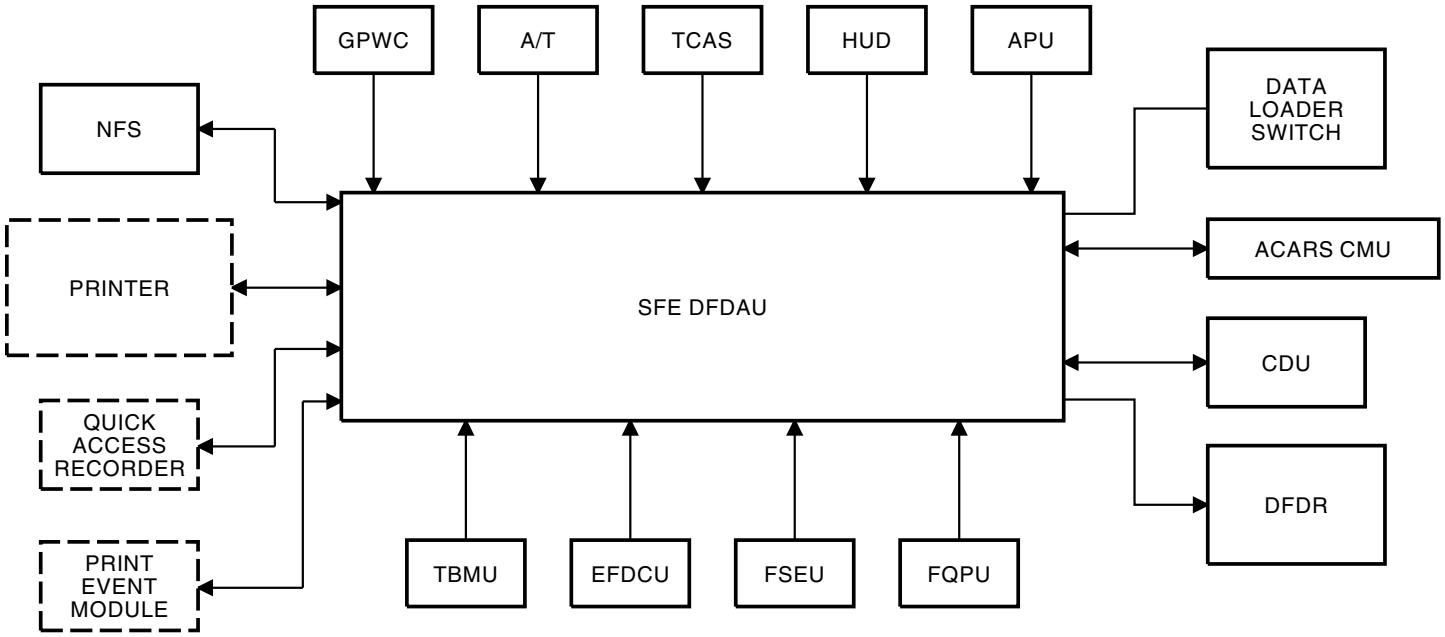
FDRS - DFDAU DIGITAL INTERFACE



2369360 S00061519395_V1

FDRS - DFDAU DIGITAL INTERFACE

FDRS - DFDAU DIGITAL INTERFACE



2470011 S0000578315_V3

FDRS - DFDAU DIGITAL INTERFACE

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FDRS - DFDAU ACMS INTERFACE

General

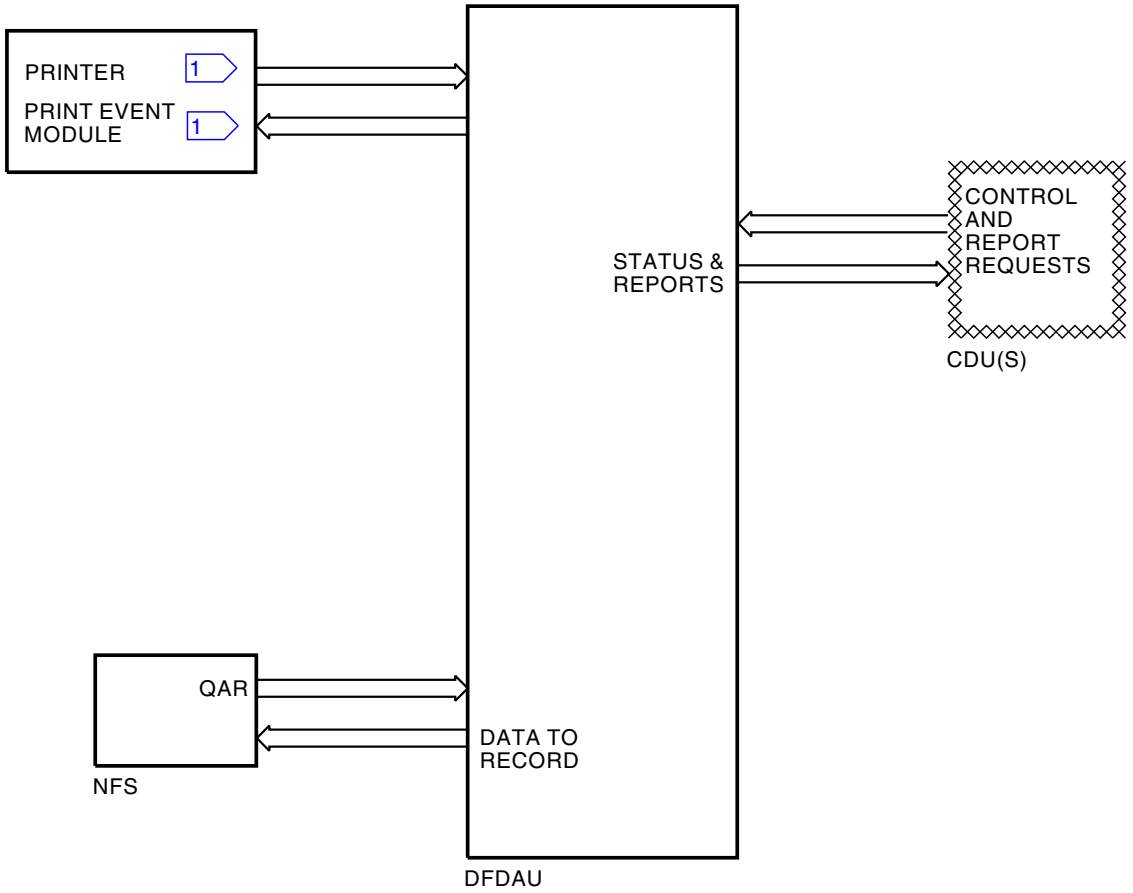
The Line Replaceable Unit (LRU) sends data to and get data from the Data Management Unit (DMU) master controller in the Digital Flight Data Acquisition Unit (DFDAU).

The Control Display Unit (CDU) controls the Airplane Condition And Monitoring System (ACMS) functions in the DFDAU.

The Network File Server (NFS) interfaces with the DFDAU to provide functionality for the Quick Access Recorder (QAR).

- Printer - The printer prints reports and sends status to the DFDAU on an output data bus.

FDRS - DFDAU ACMS INTERFACE



NOTE:

1 POSSIBLE DFDAU ACMS INTERFACE

2554988 S0000609107_V3

FDRS - DFDAU ACMS INTERFACE

FDRS - ONS QUICK ACCESS RECORDER

Purpose

The onboard network system quick access recorder (ONS QAR) receives and stores data from the DFDAU, and gives access to airplane performance data.

Power

The network file server (NFS) receives 115V AC at 400Hz for primary power.

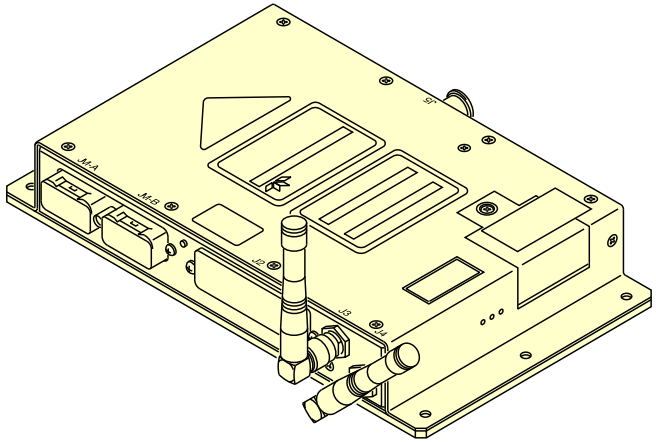
Functional Description

The ONS QAR starts to record automatically when it has power applied.

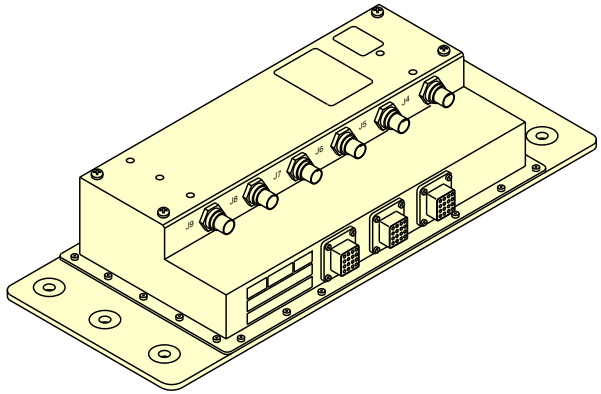
ONS QAR data files are saved on a removable storage card in the DFDAU. Data files can be downloaded from the maintenance BITE panel in the flight deck to a portable maintenance device (PMD).

You can get wireless access to QAR information. The optional airplane wireless LAN unit (AWLU) provides a cellular connection between the NFS and airplane computer terminals. The optional crew wireless LAN unit (CWLU) provides a wireless connection within the airplane between the NFS and flight crew, cabin crew, or maintenance personnel.

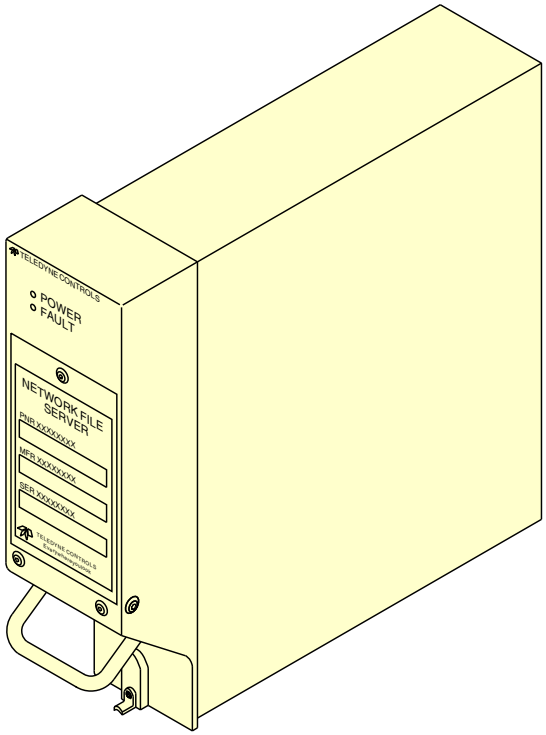
FDRS - ONS QUICK ACCESS RECORDER



AIRPLANE WIRELESS LAN UNIT (AWLU)



CREW WIRELESS LAN UNIT (CWLU)



NFS (ONS QAR)

2807164 S0000645173_V1

FDRS - ONS QUICK ACCESS RECORDER

FDRS - DFDAU ANALOG INTERFACE

General

Analog inputs to the Digital Flight Data Acquisition Unit (DFDAU) come from these sources:

- Accelerometer
- Sensors
- Transducers
- Transmitters.

These inputs go to an analog interface in the DFDAU. The analog interface changes analog signals to digital data. The DFDAU processes the digital data.

Accelerometer

The accelerometer supplies these three analog outputs to the DFDAU:

- Vertical acceleration
- Lateral acceleration
- Longitudinal acceleration.

The DFDAU gives 28v dc to the accelerometer for power.

Sensors

Eight sensors give inputs to the analog interface in the DFDAU.

The stabilizer position sensor gives pitch trim position to the DFDAU.

The spoiler position sensors give spoiler position inputs to the DFDAU.

The control wheel position sensor gives these inputs to the DFDAU:

- Captain control wheel position
- First Officer control wheel position.

The control column position sensor gives these inputs to the DFDAU:

- Captain control column position
- First Officer control column position.

The rudder pedal position sensor gives position input to the DFDAU.

Transducers

The rudder pedal force transducer gives force input to the DFDAU.

Transmitters

Six transmitters give inputs to the analog interface in the DFDAU.

The rudder position transmitter gives position input to the DFDAU.

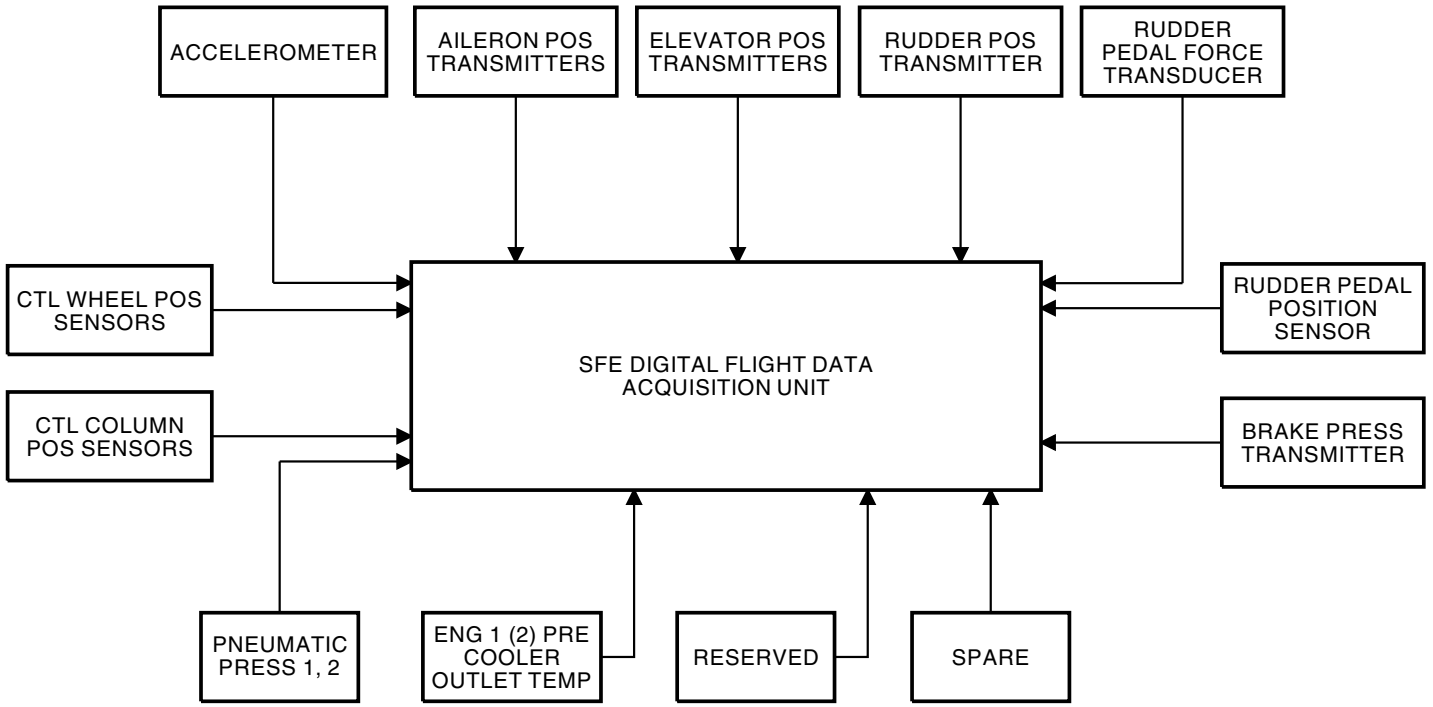
The right and left aileron position transmitters give position inputs to the DFDAU.

The right and left elevator position transmitters give position inputs to the DFDAU.

The brake pressure transmitter gives these inputs to the DFDAU:

- Main brake pressure right
- Alternate brake pressure right
- Main brake pressure left
- Alternate brake pressure left.

FDRS - DFDAU ANALOG INTERFACE



2369362 S00061519399_V1

FDRS - DFDAU ANALOG INTERFACE

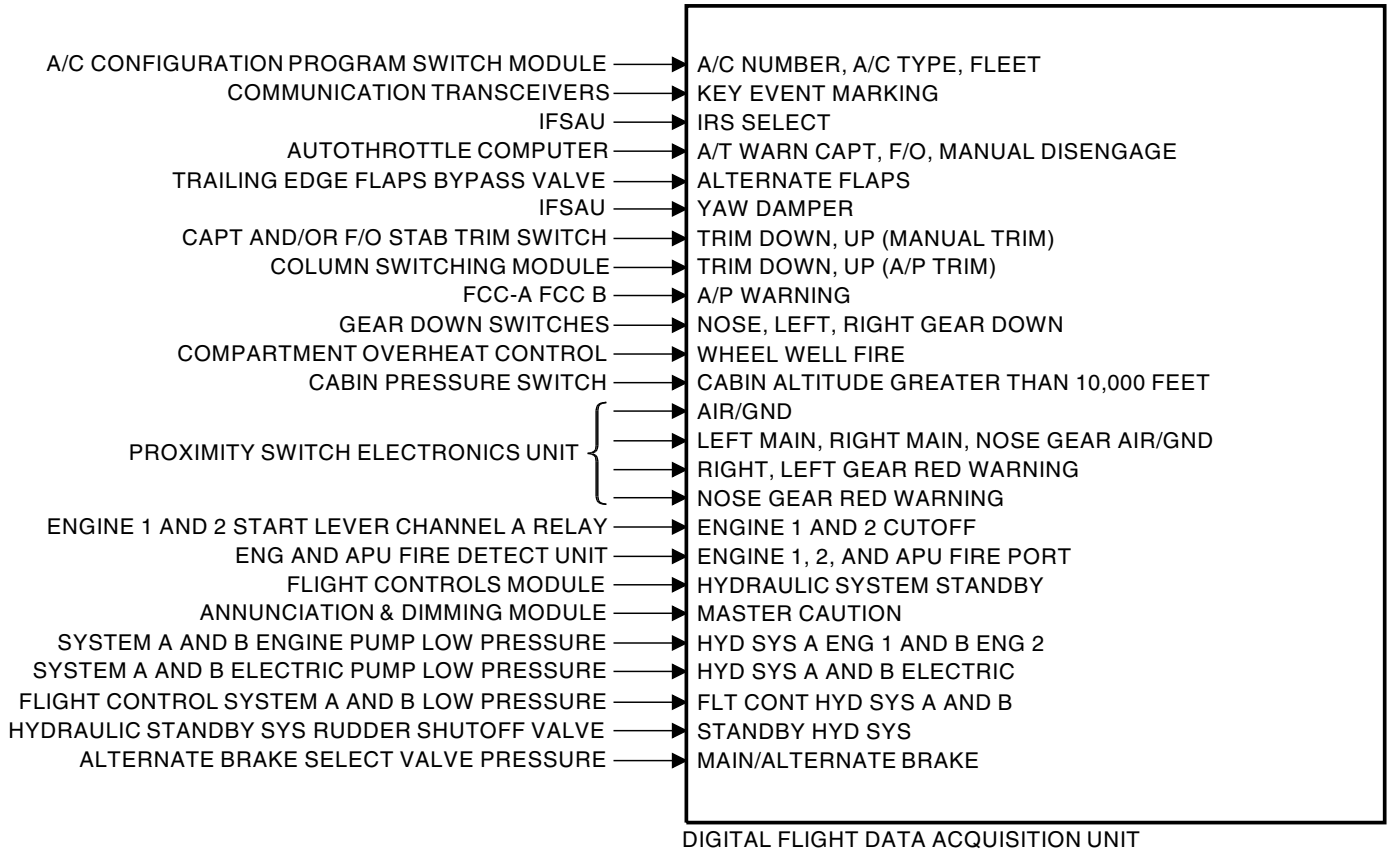
FDRS - DFDAU DISCRETE INTERFACE - 1

General

Discrete signals come into the Digital Flight Data Acquisition Unit (DFDAU). The DFDAU processes the digital data.

Regulatory agencies require mandatory parameters come into the DFDAU. Airlines also record selected parameters.

FDRS - DFDAU DISCRETE INTERFACE - 1



2369363 S00061519401_V1

FDRS - DFDAU DISCRETE INTERFACE - 1

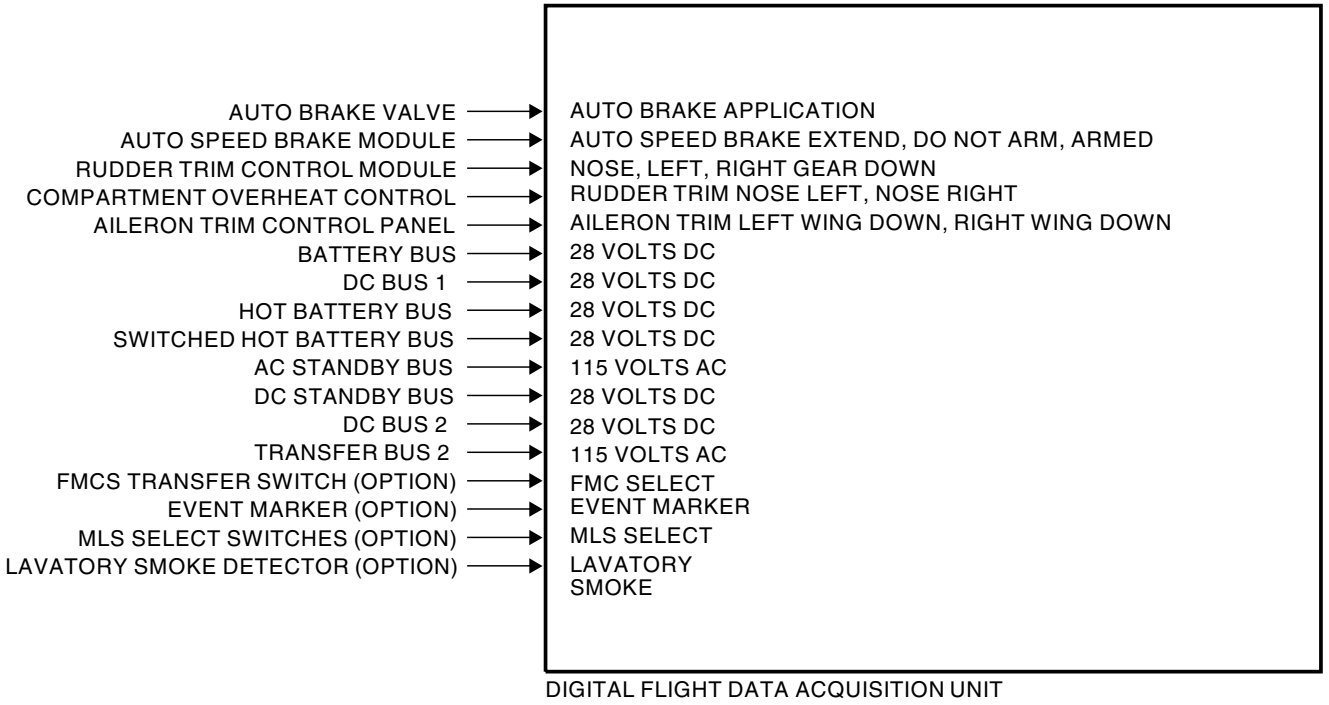
FDRS - DFDAU DISCRETE INTERFACE - 2

General

Discrete signals come into the Digital Flight Data Acquisition Unit (DFDAU). The DFDAU processes the digital data.

Regulatory agencies require mandatory parameters for the DFDAU. Airlines also record selected parameters.

FDRS - DFDAU DISCRETE INTERFACE - 2



2369364 S00061519403_V1

FDRS - DFDAU DISCRETE INTERFACE - 2

FDRS - SOLID STATE FLIGHT DATA RECORDER

General

The Solid-State Flight Data Recorder (SSFDR) stores the flight data in a solid-state memory.

Physical Description

The SSFDR is made of hard steel alloys to give protection. It weighs approximately 18 pounds (8.2 kg). The memory storage assembly in the SSFDR is crush-proof up to 5000 pounds (2273 kg). The SSFDR case also supplies protection for these conditions:

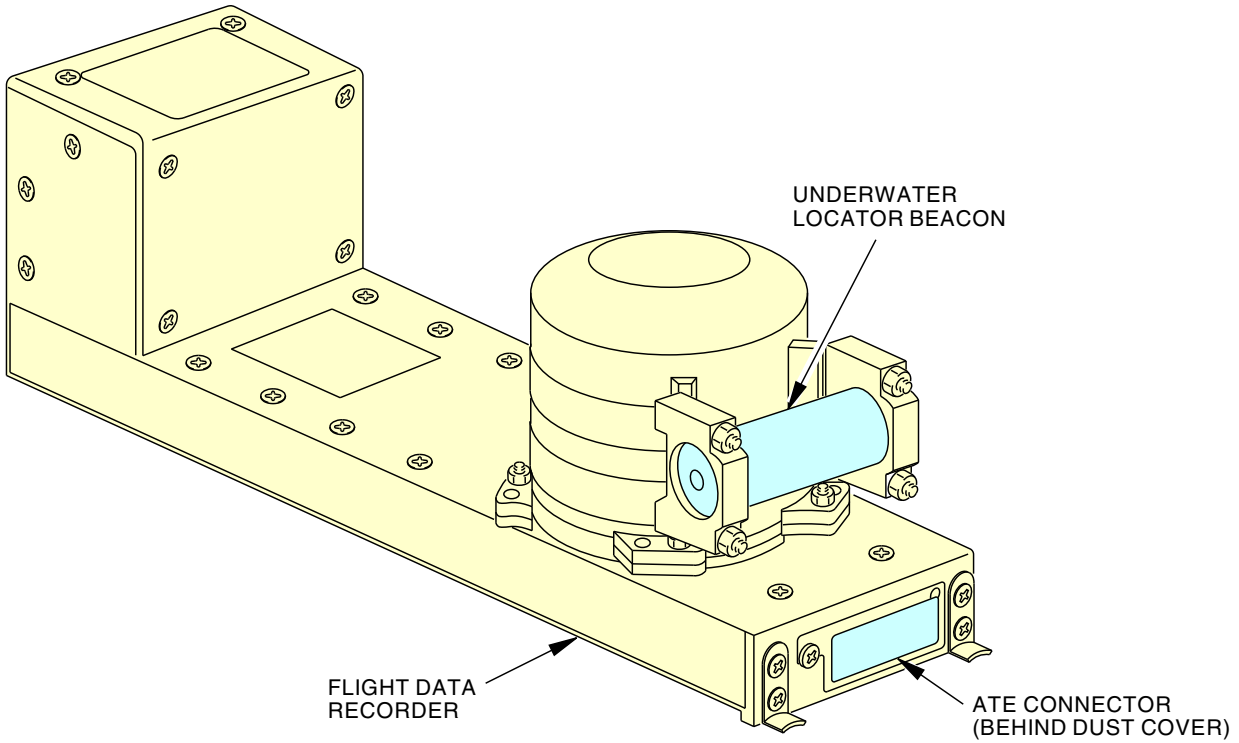
- Up to 3400 Gs of impact
- Deep sea pressures to 20,000 feet (6100 meters)
- Fire temperatures up to 1100C for 1/2 hour.

These items are on the front of the SSFDR:

- Underwater Locating Device (ULD)
- An ATE connector

The ATE connector lets you connect portable test equipment and copy information from the solid-state memory.

FDRS - SOLID STATE FLIGHT DATA RECORDER



2369365 S00061519405_V2

FDRS - SOLID STATE FLIGHT DATA RECORDER

FDRS - UNDERWATER LOCATING DEVICE

Purpose

The Underwater Locating Device (ULD) is an ultrasonic beacon. It makes the Flight Data Recorder (FDR) easier to find if it is under water.

Physical Description

Some ULDs are Line Replaceable Unit (LRU). For these units, you send the unit to the manufacturer to replace the battery. For some ULDs, the battery is an LRU. The LRU ULD is 1.3 in. (3.3 cm) in diameter and 3.92 in. (9.96 cm) long. It weighs less than 7 oz (0.20 kg).

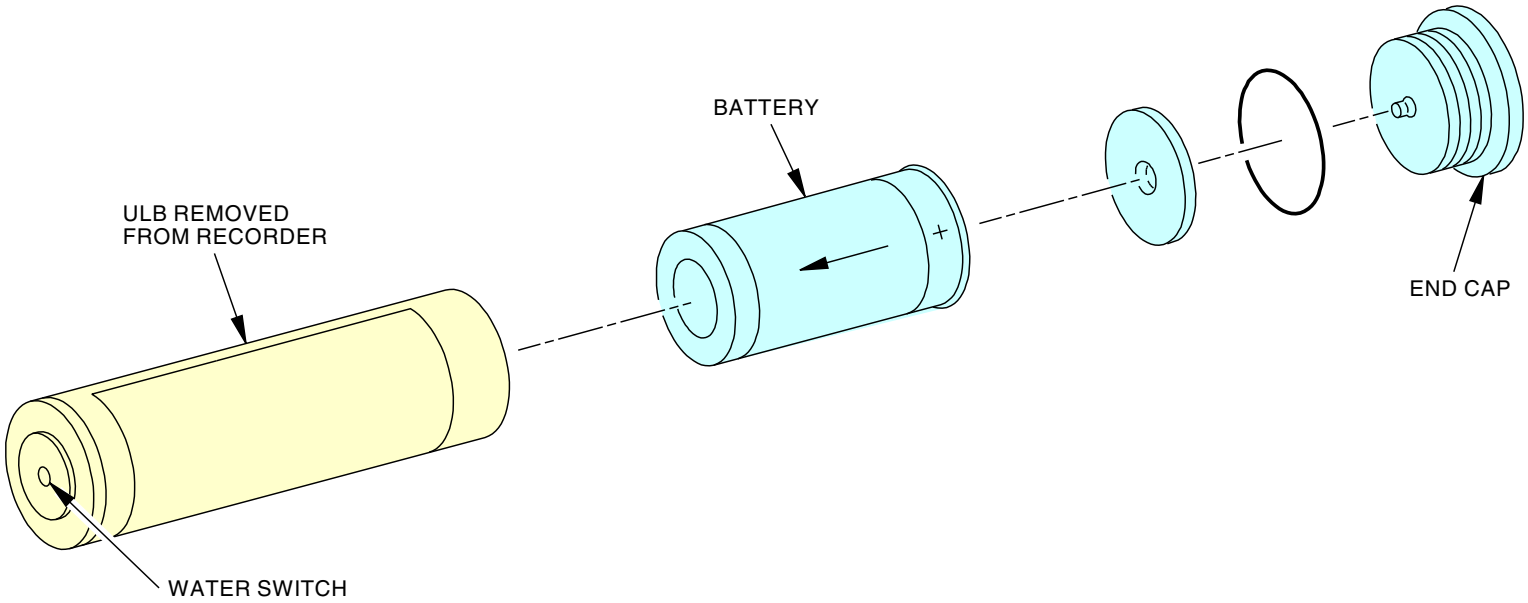
To replace the battery, grip the ULD with a gripping device such as a split rubber hose. Do not grip the ULD with a vise because you will damage the ULD.

Functional Description

The ULD has these operation characteristics:

- Operates when it is put into water
- Operates to a maximum depth of 20,000 ft (6096 m)
- Has a detection range of 6000 ft (1829 m) to 12,000 ft (3658 m)
- Can operate under water for a minimum of 90 days
- Sends out an acoustic pulse tone of 37.5 khz at a rate of one pulse-per-second.

FDRS - UNDERWATER LOCATING DEVICE

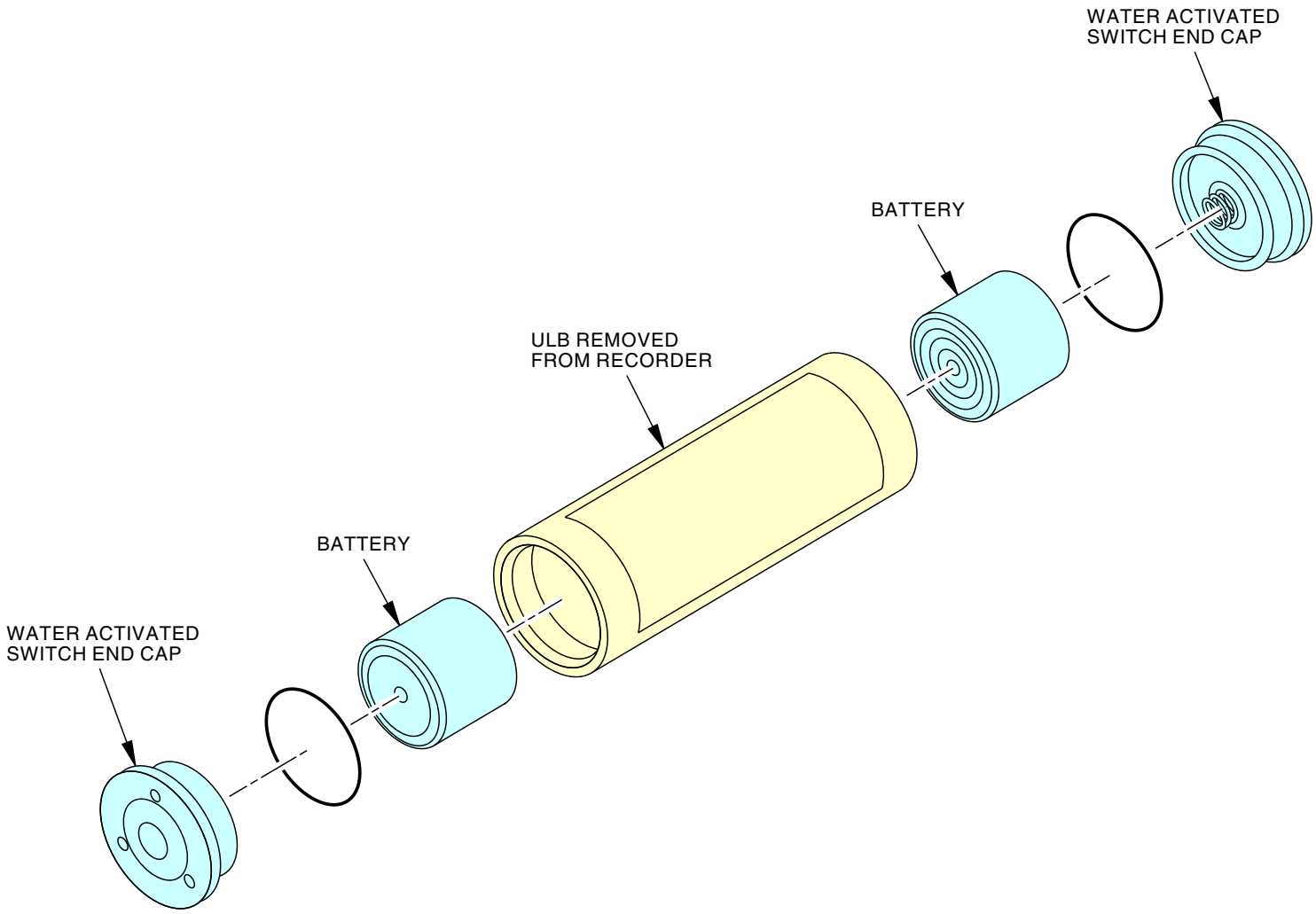


2368803 S00061518147_V2

FDRS - UNDERWATER LOCATING DEVICE

EFFECTIVITY
SIA ALL; UNDERWATER LOCATOR BEACONS WITH ONE WATER SWITCH

FDRS - UNDERWATER LOCATING DEVICE



2981696 S0000760055_V1

FDRS - UNDERWATER LOCATING DEVICE

EFFECTIVITY
SIA ALL; UNDERWATER LOCATOR BEACONS WITH TWO WATER SWITCHES

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FDRS - DIGITAL FLIGHT DATA ACQUISITION UNIT (DFDAU)

Purpose

The Digital Flight Data Acquisition Unit (DFDAU) collects, multiplexes and changes inputs into a standard digital format. The inputs come from many airplane systems and sensors. The Flight Data Recorder (FDR) stores the processed signals from the DFDAU.

Power Requirement

The DFDAU uses 115v ac, 400 Hz, single phase power.

Features

The DFDAU has a Data Management Unit (DMU). The DMU does data monitoring. The DMU keeps Airplane Condition And Monitoring System (ACMS) data in a solid state memory until you download the data. The front panel of the DFDAU has a front panel keypad and a display for operator feedback and viewing to find the health condition of the unit.

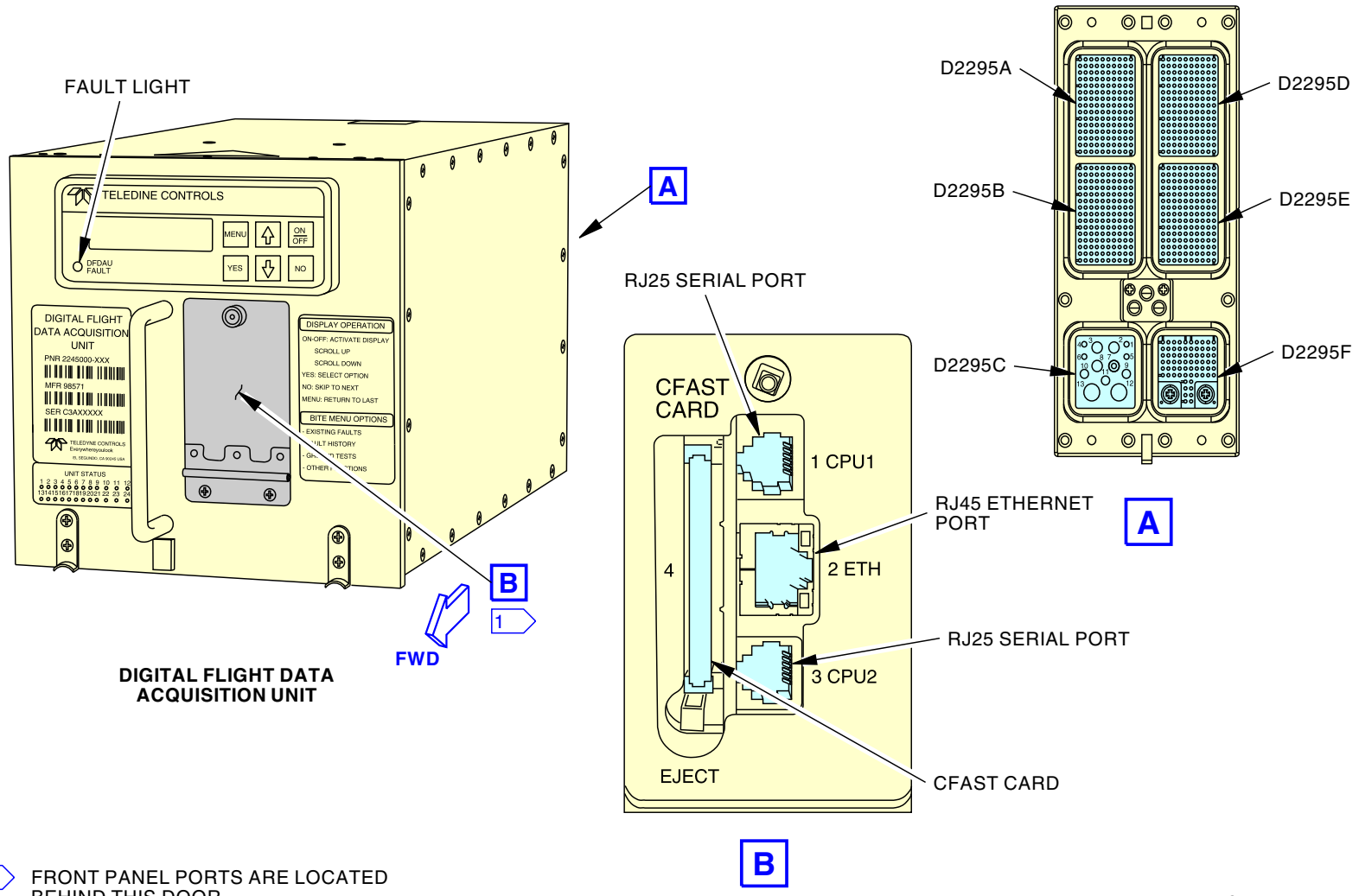
The front panel keypad and display have:

- Six push-button keys: ON/OFF, MENU, YES, NO, UP and DOWN arrows
- Two lines with 16 graphic characters in each line
- Black characters on backlit background
- DFDAU FAULT indicator (LED red) - comes on when an internal DFDAU failure occurs.

The front panel ports behind the access panel have:

- two RJ25 serial ports
- a RJ45 Ethernet port
- a CFast Card slot
- You can connect a Automatic Test Equipment (ATE) to the DFDAU and do a test while the DFDAU is in the airplane.

FDRS - DIGITAL FLIGHT DATA ACQUISITION UNIT (DFDAU)



DIGITAL FLIGHT DATA ACQUISITION UNIT

1 FRONT PANEL PORTS ARE LOCATED BEHIND THIS DOOR.

2369367 S00061519409_V1

FDRS - DFDAU

FDRS - FLIGHT RECORDER/MACH AIRSPEED WARNING TEST MODULE

Purpose

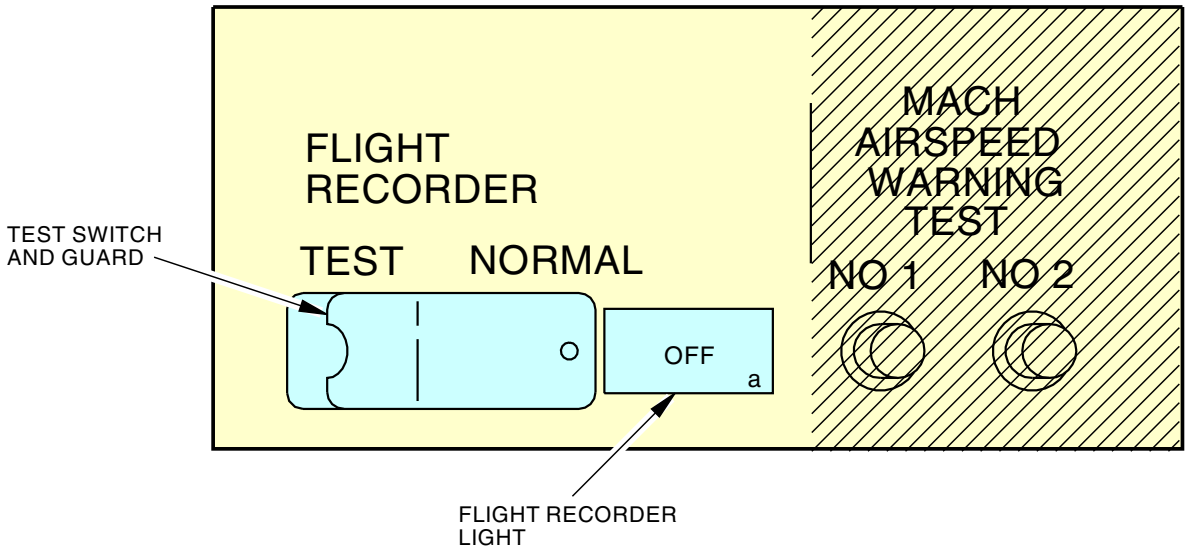
The flight recorder/mach airspeed warning test module gives the flight crew visual indications of the flight recorder operation. You can manually apply power to the flight recorder at this panel.

Features

Put the TEST/NORMAL switch in the TEST position to apply power to the Flight Data Recorder System (FDRS) for maintenance purposes.

The flight recorder light comes on when the Flight Data Recorder (FDR) or Digital Flight Data Acquisition Unit (DFDAU) finds a critical fault. The flight recorder light also comes on when the FDRS is not in operation.

FDRS - FLIGHT RECORDER/MACH AIRSPEED WARNING TEST MODULE



2369368 S00061519411_V1

FDRS - FLIGHT RECORDER/MACH AIRSPEED WARNING TEST MODULE

FDRS - ACCELEROMETER

Purpose

The three-axis accelerometer measures acceleration along the vertical, lateral, and longitudinal axes. The accelerometer sends acceleration data to the Digital Flight Data Acquisition Unit (DFDAU).

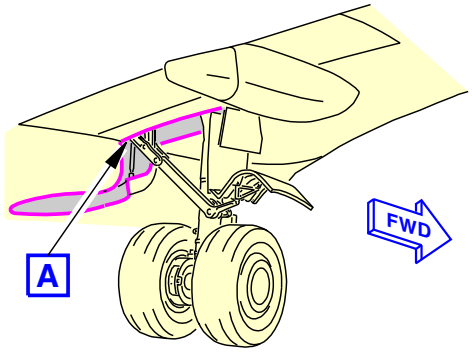
Features

The accelerometer can measure accelerations up to ten times the normal operation range. No calibration or scheduled maintenance is necessary.

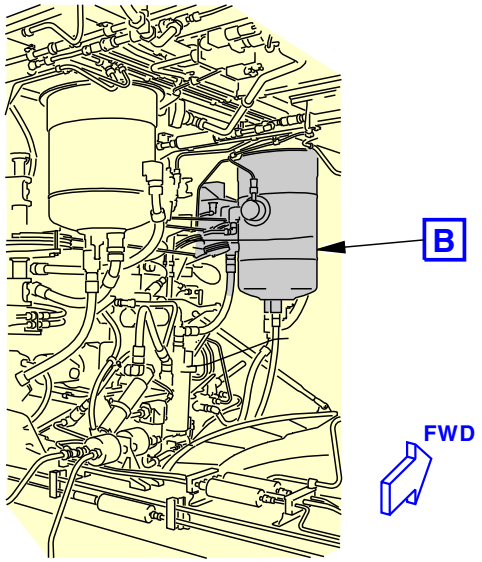
Power

The flight recorder accelerometer gets 28v dc from the DFDAU.

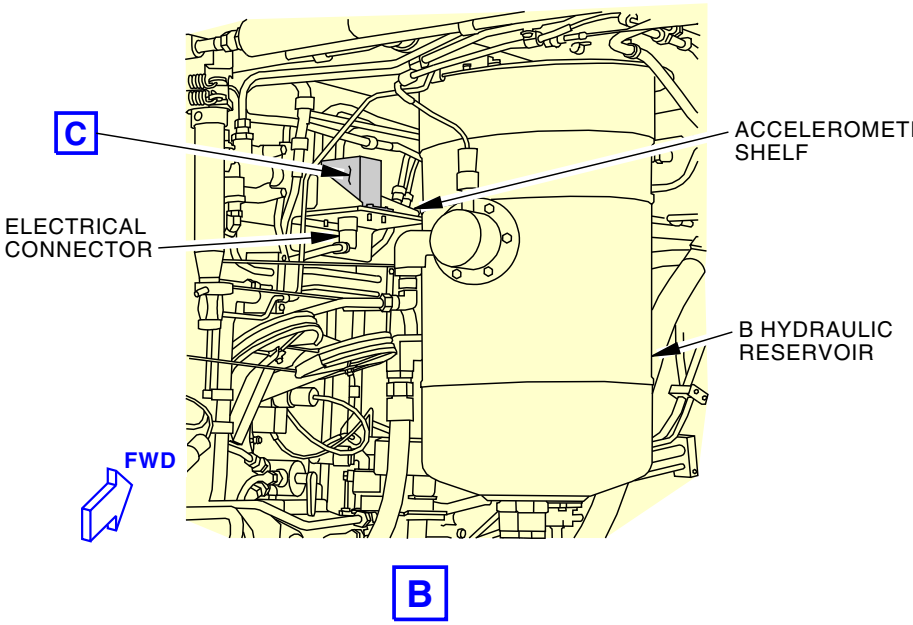
FDRS - ACCELEROMETER



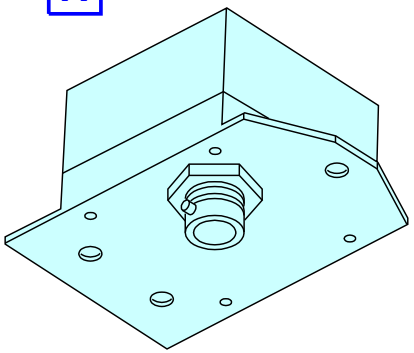
RIGHT MAIN WHEEL WELL



A



B



C

2369369 S00061519413_V1

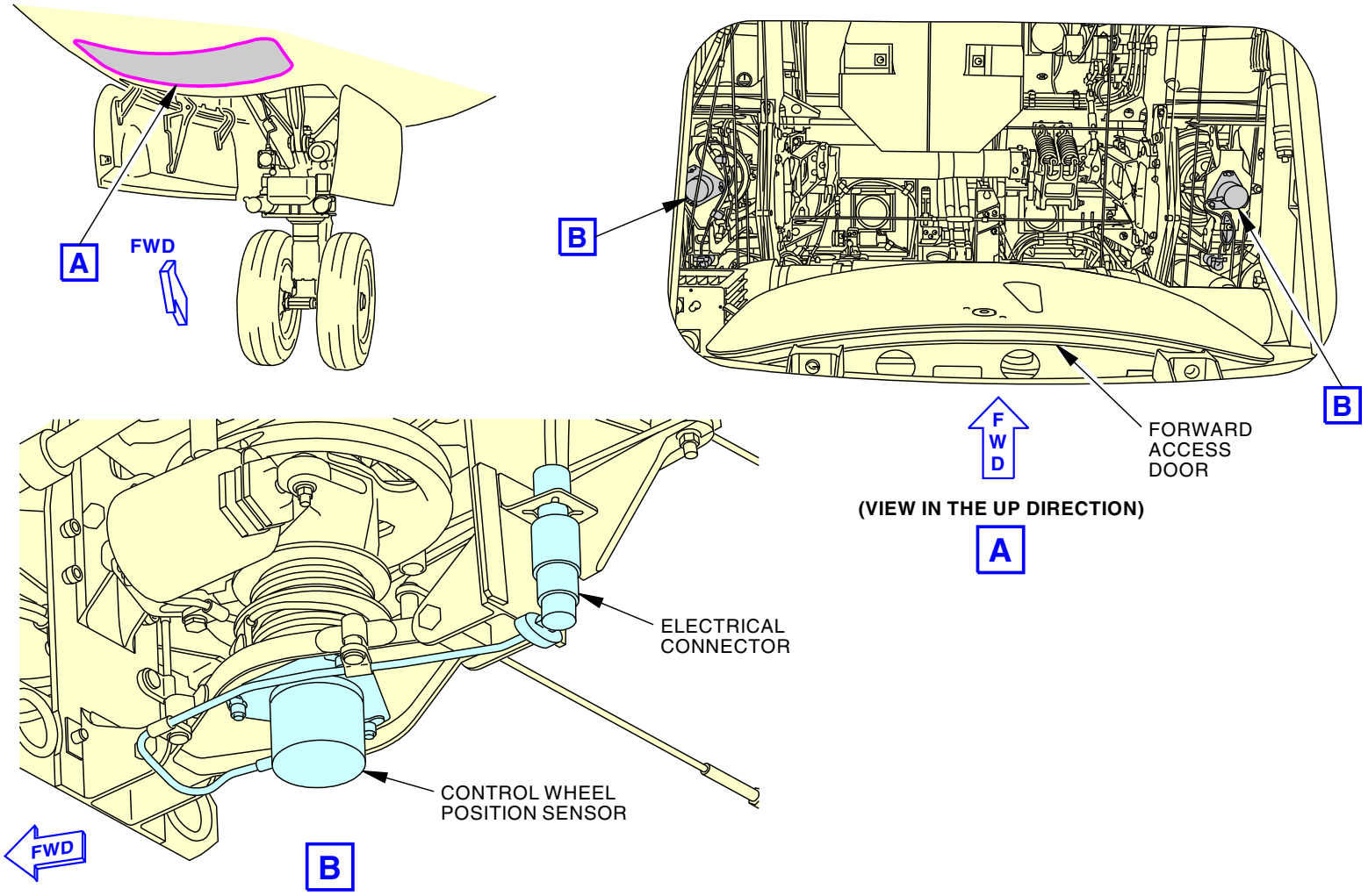
FDRS - ACCELEROMETER

FDRS - CONTROL WHEEL POSITION SENSOR

General

The control wheel position sensors measure the position of the control wheel. The sensors send this data to the Digital Flight Data Acquisition Unit (DFDAU).

FDRS - CONTROL WHEEL POSITION SENSOR



2369370 S00061519415_V1

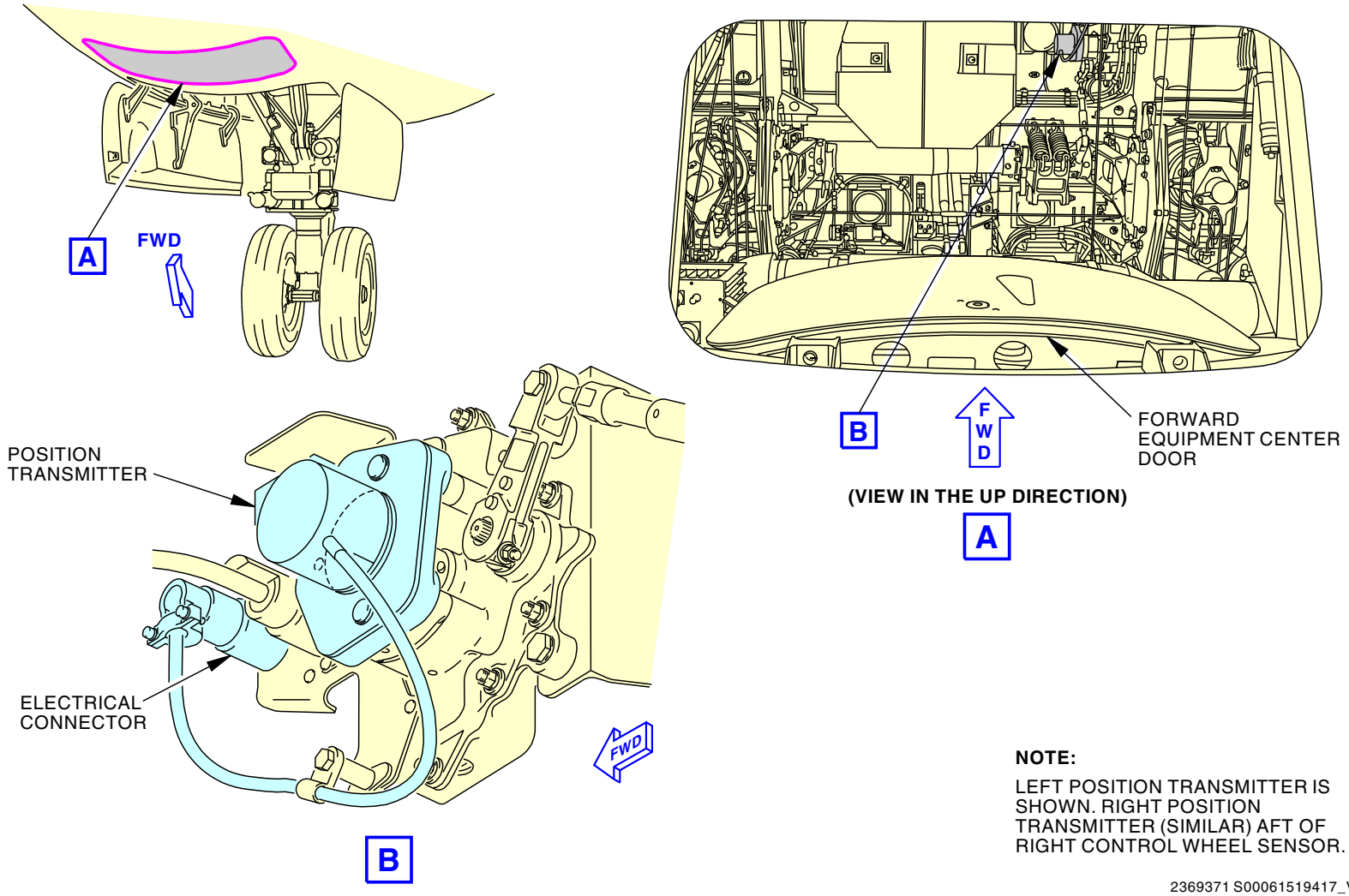
FDRS - CONTROL WHEEL POSITION SENSOR

FDRS - CONTROL COLUMN POSITION TRANSMITTER

General

Control column position transmitters send control column position information to the Digital Flight Data Acquisition Unit (DFDAU).

FDRS - CONTROL COLUMN POSITION TRANSMITTER



NOTE:

LEFT POSITION TRANSMITTER IS SHOWN. RIGHT POSITION TRANSMITTER (SIMILAR) AFT OF RIGHT CONTROL WHEEL SENSOR.

2369371 S00061519417_V1

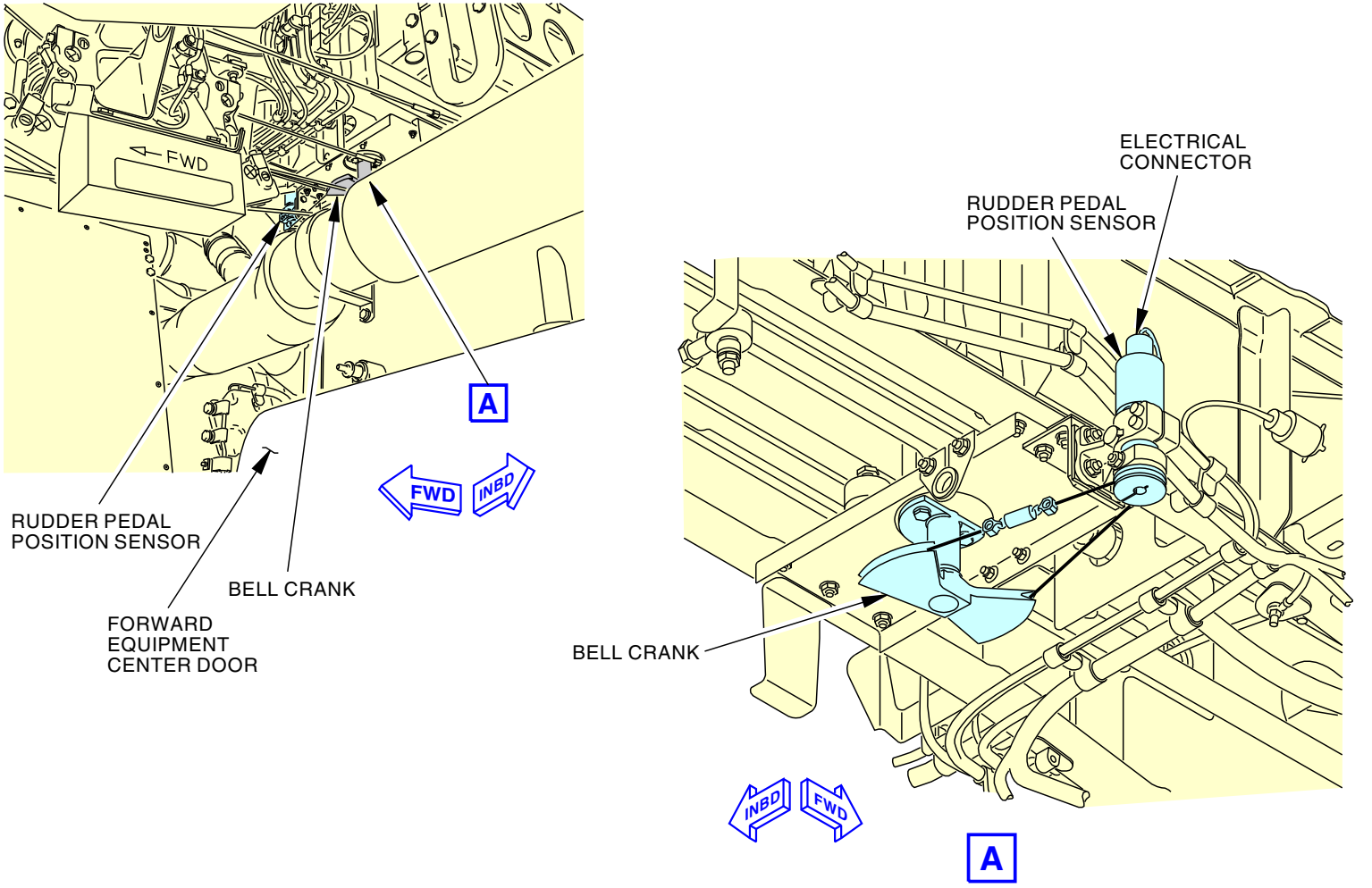
FDRS - CONTROL COLUMN POSITION TRANSMITTER

FDRS - RUDDER PEDAL POSITION SENSOR

General

Rudder pedal position sensor sends rudder pedal position information to the Digital Flight Data Acquisition Unit (DFDAU).

FDRS - RUDDER PEDAL POSITION SENSOR



2369372 S00061519419_V1

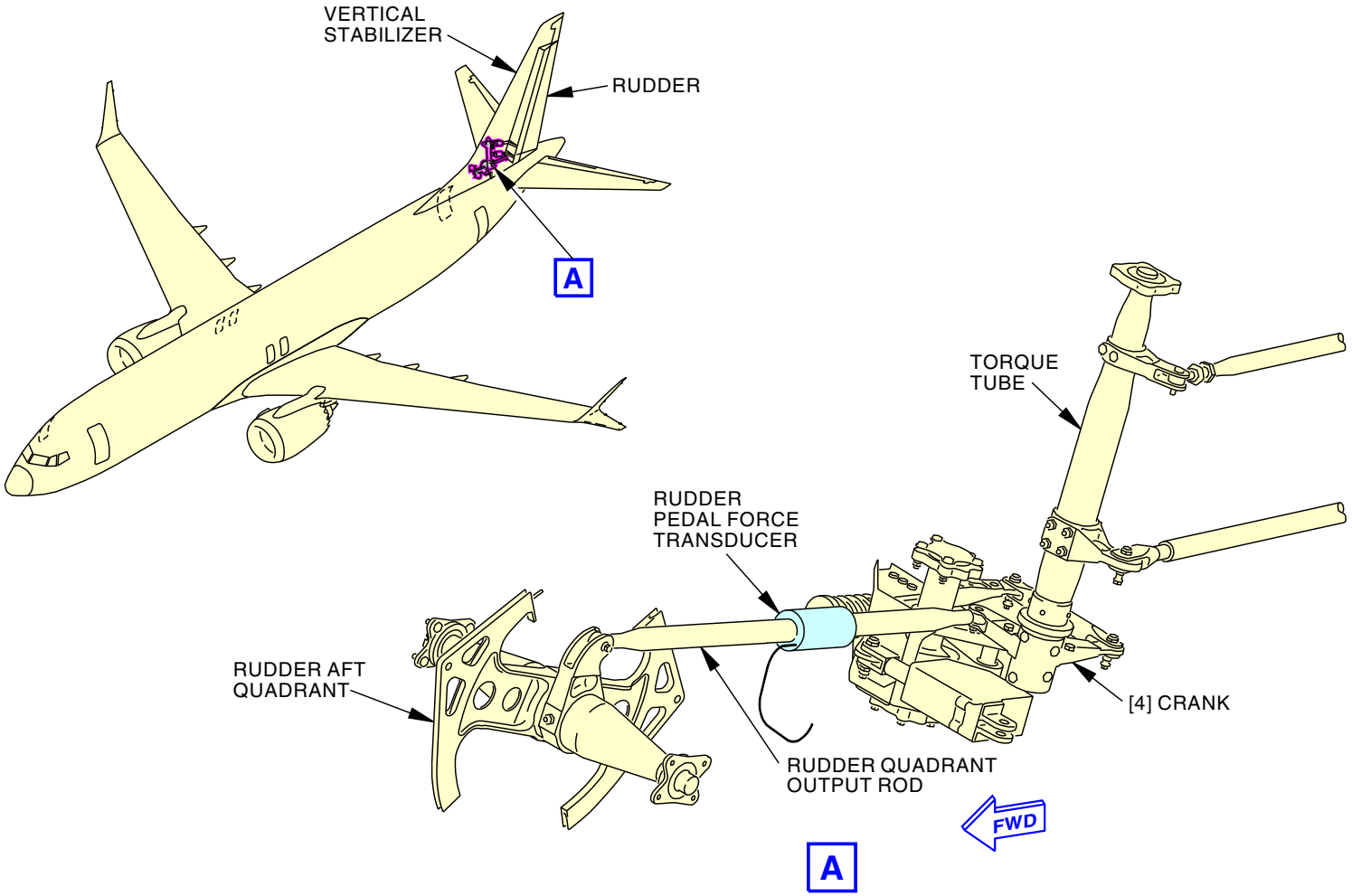
FDRS - RUDDER PEDAL POSITION SENSOR

FDRS - RUDDER PEDAL FORCE TRANSDUCER

Purpose

The rudder pedal force transducer sends rudder pedal force information to the Digital Flight Data Acquisition Unit (DFDAU).

FDRS - RUDDER PEDAL FORCE TRANSDUCER



2369373 S00061519421_V1

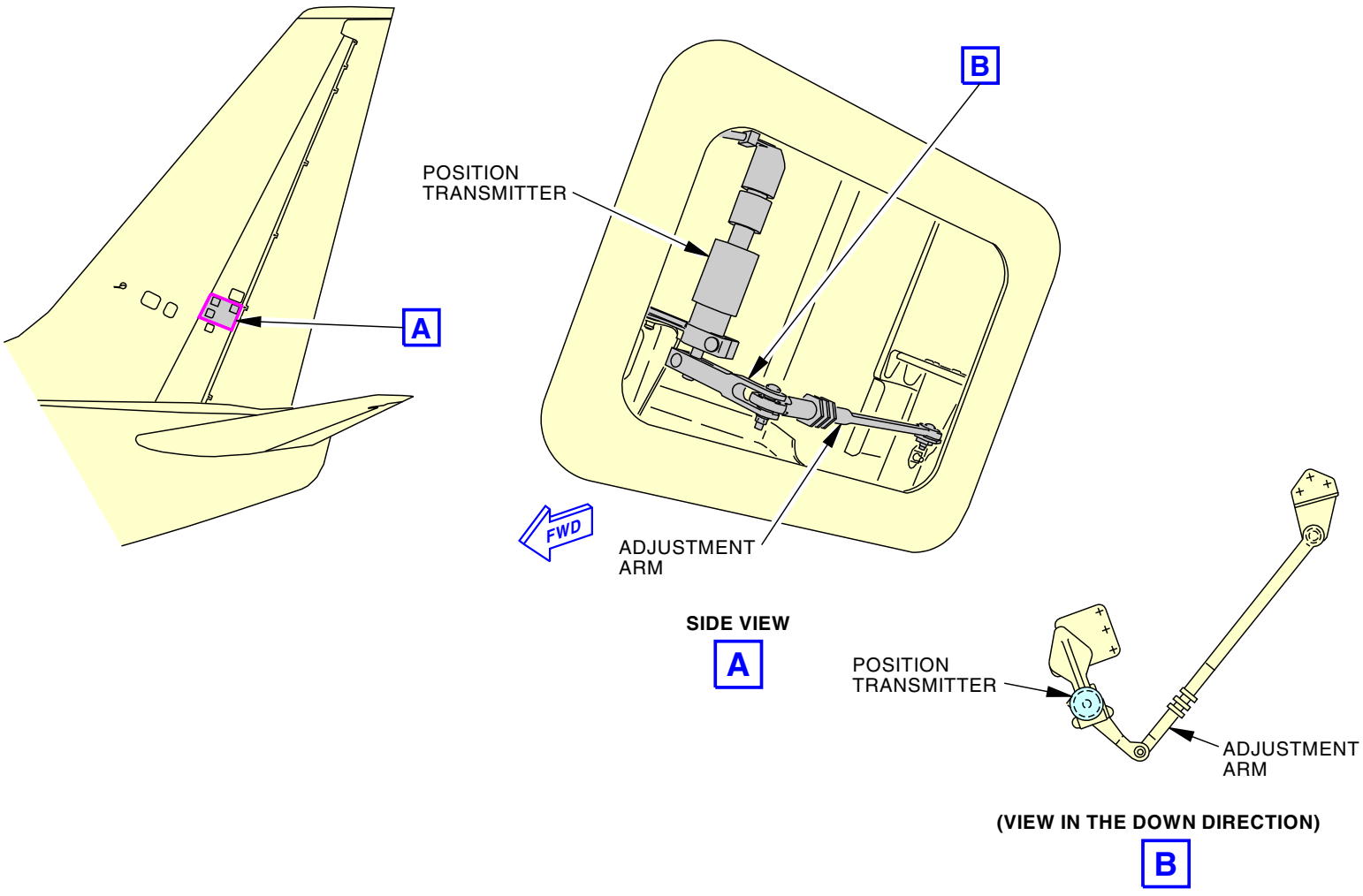
FDRS - RUDDER PEDAL FORCE TRANSDUCER

FDRS - RUDDER POSITION TRANSMITTER

General

The rudder position transmitter measures the position of the rudder. The transmitter sends this data to the Digital Flight Data Acquisition Unit (DFDAU).

FDRS - RUDDER POSITION TRANSMITTER



2369374 S00061519423_V1

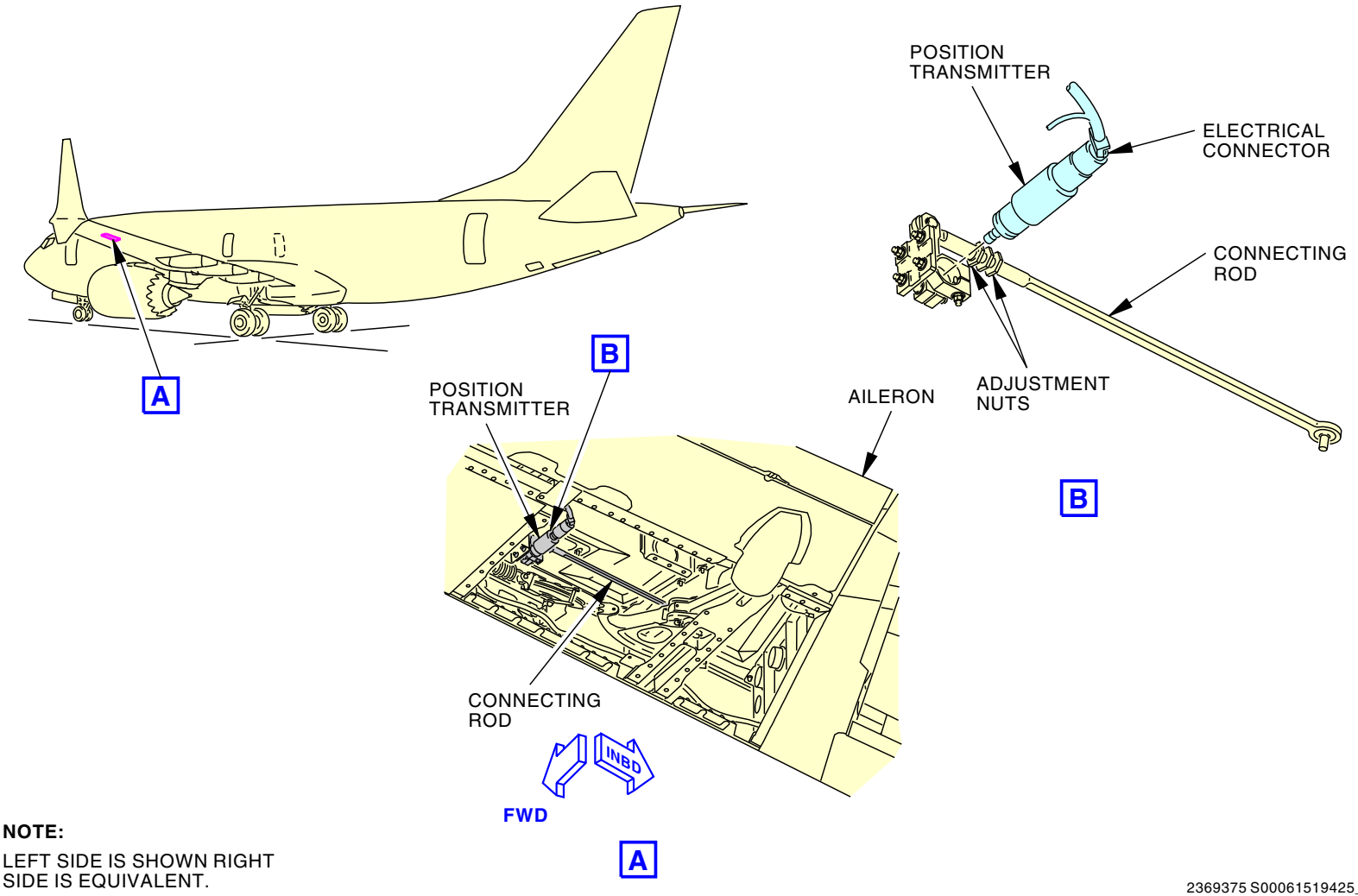
FDRS - RUDDER POSITION TRANSMITTER

FDRS - AILERON POSITION TRANSMITTER

General

The aileron position transmitters send aileron position information for each wing to the Digital Flight Data Acquisition Unit (DFDAU). These transmitters are aft of the wing rear spar. You turn the center nut to make small adjustments.

FDRS - AILERON POSITION TRANSMITTER



NOTE:

LEFT SIDE IS SHOWN RIGHT SIDE IS EQUIVALENT.

2369375 S00061519425_V1

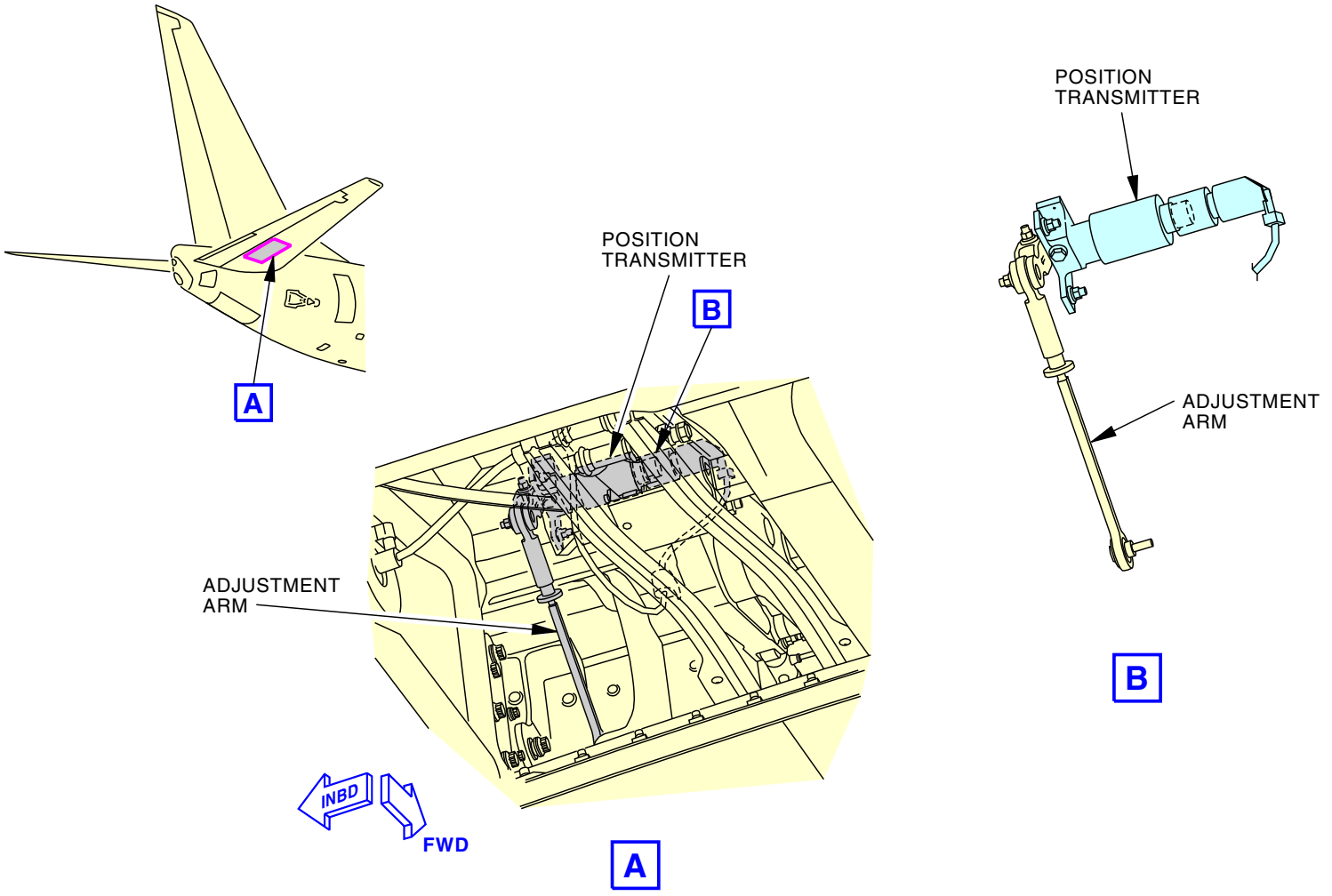
FDRS - AILERON POSITION TRANSMITTER

FDRS - ELEVATOR POSITION TRANSMITTER

General

There is an elevator position transmitter in each stabilizer. They send elevator position information to the Digital Flight Data Acquisition Unit (DFDAU). An adjustable control rod connects the transmitter to the elevator.

FDRS - ELEVATOR POSITION TRANSMITTER



2369376 S00061519427_V1

FDRS - ELEVATOR POSITION TRANSMITTER

FDRS - SSFDR FUNCTIONAL DESCRIPTION

General

The Solid-State Flight Data Recorder (SSFDR) receives and keeps the last 25 hours of flight data. The SSFDR receives the data from the Digital Flight Data Acquisition Unit (DFDAU). The data is in a crash-proof, fire-resistant container. The SSFDR does a self test at power-up to make sure the recorder is good. It also has a continuous test to find any faults.

Recording Data

The SSFDR receives data from the DFDAU in Harvard bi-phase format. The input/output interface buffer puts data on the data bus. It also sends the received data back to the DFDAU.

The Central Processing Unit (CPU) controls the data movement. It also does self-tests and sends the test results to the Built-In-Test Equipment (BITE) monitor.

BITE

The BITE monitor does a check of the power supply and the SSFDR functions. The BITE monitor controls two relays. The relays give these fault indications:

- System status flag
- Maintenance flag

These conditions cause a system status flag fault output:

- Loss of input power
- Loss of input data
- Catastrophic central processor unit failure
- Not enough memory because of defective memory devices
- Faults found in the software
- Bad data rate inputs
- Data not properly recorded
- Test mode.

These conditions cause a maintenance flag fault indication:

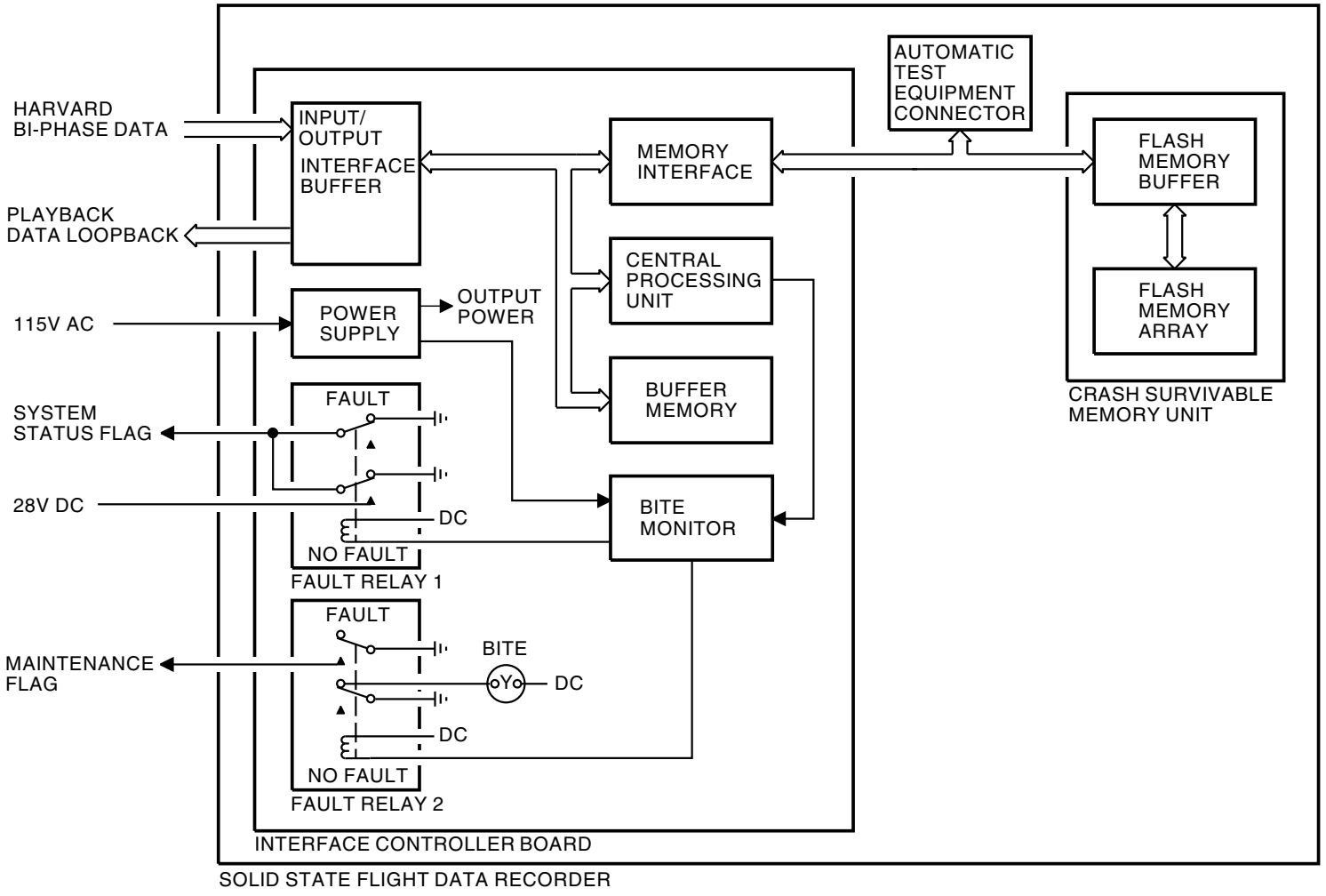
- Hardware faults
- Faults found in the software
- Bad data rate inputs.

The status output goes to the flight recorder test module. This output is a ground and turns on the OFF light on the test module if the internal record function is bad. The output is 28v dc when recorder operation is correct.

The maintenance flag output goes to the DFDAU. This output is an open with a recorder fault . The output is a ground when recorder operation is correct.

Failures or malfunctions are stored in memory. Ground support equipment can read the memory.

FDRS - SSFDR FUNCTIONAL DESCRIPTION



2369377 S00061519429_V1

FDRS - SSFDR FUNCTIONAL DESCRIPTION

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FDRS - DFDAU FUNCTIONAL DESCRIPTION

General

The Digital Flight Data Acquisition Unit (DFDAU) gets aircraft data from digital, discrete and analog sources. The DFDAU uses this data to make serial digital data for the Solid-State Flight Data Recorder (SSFDR).

The DFDAU also collects data for the Airplane Condition And Monitoring System (ACMS). The DFDAU stores the ACMS data. You can move this data to a disk at the data loader control panel.

Power Requirements

The DFDAU gets 115v ac, 400 Hz, single phase power from the P18 panel through the system test plug. An internal power supply makes all the necessary dc voltages. The DFDAU also gets 26v ac reference voltage for the analog transmitters and sensors.

The DFDAU sends 28v dc to the flight recorder accelerometer.

Analog Inputs

Analog input signals are processed in this sequence:

- Analog interface circuits receive analog signals
- Analog to digital (A/D) converters change analog signals to digital data
- The master controller receives the digital data.

The master controller does continuous self test and calibration.

Discrete Inputs

Discrete input signals are processed in this sequence:

- Discrete interface circuits receive discrete signals
- A multiplexer samples each input
- The master controller receives the discrete data.

Digital Inputs

The digital interface receives and processes Aeronautical Radio Incorporated (ARINC) 429 digital signals. The DFDAU master controller checks parity and status bits before sending the data to the SSFDR.

When the DFDAU gets power, a software routine does a check of all digital input channels. If the test fails, the DFDAU FAULT light comes on and the BITE out discrete to the status relay changes to an open.

Master Controller Signal Processing

The master controller contains the mandatory interface.

The master controller receives the flight data, puts it in a sequence, and sends it in serial mode to the ARINC 573/717 interface.

ARINC 573/717 Interface

This interface formats digital data to harvard biphase code. The interface sends this code to the SSFDR.

Data Management Unit (DMU) Master Controller Processing

The Data Management Unit (DMU) master controller processes ACMS data. The DMU monitors DFDAU inputs for specified ACMS parameters. When the DMU master controller sees the data change to a value to record, the ACMS makes a report of the parameters. Also, at various times during flight, the ACMS stores reports. The ACMS memory keeps the reports.

The DMU master controller gets data from the DFDAU master controller on an internal data bus.

Solid State Memory

Solid state memory holds the data until you want to download reports.

FDRS - DFDAU FUNCTIONAL DESCRIPTION

Built In Test Equipment (BITE)

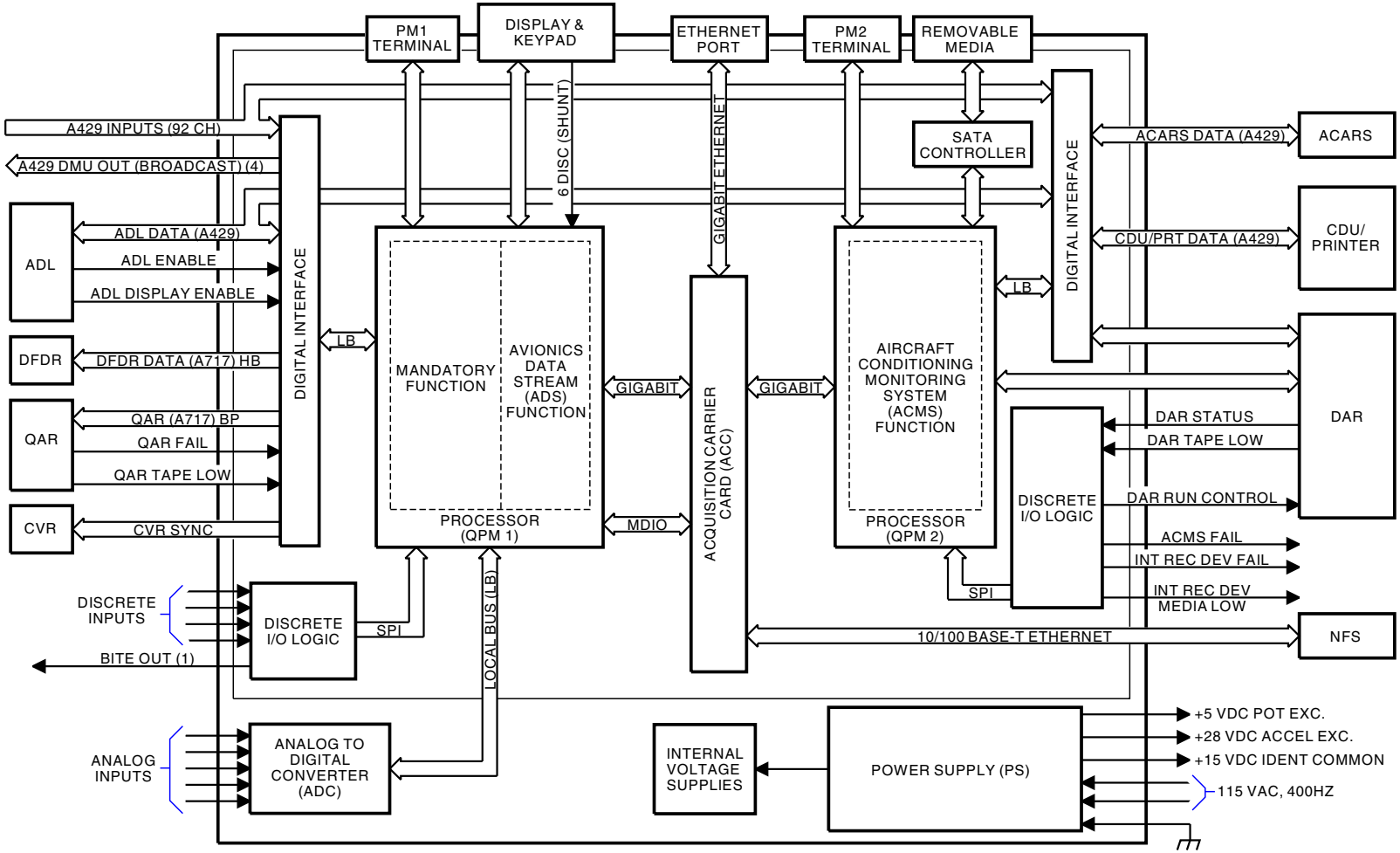
The DFDAU fail signal (an open) goes to the status relay with a FDAU fault.

Self tests do a check of the system continuously. Configuration and BITE data show in the front panel display. The ESC, +/-, and ENT buttons control display.

These lights come on with a fault:

- DFDR FAIL - FDR fault.

FDRS - DFDAU FUNCTIONAL DESCRIPTION



2369378 S00061519431_V2

FDRS - DFDAU FUNCTIONAL DESCRIPTION

FDRS - SYSTEM TESTS

General

The Digital Flight Data Acquisition Unit (DFDAU) and Solid-State Flight Data Recorder (SSFDR) do continuous self-tests. These tests are active when an engine is in operation or the airplane is in the air. For flight recorder system faults, the flight recorder light comes on.

You can give power to the flight recorder on the ground with the engines not in operation. To turn on the flight recorder, set the flight recorder/mach airspeed warning test module TEST/NORMAL switch to the TEST position.

DFDAU Faults

If the DFDAU has a fault with the process of data for the flight recorder, these lights come on:

- DFDAU FAULT light on the front of the DFDAU
- Flight recorder OFF light on the flight recorder/mach airspeed warning test module
- Both master caution lights
- OVERHEAD caution annunciator.

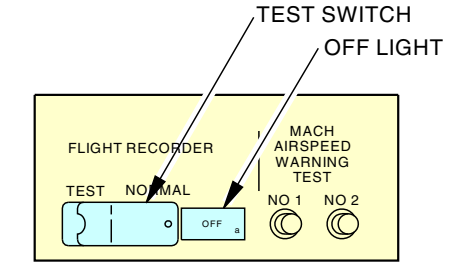
If the DFDAU has a fault with the process of data for the Airplane Condition And Monitoring System (ACMS), the DFDAU CAUTION light comes on.

FDR Faults

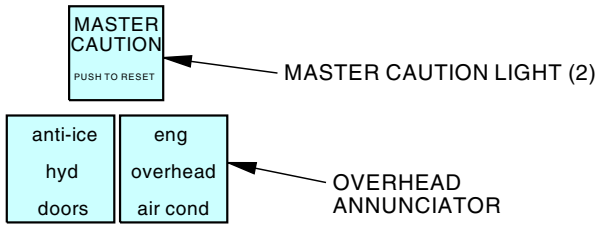
Faults in the SSFDR cause these lights to come on:

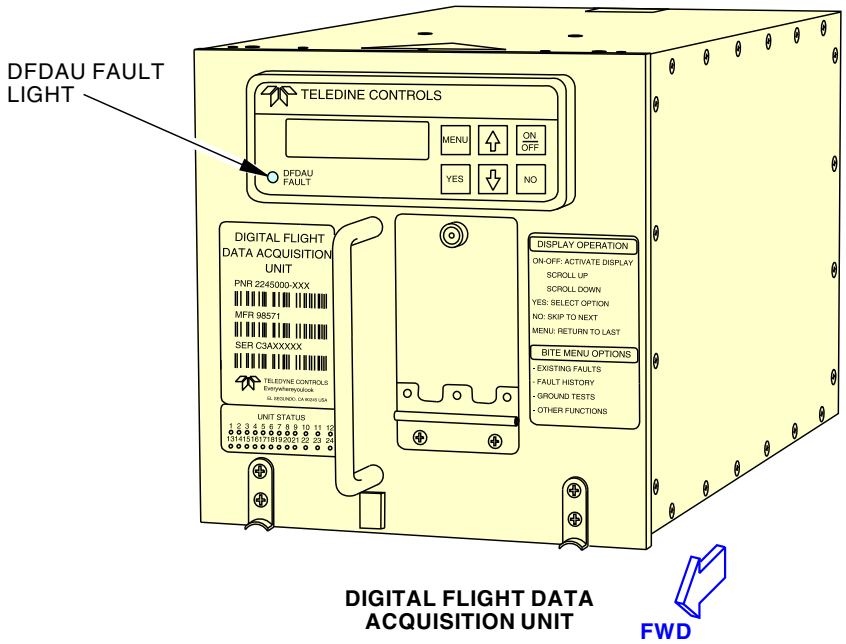
- Flight recorder fail light on the DFDAU.
- Flight recorder OFF light on the flight recorder/mach airspeed warning test module.
- Both master caution lights.
- The OVERHEAD caution annunciator.

FDRS - SYSTEM TESTS



FLIGHT RECORDER/MACH AIRSPEED WARNING TEST MODULE





DIGITAL FLIGHT DATA ACQUISITION UNIT

2369379 S00061519433_V4

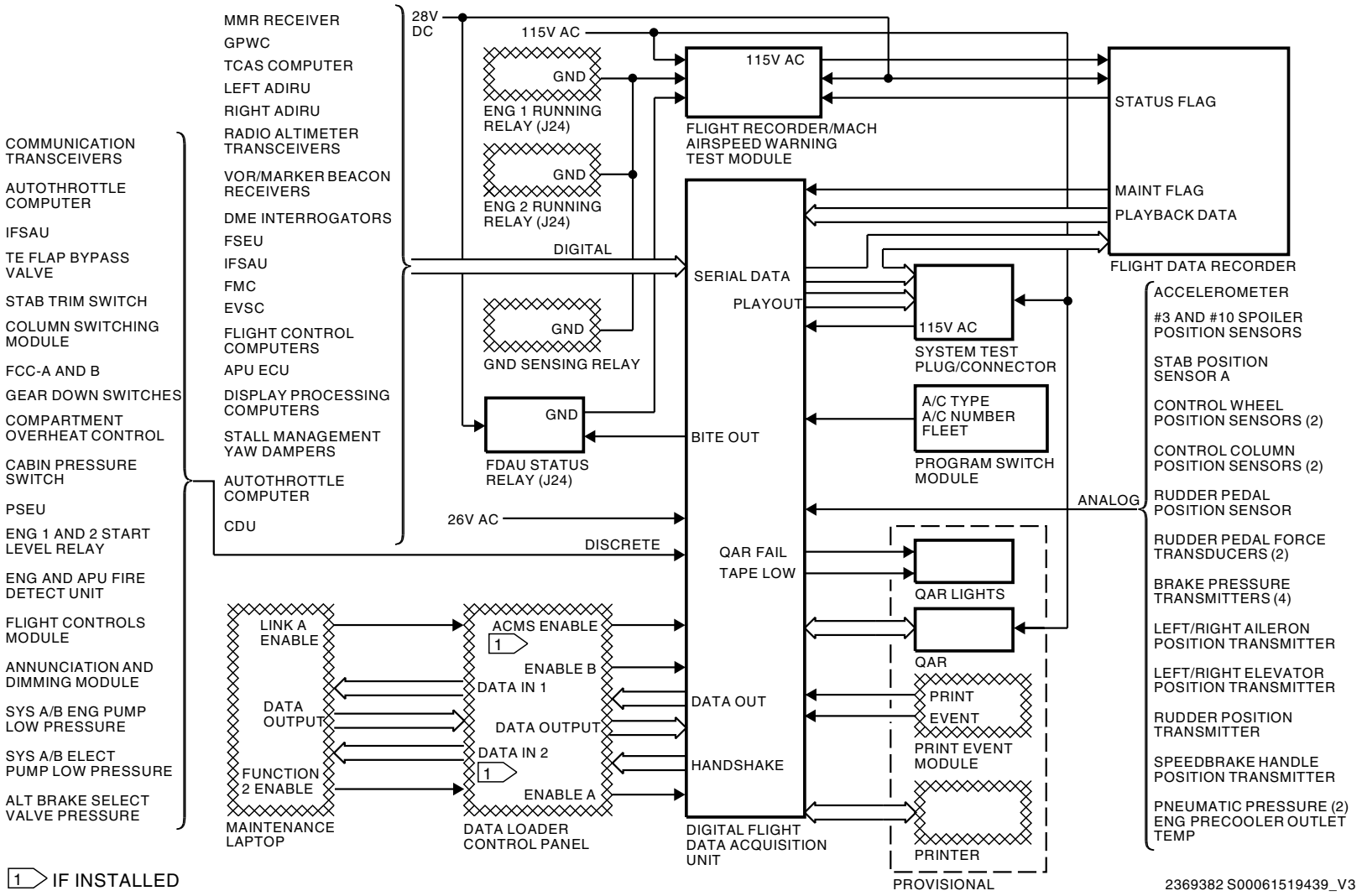
FDRS - SYSTEM TESTS

FDRS - SYSTEM SUMMARY

General

This page is for reference.

FDRS - SYSTEM SUMMARY



FDRS - SYSTEM SUMMARY

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PRINTER SYSTEM - GENERAL DESCRIPTION

General

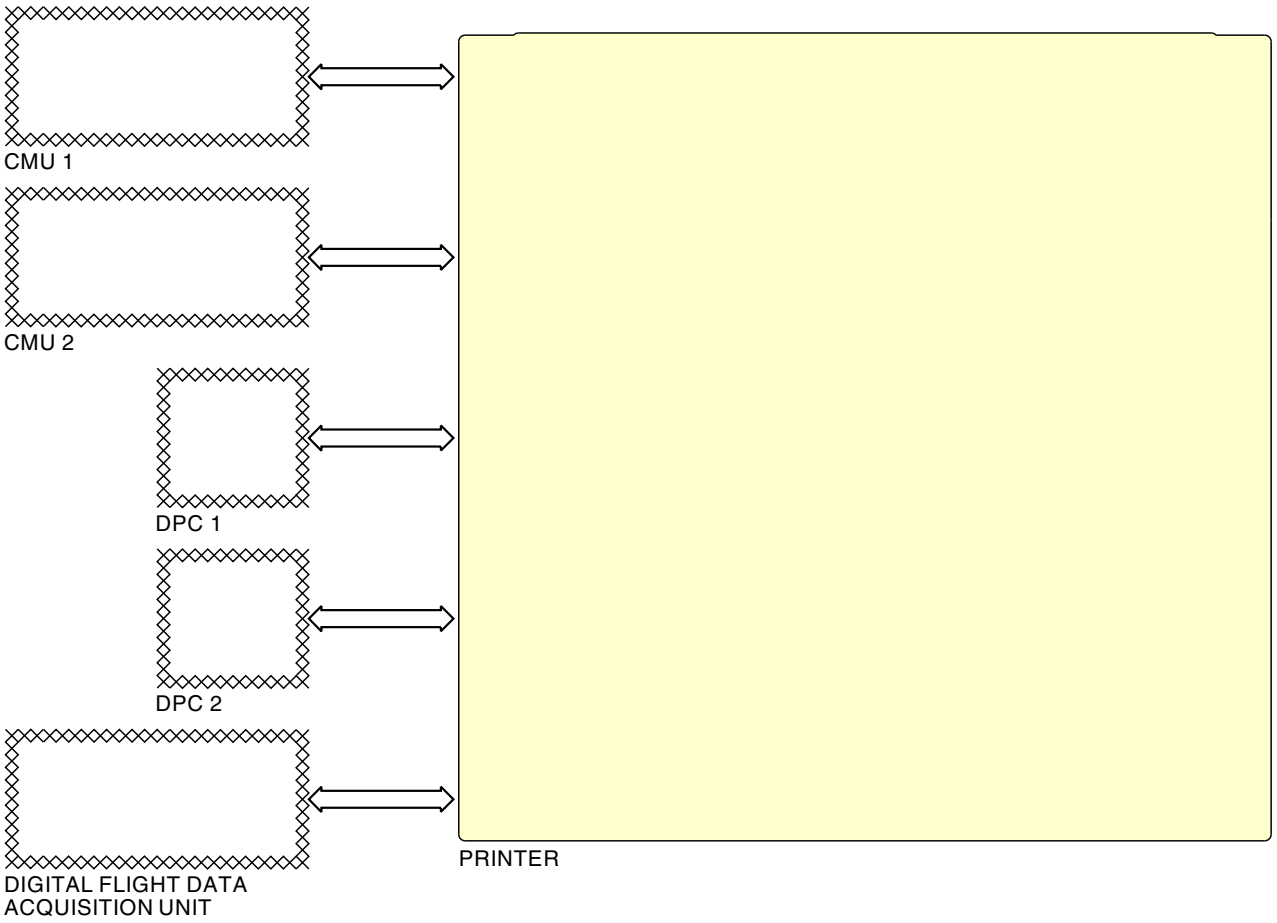
The purpose of the printer system is to give the flight crew and maintenance personnel printed reports when they ask for them. The flight compartment printer receives reports from connected systems.

Input Signals

The printer gets signals and commands from these systems:

- Communication Management Units (CMUs)
- Digital flight data acquisition unit (DFDAU)
- Display processing computers (DPCs).

PRINTER SYSTEM - GENERAL DESCRIPTION



2572020 S0000617058_V3

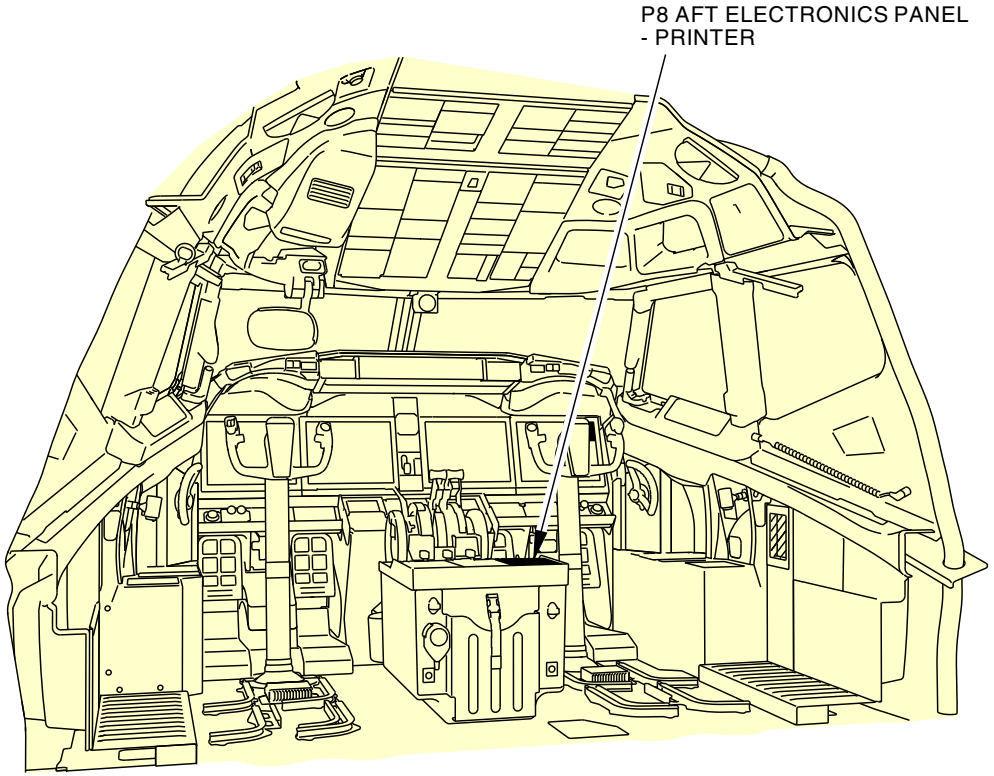
PRINTER SYSTEM - GENERAL DESCRIPTION

PRINTER SYSTEM - COMPONENT LOCATION

Flight Compartment

The printer is on the aft electronics panel P8.

PRINTER SYSTEM - COMPONENT LOCATION



2572021 S0000617068_V1

PRINTER SYSTEM - COMPONENT LOCATION

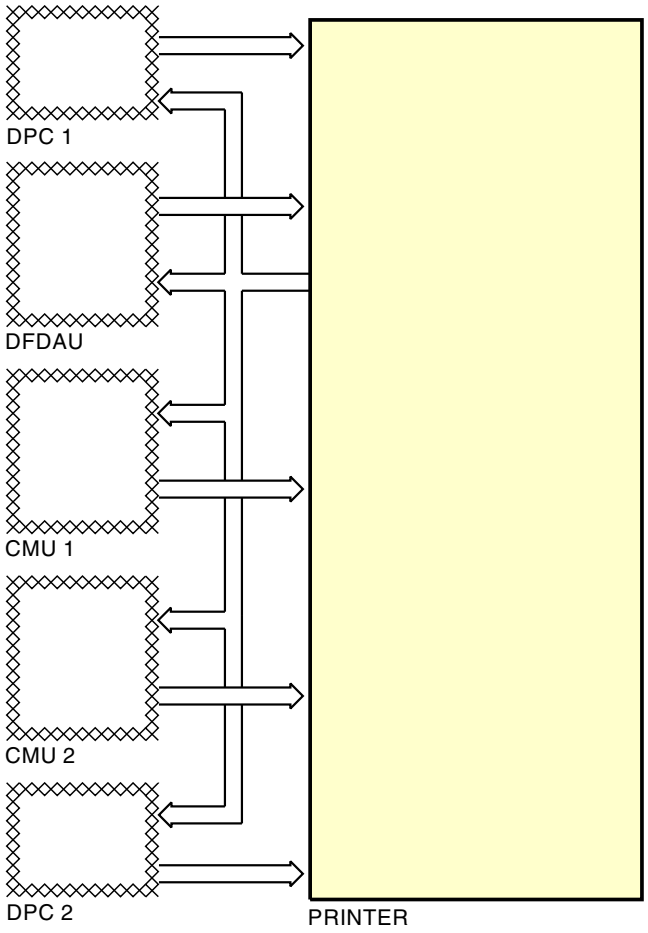
PRINTER SYSTEM - INTERFACES

The printer interfaces with these line replaceable units (LRUs):

- DPC - Display Processing Computer (DPC 1 and DPC 2) sends reports to the printer on an ARINC 429 data bus. The DPC sends the reports when it gets a command.
- Communication Management Unit (CMU 1 and CMU 2) - sends reports to the printer on an ARINC 429 data bus. The CMUs sends the reports automatically or when it gets a command.
- Flight data recorder system - DFDAU sends reports to the printer on an ARINC 429 data bus. The DFDAU sends the reports when it gets a command.

The printer sends status and handshake to the DFDAU, ACARS CMUs, and the DPCs on ARINC 429 data buses.

PRINTER SYSTEM - INTERFACES



2572022 S0000617075_V3

PRINTER SYSTEM - INTERFACES

PRINTER SYSTEM - PRINTER

Purpose

The printer gives a paper copy of reports.

Features

The printer has 12 ARINC 429 data bus inputs and 1 status/control output ARINC 429 data bus. The printer uses white thermal sensitive paper.

The printer power can be turned on/off from the control panel. The printer can be turned off by the pilots if an overheated paper and smoke condition occurs, or a runaway print report occurs. The on/off switch is a printer enhancement that gives the pilots more control of printer operation.

In normal conditions, the printhead will not overheat. But, in some conditions, the printer will stop printing due to a printhead overheat condition. In this situation, the FAULT and PAPER lights will come on. When the printhead temperature decreases sufficiently, the printer will continue printing without the loss of data.

Controls and Indicators

These are the printer controls:

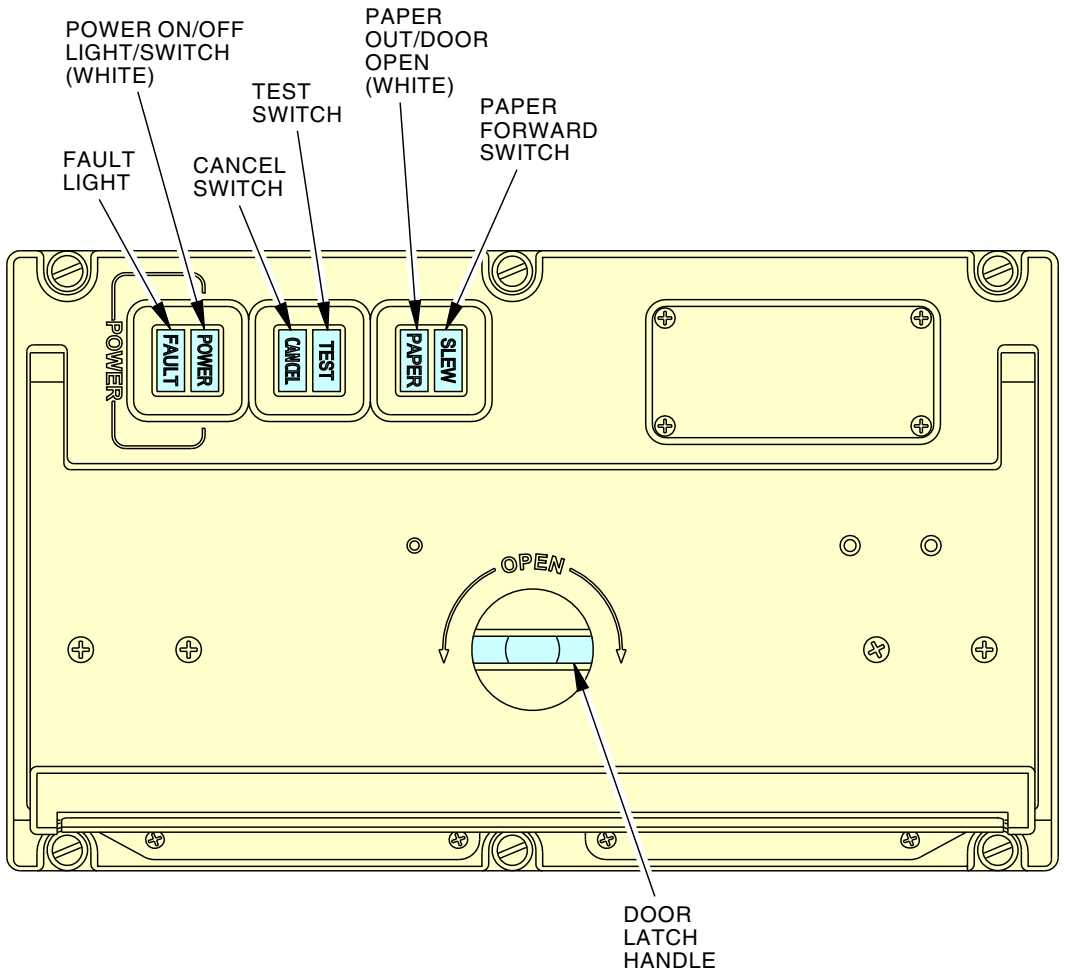
- SLEW switch (white) - moves the paper
- CANCEL switch (white) - cancels the current job and returns to the ready state
- TEST switch (white) - starts the built-in test.

These are the printer indicators:

- POWER light (white) - comes on when power is on
- PAPER light (white) - comes on when the printer finds that the paper is out or the front paper loading door is open.
- FAULT light - comes on if errors are found during the test.

Turn the door latch handle OPEN to open the front panel door. This gives you access to the paper roll.

PRINTER SYSTEM - PRINTER



2581711 S0000622224_V1

PRINTER SYSTEM - PRINTER

PRINTER SYSTEM - TESTS

General

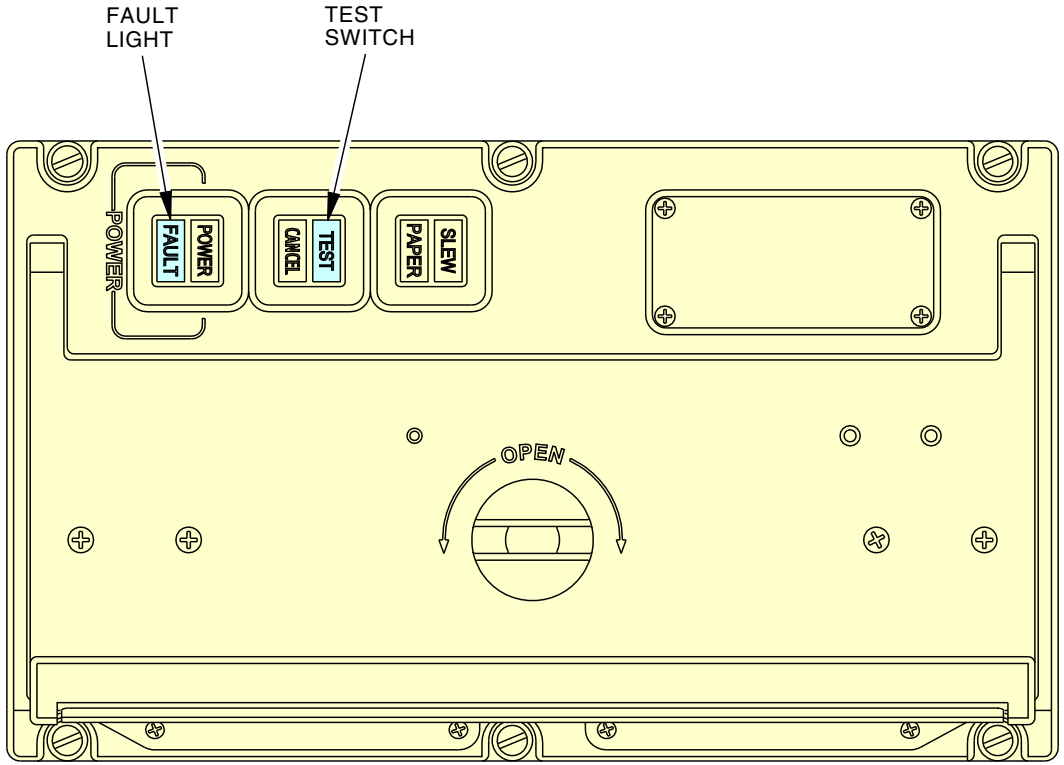
These are the printer tests:

- Self-test
- Printed test that shows all the characters the printer can print.

Printer Tests

Push and hold the TEST button for more than two seconds to do a self-test of the printer and print a test pattern. The white POWER light will turn on and the printer will return to the ready state. If the self-test is not satisfactory, the FAULT light will come on and no printing will occur.

PRINTER SYSTEM - TESTS



2581735 S0000622225_V1

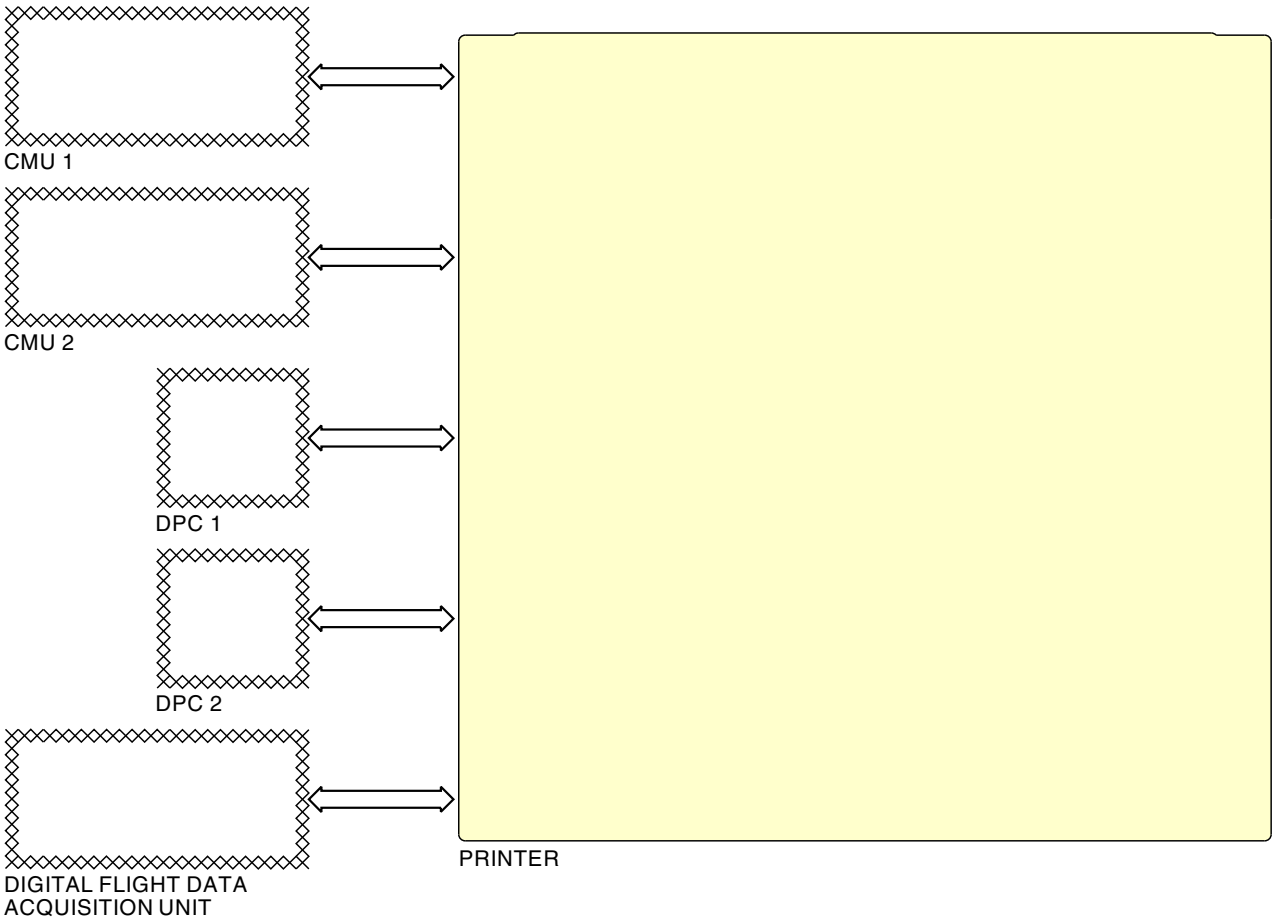
PRINTER SYSTEM - TESTS

PRINTER SYSTEM - SYSTEM SUMMARY

General

This page is for reference.

PRINTER SYSTEM - SYSTEM SUMMARY



2572020 S0000617058_V3

PRINTER SYSTEM - SYSTEM SUMMARY

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AURAL WARNING SYSTEM - INTRODUCTION

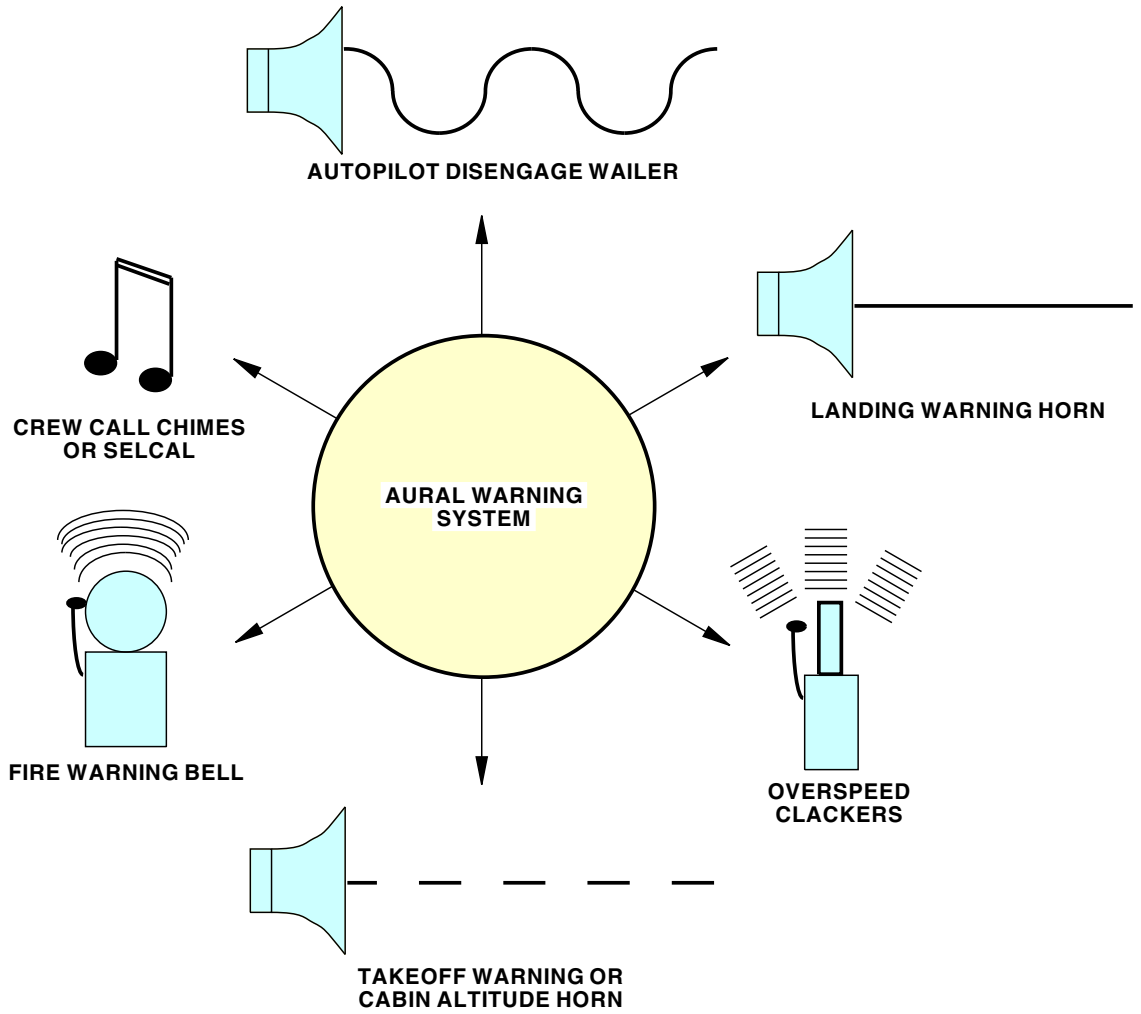
General

The flight compartment aural warning system supplies audio signals to alert the flight crew of incorrect airplane system conditions.

Abbreviations and Acronyms

- ADIRU - Air Data Inertial Reference Unit
- APU - Auxiliary Power Unit
- BITE - Built-In Test Equipment
- DB - decibel
- DC - Direct Current
- DFCS - Digital Flight Control System
- F/O - First Officer
- MCP - Mode Control Panel
- SELCAL - Selective Calling System

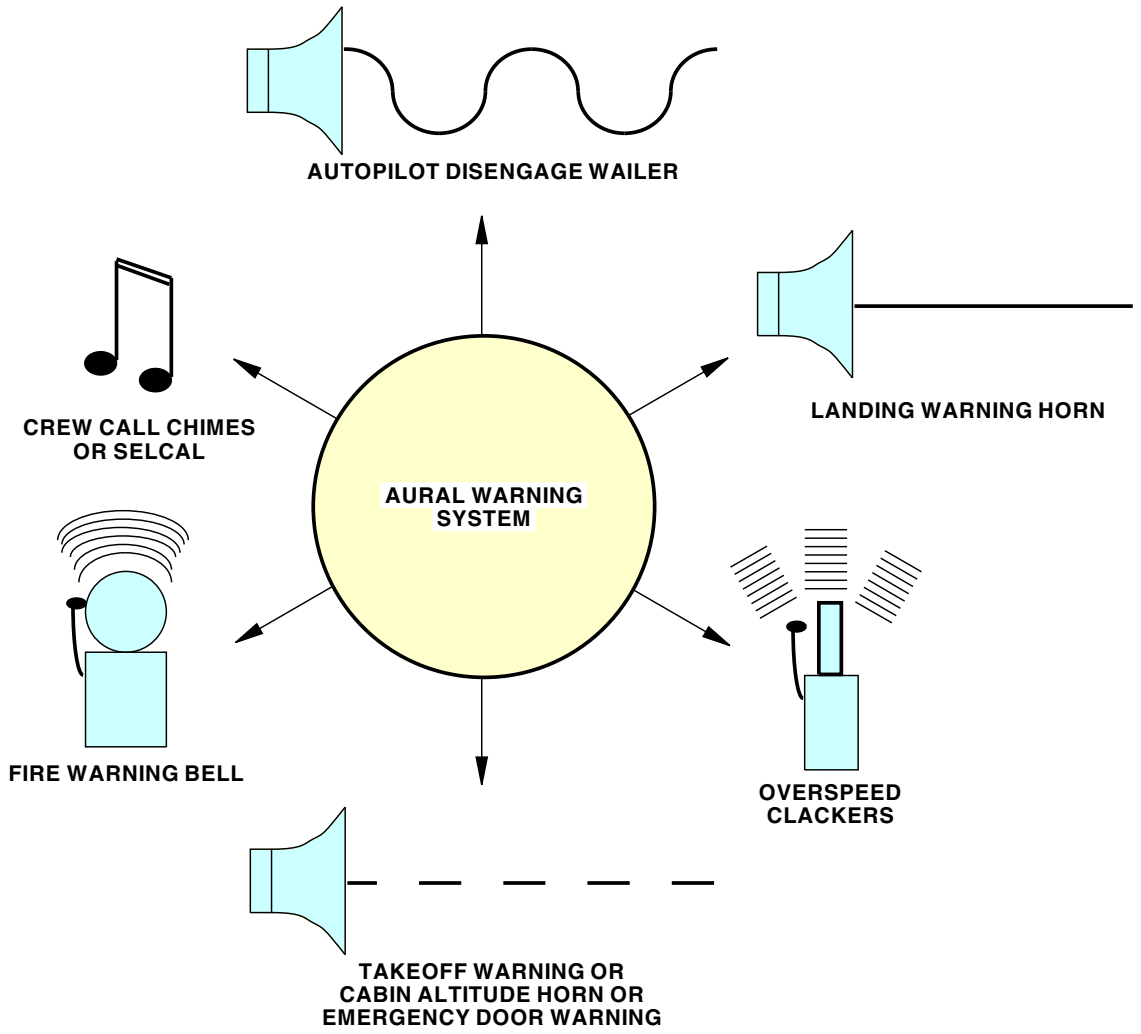
AURAL WARNING SYSTEM - INTRODUCTION



2369383 S00061519443_V2

AURAL WARNING SYSTEM - INTRODUCTION

AURAL WARNING SYSTEM - INTRODUCTION



2942056 S0000718502_V1

AURAL WARNING SYSTEM - INTRODUCTION

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AURAL WARNING SYSTEM - GENERAL DESCRIPTION

General

The aural warning module is the only component in the aural warning system. System monitor circuits detect incorrect system conditions and flight crew alerts. The monitor circuits supply discrete signals to the aural warning module.

These are the discrete inputs to the aural warning system:

- Unsafe landing warning
- Unsafe takeoff warning
- Cabin pressure warning

SIA 007-999; SIA 001-006 POST SB 737-32-1555

- Emergency door open warning

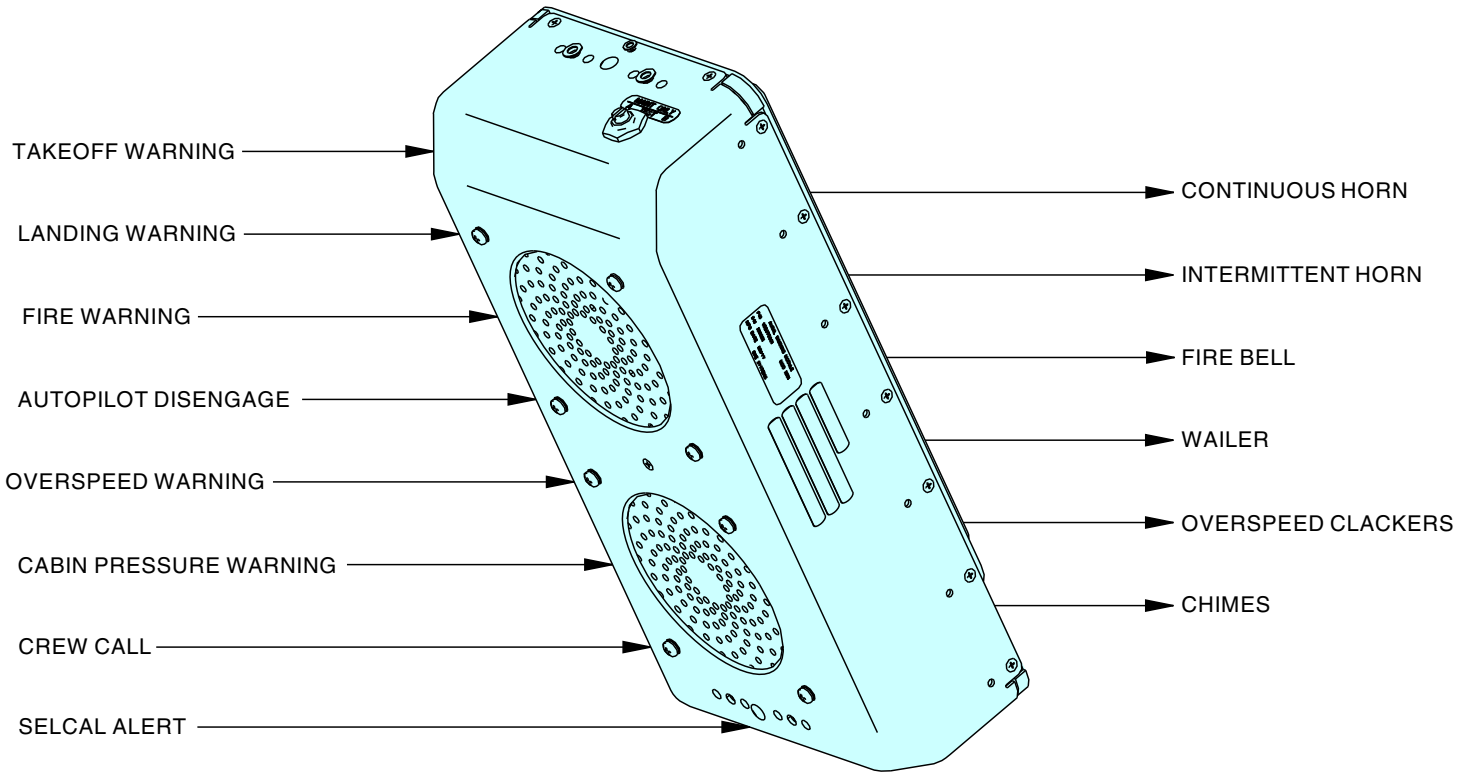
SIA ALL

- Autopilot disengage
- Overspeed warning
- Fire warning
- SELCAL alert
- Crew call.

The aural warning module gives these sounds in the flight compartment:

- Fire bells
- Chimes
- Overspeed clackers
- Wailer
- Continuous horn
- Intermittent horn.

AURAL WARNING SYSTEM - GENERAL DESCRIPTION

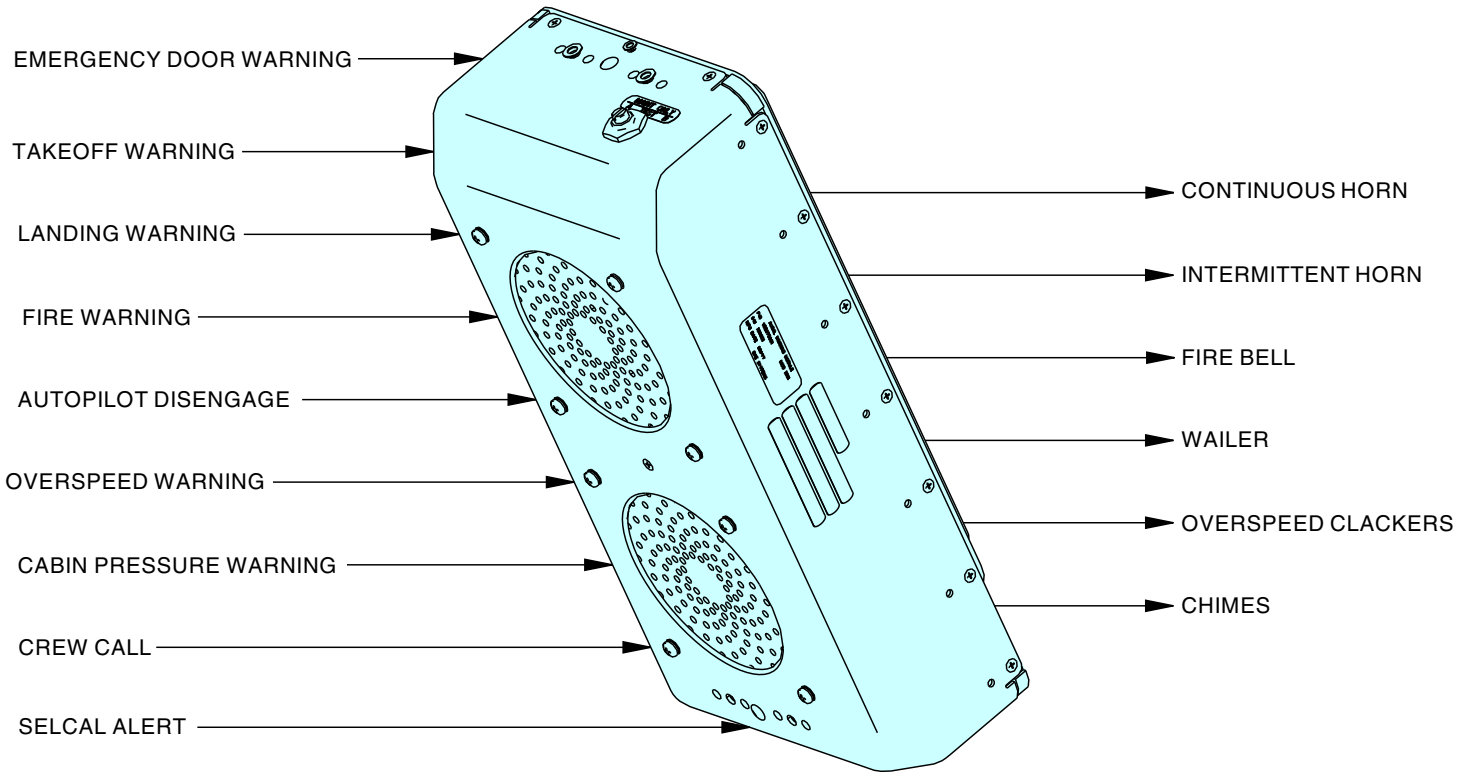


AURAL WARNING MODULE

2369384 S00061519445_V2

AURAL WARNING SYSTEM - GENERAL DESCRIPTION

AURAL WARNING SYSTEM - GENERAL DESCRIPTION



AURAL WARNING MODULE

2933914 S0000710254_V1

AURAL WARNING SYSTEM - GENERAL DESCRIPTION

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AURAL WARNING SYSTEM - COMPONENT LOCATION

General

The aural warning module is in the flight compartment. It is on the aft right face of the P9 forward electronic panel.

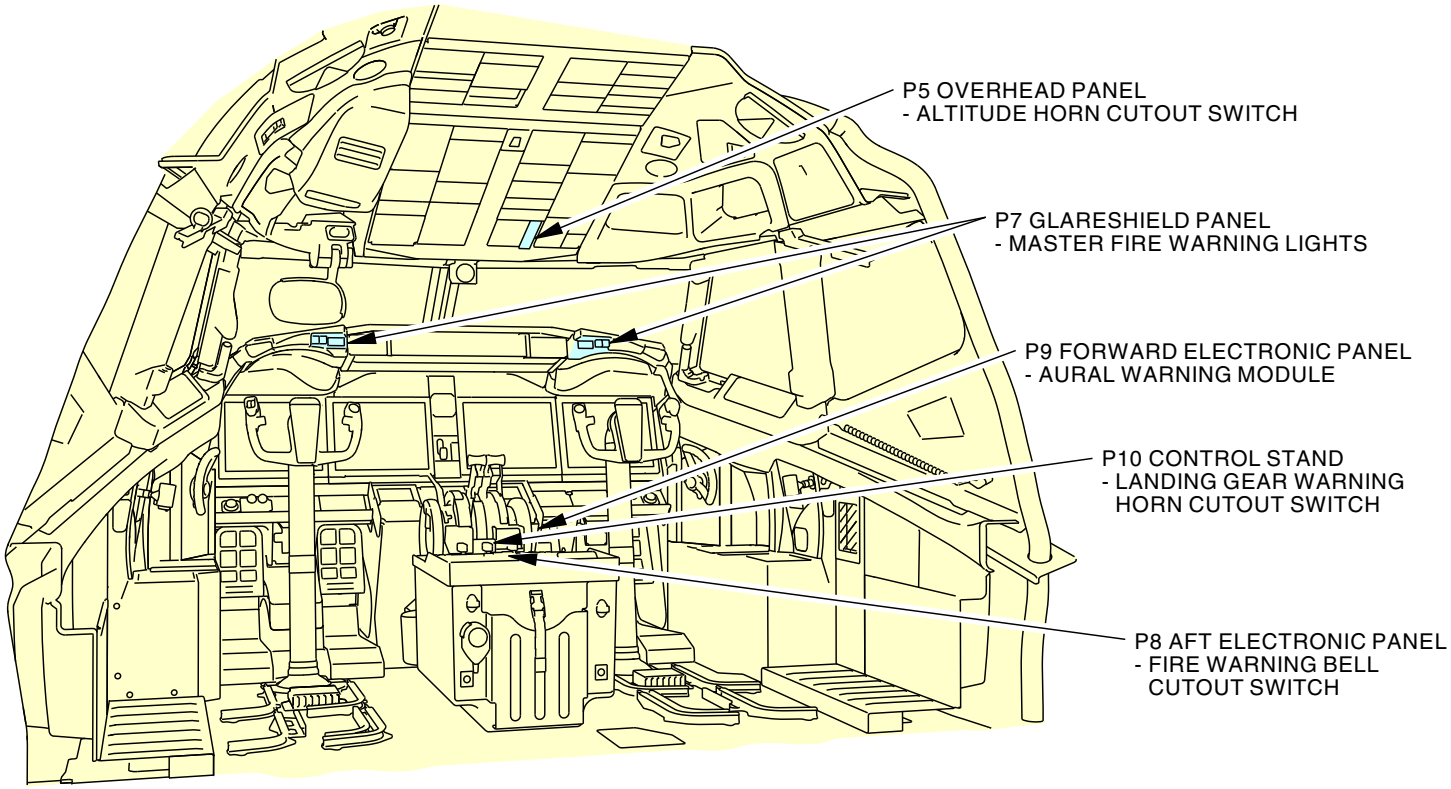
The altitude horn cutout switch is on the P5 forward overhead panel.

The master fire warning lights are on the P7 glareshield panel.

The landing gear warning horn cutout switch is on the P10 control stand.

The fire warning bell cutout switch is on the P8 aft electronic panel.

AURAL WARNING SYSTEM - COMPONENT LOCATION



FLIGHT COMPARTMENT

2369385 S00061519447_V2

AURAL WARNING SYSTEM - COMPONENT LOCATION

AURAL WARNING SYSTEM - INTERFACES

Power

The aural warning module receives 28V DC from four circuit breakers. Each circuit breaker supplies power for different audio sounds.

Continuous Horn Inputs

To make the continuous horn sound, the aural warning module receives a discrete input from the proximity switch electronics unit (PSEU) for a landing warning.

Intermittent Horn Inputs

To make the intermittent horns sound, the aural warning module receives discrete inputs from these units:

- Proximity switch electronics unit (PSEU) for a takeoff warning

SIA 007-999; SIA 001-006 POST SB 737-32-1555

- PSEU for a emergency door open warning

SIA ALL

- Cabin altitude panel for a cabin altitude warning.

Bell Inputs

To make the bell sound, the aural warning module receives discrete inputs from these units:

- Engine and APU fire detection module for an engine or APU fire
- Cargo smoke detection and fire suppression panel for smoke detection in the forward or aft cargo compartment
- Compartment overheat detection controller for a wheel well fire.

Wailer Inputs

To make the wailer sound, the aural warning module receives discrete inputs from the digital flight control system (DFCS) mode control panel (MCP) for the autopilot disconnect warning.

Clacker Inputs

To make the clacker sound, the aural warning module receives discrete inputs from the left or right air data inertial reference unit (ADIRU) for an overspeed warning.

HI Chime Inputs

To make the HI chime sound, the aural warning module receives discrete inputs from these units:

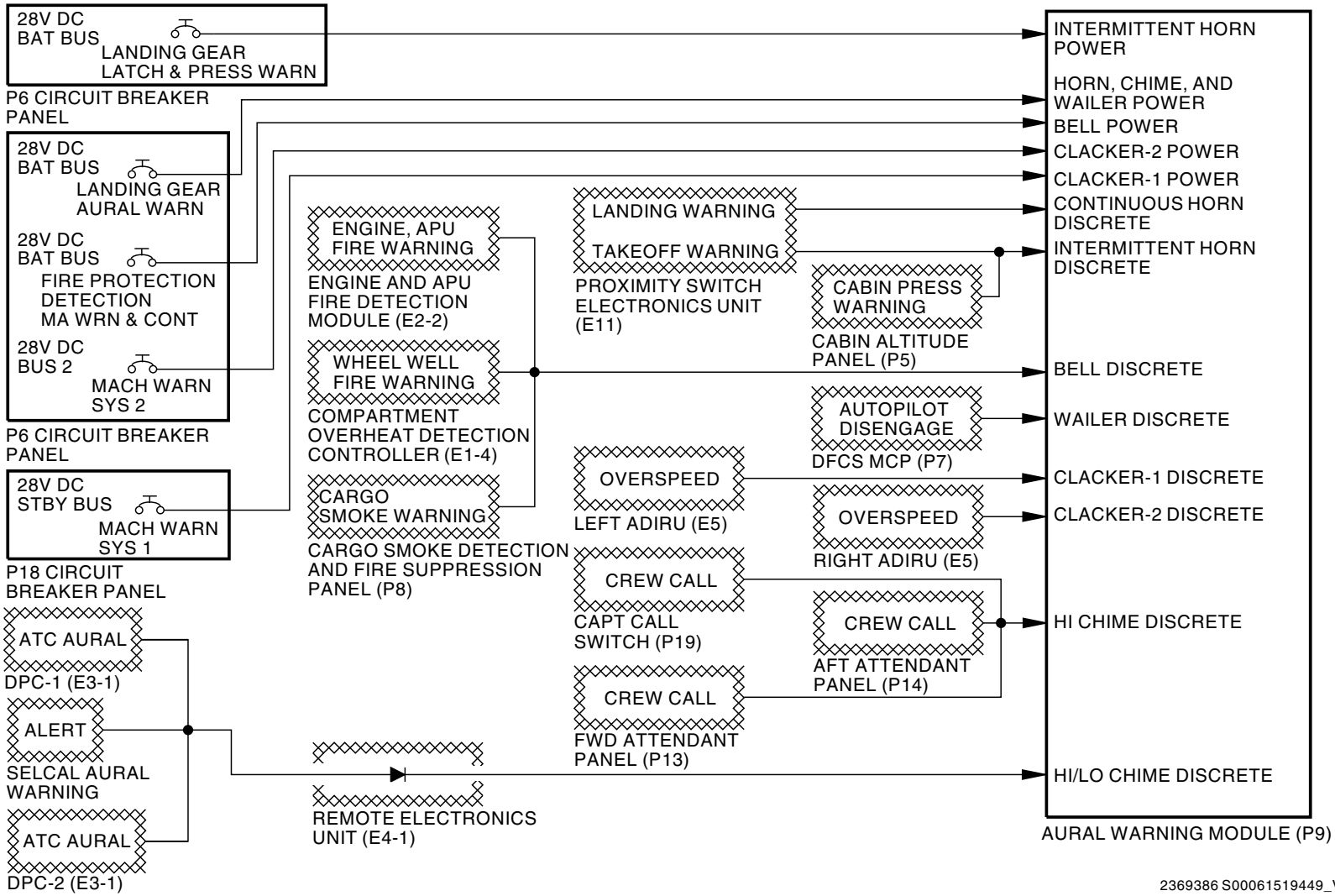
- Captain call switch for a call from ground personnel at the external power panel
- Forward and aft attendant panels for a call from someone at the attendant stations.

HI/LO Chime Inputs

To make the HI/LO chime sound, the aural warning module receives a discrete input from the remote electronics unit.

The remote electronics unit receives a signal from the SELCAL aural warning relay when the SELCAL decoder receives a SELCAL call from the ground station.

AURAL WARNING SYSTEM - INTERFACES



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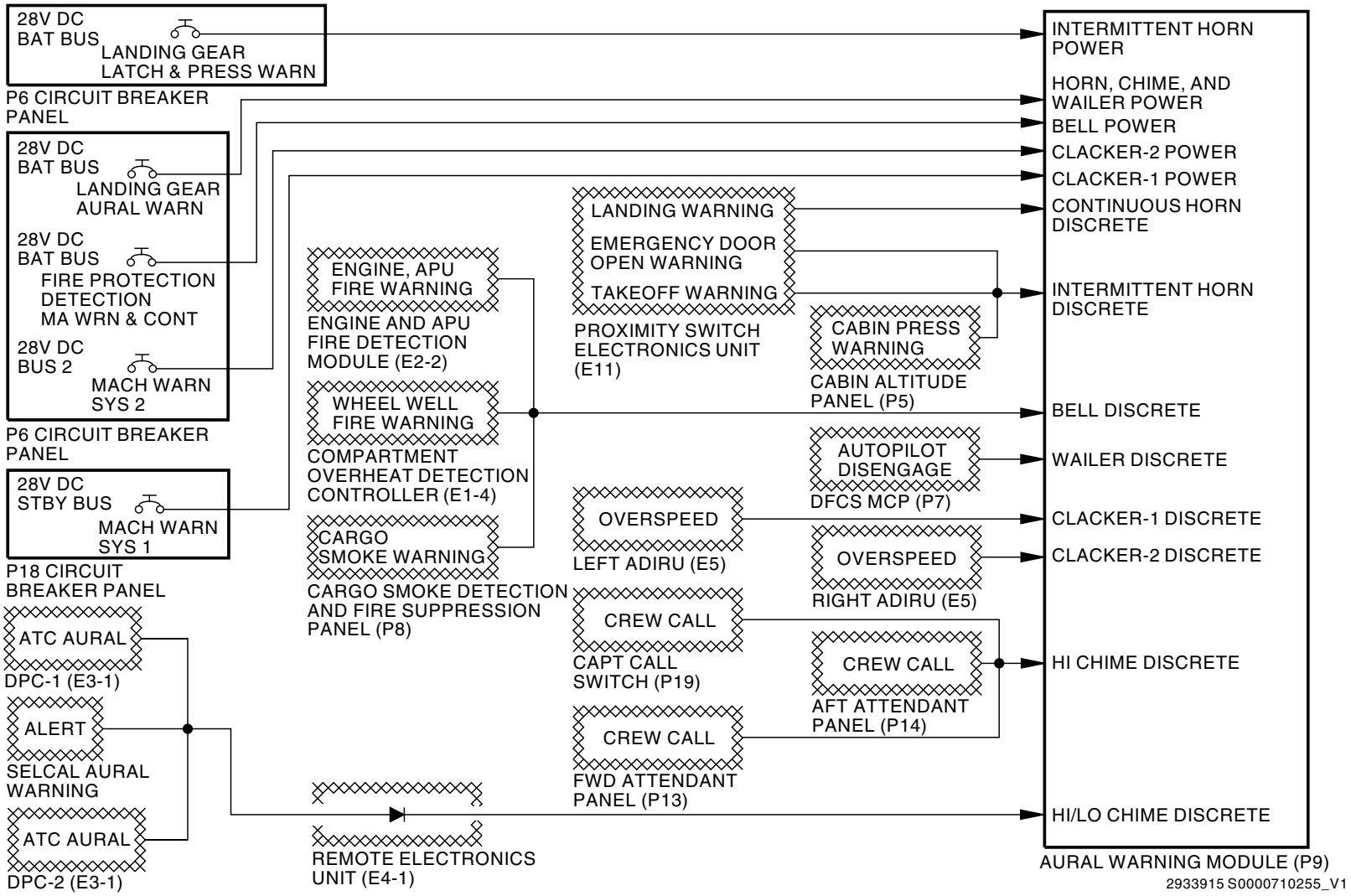
AURAL WARNING SYSTEM - INTERFACES

AURAL WARNING SYSTEM - INTERFACES



AURAL WARNING SYSTEM - INTERFACES

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AURAL WARNING SYSTEM - AURAL WARNING MODULE

Purpose

The aural warning module receives discrete inputs from various systems. The aural warning module uses these inputs to make aural alert sounds for the flight crew.

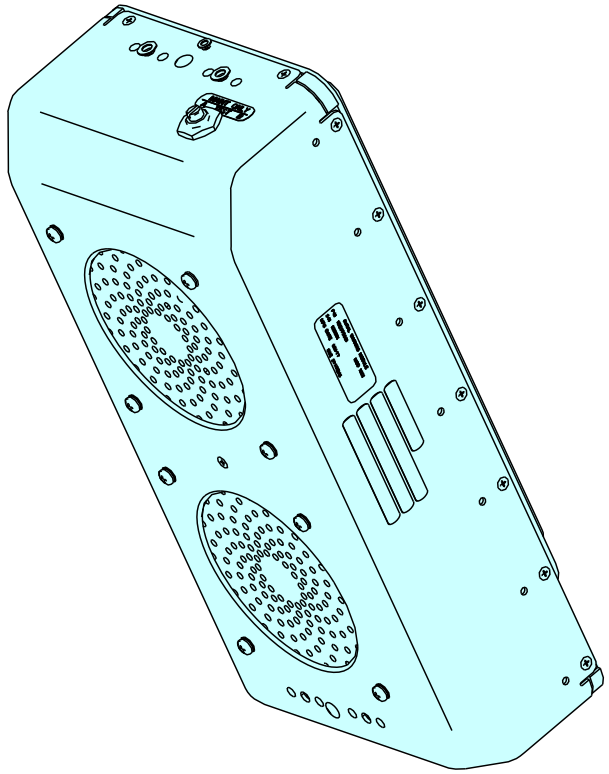
Aural Warning Module Channels

The aural warning module has two channels. Each channel is the same. The two channels are connected in parallel. If one channel fails, the audio output of the aural warning module will decrease by 6db.

Test Switch

A test switch is on the top of the aural warning module. The test switch checks operation of both channels of the aural warning module.

AURAL WARNING SYSTEM - AURAL WARNING MODULE



AURAL WARNING MODULE

2369387 S00061519451_V2

AURAL WARNING SYSTEM - AURAL WARNING MODULE

AURAL WARNING SYSTEM - FUNCTIONAL DESCRIPTION

General

The aural warning module has two parallel channels, channel A and channel B. Both channels receive inputs from the airplane systems. Both channels operate at the same time.

If one channel fails, the flight crew will hear a 6db decrease in volume from the aural warning module.

Each channel has these components:

- Power supply
- Discrete ground input circuit
- Discrete power input circuit
- Controller circuit
- Two aural synthesizers
- Analog amplifier
- Speaker.

There is a Built-In Test Equipment (BITE) switch on the aural warning module. Each channel receives a signal from the BITE switch.

Input Circuit

Each channel has two input circuits. One circuit receives discrete ground inputs, the other receives power (28V DC) discrete inputs.

Discrete inputs from the crew call system and the SELCAL system are power discretes. All other inputs are discrete grounds.

Controller

The controller receives signals from both input circuits and causes the aural synthesizers to make sounds. It controls the sequence of some sounds made by the synthesizer. This is the sequence of the sounds from most important to least important:

- Intermittent horn
- Steady horn
- Wailer
- Chime.

The bell, clacker, and one of the above sequenced sounds do not have a sequence. The controller permits not more than these three sounds at the same time.

Aural Synthesizer

The aural synthesizers make all the sounds that the pilots hear from the aural warning module. One aural synthesizer makes the bell and clacker sounds. The other aural synthesizer makes the horn, wailer, and chime sounds. The synthesizers can make more than one sound at a time.

Analog Amplifier

The analog amplifier adds the signals from both synthesizers. The amplifier also increases the signal strength from the aural synthesizers and sends it to the speaker.

Speaker

The speakers provide the sound. Channel A drives the top speaker. Channel B drives the bottom speaker. When there is an aural warning, both speakers provide sound at the same time.

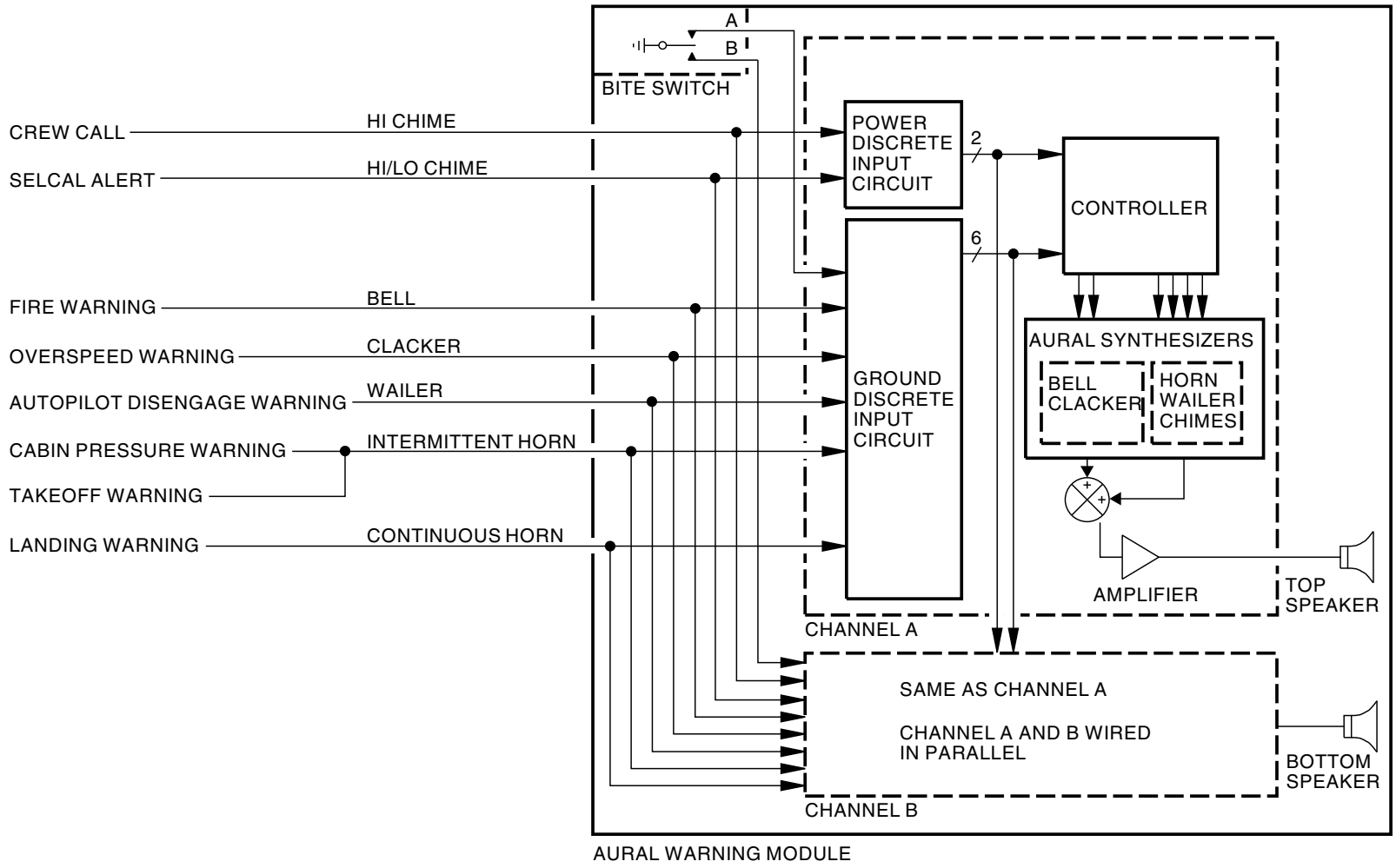
BITE Switch

The BITE switch lets the operator do a test of each channel of the aural warning module.

When you move the switch to the A position, channel A causes the aural synthesizer to make the intermittent horn sound. When you release the switch, channel A causes the aural synthesizer to make the clacker sound. The sound comes out of the top speaker.

When you put the switch to the B position and release it, channel B makes the horn and clacker sounds. The sound comes out of the bottom speaker.

AURAL WARNING SYSTEM - FUNCTIONAL DESCRIPTION



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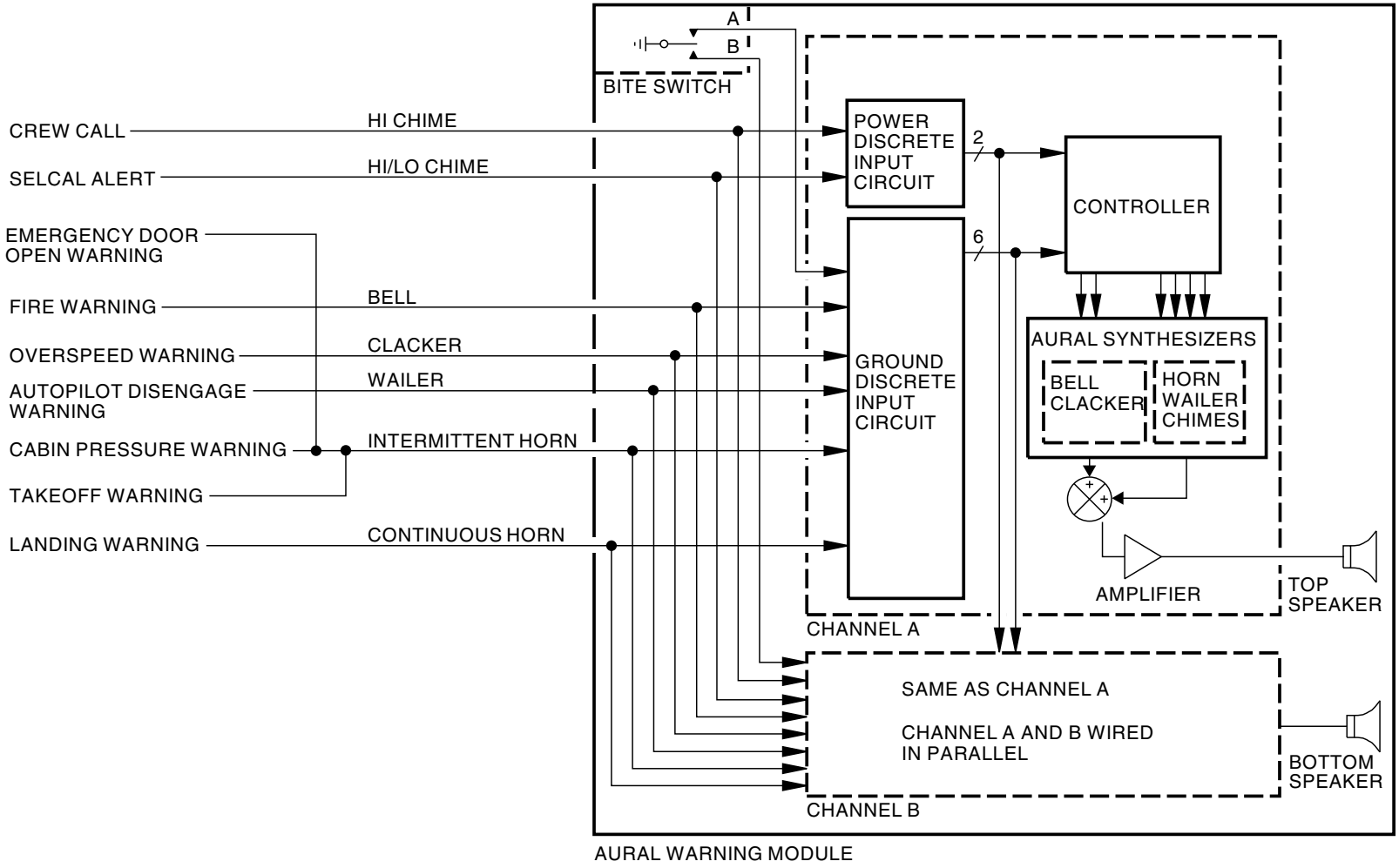
AURAL WARNING SYSTEM - FUNCTIONAL DESCRIPTION

AURAL WARNING SYSTEM - FUNCTIONAL DESCRIPTION



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AURAL WARNING SYSTEM - FUNCTIONAL DESCRIPTION

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AURAL WARNING SYSTEM OPERATION - TAKEOFF

General

The aural warning module gives the sound of an intermittent horn for a takeoff warning.

On the Ground

These are the conditions that cause the takeoff warning on the ground:

- Position of the horizontal stabilizer is out of the green band
- Trailing edge flaps are less than 1 unit or more than 25 units
- Leading edge devices are retracted or there is uncommanded motion
- Trailing edge flaps are asymmetric, skewed, or there is uncommanded motion

SIA 007-999; SIA 001-006 POST SB 737-32-1555

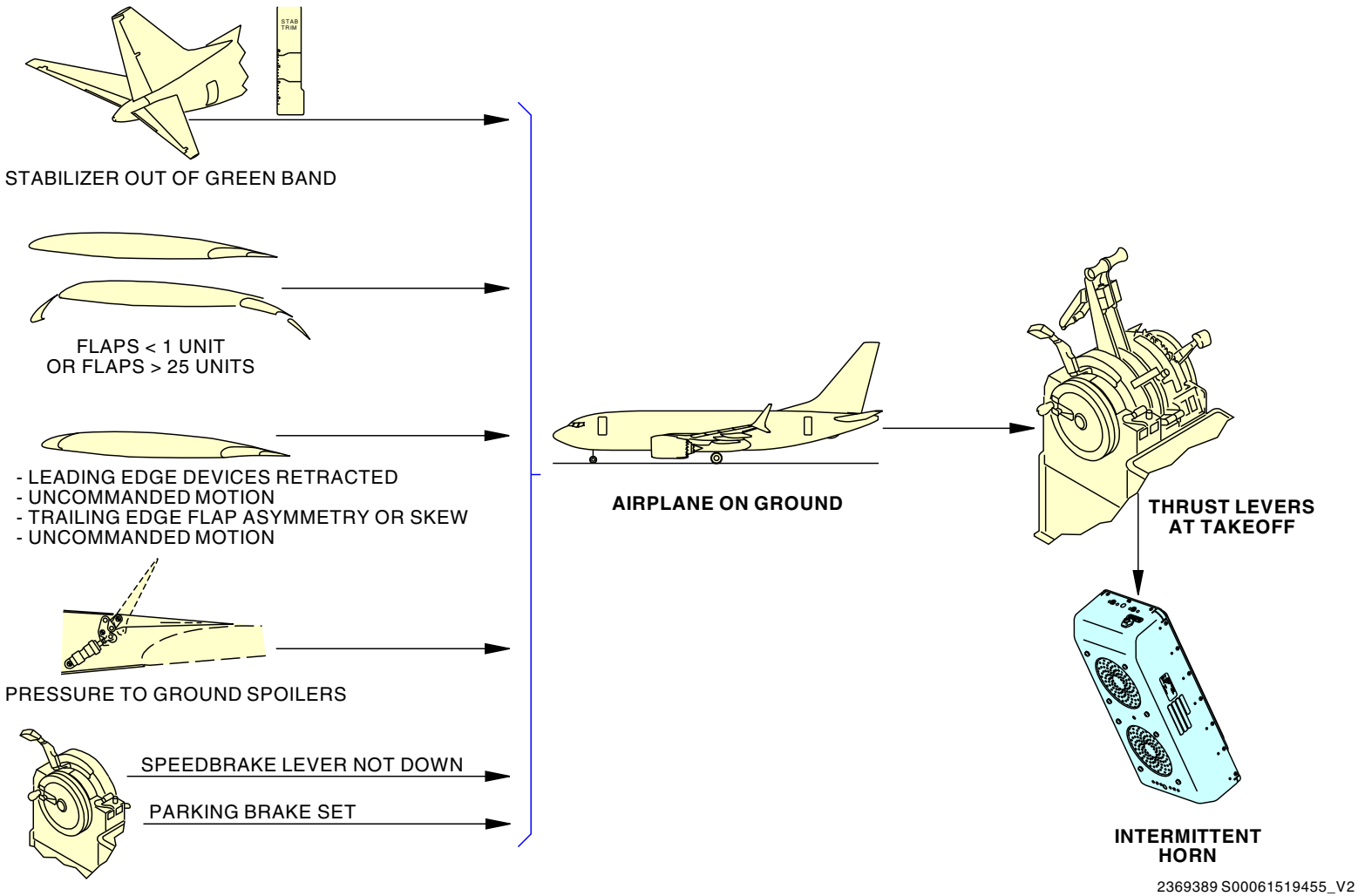
- Emergency door is open and ground speed is less than 40 kts

SIA ALL

- Speedbake lever is not down
- Parking brake is set.

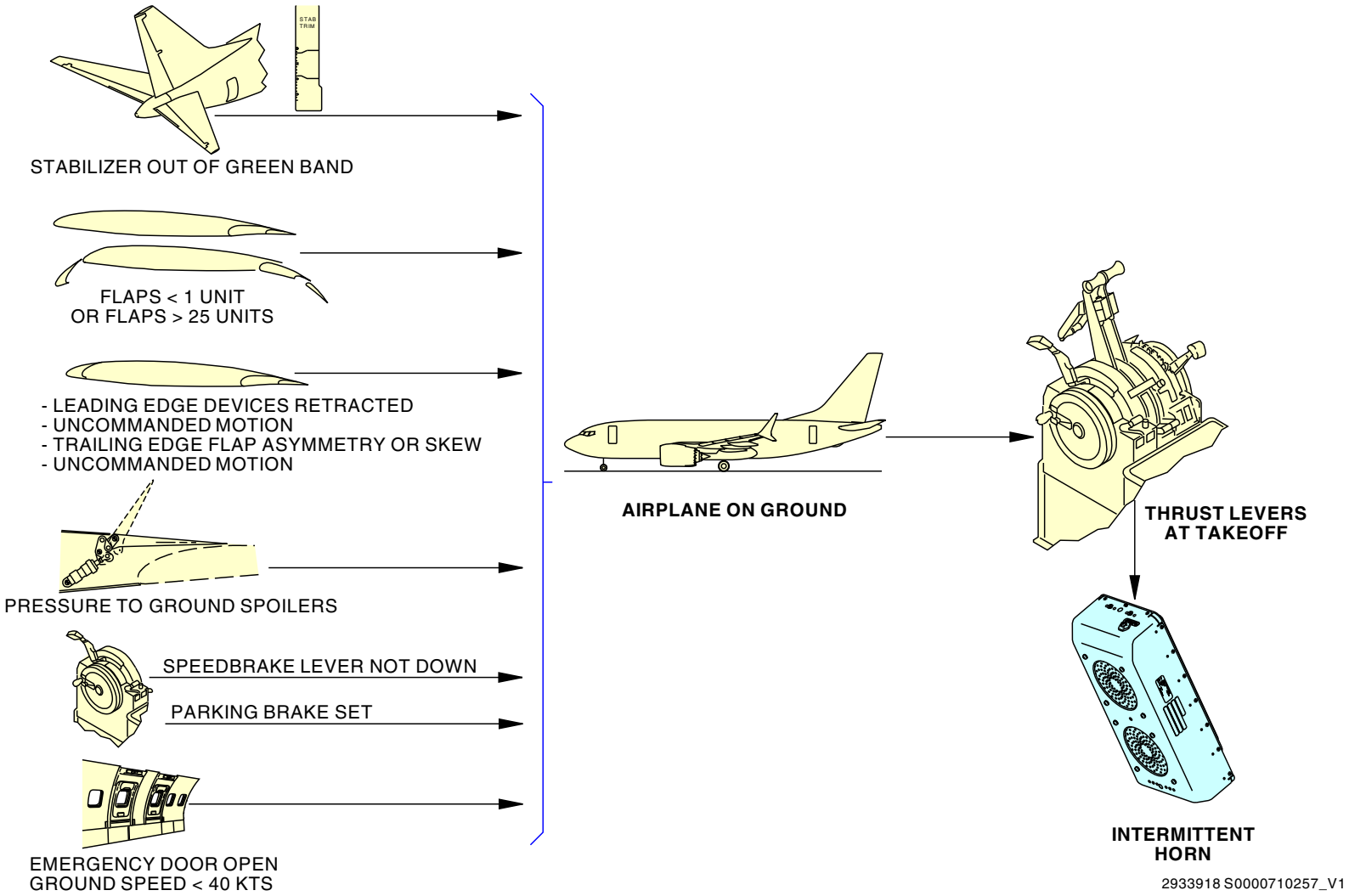
The airplane must be on the ground and you must move the thrust levers towards takeoff power before the aural warning system gives the takeoff warning sound for the conditions above.

AURAL WARNING SYSTEM OPERATION - TAKEOFF



AURAL WARNING SYSTEM OPERATION - TAKEOFF

AURAL WARNING SYSTEM OPERATION - TAKEOFF



AURAL WARNING SYSTEM OPERATION - TAKEOFF

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AURAL WARNING SYSTEM OPERATION - LANDING

General

The aural warning module gives the sound of a continuous horn for a landing warning.

There are four sets of conditions which cause the landing warning.

In the first set of conditions, the horn sounds with these conditions:

- Gear is not down and locked
- Flap position is from 0 to 10 units
- Thrust levers are set for landing
- Radio altitude is between 200 and 800 feet.

For the first set of conditions, push the horn cutout switch near the flap lever to stop the horn.

In the second set of conditions, the horn sounds with these conditions:

- Gear is not down and locked
- Flap position is from 0 to 10 units
- Thrust levers are set for landing
- Radio altitude is less than 200 feet.

For the second set of conditions, the pilot cannot stop the horn.

In the third set of conditions, the horn sounds with these conditions:

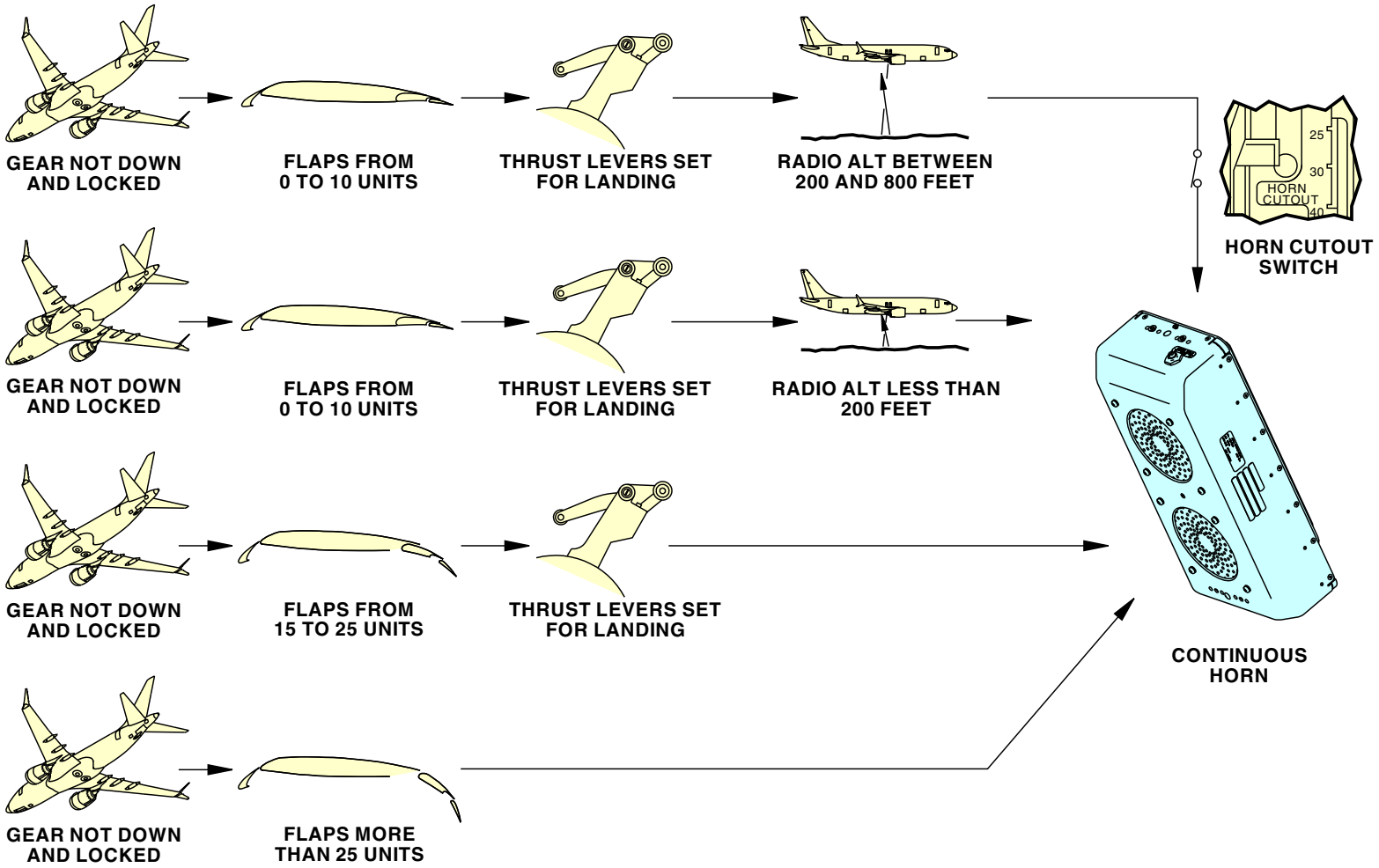
- Gear is not down and locked
- Flap position is from 15 to 25 units
- Thrust levers are set for landing.

For this set of conditions, the pilot cannot stop the horn.

In the fourth set of conditions, the horn sounds when the gear is not down and locked and the flap position is more than 25 units. The pilot cannot stop the horn.

When the airplane is in the fourth set of conditions, the system inhibits the landing warning horn during a go-around. The system inhibits the warning for 12 seconds after the pilot puts the gear lever in the up position.

AURAL WARNING SYSTEM OPERATION - LANDING



2369391 S00061519459_V2

AURAL WARNING SYSTEM - OPERATION - LANDING

AURAL WARNING SYSTEM OPERATION - FIRE

General

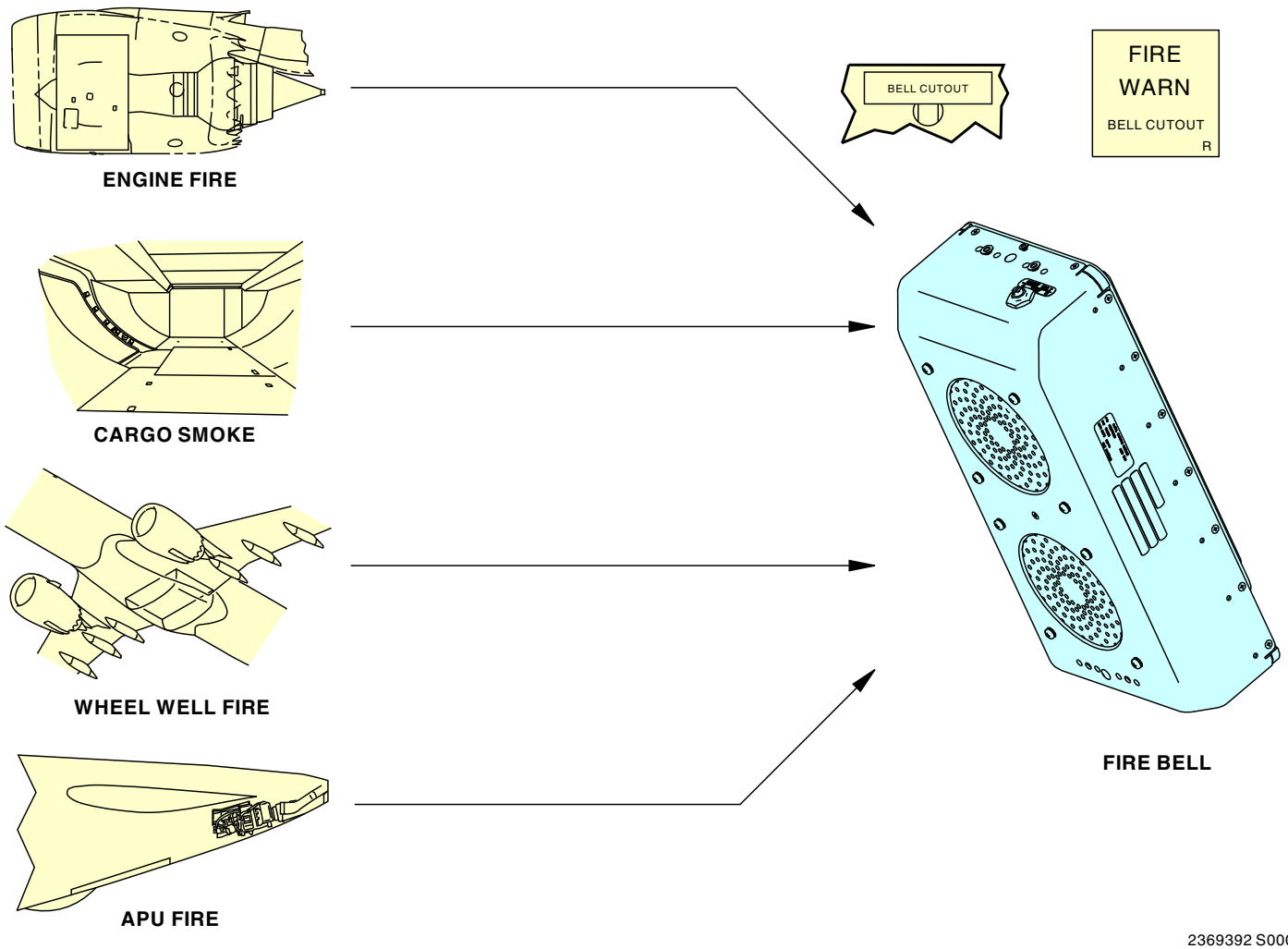
The aural warning module gives the sound of a fire bell for a fire warning.

These are the conditions which cause the fire warning:

- Engine fire
- Cargo smoke
- Wheel well fire
- APU fire.

The fire bell stops when you push the bell cutout switch or the fire warning light.

AURAL WARNING SYSTEM OPERATION - FIRE



2369392 S00061519461_V2

AURAL WARNING SYSTEM OPERATION - FIRE

AURAL WARNING SYSTEM - OPERATION - AUTOPILOT DISCONNECT, OVERSPEED, CABIN PRESSURE

General

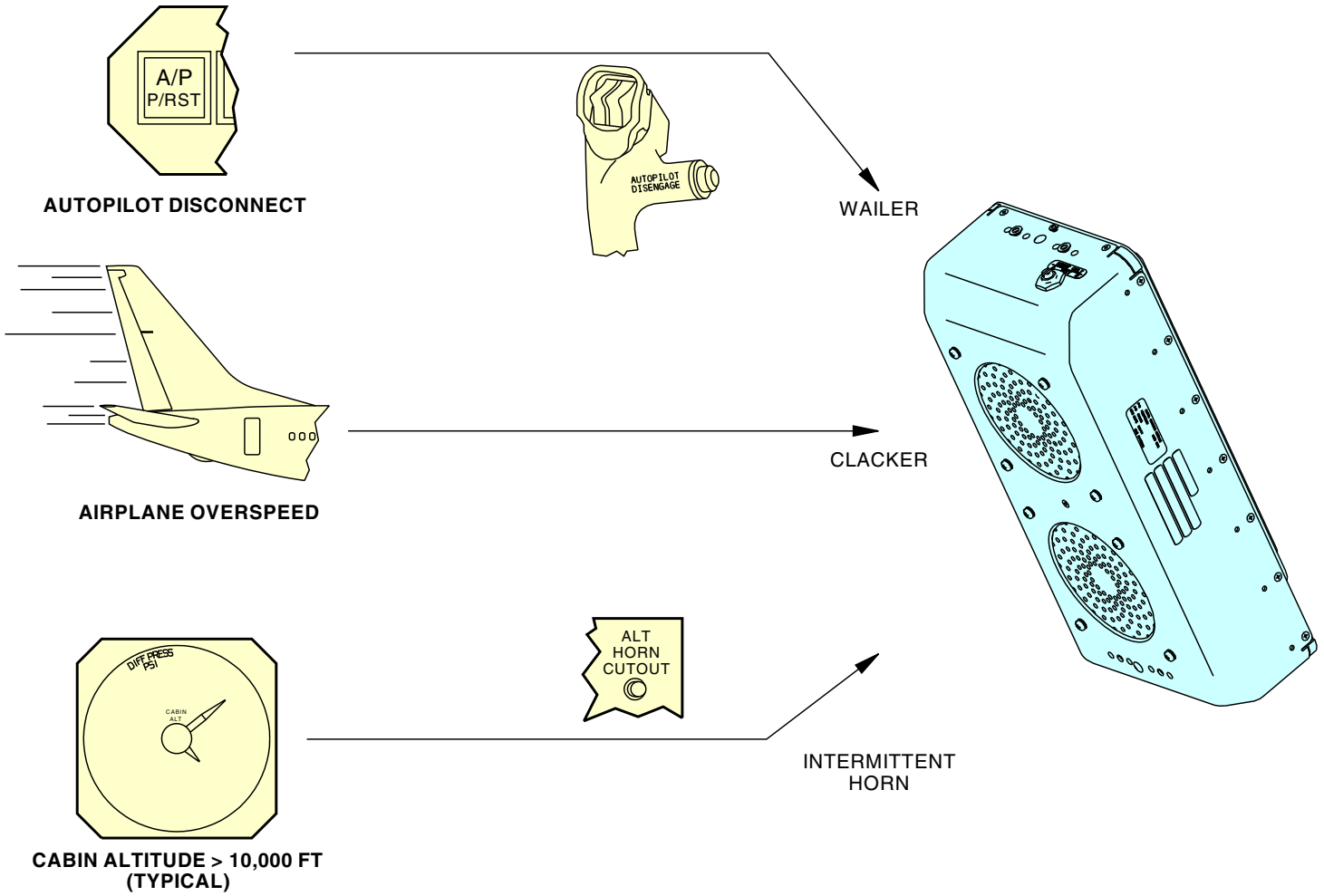
The aural warning module gives the sound of a wailer for an autopilot disconnect warning. Do one of these things to stop the wailer:

- Push the autopilot disconnect switch
- Push the autopilot P/RST switch
- Engage the autopilot again.

The aural warning module gives the sound of a clacker for an airplane overspeed warning.

The aural warning module gives the sound of an intermittent horn for a cabin pressure warning. Push the altitude horn cutout switch on the P5 overhead panel to stop the intermittent horn.

AURAL WARNING SYSTEM - OPERATION - AUTOPILOT DISCONNECT, OVERSPEED, CABIN PRESSURE



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AURAL WARNING SYSTEM - OPERATION - AUTOPILOT DISCONNECT, OVERSPEED, CABIN PRESSURE

AURAL WARNING SYSTEM OPERATION - FLIGHT COMPARTMENT CALL

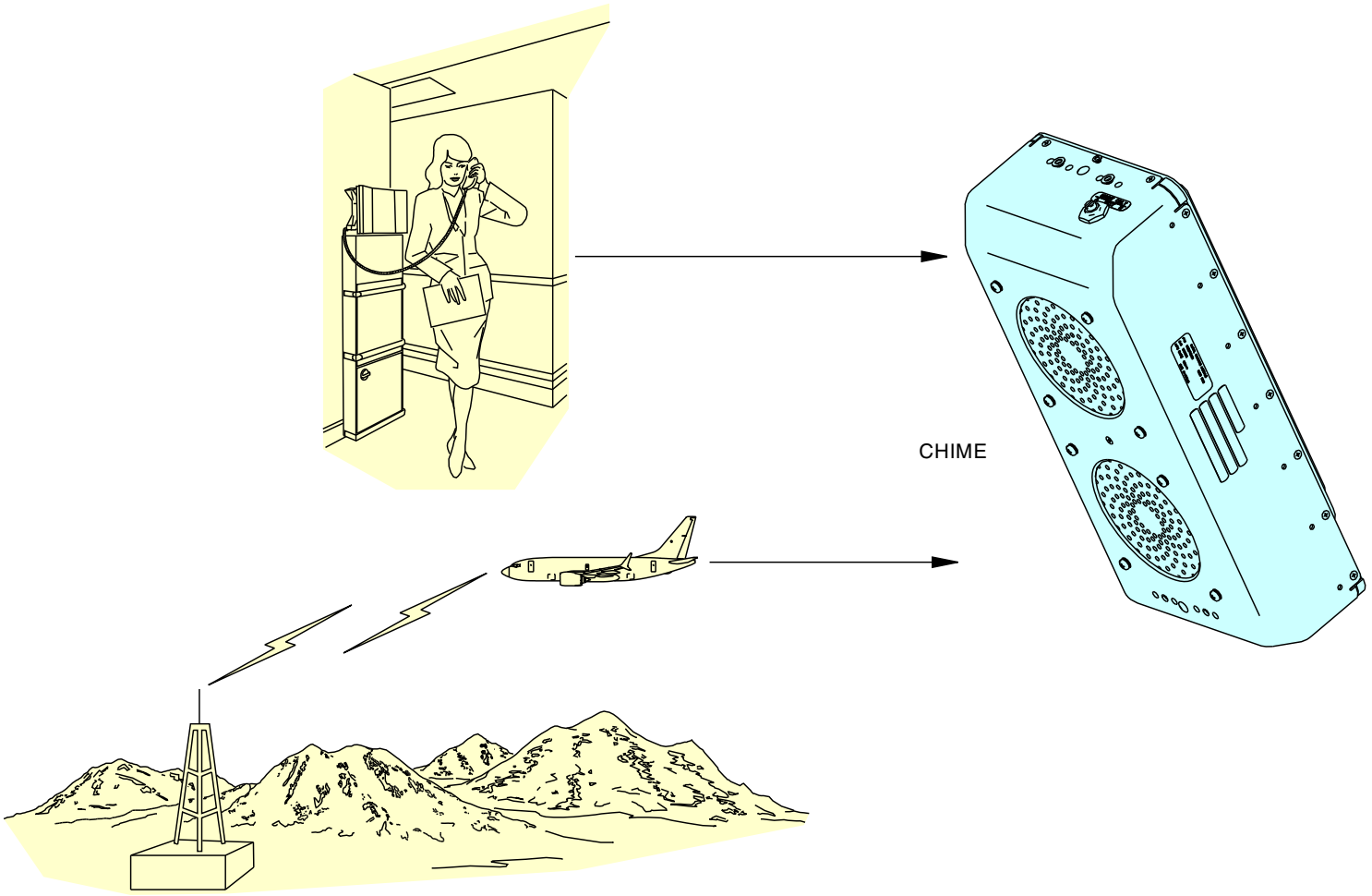
General

The aural warning unit gives the sound of a single high chime for a flight crew call.

When the flight attendant calls the flight crew, there is a single high chime.

When the ground station uses SELCAL to call the flight crew, there is a single high/low chime.

AURAL WARNING SYSTEM OPERATION - FLIGHT COMPARTMENT CALL



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AURAL WARNING SYSTEM OPERATION - FLIGHT COMPARTMENT CALL

AURAL WARNING SYSTEM - TEST

General

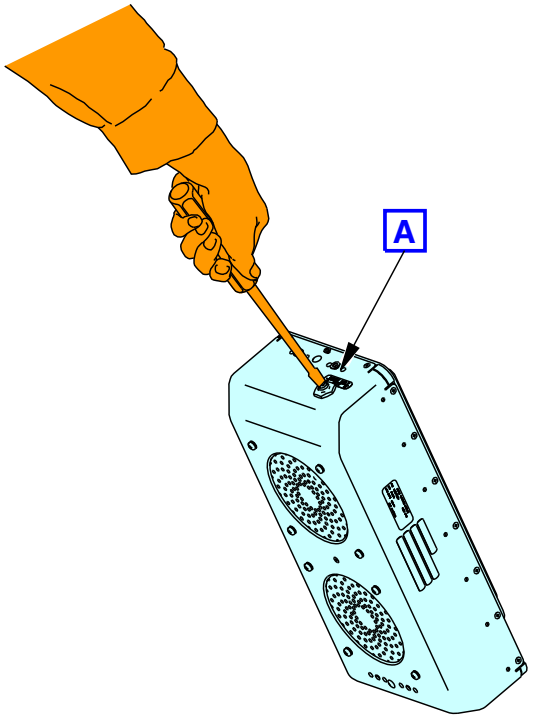
The aural warning system test checks the aural warning module for correct operation. You hear the intermittent horn and the clacker sounds for a good test.

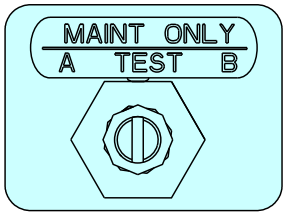
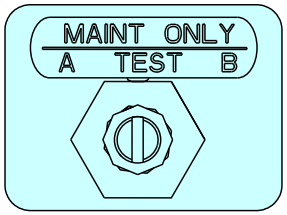
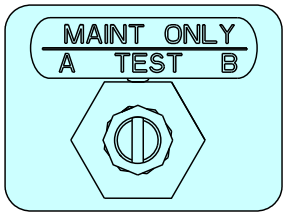
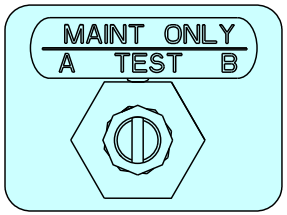
A test switch is on the top of the aural warning module. The test switch is spring loaded so that it returns to center when it is released. Use a screwdriver to turn the switch. Turn the switch counterclockwise to test channel A. Turn the switch clockwise to test channel B.

Turn the switch to hear the intermittent horn. Release the switch to hear the clacker.

The clacker stops at the end of the test.

AURAL WARNING SYSTEM - TEST



	CHANNEL A TEST	CHANNEL B TEST
TURN TEST SWITCH	 "BEEP-BEEP-BEEP-BEEP" (INTERMITTENT HORN SOUND)	 "BEEP-BEEP-BEEP-BEEP" (INTERMITTENT HORN SOUND)
RELEASE TEST SWITCH	 "CLACK-CLACK-CLACK-CLACK" (CLACKER SOUND)	 "CLACK-CLACK-CLACK-CLACK" (CLACKER SOUND)

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2369395 S00061519467_V2

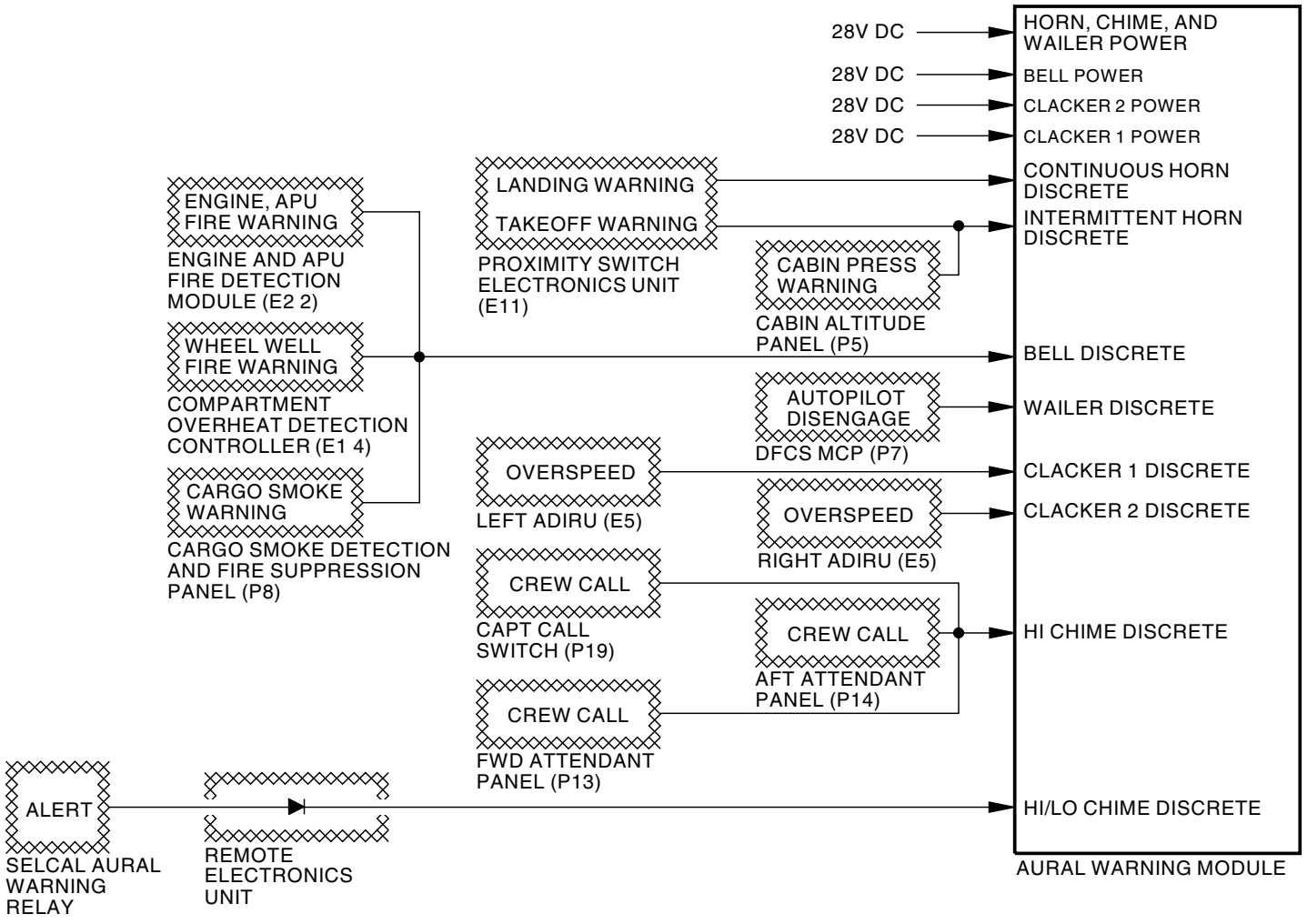
AURAL WARNING SYSTEM - TEST

AURAL WARNING SYSTEM - SUMMARY

General

This page is for reference.

AURAL WARNING SYSTEM - SUMMARY



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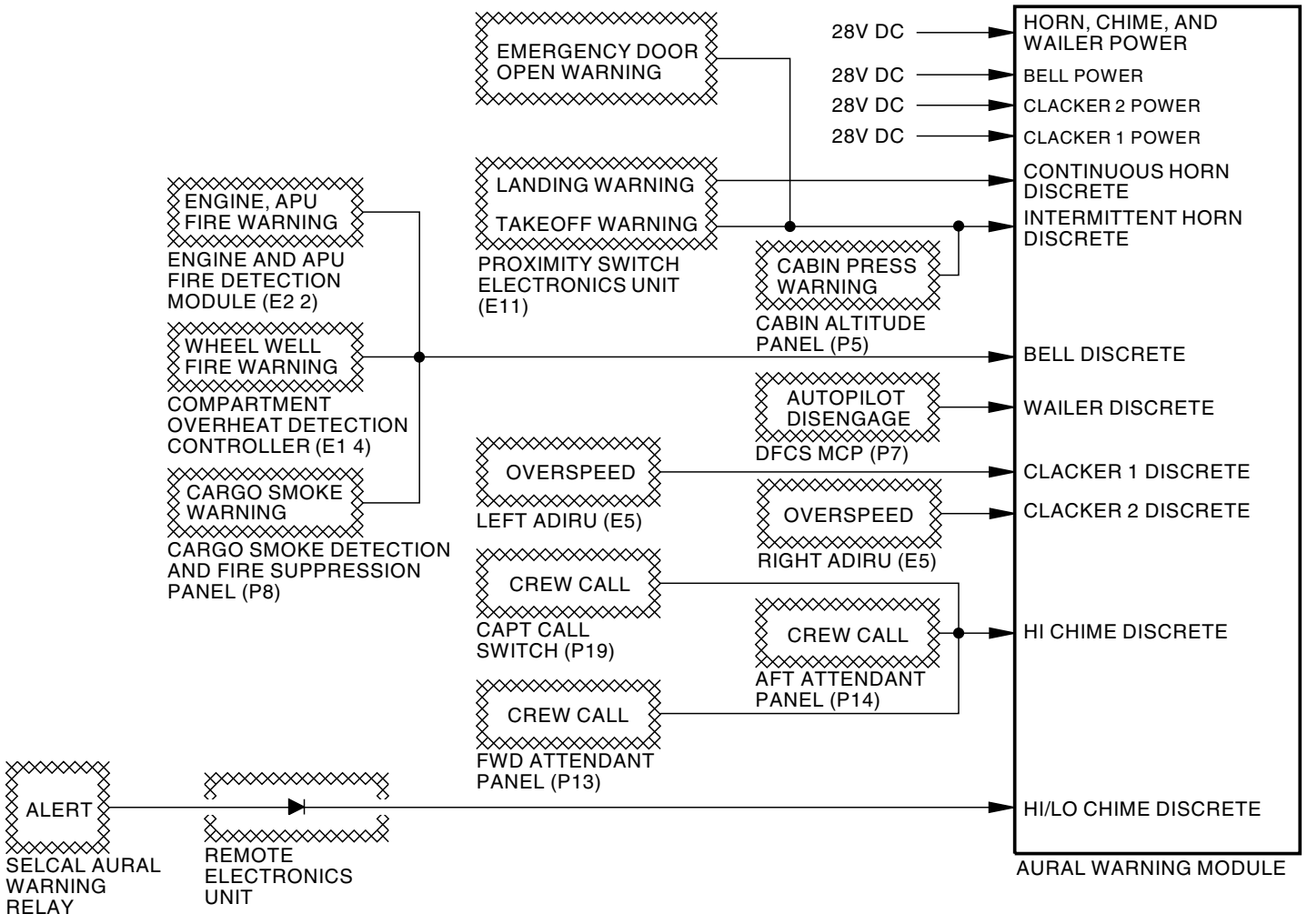
AURAL WARNING SYSTEM - SUMMARY

AURAL WARNING SYSTEM - SUMMARY



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AURAL WARNING SYSTEM - SUMMARY

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MASTER CAUTION SYSTEM - INTRODUCTION

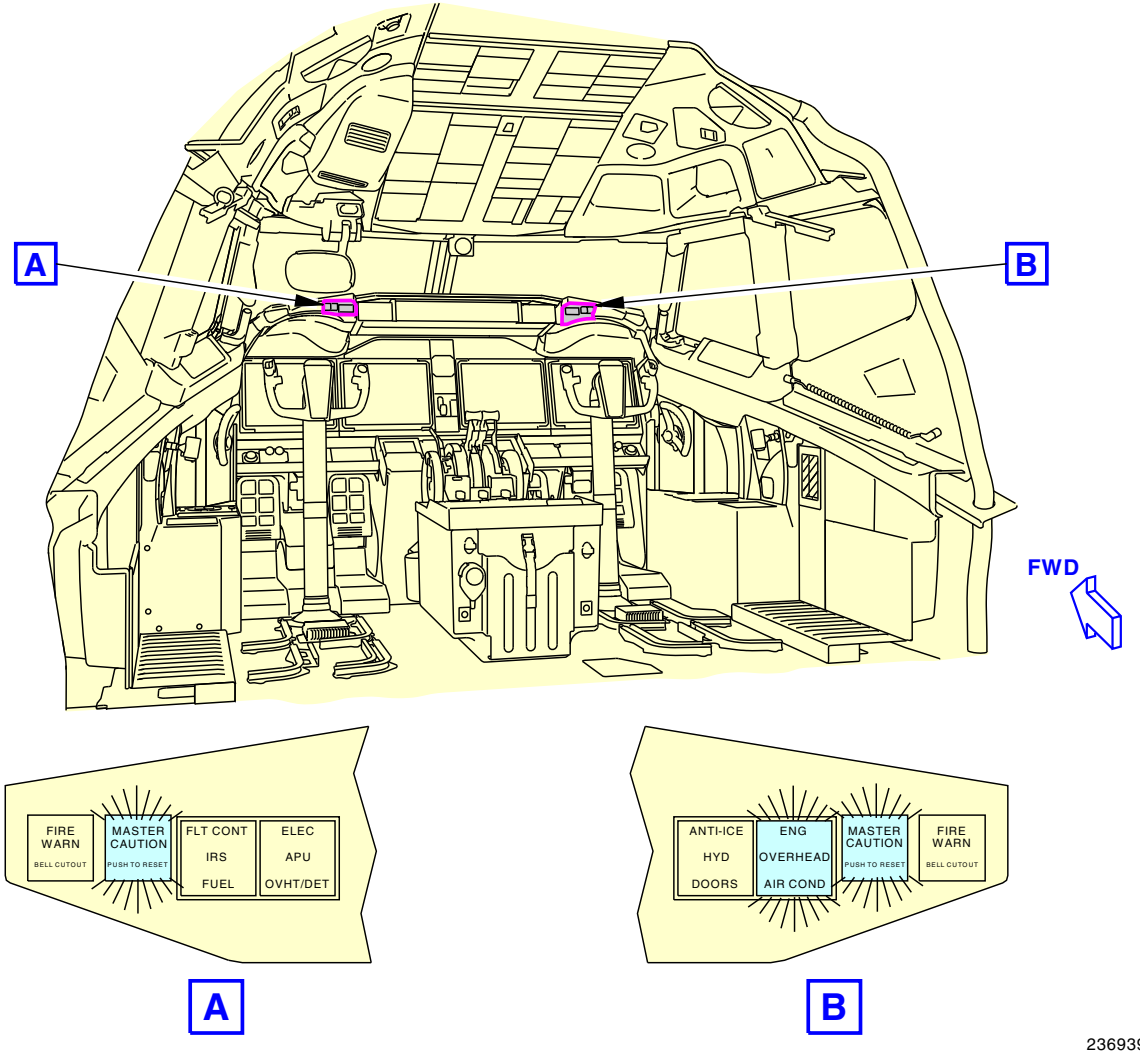
General

The master caution system gives a visual alert to the flight crew for incorrect airplane systems operation.

Abbreviations and Acronyms

- AC - alternating current
- altn - alternate
- annun - annunciator
- APU - auxillary power unit
- aux - auxillary
- bat - battery
- brt - bright
- cab - cabin
- capt - captain
- cond - condition/conditioning
- cont - control
- cowl - cowling
- ctr - center
- DC - direct current
- det - detector/detection
- EEC - electronic engine control
- elec - electric/electrical
- ELT - emergency locator transmitter
- emer - emergency
- eng - engine
- equip - equipment
- flt - flight
- F/O - first officer
- fwd - forward
- gen - generator
- GPS - global positioning system
- hyd - hydraulic
- inop - inoperative
- IRS - inertial reference system
- L - left
- lt - light
- ma wrn - master warning
- ovht - overheat
- oxy - oxygen
- press - pressure
- PSEU - proximity system electronics unit
- pwr - power
- R - right
- rcdr - recorder
- rec - recorder
- sched - scheduled
- stby - standby
- sw - switch
- temp - temperature
- V - volts
- warn - warning

MASTER CAUTION SYSTEM - INTRODUCTION



2369397 S00061519473_V1

MASTER CAUTION SYSTEM - INTRODUCTION

EFFECTIVITY

SIA ALL

MASTER CAUTION SYSTEM - GENERAL DESCRIPTION

General

The master caution system receives discrete ground signals from many airplane systems. The discrete ground signals cause the MASTER CAUTION lights and the system annunciator lights to come on. This gives a visual alert of system failures.

Hydraulic Panel

The hydraulic panel causes both MASTER CAUTION lights and the HYD light on the right system annunciator lights to come on when one or more of these hydraulic system lights come on:

- System A Elec 2 Low Press
- System A Elec 2 Overheat
- System A Eng 1 Low Press
- System B Elec 1 Low Press
- System B Elec 1 Overheat
- System B Eng 2 Low Press

Flight Control Panel

The flight control panel causes both MASTER CAUTION lights and the FLT CONT light on the left system annunciator lights to come on when one or more of these flight control system lights come on:

- Speed Trim
- Feel Diff Press
- Flt Cont A Low Press
- Flt Cont B Low Press
- Auto Slat Fail
- Mach Trim Fail
- Stby Hyd Low Press
- Stby Hyd Low Quantity
- Yaw Damper

Generator Drive and Standby Power Panel

The generator drive and standby power panel causes both MASTER CAUTION lights and the ELEC light on the left system annunciator lights to come on when one or more of these lights come on:

- Batt Discharge
- TR Unit
- Elec
- Gen 2 Xfr Bus Off
- Gen 2 Source Off
- Gen 1 Xfr Bus Off
- Gen 1 Source Off
- Standby Power Off

APU Indicator Panel

The APU indicator panel causes both MASTER CAUTION lights and the APU light on the left system annunciator lights to come on when one or more of these APU lights come on:

- APU Low Oil Press
- APU Fault
- APU Overspeed

Fuel Control Panel

The fuel control panel causes both MASTER CAUTION lights and the FUEL light on the left system annunciator lights to come on as follows:

- When the Eng 1 Filter Bypass light comes on
- When the Eng 2 Filter Bypass light comes on
- When both Tank 1 Fwd and Aft Low Press lights come on
- When both Tank 2 Fwd and Aft Low Press lights come on
- When the Ctr Tank L Low Press light comes on
- When the Ctr Tank R Low Press comes on

- There is a 10 second delay after the fuel LOW PRESSURE light comes on, before the master caution lights come on

Overheat/Fire Protection Panel

The overheat/fire protection panels causes both MASTER CAUTION lights and the OVHT/DET light on the left system annunciator lights to come on when one or more of these system lights come on:

- Eng 1 Overheat
- Eng 2 Overheat
- APU Det Inop

Air Conditioning/Bleed Air Control Panel

The air conditioning/bleed air control panel causes both MASTER CAUTION lights and the AIR COND light on the right system annunciator lights to come on when one or more of these air conditioning system lights come on:

- L Pack Off
- R Pack Off
- Cont Cab Zone Temp
- Fwd Cab Zone Temp
- Aft Cab Zone Temp
- Auto Fail
- Off Sched Descent
- L Wing Body Ovht
- R Wing Body Ovht
- L Bleed Trip Off
- Dual Bleed
- R Bleed Trip Off

Window Heat and Probe Heat Panels

The window heat and probe heat panels cause the MASTER CAUTION lights and the ANTI-ICE light on the right system annunciator lights to come on when one or more of these lights come on:

- Capt Pitot
- F/O Pitot
- L Elevator Pitot
- Aux Pitot
- Temp Probe
- R Elevator Pitot
- L Alpha Vane
- R Alpha Vane
- Eng 1 Cowl Anti-Ice
- Eng 2 Cowl Anti-Ice
- L Front Window Ovht
- R Front Window Ovht
- L Side Window Ovht
- R Side Window Ovht

Engine Panel

The engine panel causes both MASTER CAUTION lights and the ENG light on the right system annunciator lights to come on when one or more of these lights come on:

- Eng 1 Reverser Fault
- Eng 1 EEC Altn Sw
- Engine 1 Engine Control
- Eng 2 Reverser Fault
- Eng 2 EEC Altn Sw
- Engine 2 Engine Control

MASTER CAUTION SYSTEM - GENERAL DESCRIPTION

System Annunciators

The system annunciators cause both MASTER CAUTION lights and the DOORS light on the right system annunciator lights to come on when one or more of these lights come on:

- Fwd Cargo Door
- Aft Cargo Door
- Fwd Service Door
- Aft Service Door
- Fwd Entry Door
- Aft Entry Door
- Equipment Door
- Overwing Exit Door

IRS Master Caution Unit

The IRS master caution unit causes both MASTER CAUTION lights and the IRS light on the left system annunciator lights to come on when one or more of these lights come on:

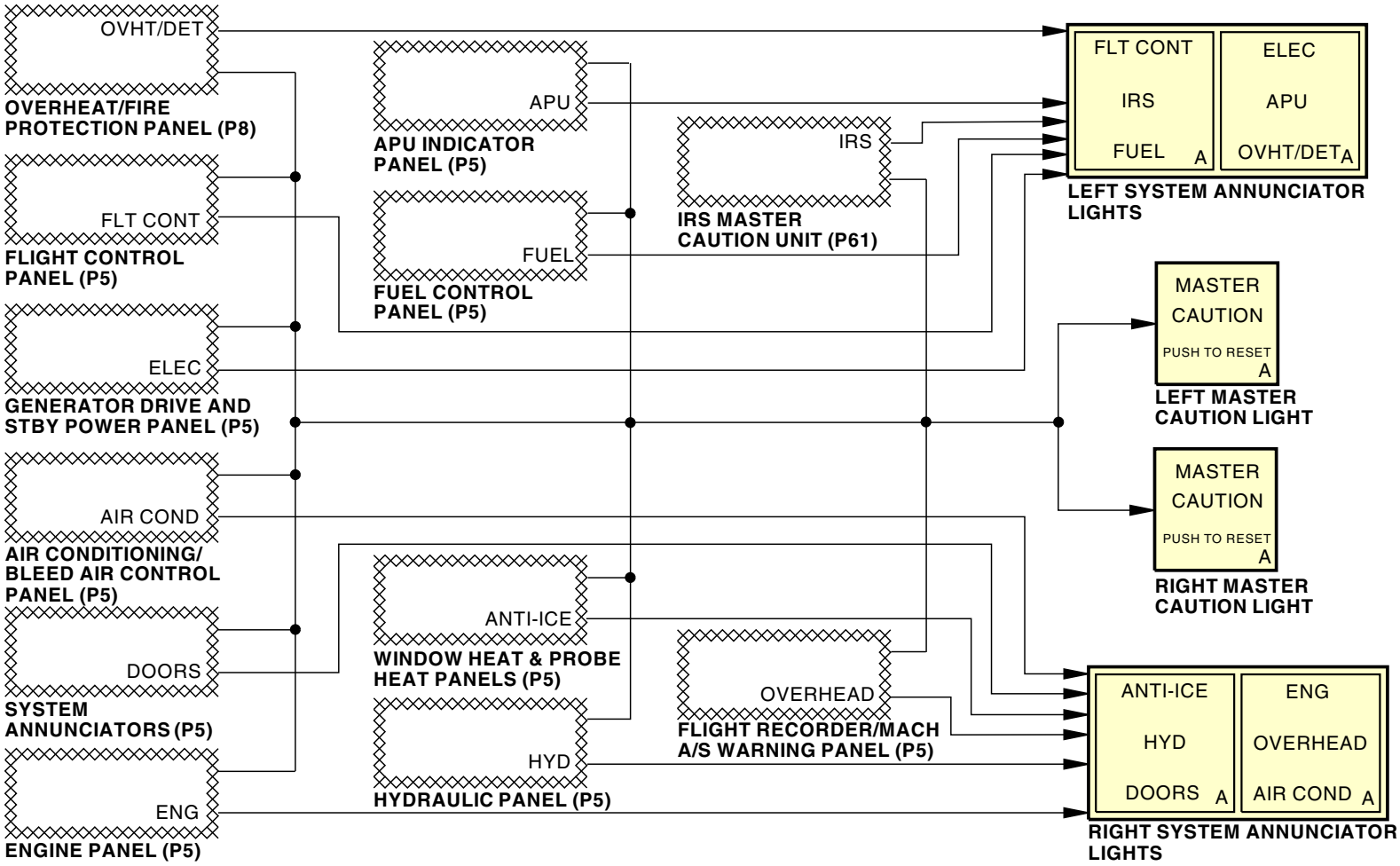
- GPS Fault
- L Fault
- L On DC
- L DC FAIL
- R Fault
- R On DC
- R DC Fail

Flight Recorder/Mach Airspeed Warning Panel

The flight recorder/Mach airspeed warning panel causes both MASTER CAUTION lights and the OVERHEAD light on the right system annunciator lights to come on when one or more of these lights come on:

- Pass Oxy On
- Emer Exit Not Armed
- Flt Rcdr Off
- ELT
- Equip Cooling Exhaust Off
- Equip Cooling Supply Off
- PSEU Fault

MASTER CAUTION SYSTEM - GENERAL DESCRIPTION



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MASTER CAUTION SYSTEM - GENERAL DESCRIPTION

MASTER CAUTION SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT - 1

General

The components for the master caution system are in the flight compartment.

Master Caution System Components

These are the master caution system components on the P7 glareshield panel:

- Master caution lights
- Left system annunciator lights
- Right system annunciator lights

Input Components

Many systems provide discrete inputs to the master caution system.

These are the components on the P5 aft overhead panel:

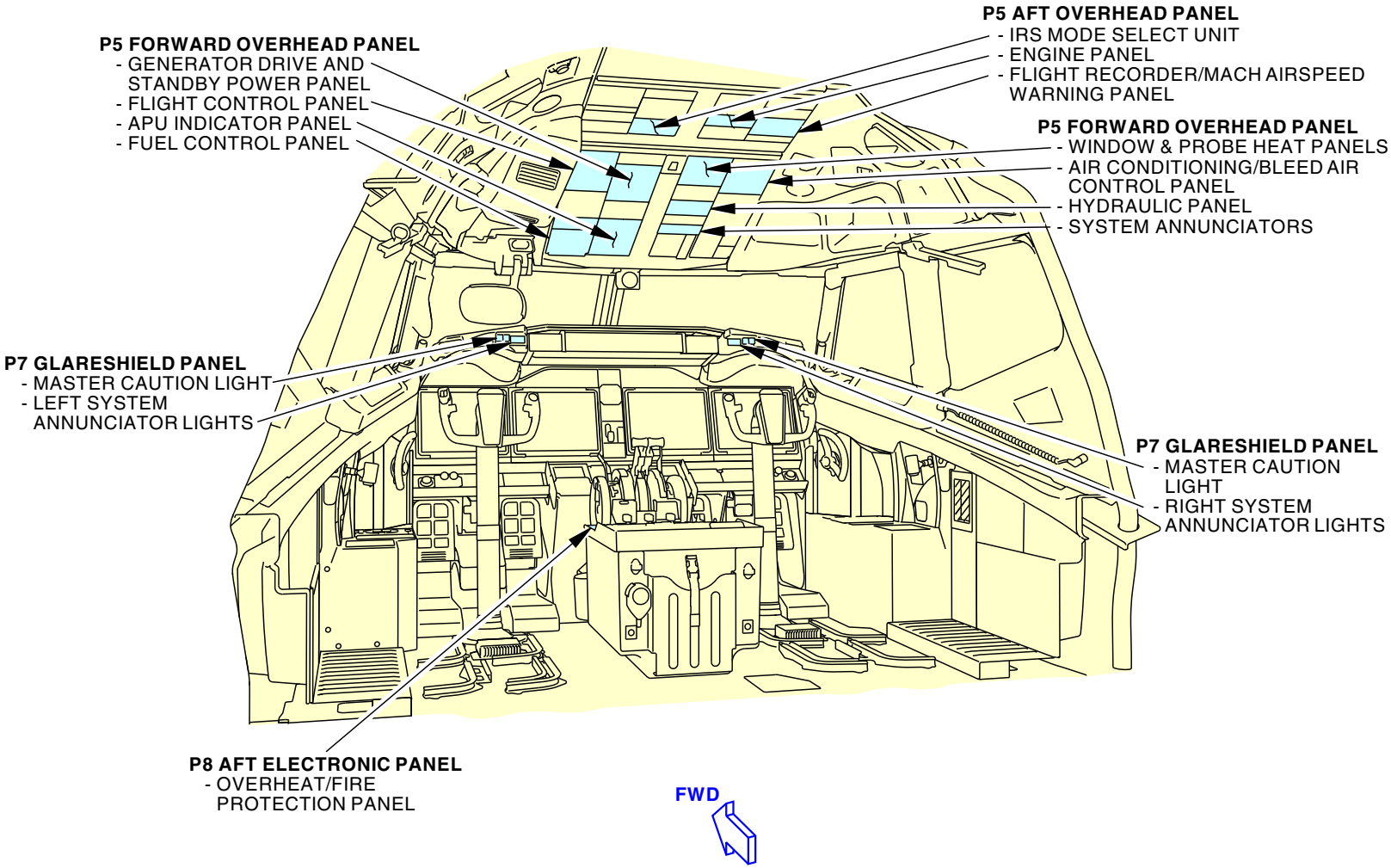
- IRS mode select unit
- Engine panel
- Flight recorder/Mach airspeed warning panel

These are the components on the P5 forward overhead panel:

- Flight control panel
- Fuel control panel
- Generator drive and standby power panel
- APU indicator panel
- Window heat panel
- Probe heat panel
- Hydraulic panel
- System annunciators
- Air conditioning/bleed air controls panel

The overheat/fire protection panel is on the P8 aft electronic panel

MASTER CAUTION SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT - 1



2369399 S00061519477_V1

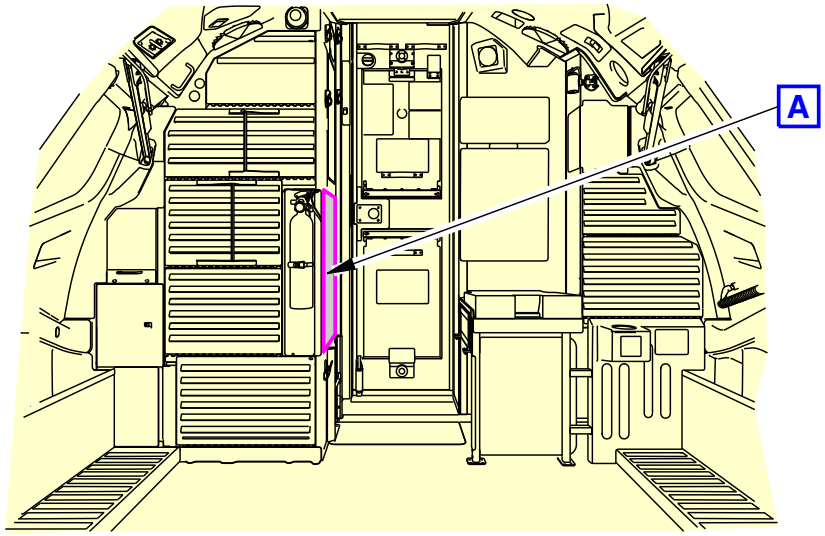
MASTER CAUTION SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT - 1

MASTER CAUTION SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT - 2

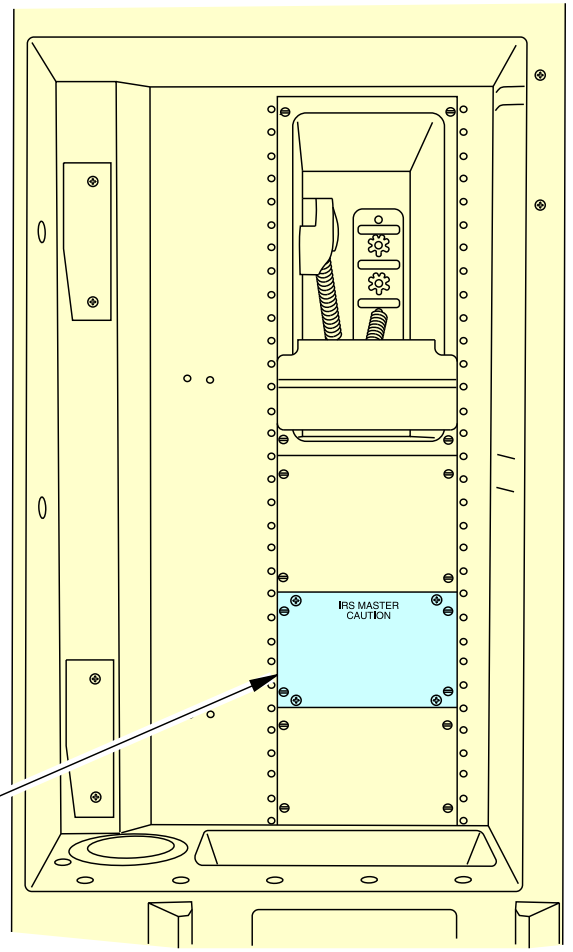
General

The IRS master caution unit provides discrete inputs to the master caution system. The IRS master caution unit is on the P61 panel in the flight compartment.

MASTER CAUTION SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT - 2



FLIGHT COMPARTMENT
(VIEW IN THE AFT DIRECTION)



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MASTER CAUTION SYSTEM - COMPONENT LOCATION - FLIGHT COMPARTMENT - 2

MASTER CAUTION SYSTEM - INTERFACES

Lights

The 28V DC battery bus and the 28V DC bus 1 supply power for the master caution lights and the system annunciator lights.

The 28V DC power goes through switches in the master caution lights.

The power goes through the annunciation and dimming module. When you select bright (BRT) on the master lights control on P1, the voltage is 28 volts. When you select DIM on the master lights control, the voltage is 16 volts.

Control

Power for the control of the master caution annunciation goes through separate circuit breakers on P6 to the control panels on the overhead panel (P5) and the aft electronic stand (P8).

The MASTER CAUTION ANNUNCIATOR CONT 1 circuit breaker supplies power to the logic in these panels:

- Flight control panel
- Fuel control panel

The MASTER CAUTION ANNUNCIATOR CONT 2 circuit breaker supplies power to the logic in these panels:

- Hydraulic panel
- Window heat panel
- System annunciators

The MASTER CAUTION ANNUNCIATOR CONT 3 circuit breaker supplies power to the logic in these panels:

- Air conditioning/bleed air control panel
- Engine panel

The MASTER CAUTION ANNUNCIATOR CONT 4 circuit breaker supplies power to the logic in these panels:

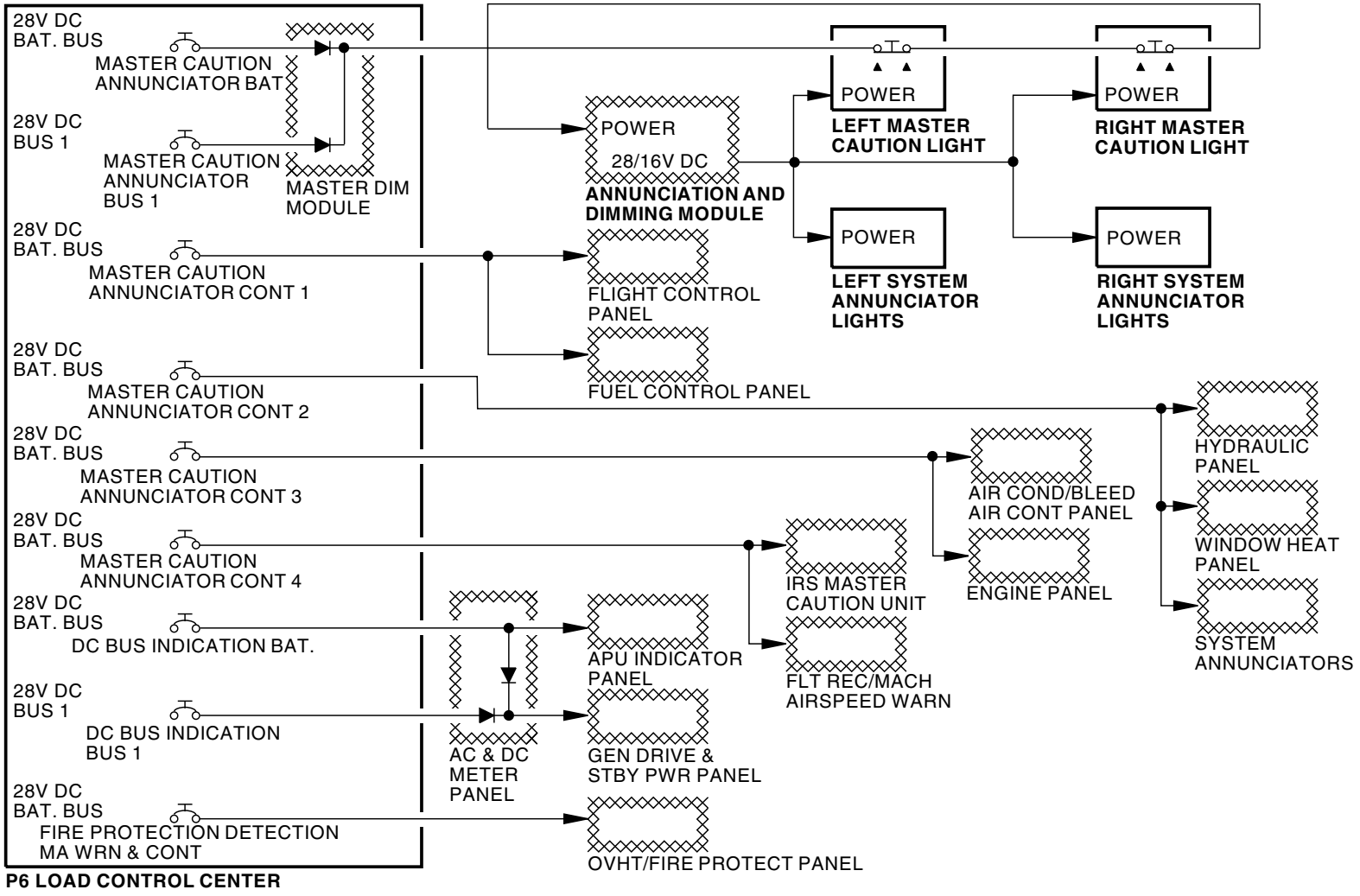
- IRS master caution unit
- Flight recorder/Mach airspeed warning panel

The DC BUS INDICATION BAT circuit breaker supplies power to the logic in the APU indicator panel and the generator drive and standby power panel.

The DC BUS INDICATION BUS 1 circuit breaker supplies power to the logic in the generator drive and standby power panel.

The FIRE PROTECTION DETECTION MA WRN & CONT circuit breaker supplies power to the logic in the overheat/fire protection panel.

MASTER CAUTION SYSTEM - INTERFACES



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MASTER CAUTION SYSTEM - INTERFACES

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MASTER CAUTION SYSTEM - INTERFACES - CONTROL

Power

The 28V DC battery bus and the 28V DC bus 1 supply power for the master caution lights and the system annunciator lights.

The 28V DC power goes through switches in the master caution lights.

The power goes through the annunciation and dimming module. When you select bright (BRT) on the master lights control on P1, the voltage is 28 volts. When you select DIM on the master lights control, the voltage is 16 volts.

Control of the Master Caution Light

The control of the left and right master caution lights come from these components:

- Flight control panel
- IRS master caution unit
- Flight control panel
- Generator drive and standby power panel
- APU indicator panel
- Overheat/fire protection panel
- Window heat panel
- Hydraulic panel
- System annunciators
- Engine panel
- Flight recorder/Mach airspeed warning panel
- Air conditioning/bleed air control panel

The annunciation and dimming module receive these discrete signals. When any one of the discrete signals is at ground, the annunciation and dimming module sends a master caution signal (ground) on the control line. This causes both master caution lights to come on.

The annunciation and dimming module sends the master caution signal to the flight data acquisition unit.

Control of the System Annunciator Lights

The control of the left system annunciator lights come from these components:

- Flight control panel (FLT CONT)
- IRS master caution unit (IRS)
- Flight control panel (FUEL)
- Generator drive and standby power panel (ELEC)
- APU indicator panel (APU)
- Overheat/fire protection panel (OVHT/DET)

The control of the right system annunciator lights come from these components:

- Window heat panel (ANTI-ICE)
- Hydraulic panel (HYD)
- System annunciators (DOORS)
- Engine panel (ENG)
- Flight recorder/Mach airspeed warning panel (OVERHEAD)
- Air conditioning/bleed air control panel (AIR COND)

Reset of the Master Caution Light

When you push the master caution light, you remove power to all the master caution circuits. This causes the circuits to reset the master caution annunciation. These results occur:

- Master caution lights go off
- System annunciator lights go off
- Fault lights on the individual panels remain on if the panel still senses a fault

The master caution lights and the system annunciator lights remain off until a new fault occurs.

When a new fault occurs, these lights come on:

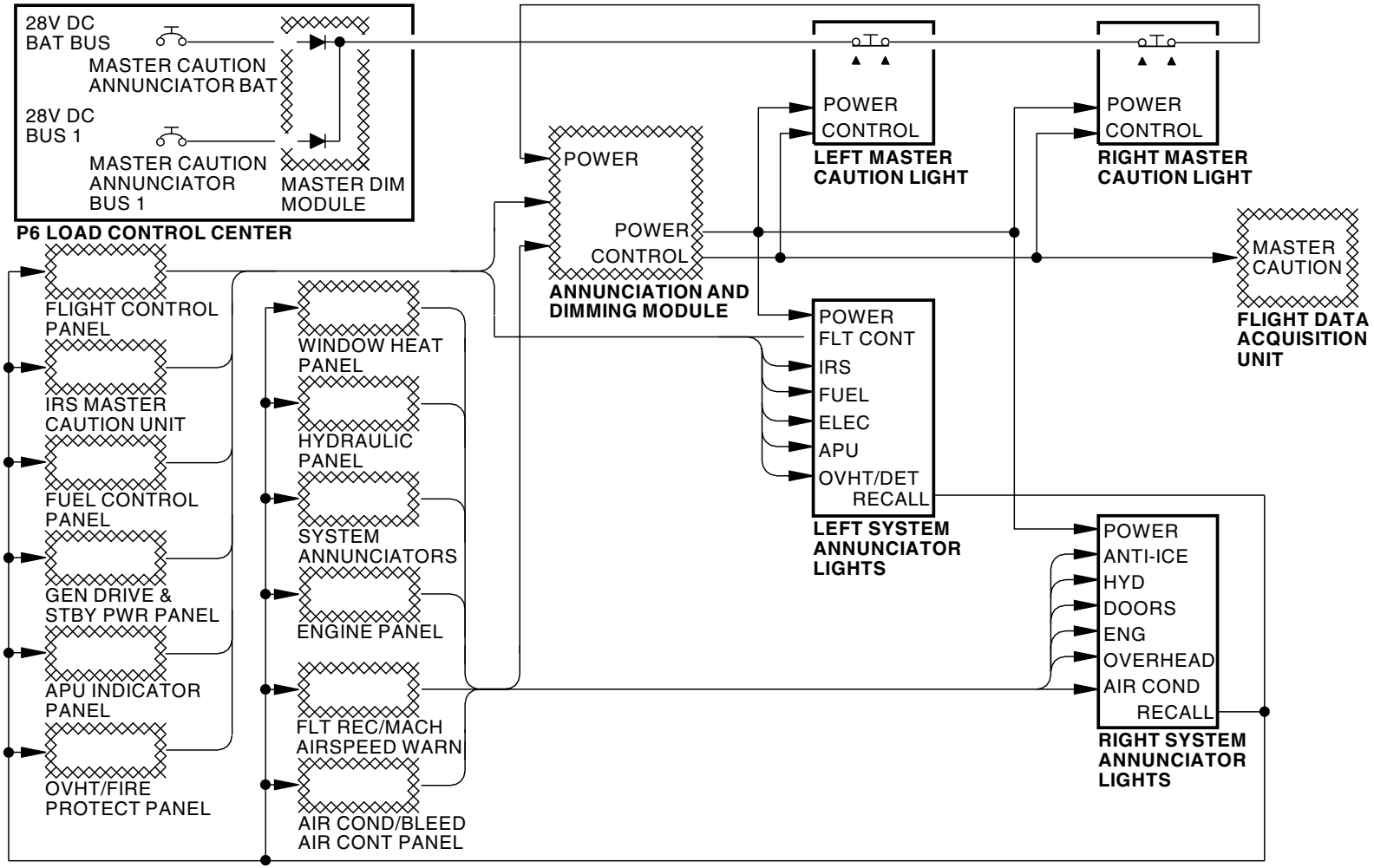
- Fault light on the individual panel which senses the fault
- Master caution lights
- Light on the system annunciator which agrees with the fault

Recall of the System Annunciator Lights

When you push and hold the system annunciator lights, the recall signal goes to all the components which cause the lights on the system annunciators to come on. This causes all the lights on the system annunciators to come on.

When you release the system annunciator lights, the system annunciator lights show only the systems which have faults.

MASTER CAUTION SYSTEM - INTERFACES - CONTROL



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MASTER CAUTION SYSTEM - INTERFACES - CONTROL

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TAKEOFF WARNING - INTRODUCTION

General

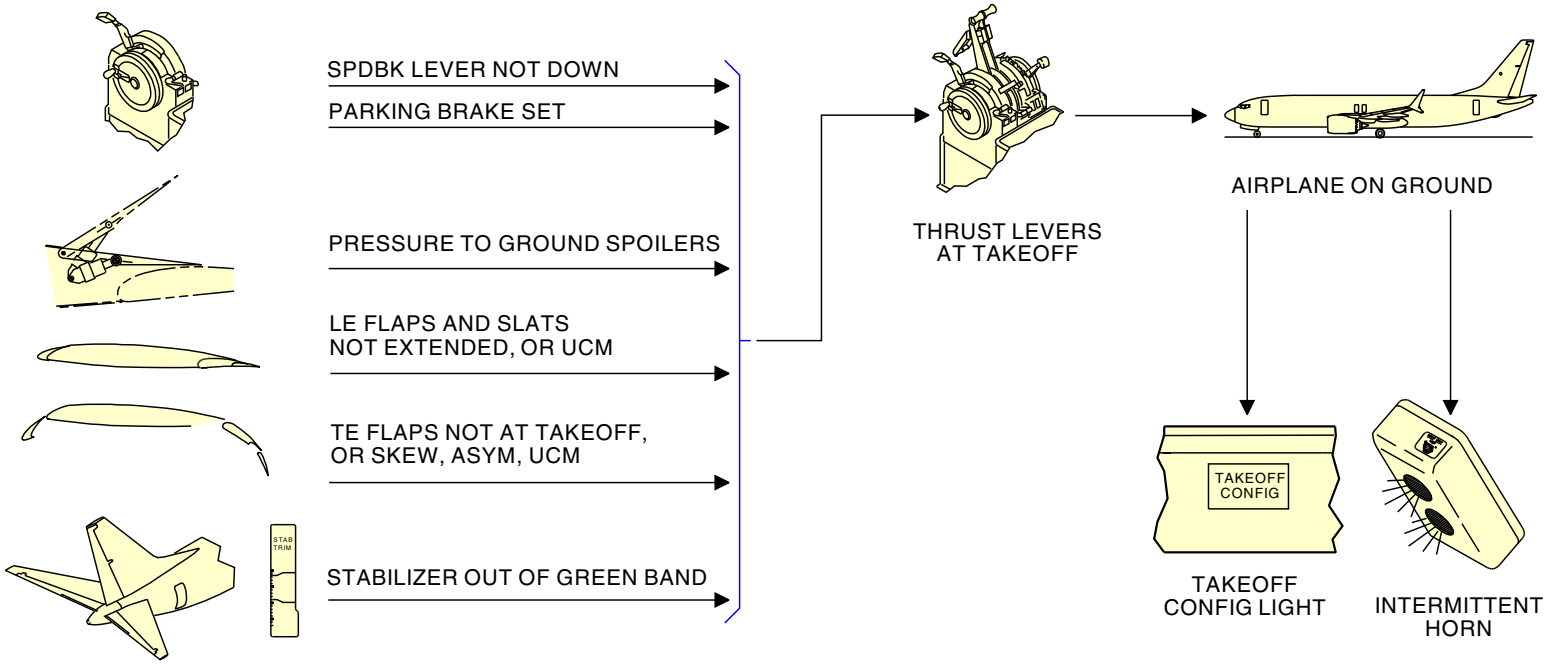
The takeoff warning function gives these indications if the airplane is not in the correct configuration for takeoff or there is uncommanded movement of the leading or trailing edge devices.

- An aural warning sound
- TAKEOFF CONFIG indicator lights on the P1-3 and P3-1 panels illuminate

Abbreviations and Acronyms

- ASYM - asymmetry
- FSEU - Flap/Slat Electronics Unit
- LE - Leading Edge
- PSEU - Proximity Switch Electronic Unit
- SMYD - Stall Management Yaw Damper
- SPDBK - speedbrake
- TE - Trailing Edge
- TO - takeoff
- UCM - Uncommanded Motion

TAKEOFF WARNING - INTRODUCTION



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TAKEOFF WARNING - INTRODUCTION

TAKEOFF WARNING - FUNCTIONAL DESCRIPTION

General Description

The takeoff warning function is in the Proximity Switch Electronic Unit (PSEU). The aural warning module gives the sound of an intermittent horn for a takeoff warning. It warns the pilots that the airplane configuration is not correct for takeoff.

The TAKEOFF CONFIG indicator lights on the P1-3 and P3-1 panels illuminate for a takeoff warning on the ground and in the air.

Functional Description

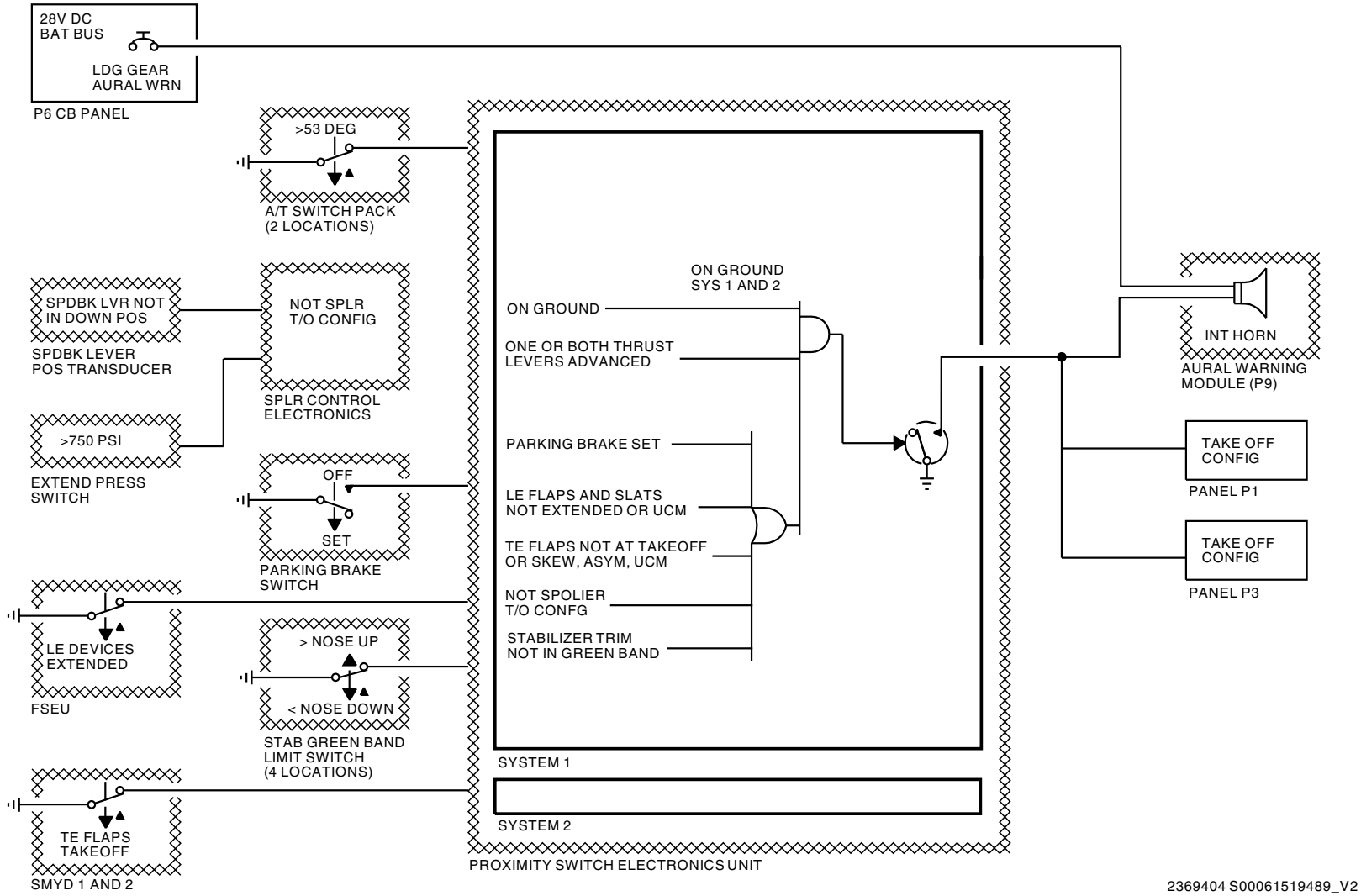
When the airplane is on the ground and one or both thrust levers are moved to the takeoff power position (thrust resolver angle more than 53 degrees), the aural warning system gives the takeoff warning indication with these conditions:

- Speedbrake lever not down
- Parking brake set
- Spoiler extend hydraulic pressure is more than 750 PSI
- Leading Edge (LE) flaps and slats not extended or have an Uncommanded Motion (UCM)
- Trailing Edge (TE) flaps not in takeoff position
- TE flaps in a skew or asymmetry condition or have an UCM
- Stabilizer not in the green band

System 1 and system 2 each calculate separate output signals and are combined for a takeoff warning. This turns on the following warning indications:

- Intermittent horn in the aural warning module
- TAKEOFF CONFIG lights illuminate

TAKEOFF WARNING - FUNCTIONAL DESCRIPTION



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TAKEOFF WARNING - FUNCTIONAL DESCRIPTION

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MDS - INTRODUCTION

General

The MAX display system (MDS) shows navigation, engine, performance, and maintenance data in many different formats on four display units in the flight compartment.

Integrated Functions

The MAX display system (MDS) shows flight and engine data to the flight crew. The data that the MDS shows includes:

- Air data
- Inertial reference data
- Navigation data
- Flight mode annunciations
- Engine parameters
- Hydraulic system data
- Flight control surface positions (option)
- Brake temperature (option)
- Tire pressure (option)
- Flight deck entry video (option).

Reliability

The system configuration gives protection for safe operation. The software configuration gives a high level of function and precision. The software functions are isolated to increase safety.

Redundancy

There are two display processor computers (DPCs). One DPC can give display data to all four of the display units.

Display Management

The multi-function panel and the lighting control modules let the crew manually manage the displays on the MDS. Some displays move automatically when there is a display unit failure.

BITE

Fault data shows on the MDS maintenance pages.

Abbreviations and Acronyms

A/C - Air Conditioning

AC - Alternating Current

ACARS - Aircraft Communications Addressing and Reporting System

AD - Air Data

ADIRS - Air Data Inertial Reference System

ADIRU - Air Data Inertial Reference Unit

AFD - Adaptive Flight Display

AGS - ARINC 661 Graphics Server

AIM - Application Integrity Monitor

ALU - Arithmetic Logic Unit

ANC - Analog Card

AOA - Angle Of Attack

AOB - Auxiliary Outboard Display

API - Application Program Interface

APP - Application

APU - Auxiliary Power Unit

ARINC - Aeronautical Radio Inc

ASIC - Application Specific Integrated Circuit

ATC - Amended Type Certificate

BIT - Built In Test

BITE - Built In Test Equipment

CAS - Crew Alerting System

EFFECTIVITY

SIA ALL

CAS - Computed Air Speed
CBIT - Continuous BIT
CCA - Circuit Card Assembly
CDU - Control Display Unit
CDR - Critical Design Review
CMM - Component Maintenance Manual
CMR - Certification Maintenance Requirement
COTS - Commercial Off-The-Shelf CP Control Panel
CPCI - Computer Program Configuration Item
CPLD - Complex Programmable Logic Devices
CPU - Central Processing Unit
CRC - Cyclic Redundancy Check
CRI - Certification Review Item
DAL - Design Assurance Level
DB - Database
DH - Decision Height
DHM - Display Head Module
DOORS - Dynamic Object Oriented Requirements System
DPC - Display Processing Computer
DRA - Diagnostic and Reporting Application
DSC - Discrete Card
DSP - Display Select Panel
DSM - Digital Switch Module
DSS - Display Select Switch
DU - Display Unit
DVI - Digital Video Interface
DWM - Display Windows Management
ECMP - Electronic Component Management Plan
ECS - Environmental Control System
EDAC - Error Detection And Correction
EDL - Ethernet Data Load
EFIS - Electronic Flight Instrument System
EFIS CP - EFIS Control Panel
EGT - Exhaust Gas Temperature
EGPWS - Enhanced Ground Proximity Warning System
EI - Engine Instruments
EMC - Electro Magnetic Compatibility
EME - Electro Magnetic Effects
ETOPS - ExTended OPerationS
FAA - Federal Aviation Administration
FADEC - Full Authority Digital Engine Control
FAI - First Article Inspection
FANS - Future Air Navigation System
FAR - Federal Aviation Regulation
FC - Flight Change
FD - Flight Deck
FDRS - Flight Data Recording System
FIFO - First In First Out (buffer)
FlexIO - Input / Output technology
Flt - Flight

FMC - Flight Management Computer

FMCS - Flight Management Computer System

FMEA - Failure Modes and Effects Analysis

FO - (F/O) First Officer

FPGA - Field Programmable Gate Array

FPU - Floating Point Unit

FRS - Flammability Reduction System

GA - Go Around

GE - General Electric

GE5 - Graphics Engine 5

GFX - Dynamic Device Driver within the DPC

GBST - Ground Based Software Tool

GLS - GPS Landing System

GPS - Global Positioning System

GPWS - Ground P r o x i m i t y Warning System

GWA - Gateway Application

HAS - Hardware Accomplishment Summary

HCI - Hardware Configuration Index

HCL - HCL India

HECI - Hardware Environment Configuration Index

HIRF - High Intensity Radiated Field

HM - Health Monitor HPa Hectopascal (s)

HUD - Heads - Up Display

HVP - Hardware Verification Plan

HW - Hardware

HWPP - Hardware Program Pin

IAN - Integrated Approach Navigation

ICA - Instructions for Continued Airworthiness

IDC - INDIA Design Center

IDU - Integrated Display Unit

IMA - Interactive Maintenance Application IO, I/O I n p u t / O u t p u t

IOM - Input/Output Manager IP Issue Paper

IRU - Inertial Reference Unit

IVSI - Instantaneous Vertical Speed Indicator

JAA - Joint Aviation Authorities

LCD - Liquid Crystal Display

MDS - MAX Display System

LED - Light Emitting Diode

LIB - Left Inboard

LOB - Left Outboard

LRU - Line Replaceable Unit

LTVS - Load Time Verification Software

MBD - Model Based Development

MC/DC - Modified Condition / Decision Coverage

MCU - Modular Concept Unit

Mech/Hyd - Mechanical/Hydraulics

MEL - Minimum Equipment List

MFD - Multi-Function Display MM Mini Map

MMEL - Master Minimum Equipment List

MMR - Multi-Mode Rece iver

ND - Navigation Display

NEA - Nitrogen Enriched Air

NFF - No Fault Found

NNC - NVRAM NOR CEC bus

NPS - Navigation Performance Scales

NOR - Not Or

NVM - Non-Volatile Memory

OBAR - Outside Boeing AR

OMF - Onboard Maintenance Function

ONS - Onboard Network System

OPS - Operational Program Software

OS - Operating System

OSS - Option Selection Software

PAV - Presence And Validity

PC - Processor Card

PCI - Personal Computer Interface

PDCU - Panel Data Concentrator Unit

PDH - Previously Developed Hardware

PDM - Product Data Manager

PDR - Preliminary Design Review

PFD - Primary Flight Display

PHAC - Plan for Hardware Aspects of Certification

PLD - Programmable Logic Device

PLOD - Program Letter of Definition

PM - Protocol Manager Post Power-on Self Test

PRC - Processor Resource Card

PSAC - Plan for Software Aspects of Certification

PSM - Power Supply Module

PSSA - Preliminary System Safety assessment

PSW - Platform Software

QA - Quality Assurance

QRH - Quick Reference Handbook

QSTAS - Qualified SW Tool Accomplishment Summary

QSDTP - Qualified SW Development Tool Plan

QTP - Qualification Test Procedure

QTR - Qualification Test Report

RBT - Requirements Based Tests

RC - Rockwell Collins

RIB - Right Inboard

RIC - Rear Interconnect Card

RISC - Reduced Instruction Set Computer

RLS - Remote Light Sensor ROB Right Outboard

ROM - Read Only Memory RSC Reusable Software Component

RTCA - Radio Technical Commission for Aeronautics

RTE - Real Time Executive

RTOS - Real Time Operating System

SAS - Software Accomplishment Summary

SATCOM - Satellite Communication

SCD - Specification Control Drawing

SCI - Software Configuration Index

SCIA - Software Change Impact Analysis

SCL - Software Control Library

SCMP - Software Configuration Management Plan

SDD - System Design Description

SDP - Software Development Plan

SDVP - Software Development and Verification Plan

SELCAL - Selective Call

SEU - Single Event Upset

SMT - Scheduled Maintenance Task

SOI - Stage Of Involvement

SQAP - Software Quality Assurance Plan

SRAM - Static Random Access Memory

SRIC - Sub-Rear Interconnect Card

SS - System Safety

SSA - System Safety Assessment

SVPR - Software Verification Procedures and Results

SW, S/W - Software

SWPP - Software Program Pin

SYS - System

TAWS - Terrain Awareness and Warning System

TC - Type Certification

TCAS - Traffic Alert and Collision Avoidance System

TCDS - Type Certificate Data Sheet

TERR - Terrain

TFC - Traffic

TO - Take Off

TRR - Test Readiness Review

TSR - Technical Specialist Review

UMS - User Modifiable Software

UTC - Universal Time Coordinate

VISTA - Virtual Integrated Software Testbed for Avionics

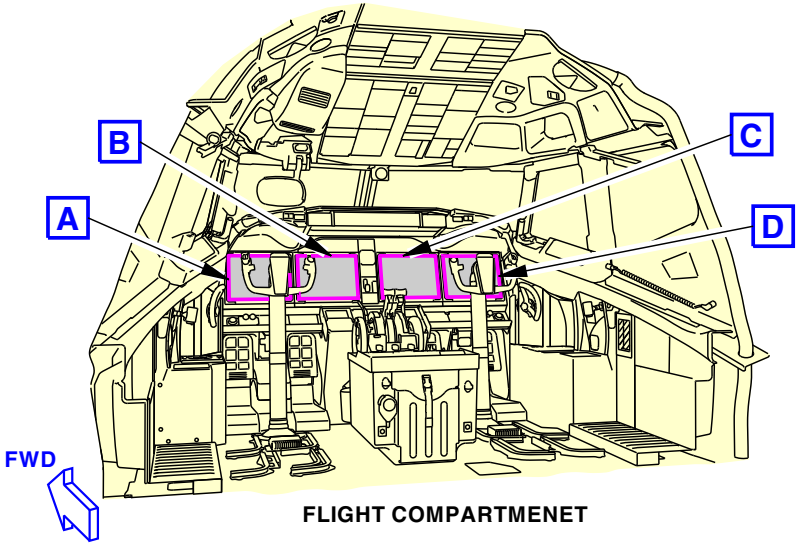
VSD - Vertical Situation Display

VSI - Vertical Speed Indicator

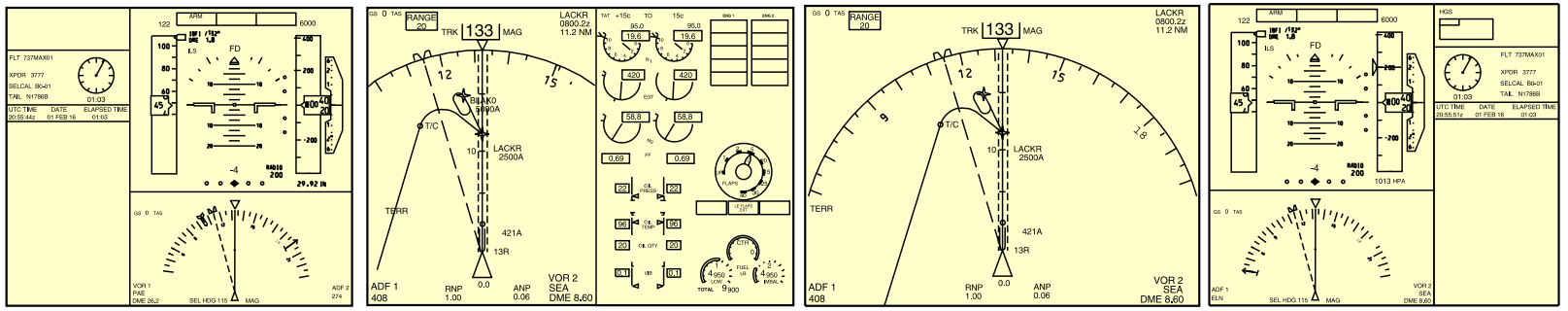
WPT - Waypoint

WXR - Weather Radar

MDS - INTRODUCTION



FLIGHT COMPARTMENET



2369405 S00061519493_V5

MAX DISPLAY SYSTEM - INTRODUCTION

MDS - GENERAL DESCRIPTION

General Description

The MAX display system (MDS) shows data on four liquid crystal displays (LCD). These display units (DUs) show primary flight, navigation and engine data to the crew.

The MDS has these components:

- Display processing computer (2)
- Display unit (4)
- EFIS control panel (2)
- Multi-function panel
- Lighting control module (2)
- Instrument switching module
- Maintenance BITE panel
- Remote light sensor (RLS) (2).

The MDS normally shows the primary flight data on the outboard DUs. The primary flight data can show on the inboard DUs if necessary.

The MDS normally shows the navigation data on the inboard DUs. The navigation data can show on the outboard DUs if necessary.

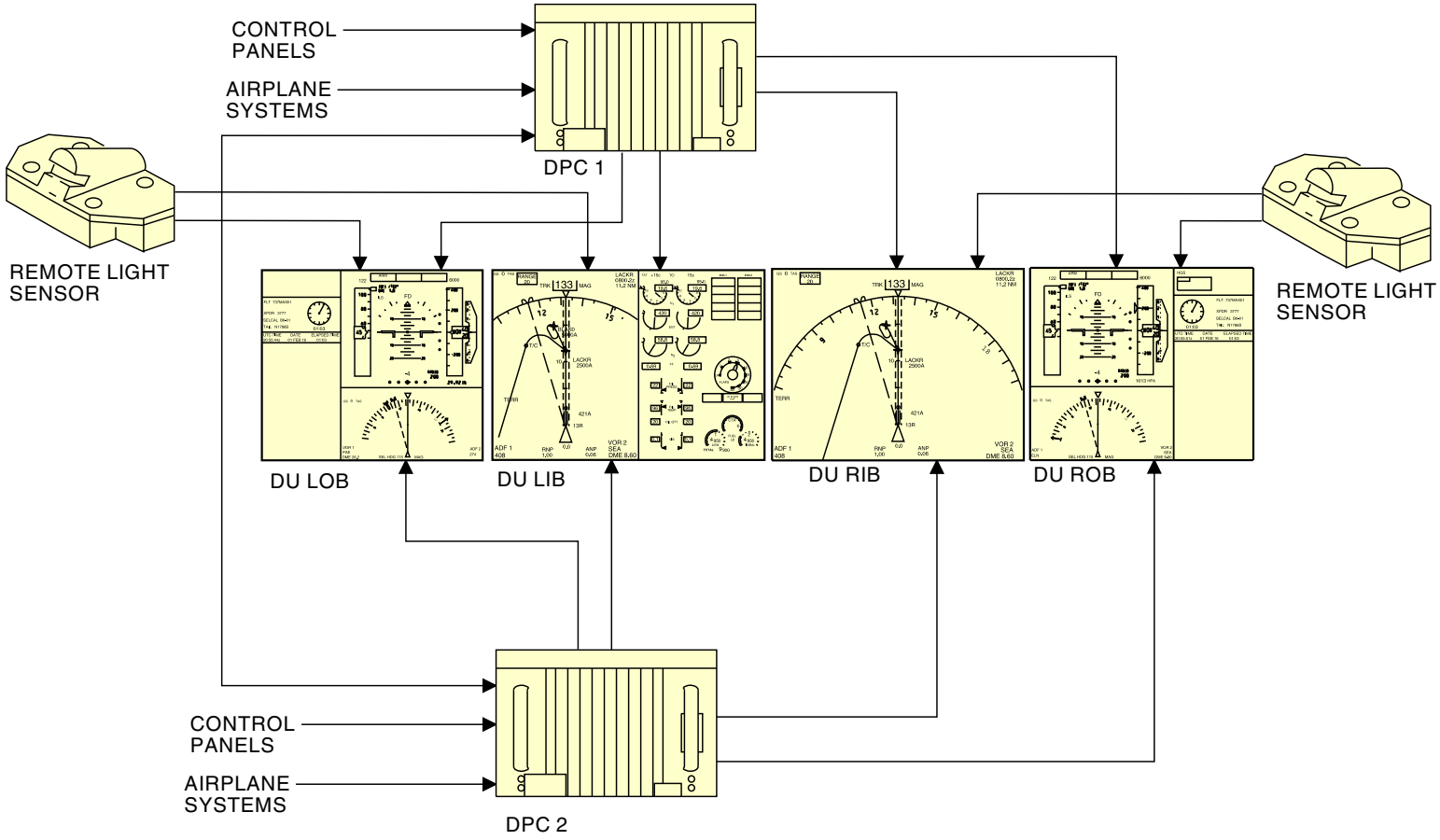
The MDS normally shows the engine indication (EI) display on one of the two inboard DUs. The EI display can show on one of the outboard DUs if necessary.

The display processing computers (DPCs) receive inputs from the avionics and airframe systems.

Each DPC uses data from the airplane systems to make the MDS displays. Each DPC then sends the display data to all four DUs.

If there is a failure of one DPC, the other DPC can make all the displays for the four DUs.

MDS - GENERAL DESCRIPTION



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MDS - GENERAL DESCRIPTION

Control Panels

The control panels let the pilots set the type of data and the location for the displays.

These are the control panels:

- EFIS control panels
- Multi-function panel
- Lighting control modules
- Instrument switching module.

The EFIS control panels control the primary flight data and the navigation data. They let the pilots control these display data:

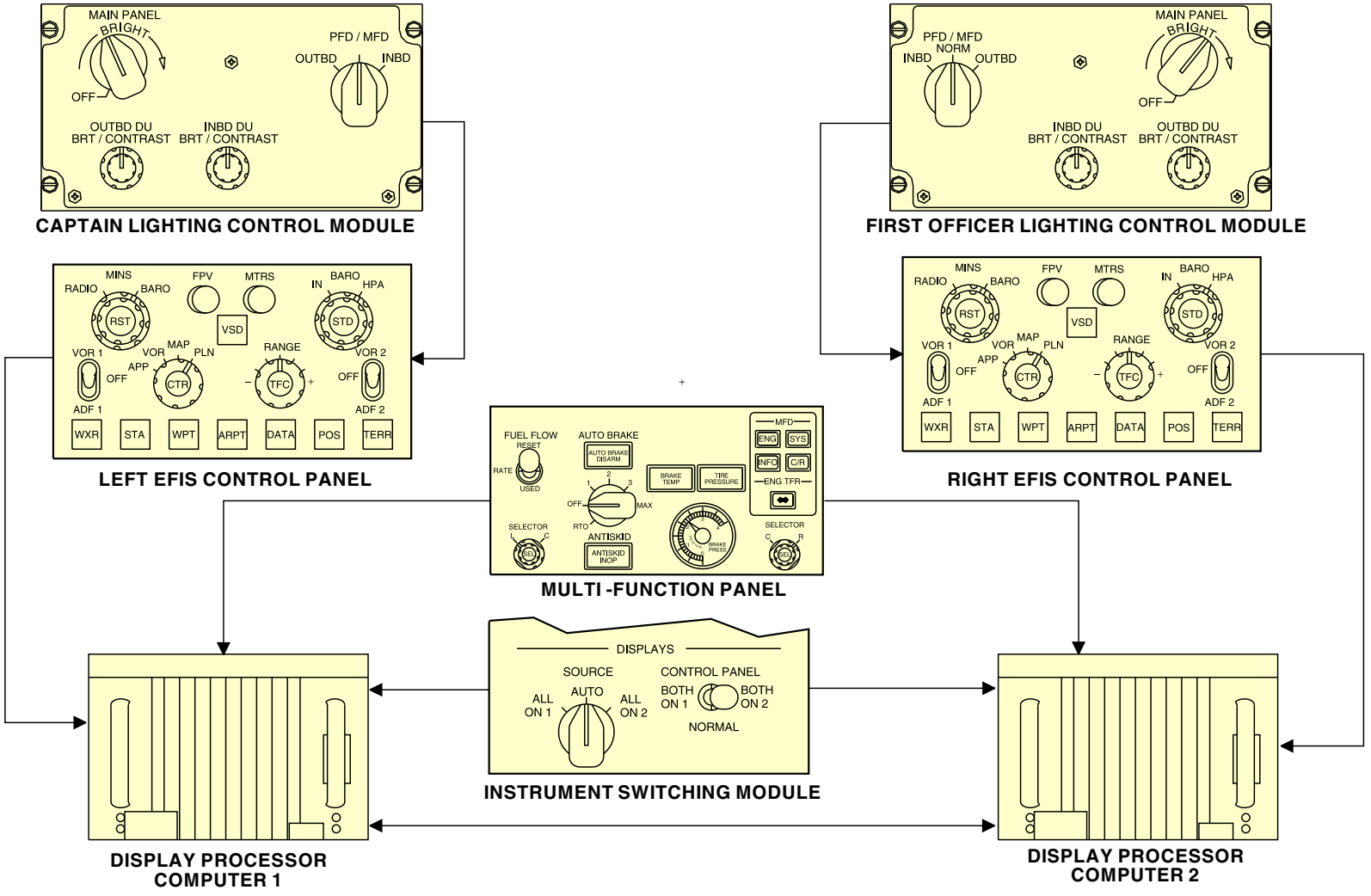
- Radio and barometric minimum altitude
- Barometric reference
- Metric altitude display
- Weather radar
- TCAS traffic display
- Navigation display modes
- Navigation display information
- VOR/ADF display.

The Multi-Function Panel (MFP) lets the crew change the Multi-Function Display (MFD) and the fuel flow display data. The MFP also lets the crew move the Engine Indication (EI) display and control the display cursor.

The lighting control modules let the crew manually move displays from one display unit to a different display unit. The lighting control modules also let the crew adjust the brightness for the display units.

The two DISPLAYS switches on the instrument switching module let the crew change the operation of the MAX display system. The SOURCE switch can set one display processing computer as the source for all four displays. The CONTROL PANEL switch can give control of the left side and right side displays to one EFIS control panel.

MDS - CONTROL PANELS



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MDS - CONTROL PANELS

MDS - PRIMARY FLIGHT DISPLAY

Features

The two outboard display units normally show the primary flight display/mini-map display (PFD/MM) and the auxiliary outboard (AOB) display. In this normal condition, the PFD shows on the inboard part of the display and above a mini map display. The AOB shows on the outboard part of the display.

This data shows on the PFD:

- Airspeed
- Attitude
- Barometric altitude
- Vertical speed
- Radio altitude
- Flight mode annunciations
- Lateral and vertical deviations
- Angle of attack

This data shows on the mini map:

- Heading
- Selected heading
- Active flight plan
- Groundspeed
- True airspeed

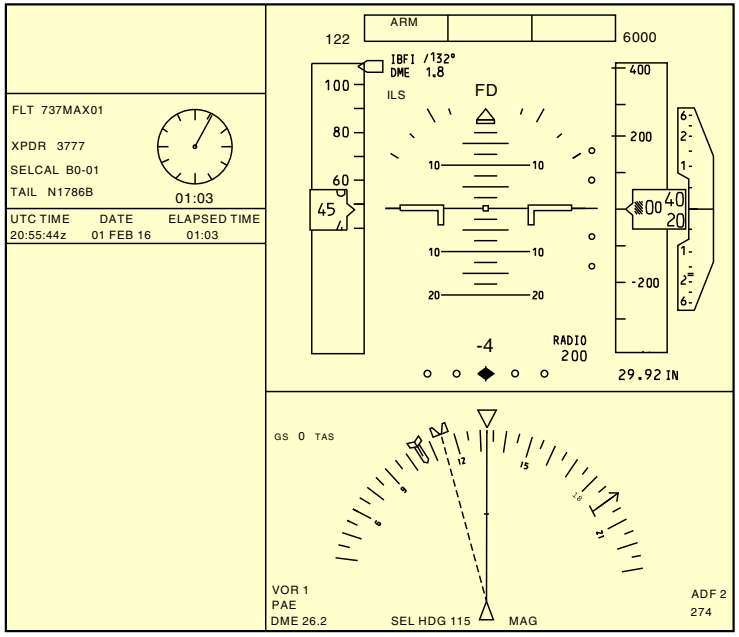
When the navigation display does not show on the same side of the flight deck, this information can also show on the mini map:

- Automatic direction finder (ADF)
- VHF omnidirectional ranging (VOR)
- Traffic alert and collision avoidance system (TCAS)
- Weather radar (WXR)
- Terrain awareness.

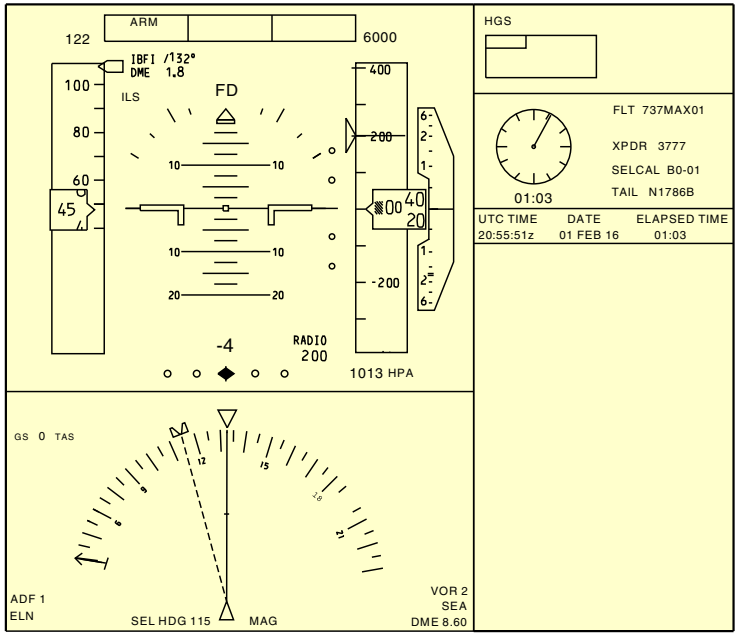
This data shows on the AOB:

- Flight number
- Transponder code
- SELCAL code
- Tail number
- Universal time coordinated (UTC) time
- UTC date
- Elapsed time
- Chronograph
- Landing capability placard status (Optional)

MDS - PRIMARY FLIGHT DISPLAY



LEFT OUTBOARD
PRIMARY FLIGHT DISPLAY/MINIMAP-NORMAL



RIGHT OUTBOARD
PRIMARY FLIGHT DISPLAY/MINIMAP-NORMAL

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MDS - PRIMARY FLIGHT DISPLAY

Approach Display

The Approach (APP) mode display can show in a full-screen or halfscreen format. The APP display can also show in an expanded view and a center view.

The expanded full screen mode shows 140 degrees of the compass rose. The expanded half screen mode shows 60 degrees of the compass rose. The airplane symbol, localizer deviation scale, and bar are at the bottom with the glideslope deviation scale and pointer on the right side of the displays.

The center full screen and center half screen modes show 360 degrees of the compass rose. The airplane symbol, localizer deviation scale and bar are in the center with the glideslope deviation scale and pointer on the right side of the displays.

This ILS information shows on the display:

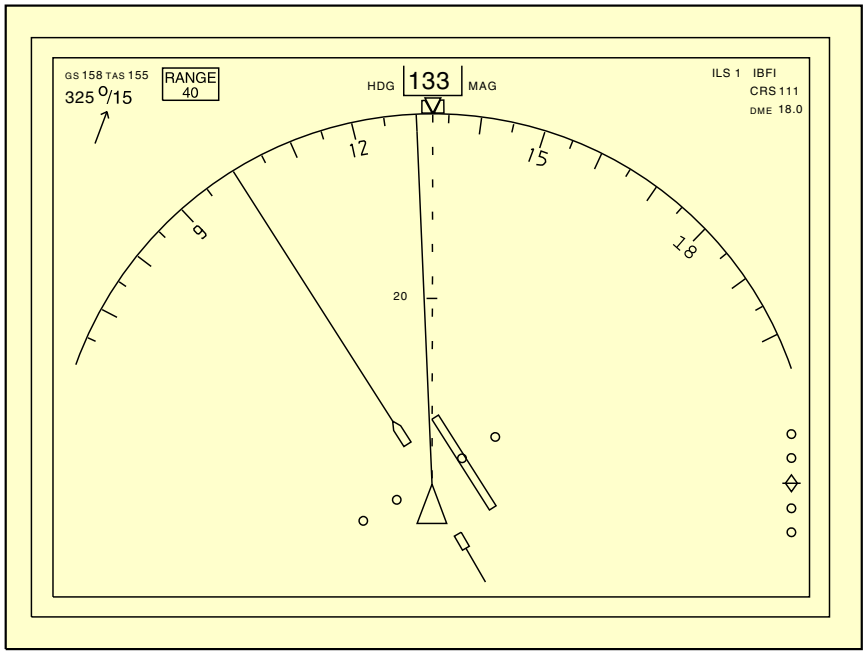
- Localizer deviation
- Glide slope deviation
- System source annunciation
- Station identifier or frequency
- Selected runway heading
- DME distance.

This additional information shows:

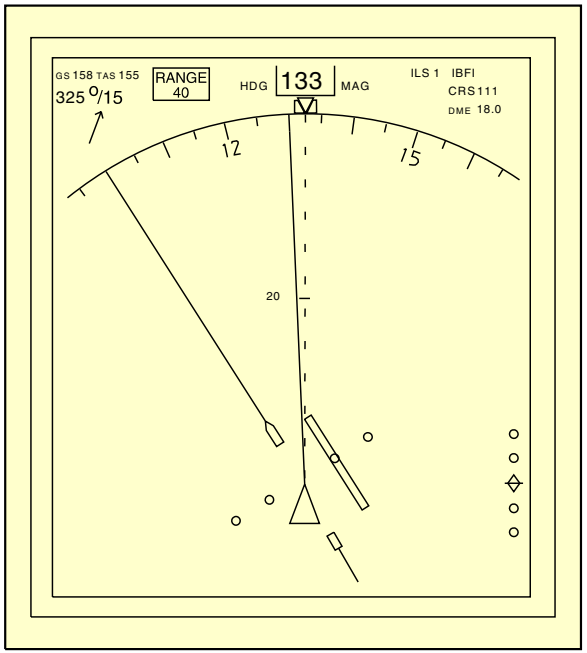
- Ground speed • True airspeed • Wind speed and direction • Range setting
- True airspeed
- Wind speed and direction
- Range setting

The MAX display system expands the localizer deviation scale upon localizer capture during Flight Director (FD) manual approach and Autopilot (AP) approach.

MDS - APPROACH DISPLAY



FULL-SCREEN APP DISPLAY



HALF-SCREEN APP DISPLAY

2552792 S0000608465_V2

MDS - APPROACH DISPLAY

VOR Display

The very high frequency (VHF) omnidirectional ranging (VOR) mode can show in a full-screen or half-screen format. The VOR display can also show in an expanded view and a center view.

The expanded VOR mode shows 140 degrees of the compass rose. The airplane symbol with the VOR deviation scale and deviation bar show at the bottom.

The center VOR mode shows 360 degrees of the compass rose. The airplane symbol with the VOR deviation scale and deviation bar show in the center.

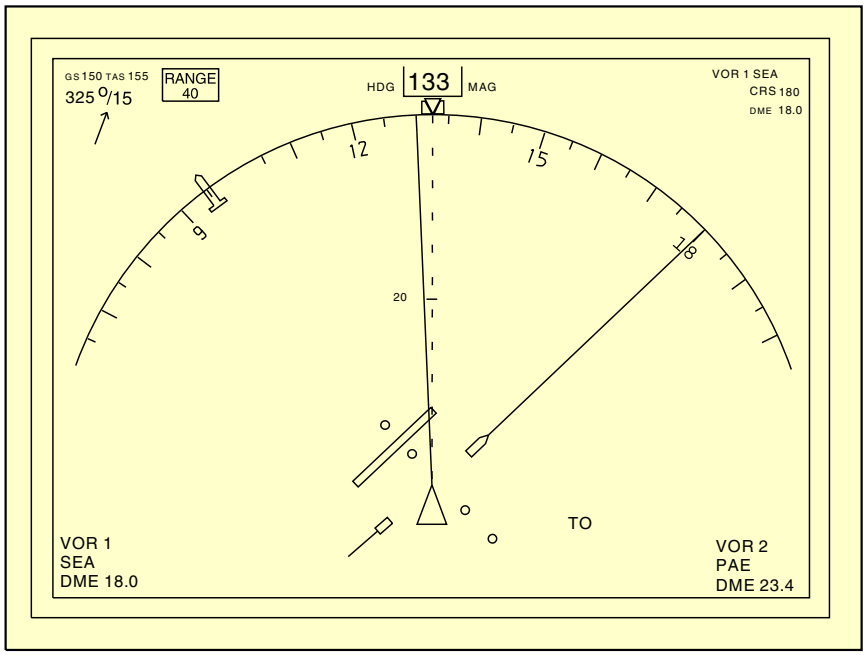
This VOR data shows on the VOR display:

- VOR deviation scale and deviation bar
- To/from annunciation
- System source annunciation
- Station identifier or frequency
- Station bearing
- Selected course
- Distance measuring equipment (DME) distance to the VOR station.

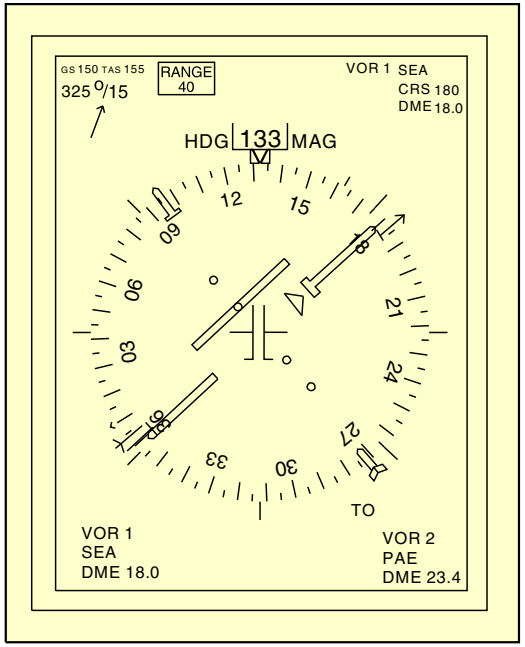
This additional data shows on the VOR display:

- Ground speed • True airspeed • Wind speed and direction • Range setting (expanded view only).
- True airspeed
- Wind speed and direction
- Range setting (expanded view only).

MDS - VOR DISPLAY



FULL-SCREEN VOR DISPLAY



HALF-SCREEN VOR DISPLAY

2552793 S0000608466_V2

MDS - VOR DISPLAY

MAP Mode

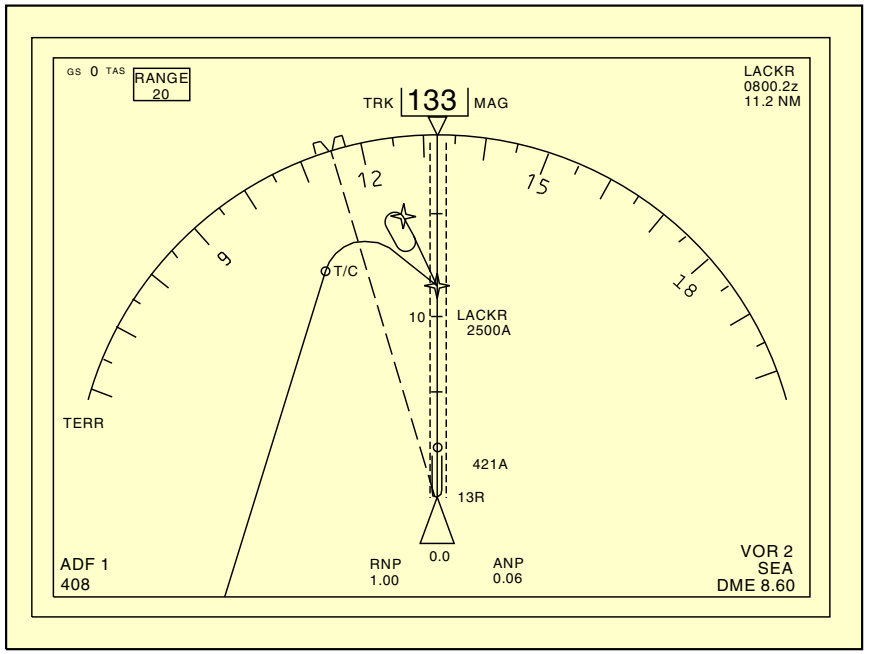
The map mode can show in a fullscreen or half-screen format. The full-screen map mode can only show on an inboard display unit. The half-screen map mode can show on the inboard side of the outboard display unit or the outboard side of the inboard display unit.

The map mode can show in a center view or an expanded view. The map mode can show with the vertical situation display (VSD) or without the VSD.

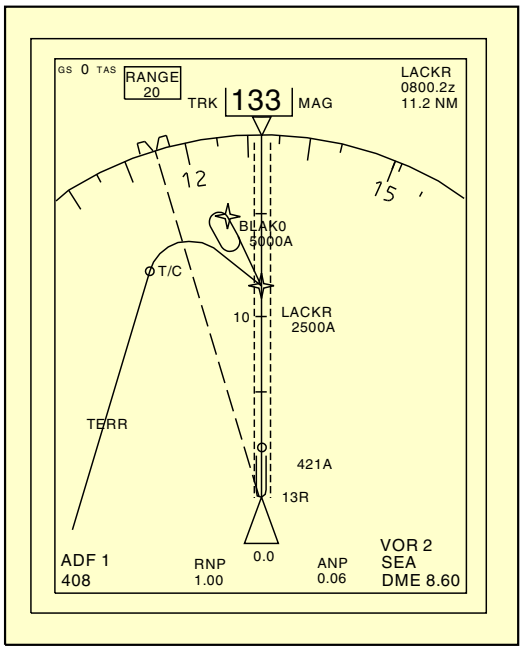
This data can show in the map mode:

- Airplane track
- Airplane heading
- Flight plan data
- Active waypoint data
- Navigation aids
- Waypoints
- Airports
- Vertical path deviation
- Trend vectors
- Groundspeed
- True airspeed
- Wind data
- Automatic direction finder (ADF)
- VHF omnidirectional ranging (VOR)
- Traffic alert and collision avoidance (TCAS)
- Weather radar (WXR)
- Terrain awareness

MDS - MAP MODE



FULL-SCREEN MAP DISPLAY



HALF-SCREEN MAP DISPLAY

2552794 S0000608467_V2

MDS - MAP MODE

MDS - MAP DISPLAY WITH VSD OPTION

Map Display with VSD option

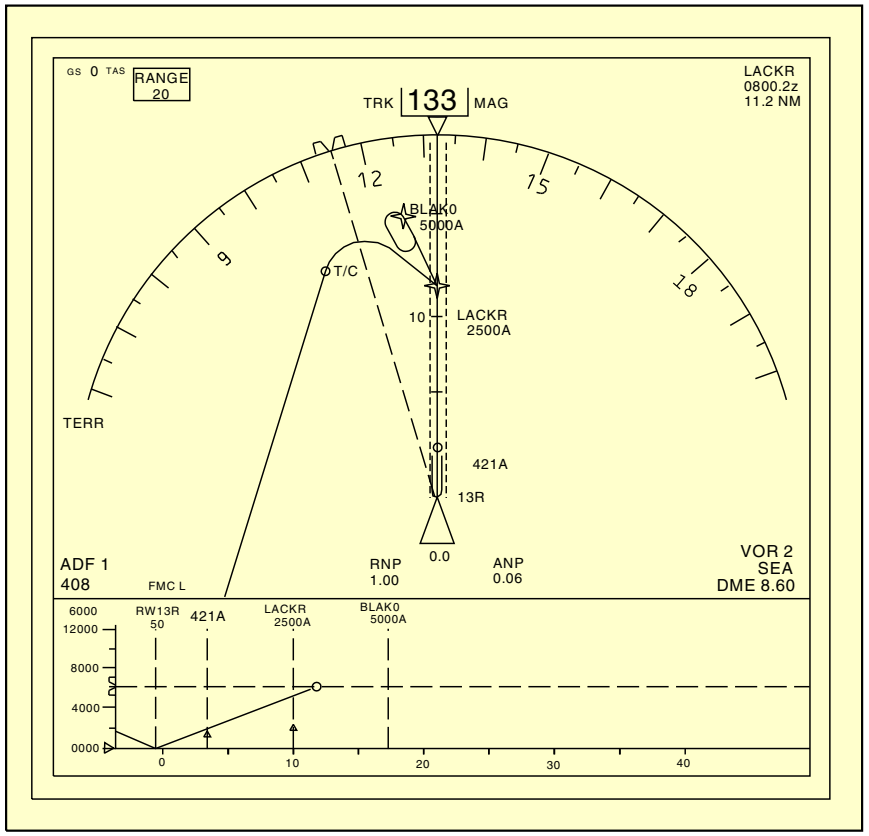
The vertical situation display (VSD) shows a side view of the airplane and the ground below the current airplane track. The VSD is provided to enhance the flight crew's situational awareness. It is not intended to be a control display.

The lower 35% of the MAP display is used for the VSD and the upper display area shows the expanded or center MAP display. VSD is selected by first selecting MAP as the display mode and then pushing the VSD pushbutton on the EFIS control panel.

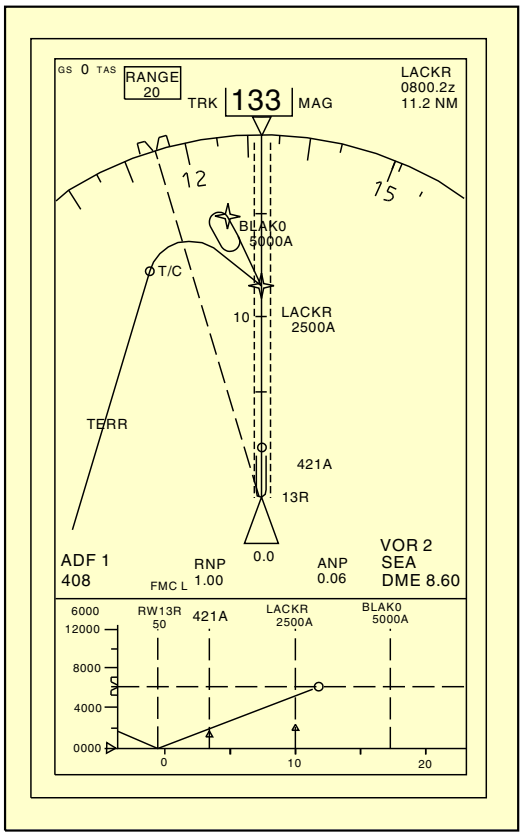
This data can be displayed on the VSD:

- Airplane altitude
- Vertical flight path vector
- Selected vertical speed
- Selected altitude
- Waypoints
- Waypoint altitude constraints
- Destination runway
- VNAV final descent angle
- Terrain data.

MDS - MAP DISPLAY WITH VSD OPTION



FULL-SCREEN MAP DISPLAY WITH VSD



HALF-SCREEN MAP DISPLAY WITH VSD

2552795 S0000608468_V2

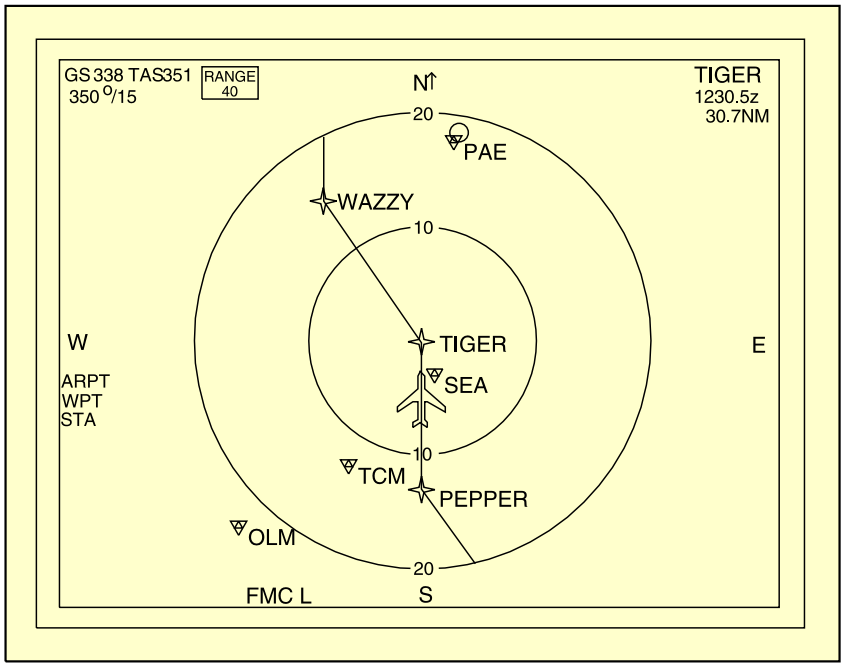
MDS - MAP DISPLAY WITH VSD OPTION

MDS - PLAN MODE

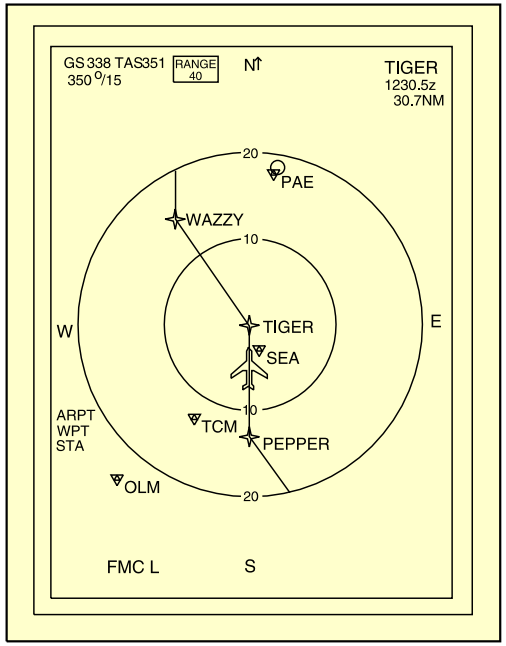
Plan Mode

The flight crew uses the plan mode to create, view or change a flight plan. The display is a north up display. The airplane symbol shows present position and FMC track.

MDS - PLAN MODE



FULL-SCREEN PLN DISPLAY



HALF-SCREEN PLN DISPLAY

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MDS - PLAN MODE

Engine Indication Display

The engine indication (EI) display normally shows on the left or right inboard display unit. The EI display can show on an outboard display unit if the inboard display unit on that side has a failure.

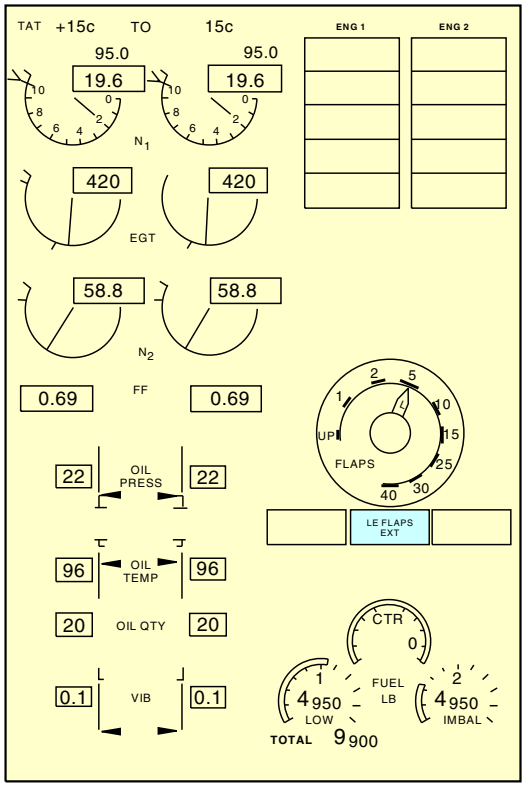
This data shows on the EI display:

- N1
- Exhaust gas temperature
- N2
- Fuel flow
- Oil pressure
- Oil temperature
- Oil quantity
- Engine vibration
- Crew alert messages
- Flaps data
- Fuel quantity
- Total air temperature
- Thrust mode annunciation
- Selected air temperature.

The EI display can also show in a decluttered format. You use the ENG push-button on the multifunction panel (MFP) to change between the normal EI display and the decluttered IE display. When the decluttered EI display shows, these indications do not show:

- N2 • Fuel flow (can show full time) • Oil pressure • Oil temperature • Oil quantity • Engine vibration
- Fuel flow (can show full time)
- Oil pressure
- Oil temperature
- Oil quantity
- Engine vibration

MDS - ENGINE INDICATION DISPLAY



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MDS - ENGINE INDICATION DISPLAY

Crew Alert Messages

These are the crew alert messages for each engine:

- START VALVE OPEN
- OIL FILTER BYPASS
- LOW OIL PRESSURE
- THRUST
- FUEL FLOW.

See the engine starting section for more information on the START VALVE OPEN message (SECTION 80-00).

See the engine oil indicating section for more information on the OIL FILTER BYPASS and LOW OIL PRESSURE messages (SECTION 79-30).

See the thrust reverser indicating section for more information on the THRUST message (SECTION 78-36).

See the fuel indicating section for more information on the FUEL FLOW message (SECTION 73-30).

COMM Messages

These are the COMM messages:

- ACARS (medium level)
- ACARS (low level)
- ATC.

The COMM messages show in a list with new messages at the top. New COMM messages do not show during the takeoff or landing. If you push the Cancel/Recall button (C/R) on the Multi-Functional Panel Control, the COMM messages do not change.

The .ATC message is a medium level COMM message. The message shows when the FMC or the ACARS receives a DISPLAYABLE ATC uplink. When the message shows, the Aural Warning System makes a Hi-Low chime sound. Only one .ATC message shows at a time. On airplanes equipped with a FANS CDU, press the ATC key on the CDU to display the ATC uplink message.

The .ACARS message shows when the ACARS receives a DISPLAYABLE ACARS uplink.

When the medium level .ACARS message shows, the Aural Warning System makes a Hi-Low chime sound.

The low level .ACARS message does not make the Hi-Low chime sound. Also, the low level .ACARS message always shows on the bottom of the list of COMM messages. The low level .ACARS message shows one space to the right of the other types of messages.

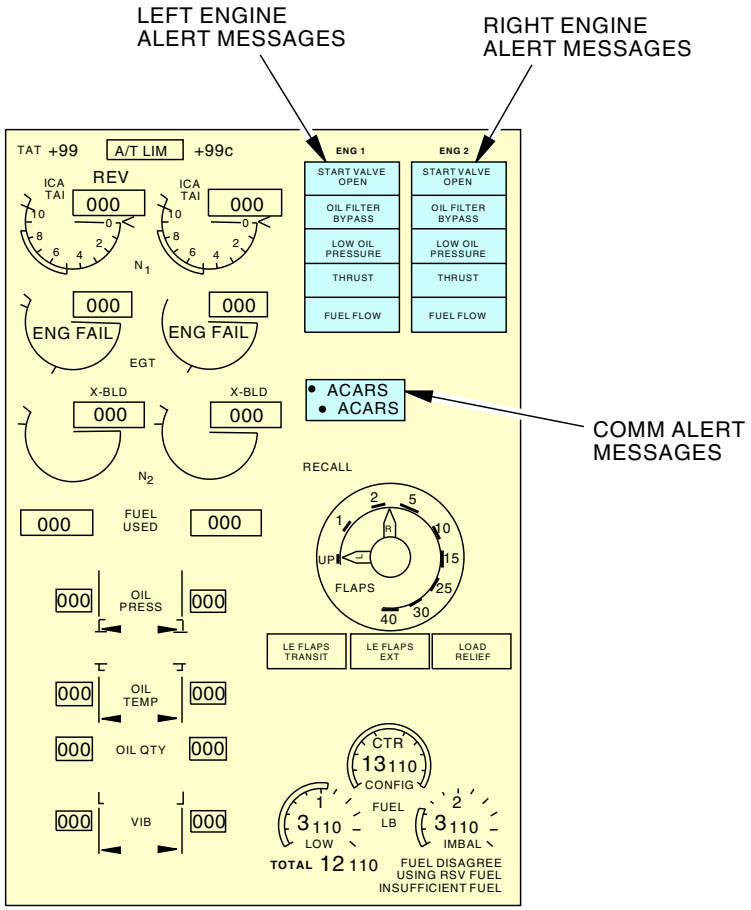
Cat IIIb Messages

Cat IIIb messages show below the crew alert messages. If you push the Cancel/Recall button (C/R) on the Multi-Functional Panel Control, the messages are removed. After you cancel a message, the Recall Cue shows. While the Recall Cue shows, you can push the Cancel/Recall button (C/R) to make the cancelled messages show again.

These are the Cat IIIb messages that can show:

- NO AUTOLAND
- NO LAND 3.

MDS - ENGINE INDICATION DISPLAY - CREW ALERT MESSAGES

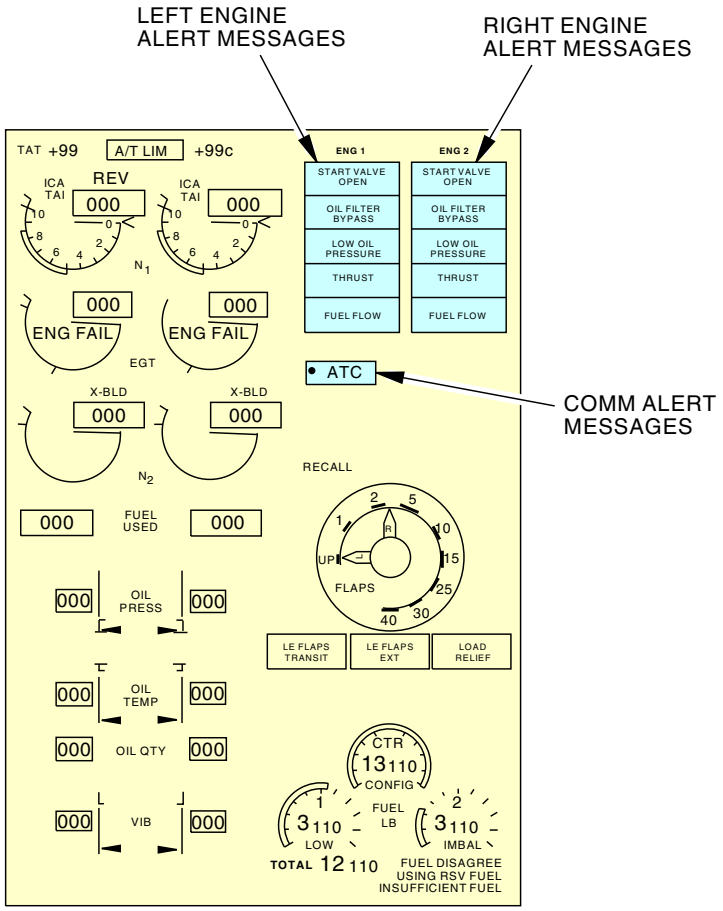


(EXAMPLE)

2567285 S0000614577_V3

MDS - ENGINE DISPLAY - CREW ALERT MESSAGES

MDS - ENGINE INDICATION DISPLAY - CREW ALERT MESSAGES

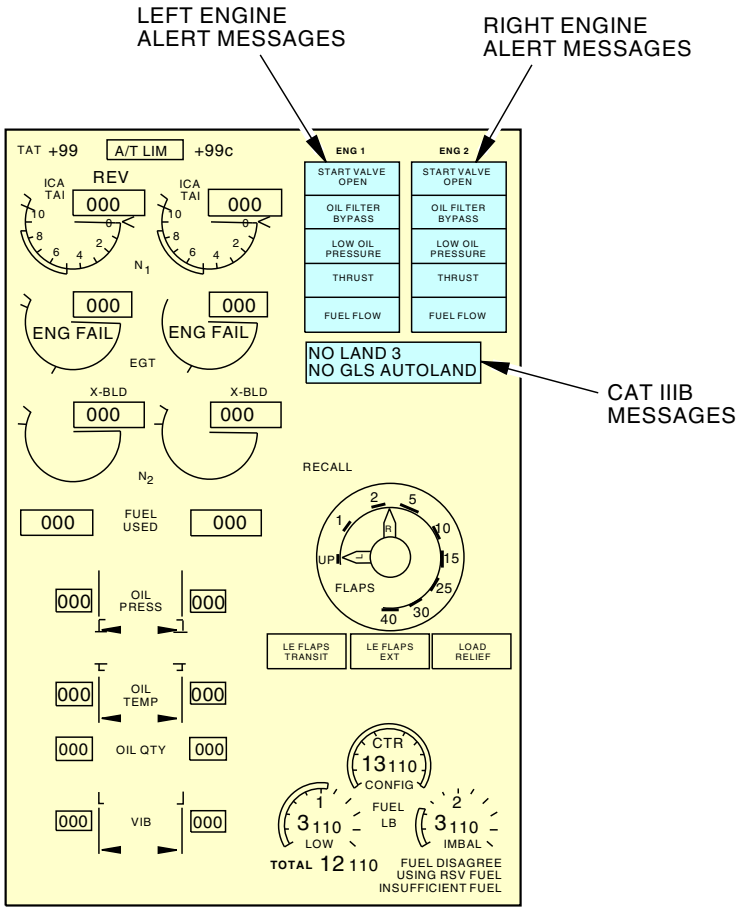


(EXAMPLE)

2567287 S0000614578_V3

MDS - ENGINE DISPLAY - CREW ALERT MESSAGES

MDS - ENGINE INDICATION DISPLAY - CREW ALERT MESSAGES



(EXAMPLE)

2567290 S0000614579_V3

MDS - ENGINE DISPLAY - CAT IIIB MESSAGES

MDS - SYSTEMS DISPLAY

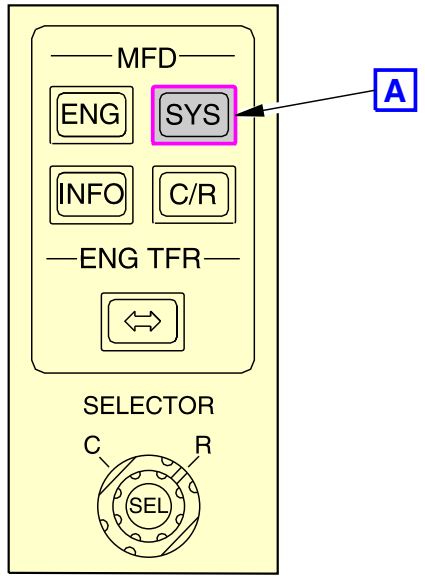
System Display

The systems display shows when you push the MFD - SYS (multifunction display - system) pushbutton on the multifunction panel. The systems display can show on an inboard or outboard display unit.

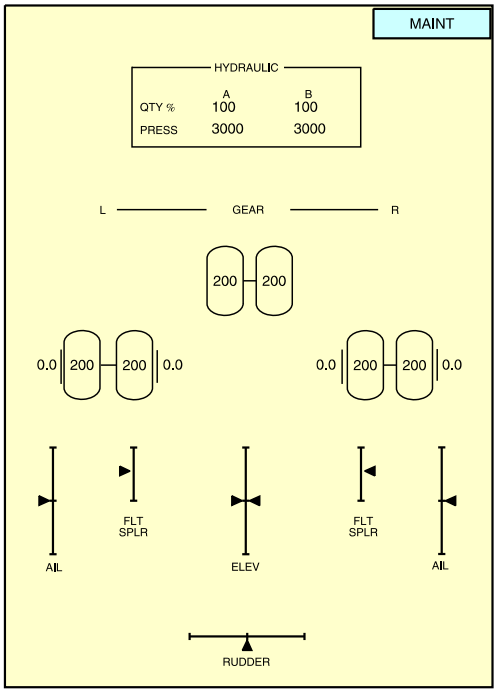
This data shows on the systems display:

- Hydraulic quantity
- Hydraulic pressure
- Brake temperature
- Tire pressure
- Flight control surface positions.

MDS - SYSTEMS DISPLAY



MULTI-FUNCTION PANEL



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MDS - SYSTEMS DISPLAY

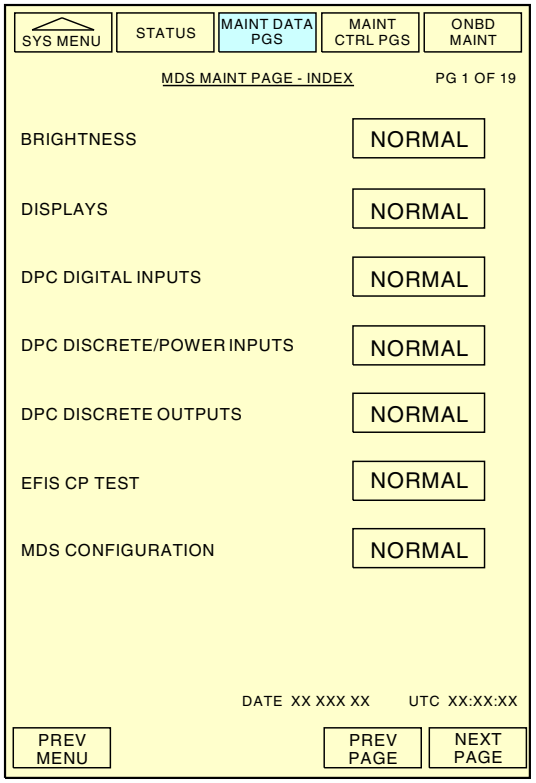
MDS - MAINTENANCE PAGES

Maintenance Pages

Maintenance data shows on the MDS maintenance pages. The maintenance data includes:

- BRIGHTNESS
- DISPLAYS
- DPC DIGITAL INPUTS
- DPC DISCRETE/POWER INPUTS
- DPC DISCRETE OUTPUTS
- EFIS CP TEST
- MDS CONFIGURATION.

MDS - MAINTENANCE PAGES



MDS MAINT PAGE-INDEX

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MDS - MAINTENANCE PAGES

MDS - MISCELLANEOUS SYSTEM CONTROL PAGE

Miscellaneous System Control Page

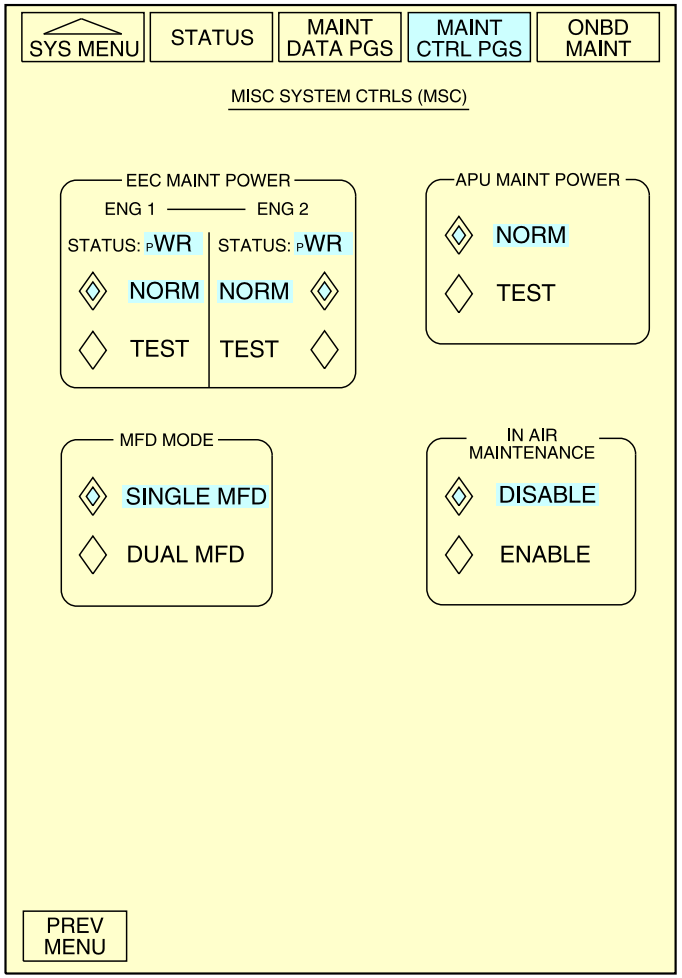
The Miscellaneous System Control page provides controls for setting the following aircraft system components into test mode:

- APU Maintenance
- EEC Maintenance

This page also provides settings for controlling the following:

- Single or Dual MFD Mode
- Enable or Disable of Maintenance Page Access in Air
- Enable Landing Capability Placard (Optional)

MDS - MISCELLANEOUS SYSTEM CONTROL PAGE



(EXAMPLE)

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MISCELLANEOUS SYSTEM CONTROLS W/O LANDING PLACARD CONFIGURATION

MDS - MAINTENANCE AWARENESS SYSTEM (MAS)

General

The Maintenance Awareness System (MAS) gives information directly related to airworthiness and system information. The system includes the status messages page, maintenance data pages, and maintenance control pages.

MAINT Light

Before flight, the flight crew must make sure that the aircraft is airworthy. The MAINT light shows that there is a system fault that has an effect on airplane airworthiness. The flight crews report the MAINT light to maintenance personnel.

If a new message is active, the MAINT light comes on 30 seconds after the airplane touches down or when engines are off.

If all messages are confirmed (checked) on the MAINT LIGHT page, the MAINT light goes off.

If the MAINT light is still on, it goes off when the first engine starts.

When the airplane is in the air, 30 seconds after the flaps transition to up, confirmations on the MAINT LIGHT page are automatically unlatched if the respective message is no longer active or latched.

Each DPC controls the MAINT light through an analog discrete.

The DPCs collect airworthiness faults from the following systems:

- Auxiliary Power Unit (APU)
- Electronic Engine Controller (EEC)
- Flight Management Computer (FMC)
- Integrated Air Supply Controller (IASC)
- Electronic Bleed Air System (EBAS)
- Proximity Sensing Electronic Unit (PSEU)
- Spoiler Control Unit (SCU)
- Stall Management Yaw Damper (SMYD)
- Tire Brake Monitoring Unit (TBMU).

Status Page

The status messages page shows after you select the MAINT button. The status messages page gives information to help analyze aircraft airworthiness.

Maintenance Data Pages

The maintenance data pages give information for these systems:

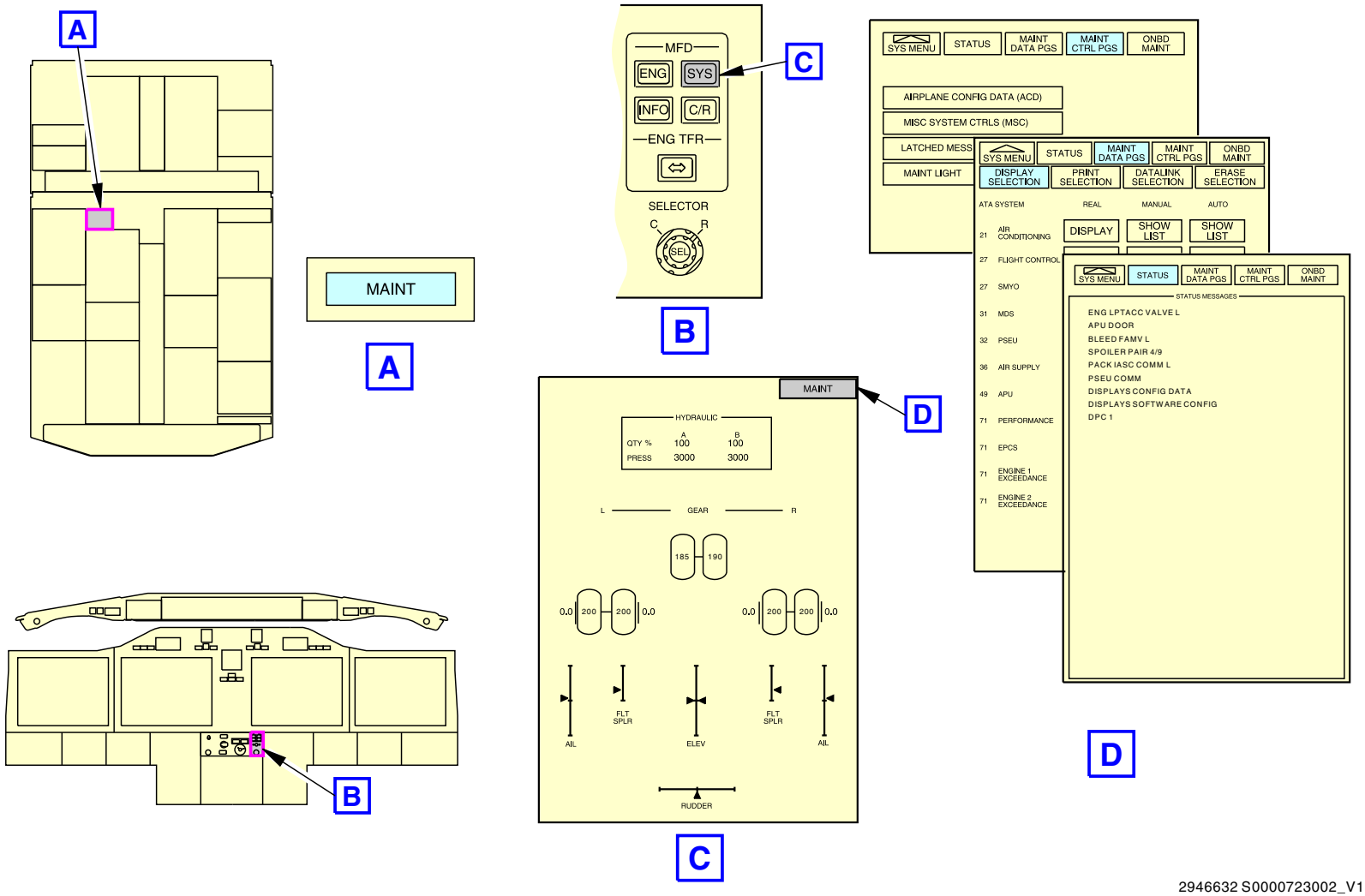
- Air conditioning systems
- Flight control systems
- Stall management yaw damper system
- Proximity switch electronic unit
- Air supply systems
- Performance system
- Auxiliary power unit
- Main engine systems.

Maintenance Control Pages

The maintenance control pages give access to these pages:

- Airplane configuration data (ACD)
- Miscellaneous system controls (MSC)
- Latched message erase
- Maint light.

MDS - MAINTENANCE AWARENESS SYSTEM (MAS)



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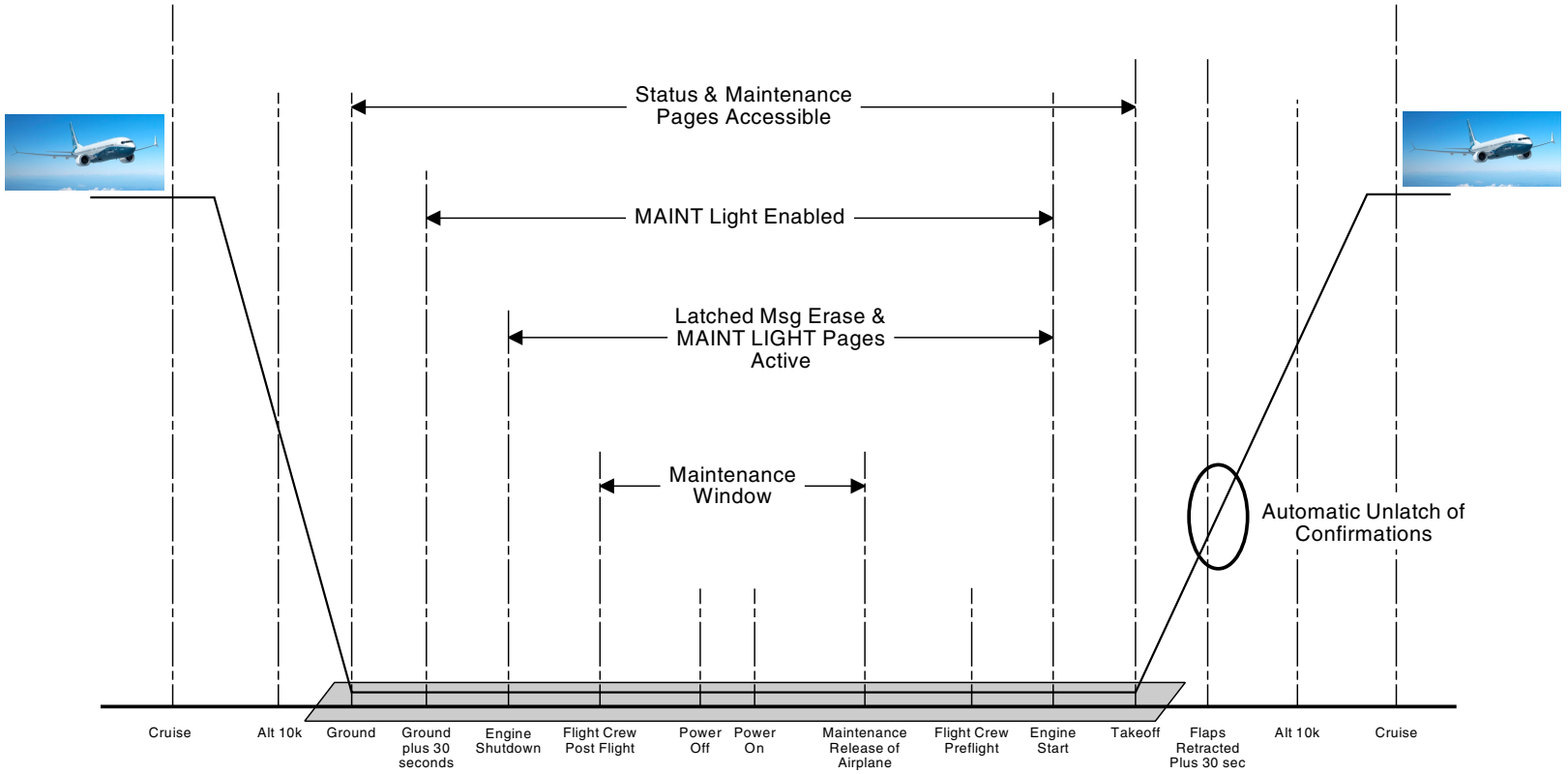
MDS - MAINTENANCE AWARENESS SYSTEM (MAS)

MDS - MAINTENANCE AWARENESS SYSTEM (MAS)



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MDS - MAINTENANCE AWARENESS SYSTEM (MAS)

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MDS - PORTABLE MAINTENANCE DEVICE

Equipment

The portable maintenance device (PMD) can be a laptop, tablet, or similar device that has sufficient hardware, proper software installed and correct security certificates.

The PMD has a menu driven screen with the same selections as the MAX display system OMF menus plus additional applications to allow for control, monitoring and testing.

PMD Maintenance Menu

The primary menus are:

- Line Maintenance
- Extended Maintenance
- Other Functions.

Line Maintenance

The line maintenance menu has these sub menus available:

- Inbound flight deck effects
- Existing flight deck effects
- Ground tests
- System configuration
- Fault guidance
- Download manager
- Security
- Airplane ID.

Extended Maintenance

The primary menus are:

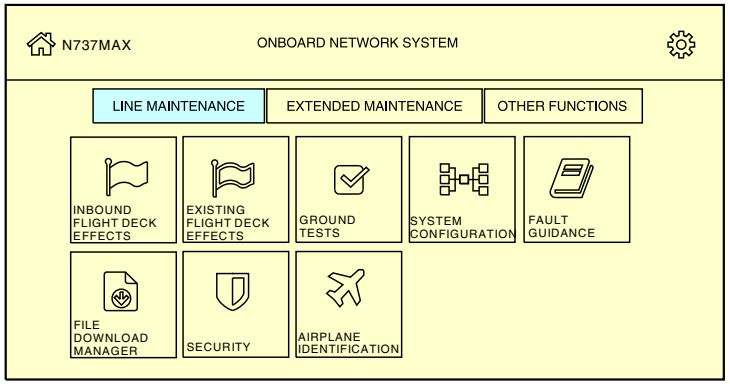
- Present leg faults
- Existing faults
- Fault history
- Data load
- Maintenance enable/disable
- Network file server
- Mass storage device
- LRU reports
- Off board links
- Crew wireless
- Printer condition.

Other Functions

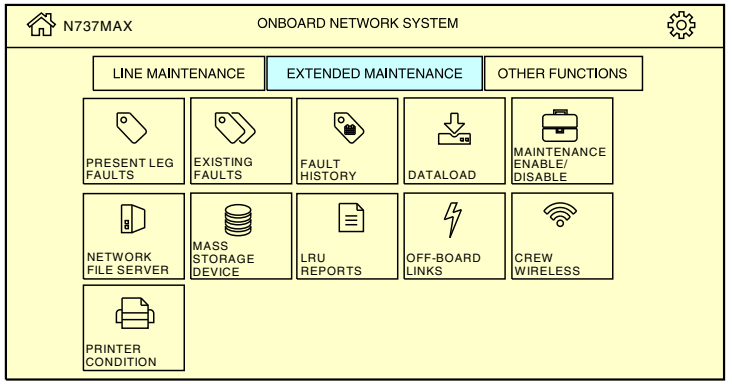
The other functions menu only has these sub menus available:

- Special functions
- Shop faults
- Input monitoring
- Airplane data monitoring
- Engine health management.

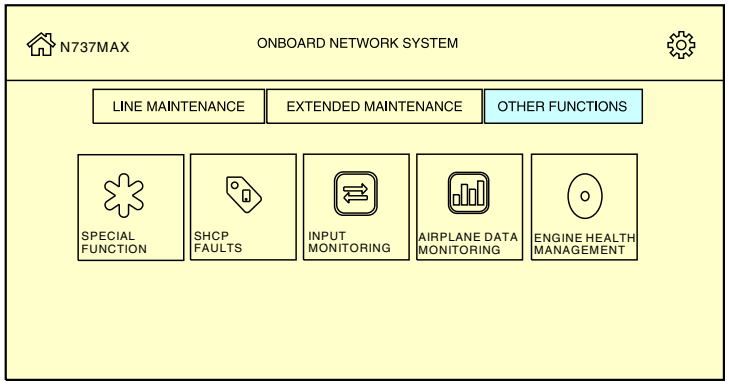
MDS - PORTABLE MAINTENANCE DEVICE



LINE MAINTENANCE MENU



EXTENDED MAINTENANCE MENU



OTHER MAINTENANCE MENU

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MDS - PORTABLE MAINTENANCE DEVICE

Loading Software

To load the LSAPs into the airplane requires two steps or stages. Stage one loads data from the portable maintenance device (PMD) to the network file server (NFS). Stage two loads data from the NFS to the user line replaceable unit (LRU).

Stage One

Use the portable maintenance device (PMD) to upload the data to a mass storage device where the information will reside on the airplane until required.

These are the choices available for the mass storage device depending on airplane configuration:

- Network file server
- Cabin services system
- Aircraft information management system (AIMS).

The NFS is the main storage point on the airplane for all current software. This would include one time uploaded files such as operational software used on a LRU. LSAPs that are changed under specific time frames would also be stored here such as:

- FMC 28 day NAV data base
- EGPWS 60 day updates.

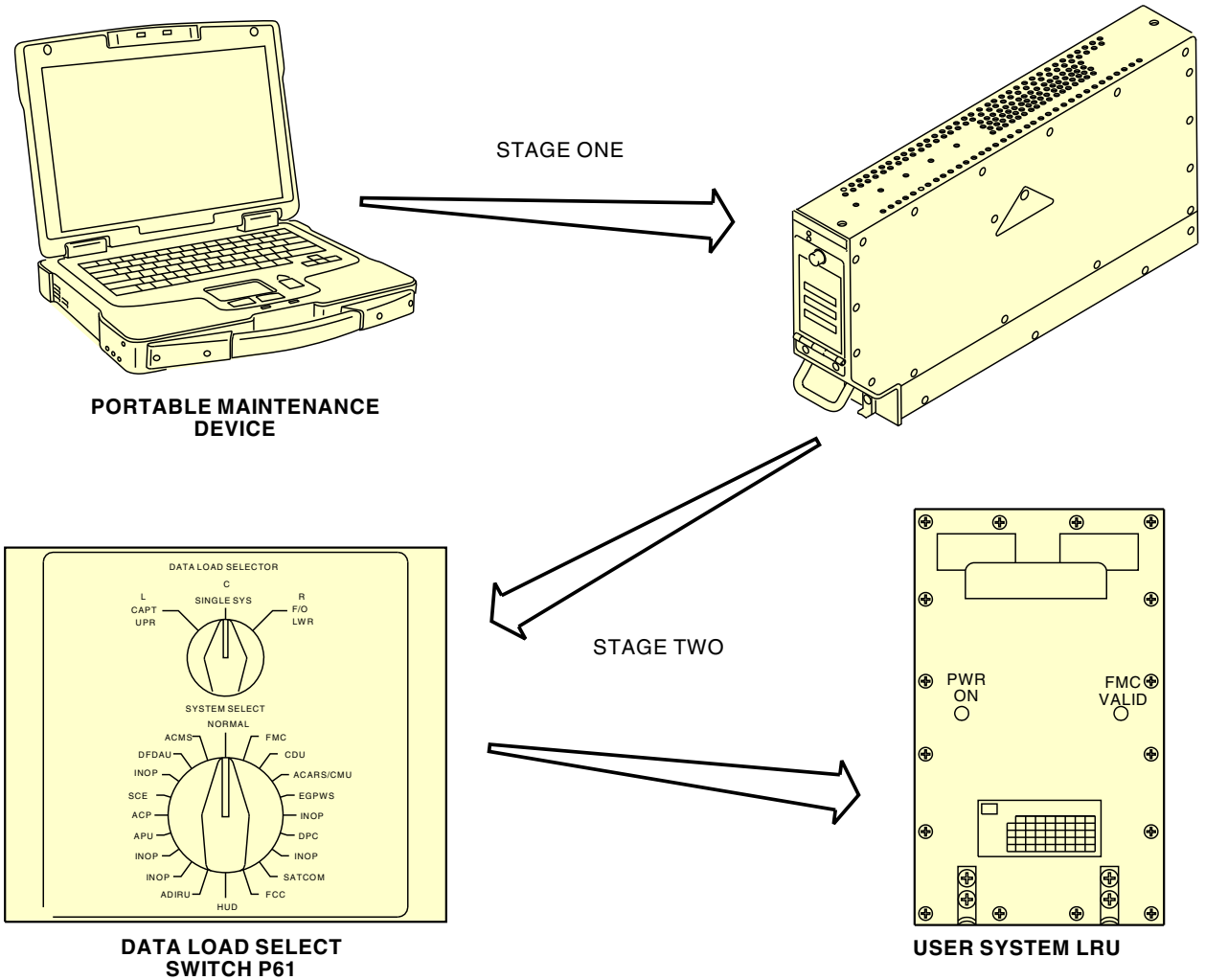
Stage Two

Moving the LSAP from the mass storage device to the LRU. The information is transferred either by ARINC 429 or Ethernet (ARINC 615A) data bus.

For ARINC 429 data, the data load select switch on P61 is used to select the receiving LRU. The MAX display system or portable maintenance device is used to control the transfer of the LSAP.

Ethernet (ARINC 615A) is directly connected from the NFS to the LRU. The dataload select switch can be used to send a discrete to the LRU to enable software loading.

MDS - LOADABLE SOFTWARE PARTS (LSAP)



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MDS - LOADABLE SOFTWARE PARTS (LSAP)

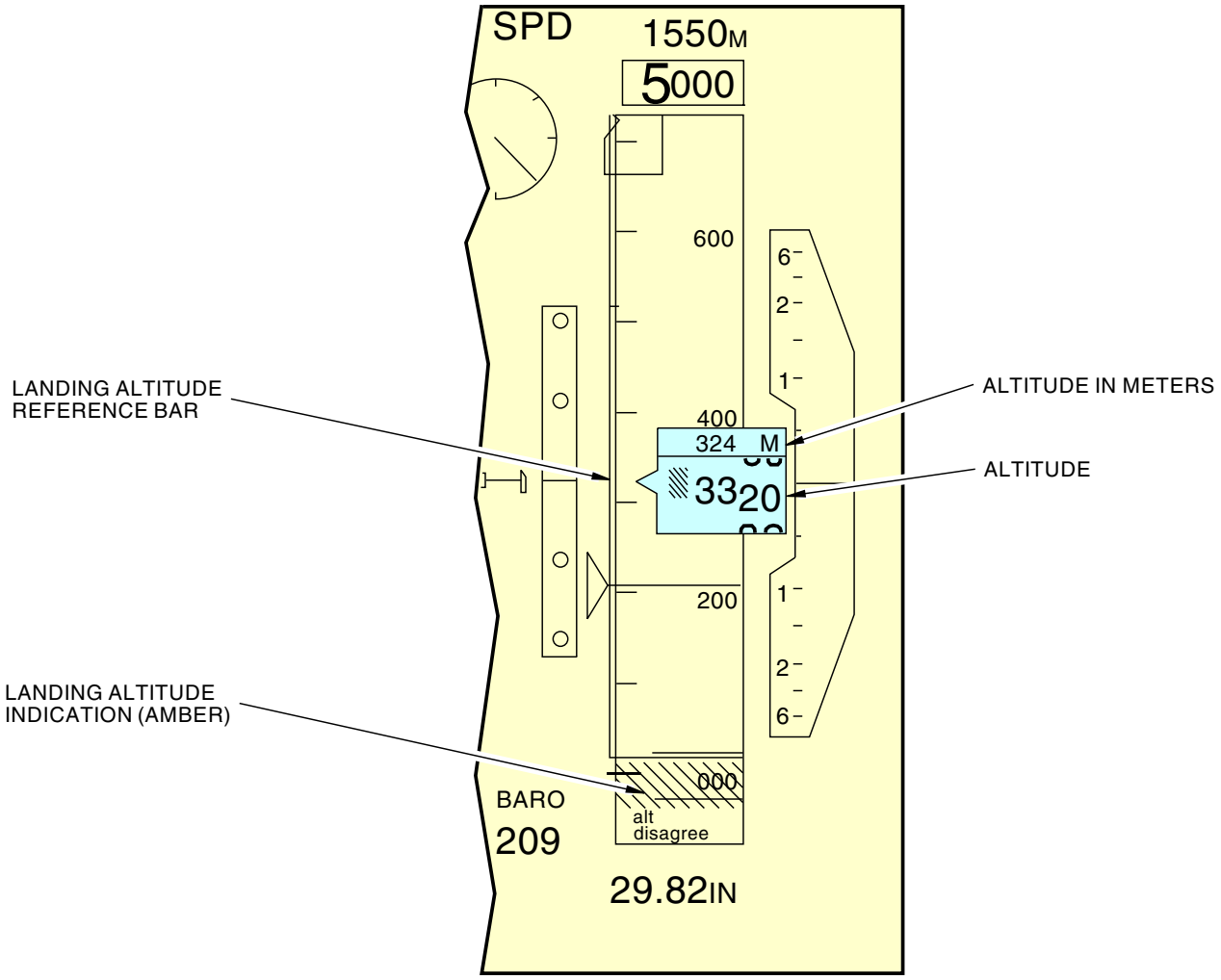
Landing Altitude Indications

The landing altitude indication shows as a crosshatched area on the altitude tape.

This shows the Flight Management Computer (FMC) landing altitude for the destination runway or airport. Or the landing altitude for the departure runway or airport until 400NM from the departure or half the distance to the destination, whichever occurs first.

A landing altitude reference bar is shown along the inner edge of the altitude indication. The landing altitude reference bar shows the height above touchdown. From 0 to 500 feet above landing altitude, the bar is amber. From 500 to 1000 feet, the bar is white.

MDS - PFD - ALTITUDE INDICATIONS



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MDS - PFD - ALTITUDE - INDICATIONS