CHAPTER

73

Engine Fuel and Control

(CFM56 ENGINES (CFM56-7))

CHAPTER 73
ENGINE FUEL AND CONTROL

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ENGINE FUEL AND CONTROL - INTRODUCTION

General

The engine fuel and control system calculates the quantity of fuel necessary to make the commanded thrust. The engine fuel and control system then meters the fuel and injects it into the combustor. The engine fuel and control system also sends the necessary fuel to the engine air system so the engine operation is efficient and stable. See the engine air system chapter for more information. (CHAPTER 75)

The engine fuel and control system has three subsystems:

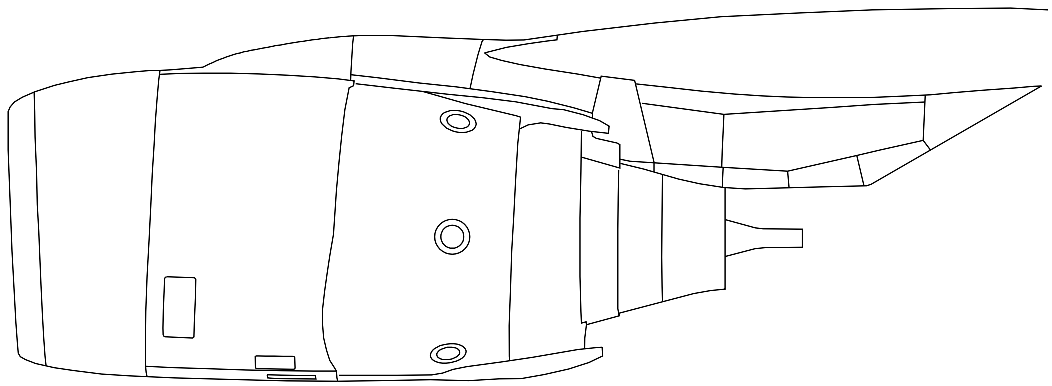
- Fuel distribution
- Fuel control
- Fuel indication.

Abbreviations And Acronyms

- ACS - air conditioning system
- ADIRU - air data inertial reference unit
- AGB - accessory gearbox
- ASM - autothrottle servo-motor
- A/T - autothrottle
- BITE - built-in test equipment

AKS ALL PRE SB CFM56-7B 73-44
- BSV - burner staging valve

AKS ALL
- CDS - common display system
- CDU - control display unit
- CCDL - cross channel data link
- DEU - display electronics unit
- FIM - fault isolation manual
- FF - fuel flow
- EEC - electronic engine control
- EHSV - electro-hydraulic servo valve
- FWD - forward
- HPSOV - high pressure shutoff valve
- HPT - high pressure turbine
- HPTACC - high pressure turbine active clearance control
- HMU - hydro-mechanical unit
- IDG - integrated drive generator
- J - junction
- LPT - low pressure turbine
- LPTACC - low pressure turbine active clearance control
- LRU - line replaceable unit
- LVDT - linear variable differential transformer
- N1 - low pressure compressor rotor speed
- N2 - high pressure compressor rotor speed
- P - pressure
- PDL - portable data loader
- PT - total pressure
- RVDT - rotary variable differential transducer
- SAC - single annular combustor
- T - temperature
- TAT - total air temperature
- TBV - transient bleed valve
- TGB - transfer gearbox
- T/L - thrust lever
- TLA - thrust lever angle
- TLR - thrust lever angle resolver
- T/R - thrust reverser
- TRA - thrust resolver angle
- VBV - variable bleed valve
- VSV - variable stator vane



ENGINE FUEL AND CONTROL SYSTEM

FUEL DISTRIBUTION

- FUEL PUMP ASSEMBLY
- IDG OIL COOLER
- BSV
- SERVO FUEL HEATER

FUEL CONTROL

- AIRPLANE INTERFACES
- SENSORS
- EEC
- HMU

FUEL INDICATING

- FUEL FLOW RATE
- FUEL USED
- HPSOV POSITION
- FILTER BYPASS LIGHT

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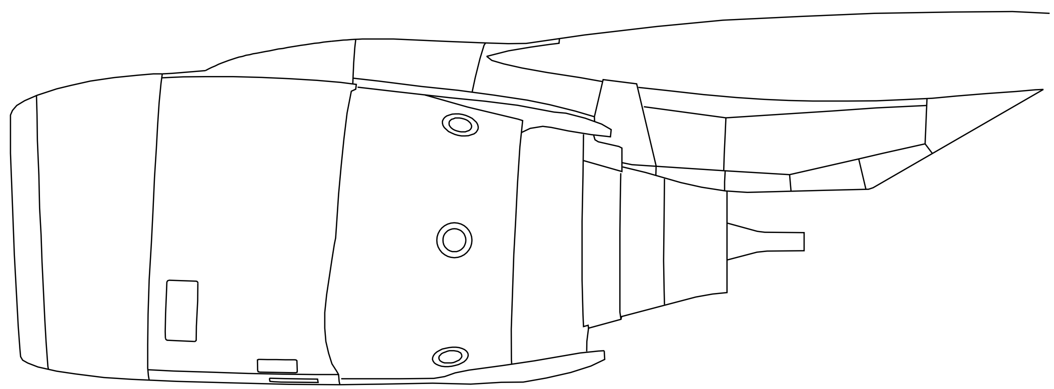
ENGINE FUEL AND CONTROL - INTRODUCTION



ENGINE FUEL AND CONTROL SYSTEM

FUEL DISTRIBUTION
- FUEL PUMP ASSEMBLY
- IDG OIL COOLER
- SERVO FUEL HEATER

FUEL CONTROL
- AIRPLANE INTERFACES
- SENSORS
- EEC
- HMU

FUEL INDICATING
- FUEL FLOW RATE
- FUEL USED
- HPSOV POSITION
- FILTER BYPASS LIGHT

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ENGINE FUEL AND CONTROL - INTRODUCTION

ENGINE FUEL AND CONTROL - GENERAL DESCRIPTION

General

All engine fuel and control components are on the engine. The airplane fuel system supplies fuel to the engine fuel and control system. The airplane also gives and receives digital and analog control data to and from the engine fuel and control system. The engine fuel and control system uses this data to control the engine and give engine status to other airplane systems.

Electronic Engine Control (EEC)

The EEC controls the engine fuel and control system. Two channels in the EEC use input data to calculate the engine fuel and control outputs to operate the engine.

Airplane Fuel System

The airplane fuel system supplies pressurized fuel from the center or main tank. The fuel goes from the tank through a boost pump and a spar valve before the fuel goes to the engine. See the fuel system chapter for more information on the airplane fuel system. (CHAPTER 28)

Engine Strut

The engine strut has grounds that supply the airplane model data to the EEC. The EEC uses this to find the maximum certified thrust for the airplane. This is different from the rated thrust. The maximum certified thrust is the thrust the engines will produce if the thrust levers are put against the forward stops. The rated thrust is the maximum thrust the autothrottle will command. The strut grounds also give the EEC the engine position.

Thrust Reverser System

The EEC gets thrust reverser translating sleeve position from a linear variable differential transformer (LVDT). The EEC uses this data to limit engine thrust while the thrust reverser translating sleeves move. The EEC also commands the engine to idle if it senses a thrust reverser sleeve is deployed part way in flight. The EEC sends thrust reverser position to the DEUs for thrust reverser indication on the display units (DUs). See the thrust reverser section for more information. (SECTION 78-30)

Aisle Control Stand

The EEC uses the thrust lever resolvers (TLRs) on the aisle stand to get thrust resolver angle (TRA). The EEC uses this data to find the commanded engine thrust. The EEC also sends TRA to the autothrottle computer.

The engine start lever and fire handle send signals directly to the HPSOV in the HMU. This lets the flight crew shut down the engine in normal or emergency situations. The EEC does not close the HPSOV. See the engine controls chapter for more information on the engine controls in the aisle stand. (CHAPTER 76)

In the IDLE or RUN position, the engine start levers send a start signal to the EEC through the DEUs. The engine start levers also send ignition power to the EEC. The EEC operates the engine ignition system. See the ignition chapter for more information. (CHAPTER 74)

ENG VALVE CLOSED Light

The ENG VALVE CLOSED light shows the position of the HPSOV. The ENG VALVE CLOSED light comes on bright when the HPSOV is in transit or is not in the commanded position. This light is on dim when the HPSOV is closed and is commanded closed. The ENG VALVE CLOSED light is off when the HPSOV is open and commanded open.

Display Electronics Units (DEUs)

The EEC gets and receives data from these airplane systems and components through the two DEUs:

- Engine and fuel indication
- Engine start lever IDLE or RUN or CUTOFF command
- Air data inertial reference unit (ADIRU) 1 and 2
- Flight management computer (FMC) and control display units (CDUs)
- Flight data acquisition unit (FDAU).

ENGINE FUEL AND CONTROL - GENERAL DESCRIPTION

The EEC sends input data from many of the engine sensors to the DEUs. The DEUs sends some of this data to the display units (DUs). These become engine data that shows on the primary and secondary engine displays. See the engine indicating chapter for more information. (CHAPTER 77)

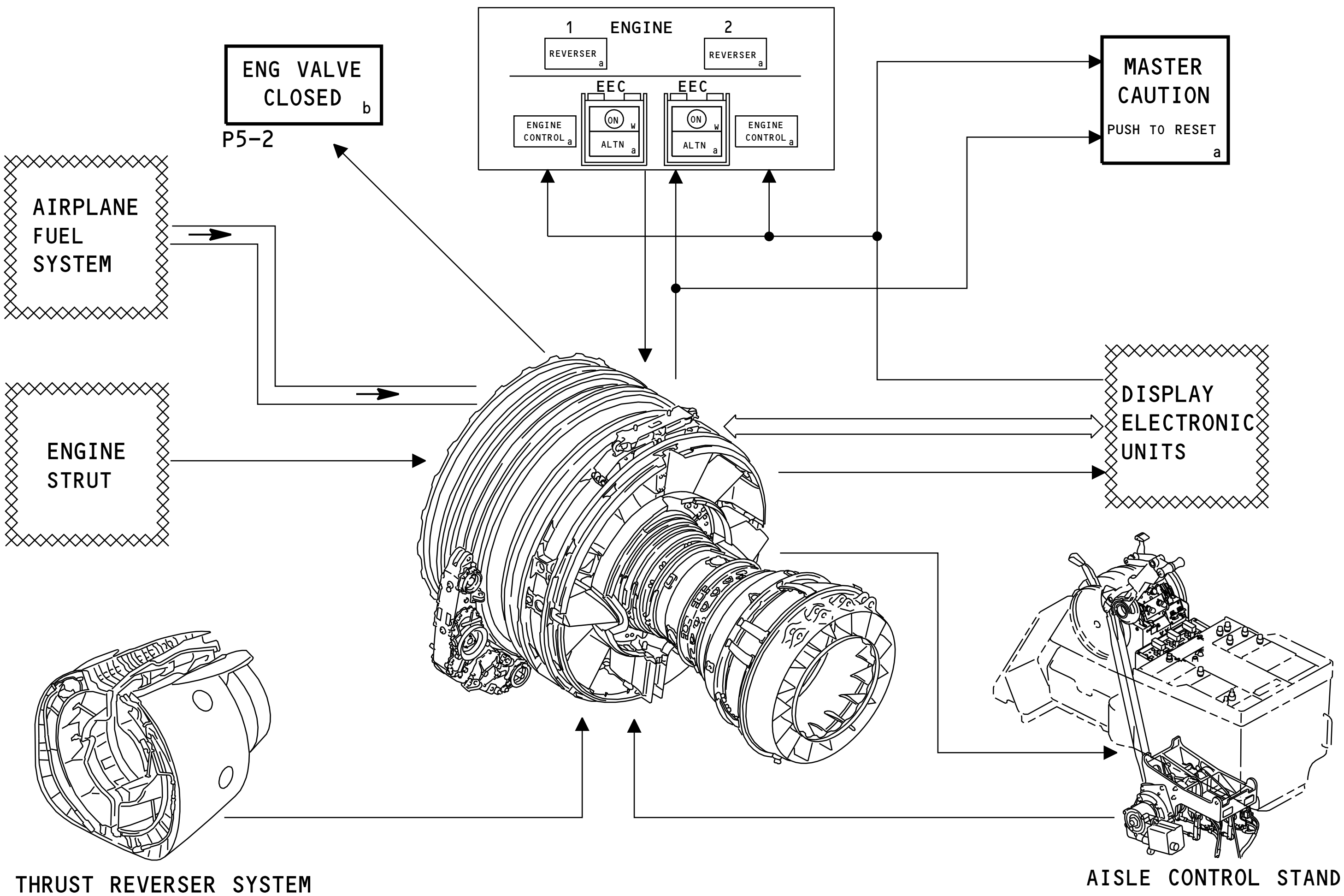
The ADIRU sends total and static air pressure and total air temperature data to the EEC through the DEUs. The EEC uses this data to control engine thrust.

The FMC supplies a connection between the CDU and the DEUs. The FMC also supplies target thrust to the EEC. The CDU shows EEC maintenance data, and sends commands to the EEC to do system BITE tests.

The FDAU collects engine parameter data. It sends this data to the flight data recorder (FDR).

Engine Control Light and EEC Switches

The EEC sends a signal to the engine control light on the P5 aft overhead panel through the DEUs for some faults detected by the EEC. If this light is on, the airplane cannot be dispatched. The EEC sends a signal to the EEC ALTN light on the P5 aft overhead panel if the EEC is in soft or hard alternate modes. When the EEC switch is in the off position, the EEC goes to the hard alternate mode. If the ENGINE CONTROL or ALTN light is on, the MASTER CAUTION lights also come on.



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ENGINE FUEL AND CONTROL - GENERAL DESCRIPTION

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ENGINE FUEL AND CONTROL - DISTRIBUTION - INTRODUCTION

Purpose

The engine fuel distribution system supplies fuel to the engine for combustion and servo system operation. The airplane fuel system supplies fuel to the engine fuel distribution system.

These are the major components of the engine fuel distribution system:

- Fuel pump assembly
- IDG oil cooler

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- Burner staging valve (BSV).

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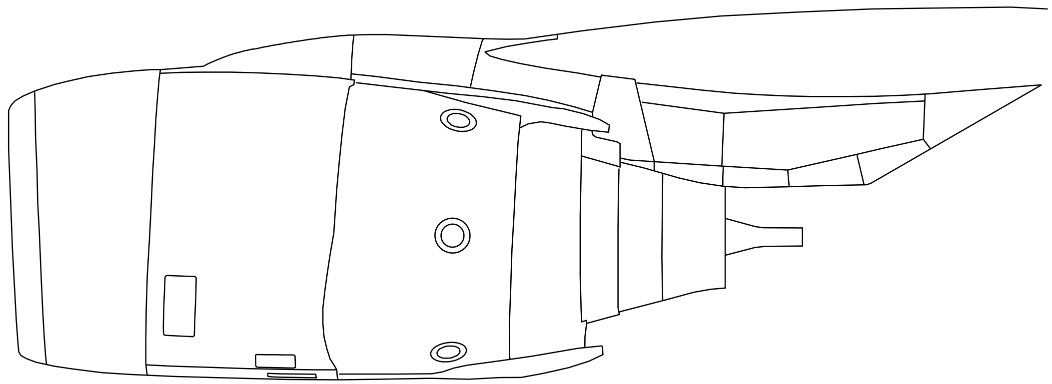

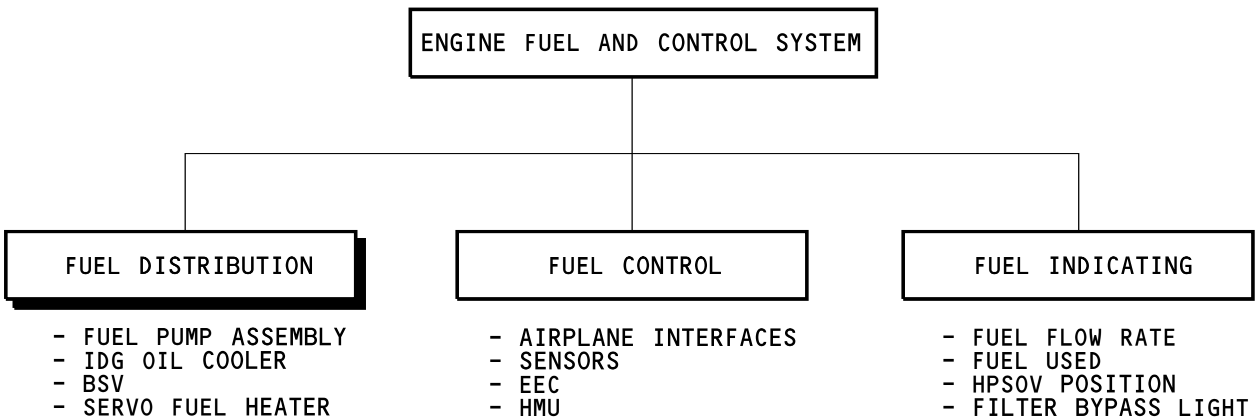

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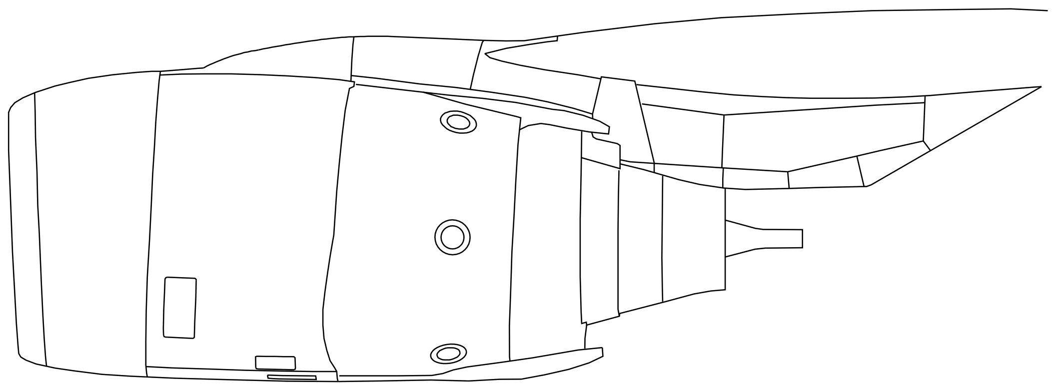
ENGINE FUEL AND CONTROL - DISTRIBUTION - INTRODUCTION



ENGINE FUEL AND CONTROL SYSTEM

FUEL DISTRIBUTION
- FUEL PUMP ASSEMBLY
- IDG OIL COOLER
- SERVO FUEL HEATER

FUEL CONTROL
- AIRPLANE INTERFACES
- SENSORS
- EEC
- HMU

FUEL INDICATING
- FUEL FLOW RATE
- FUEL USED
- HPSOV POSITION
- FILTER BYPASS LIGHT

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ENGINE FUEL AND CONTROL - DISTRIBUTION - INTRODUCTION

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ENGINE FUEL AND CONTROL - DISTRIBUTION - GENERAL DESCRIPTION

General

The engine fuel pump assembly receives fuel from the airplane fuel system.

The fuel pump assembly supplies pressurized fuel to the servo and metering sections of the HMU. The fuel filter in the pump cleans the fuel that goes to the HMU.

These units heat the fuel before it goes to the HMU:

- IDG oil cooler
- Oil/fuel heat exchanger
- Servo fuel heater.

Fuel goes from the fuel pump to the IDG oil cooler, then to the oil/fuel heat exchanger. From the oil/fuel heat exchanger, the fuel goes back to the fuel pump assembly. This fuel becomes high pressure fuel. This high pressure fuel goes to the HMU. Part of the high pressure fuel goes through the servo fuel heater before it goes to the HMU. The other part of the high pressure fuel becomes metered fuel in the HMU.

The fuel pump always supplies more fuel to the HMU than the HMU can use. The fuel that the HMU does not use (bypass fuel) goes back to the outlet of the integrated drive generator (IDG) oil cooler. This fuel returns to the fuel pump.

Metered fuel goes through the fuel flow transmitter.

From the fuel flow transmitter, metered fuel goes through the fuel nozzle filter.

AKS ALL PRE SB CFM56-7B 73-44

Fuel goes from the fuel nozzle filter to the unstaged fuel nozzles and to the burner staging valve (BSV). When the BSV opens, fuel goes to the staged fuel nozzles. The unstaged and staged fuel nozzles supply atomized fuel to the engine combustion chamber.

AKS ALL POST SB CFM56-7B 73-44

Fuel goes from the fuel nozzle filter to the fuel nozzles. The fuel nozzles supply atomized fuel to the engine combustion chamber.

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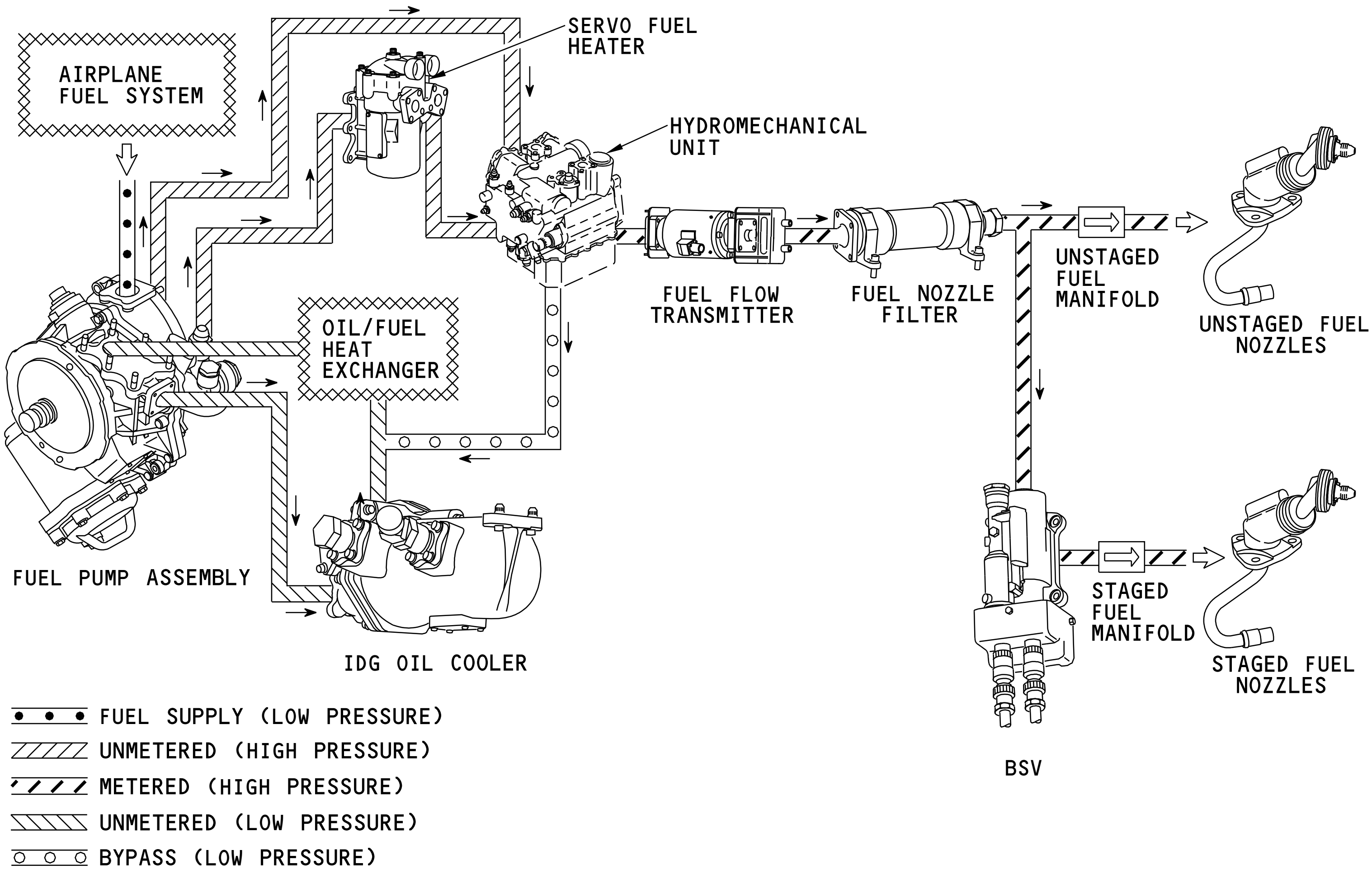

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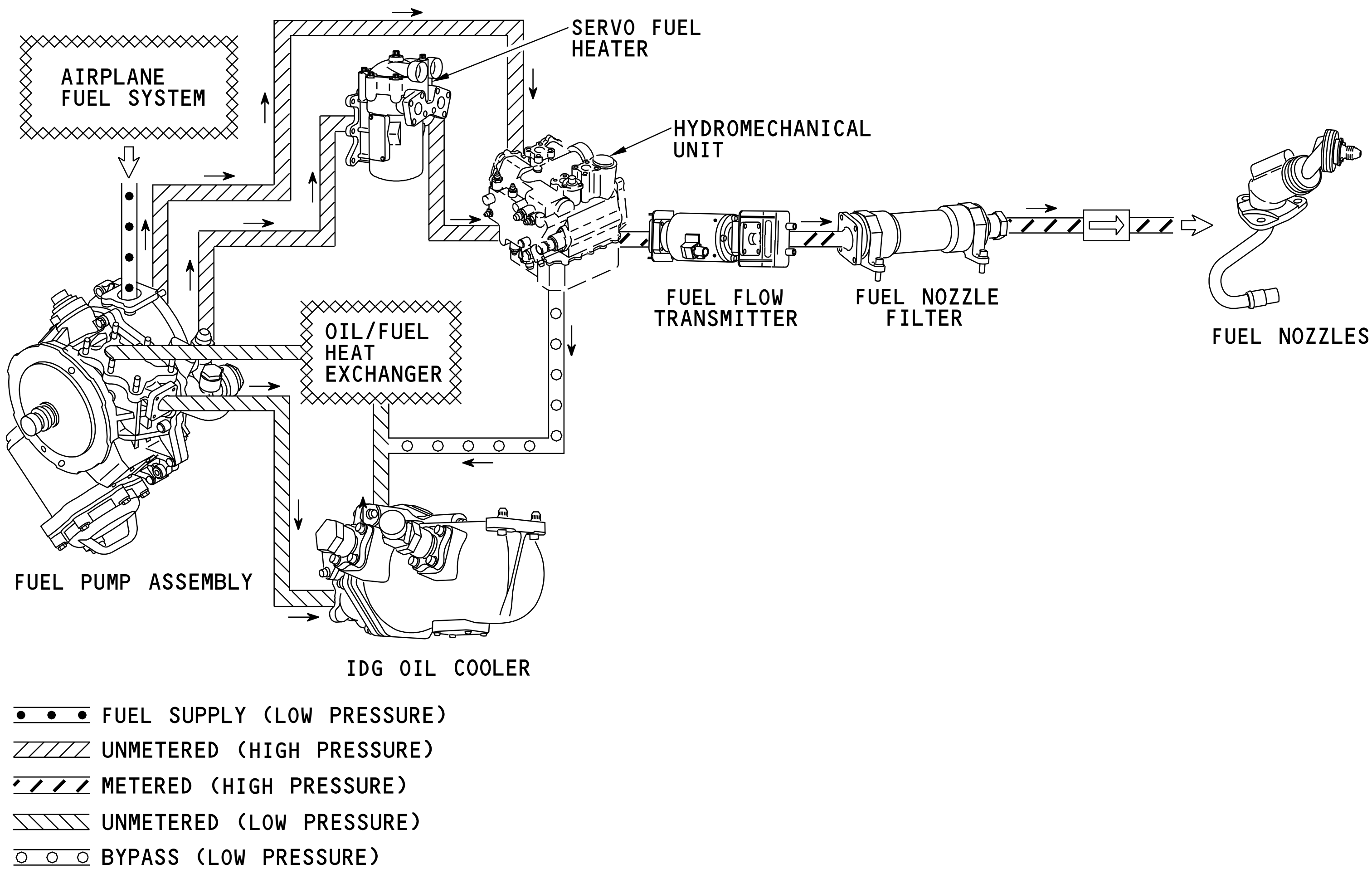
ENGINE FUEL AND CONTROL - DISTRIBUTION - GENERAL DESCRIPTION



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ENGINE FUEL AND CONTROL - DISTRIBUTION - GENERAL DESCRIPTION

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ENGINE FUEL AND CONTROL - DISTRIBUTION - COMPONENT LOCATION

General

These are the engine fuel distribution system components:

- Fuel nozzle filter
- Fuel pump assembly
- Fuel filter
- IDG oil cooler
- Servo fuel heater

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- Burner staging valve (BSV)

AKS ALL

- Fuel manifolds
- Fuel nozzles.

Component Locations

The fuel nozzle filter is near the top of the engine fan case at the 10:00 position.

The fuel pump assembly attaches to the aft face of the accessory gearbox (AGB) on the left side of the engine fan case.

The fuel filter is a part of the fuel pump assembly.

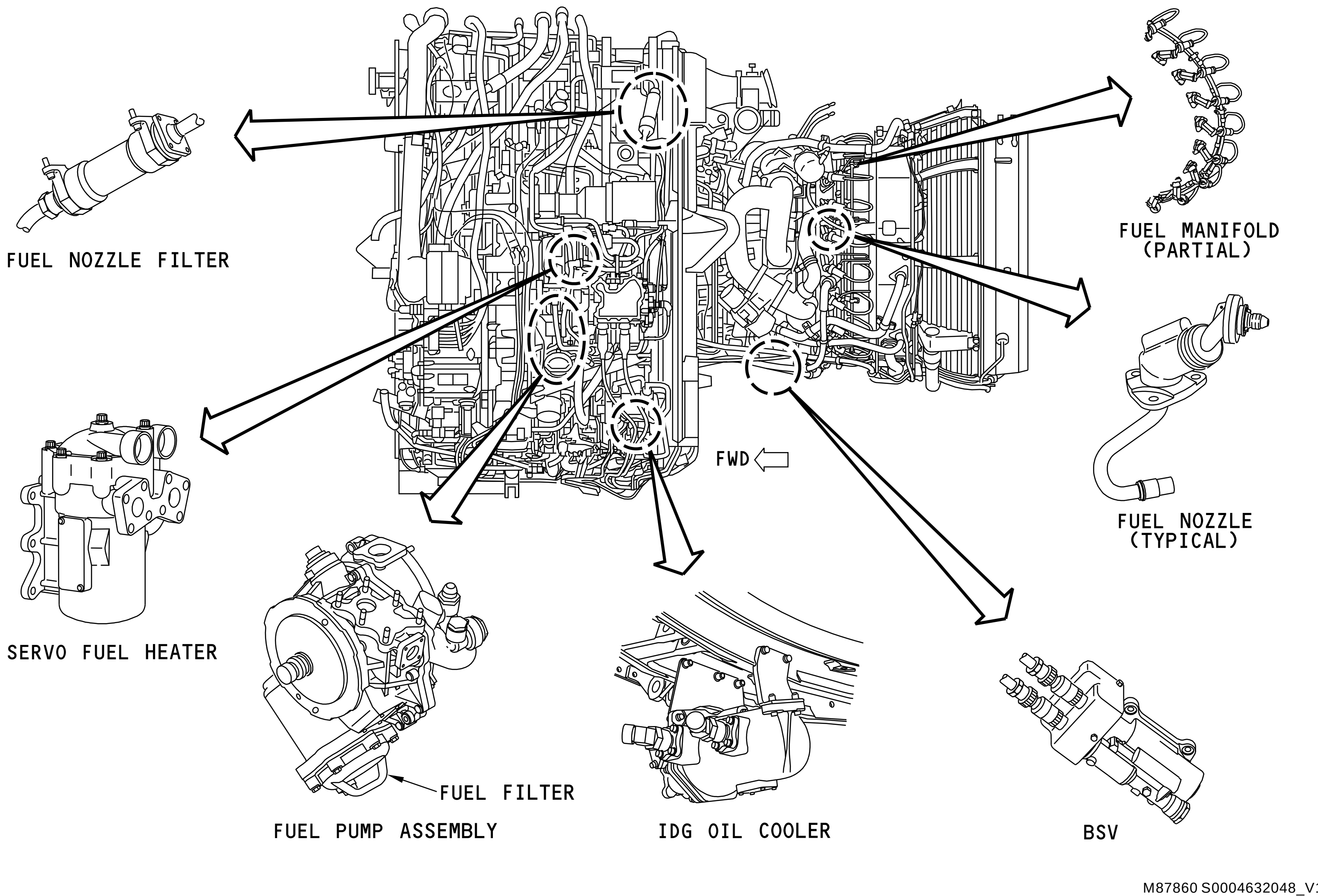
The IDG oil cooler attaches at the rear of the fan frame at the 7:00 position.

The servo fuel heater attaches to the main oil/fuel heat exchanger, which attaches to the top of the fuel pump assembly. See the engine oil chapter for more information about the main oil/fuel heat exchanger. (SECTION 79-20)

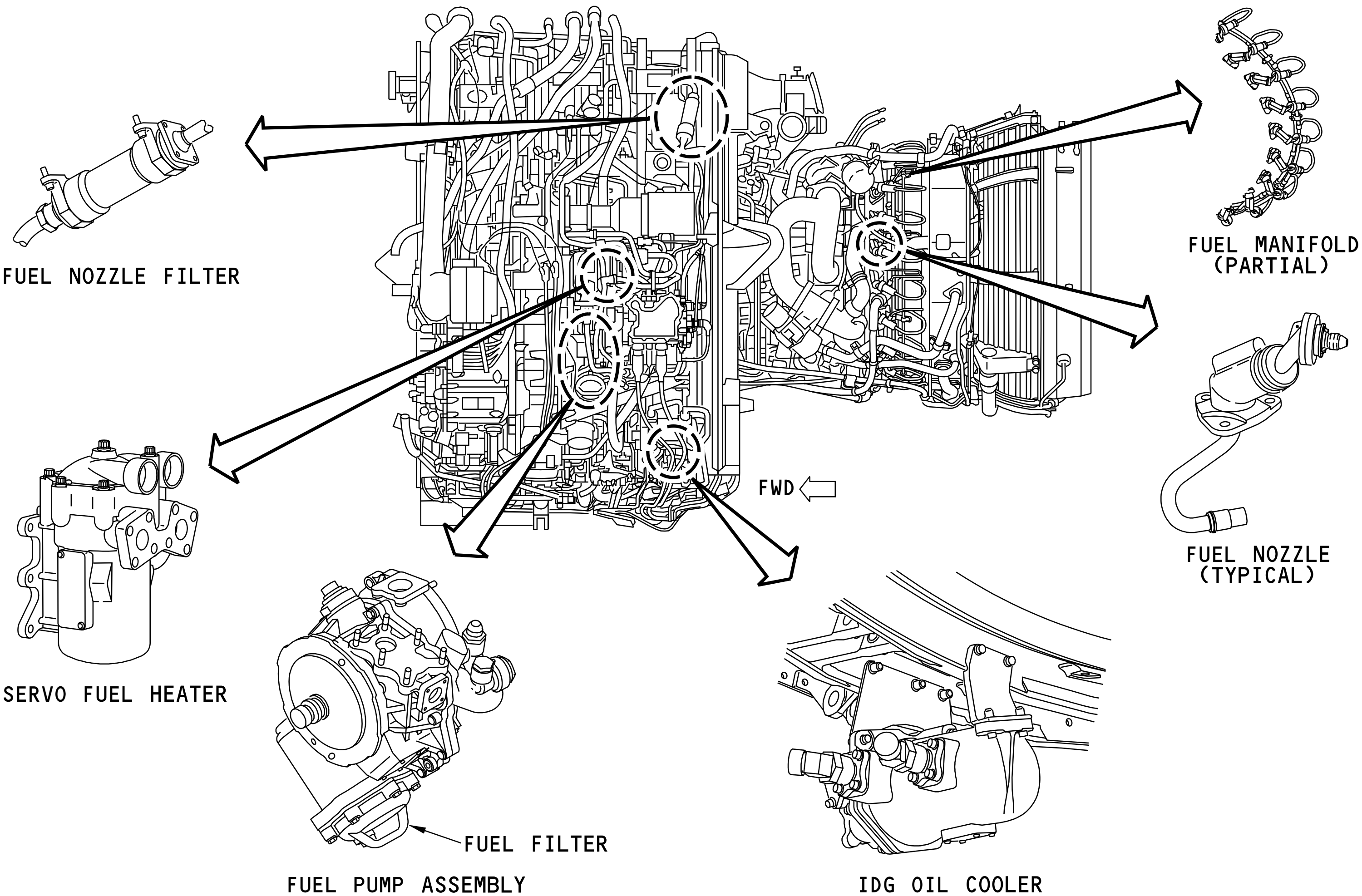
The BSV is in the core section of the engine. It is at the 6:00 position on the high pressure compressor case.

The fuel manifold goes from the fuel nozzle filter, down the left side of the fan case to the fan support strut at the 6:00 position. The manifold then goes along the high pressure compressor case at the 6:00 position. The manifold attaches to the BSV. The manifold that supplies the fuel nozzles around the combustion chamber case, also attach to the BSV.

There are 20 fuel nozzles in the combustion case assembly.



ENGINE FUEL AND CONTROL - DISTRIBUTION - COMPONENT LOCATION



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ENGINE FUEL AND CONTROL - DISTRIBUTION - COMPONENT LOCATION

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ENGINE FUEL AND CONTROL - DISTRIBUTION - FUEL PUMP ASSEMBLY

General

The fuel pump assembly supplies pressurized fuel for engine operation. The fuel pump assembly has two types of components. These components are fuel pumps and filters.

Fuel comes from the airplane fuel system and goes to the low pressure fuel pump. After the low pressure fuel pump, fuel goes out of the fuel pump assembly to the IDG oil cooler and the oil/fuel heat exchanger. After the heat exchangers, the heated fuel returns to the fuel pump assembly and goes to the fuel filter. The fuel then goes to the high pressure fuel pump. After the high pressure fuel pump fuel goes to the hydromechanical unit (HMU) for engine combustion or goes through the wash filter and servo fuel heater for use in the servo system.

Fuel Pumps

There is a low pressure fuel pump and a high pressure fuel pump in the fuel pump assembly. The pumps increase fuel pressure to send the fuel through the heat exchangers to operate the servo systems and give fuel to the fuel nozzles.

The low pressure fuel pump is a centrifugal impeller pump. This type of pump can operate at low fuel inlet pressure and with fuel that is part liquid and part vapor. The low discharge pressure of this pump lets the heat exchangers be lighter and more efficient.

The high pressure pump is a single element, positive displacement gear pump. This type of pump produces high fuel pressures. This pressure is necessary to give a strong combustor fuel spray pattern and to operate the engine actuators that are part of the servo system.

The engine accessory gearbox (AGB) turns a drive shaft to operate the fuel pump assembly. The fuel pump assembly attaches to the aft side of the AGB. A quick attach detach (QAD) ring attaches the pump to the AGB. The HMU attaches to the aft end of the fuel pump assembly.

Fuel Filters

There are two fuel filters in the fuel pump assemblies, the fuel filter and the servo wash filter.

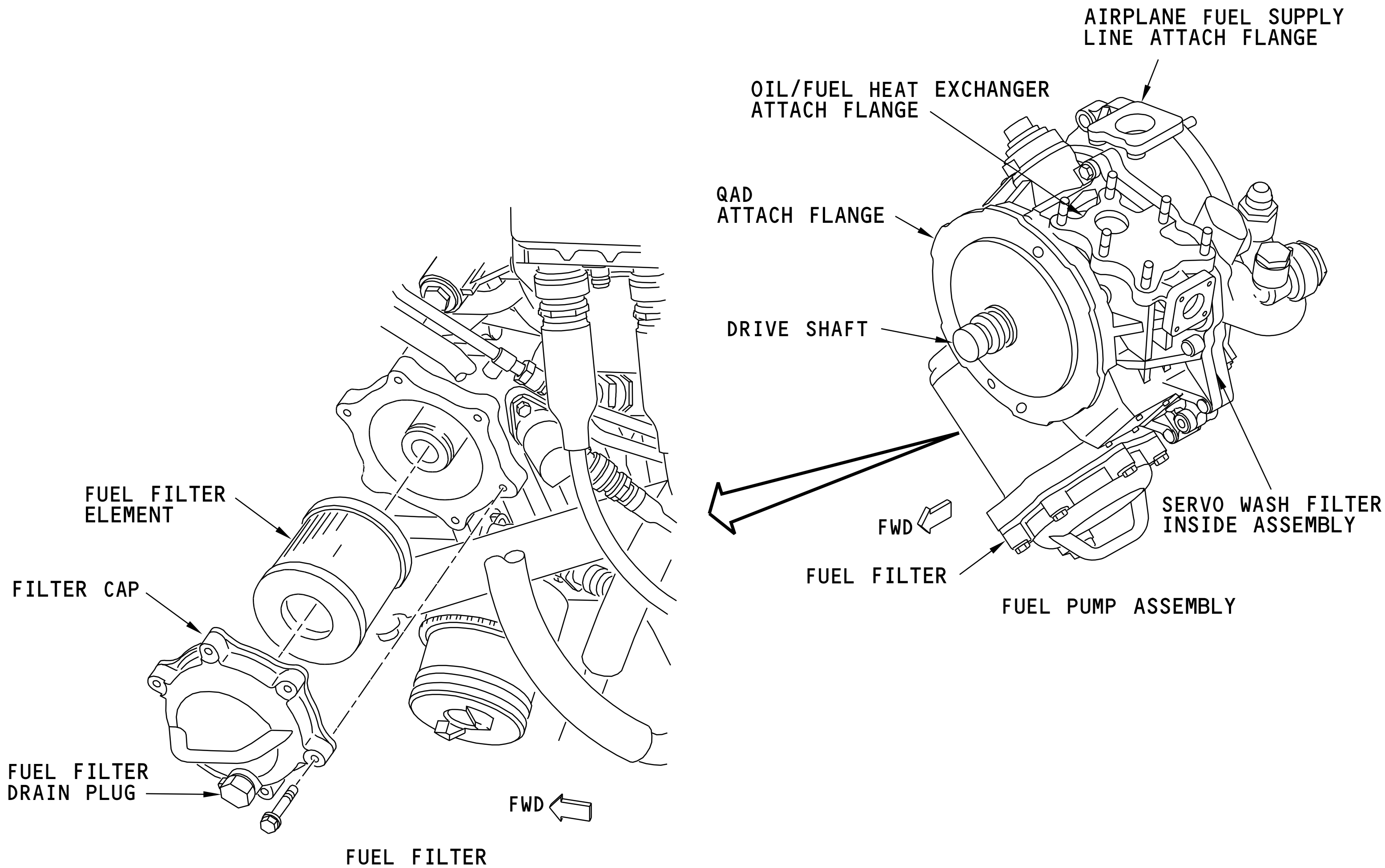
The fuel filter has a line replaceable filter element. To remove and replace the filter, first remove the drain plug to drain the fuel from the filter housing. Next, remove the six bolts that hold the filter cover and remove the filter cover and filter element. A bypass valve is part of the filter assembly. If contamination starts to clog the filter, a FILTER BYPASS light on the P5-2 fuel control module comes on. If the filter fully clogs, the bypass valve opens. When the bypass valve is open, fuel does not go through the filter before it goes to the high pressure pump.

See the fuel flow indicating section for more information on the inlet fuel filter bypass light. (SECTION 73-30)

NOTE: Make sure you torque the six bolts on the filter cap per the AMM when you replace the filter. If the bolts are over-torqued, the threads in the pump assembly can be damaged. Damaged threads can cause large engine fuel leaks.

The servo wash filter cleans the fuel that goes to the servo section of the hydromechanical unit (HMU). There is a bypass valve for this filter. If contamination clogs the wash filter, the bypass valve opens. Fuel that goes through the bypass valve to the HMU servo section does not go through the servo wash filter. There is no indication to show if the bypass valve opens. The servo wash filter is not a Line Replaceable Unit (LRU).

NOTE: A manufacturer certified repair facility must open the fuel pump assembly to inspect or remove and replace the servo wash filter.



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ENGINE FUEL AND CONTROL - DISTRIBUTION - FUEL PUMP ASSEMBLY

ENGINE FUEL AND CONTROL - DISTRIBUTION - IDG OIL COOLER

General

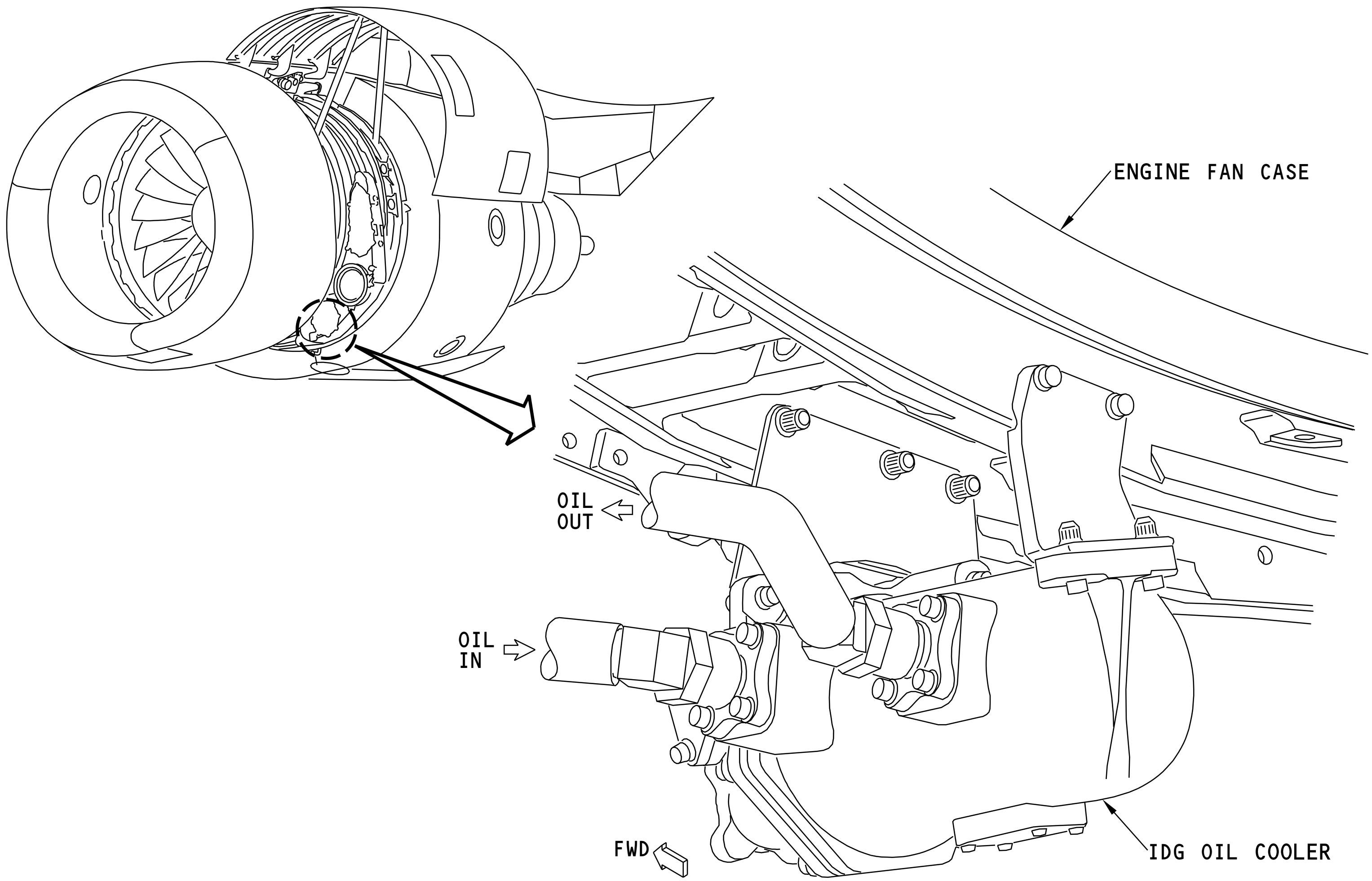
The integrated drive generator (IDG) oil cooler cools the IDG oil. This also heats the engine fuel. Heating the fuel stops the formation of ice from the water in the fuel. If there is ice in the fuel, the fuel filter, the servo system components, and the fuel nozzles could clog.

The IDG oil cooler has a bypass valve in the fuel path of the heat exchanger. If the heat exchanger clogs, the fuel will bypass the IDG oil cooler. This lets the engine continue to operate. There are no direct indications of a clogged IDG oil cooler in the flight compartment except for IDG disconnect due to oil over temperature.

Location

The IDG oil cooler attaches to the fan case at the 7:00 position.

See the electrical chapter for more information on the IDG cooling system. (CHAPTER 24)



ENGINE FUEL AND CONTROL - DISTRIBUTION - IDG OIL COOLER

ENGINE FUEL AND CONTROL - DISTRIBUTION - SERVO FUEL HEATER

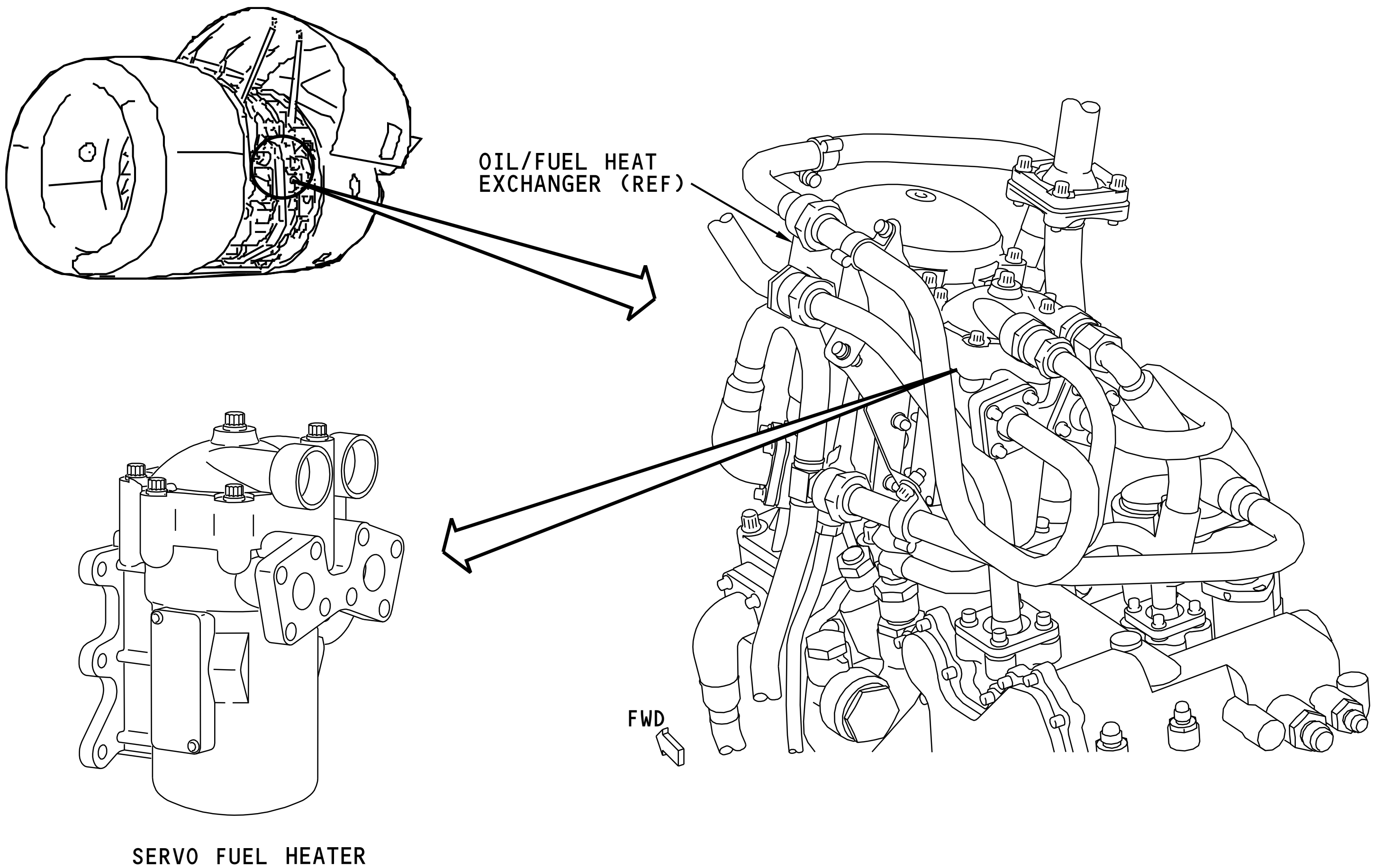
General

The servo fuel heater heats the supply of fuel that goes to the servo system in the hydromechanical unit (HMU). This function also helps to cool the engine scavenge oil. The servo fuel heater is a heat exchanger which uses the warmer scavenge oil temperature to increase the servo fuel supply temperature.

Location

The servo fuel heater attaches to the engine oil/fuel heat exchanger.

See the engine oil chapter for more information on the oil fuel heat exchanger. (SECTION 79-20)



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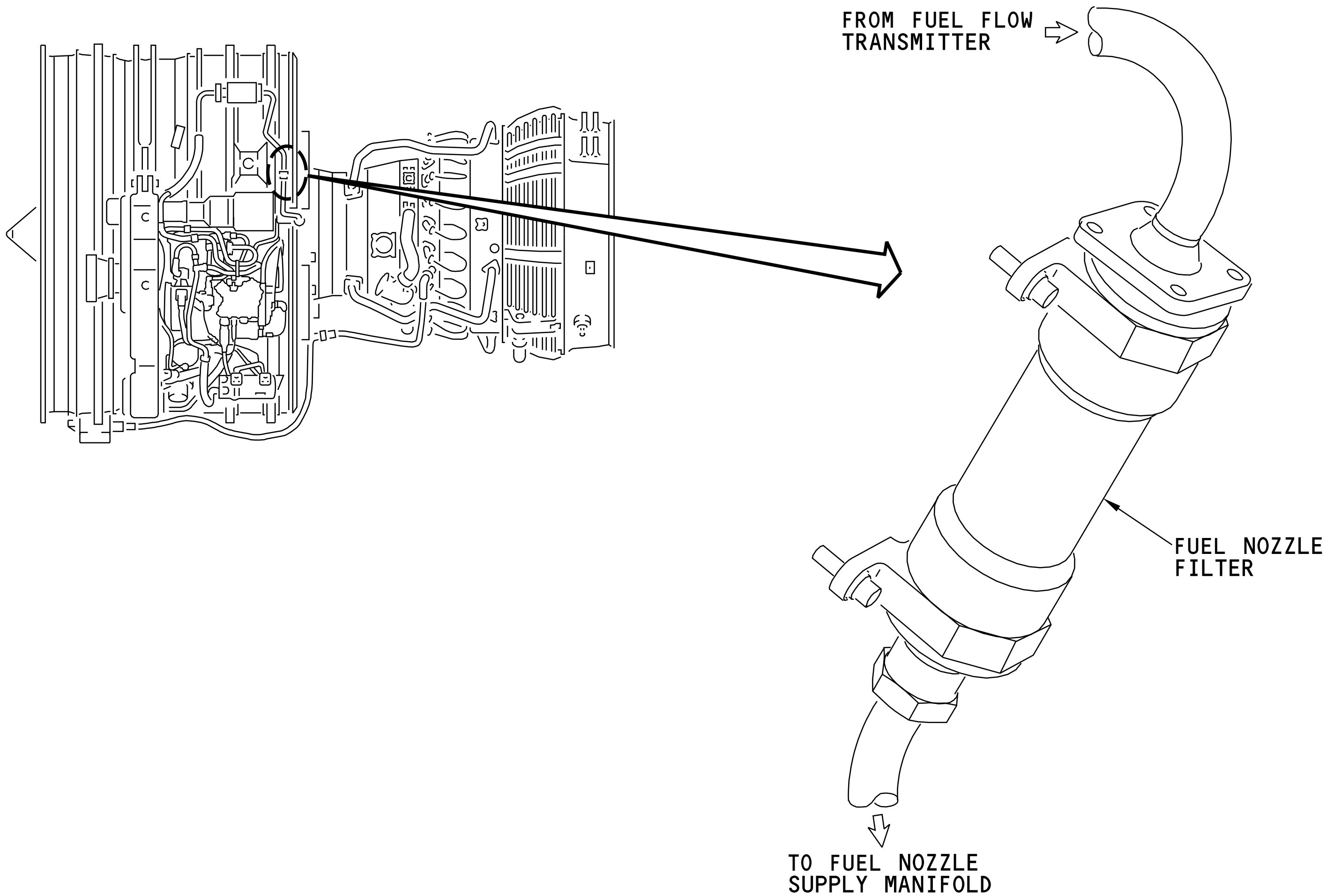
ENGINE FUEL AND CONTROL - DISTRIBUTION - SERVO FUEL HEATER

ENGINE FUEL AND CONTROL - DISTRIBUTION - FUEL NOZZLE FILTER

Purpose

The fuel nozzle filter collects contamination from the high pressure fuel pump and the HMU before it can go to the fuel nozzles. The inline filter attaches to the fuel flow transmitter outlet.



ENGINE FUEL AND CONTROL - DISTRIBUTION - FUEL NOZZLE FILTER

ENGINE FUEL AND CONTROL - DISTRIBUTION - BURNER STAGING VALVE

Purpose

There are ten unstaged and ten staged fuel nozzles in the combustion chamber. The burner staging valve (BSV) controls fuel flow to the ten staged fuel nozzles. The BSV has two positions, open and closed. The EEC sends a signal to the HMU to close the BSV.

General Description

When closed, the BSV prevents fuel flow to the staged nozzles. Fuel flows only to the unstaged nozzles.

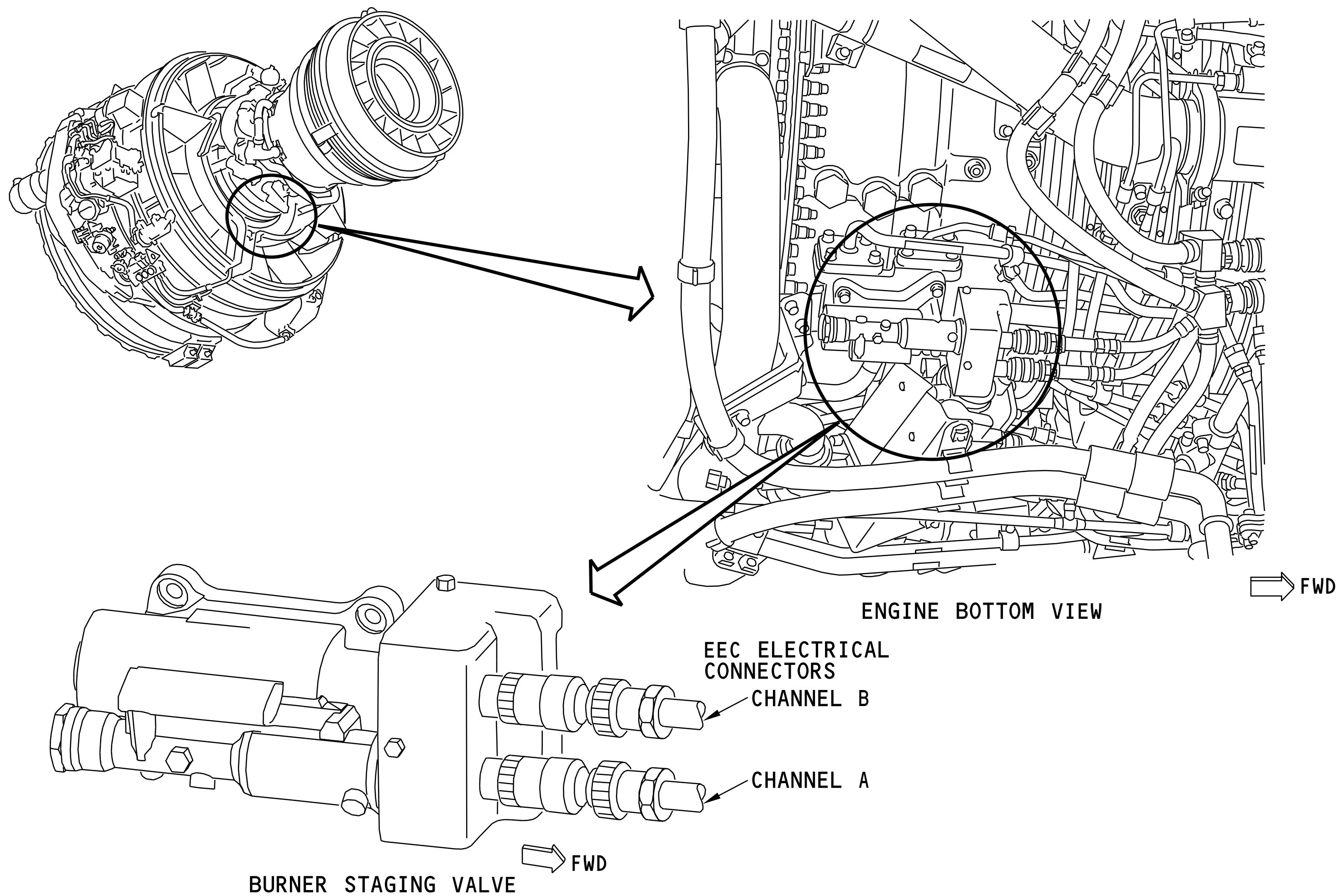
When the staged nozzles are closed, all metered fuel goes through the ten unstaged nozzles only. This gives a stronger spray pattern during low fuel/air ratio operation. A stronger spray pattern helps prevent engine flame out in rain and snow conditions. Low fuel/air ratio operation normally occurs when engine thrust command is reduced during descent.

At higher fuel/air ratios, the BSV opens and lets fuel flow to the staged nozzles. Fuel now flows through both the unstaged and staged fuel nozzles.

The BSV has four switches. These switches give BSV position to channel A and channel B of the EEC. Each EEC channel gets a signal from two switches. You get the BSV switch position information from EEC BITE on the CDU.

Location

The BSV is at the 6:00 position of the engine core section.



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ENGINE FUEL AND CONTROL - DISTRIBUTION - BURNER STAGING VALVE

ENGINE FUEL AND CONTROL - DISTRIBUTION - BSV - FUNCTIONAL DESCRIPTION

Functional Description

The burner staging valve (BSV) opens to send fuel to the ten staged fuel nozzles. The EEC software logic schedules BSV operation. The EEC controls the hydromechanical unit (HMU) to operate the BSV. Switches in the BSV send position signals to both EEC channels.

The EEC uses these inputs to find fuel/air ratio in the combustor:

- T3 (high pressure compressor discharge temperature)
- PS3 (high pressure compressor discharge pressure)
- FMV position (fuel flow)
- N2 speed
- Air/ground signal from DEU.

The EEC controls the BSV based on fuel air ratio. At low fuel/air ratios, the EEC energizes the BSV solenoid in the HMU. The HMU then sends servo fuel pressure to close the BSV. The closed BSV stops metered fuel flow to the staged fuel nozzles. Metered fuel goes only to the unstaged nozzles in the combustion chamber. In this condition, each of the 10 unstaged fuel nozzles supply more fuel to the combustor. The higher flow of fuel in each nozzle causes a stronger spray pattern. The stronger spray pattern helps prevent engine flame out in rain, snow, and ice conditions.

At higher fuel/air ratios, the EEC deenergizes the BSV solenoid in the HMU. The HMU removes servo fuel pressure from the BSV. The BSV opens and metered fuel goes to the staged fuel nozzles. Metered fuel now flows to all 20 nozzles in the combustion chamber.

The BSV has an override function. An override valve causes the BSV to open at higher fuel flows when the BSV is commanded closed by the HMU. The high fuel pressure associated with high fuel flow causes the override valve to block the return flow of BSV control fuel. The fuel pressures on each side of the BSV shuttle valve become equal. This lets the spring move the shuttle valve to the open position. The override valve makes sure the engine provides the commanded thrust if the BSV is incorrectly commanded closed.

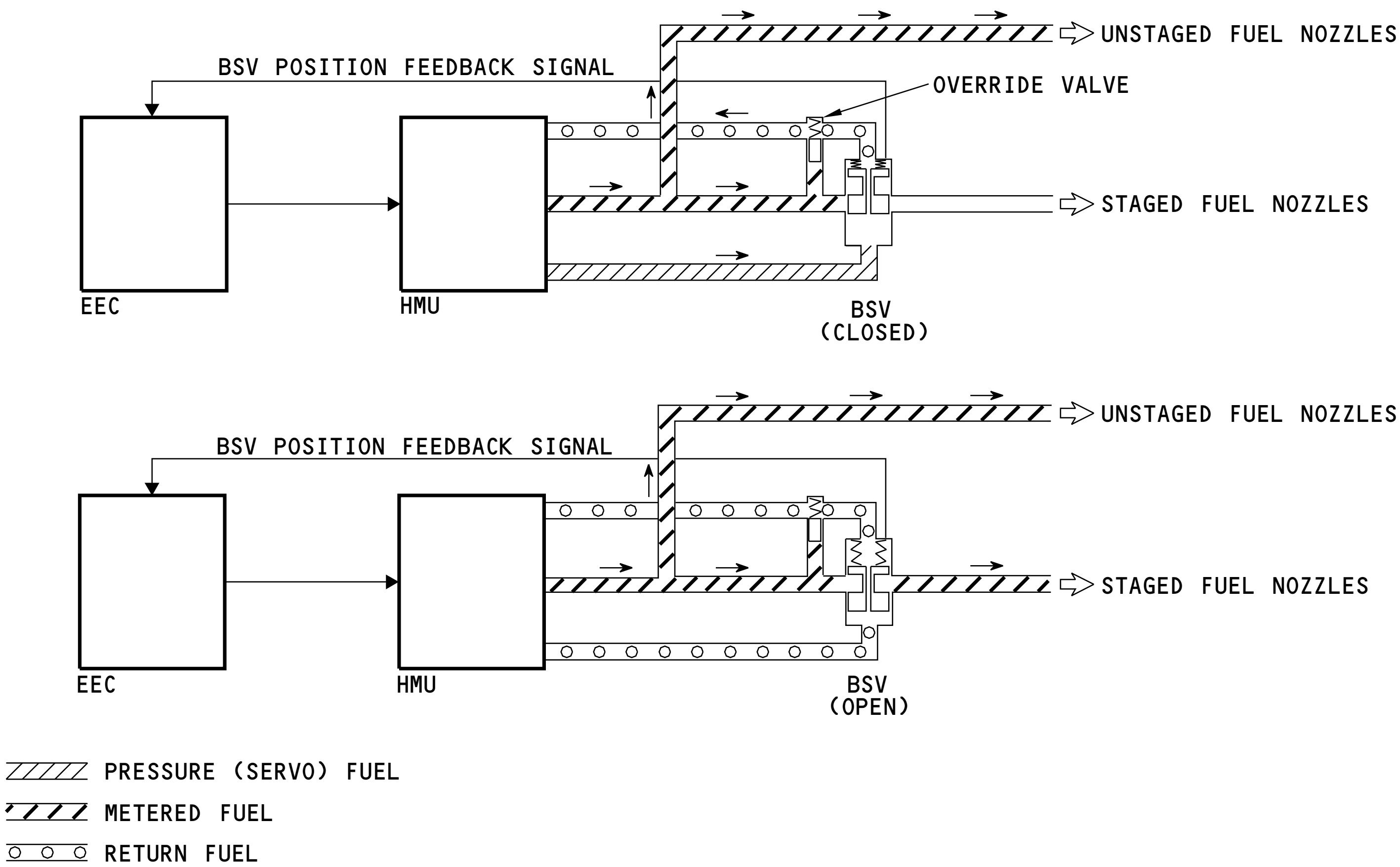
The EEC always commands the BSV open for these conditions (unstaged):

- N2 speed less than 55%
- N2 speed greater than 80%
- Engine at steady state on the ground
- EEC cannot read the BSV position.

The EEC finds a no dispatch condition and sends a signal to the DEU when one of these failures occur:

- BSV failed in the closed position
- Control current to the BSV solenoid out of range and EEC in single channel operation.

The DEU energizes the ENGINE CONTROL light on the P5 aft overhead panel and the MASTER CAUTION lights when the DEU senses the airplane on the ground and the EEC has detected a no dispatch condition.



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ENGINE FUEL AND CONTROL - DISTRIBUTION - BSV - FUNCTIONAL DESCRIPTION

ENGINE FUEL AND CONTROL - DISTRIBUTION - FUEL MANIFOLDS AND FUEL NOZZLES

General

AKS ALL POST SB CFM56-7B 73-44

The fuel manifold supplies fuel to the fuel nozzles. There are twenty fuel nozzles. The fuel nozzles send a spray of fuel into the combustion chamber.

AKS ALL PRE SB CFM56-7B 73-44

Two fuel manifolds supply fuel to the fuel nozzles. Ten fuel nozzles connect to each fuel manifold. The fuel nozzles send a spray of fuel into the combustion chamber.

Fuel Manifolds

One fuel manifold is the unstaged fuel manifold, the other is the staged fuel manifold.

The unstaged fuel manifold flows fuel continuously with the hydromechanical unit (HMU) high pressure shutoff valve (HPSOV) open. The HPSOV is part of the HMU.

The staged fuel manifold supplies fuel to the ten staged fuel nozzles. The burner staging valve (BSV) lets fuel flow to the staged fuel nozzles when it is open.

AKS ALL

Fuel Nozzles

All of the fuel nozzles have primary and secondary fuel flow. At approximately 15 psig, the fuel nozzles open in the primary fuel flow mode. When the fuel pressure increases to approximately 125 psig, the fuel nozzles also open in secondary fuel flow mode.

A color code band identifies the fuel nozzle types. Four nozzles have a silver color band. The other sixteen nozzles have a blue color band.

The nozzles with a silver band have a higher fuel flow than the other sixteen nozzles. This higher fuel flow supplies a stronger spray pattern. Two of these nozzles are adjacent to each spark igniter in the combustion chamber case. This installation helps with engine starts. It also helps the engine to continue to operate when the airplane flies in rain, snow, or icing conditions.

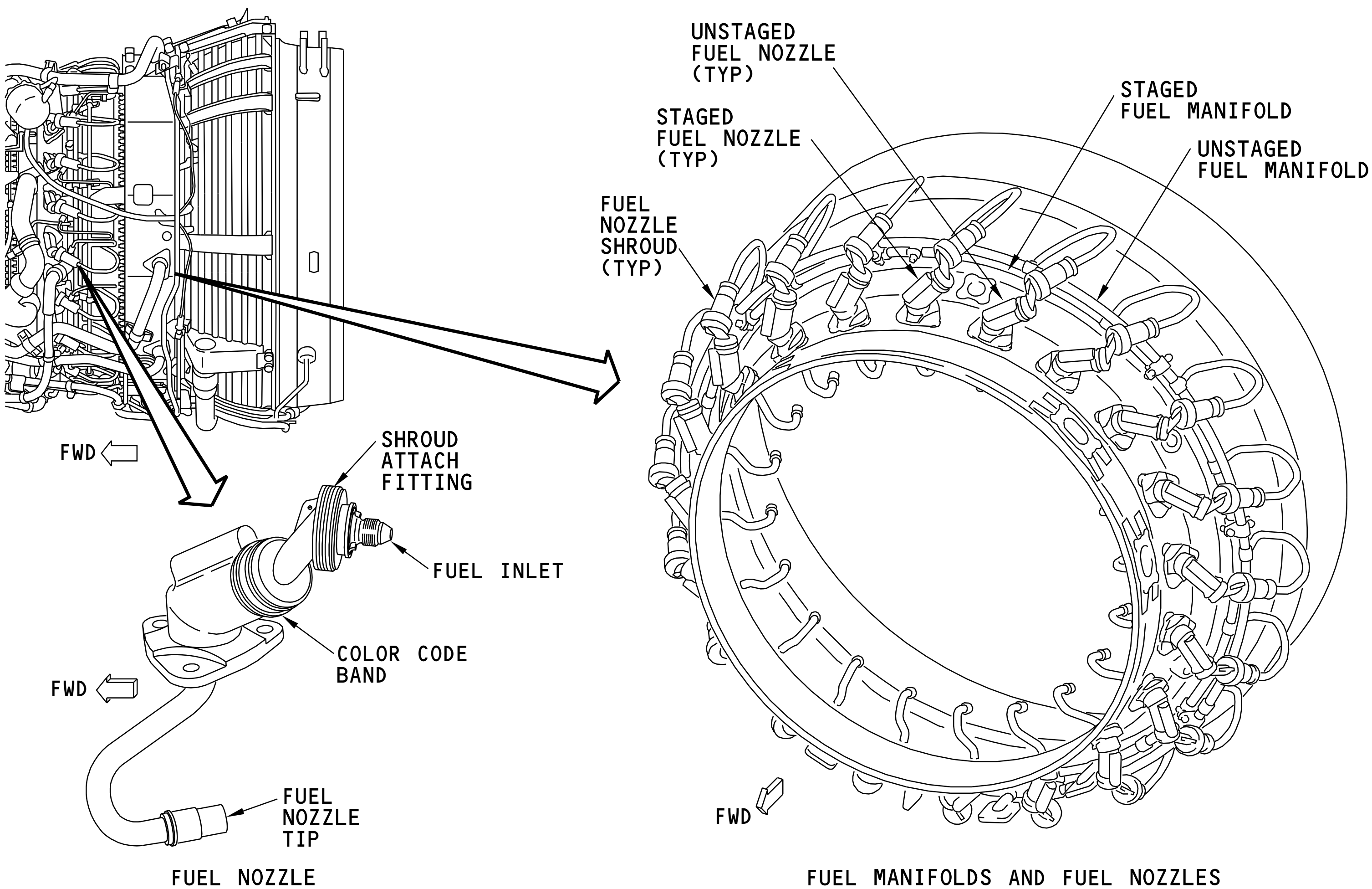
AKS ALL PRE SB CFM56-7B 73-44

The nozzle installation around the combustion chamber case alternate between staged and unstaged nozzles.

AKS ALL

Fuel Nozzle Shrouds

Each fuel nozzles has a shroud. The fuel nozzle shrouds close over the connection between the fuel manifold and the nozzles. If this connection leaks, the shroud prevents a fuel leak onto the combustion chamber case.



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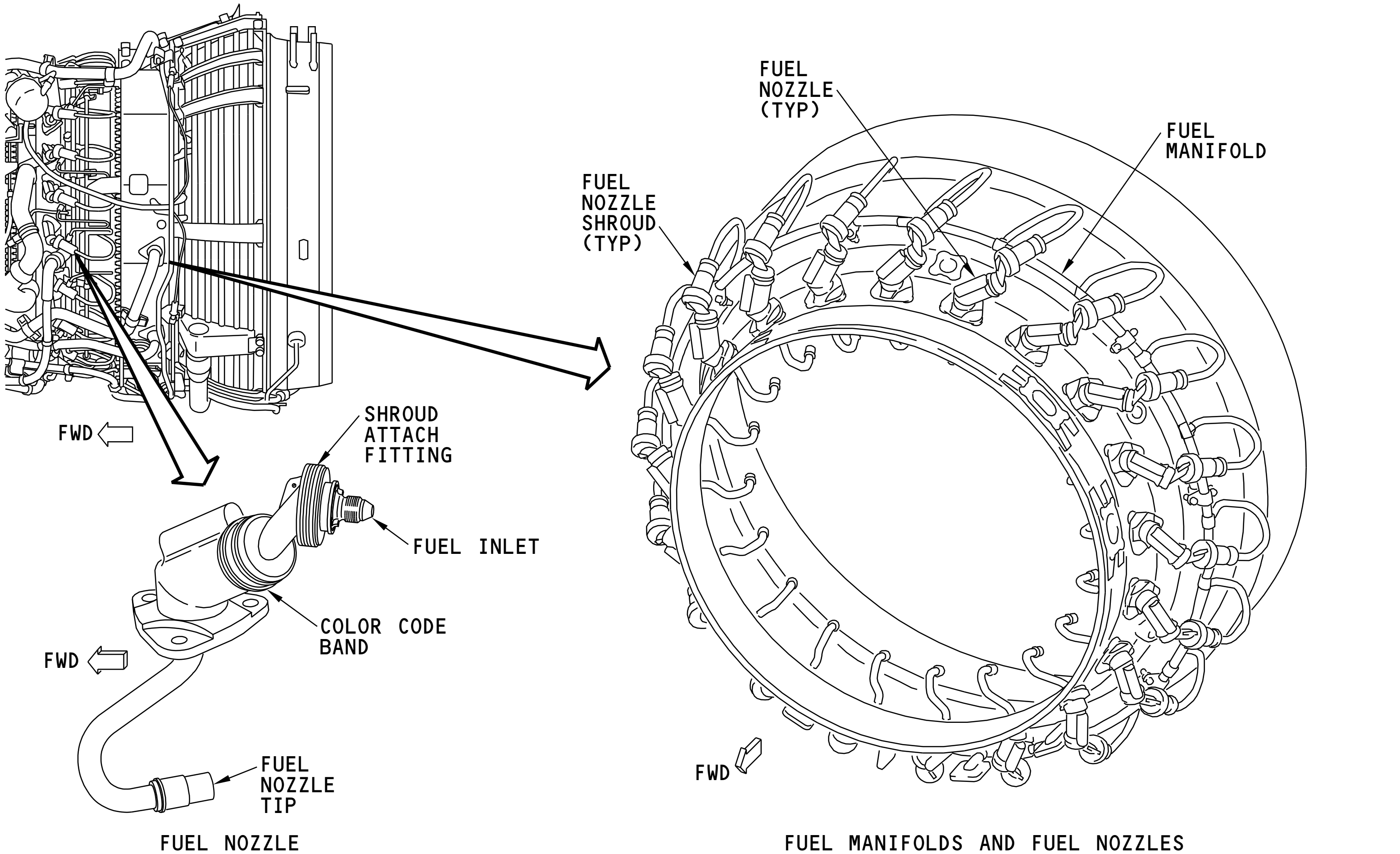
ENGINE FUEL AND CONTROL - DISTRIBUTION - FUEL MANIFOLDS AND FUEL NOZZLES



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ENGINE FUEL AND CONTROL - DISTRIBUTION - FUEL MANIFOLDS AND FUEL NOZZLES

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ENGINE FUEL AND CONTROL - DISTRIBUTION - FUNCTIONAL DESCRIPTION

General

The fuel pump assembly receives fuel from the airplane fuel system. The fuel pump assembly supplies fuel to the hydromechanical unit (HMU). Fuel manifolds supply metered fuel to the fuel nozzles.

Fuel System

The fuel pump assembly has two pumps. There is a low pressure pump (LP) that has a centrifugal impeller. There is a high pressure pump (HP) that uses two constant displacement gears.

Fuel first goes to the LP pump. From the LP pump, fuel goes to the IDG oil cooler and then to the engine oil/fuel heat exchanger. The fuel then goes to the fuel filter in the pump assembly.

The fuel filter cleans the fuel. A bypass valve opens if contamination clogs the fuel filter.

After the fuel filter, fuel goes to the high pressure pump. The HP pump increases fuel pressure for servo system operation and for combustion.

From the high pressure pump, fuel goes through a servo wash filter before it goes to the servo fuel heater. The servo wash filter is in the pump assembly. The wash filter cleans fuel that goes to the HMU servo section. A bypass valve opens if the servo wash filter clogs. This filter does not clean fuel that goes to the combustion chamber. The fuel that goes to the combustion chamber goes into the HMU through a different port than the servo fuel.

The servo fuel goes through the servo fuel heater. The servo fuel heater uses engine oil to heat the servo fuel. Servo fuel is heated to make sure any water in the fuel will not freeze in the servo system. The servo fuel then goes to the servo section of the HMU.

With EEC control, the HMU supplies fuel to operate the servo systems, and supplies metered fuel to the manifolds. The high pressure shutoff valve (HPSOV) stops the metered fuel flow when it closes. The control signal to operate the HPSOV usually comes from the engine start lever. The fire handle switch can override the engine start lever to close the HPSOV.

AKS ALL PRE SB CFM56-7B 73-44

The metered fuel goes from the HMU through the fuel flow transmitter and fuel nozzle filter. The metered fuel then goes to unstaged manifold. The fuel also goes to the staged manifold through the BSV.

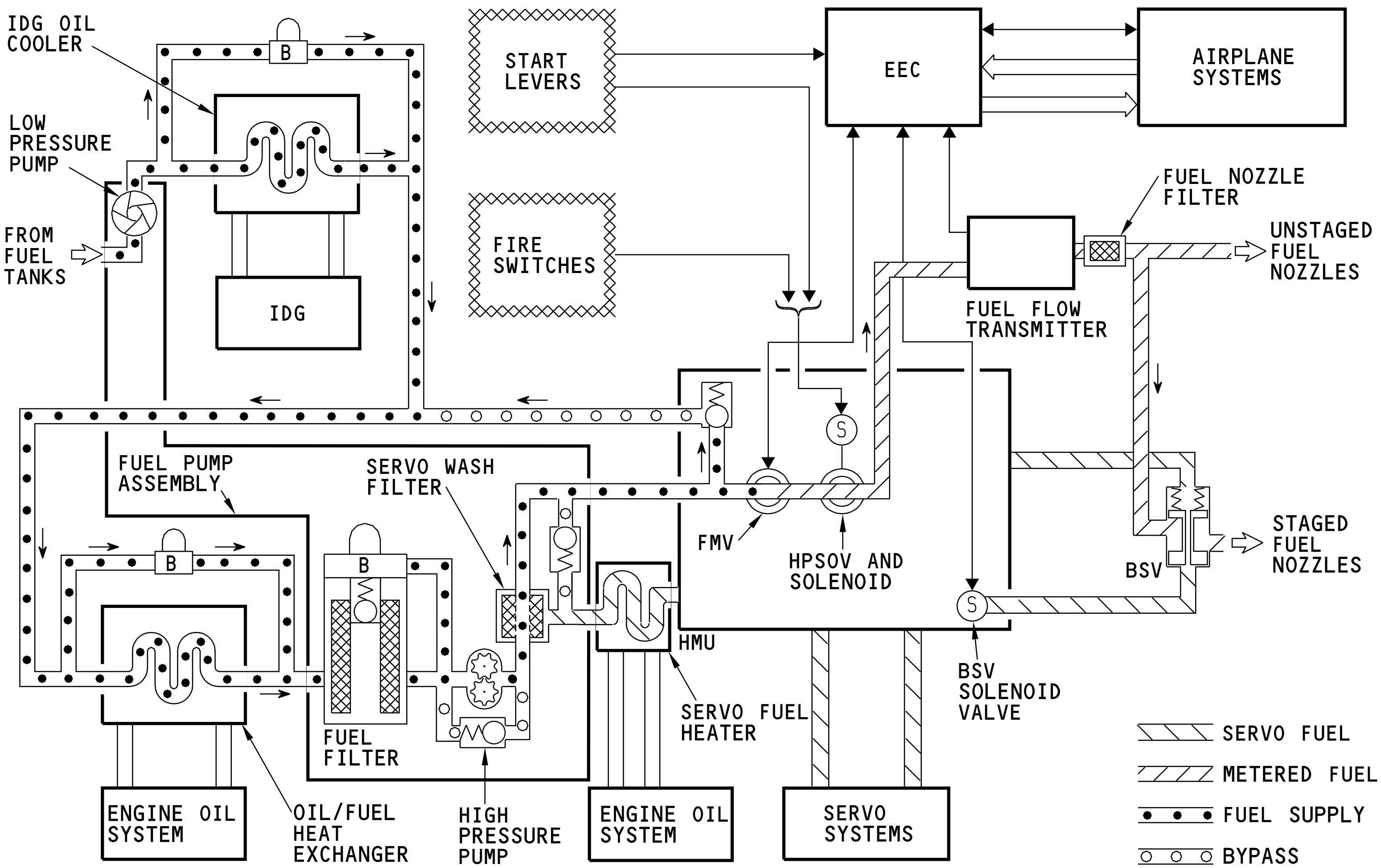
AKS ALL POST SB CFM56-7B 73-44

The metered fuel goes from the HMU through the fuel flow transmitter and fuel nozzle filter. The metered fuel then goes through the fuel manifold to the fuel nozzles.

AKS ALL

Training Information Point

The EEC uses the fuel flow transmitter signal for engine control when the FMV position signal is not valid.



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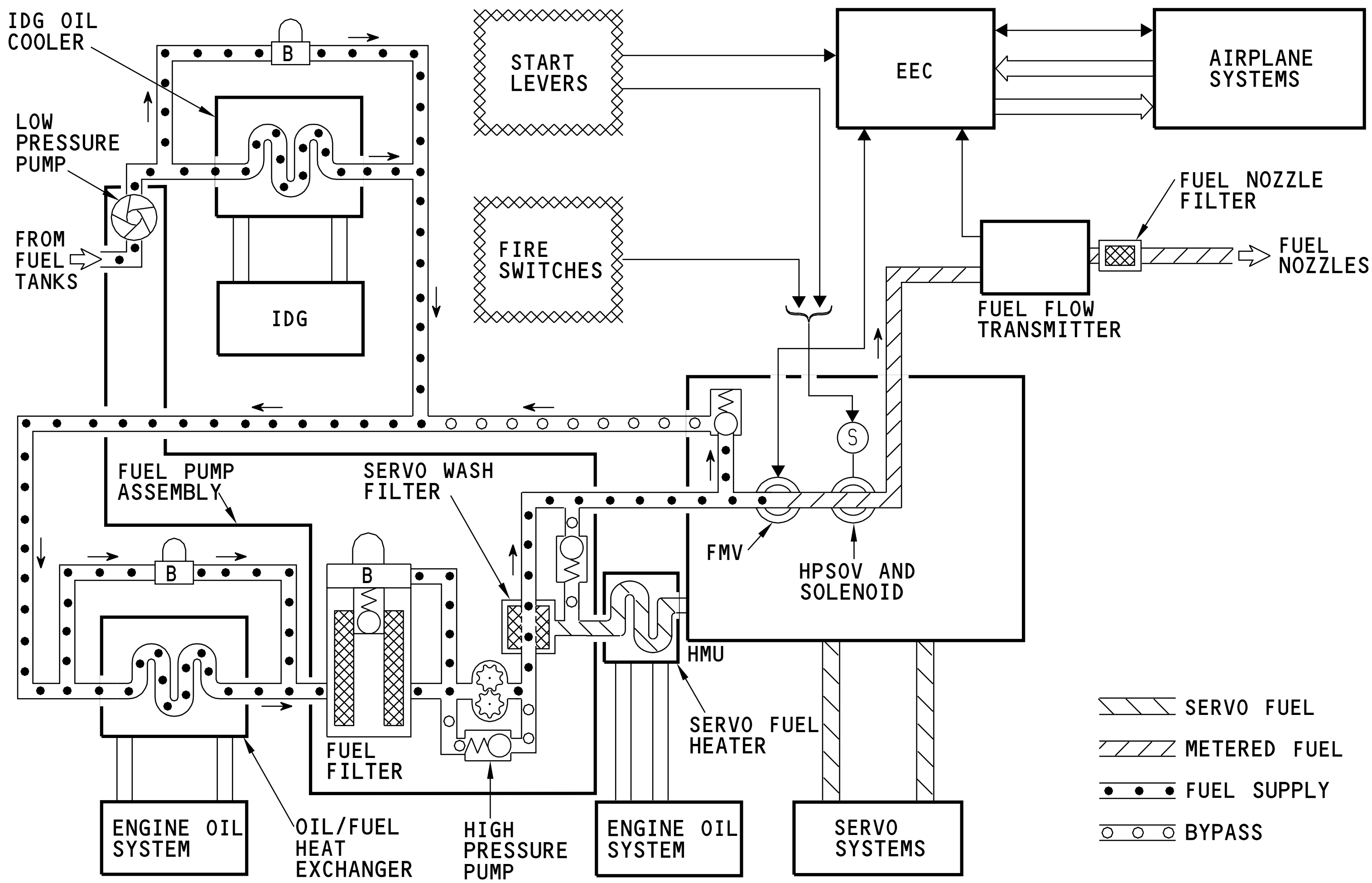
ENGINE FUEL AND CONTROL - DISTRIBUTION - FUNCTIONAL DESCRIPTION



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ENGINE FUEL AND CONTROL - DISTRIBUTION - FUNCTIONAL DESCRIPTION

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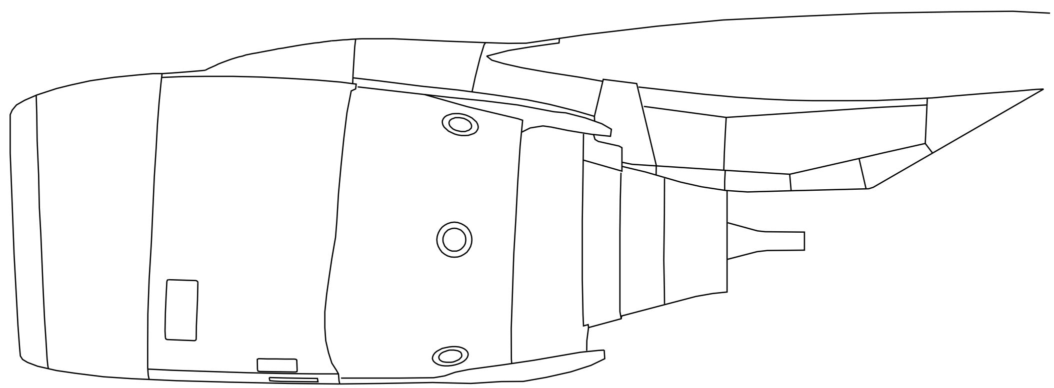
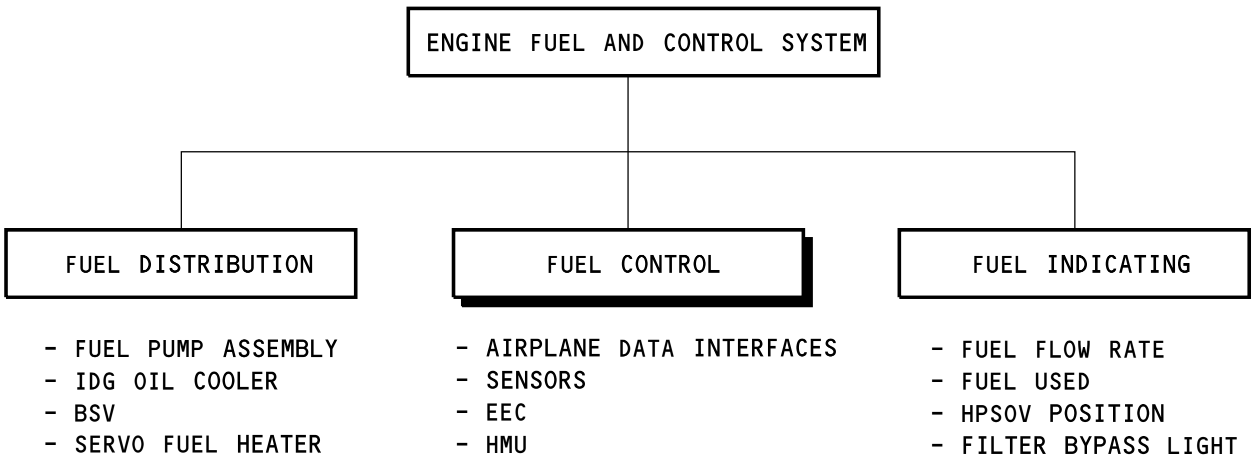
ENGINE FUEL AND CONTROL - ENGINE CONTROL - INTRODUCTION

General

The engine control system controls fuel flow for engine operation. These are the major engine control system components:

- Airplane data interfaces
- Sensors
- Electronic engine control (EEC)
- Hydromechanical Unit (HMU).





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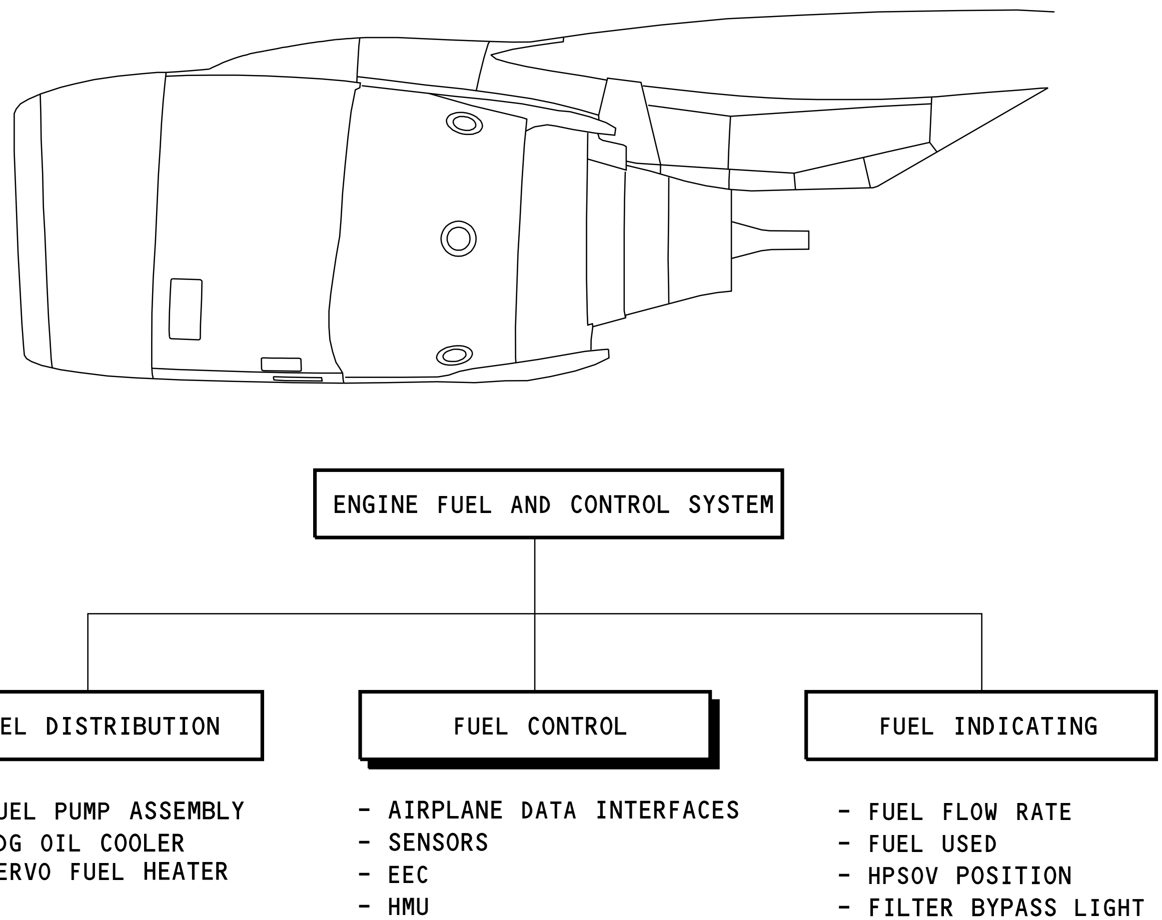
ENGINE FUEL AND CONTROL - ENGINE CONTROL - INTRODUCTION



ENGINE FUEL AND CONTROL - ENGINE CONTROL - INTRODUCTION

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - GENERAL DESCRIPTION

Electronic Engine Control

The electronic engine control (EEC) is the main component of the engine fuel and control system.

Control Display System / Display Electronic Unit 1 or 2

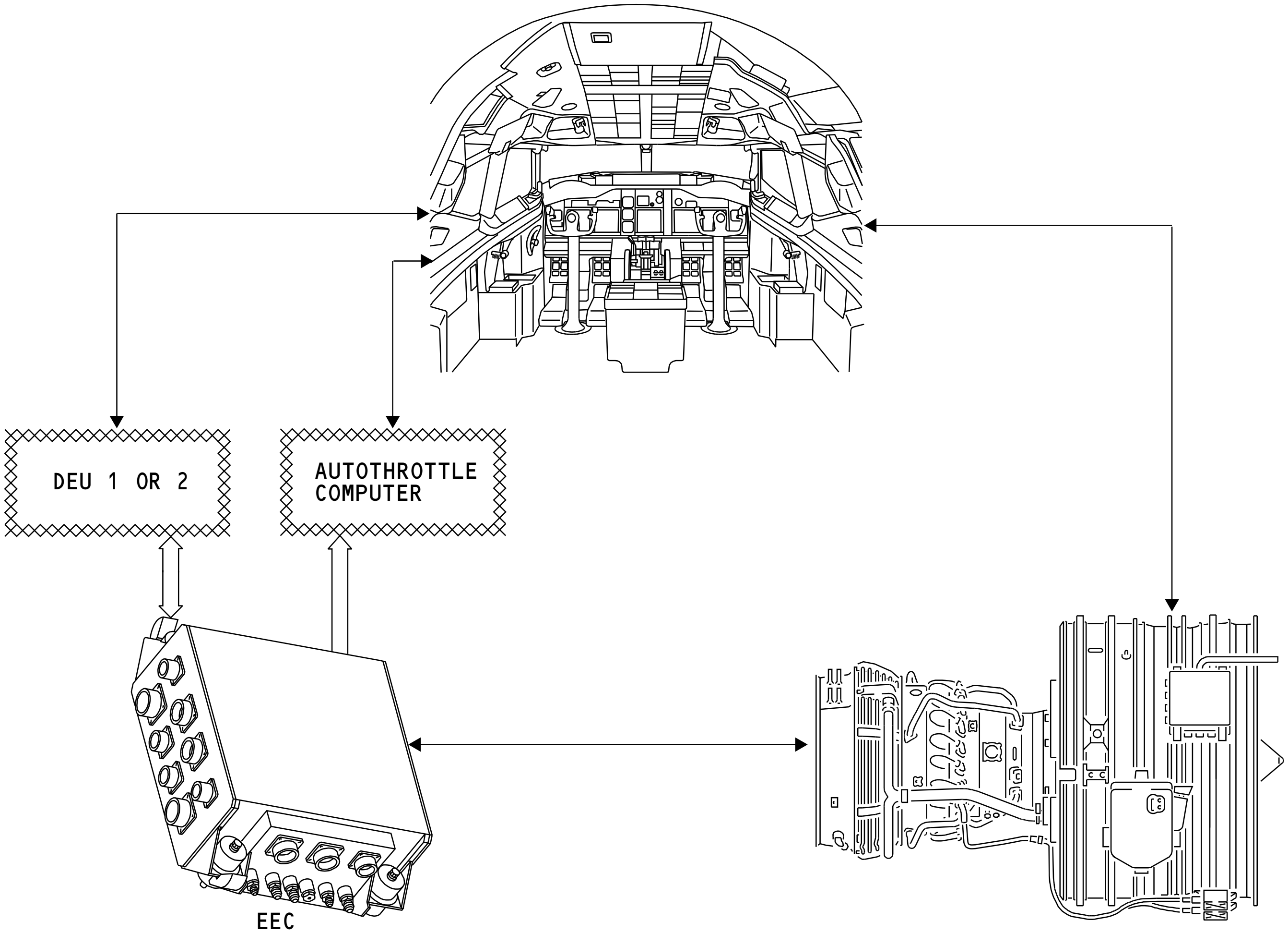
The EEC receives data from many airplane systems through the common display system display electronic units (DEUs). The EEC sends engine system data to the airplane. All of this data goes through DEU 1 or DEU 2.

Autothrottle Computer

The autothrottle computer receives thrust resolver angle (TRA) and engine maximum thrust rating data from the EEC. The autothrottle computer uses this data to calculate thrust lever angles (TLA). The autothrottle computer can operate the thrust levers. See the autothrottle section for more information on auto throttle computer control of the thrust levers. (SECTION 22-31)

Flight Compartment

Some controls in the flight compartment supply control data directly to some components on the engine.



ENGINE FUEL AND CONTROL - ENGINE CONTROL - GENERAL DESCRIPTION

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - INTERFACES

General

The engine fuel and control system has interfaces with many systems and components. There are digital and analog interfaces between the engine fuel and control system, the engine systems, and the airplane systems.

The electronic engine control (EEC) controls the engine. The EEC uses analog and digital input data to calculate the engine fuel and control outputs to operate the engine. The EEC also gives digital data to other airplane systems. This data gives engine status.

Engine Fuel And Control System To Engine Connection

The EEC has an interface with these engine systems and components:

- Engine identification plug
- Hydromechanical unit (HMU)
- Engine air control system
- Engine sensors
- Fuel flow transmitter
- EEC alternator
- Ignition system.

Engine Identification Plug

The EEC uses the engine identification plug for thrust rating and other engine information.

Hydromechanical Unit (HMU)

The HMU supplies metered fuel for combustion and servo fuel pressure for engine systems operation. The HMU gets electrical commands from the EEC for engine fuel control. The HMU also gets commands from the airplane engine start lever and fire handle switch to control the HPSOV.

Engine Air Control

The EEC controls engine air flow for thrust and turbine clearance control systems. This is done through the HMU servo fuel system. These are the servo fuel systems the EEC controls through the HMU:

- Variable stator vanes (VSVs)
- Variable bleed valves (VBVs)
- Transient bleed valve (TBV)
- Low pressure turbine active clearance control (LPTACC)
- High pressure turbine active clearance control (HPTACC).

See the engine air system section for more information. (CHAPTER 75)

Engine Sensors

The EEC uses input data from various engine sensors to calculate the engine fuel and control outputs for engine operation. These are the engine sensors:

- T12 (inlet total temperature)
- PT25 (high pressure compressor inlet temperature)
- T3 (high pressure compressor discharge temperature)
- HPTACC sensor
- T49.5 (second stage low pressure turbine nozzle temperature)
- P0 (inlet static pressure)
- PS3 (high pressure compressor discharge pressure).

Fuel Flow Transmitter

The fuel flow transmitter sends fuel flow information to the EEC. The EEC sends this information to the DEUs. The DEUs then show fuel flow along with other engine parameters.

Electronic Engine Control Alternator

The EEC alternator is the normal electrical power supply for the EEC.

ENGINE FUEL AND CONTROL - ENGINE CONTROL - INTERFACES

Ignition System

The EEC controls ac power from the airplane electrical power system to operate the left and right ignition systems on the engine. See the ignition section for more information. (CHAPTER 74)

Fuel And Control System To Airplane Connection

The engine fuel and control system has an interface with these airplane systems and components:

- Display electronic units (DEUs)
- Engine start lever stop command
- Engine fire switches
- AC transfer bus 1 or 2
- Autothrottle computer
- Thrust lever angle
- Engine strut
- Thrust reverser sleeve position.

ARINC 429 Components

The engine fuel and control system connects through the ARINC 429 bus to these components:

- Common display system display electronics units (DEUs)
- Autothrottle computer.

DEUs

The ADIRU sends total air pressure and temperature data to the EEC. The EEC uses this data to control engine thrust.

The FMC controls the CDU. The FMC gets and sends CDU commands to the EEC through the DEUs. The FMC also supplies some airplane data to the EEC through the DEUs. The CDU shows EEC maintenance data and sends commands to the EEC to do system BITE tests.

The FDAU collects engine parameter data. It sends this data to the flight data recorder (FDR).

Engine Fire Switches

When pulled up, engine fire switches send a close command to the HPSOV in the HMU. This stops metered fuel flow for combustion.

AC Transfer Bus 1 or 2

The EEC uses the airplane transfer buses for power when it does not receive power from the EEC alternator.

Autothrottle Computer

The autothrottle computer receives thrust lever resolver angle (TRA) and other engine data from the EEC. The autothrottle computer uses this data to control the thrust lever. See the autothrottle section for more information. (SECTION 22-31)

Thrust Lever Angle Resolvers

The flight and ground crews move the thrust levers to send engine thrust commands to the EEC. The EEC gets these commands from the thrust lever angle resolvers (TLR). See the engine controls section for more information. (CHAPTER 76)

Engine Strut

The engine strut gives airplane model and engine position data to the EEC. The EEC uses airplane model information to find the maximum certified thrust and N1 reference speeds for the airplane. The EEC uses engine position to format the engine maintenance message numbers that show on the CDU.

Thrust Reverser

The EEC monitors thrust reverser sleeve position. It also controls the thrust reverser interlocks for engine reverse thrust operation. See the thrust reverser system section for more information. (SECTION 78-30)

Digital Control Data

The display electronics units (DEUs) send and receive airplane digital control data from the engine fuel and control system through ARINC 429 data buses.

The ADIRU sends total air pressure and temperature data to the EEC. The EEC uses this data to control engine thrust.

The FMC controls the CDU. The FMC sends and receives CDU commands to and from the EEC through the DEUs. The FMC also supplies some airplane data to the EEC through the DEUs. The CDU shows EEC maintenance data and sends commands to the EEC to do system BITE tests.

The FDAU collects engine data. It sends this data to the flight data recorder (FDR).

Other airplane systems also provide data to and get data from the DEUs. Some of this data goes to the EEC. See the indicating and recording systems section for more information on the data received and sent by the DEUs. (CHAPTER 31)

This is the digital input data the DEUs send to the EEC:

- Total air temperature
- Corrected static pressure
- Total pressure
- Calculated mach number
- Greenwich mean time
- Clock date
- N1 target
- Flight number
- Bite data
- Landing gear position
- Start valve position
- Engine run status of other engine
- Databus status
- Start switch position
- Start lever position
- Ignition switch position
- Control mode switch position
- Air/ground
- Flap position
- Engine bleed switch position
- ACS pack switch position
- Cowl thermal anti-ice switch position
- Wing anti-ice switch position
- Isolation valve position.

This is the digital data the EEC sends to the DEUs:

- Bite data
- Engine start mode
- Engine starting status
- Ignition system status
- Engine running status
- Control mode switch position
- Minimum idle
- Idle selected
- N1 speed data
- N2 speed data
- Overspeed governor status
- Engine starter cutout
- Exhaust gas temperature (EGT) data
- Fuel flow data
- Fuel filter status
- Oil pressure and temperature data
- Oil filter status
- Thrust resolver angle (TRA) data

- Thrust reverser status
- Thrust reverser interlock status
- Engine thrust
- Values from engine Sensors
- EEC software version
- Engine serial number
- Position of engine actuators
- Fuel-air ratio in combustor
- EEC channel in control
- Engine start lever position
- Airplane-on-ground selection status
- Engine running
- Engine thrust rating and airplane model Incompatible
- Airplane model
- Engine rating
- Engine options
- EEC alternator status
- Engine position
- Engine bleed load
- Air data status from ADIRUs
- Internal EEC fault.

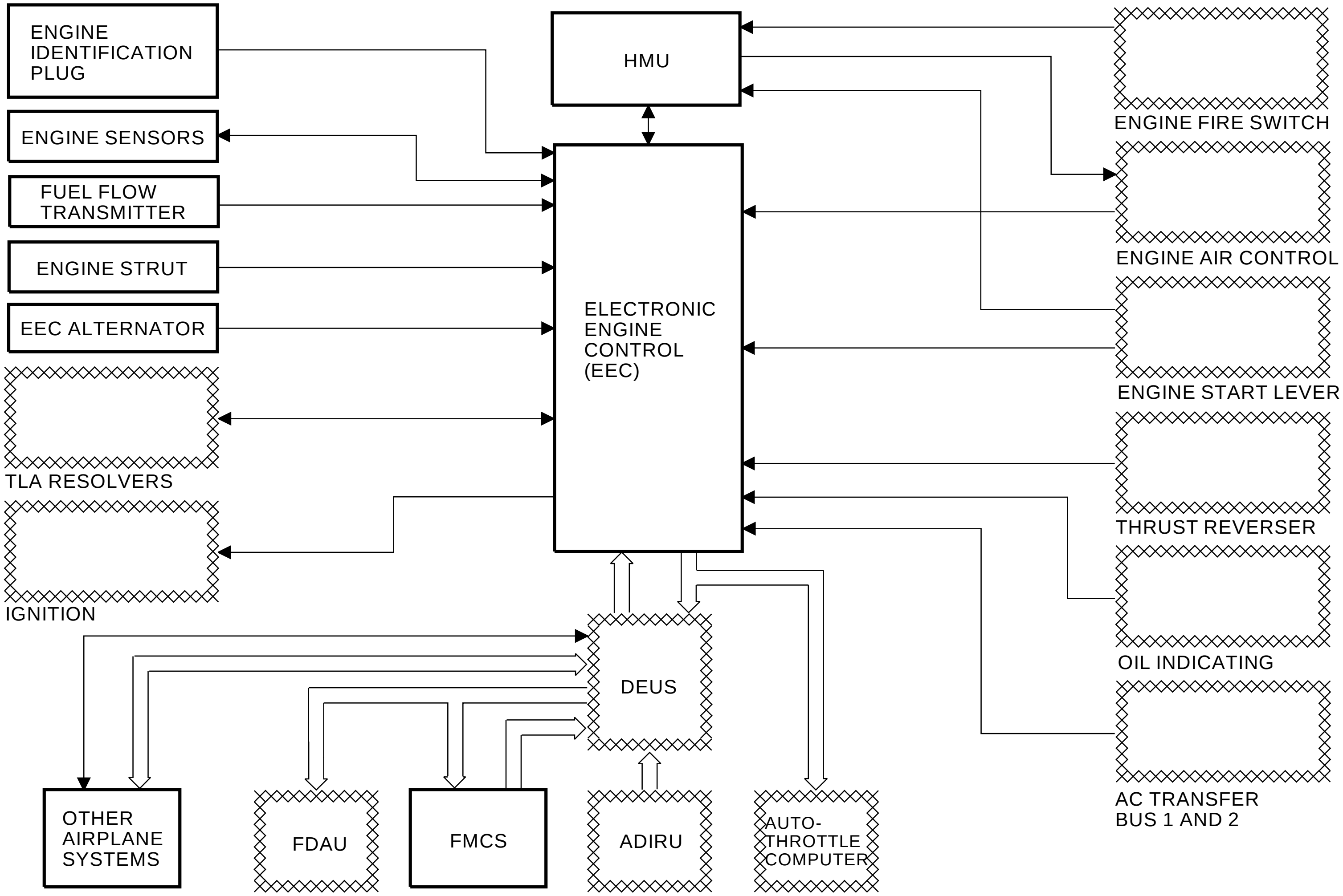
Analog Control Data

The airplane sends and receives analog control data. This is the analog data the EEC receives:

- Thrust lever resolver angle (TRA)
- Thrust reverser position
- Engine position
- Airplane model
- Position of engine actuators
- Control mode switch data.

This is the analog data the engine sends to other airplane systems:

- N1 speed
- N2 speed
- Oil quantity
- HPSOV position command
- Thrust reverser interlock solenoid command.



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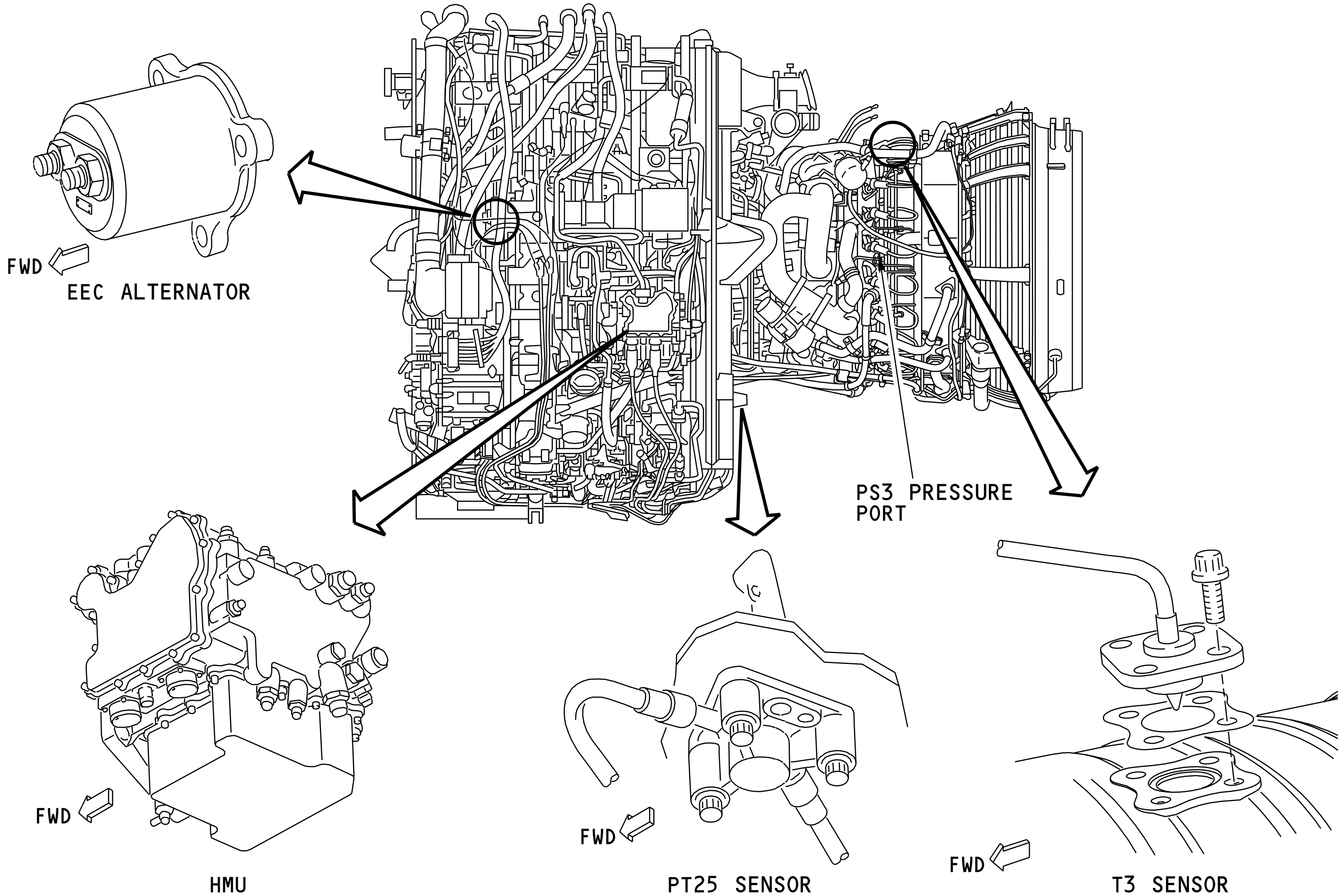
ENGINE FUEL AND CONTROL - ENGINE CONTROL - INTERFACES

ENGINE FUEL AND CONTROL - ENGINE CONTROL - COMPONENT LOCATION - LEFT SIDE

Engine Left Side

These components of engine fuel and control system are on the left side of the engine:

- T3 sensor
- PS3 pressure port
- EEC alternator
- PT25 sensor
- Hydromechanical unit (HMU).



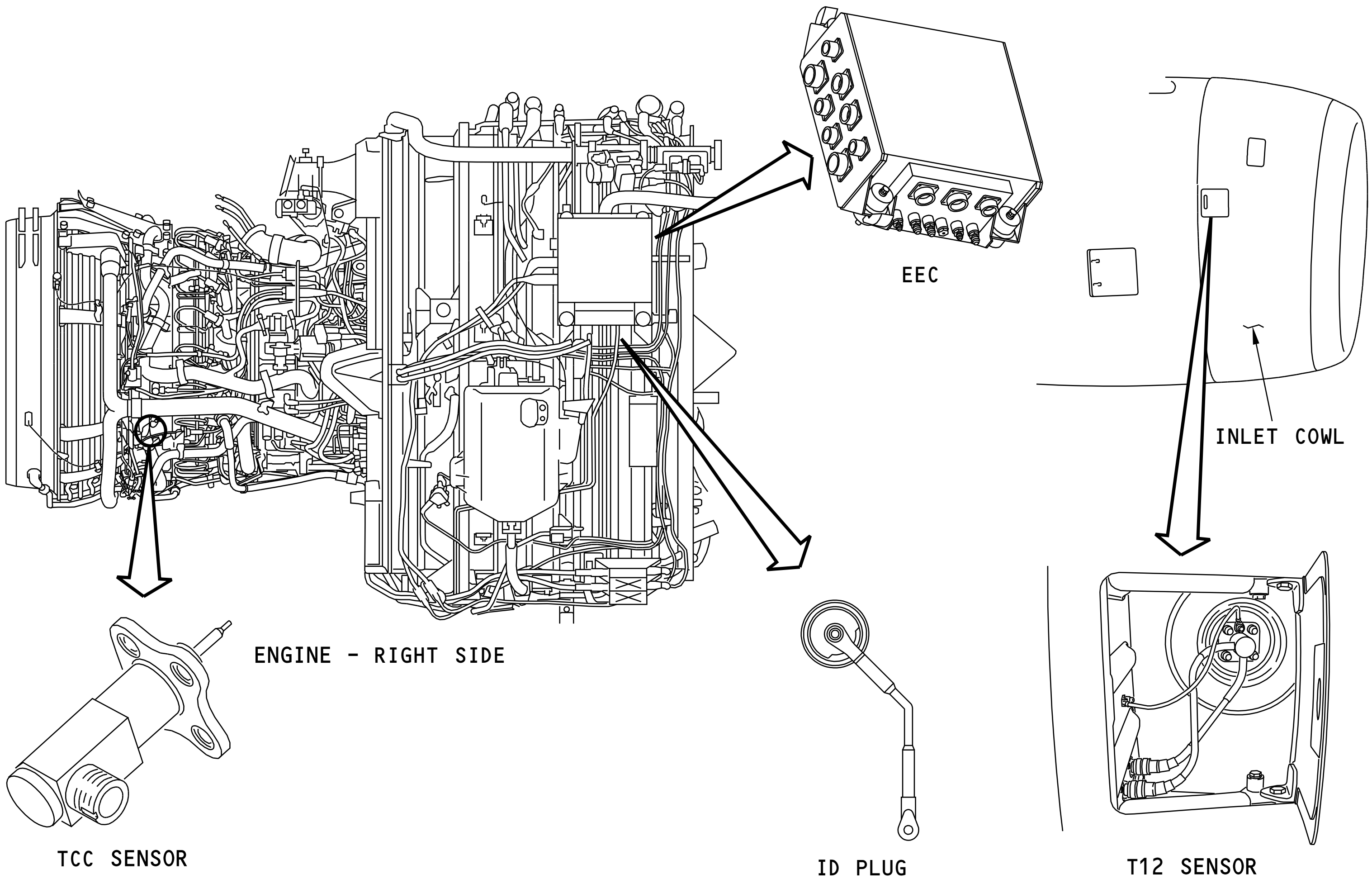
ENGINE FUEL AND CONTROL - ENGINE CONTROL - COMPONENT LOCATION - LEFT SIDE

ENGINE FUEL AND CONTROL - ENGINE CONTROL - COMPONENT LOCATION - RIGHT SIDE

Engine Right Side

These components of the engine fuel and control system are on the right side of the engine:

- EGT wiring harness
- TCC sensor
- Identification (ID) plug
- Engine electronic control (EEC)
- T12 sensor.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - COMPONENT LOCATION - RIGHT SIDE

ENGINE FUEL AND CONTROL - ENGINE CONTROL - PT25 SENSOR

Purpose

The dual temperature PT25 sensor supplies high pressure compressor (HPC) inlet temperature data to the EEC. The EEC uses the T25 temperature information to control these components:

- Transient bleed valve (TBV)
- Variable bleed valve (VBV)
- Variable stator vanes (VSV).

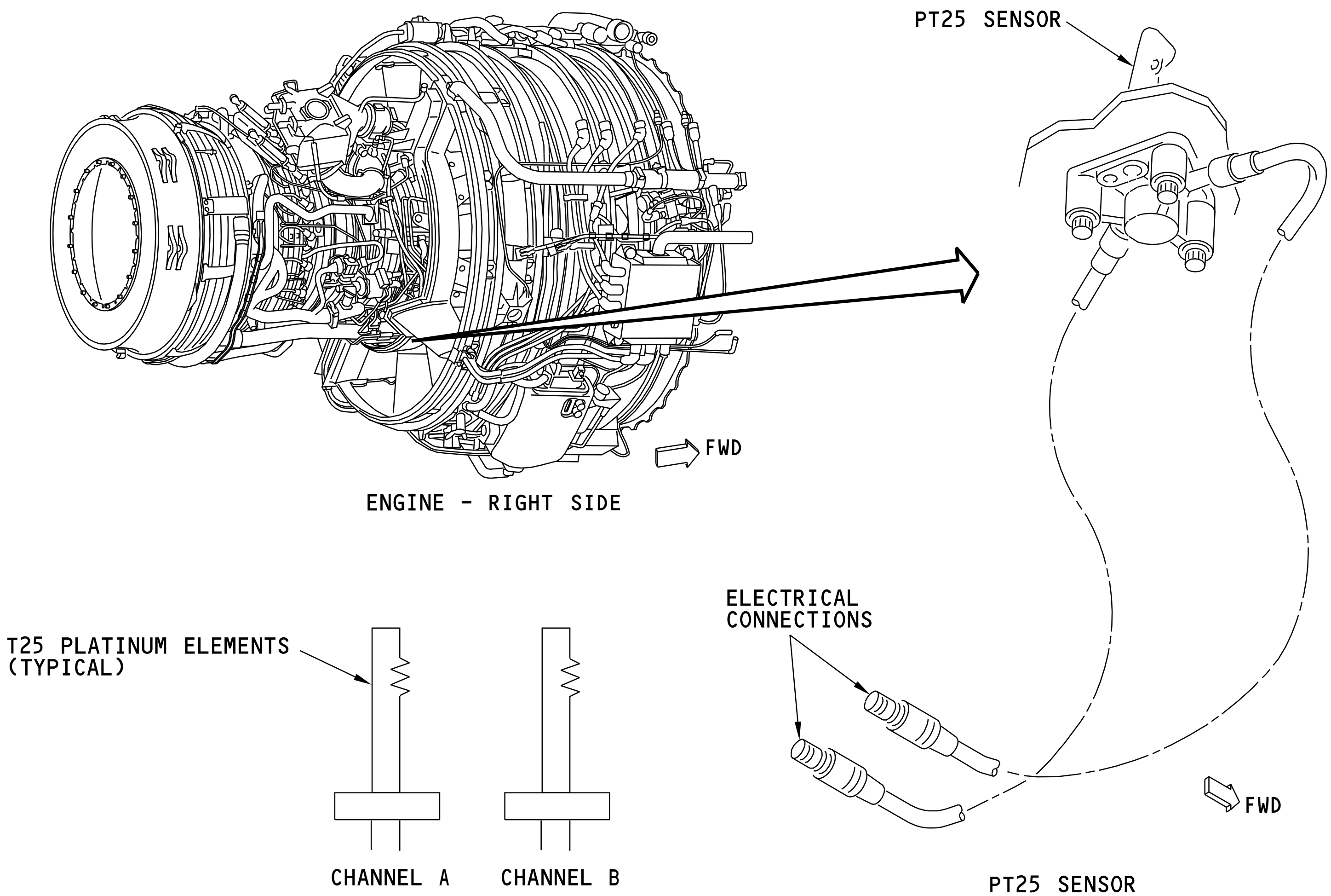
The PT25 sensor has two electrical connections that supply data to both EEC channels.

Location

The PT25 sensor is at the 6:00 position on the inner wall of the fan frame under the fan duct panel.

Functional Description

There are two platinum elements in the PT25 sensor assembly. One element is for channel A, the other is for channel B. The EEC supplies a constant voltage power supply to the T25 sensor elements. The elements change resistance to the electrical current in proportion to air temperature. The different output voltages from the platinum elements goes to the EEC. The EEC measures the difference between the constant output voltage and input voltage from the sensor. The EEC converts the difference into a HPC inlet temperature.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - PT25 SENSOR

ENGINE FUEL AND CONTROL - ENGINE CONTROL - T12 SENSOR

General

The T12 sensor supplies fan inlet total temperature data to the EEC when the airplane is on the ground and for five minutes after takeoff. In-flight and more than five minutes after takeoff, the EEC uses these to calculate the selected total temperature:

- T12 from the active EEC channel
- T12 from the standby EEC channel
- Total air temperature from ADIRU 1
- Total air temperature from ADIRU 2.

The EEC uses total temperature to control these:

- Engine thrust management
- Variable bleed valve (VBV)
- VSV and LPTACC systems.

Location

The T12 sensor is at the 2:30 position in the engine inlet cowl. The T12 sensor probe extends into the air that flows to the fan.

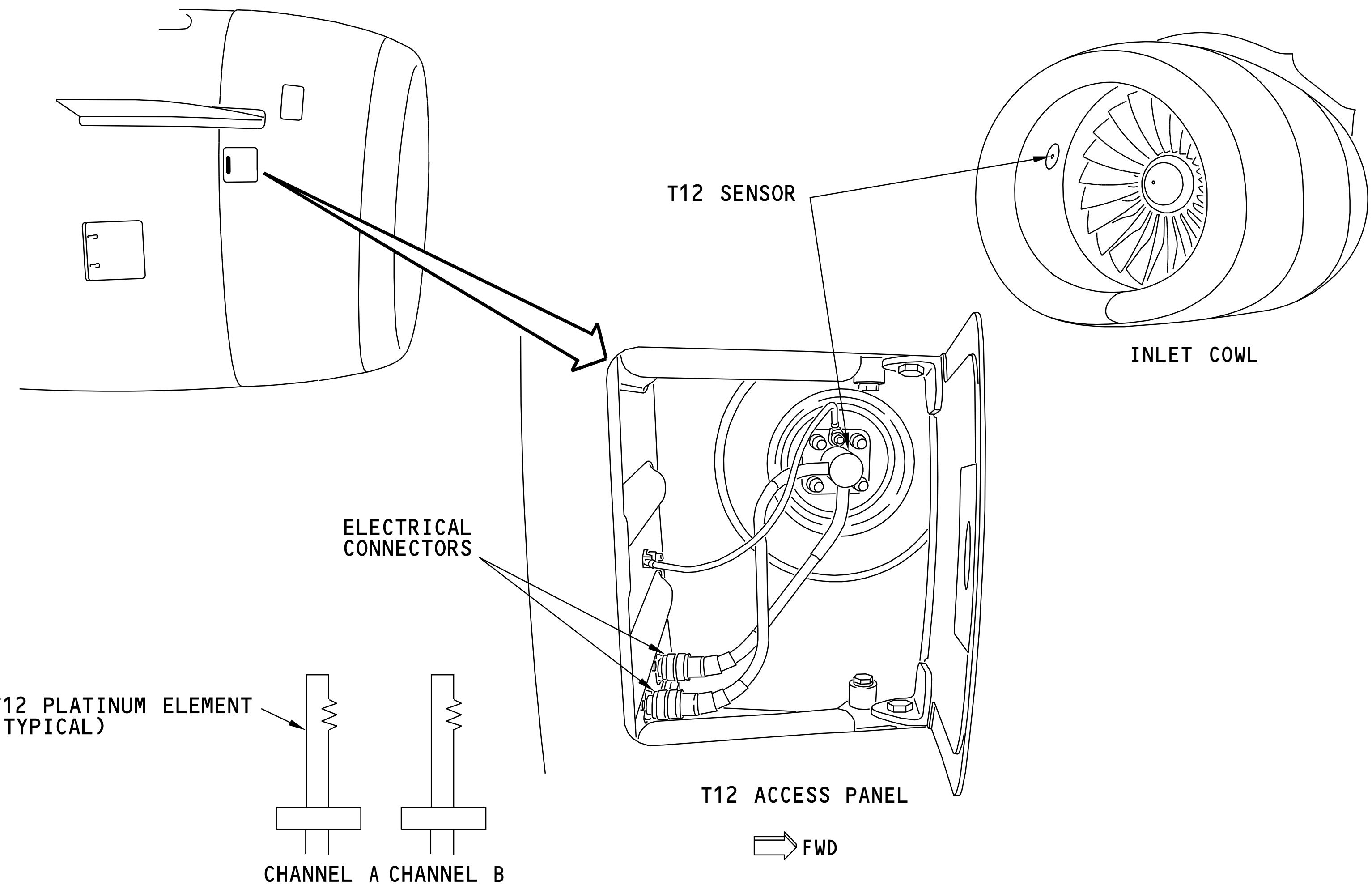
An access panel on the outer right side of the inlet cowl supplies access to the T12 sensor.

Two electrical connectors connect the T12 sensor to the EEC. The connectors are in the inlet cowl assembly. They let you remove and install the sensor quickly.

Functional Description

There are two platinum elements in the sensor assembly. One element is for channel A, the other is for channel B.

The EEC supplies a constant voltage power supply to the T12 platinum sensor elements. The elements change resistance in proportion to air temperature. The output from the platinum elements goes to the EEC. The EEC measures the difference between the constant output voltage and input from the sensor. The EEC converts the difference into a fan inlet temperature.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - T12 SENSOR

ENGINE FUEL AND CONTROL - ENGINE CONTROL - T3 SENSOR

General

The T3 temperature sensor is a thermocouple that measures 9th stage compressor discharge air temperature. The T3 sensor sends this temperature data to the EEC.

AKS ALL PRE SB CFM56-7B 73-44

The EEC uses T3 temperature data to control the burner staging valve (BSV) and the high pressure turbine active clearance control (HPTACC).

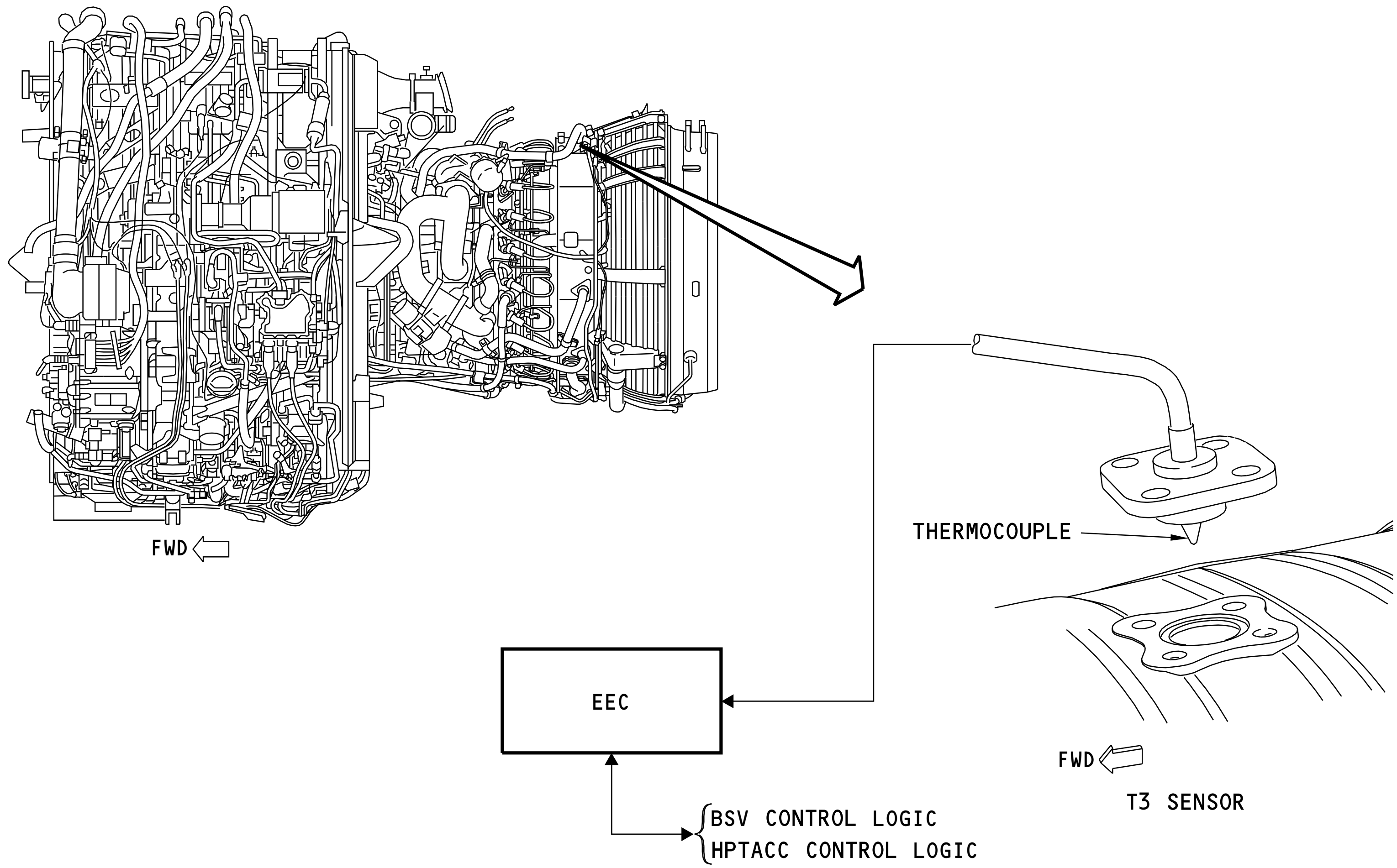
AKS ALL POST SB CFM56-7B 73-44

The EEC uses T3 temperature data to control the high pressure turbine active clearance control. (HPTACC)

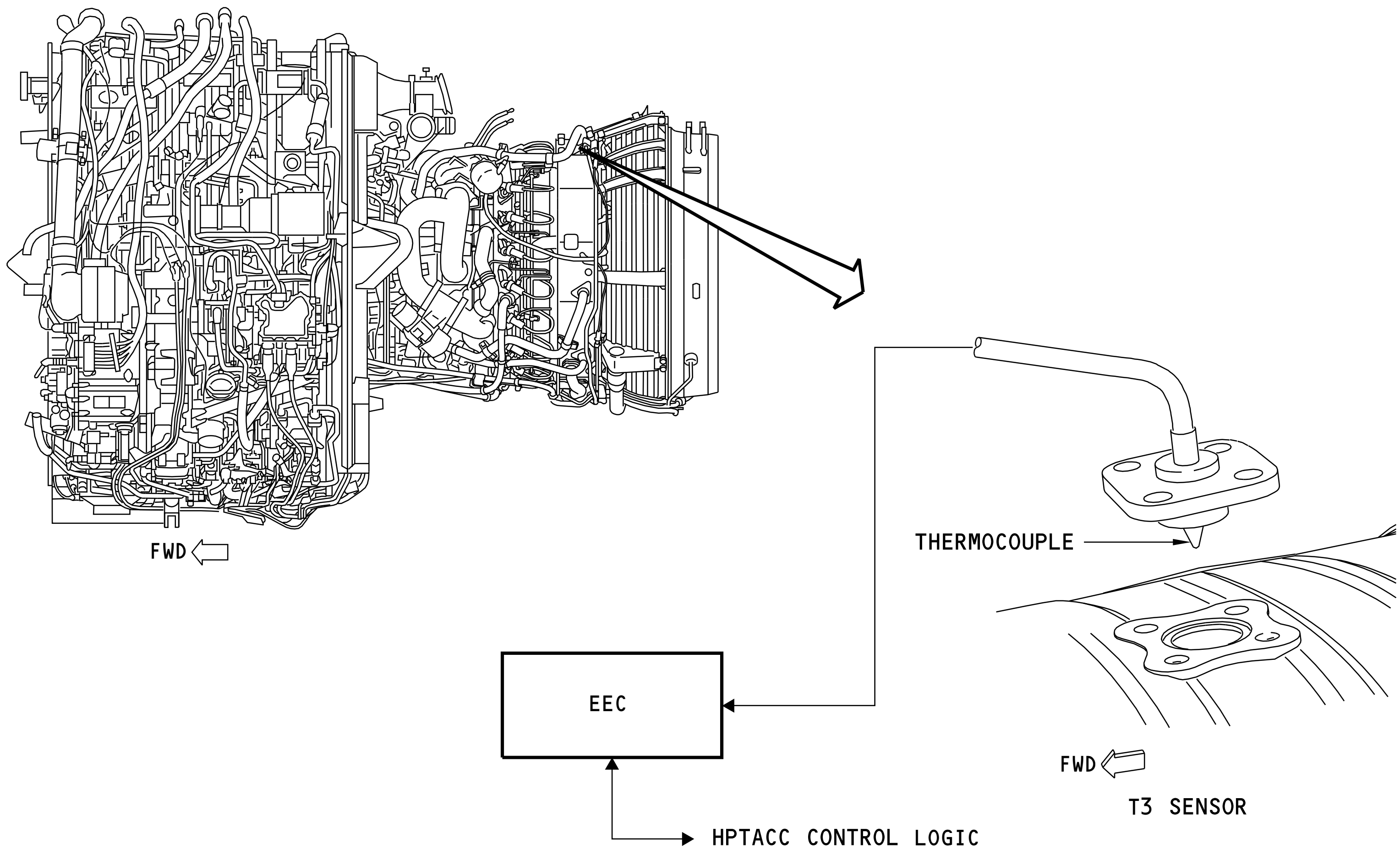
AKS ALL

Functional Description

The bi-metallic sensor makes a milliamp (mA) current proportional to temperature. When temperature increases, the current increases. When temperature decreases, the current decreases.



ENGINE FUEL AND CONTROL - ENGINE CONTROL - T3 SENSOR



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - T3 SENSOR

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TCC SENSOR

Purpose

The turbine clearance control (TCC) sensor supplies the EEC with temperature data from the high pressure turbine (HPT) shroud. The EEC uses the milliamp (mA) signal from this sensor to control the high pressure turbine active clearance control valve.

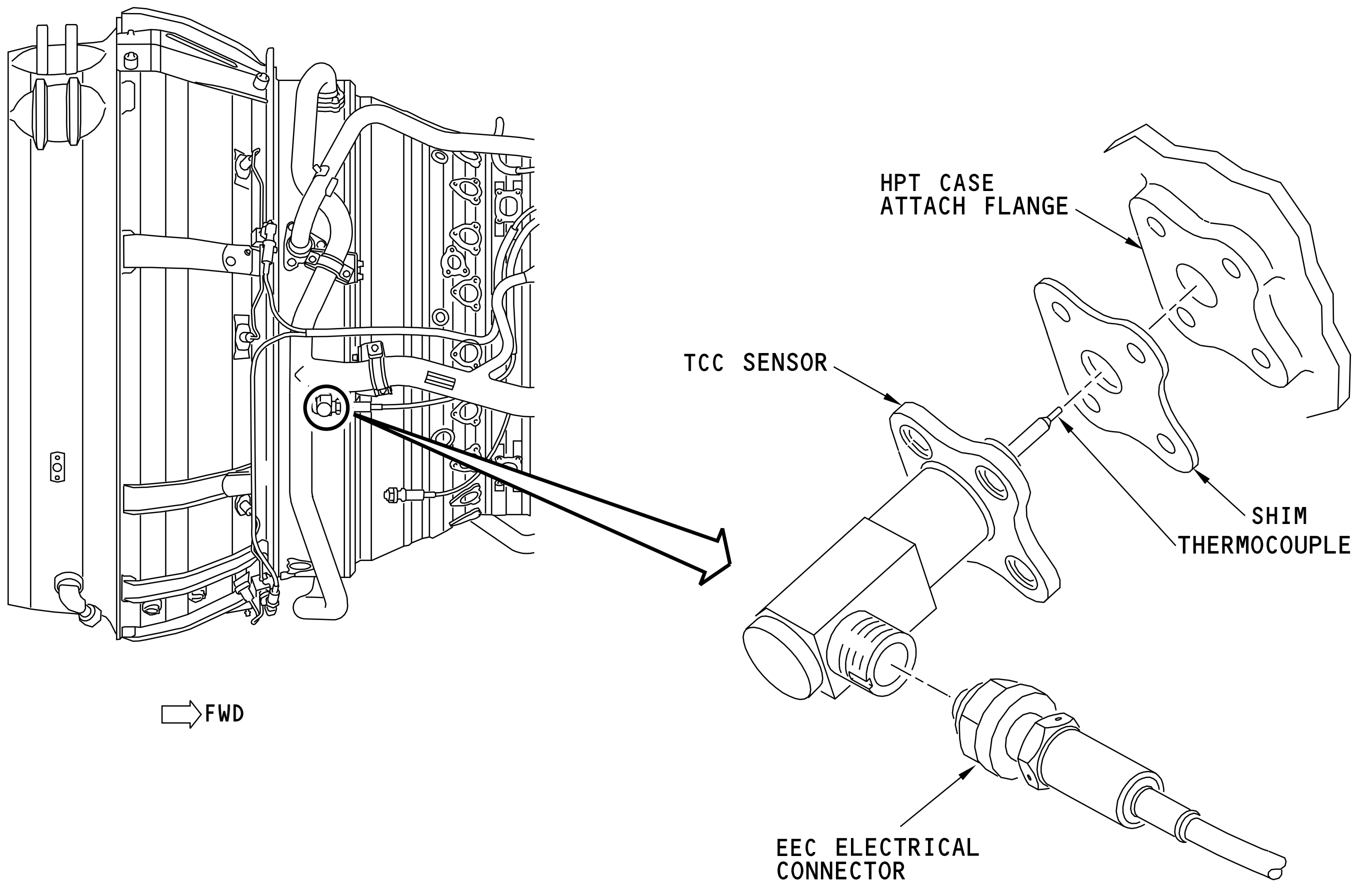
See the air chapter for more information on the HPTACC system. (CHAPTER 75)

Location

The TCC sensor is on the engine at the 3:00 position. The sensor is on the HPT case. To get access to the sensor, open the right fan cowl and thrust reverser cowl.

Physical Description

The TCC sensor is a thermocouple. The sensor extends from the engine case to the HPT shroud. A metal shim below the sensor controls the depth the thermocouple goes into engine case.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TCC SENSOR

ENGINE FUEL AND CONTROL - ENGINE CONTROL - ELECTRONIC ENGINE CONTROL

General

The electronic engine control (EEC) is the primary control for the engine. The EEC uses digital and analog signals from the engine and other airplane systems to control and monitor the engine. The EEC sends engine data to other airplane systems.

EEC Electrical Connections

There are electrical connectors on the EEC. The EEC uses these connectors to receive and send data to the airplane, and engine. The connectors are J1 to J10.

The engine identification plug connects to P11. The identification plug supplies the EEC with engine configuration data.

EEC Air Connections

The EEC also has air connections. These air connections get air pressures from different places on the engine. The sensors that change air pressure to a digital signal are part of the EEC. These are the air pressure signals:

- P0 (outside air static pressure)
- PS3 (HPC discharge).

The EEC gets P0 from the ADIRUs and from the P0 pressure transducers in the EEC. Each EEC channel has a P0 transducer. The EEC senses P0 through an open port on the bottom of the EEC. Because the P0 sense port for the EEC is inside the fan cowl, the EEC needs to correct P0 to get ambient pressure.

When the EEC is in normal mode, P0 is used to calculate airplane speed for engine thrust management. When the EEC is in an alternate mode, the EEC uses P0 to estimate PT or to find an assumed PT. See the ENGINE THRUST MANAGEMENT page in this section for more information.

Each EEC channel has a PS3 transducer. The EEC uses PS3 to prevent high pressure compressor stall or surge and to make sure the bleed pressure is above the minimum allowed value. If bleed pressure is below the minimum, the EEC increases the minimum idle speed. If the compressor is close to stall or surge, the EEC controls the VSV, VBV, and TBV to protect the compressor. Hard tubes and flexible hoses get PS3 air pressure to the PS3 air connection on the bottom of the EEC.

EEC Cooling

A ram air inlet supplies air to keep the EEC cool. The ram air inlet is on the outside of the inlet cowl, at the 1:00 position.

EEC Installation

The EEC attaches to the engine fan case at the 2:00 position. The EEC attaches to the fan case with four shock mounts. The EEC is grounded to the engine with metallic straps.

Functional Description

Each EEC has two computers. Each computer can control the engine. One computer is in active control while the other computer is in standby. The computers are called channels. One computer is called channel A and the other computer is called channel B. The two channels communicate through a cross channel data link (CCDL).

Each EEC channel has driver circuits. A driver circuit changes digital command signals to analog signals that go to the engine and airplane actuators and solenoids. One EEC channel cannot control the other channels drivers.

Each EEC has sense circuits. A sense circuit reads signals from various sensors on the engine and airplane. The active channel can read input data from either channel A or channel B with the cross channel data link. The active channel chooses the best signal or averages the signals to calculate the value it uses to control the engine.

If the active channel is not valid, the standby channel becomes the active channel. If one EEC channel is not valid, the EEC stays in the dual channel mode. Dual channel mode lets the active channel use the sense circuits from both channels for engine control. If one channel is not valid, a fault is stored in the BITE memory. Many of these EEC faults cause the ENGINE CONTROL and MASTER CAUTION lights in the flight deck to come on. If the ENGINE CONTROL light comes on, you cannot dispatch the airplane until you correct the condition that caused the light. You can see the BITE information on the control display unit (CDU) in the flight deck. See the TRAINING INFORMATION POINT pages in this section for more information on BITE.

The EEC is usually in the dual channel mode. The EEC goes to single channel mode when the EEC alternator supplies power to only one channel. The EEC channel with EEC alternator power becomes the active channel and the other channel goes to standby. The standby channel gets power from the airplane transfer bus. The EEC also goes to single channel operation when the EEC channels can not communicate with each other. When the EEC is in single channel operation, the active channel of the EEC uses only its own sense circuits to control the engine.

When both channels operate normally, channels A and B alternate between active channel and standby channel each time the engine is started. This change of control occurs if N2 was more than 76 percent during the previous engine run and the new active channel has no faults or fewer faults than the new standby channel.

These are the major functions of the EEC:

- Input signal validation and processing
- Starting, shutdown, and ignition control
- Engine power management
- Reverse thrust control
- Engine core control
- High pressure turbine active clearance control (HPTACC) and low pressure turbine active clearance control (LPTACC)
- BITE
- Flight compartment indication.

Input Signal Validation and Processing

The EEC gets digital and analog signals from the engine and other airplane systems. Some of these signals have more than one source for the same data. This improves engine reliability because if one data source is inoperative the EEC can use the other data sources. If the EEC finds that all data sources are valid, it uses the best data to control the engine. An example of this is T495 (low pressure turbine nozzle temperature). This signal is also called exhaust gas temperature (EGT). Each EEC channel gets two EGT signals. If all four signals are valid, the EEC uses the average temperature as the selected EGT. If one of the signals is out of range, the average of the other three EGTs is used to control the engine.

If all sources of a given parameter are not valid, the EEC will use a default value to operate the engine safely.

If the EEC finds that one signal is not valid, it will store a message in BITE memory.

Starting, Shutdown, and Ignition Control

The EEC does enhanced manual starts. An enhanced manual start uses the same basic start procedures as for other 737 models but adds wet start and hot start protection. See the engine starting section for more information. (CHAPTER 80)

The EEC controls the normal engine shutdown when the pilot puts the start lever in the cutoff position.

The EEC controls which ignition system is energized during the start and deenergizes the ignition system for a hot start and wet starts. The EEC can also energize the ignition system automatically if the engine slows incorrectly. See the ignition section for more information. (CHAPTER 74)

Engine Power Management

The EEC calculates the engine thrust with N1 speed and ambient pressure and temperature conditions. The EEC uses N1 speed to control engine thrust. The flight crew moves the thrust levers to command more or less engine thrust. The EEC gets thrust lever angle (TLA) from the thrust lever resolvers. The resolvers send thrust lever resolver angle (TRA) to the EEC. See the engine controls section for more information. (CHAPTER 76)

You can see TRA angles in engine BITE input monitoring pages on the flight deck CDU. See the TRAINING INFORMATION POINT pages in this section for more information on BITE.

Reverser Thrust Control

The EEC uses thrust reverser translating sleeve position to limit reverse thrust until the thrust reversers are deployed. The EEC energizes the reverse thrust interlock solenoid to keep the reverse thrust levers in the deploy position until the thrust reversers are deployed. This gives the flight crew an indication of when thrust reversers are deployed. See the engine controls section for more information. (CHAPTER 76)

Engine Core Control

The EEC has hardware and software limits to keep engine operation safe and satisfactory. The EEC keeps these engine parameters in limits:

- N2 speed
- PS3 (HPC static pressure)
- Fuel flow.

The EECs control these engine systems and components to keep engine parameters in limits:

- Engine fuel flow
- BSV
- Variable stator vanes (VSV)
- Variable bleed valve (VBV)
- Transient bleed valve (TBV).

See the engine air system section for more information on VSV, VBV and TBV. (CHAPTER 75)

HPTACC and LPTACC Control

The EEC heats or cools the turbine case to control the high pressure and low pressure turbine tip clearances. See the engine air system section for more information on VSV, VBV and TBV. (CHAPTER 75)

BITE

The EEC supplies fault data for engine troubleshooting and maintenance support. You use the control display unit (CDU) in the flight compartment to do troubleshooting and to do ground tests on engine systems. You can also use the CDU to monitor EEC inputs and outputs. BITE data is available through the CDU on the ground only. See the TRAINING INFORMATION POINT pages in this section for more information on BITE.

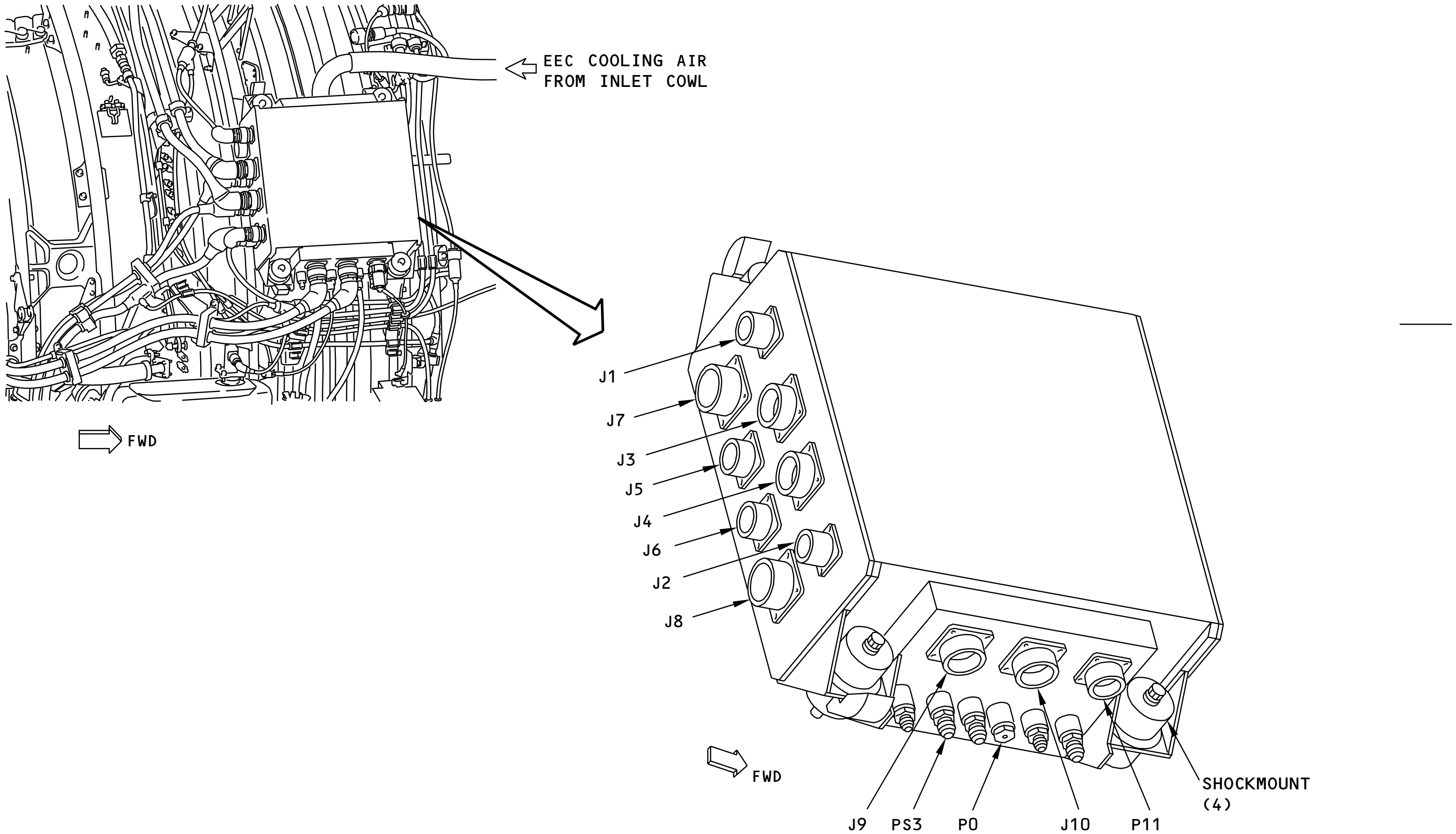
Engine Indication

The EEC supplies data to display electronic units (DEU) 1 and 2 of the common display system (CDS). The CDS display units (DU) show engine primary and secondary indications.

See the engine indicating chapter for more information on engine indications. (CHAPTER 77)

Training Information Point

An operator can update the EEC software program with the use of a portable data loader (PDL). Refer to the engine manufacturer manuals for more information on the use of the PDL.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - ELECTRONIC ENGINE CONTROL

ENGINE FUEL AND CONTROL - ENGINE CONTROL - ENGINE IDENTIFICATION PLUG

Purpose

The engine identification (ID) plug supplies configuration data to the electronic engine control (EEC).

This is the engine ID plug data:

- Engine type (7B)
- N1 trim
- Thrust rating
- Engine condition monitoring (option)
- Engine combustor configuration (SAC or DAC).

AKS ALL PRE SB CFM56-7B 73-44

- BSV active

AKS ALL

Location

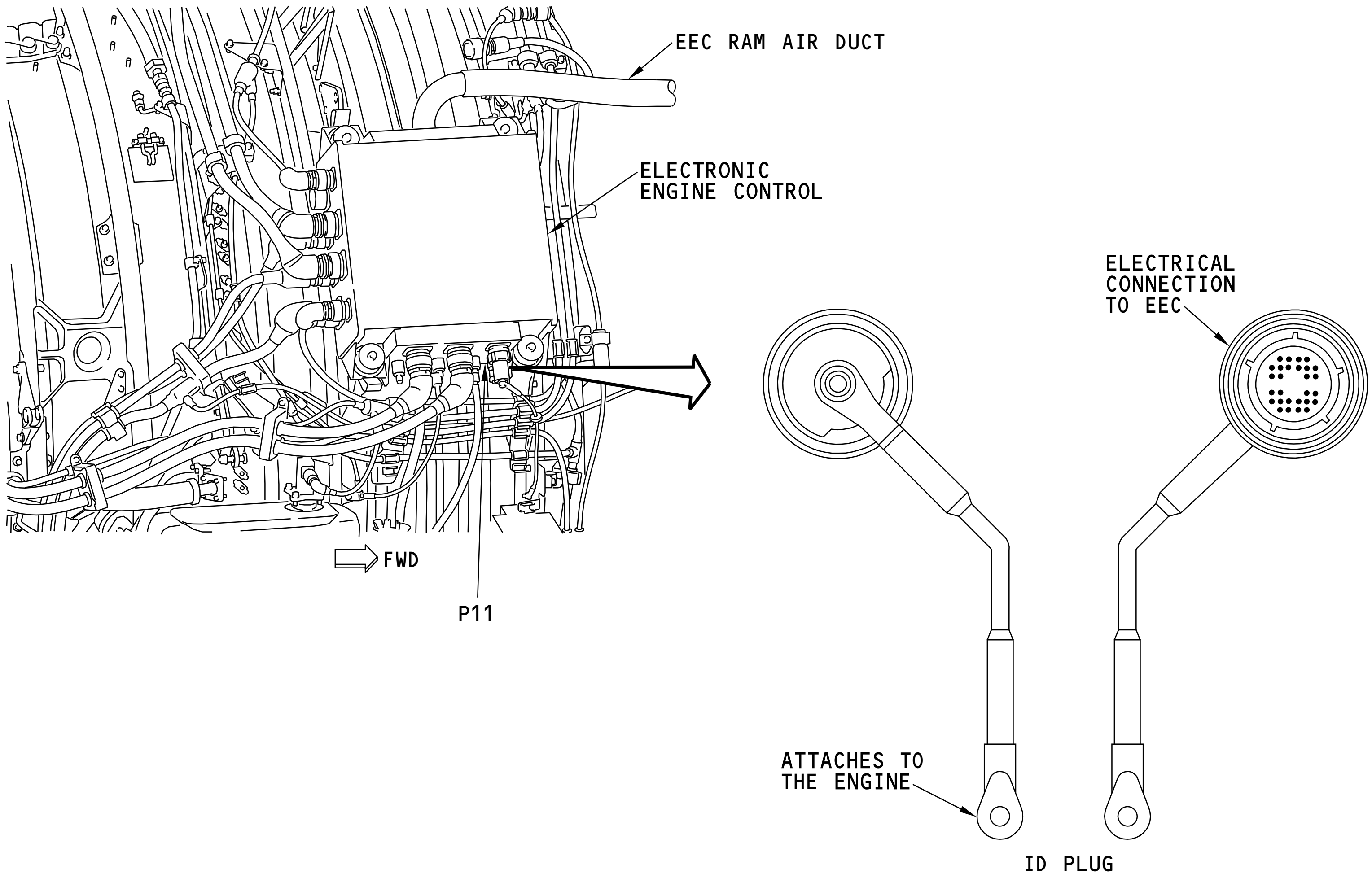
The EEC is on the right side of the engine fan case. The engine ID plug connects to the P11 connector on the bottom of the EEC. To get access to the EEC and ID plug, open the right fan cowl.

Training Information Point

The engine identification plug stays with the engine when you remove the EEC.

Training Information Point

The engine identification plug does not contain the engine serial number. During an engine change, it will be necessary to change the serial number with the FMC CDU. Use either CDU to enter the serial number for the new engine.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - ENGINE IDENTIFICATION PLUG

ENGINE FUEL AND CONTROL - ENGINE CONTROL - EEC ALTERNATOR

General

The electronic engine control (EEC) alternator usually supplies electrical power to the EEC. The EEC alternator is the primary electrical power source for the EEC.

NOTE: The airplane ac transfer bus 1 is another source of power for engine 1 EEC. AC transfer bus 2 is another source of power for engine 2 EEC. The transfer buses supply electrical power to the EECs when the alternator can not supply power.

Location

The EEC alternator is on the top forward side of the accessory gearbox (AGB). To get access to the EEC alternator, open the left fan cowl.

Physical Description

The EEC alternator contains a housing and stator assembly and a rotor. The stator has two separate sets of windings. One set of windings gives power to channel A and the other set gives power to channel B.

Functional Description

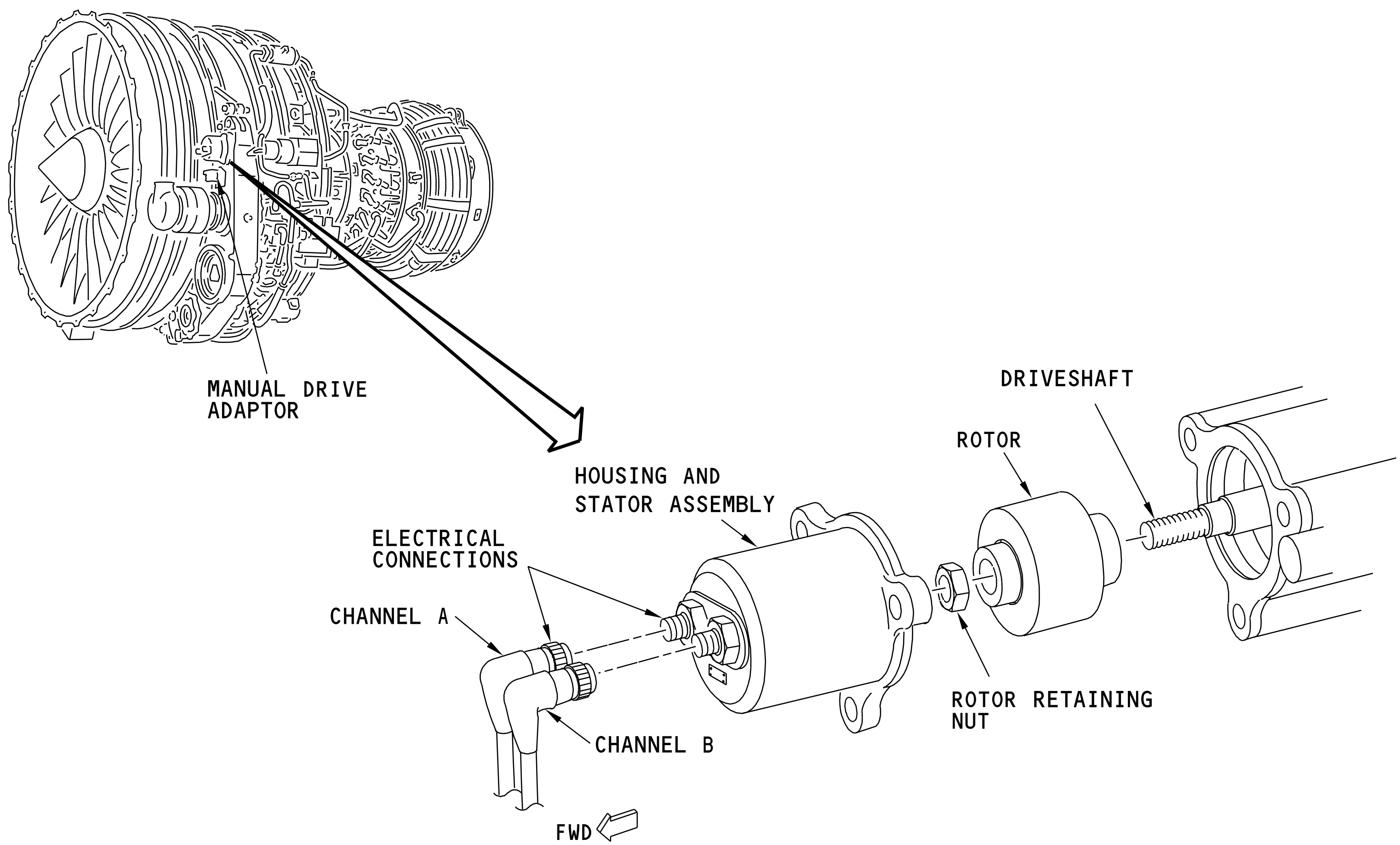
The EEC alternator supplies electrical power to channel A and channel B of the EEC.

If the EEC alternator cannot supply power for either channel A or B, the airplane electrical system can supply power to the EEC. If N2 speed is more than 15 % and the alternator does not have good power for one of the EEC channels, a message is stored in BITE memory. This condition also causes the EEC to go to single channel operation.

Training Information Point

Use the accessory gearbox (AGB) manual drive adaptor when you remove or install the rotor. Put a 3/4-inch square drive tool into the adaptor. This prevents movement of the alternator driveshaft and rotor when you loosen or tighten the rotor retaining nut.

CAUTION: DO NOT LET THE ROTOR AND STATOR TOUCH WHEN YOU REMOVE THE STATOR. THE MAGNETS ON THE ROTOR WILL APPLY A STRONG MAGNETIC PULL ON THE STATOR. DAMAGE TO THESE PARTS CAN OCCUR.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - EEC ALTERNATOR

ENGINE FUEL AND CONTROL - ENGINE CONTROL - EEC ELECTRICAL POWER SUPPLY - FUNCTIONAL DESCRIPTION

Purpose

The EEC alternators are the primary ac power supply for EEC operation. The airplane ac transfer buses can also supply power to the EEC.

Functional Description

The two transfer relays in the EEC let the transfer bus supply ac power to the EEC. One relay supplies power to channel A, the other relay supplies power to channel B.

The engine 1 alternate power relay is in junction box J22. This relay is controlled by the DEUs. There are two contacts on this relay, one for channel A, the other for channel B. When energized, the alternate power relay supplies airplane transfer bus power to the EEC through the internal EEC transfer relays. Any of these conditions cause the DEUs to energize the alternate power relay:

- Engine Start lever set to IDLE or RUN
- Engine start switch set to ground (GRD)
- Engine start switch set to continuous (CONT)
- Control display unit (CDU) set to engine maintenance pages.

NOTE: The engine 2 alternate power relay is in junction box J24. The engine 2 alternate power relay operates almost the same as the engine 1 alternate power relay.

Operation

At engine start, the EEC receives transfer bus power. The EEC alternator speed logic sensor monitors the speed of the EEC alternator. When the N2 speed is more than 40% and alternator power quality is in limits, the EEC energizes the transfer relays. The transfer relays disconnect the transfer bus power supply. The EEC now gets power from the EEC alternator.

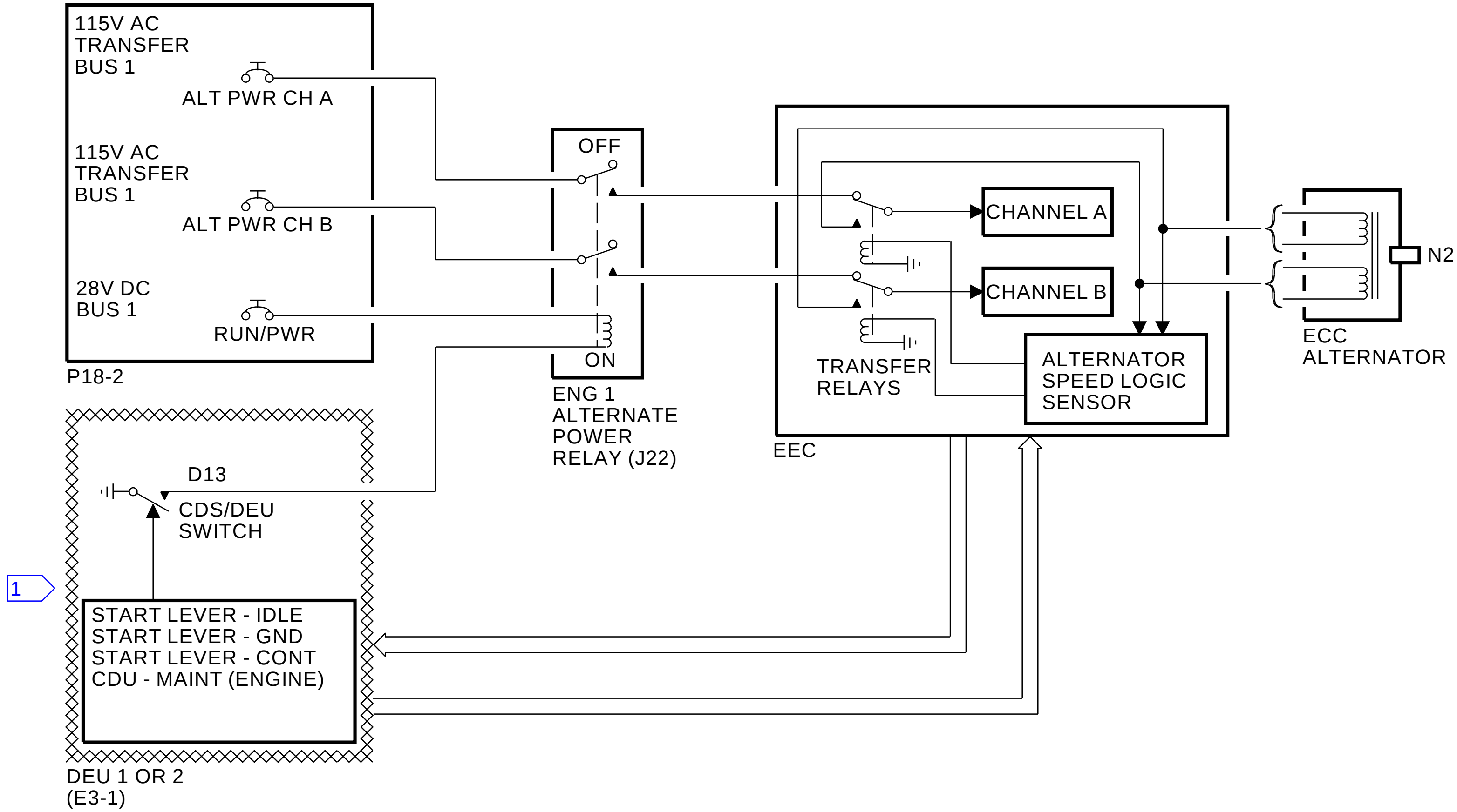
If one set of alternator windings fail, the transfer relay closes for that channel. This provides alternate power from the airplane transfer bus. The other EEC channel continues to receive power from the alternator if the alternator power is in limits.

If both sets of alternator windings fail, both EEC channels receive power from the airplane transfer bus through both EEC transfer relays.

Training Information Point

If both EEC channels are normal and power from one EEC alternator channel stops, engine control changes to the channel with EEC alternator power and a short term dispatch fault is stored in EEC memory. This fault shows on the CDU engine maintenance pages. The EEC channel without EEC alternator power gets power from the airplane transfer bus.

If the EEC is in single channel operation (the other channel is inoperative) and EEC alternator power stops for the active channel, the active channel gets power from the transfer bus and a no dispatch fault is stored in EEC memory. This fault shows on the CDU engine maintenance pages. This also causes the ENGINE CONTROL light on the P5 overhead panel and the MASTER CAUTION light to come on when the airplane is on the ground. You must correct this fault before airplane dispatch is permitted.



NOTE:

ENGINE 2 ELECTRICAL POWER SUPPLY IS ALMOST THE SAME AS ENGINE 1.

1 ENGINE START LEVER PROVIDES START LEVER INPUT

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - EEC ELECTRICAL POWER SUPPLY - FUNCTIONAL DESCRIPTION

ENGINE FUEL AND CONTROL - ENGINE CONTROL - HYDROMECHANICAL UNIT

Purpose

The hydromechanical unit (HMU) supplies fuel for engine servo system operation and combustion. The HMU receives fuel metering signals and engine servo command signals from the EEC and the airplane.

Location

The HMU is at the 8:00 position. The HMU attaches to the aft side of the fuel pump assembly. The fuel pump assembly attaches to the aft side of the accessory gearbox (AGB). You open the left fan cowl to get access to the HMU.

Physical Description

The HMU has electrical and fuel connections. These connect the HMU to the EEC, to airplane control systems, and to engine servo systems. These connections are necessary for correct engine operation.

These are the HMU electrical connections:

- EEC channel A electrical connector
- EEC channel B electrical connector
- High pressure shutoff valve (HPSOV) solenoid

AKS ALL PRE SB CFM56-7B 73-44

- Burner staging valve (BSV) solenoid.

AKS ALL

These are the HMU hydraulic (fuel) connections:

- Metered fuel line (on the top of the HMU, not shown)

AKS ALL PRE SB CFM56-7B 73-44

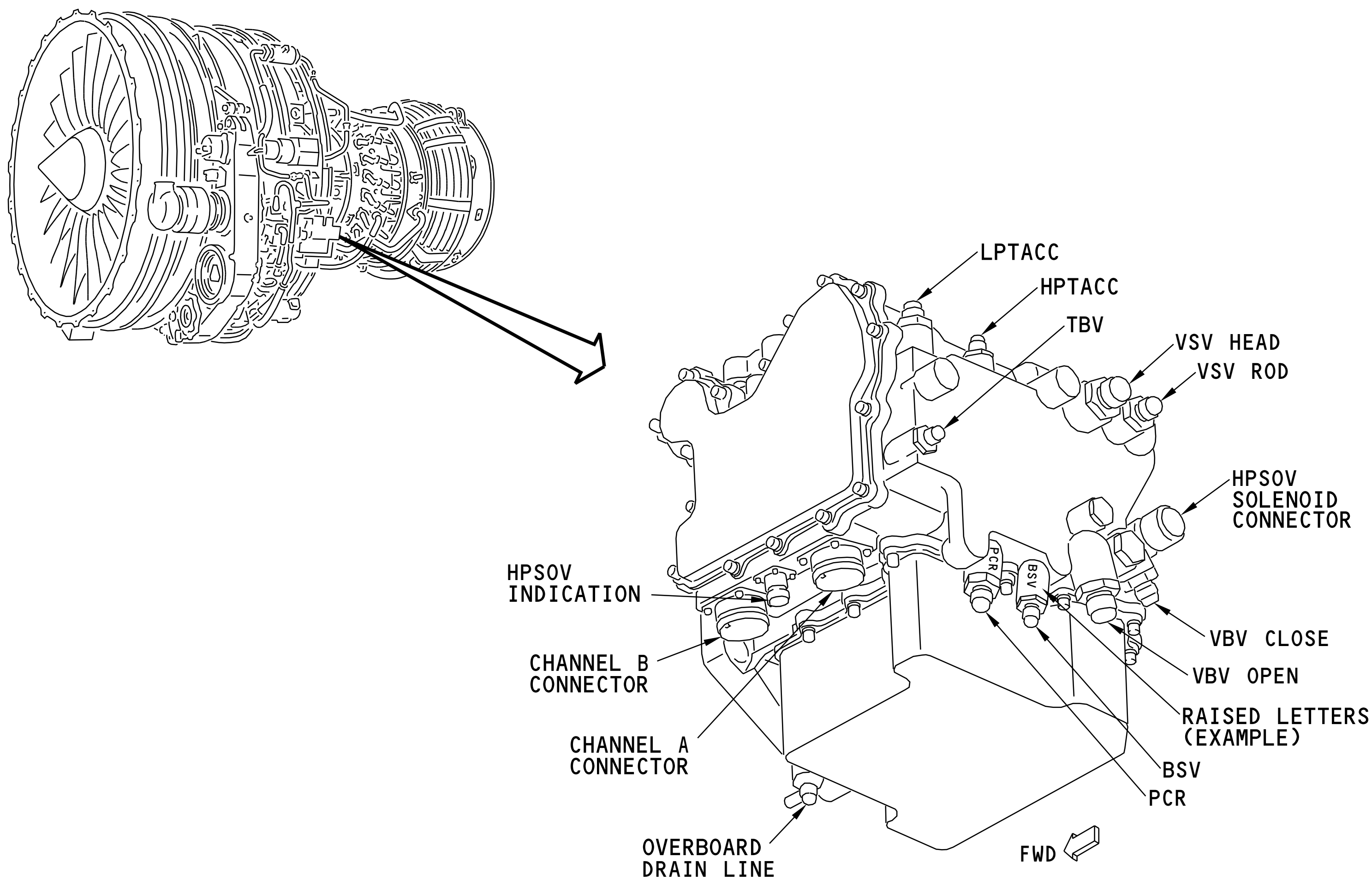
- Burner staging valve (BSV) fuel line

AKS ALL

- Variable bleed valve (VBV) OPEN fuel pressure line
- VBV CLOSE fuel pressure line
- Variable stator vane (VSV) ROD (open) fuel pressure line
- VSV HEAD (close) fuel pressure line
- Pressure case regulated (PCR) fuel pressure line
- Low pressure turbine active clearance control (LPTACC) valve fuel line
- High pressure turbine active clearance control (HPTACC) valve fuel line
- Transient bleed valve (TBV) fuel line
- Overboard drain line.

Training Information Point

The raised letters on the HMU identify the different servo fuel connections.



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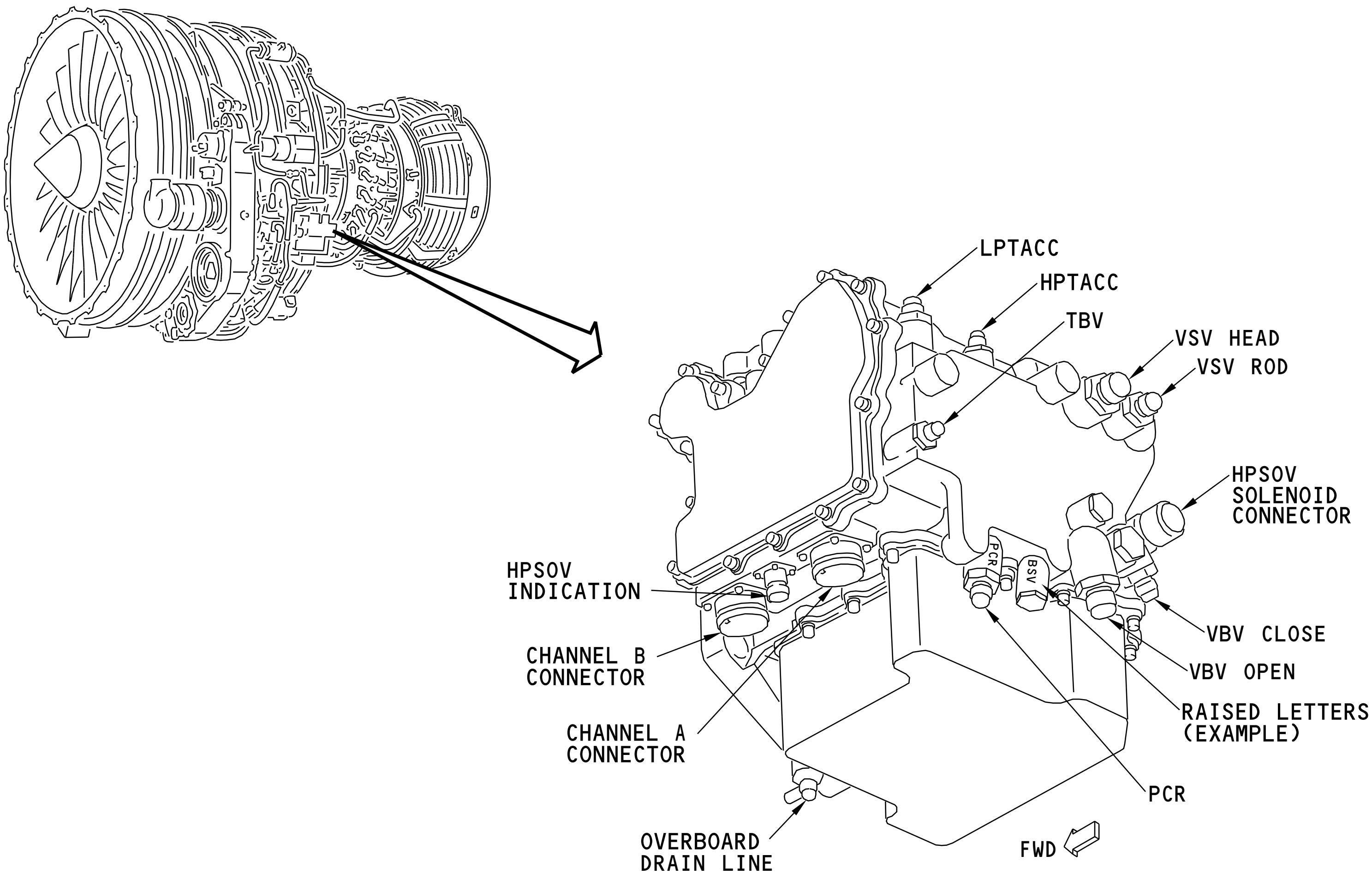
ENGINE FUEL AND CONTROL - ENGINE CONTROL - HYDROMECHANICAL UNIT



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - HYDROMECHANICAL UNIT

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - HMU - FUNCTIONAL DESCRIPTION

General

The electronic engine control (EEC) sends control signals to servo system in the hydromechanical unit (HMU). The electro-hydraulic servo valves (EHSVs) in the HMU change these signals to hydraulic fuel pressure for these components:

- Fuel metering valve (FMV)
- Transient bleed valve (TBV)
- High pressure turbine active clearance control (HPTACC) valve
- Low pressure turbine active clearance control (LPTACC) valve
- Variable bleed valves (VBV)
- Variable stator vanes (VSV).

AKS ALL PRE SB CFM56-7B 73-44

The EEC also sends a signal to the burner staging valve (BSV) solenoid in the HMU. This valve supplies servo fuel to open and close the BSV.

AKS ALL

The high pressure shutoff valve (HPSOV) and mechanical overspeed governor are also in the HMU. The start lever and the fire handle control the HPSOV independent of the EEC. When closed this valve stops fuel flow to the combustor. The mechanical overspeed governor makes sure the N2 rotor does not turn too fast.

Fuel Metering Valve (FMV)

The EEC controls the FMV with servo fuel pressure from the FMV EHSV. The FMV resolver sends the position of the FMV back to the EEC. Fuel flow through the open FMV causes the high pressure shutoff valve (HPSOV) to open.

The EEC can fully close the FMV on the ground during engine start for these conditions:

- Exhaust gas temperature is more than the limits for engine start
- Engine goes to idle speed during start, but speed then decreases below 50% N2 speed and EGT goes above the start limit
- EEC senses fuel flow but no EGT for 15 seconds after the engine start lever is put to IDLE or RUN with TAT more than 2C or 20 seconds after the engine start lever is put to IDLE or RUN if TAT is less than 2C, (wet start or hung start).

The EEC sends a no dispatch signal to the DEUs for these FMV failures:

- FMV is not in the correct position
- FMV position signal is out of range on both EEC channels
- FMV position signal is out of range and EEC in single channel operation
- Control current to the FMV EHSV is out of range and EEC in single channel operation.

The DEUs energize the ENGINE CONTROL light on the P5 aft overhead panel and the MASTER CAUTION lights when these conditions occur:

- Airplane is on the ground more than 30 seconds after landing or increasing ground speed is less than 80 knots
- EEC is energized (engine starting, running, or EEC energized for maintenance)
- A no dispatch engine fault occurs.

Transient Bleed Valve (TBV)

The TBV EHSV controls the flow of servo fuel pressure to the TBV. A switch supplies TBV position feedback to the EEC.

The EEC sends a no dispatch signal to the DEUs for these failures:

- TBV is not in the correct position
- TBV position signal is out of range on both EEC channels
- TBV position signal is out of range and EEC in single channel operation
- Control current to the TBV EHSV is out of range and EEC in single channel operation.

See the transient bleed section for more information. (SECTION 75-23)

HPTACC and LPTACC

The HPTACC and LPTACC EHSVs control the servo fuel pressure for the HPTACC and LPTACC valve operation. LVDTs on these valves send valve position to the EEC.

The EEC sends a no dispatch signal to the DEUs for these failures:

- HPTACC is not in the correct position
- HPTACC position signal is out of range on both EEC channels
- HPTACC position signal is out of range and EEC in single channel operation
- Control current to the HPTACC EHSV is out of range and EEC in single channel operation.

NOTE: LPTACC failures do not cause the ENGINE CONTROL and MASTER CAUTION lights to come on.

See the HPTACC section for more information. (SECTION 75-21)

VBV And VSV Actuators

The VBV and VSV EHSVs control the servo fuel pressure for the VBV and VSV actuator operation. LVDTs on these actuators send valve position to the EEC.

The EEC sends a no dispatch signal to the DEUs for these failures:

- VBV or VSV is not in the correct position
- VBV or VSV position signal is out of range on both EEC channels
- VBV or VSV position signal is out of range and EEC in single channel operation
- Control current to the VBV or VSV EHSV is out of range and EEC in single channel operation.

See the variable stator vane actuation system section for more information. (SECTION 75-31)

See the variable bleed valve doors section for more information. (SECTION 75-32)

AKS ALL PRE SB CFM56-7B 73-44

Burner Staging Valve Solenoid

The EEC operates the burner staging valve (BSV) solenoid to the control the flow of servo fuel pressure to the BSV. The EEC monitors the BSV position.

The EEC sends a no dispatch signal to the DEUs for these failures:

- BSV failed in the closed position
- Control current to the BSV solenoid out of range and EEC in single channel operation.

For more information on the BSV, see BSV in this chapter.

AKS ALL

High Pressure Fuel Shutoff Valve (HPSOV)

The high pressure shutoff valve (HPSOV) lets fuel flow from the FMV to the fuel nozzles.

The start lever sends an open signal to the DEUs when it is in the idle position. The DEU sends the open signal to the EEC. The EEC causes the FMV to open. Fuel pressure from the open FMV causes the HPSOV to open.

The start lever in the CUTOFF position energizes the HPSOV solenoid. When HPSOV solenoid is energized, servo fuel closes the HPSOV. Fuel pressure from the FMV can not open the HPSOV when the HPSOV solenoid is energized. The fire handle switch can also energize the HPSOV solenoid.

When the HPSOV closes, fuel flow to the fuel nozzles stop.

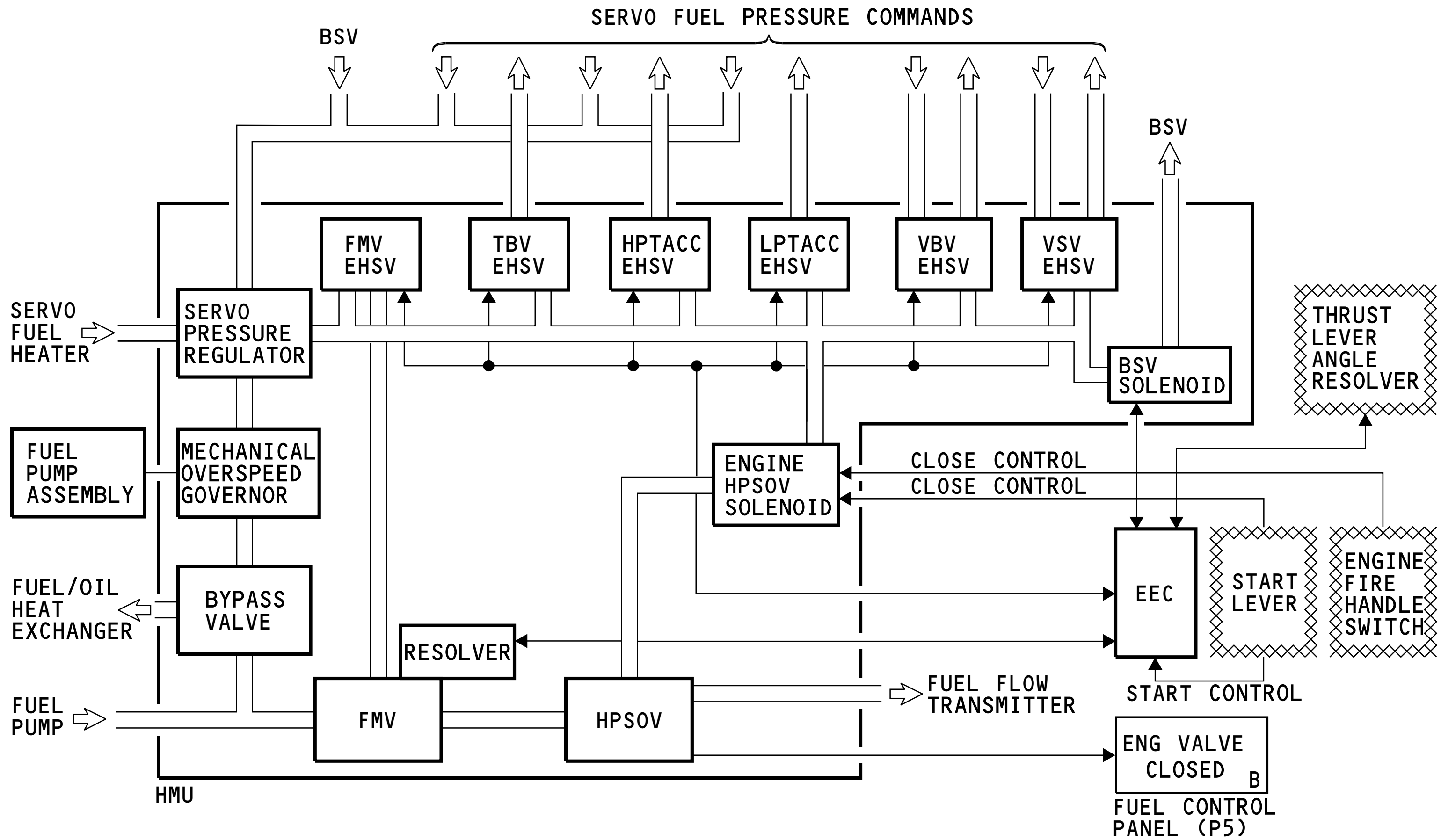
The blue ENGINE VALVE CLOSED light, on the fuel control panel, comes on dim when the HPSOV is closed. The light is off when the valve is open. The light is on bright during valve transition.

Mechanical Overspeed Governor

A mechanical overspeed governor can prevent an N2 overspeed condition.

When the overspeed governor senses an N2 overspeed condition, it causes the bypass valve to open more. When the bypass valve opens more, less fuel goes to the FMV and the fuel nozzles. This causes the N2 speed to decrease.

This is an alternate N2 overspeed protection from the EEC. The EEC monitors the operation of the overspeed governor during each engine start.



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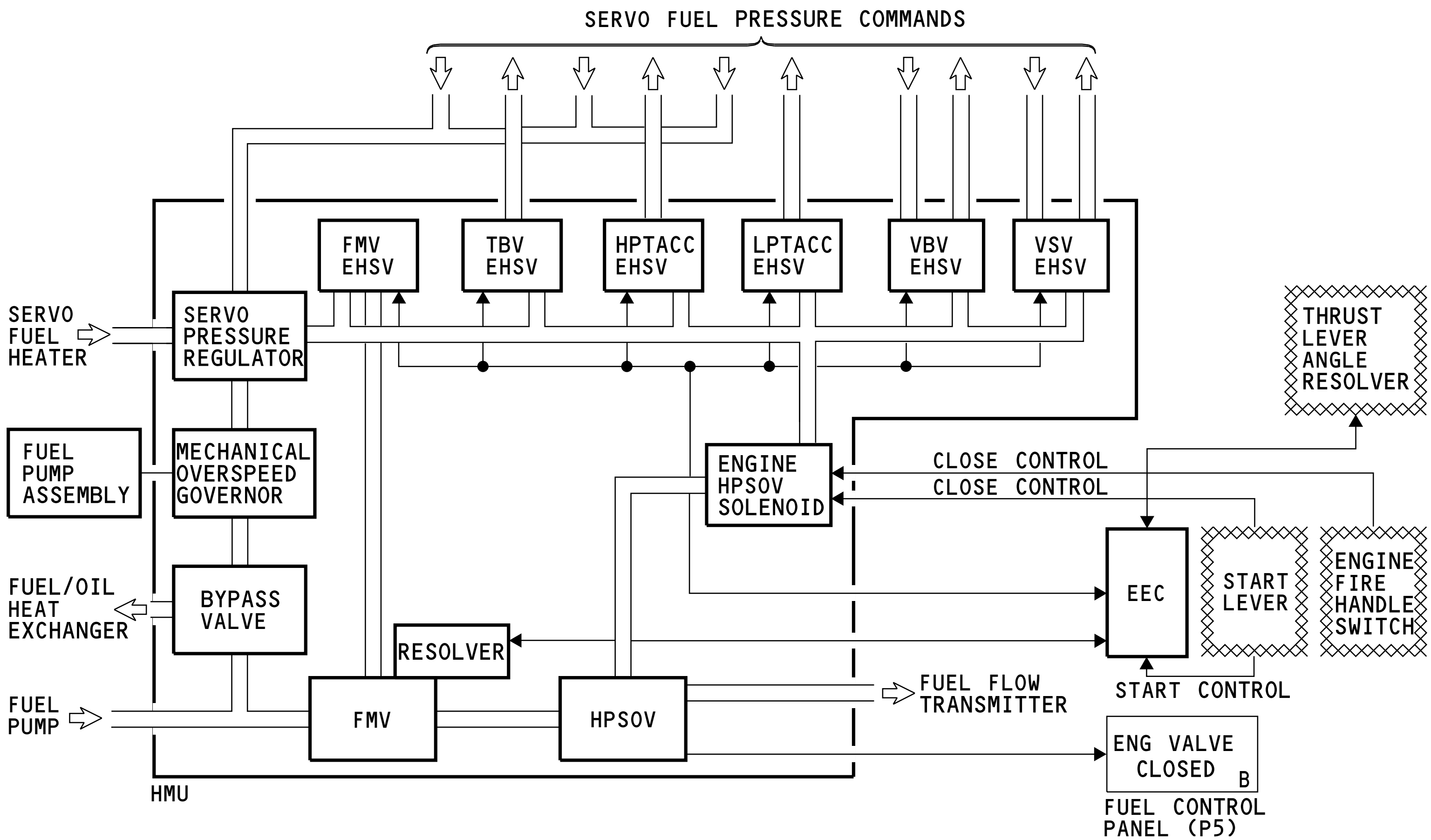
ENGINE FUEL AND CONTROL - ENGINE CONTROL - HMU - FUNCTIONAL DESCRIPTION



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - HMU - FUNCTIONAL DESCRIPTION

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - ENGINE CONTROL LIGHT AND EEC SWITCHES

Purpose

These engine indications on the engine panel show this engine control status:

- EEC switch position indication
- EEC switch ALTN light
- ENGINE CONTROL light.

The white ON switch position indicator and amber ALTN light are in the EEC switches. These indications show if the EEC is in the normal mode or an alternate mode. When the EEC is in an alternate mode, it sends a signal to the ALTN light and the light comes on.

There are two alternate modes, the soft alternate and hard alternate modes. These modes are also called soft and hard reversionary modes.

The soft or hard alternate modes are used when the EEC does not receive valid total air pressure data from both air data inertial reference units (ADIRUs) or the flight crew selects the EEC switch to the OFF position. See the POWER MANAGEMENT page in this section for information on EEC alternate modes.

The ground or flight crew can put the EEC in the hard alternate mode by selection of the EEC switch for that engine. The white ON does not show in the EEC switch when the hard alternate mode is selected. The white ON in the EEC switch shows when the switch is not selected.

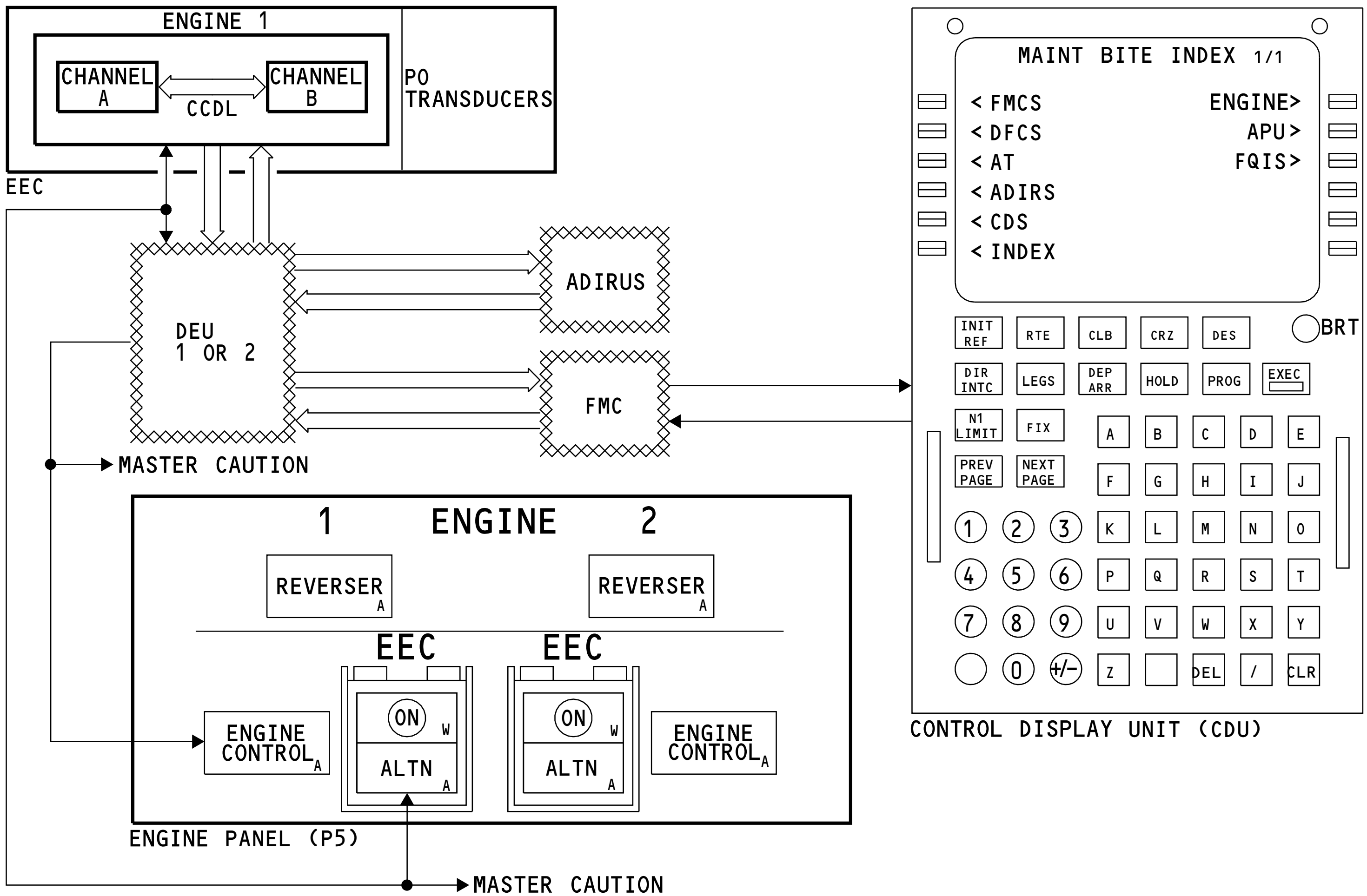
The amber ENGINE CONTROL light shows when the EEC detects an engine failure that does not allow airplane dispatch. The EEC sends a signal to the DEUs to energize the ENGINE CONTROL light. The ENGINE CONTROL light does not come on in flight. The ENGINE CONTROL light comes on when all of these conditions occur:

- Airplane is on the ground and the ground speed is less than 30 knots for more than 30 seconds or increasing ground speed is less than 80 knots
- A no dispatch engine fault occurs.

NOTE: The airplane cannot dispatch with this light on.

Training Information Point

When the ENGINE CONTROL light comes on, use the CDU, fault isolation manual (FIM) and the airplane maintenance manual (AMM) to find and correct the cause. See the TRAINING INFORMATION POINT PAGES of this section for more information on CDU BITE operation.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - ENGINE CONTROL LIGHT AND EEC SWITCHES

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - FUNCTIONAL DESCRIPTION

Electronic Engine Control

The electronic engine control (EEC) is a two-channel computer. The two channels (A and B) are independent but connect by a cross channel data link (CCDL) during engine operation. The EEC chooses either channel A or B as the active control channel. The active channel changes at each engine start if N2 speed during the previous engine run was more than 76 percent and both channels are valid. If the active channel is not valid, the EEC changes the standby channel to the active channel.

The EEC goes to single channel operation when the CCDL is inoperative or when one EEC channel is not powered from the EEC alternator. While in single channel operation, the active channel does not use sensor data from the standby channel.

Electrical Power Supply

The normal power supply for the EEC is the EEC alternator. The EEC can also use ac electrical power from the related airplane transfer buses. See the EEC ELECTRICAL POWER SUPPLY pages in this section for more information on EEC power.

Ignition System Control Power Supply

The transfer buses supply ac power for ignition. The EEC operates the left ignition system with transfer bus power.

The ac standby bus also supplies electrical power for ignition. The EEC operates the right ignition system with ac standby bus power. See the ignition section for more information. (CHAPTER 74)

Thrust Lever Control Inputs

Thrust lever movement changes the position of the thrust lever resolver (TLR). The TLR sends a thrust lever resolver angle (TRA) signal to the EEC. The EEC uses the TRA signal to control engine operation for forward and reverse thrust. See the ENGINE THRUST MANAGEMENT PAGE in this section for more information thrust management. See the engine controls section for more information. (CHAPTER 76)

Engine Temperature Sensors

The EEC uses engine air temperature to control the servo fuel system. The EEC uses the fuel servo system to make sure the engine provides the required thrust. These are the engine temperatures used to control the fuel servo system:

- TAT (Total air temperature)
- T25 (High pressure compressor inlet temperature)
- T3 (High pressure compressor discharge temperature)
- HPT case (High pressure turbine case temperature).

The EEC also gets T49.5 temperatures from engine sensors. These temperatures are used for engine protection during starting.

The EEC gets TAT from the T12 sensor on the engine and from the two ADIRUs. The T12 sensor has two elements, one for channel A and one for channel B. The TAT probe for the ADIRUs is heated to prevent ice on the probe. While on the ground, if at least one T12 value is valid, the EEC uses only the engine T12 probes for TAT to prevent errors when there is not enough air flow over the heated ADIRU TAT probes. The EEC will use the ADIRU TAT signals 5 minutes after the airplane goes in-flight.

While in-flight, if all four total inlet temperature signals are valid and in limits, the engine uses the total air temperature from ADIRU 1 for control. The EEC uses an ADIRU temperature before it uses the engine T12 sensor temperature so that both engines use the same value for TAT when possible. If both ADIRU temperatures are not valid, the EEC uses the T12 values for TAT.

The EEC uses TAT for power management, VBV, HPTACC, and LPTACC systems control.

The EEC gets T25 temperatures from the PT25 sensor. The PT25 sensor has two temperature elements, one for channel A and one for channel B. If both T25 values are valid and are in limits, the EEC uses the average of the two temperatures. If one T25 value is not valid, the EEC uses the other T25 value. If both values are not valid, the EEC estimates T25 with other engine parameters.

The EEC uses T25 to control the VSV, TBV, and VBV systems.

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The EEC gets T3 temperatures from the T3 sensor. The T3 sensor has two temperature elements, one for channel A and one for channel B. If both T3 values are valid and are in limits, the EEC uses the average of the two temperatures. If one T3 value is not valid, the EEC uses the other T3 value. If both values are not valid, the EEC estimates T3 with other engine parameters.

AKS ALL PRE SB CFM56-7B 73-44

The EEC uses T3 to control the VSV and BSV systems.

AKS ALL POST SB CFM56-7B 73-44

The EEC use T3 to control the VSV system.

AKS ALL

The EEC sends a no dispatch signal to the DEUs if T12, T25, or T3 sensors have one of these conditions:

- Both elements are out of range
- The element for the active channel is out of range and the EEC is in single channel operation.

The DEUs energize the ENGINE CONTROL light on the P5 aft overhead panel and the MASTER CAUTION lights when these conditions occur:

- Airplane is on the ground more than 30 seconds after landing or increasing ground speed is less than 80 knots
- EEC is energized (engine starting, running, or EEC energized for maintenance)
- A no dispatch engine fault occurs.

The EEC gets HPT case temperature from the HPTACC sensor. The HPTACC sensor has one element. Both EEC channels get the HPT case temperature from the HPTACC sensor. The EEC uses the HPT case temperature to control the HPTACC system.

The EEC uses the T49.5 (Low pressure turbine second stage nozzle) temperature sensors to protect the engine during a hot start on the ground and for exhaust gas temperature (EGT) indications in the flight compartment. EGT is not used for engine control. See the EGT indicating system section for more information. (SECTION 77-21)

See the starting section for more information on the engine starting system. (SECTION 80-00)

Engine Pressure Sensors

The EEC uses P0 (ambient static pressure) and PS3 (burner or HPC discharge static pressure) to control the servo fuel system.

The EEC gets P0 pressure from four different sources, two from the ADIRUs and two from P0 transducers in the EEC. The EEC has two pressure transducers, one for channel A and one for channel B. If all four P0 signals are valid and in limits, the EEC uses PO from ADIRU 1 for control. The EEC uses an ADIRU P0 before it uses an EEC PO so that both engines use the same value for PO when possible. If both ADIRU pressures are not valid, the EEC uses P0 from the EEC pressure transducers for engine control.

When the EEC is in the normal mode, P0 and other ADIRU data is used to calculate airplane speed for engine thrust management. When the EEC is in an alternate mode, the EEC uses P0 to estimate PT or to find an assumed PT. See the ENGINE THRUST MANAGEMENT page in this section for more information. P0 is also used to control the VSV, VBV, HPTACC, and LPTACC systems.

The EEC gets PS3 pressures from two PS3 transducers in the EEC, one for channel A and one for channel B. The EEC uses PS3 to prevent high pressure compressor stall or surge and to make sure the bleed pressure is more than the minimum allowed value. If bleed pressure is less than the minimum value, the EEC increases the minimum idle speed. If the compressor is close to stall or surge, the EEC controls the VSV, VBV, and TBV to protect the compressor.

The EEC sends a no dispatch signal to the DEUs if one of these conditions occur:

- Both P0 transducers are out of range

- P0 transducer for the active channel is out of range and the EEC is in single channel operation
- Both PS3 transducers are out of range
- PS3 transducer for the active channel is out of range and the EEC is in single channel operation.

Autothrottle Computer

The EEC sends this data to the autothrottle computer:

- Thrust lever resolver angle (TRA)
- N1 speed
- Maximum N1
- TRA for minimum idle
- Equivalent TRA for current N1
- N1 for the current TRA
- Minimum TRA for satisfactory engine acceleration for go-around thrust
- TRA for N1 target
- TRA for maximum allowable thrust
- Engine maximum thrust.
- Estimate engine net thrust
- Engine control mode
- Airplane model
- Engine thrust rating.

The autothrottle system uses this data to control the thrust levers when autothrottle is engaged.

See the autothrottle section for more information on the autothrottle system. (SECTION 22-31)

Engine Speed Sensors

The N1 speed sensor transmits the speed of the low pressure compressor (LPC) and low pressure turbine (LPT) to the EEC. The EEC uses N1 speed for thrust management. The EEC also sends N1 speed data to the DEUs. The speed sensor also sends N1 speed data directly to the DEUs.

The N2 speed sensor transmits the speed of the high pressure compressor (HPC) and high pressure turbine (HPT) to the EEC. The EEC uses N2 speed data for thrust management and idle control. The EEC sends N2 speed data to the DEUs. The speed sensor also sends N2 speed data directly to the DEUs.

The EEC sends a no dispatch signal to the DEUs if one of these conditions occur:

- Both N1 speed signals are out of range
- N1 speed signal for the active channel is out of range and the EEC is in single channel operation
- Both N2 speed signals are out of range
- N2 speed signal for the active channel is out of range and the EEC is in single channel operation.

See the engine tachometer system section for more information on the N1 and N2 speed sensors. (SECTION 77-11)

Servo System Position Sensors

The EEC measures the position of these components in the turbine clearance system:

- High pressure turbine active clearance control (HPTACC) actuator
- Low pressure turbine active clearance control (LPTACC) actuator.

See the HPTACC valve section for more information. (SECTION 75-21)

See the LPTACC valve section for more information. (SECTION 75-22)

The EEC measures the position of these components in the engine airflow control system:

ENGINE FUEL AND CONTROL - ENGINE CONTROL - FUNCTIONAL DESCRIPTION

- Variable stator vane (VSV) actuators
- Variable bleed valve (VBV) actuators
- Transient bleed valve (TBV) actuator.

See the VSV actuation system section for more information on the VSV system. (SECTION 75-31)

See the VBV actuation system section for more information on the VBV system. (SECTION 75-32)

See the transient bleed section for more information on the TBV. (SECTION 75-23)

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The burner staging valve (BSV) also supplies position data to the EEC.

AKS ALL

See the fuel distribution system section for more information on the BSV. (SECTION 73-11)

The EEC uses data and control inputs to calculate the necessary position of the servo system components. If the components are in the correct position, the EEC keeps them in that position. If one or more of the components are not in the correct position, the EEC uses servo fuel pressure to move the components to the correct position.

The EEC ENGINE CONTROL light logic for these servo systems is almost the same:

- FMV
- VSV
- VBV
- TBV

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- BSV

AKS ALL

- HPTACC.

The EEC sends a no dispatch signal to the DEUs when one of these conditions occur for one of the above servo systems:

- Demand and position signals do not agree within limits for more than a minimum amount of time on any or both EEC channels
- Control current to the EHSV or solenoid is out of limits for both EEC channels while in dual channel operation or the active channel while in single channel operation.
- Position signal for actuator or valve is out of limits for both EEC channels while in dual channel operation or the active channel while in single channel operation.

Identification Plug

The engine identification plug supplies this data to the EEC:

- Engine type (5C/7B)
- N1 trim
- Engine thrust rating
- Engine condition monitoring (option)

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- BSV active

AKS ALL

- Engine combustor configuration (SAC or DAC).

Display Electronic Units

The DEUs let the EEC get and send data to many of the airplane systems and components. This is the data that the EEC gets and sends through the DEUs:

- Engine indication data
- Thrust reverser position
- Start switch position
- Igniter selector switch position
- Engine start lever position
- Airplane bleed air system status
- Engine cowl thermal anti-ice (CTAI) valve command
- Air data inertial reference unit (ADIRU) total pressure (PT), total air temperature (TAT) and ambient static pressure (P0) data
- BITE data
- Forward and reverse thrust lever position
- Engine parameters

The EEC sends engine parameter data through the DEUs to the CDS engine display. Some data also shows on indicator lights in the flight compartment.

NOTE: The flight management computer (FMC) receives some data from the EEC through the DEUs.

See the flight management computer section for more information. (SECTION 34-61)

Thrust Reversers (T/Rs)

Linear variable differential transformers (LVDTs) send T/R translating sleeve position to the EEC. The EEC gets four T/R position signals, one from each T/R half for channel A and one from each T/R half for channel B. The EEC uses T/R sleeve position to control reverse thrust.

The EEC operates the thrust reverser (T/R) lever interlock solenoids. The T/R interlock solenoid prevents reverse thrust lever travel until the T/R sleeves are deployed enough for reverse thrust.

The EEC also causes the engine to go to idle if it senses a T/R sleeve not in the correct position. See the thrust reverser control system section for more information about the T/R control system. (SECTION 78-34)

The EEC sends a no dispatch signal to the DEUs when a left and a right T/R half position signals are out of range. The position signals can be from the same EEC channel or one from each EEC channel.

Engine Start and Igniter Select Switches

The EEC usually monitors the start switch position signals through the DEUs. The EEC uses the switch position to control the engine ignition systems. The start switch also sends position signals directly to the EEC.

The igniter select switch operates with the start switches. The igniter select switch supplies the EEC with control data to operate the left, right, or both ignition systems.

See the ignition section for more information on the engine start switches and igniter select switch. (SECTION 74-00)

Engine Start Lever

The engine start lever supplies a position signal to the EEC. The EEC uses the engine start lever position to control AC power to the engine ignition exciters.

When the engine start lever is in the IDLE or RUN position, the EEC also controls the FMV in the hydromechanical unit (HMU) to get engine idle power. The fuel flow through the FMV causes the high pressure shutoff valve (HPSOV) in the HMU to open.

When the engine start lever goes to the CUTOFF position, it energizes a HPSOV solenoid in the HMU. This solenoid causes servo fuel pressure in the HMU to close the HPSOV. The engine start lever also sends a signal to the EEC. This signal tells the EEC that the engine is in the shutdown mode.

See the engine controls chapter for more information on the engine start levers . (CHAPTER 76)

Fire Handle Switch

The fire handle switch on the P8 aft electronics panel sends the same close signal to the HPSOV as the start lever. When you pull the fire handle up, a switch in the handle assembly closes and sends the close signal to the HPSOV solenoid in the HMU.

ENGINE FUEL AND CONTROL - ENGINE CONTROL - FUNCTIONAL DESCRIPTION

Air and Anti-Ice Systems

The engine supplies HPC bleed air to the airplane bleed air system and to the anti-ice system.

The EEC receives control data from engine anti-ice and bleed air systems. The EEC uses this data to reduce the thrust rating of the engine. This keeps the engine core in limits for the selected thrust rating when the bleed systems operate.

See the engine bleed air distribution section for more information on the bleed air systems. (SECTION 36-11)

See the wing thermal anti-ice system section for more information. (SECTION 30-11)

See the inlet cowl anti-ice system section for more information. (SECTION 30-20)

Hydromechanical Unit (HMU)

The EEC sends control data to the hydromechanical unit (HMU). The HMU sends position data for the FMV and HPSOV to the EEC. The EEC uses the HMU to operate these systems and components:

- FMV
- LPTACC
- HPTACC
- VSVs
- VBVs

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- BSV

AKS ALL

- TBV.

Operation

When engine start is first commanded, the airplane transfer bus supplies power to the EEC. At 15 percent N2 speed, the EEC disconnects transfer bus power and connects to the EEC alternator if alternator power is in limits.

When the engine start lever is put to the IDLE or RUN position, EEC logic controls the FMV and ignition system. This causes the igniters to operate and the FMV to open. Metered fuel goes to the fuel nozzles for combustion. The EEC causes the ignition system to stop at the correct N2 speed.

The EEC operates the FMV to control the acceleration of the engine compressor and EGT during start. The EEC also operates the FMV to control engine speed for forward and reverse thrust. See the engine starting section for more information. (CHAPTER 80)

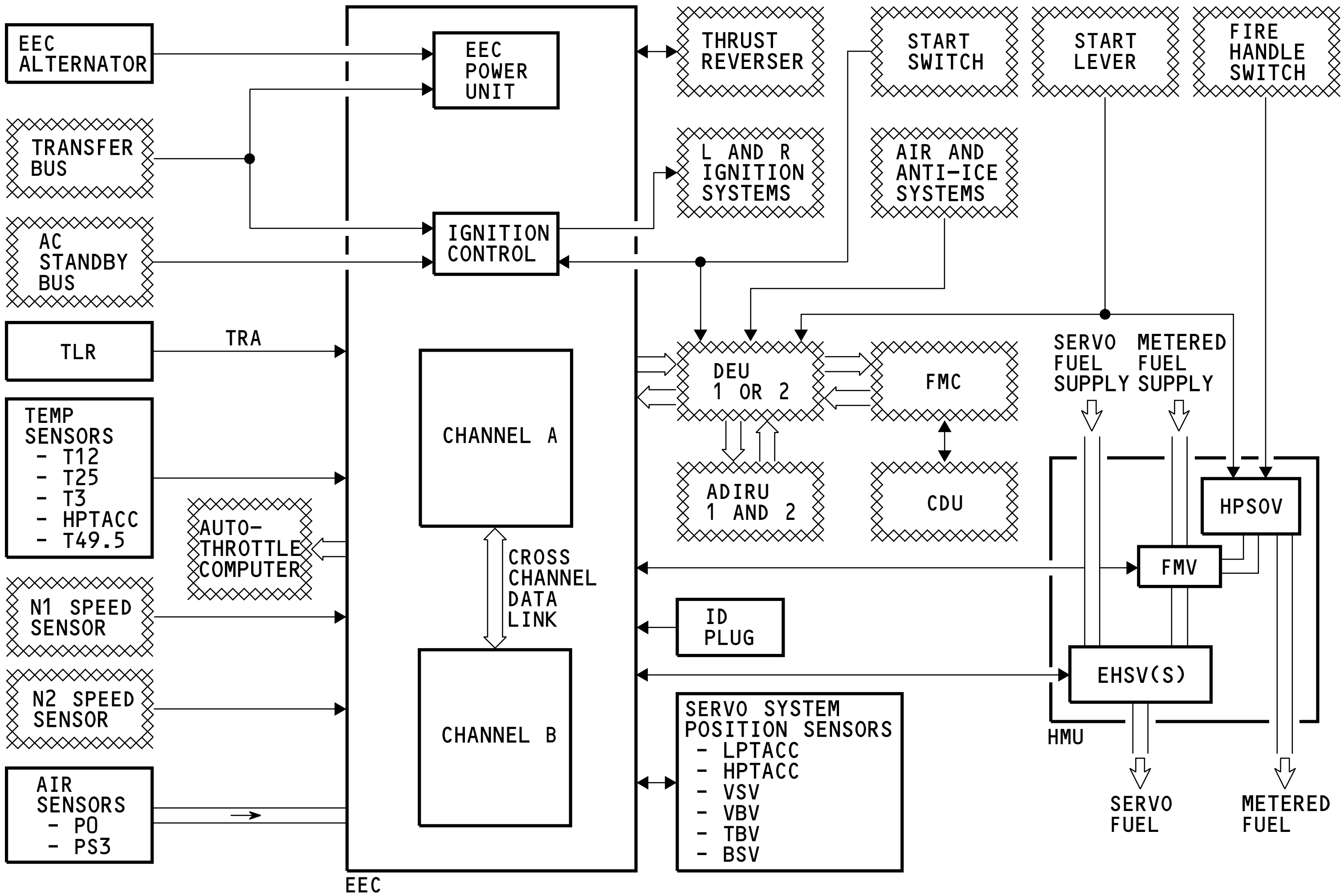
After start and while on the ground, the EEC controls engine idle speed based on electrical power, ECS bleed system, and minimum fuel flow requirements. During flight, the EEC has two Idle modes, flight idle and approach idle. These idle modes are set by weather, anti-ice system, and go-around requirements. See the Thrust Management page in this section for more information on idle control.

The EEC manages engine thrust based on ambient conditions and the commanded thrust input from the thrust levers. See the Engine Thrust Management page for more information on engine thrust management.

Training Information Point

The control display units (CDUs) show faults and other maintenance information for the engine. The CDUs also control ground tests for each engine system to find and isolate faults.

See the engine indicating section for more information on CDU BITE operation. See the training information point pages in this section for more information on engine BITE operation using the CDU.



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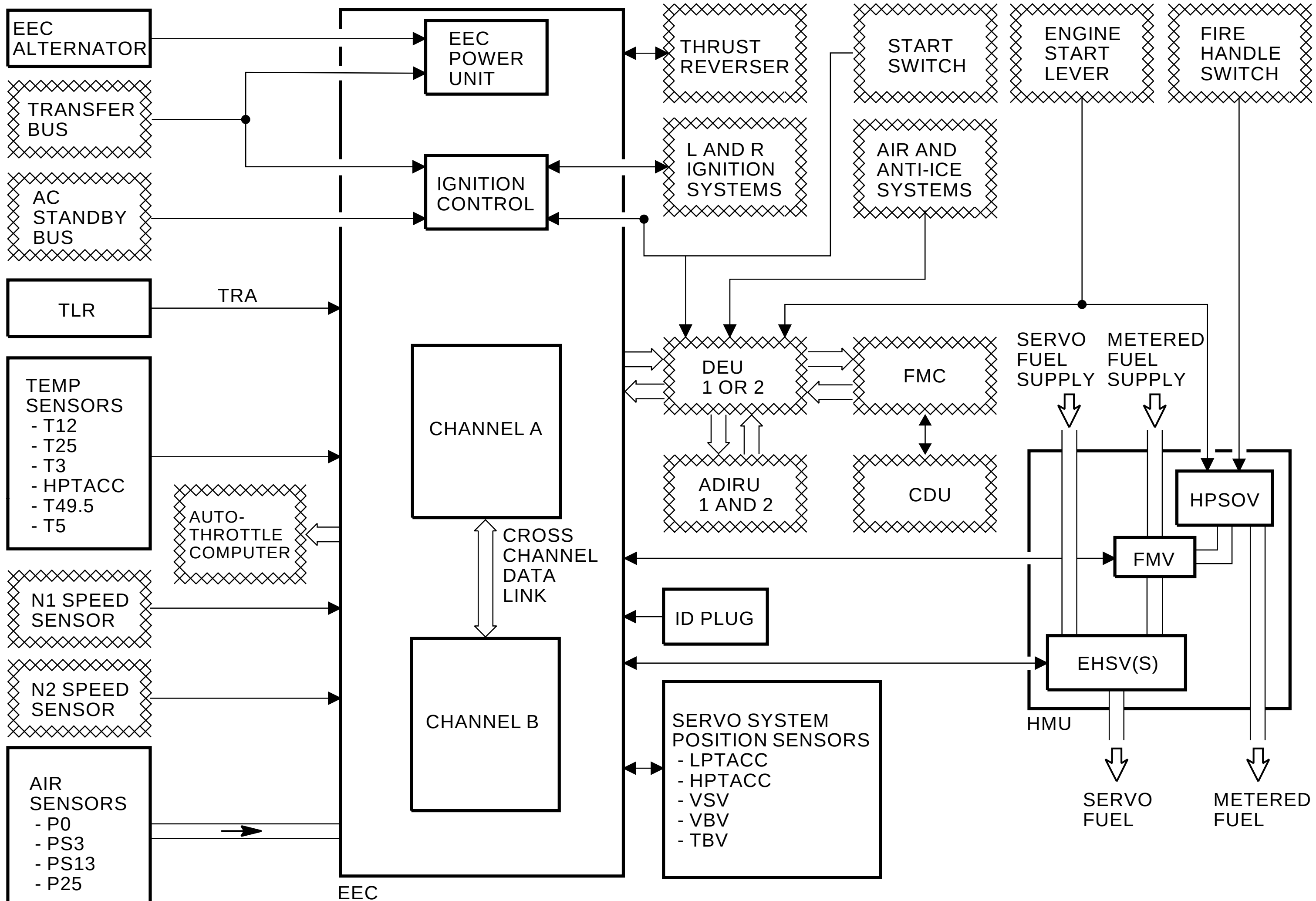

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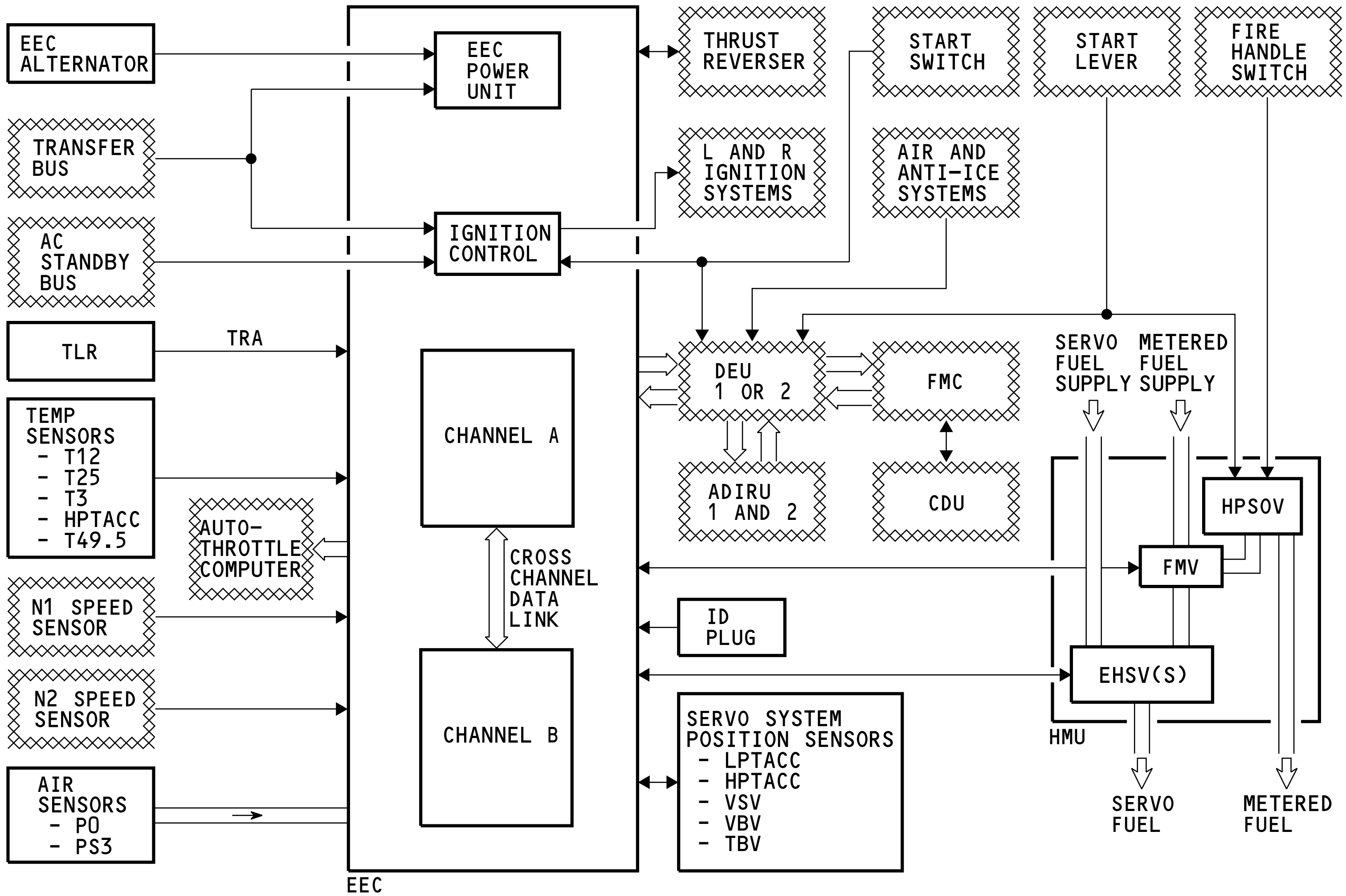
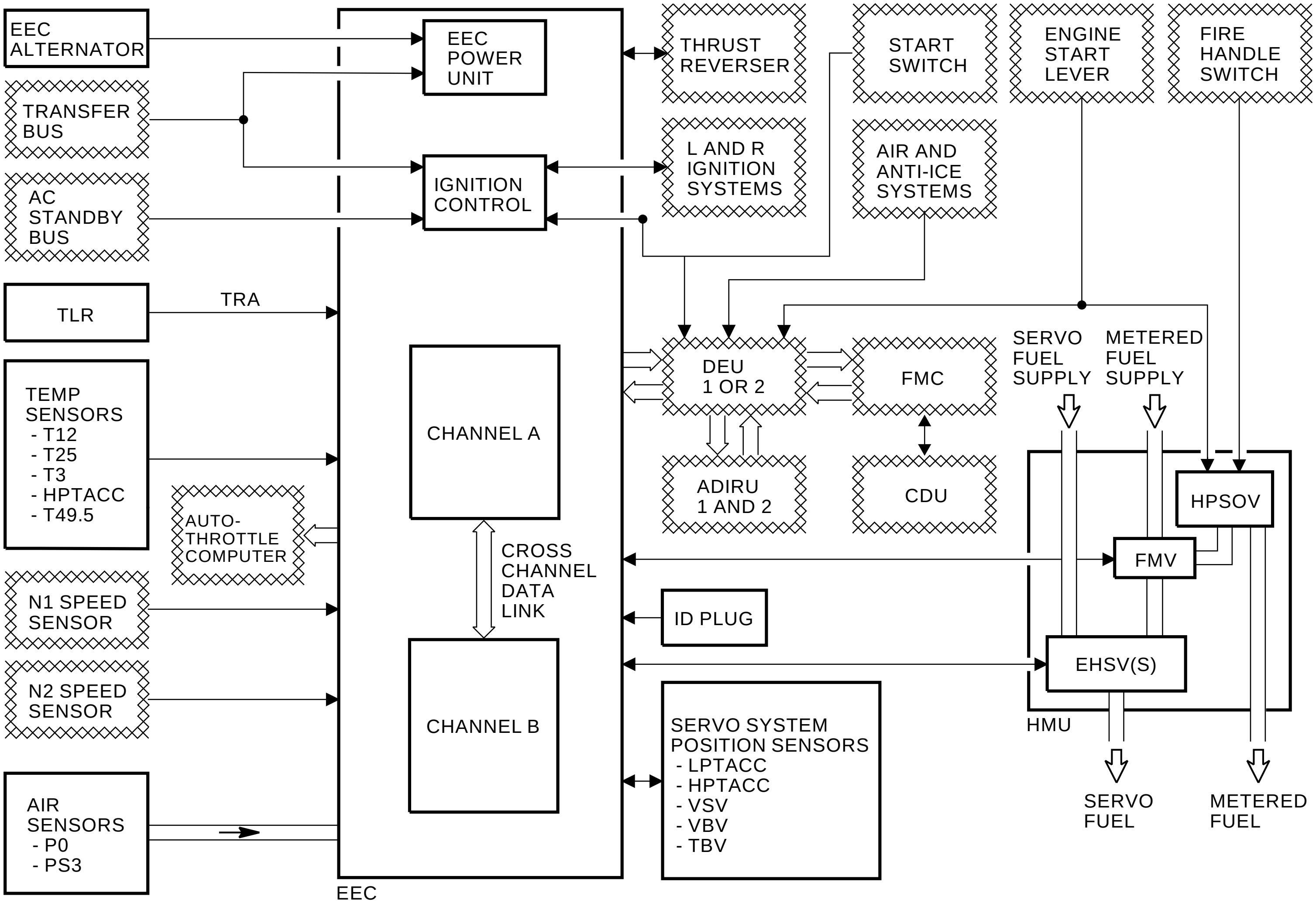


ENGINE FUEL AND CONTROL - ENGINE CONTROL - FUNCTIONAL DESCRIPTION



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - FUNCTIONAL DESCRIPTION

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - IDLE CONTROL - FUNCTIONAL DESCRIPTION

Engine Idle Control

After start and while on the ground, the EEC controls engine ground idle speed based on these parameters:

- Outside air temperature
- Electrical power
- Bleed air demand
- Minimum fuel flow requirements.

During flight, the EEC has two idle modes, flight idle and approach idle. These idle modes are set by these parameters:

- Anti-ice operation
- Flap position
- Gear position
- Altitude
- Go-around requirements.

Whichever idle mode the EEC is in, it uses the highest value input of that mode to control idle speed.

While on the ground, the EEC controls engine idle to satisfy idle speed requirements. If the idle speed is not enough to satisfy one of these requirements, the EEC controls the FMV to increase the engine idle speed until all idle speed requirements are satisfied. These are the ground idle speed requirements:

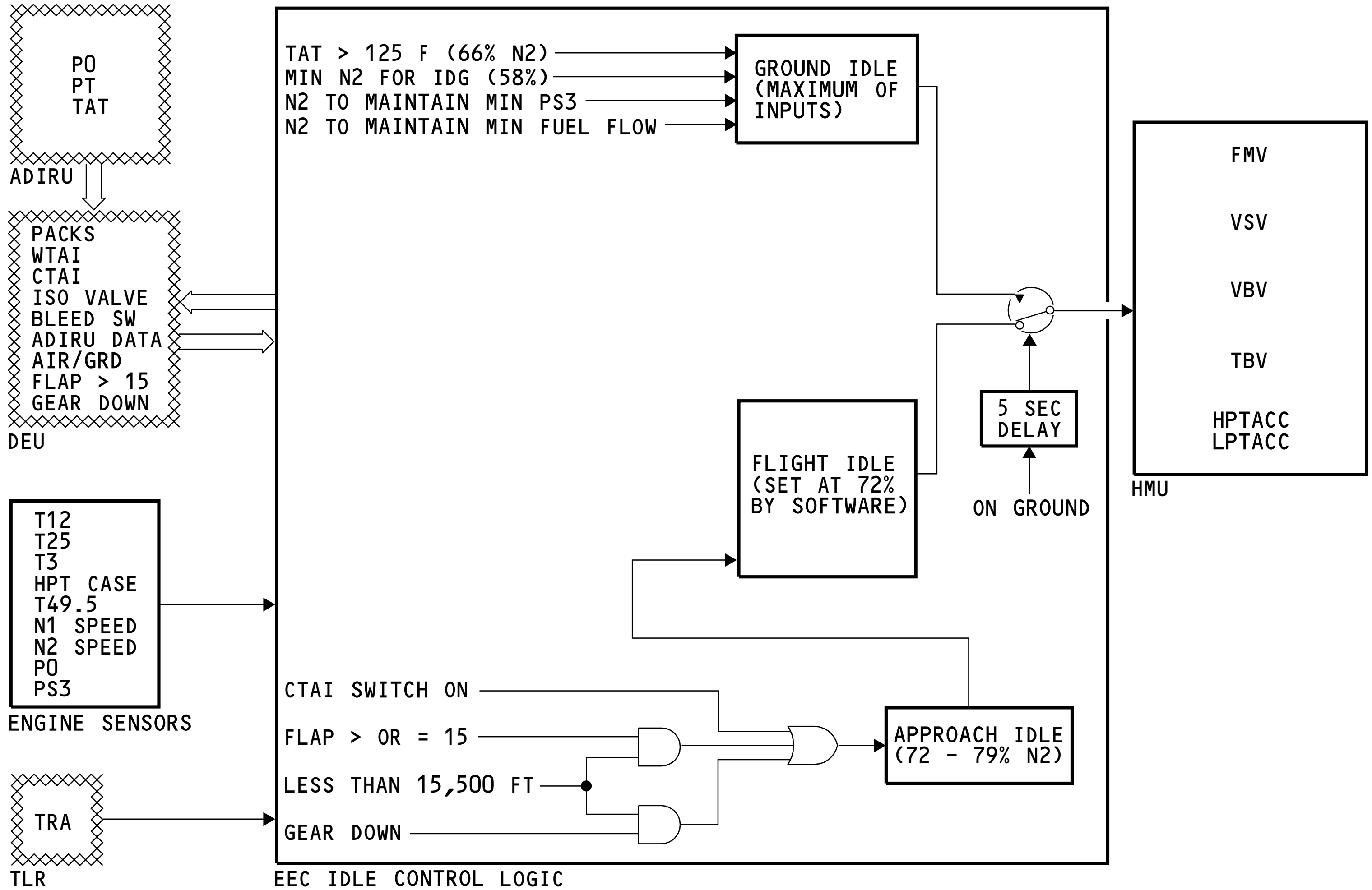
- N2 speed more than 58 percent (8500 RPM) if TAT is less than 125F (52C) to keep N2 speed high enough for IDG operation
- N2 speed more than 66 percent (9500 RPM) if TAT is more than 125F (52C) to provide improved engine component cooling
- Maintain PS3 above minimum for airplane ECS system (the minimum PS3 changes with altitude and airplane model)
- Maintain fuel flow at or more than 300 lb/hr (136 kg/h).

During flight, the EEC controls engine idle to satisfy idle speed requirements. The EEC software maintains flight idle at 72%.

The EEC goes to the approach idle mode when the airplane is in flight and one of these conditions occur:

- Cowl thermal anti-ice switch is in the on position for engine 1 or engine 2
- Below 15,500 feet and the left or right main gear is down and locked
- Below 15,500 feet and the left or right flaps are equal to or more than 15.

NOTE: There are no mechanical adjustments for idle speeds.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - IDLE CONTROL - FUNCTIONAL DESCRIPTION

ENGINE FUEL AND CONTROL - ENGINE CONTROL - THRUST CONTROL - FUNCTIONAL DESCRIPTION

Engine Thrust Control

The EEC uses N1 speed to control engine thrust. The EEC calculates six N1 reference speeds based on this data:

- Airplane model
- Engine thrust rating
- P0 (ambient static pressure)
- Mach number (air speed divided by the speed of sound at the current ambient conditions).

The N1 reference speeds are at the same thrust lever resolver and thrust lever angles for all engine thrust ratings and airplane models. These are the N1 reference speed names, the thrust lever resolver angles (TRA), thrust lever angles (TLAs), and reverse lever angles (RLA) (note: the angles are in degrees):

- Maximum reverse thrust (8 TRA, 104 RLA)
- Idle reverse (24 TRA, 62 RLA)
- Idle (36 to 38 TRA, 0 to 2.4 TLA)
- Maximum climb (72 TRA, 44 TLA)
- Maximum take-Off/go-around (78 TRA, 52 TLA)
- Maximum certified thrust (82.5 TRA, 58 TLA).

You can see TRA angles in engine BITE input monitoring pages on the CDU. See the training information point pages in this section for more information on input monitoring pages.

The EEC calculates the commanded N1 speed based on the position of the thrust levers with respect to the N1 reference speed thrust lever positions. When the thrust lever is between two N1 reference speeds, the EEC does a linear interpolation to find the commanded N1 speed. When the thrust lever is moved forward, the commanded N1 speed is more than the actual N1 speed. The EEC controls the engine servo systems to accelerate the engine to the commanded N1 speed. When the thrust lever is moved back, the commanded N1 speed is less than the actual N1 speed. The EEC again controls the engine servo system to slow the engine to the commanded N1 speed.

The EEC adjusts the commanded N1 value for the amount of bleed air the airplane takes from the engine. If bleed air demand increases, N1 speed decreases to compensate for the additional load. This keeps engine hot section in limits for the current engine thrust rating. The EEC gets this airplane bleed configuration data from the DEU to find the airplane bleed load:

- Right pack on or off
- Right pack in high or normal flow
- Left pack on or off
- Left pack in high or normal flow
- Isolation valve open or closed
- Bleed valve for opposite engine open and engine running
- Wing anti-ice on or off
- Cowl thermal anti-ice on or off.

The EEC locks the airplane bleed load in the current configuration during takeoff when airspeed is more than 65 knots. The EEC unlocks airplane bleed load if the airplane is 400 feet above takeoff altitude and one of these conditions is true:

- Airspeed more than 300 knots
- Altitude more than 4500 feet above takeoff altitude
- TRA decreases more than 3 percent.

The EEC uses fan trim balance to adjust the engine fan speed for engine variations. After engine assembly, engine tests are done to make sure it meets engine performance requirements. One of these tests is to measure engine thrust and fan speed. To make sure all engines have the same takeoff and early climb thrust for the same indicated N1 speed, the fan trim is used to adjust indicated and commanded N1 speeds. This adjustment is used to decrease the commanded N1 speed and increase the indicated N1 speed. When the EEC changes between N1 fan trim and no N1 fan trim, the transition is slow to make sure there is not a sudden change in thrust. This adjustment is effective when these conditions occur:

- Altitude is below 15,000 ft (4572 m)

- Mach number is less than 0.40
- N1 speed is between 75 and 99.54 percent.

There are eight N1 fan trim levels. These fan trim levels are N1 trim 0 through 7 with 0 as no trim and 7 the maximum trim of 2.36 percent. The N1 trim level for the engine is stored in the engine identification plug. The N1 trim level shows on the EEC CDU IDENT/CONFIG page of EEC BITE. See the TRAINING INFORMATION POINT pages in this section for more information on EEC BITE.

EEC Mode Description

The EEC gets ambient total pressure (PT) from the ADIRUs or calculates it from ambient total air temperature (TAT) and ambient static pressure (P0). The EEC gets P0 from the ADIRUs or from the P0 transducers in the EEC. The EEC gets TAT from the ADIRUs or from the T12 sensor on the engine.

These are the three EEC operation modes:

- Normal mode
- Soft alternate mode
- Hard alternate mode.

The EEC is in normal mode when all these conditions occur:

- PT is valid
- EEC SWITCH on the P5 aft overhead panel is in the ON position.

PT is valid when these conditions occur:

- PT signal from both ADIRUs are in limits
- PT signals agree
- Pitot probe heat for at least one PT probe is on
- Pitot probe heat off, airplane is on the ground and TRA is less than 53 degrees.

In the normal mode, the EEC calculates Mach number with the two PT values from the ADIRUs and P0. The Mach number is one of the parameters used to calculate the N1 reference speeds. If outside air pressure, temperature, and Mach number change, the N1 reference speeds also change. This makes sure engine thrust is satisfactory for airplane performance.

If PT is not valid or the EEC switch is put in the OFF position, the EEC goes to one of the alternate modes. The EEC energizes the ALTN light on the P5 aft overhead panel when one of these occur:

- EEC is in soft alternate mode for 15 seconds
- EEC is in hard alternate mode
- EEC switch is selected to OFF (this puts the EEC in hard alternate mode).

The EEC goes to the soft alternate mode when PT is not valid. If PT becomes valid within 15 seconds, the EEC goes back to the normal mode and the ALTN light does not come on. After the EEC is in the soft alternate mode for 15 seconds, the ALTN light comes on. The EEC goes back to the normal mode and the ALTN light goes off if these conditions occur:

- PT becomes valid
- EEC is in soft alternate mode
- Engine thrust change when the EEC mode changes back to normal mode is small or thrust levers are near to idle (TRA less than 51.6 degrees).

In the soft alternate mode, the EEC uses this data to estimate Mach number:

- Total air temperature (TAT)
- Standard day temperature (from P0)
- Last valid difference between standard day temperature and static temperature (TO).

ENGINE FUEL AND CONTROL - ENGINE CONTROL - THRUST CONTROL - FUNCTIONAL DESCRIPTION

The soft alternate mode makes sure the engine thrust does not have large changes when PT data is not valid. Engine thrust can be less than normal or engine exceedances can occur if outside air conditions change while the EEC is in soft alternate mode. This occurs because the EEC estimates Mach number using TAT, standard day temperature, and the last valid value of delta air temperature from standard day. Delta temperature from standard day is usually calculated from standard day temperature and static air temperature. While in normal mode, static air temperature is calculated from TAT and Mach number. Because Mach number is not available in the soft alternate mode, the EEC uses the last valid value for delta air temperature from standard day. This estimate is accurate only if the outside air stays the same.

The EEC goes to the hard alternate or reversionary mode when these conditions occur:

- EEC is in the soft alternate mode for more than 15 seconds (ALTN light on) and the thrust lever is less than 19 degrees above the idle stop
- EEC switch is in the OFF position.

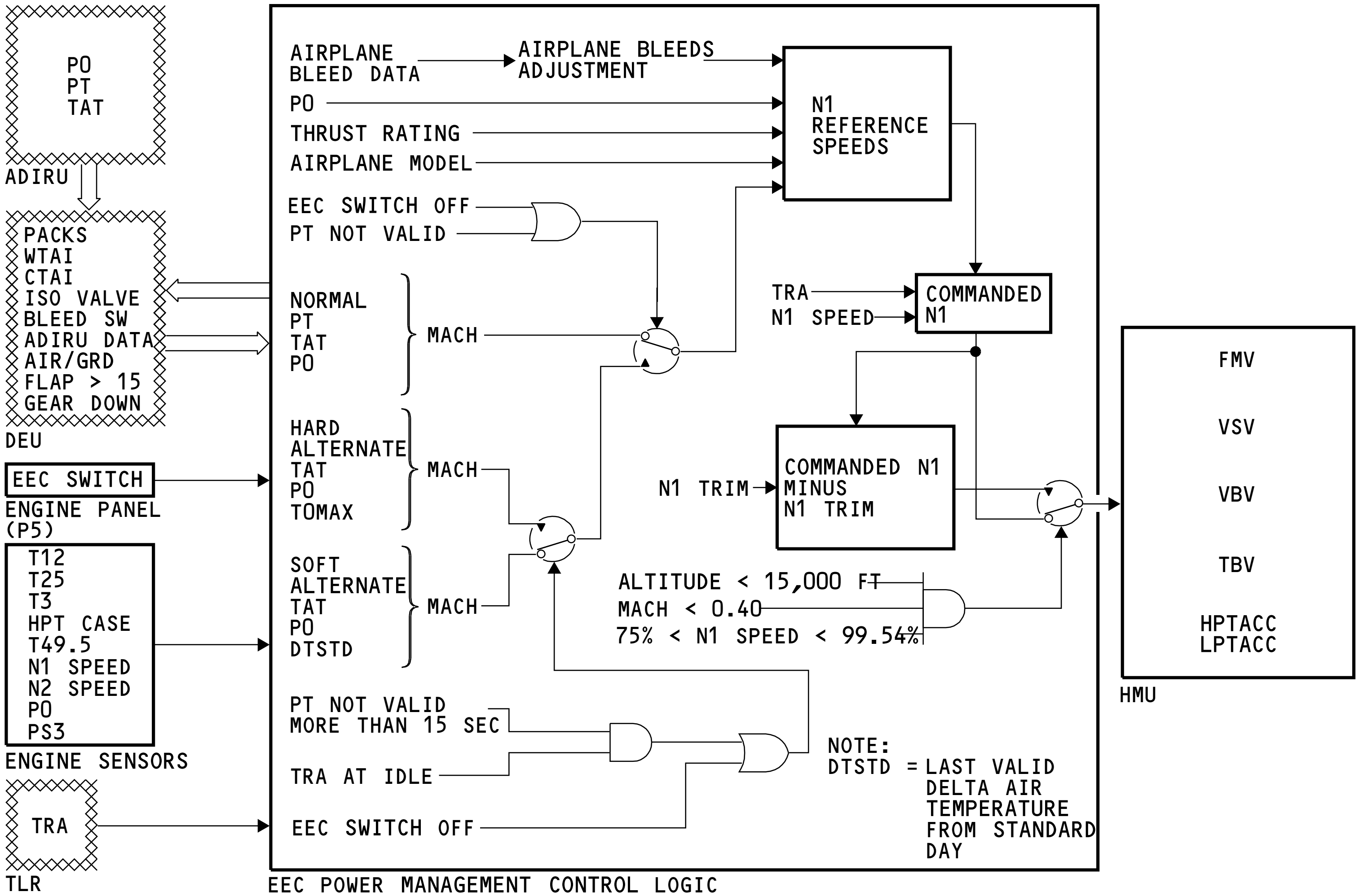
NOTE: If one EEC is in the normal mode and the other EEC is in the soft alternate mode, it can cause thrust lever stagger. When this condition occurs, the pilots must put both engine EECs in the hard alternate mode. When both EECs are in the hard alternate mode, it prevents thrust lever stagger.

At low thrust levels, there is a small thrust difference between soft alternate and hard alternate modes. At higher thrust levels there can be an uncommanded large thrust change when the EEC changes from the soft alternate mode to the hard alternate mode. Large uncommanded thrust changes are not acceptable. The EEC will not change automatically from soft alternate mode to hard alternate mode if there is a large thrust change.

In the hard alternate mode, the EEC uses static pressure (P0) to get an assumed Mach number. To make sure the airplane will have enough thrust for satisfactory airplane performance in all conditions, the EEC assumes the outside air temperature with the highest thrust requirement. In this mode, large maximum thrust rating exceedances are possible during hot day conditions. This can cause EGT exceedances during hot day conditions.

The EEC returns to the normal mode from the hard alternate mode and the ALTN light goes off if one of these occur:

- EEC switch goes from the OFF to ON position and PT is valid
- The engine is shutdown and restarted, PT is valid and the EEC switch is in ON position.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - THRUST CONTROL - FUNCTIONAL DESCRIPTION

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - GENERAL

General

The EEC built-in test equipment (BITE) stores engine information in non-volatile memory and lets the mechanic do ground tests. You get the information from the EEC BITE memory and do the ground tests with the flight management computer (FMC) control display unit (CDU). You select the data or test with the CDU. The FMC CDU sends a signal to the EEC through the display electronic unit (DEU) on a ARINC 429 data bus. The EEC returns the requested data or test results to the FMC CDU through the DEU.

These are the types of data that the EEC stores:

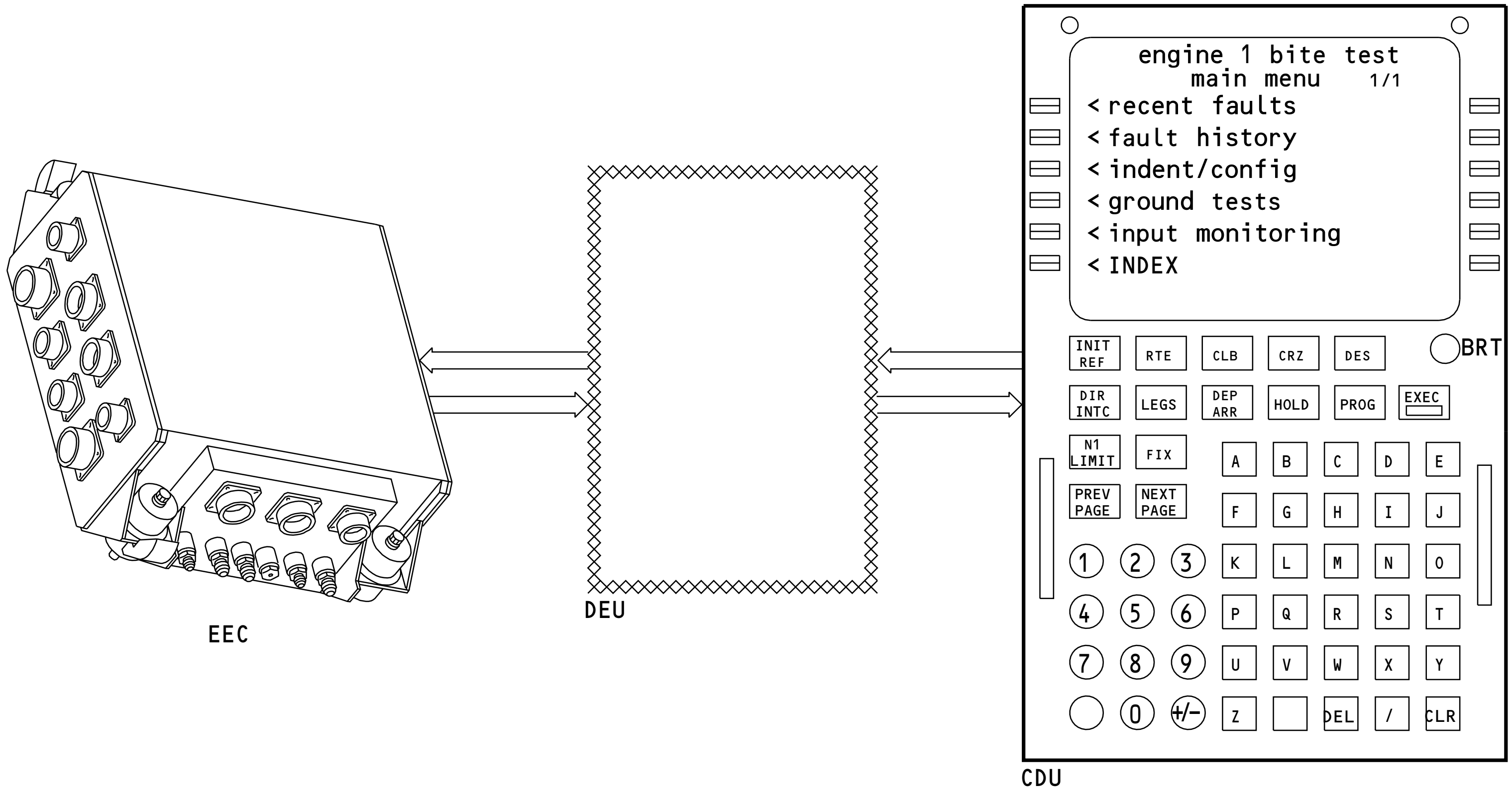
- RECENT FAULTS (faults that occurred during the last 3 flight legs)
- FAULT HISTORY (faults that occurred during the last 10 flight legs)
- IDENT/CONFIG (engine identification and configuration data)
- INPUT MONITORING (data sent to the EEC by engine and airplane sensors).

EEC BITE can do several ground tests. The ground test let the mechanic find engine system problems and make sure maintenance action corrected the problem.

Training Information Point

You use the fault isolation manual (FIM) to interpret engine faults that show on the CDU.

You use part II of the maintenance manual to do the engine ground tests.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - GENERAL

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - SIGNALS

General

The EEC built-in test equipment (BITE) monitors engine and airplane sensors, actuators, and switches. These are the components and signals the EEC BITE monitors:

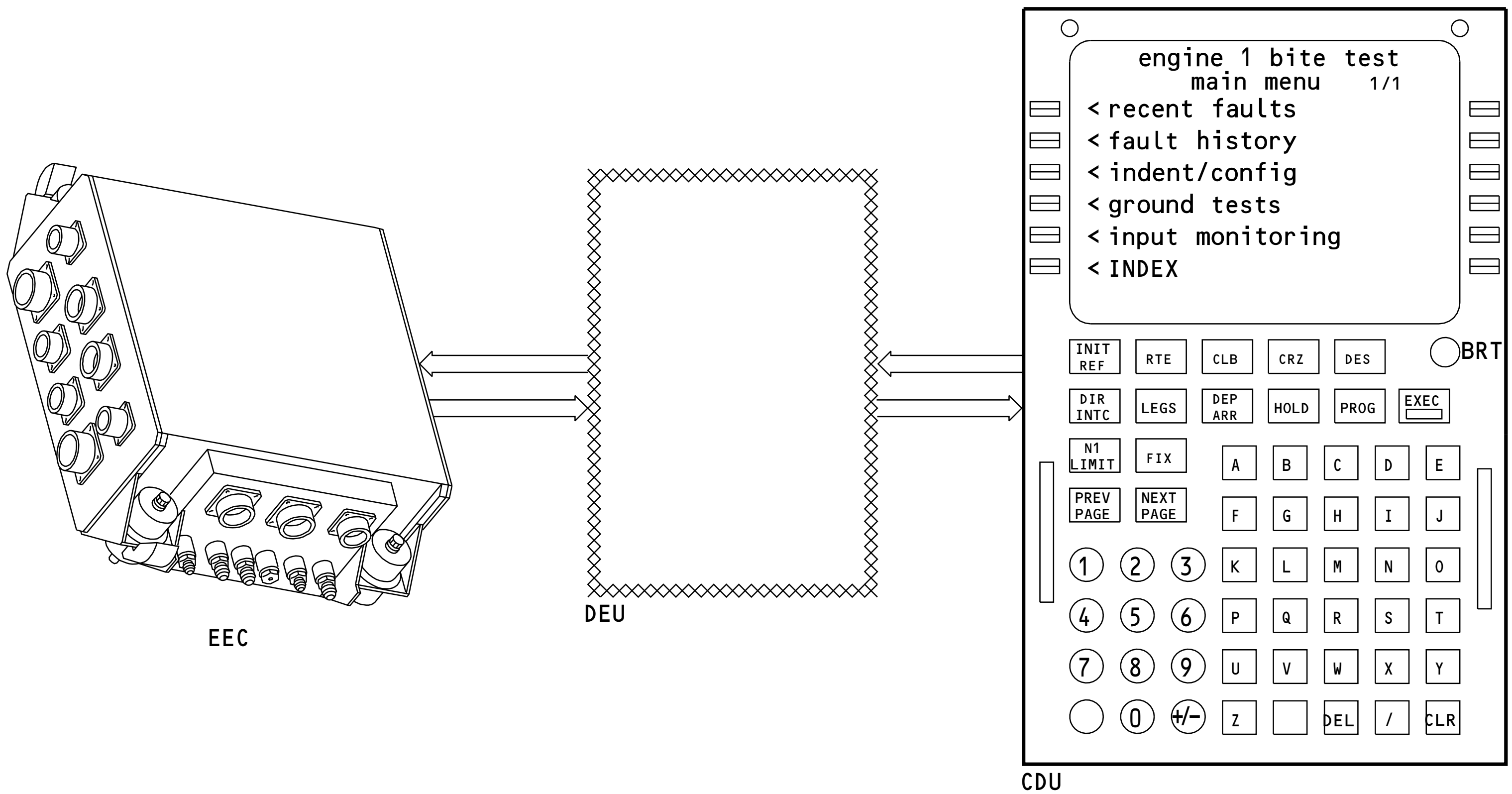
- ADIRU signals
- Air ground signal
- Airplane model signals from the strut

AKS ALL PRE SB CFM56-7B 73-44

- Burner staging valve (BSV)

AKS ALL

- Display electronic unit (DEU) signals
- EEC alternator
- EEC over temperature
- EEC switch
- EHSVs in the HMU
- Engine identification plug
- Engine position signal from the strut
- Flap position signals
- Fuel flow meter
- Fuel metering valve (FMV)
- HPTACC sensor
- HPTACC valve
- Hydromechanical unit (HMU)
- Ignition system
- Internal EEC faults
- LPTACC valve
- N1 speed sensor
- N2 speed sensor
- Oil filter switch
- Oil pressure sensor
- Oil temperature sensor
- P0 signal
- PS3 signal
- PT25 sensor
- Pitot probe heat off
- Engine start lever
- Start switch
- T12 sensor
- T3 sensor
- T49.5 sensors
- Transient bleed valve (TBV)
- Thrust lever angle resolver (TLR)
- Thrust reverser interlock solenoid
- Thrust reverser position signals
- Variable bleed valve (VBV)
- Variable stator vanes (VSVs).



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INDICATIONS

Fault Information

When EEC BITE finds faults, they are stored in BITE memory. The faults have these 5 dispatch levels:

- ENGINE CONTROL LIGHT
- ALTERNATE MODE LIGHT
- SHORT TIME
- LONG TIME
- ECONOMIC.

The EEC stores faults in memory by dispatch level. The EEC stores up to 10 of each dispatch level for 10 flight legs. The faults are erased when they are 11 flight legs old. If there are 10 faults stored in one dispatch level and a new fault in that dispatch level occurs, the EEC erases the oldest fault and records the new fault.

Faults that occur on the ground are stored in flight leg 0. When the airplane takes off, the faults from the last ground run go into flight leg 1.

Dual/Single Channel Operation

The EEC operates in either dual channel mode or single channel mode. During normal conditions, the EEC operates in dual channel mode. If the EEC alternator can not give power to one EEC channel, the EEC changes to single channel operation. The channel that receives power from the EEC alternator is the active channel. The EEC also changes to single channel operation if the EEC channels can not communicate with each other.

ENGINE CONTROL Light Faults

ENGINE CONTROL LIGHT faults occur when the EEC finds a fault that is a no dispatch condition. When one of these faults occur and the airplane is on the ground, the DEU energizes the ENGINE CONTROL light on the engine panel and the MASTER CAUTION lights. The DEU energizes the ENGINE CONTROL light when all of these conditions occur:

- Airplane is on the ground and the ground speed is less than 30 knots for more than 30 seconds or the ground speed is increasing and is less than 80 knots
- EEC BITE found a no dispatch fault.

Because the EEC is a dual channel engine control, there are five groups of ENGINE CONTROL light faults. These are the ENGINE CONTROL light fault groups:

- Faults that cause an ENGINE CONTROL light if they occur in either channel A or channel B
- Faults that cause an ENGINE CONTROL light only if a fault from this group occurs in both channels or if one fault occurs in the active channel while the EEC is in single channel operation
- Faults that cause an ENGINE CONTROL light only if the same fault occurs on both channels or if one of the faults occur while the EEC is in single channel operation
- EGT indication faults that cause an ENGINE CONTROL light if more than two EGT faults occur in both channels or if one of the faults occur while the EEC is in single channel operation (there are four EGT signals)
- While in single channel operation both thrust reverser half position signals are out of range.

The EEC finds a no dispatch fault when the engine control system is in the applicable condition and an ENGINE CONTROL fault for that condition occurs. For example, if one EGT signal fault for channel A occurs while the engine is in dual channel operation, the EEC does not find a no dispatch fault and the fault is stored as a LONG TIME fault. However, if one EGT signal fault occurs on channel A and the EEC is in single channel operation with channel A active, the EEC finds a no dispatch fault.

Alternate (ALTN) Light Faults

Alternate (ALTN) faults occur and the ALTN light and MASTER CAUTION lights come on when one of these conditions occur:

- EEC is in soft alternate mode for 15 seconds
- EEC in hard alternate mode
- EEC switch on the P5-68 panel is put to OFF (this puts the EEC to hard alternate mode).

There are 11 possible ALTN light faults. See the Minimum Equipment List for requirements to dispatch with the ALTN light on.

SHORT TIME Faults

SHORT TIME faults occur when the EEC finds a fault condition that you must correct in a short time. A SHORT TIME fault can be deferred for 150 flight hours from the time the EEC BITE was last monitored. For example, if you monitor the FMC CDU for engine faults every 70 hours, and find a new SHORT TIME fault, you may defer the new fault for 80 hours. Or, if you monitor the FMC CDU every 150 flight hours and find a SHORT TIME fault, you must correct the fault before the airplane can fly. These faults do not cause an indication in the flight compartment.

There are three groups of these faults. These are the SHORT TIME fault groups:

- Faults that are SHORT TIME faults if any fault from this group occurs in one channel while in dual channel operation or if one fault occurs in the standby channel while in single channel operation
- Thrust reverser position signals out of range for a left and a right thrust reverser while in dual channel operation or both thrust reverser signals out of range on the standby channel while in single channel operation
- Faults that are SHORT TIME faults if any fault from this group occurs while in dual channel operation or single channel operation.

LONG TIME Faults

You can defer a LONG TIME fault for approximately 500 flight hours from the time the EEC BITE was last monitored. These faults do not cause an indication in the flight compartment.

For example, the remaining flight hours (T) = 500 flight hours - S/2, where S/2 is one half the scheduled maintenance interval your airline uses to check the EEC BITE.

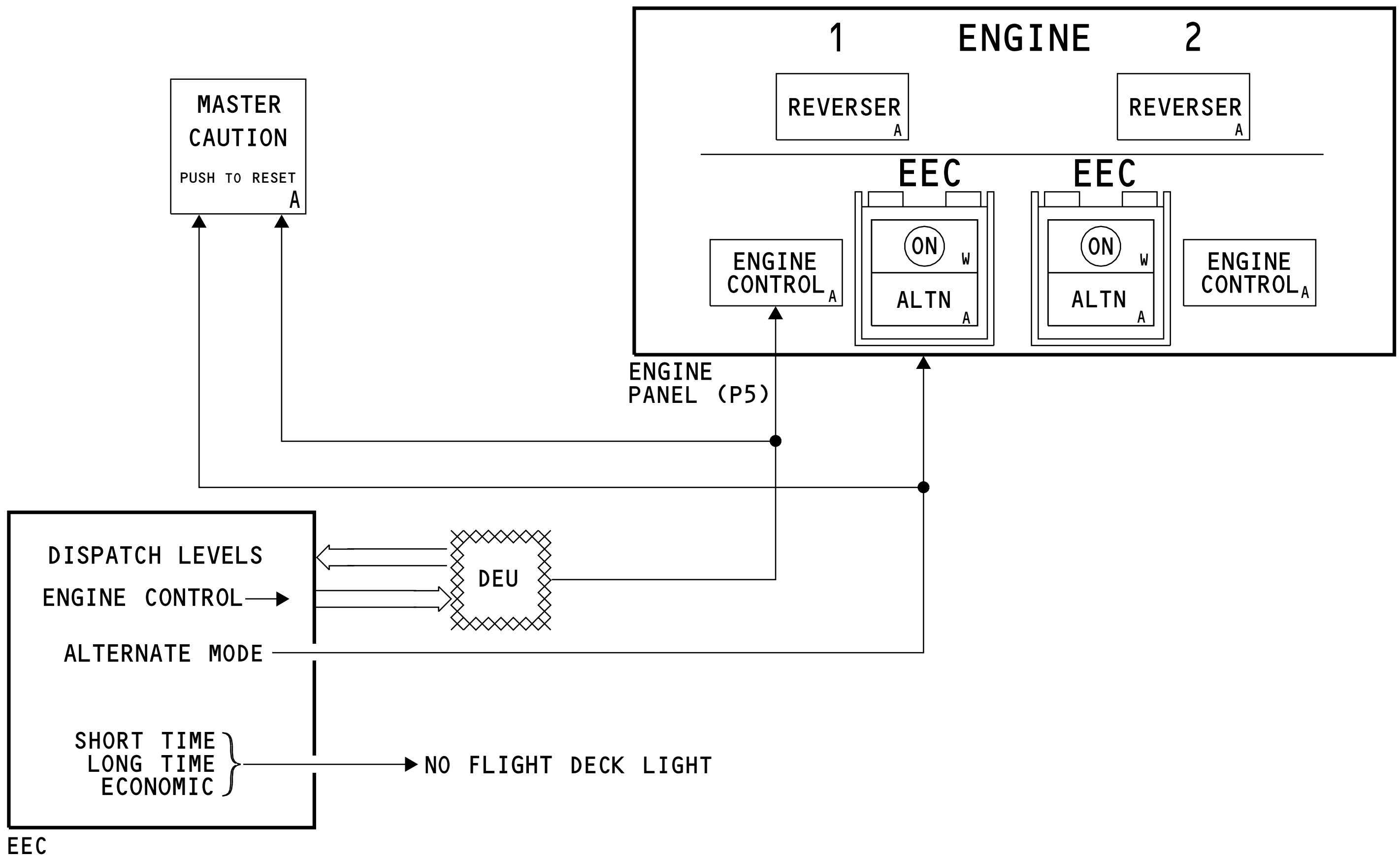
If your airline looks for EEC faults every 70 flight hours, S/2 = 35. If you airline looks for EEC faults every 150 flight hours, S/2 = 75.

ECONOMIC Faults

ECONOMIC faults occur when the EEC finds a fault condition that does not have a set deferral time but should be corrected at operator convenience. These faults detect conditions that may make the engine operation less efficient. These faults do not cause an indication in the flight compartment.

Training Information Point

You use the fault isolation manual (FIM) to interpret engine faults that show on the CDU.



M87926 S0004632150_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INDICATIONS

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - MAIN MENU

General

The EEC BITE shows on the control display unit (CDU).

To see the EEC BITE data or do engine ground tests, select ENGINES on the MAINT BITE INDEX page.

ENGINE/EXCEED BITE INDEX Page

The ENGINE/EXCEED BITE INDEX page lets you select the ENGINE 1 or 2, or EXCEEDANCES.

If you want to do engine BITE for engine 1, select ENGINE 1. If channel A can not get data from channel B and channel B can not get data from channel A, the CDU uses channel B only to do EEC BITE. To do engine BITE for engine 1 with EEC channel A, select ENGINE 1 CH A ONLY.

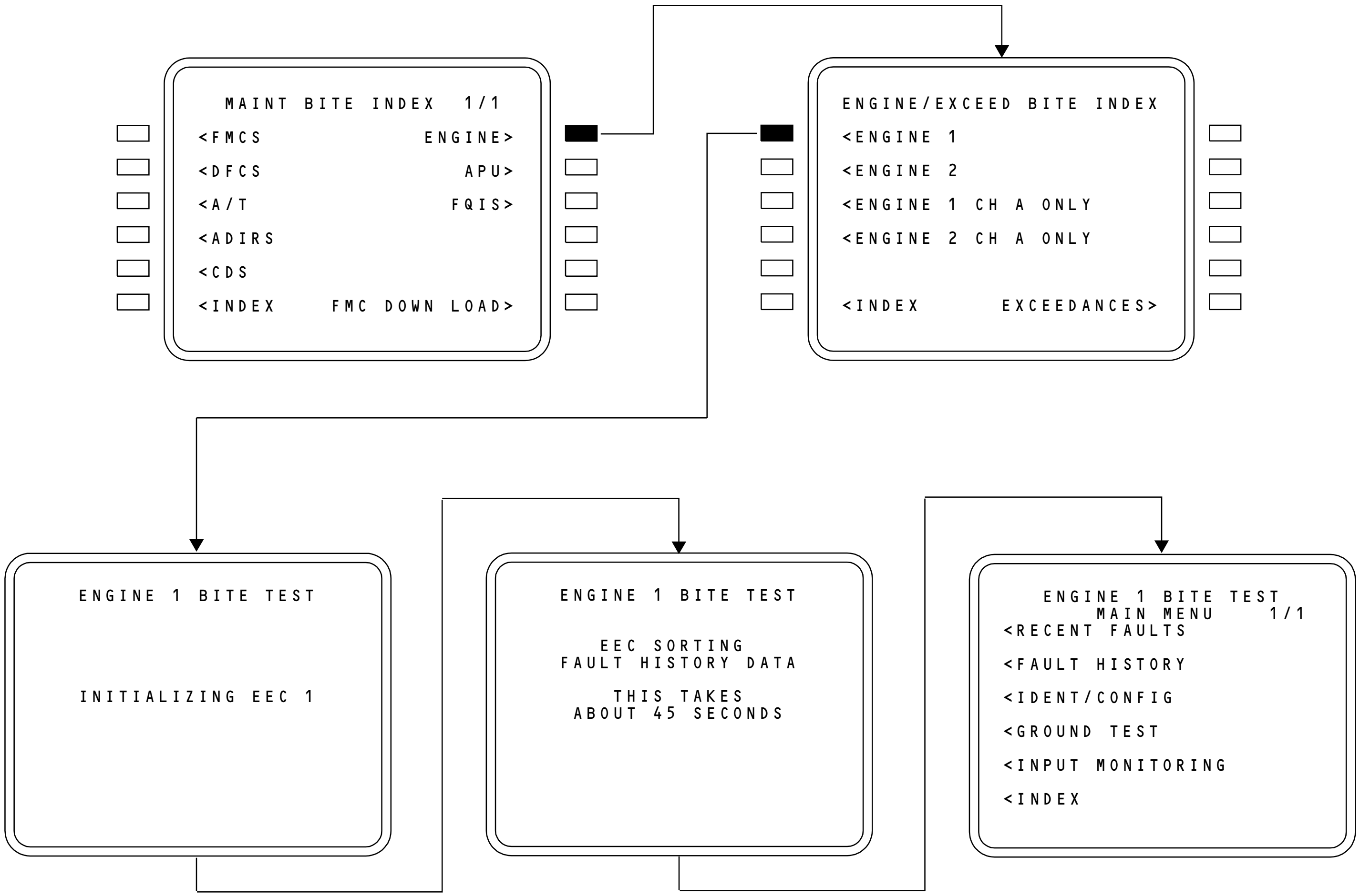
You do engine 2 BITE the same as engine 1.

MAIN MENU

These are the 5 EEC BITE functions you can do from the MAIN MENU page:

- RECENT FAULTS
- FAULT HISTORY
- IDENT/CONFIG
- GROUND TESTS
- INPUT MONITORING.

You can use the above EEC functions when the airplane is on the ground. You cannot do EEC BITE in flight. To use the GROUND TEST function, N2 must be less than 5 percent and the start lever must be in the CUTOFF position. To use the RECENT FAULTS or FAULT HISTORY functions, N2 must be less than 5 percent.



M87927 S0004632152_V2

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - MAIN MENU

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE RECENT FAULTS

General

The RECENT FAULTS function gives you the faults stored in EEC non-volatile memory (NVM) for the last three flight legs. The EEC stores up to 10 faults in each dispatch level. If there are 10 faults stored in EEC memory for a given dispatch level during the last 10 flight legs and a new fault occurs with the same dispatch level, the EEC erases the oldest fault to make space for the new fault. One fault shows on each page. The EEC erases all faults that are older than 10 flight legs.

If data is not available from both EEC channels, you see a message that tells you which EEC channel the CDU cannot use. You select CONTINUE to see the data for the channel the CDU can use.

The dispatch level shows on line 3 of the RECENT FAULTS screen.

Line 5 gives the maintenance message number. You use this number to find the correct fault isolation procedures to correct the fault.

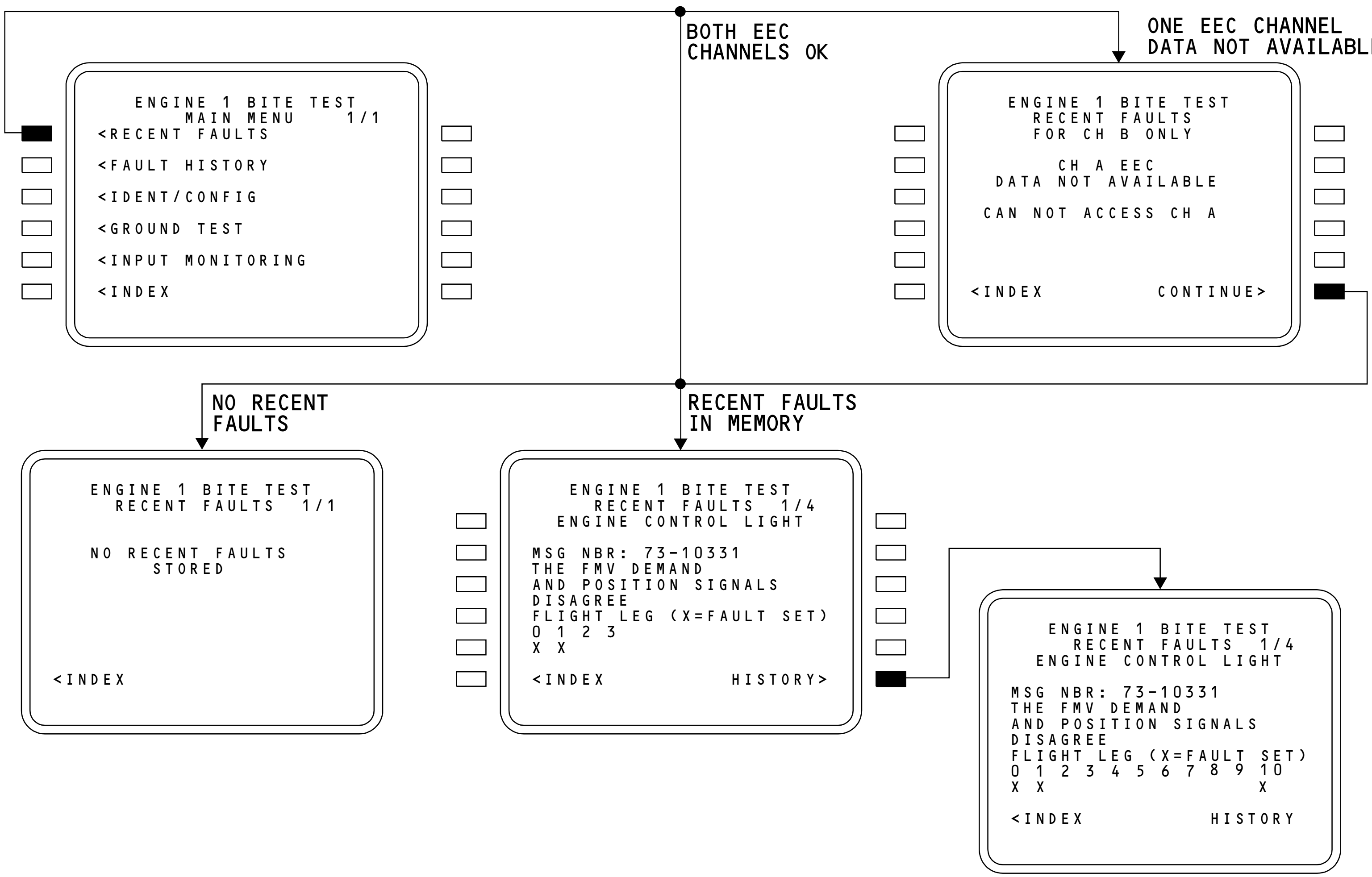
Lines 6, 7, and 8 give a short description of the fault.

Lines 9 through 11 show the last three flight legs and which leg or legs has the fault. The X under the flight leg number shows the fault on this page occurred during that leg. Flight leg 0 is the most recent engine ground run. The EEC puts faults from ground runs in flight leg 1 when the airplane goes to air mode.

The AIR/GROUND system sends an air/ground signal to the DEUs. The DEUs then send this signal to the EECs. The EECs use the air/ground signal and air speed to increment the leg count when the airplane goes to air mode.

If there are no faults for the last three flight legs and the last ground run, the CDU shows the NO RECENT FAULTS message.

You select HISTORY to see the last 10 flight legs.



M87928 S0004632154_V2

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE RECENT FAULTS

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE FAULT HISTORY

General

The FAULT HISTORY function gives you the faults stored in EEC non-volatile memory (NVM) for the last 10 flight legs. The EEC stores up to 10 faults in each dispatch level. If there are 10 faults stored in EEC memory for a given dispatch level during the last 10 flight legs and a new fault occurs with the same dispatch level, the EEC erases the oldest fault to make space for the new fault. One fault shows on each page. The EEC erases all faults that are older than 10 flight legs. A new leg begins when the EEC detects transition from ground to air.

If fault data is not available from both EEC channels, you see a message that tells you which EEC channel the CDU cannot use. You select CONTINUE to see the data for the channel the CDU can use.

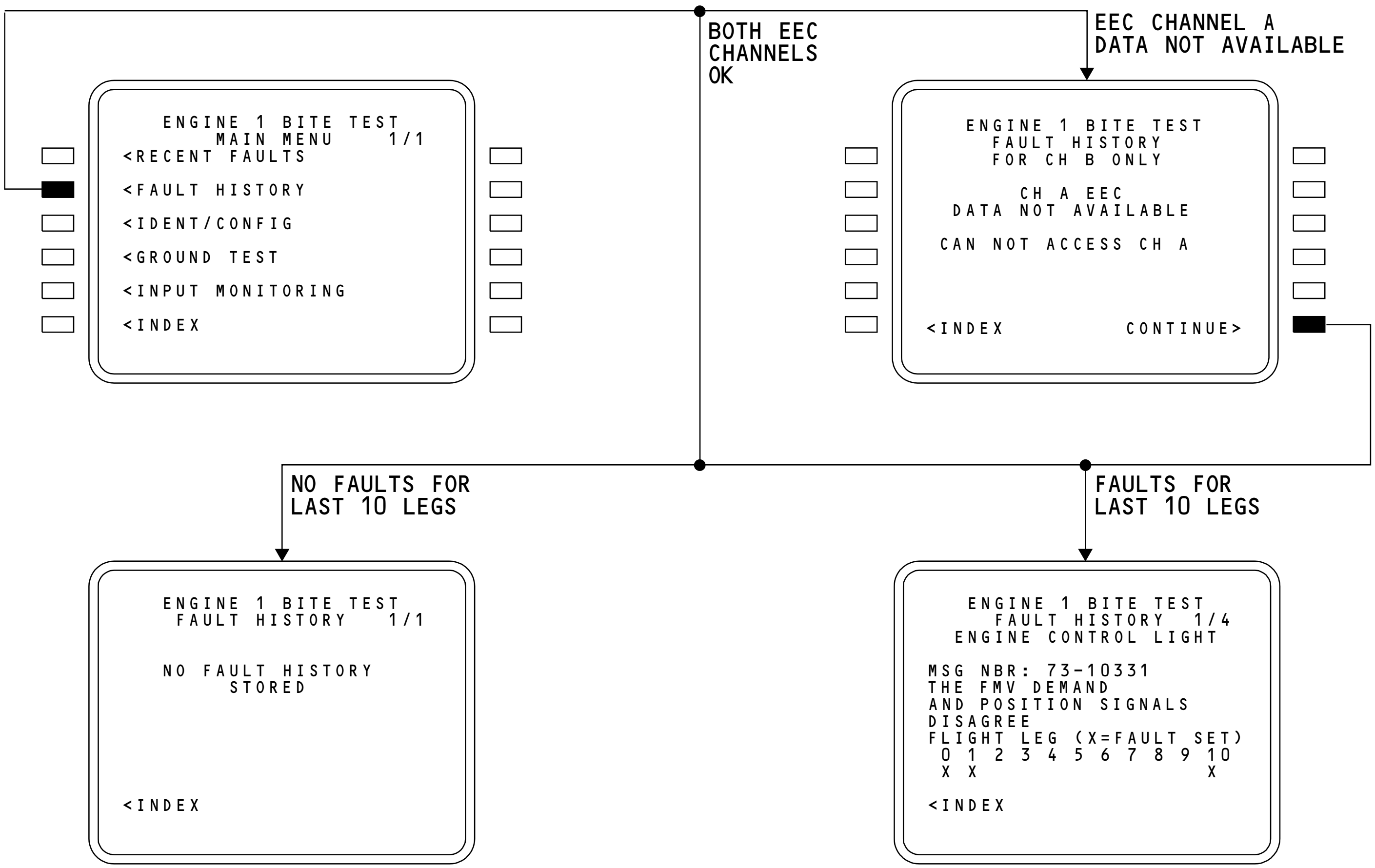
The dispatch level shows on line 3 of the FAULT HISTORY screen.

Line 5 gives the maintenance message number. You use this number to find the correct fault isolation procedures to correct the fault.

Lines 6, 7, and 8 give a short description of the fault.

Lines 9 through 11 shows the last 10 flight legs and which leg or legs has the fault. The X under the flight leg number shows the fault on this page occurred during that leg. Flight leg 0 is the most recent ground run. The EEC stores faults from this ground run in flight leg 1 when the airplane goes in-flight.

If there are no faults for the last 10 flight legs and the last ground run, the CDU shows the NO FAULT HISTORY STORED message.



M87929 S0004632156_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE FAULT HISTORY

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IDENT/CONFIG

General

The IDENT/CONFIG pages show engine and EEC configuration and identification data. There are two pages of this data.

IDENT/CONFIG Page 1

The IDENT/CONFIG page 1 gives this data:

- AIRPLANE MODEL (737-600/700/800/900)
- ENGINE MODEL (7Byy where yy X 1000 is the base thrust rating; a /1 indicates SAC, a /3 indicates a /3 Engine)
- BUMP (hot day thrust cutback point increase)
- N1 TRIM (N1 trim setting)
- EEC P/N (EEC part number)
- EEC S/W VER (EEC software version)
- START MODE (engine start mode)
- ENG S/N (engine serial number).

You select ENG S/N to change the engine serial number. When you select ENG S/N, a new screen shows and instructs you to enter the six-digit engine serial number. After you enter the new engine serial number in the CDU scratch pad, select continue to store the serial number in the EEC. If you do not want to store the new serial number, select GO BACK and the serial number will not change.

If you need to erase the faults in EEC memory, select ERASE. A notice shows on the CDU to confirm that you want to erase the faults in EEC memory. To erase the faults, type OK in the CDU scratch pad and select ERASE ALL. A screen shows with the message, EEC ERASING FAULTS, THIS WILL TAKE 7 SEC. If you do not want to erase the faults, select GO BACK. If one EEC channel data is not available, you can not erase data in EEC memory.

AKS ALL PRE SB CFM56-7B 73-40

IDENT/CONFIG Page 2

The IDENT/CONFIG page 2 gives this data:

- PMUX INSTALLED (optional condition monitoring sensors installed)
- IGNITION MODE (STANDARD or AUTOMATIC).

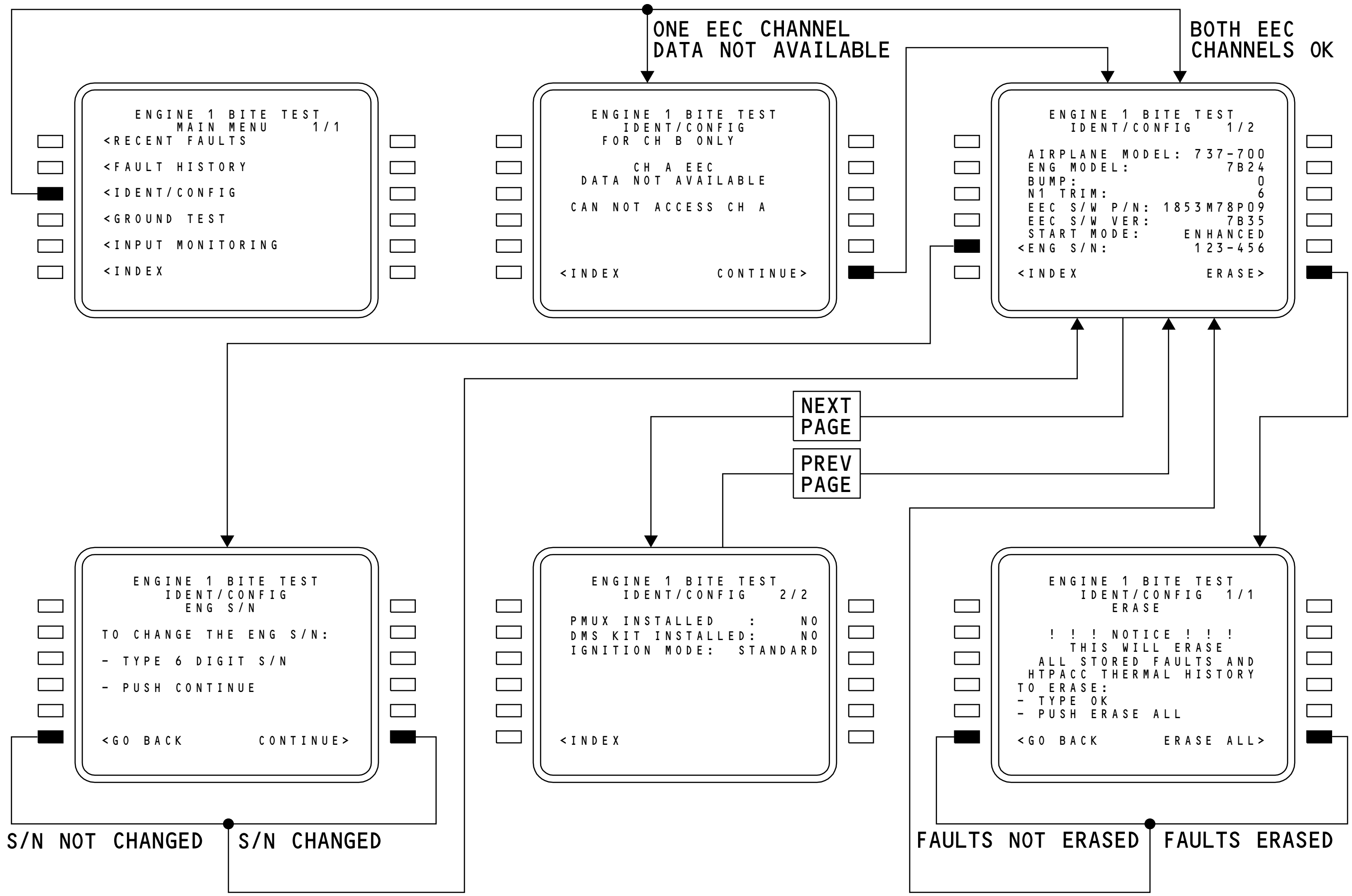
AKS ALL POST SB CFM56-7B 73-40

IDENT/CONFIG Page 2

The IDENT/CONFIG page 2 gives this data:

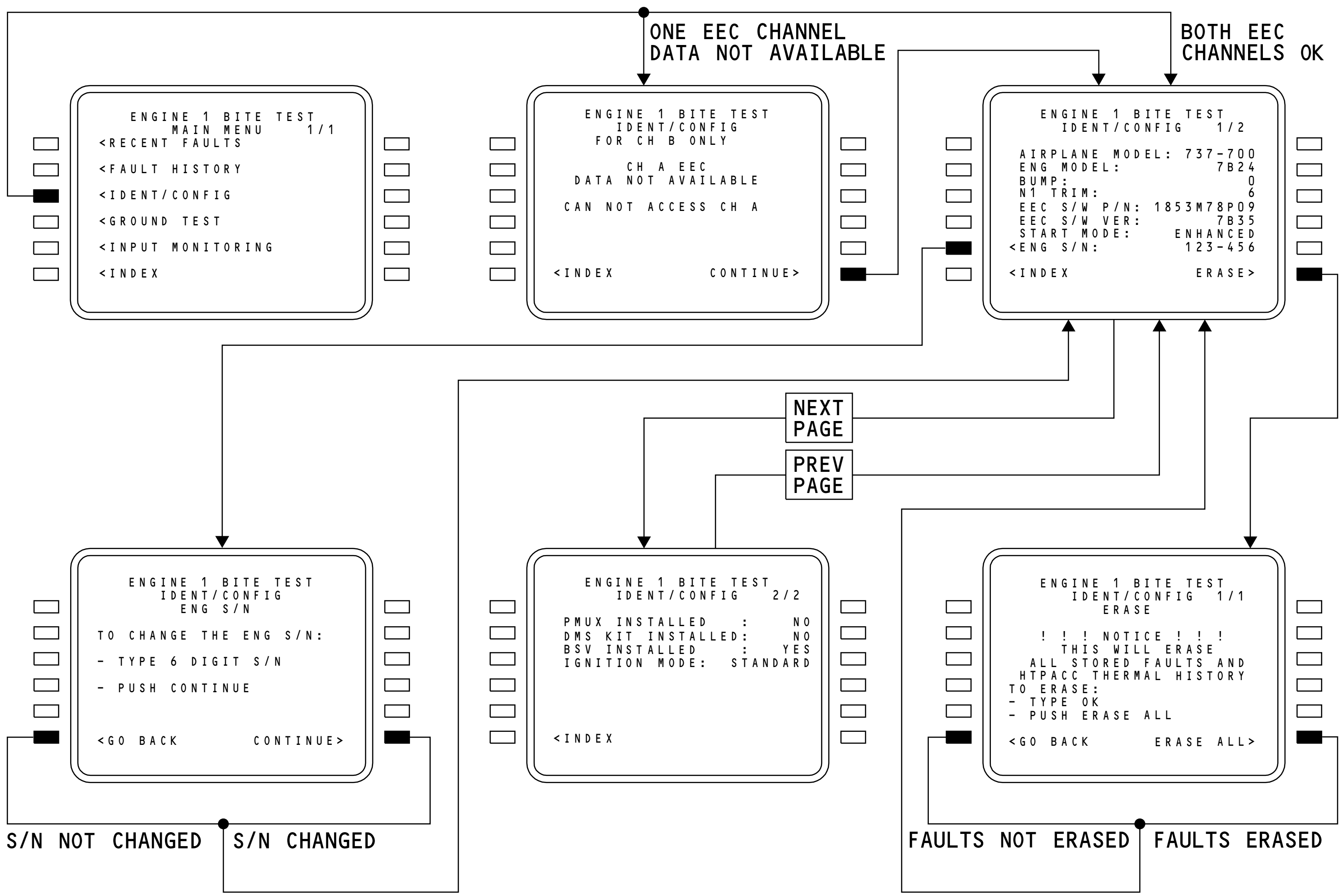
- PMUX INSTALLED (shows YES with optional condition monitoring sensors installed)
- DMS KIT INSTALLED (shows YES with optional electronic chip detector installed)
- BSV INSTALLED (shows YES with burner staging valve installed)
- IGNITION MODE (STANDARD or AUTOMATIC)

AKS ALL



M87931 S0004632159_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IDENT/CONFIG



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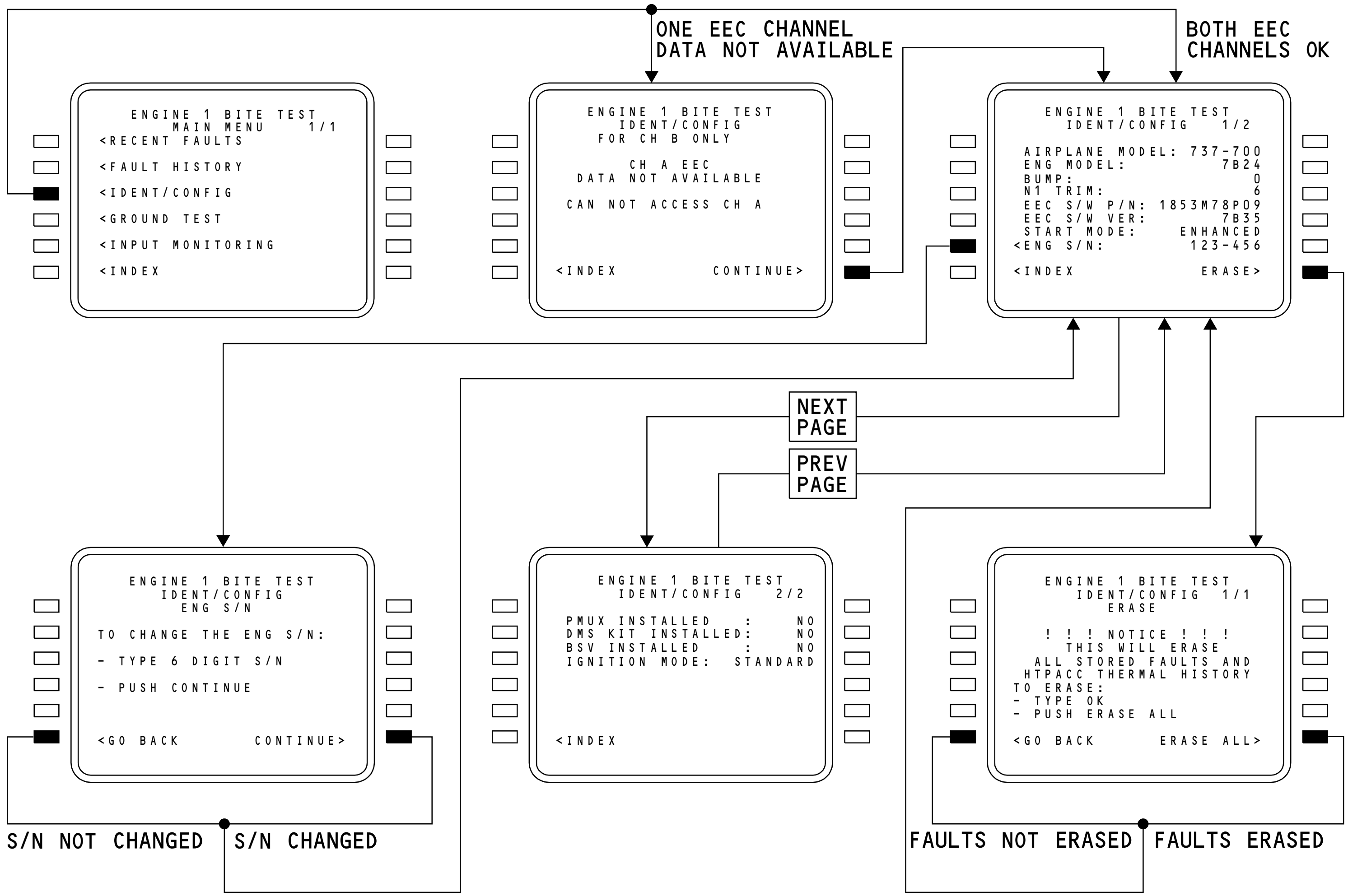
ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IDENT/CONFIG



ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IDENT/CONFIG

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - GROUND TESTS

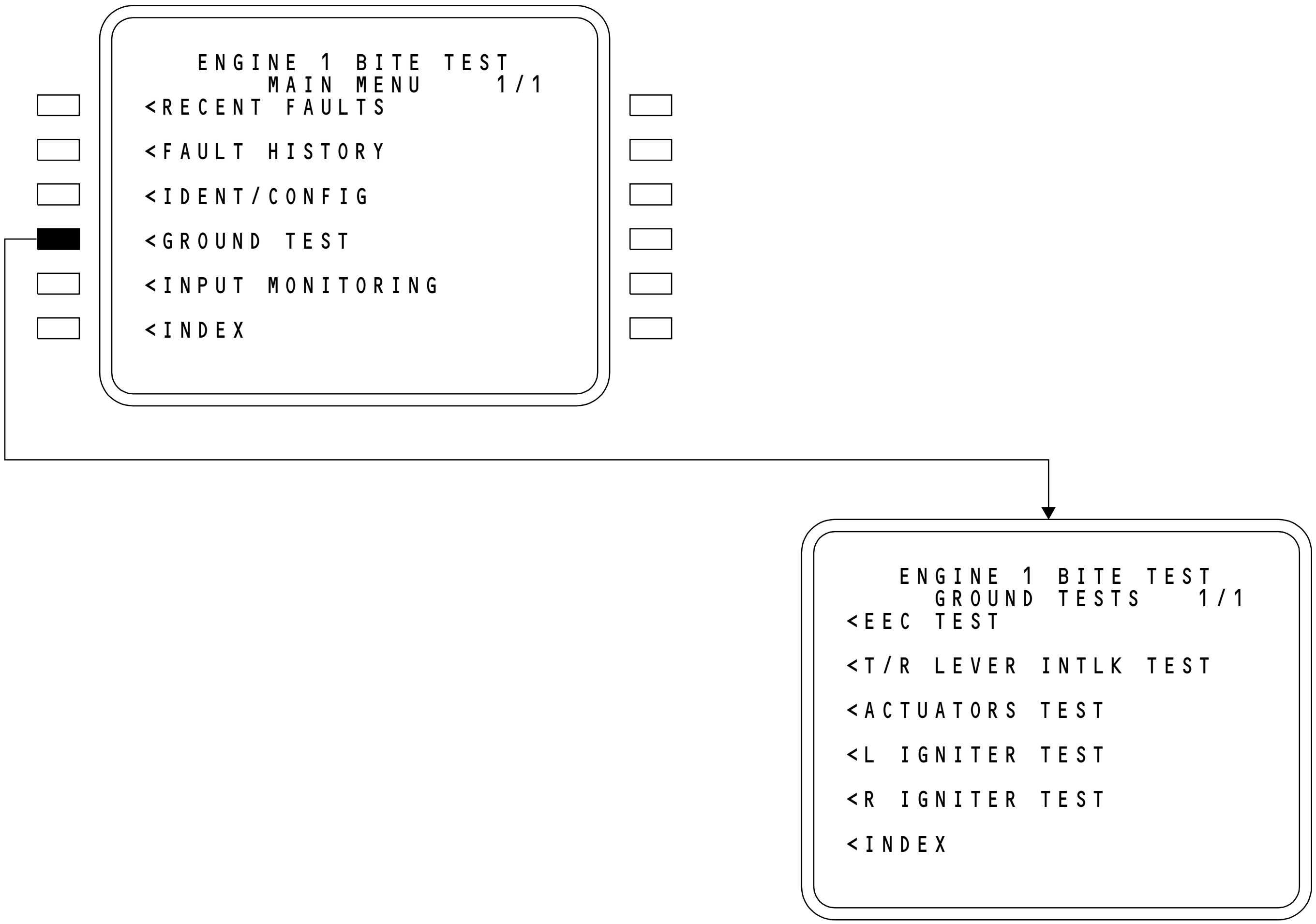
General

The GROUND TEST page lets you select one of these four engine ground tests:

- EEC TEST
- T/R LEVER INTLK TEST (thrust reverser lever interlock test)
- ACTUATORS TEST
- L IGNITER TEST
- R IGNITER TEST.

To start an engine ground test, these conditions must be true:

- Airplane on ground
- N2 < 5 percent
- Start lever in the CUTOFF position.



M87937 S0004632165_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - GROUND TESTS

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - EEC TEST 1

General

The EEC TEST does a test of these components:

- Sensor interfaces
- EEC internal components
- Flight compartment lights and messages.

You select START TEST on the GROUND TESTS EEC TEST page and follow the procedure in the AMM and the steps on the CDU to do the test.

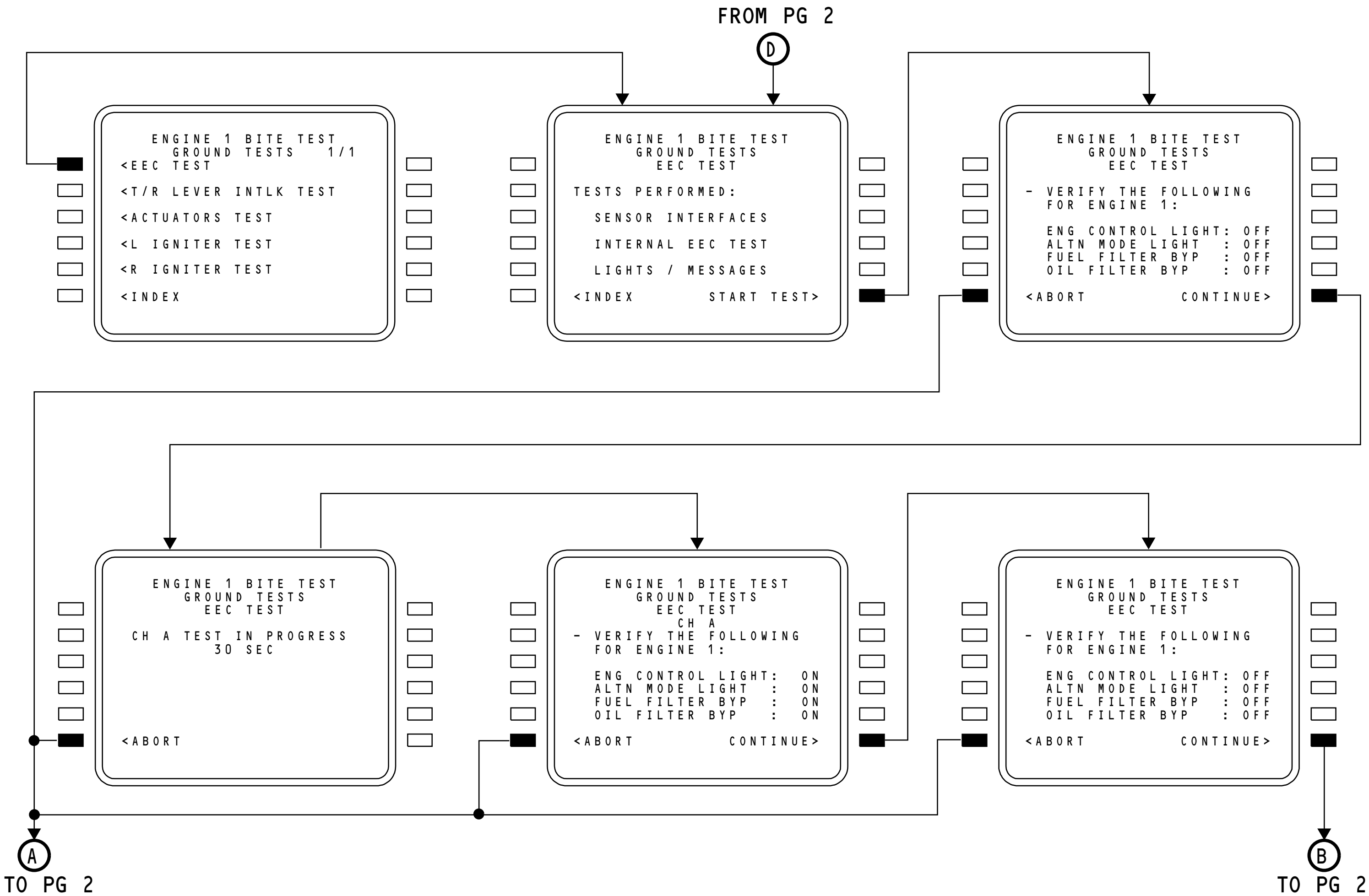
See section 73-21 of part II of the AMM for the EEC test procedure.

During the EEC TEST, the EEC makes these lights and messages come on:

- ENG CONTROL light on the P5 engine panel
- ALTN mode light on the P5 engine panel
- Fuel FILTER BYPASS light on the P5 fuel control panel
- OIL FILTER BYPASS message on engine indications display unit.

The EEC TEST first does a test of channel A then repeats the test for channel B. When the tests are complete, you select TEST RESULTS. The EEC shows the faults that were found or shows the EEC TEST PASSED message. You next select END TEST or REPEAT TEST. If you select END TEST, the TEST COMPLETE page shows on the CDU. If one channel of the EEC does not operate, the TEST COMPLETE page tells you which channel does not operate.

If you select abort during the test, the test stops and the CDU shows the test abort page.



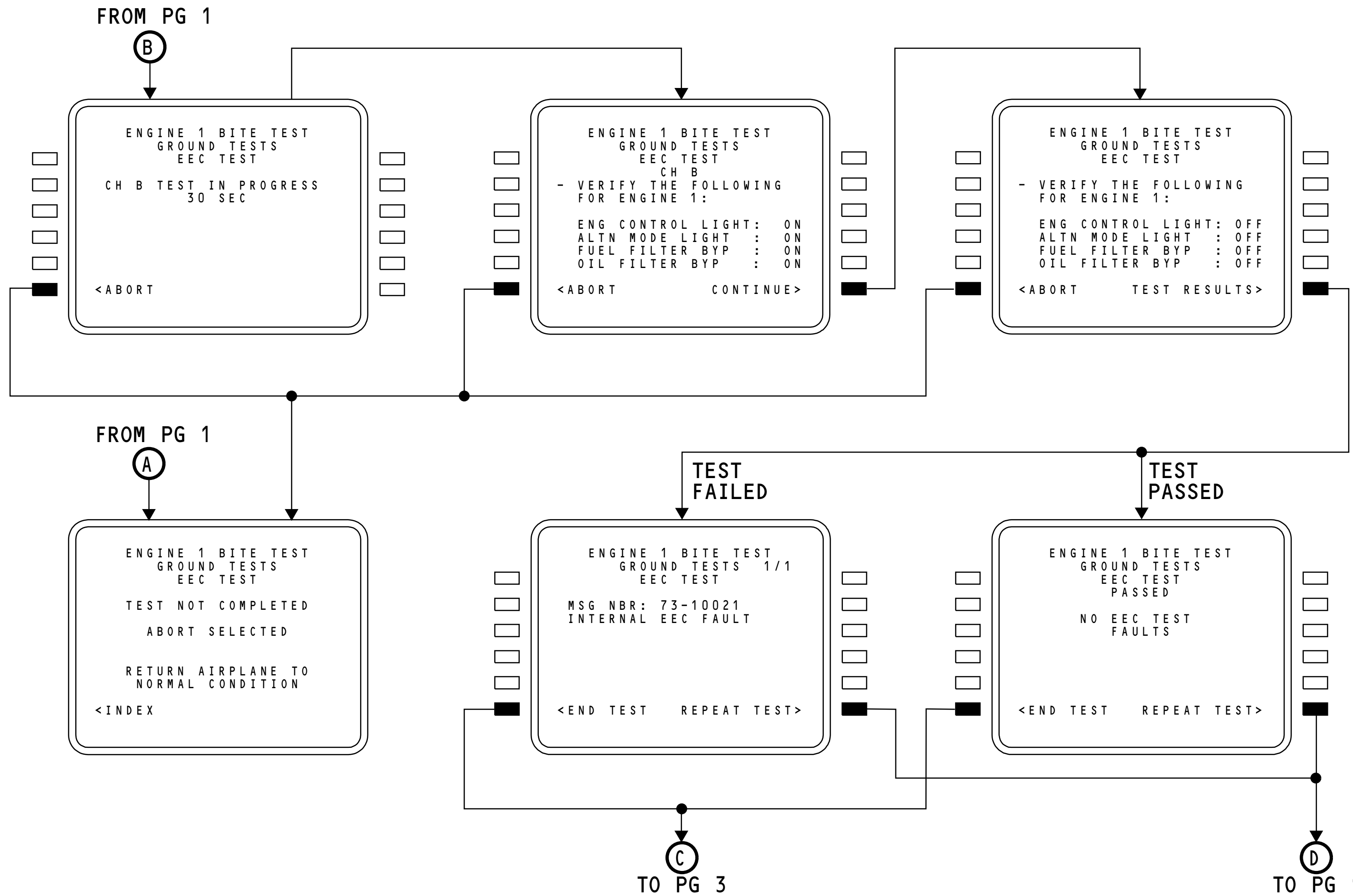
M87938 S0004632167_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - EEC TEST 1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - EEC TEST 2

General

Here are additional CDU screens for the EEC test.



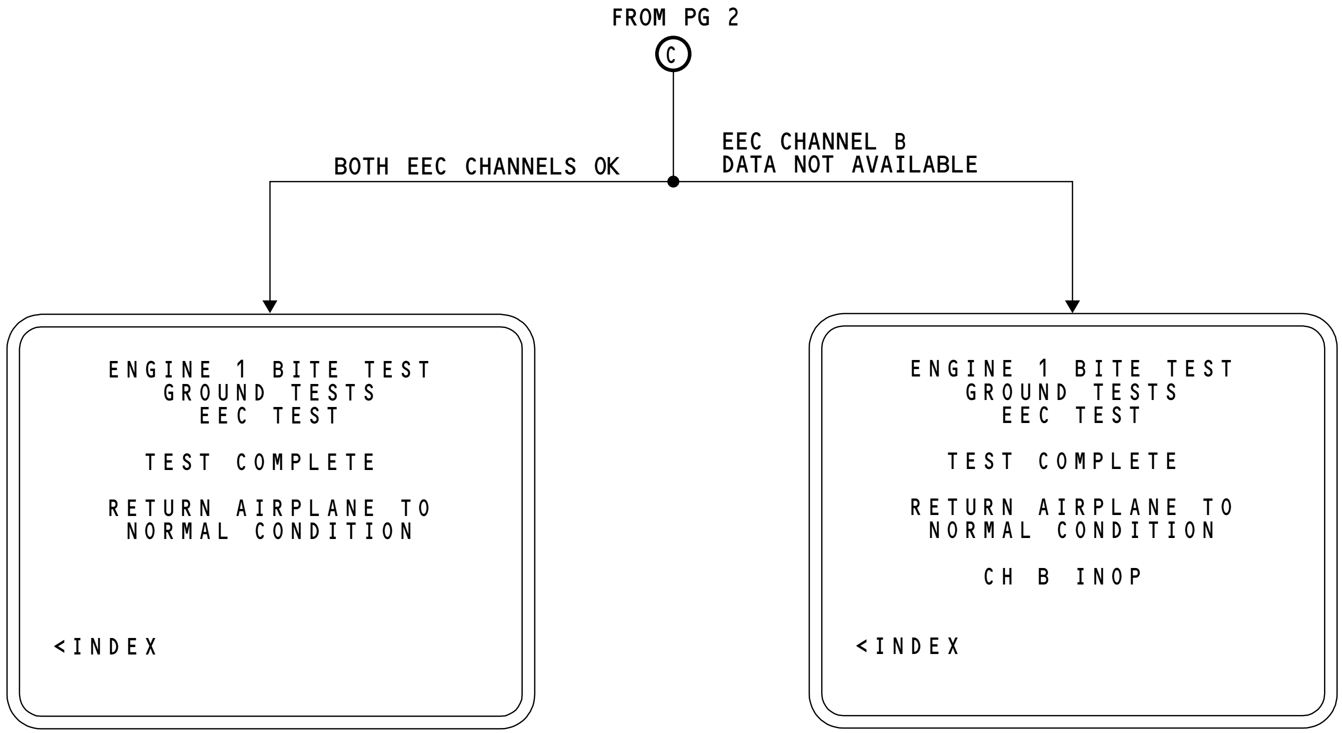
M87939 S0004632169_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - EEC TEST 2

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - EEC TEST 3

General

Here are additional CDU screens for the EEC test.



M87940 S0004632171_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - EEC TEST 3

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - T/R INTLK 1

General

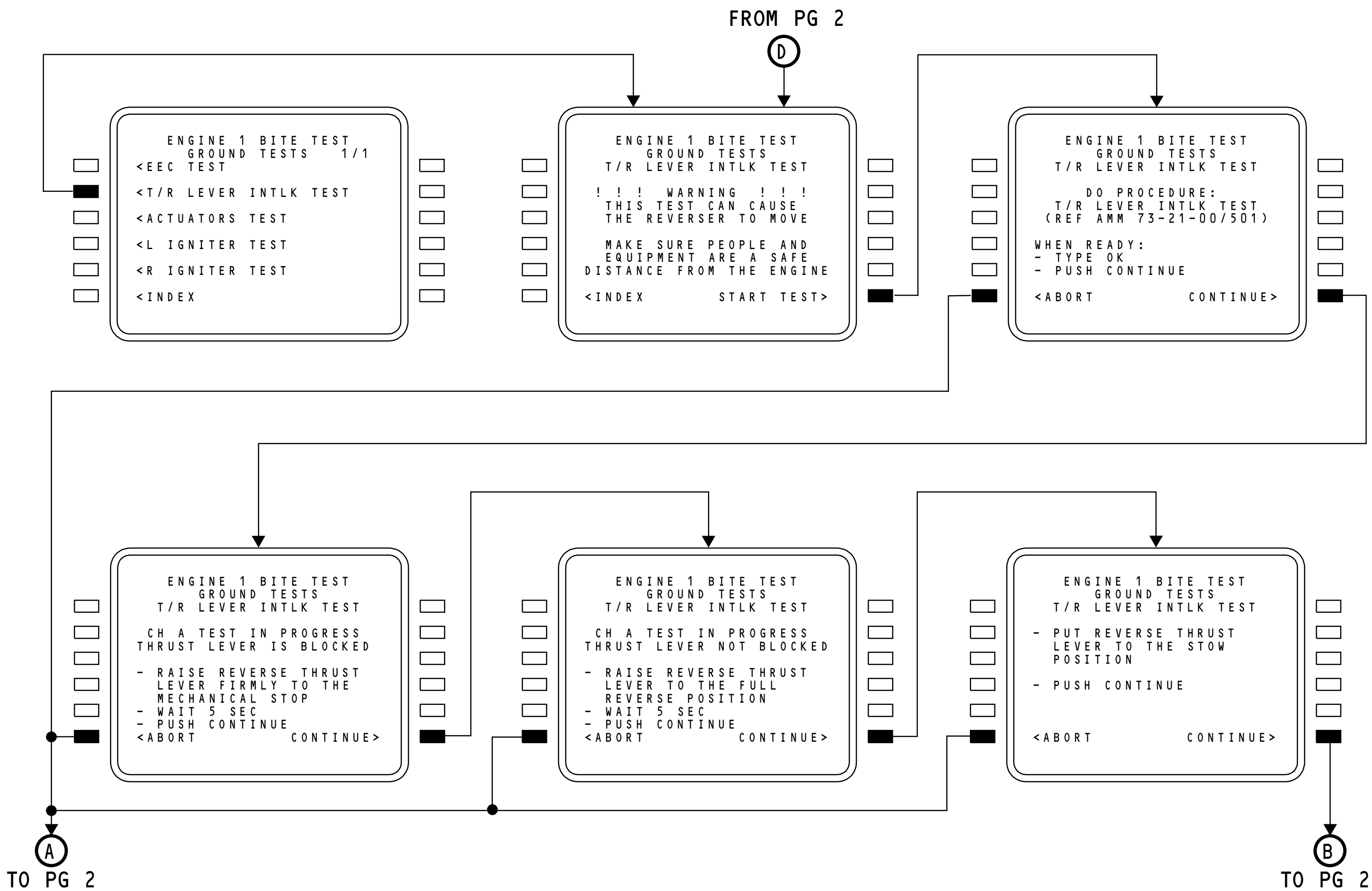
The T/R LEVER INTLK TEST does a test to make sure the EEC can operate the thrust lever interlock.

NOTE: The CDU screen will show a warning about operation of the thrust reverser during this test.

You select START TEST on the GROUND TEST T/R LEVER INTLK TEST page and follow the procedure in 73-21 of the AMM part II and the steps on the CDU to do the test.

The T/R LEVER INTLK TEST first does a test of channel A then repeats the test for channel B. When the tests are complete, you select TEST RESULTS. The EEC shows the faults that were found or shows the TEST PASSED message. You next select END TEST or REPEAT TEST. If you select END TEST, the TEST COMPLETE page shows on the CDU. If one channel of the EEC does not operate, the TEST COMPLETE page tells you which channel does not operate.

If you select abort during the test, the test stops and the CDU shows the test abort page.



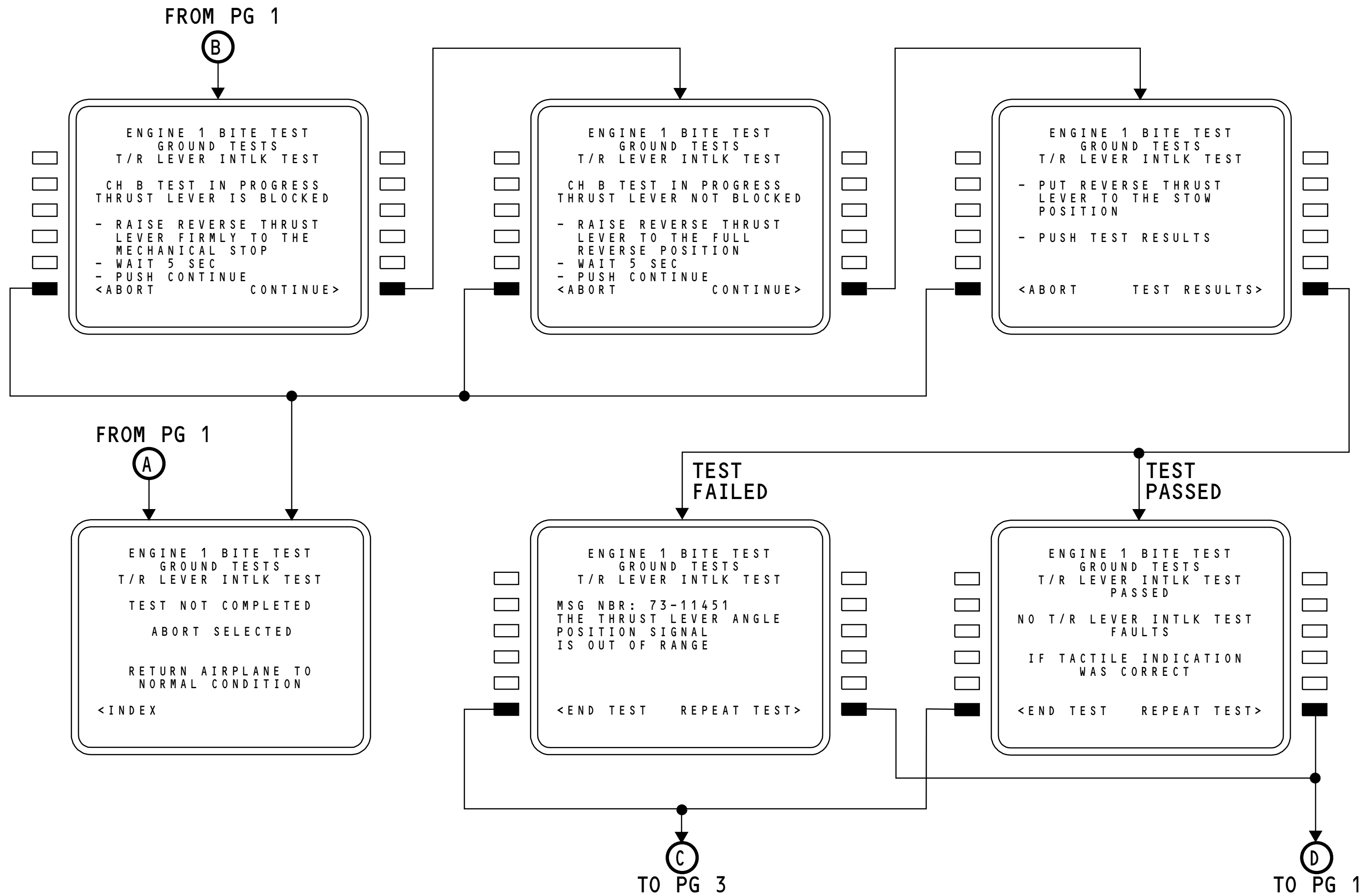
M87941 S0004632173_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - T/R INTLK 1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - T/R INTLK 2

General

These are additional CDU screens for the T/R LEVER INTLK TEST.



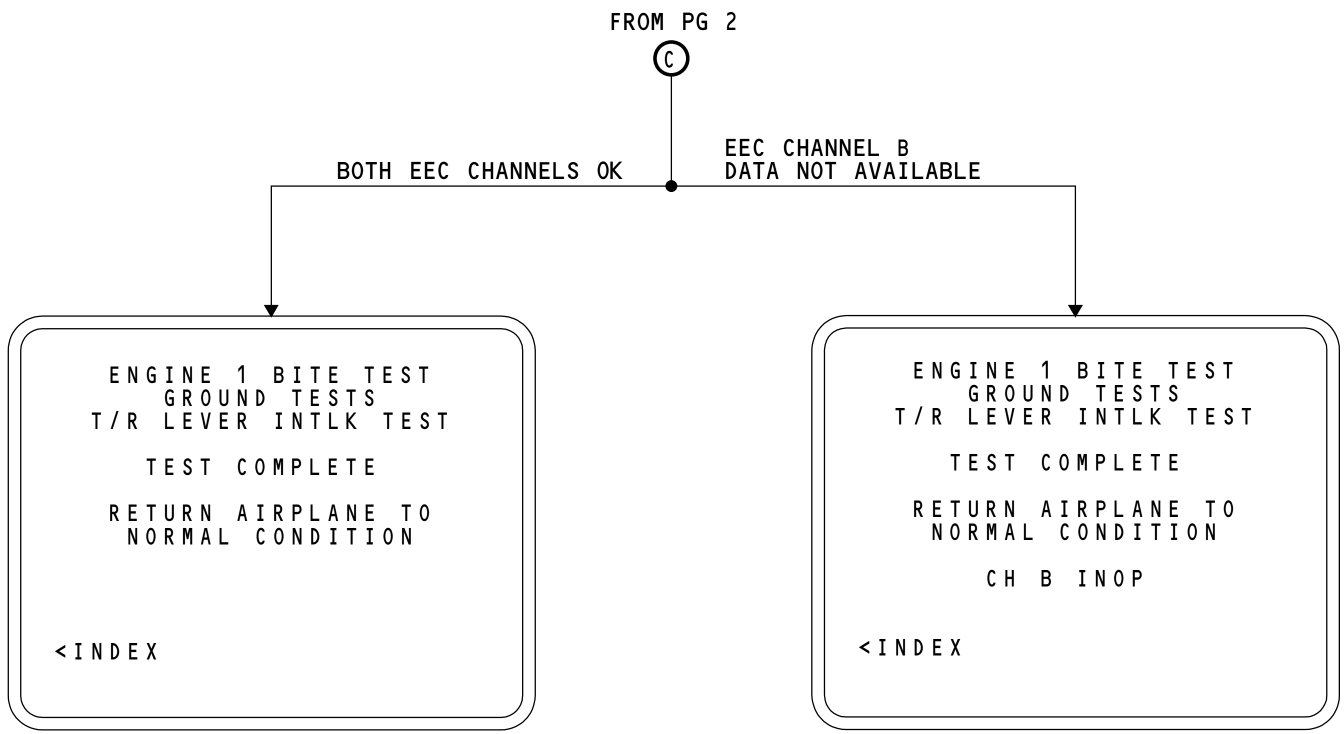
M87942 S0004632175_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - T/R INTLK 2

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - T/R INTLK 3

General

Here are additional CDU screens for the T/R LEVER INTLK TEST.



M87943 S0004632177_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - T/R INTLK 3

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - ACTR TST1

General

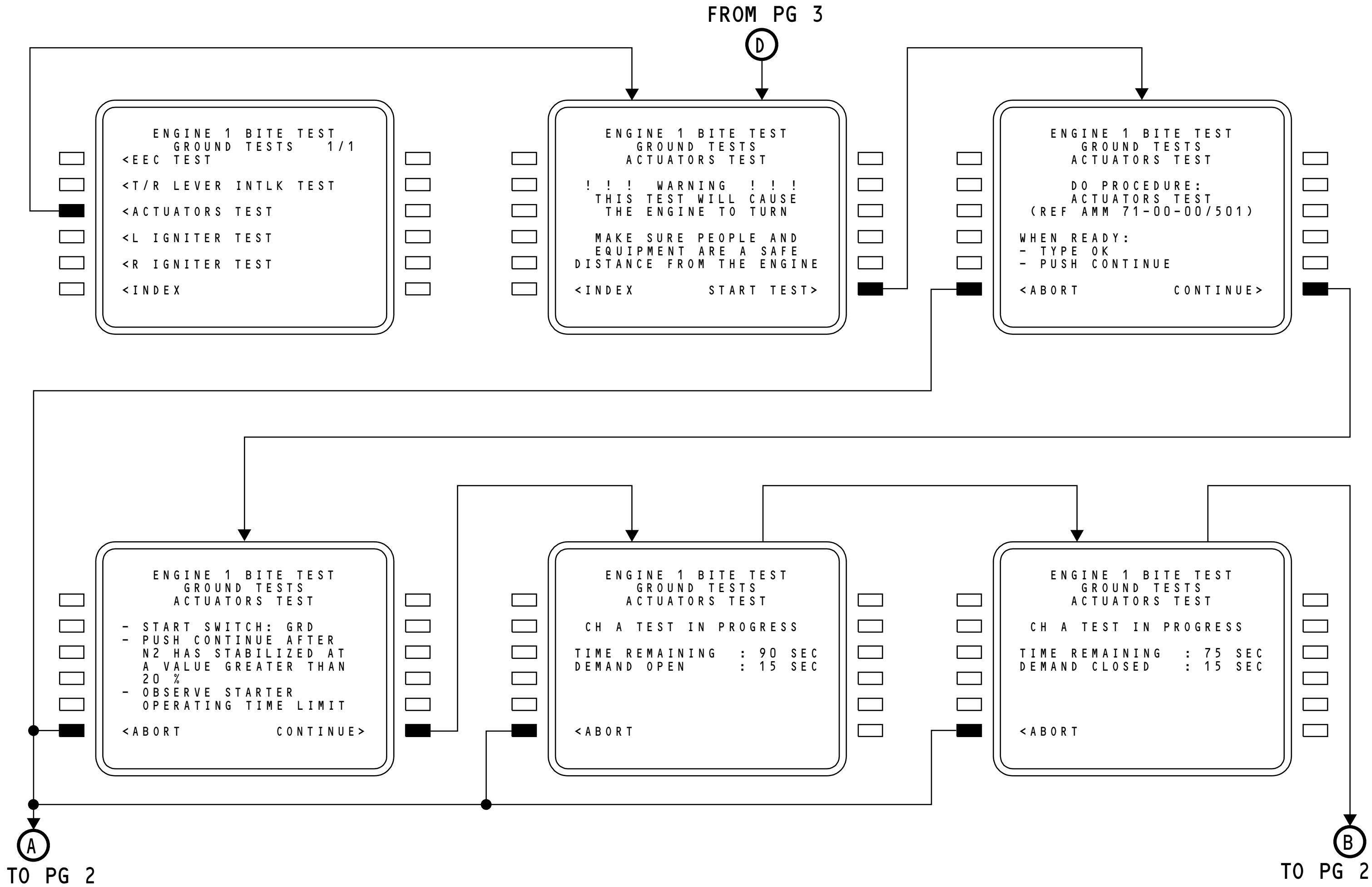
The ACTUATOR TEST operates engine actuators to their minimum and maximum positions with each EEC channel.

NOTE: The CDU screen will show a warning about operation of the engine during this test.

You select START TEST on the GROUND TEST ACTUATOR TEST page and follow the procedure in 71-00 of the AMM part II and the steps on the CDU to do the test.

The ACTUATOR TEST first does a test of channel A then repeats the test for channel B. When the tests are complete, you select TEST RESULTS. The EEC shows the faults that were found or shows you the TEST PASSED message. You next select END TEST or REPEAT TEST. If you select END TEST, the TEST COMPLETE page shows on the CDU. If one channel of the EEC does not operate, the TEST COMPLETE page tells you which channel does not operate.

If you select abort during the test, the test stops and the CDU shows the test abort page.



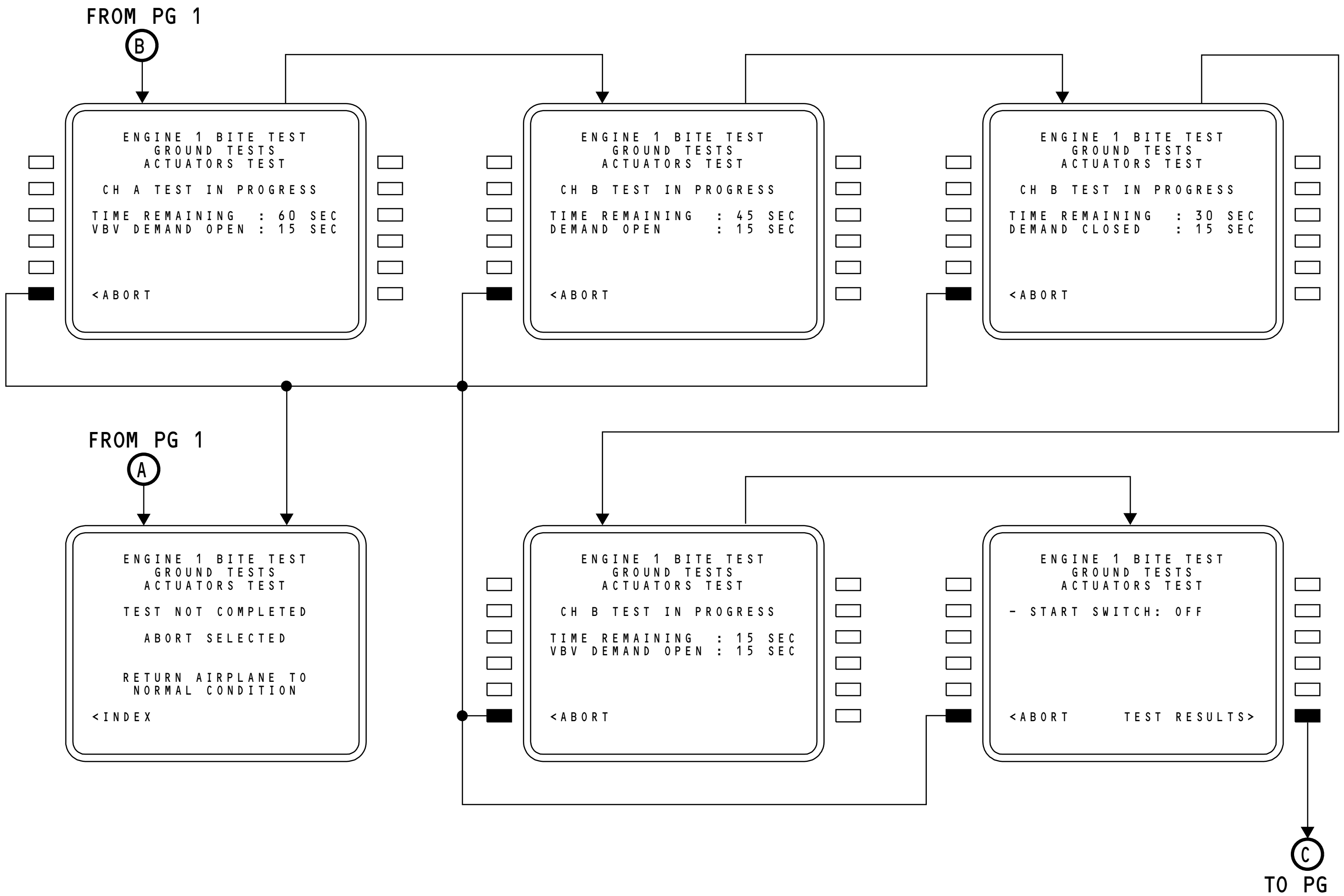
M87944 S0004632179_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - ACTR TST1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - ACTR TST2

General

These are additional CDU screens for the ACTUATORS TEST.



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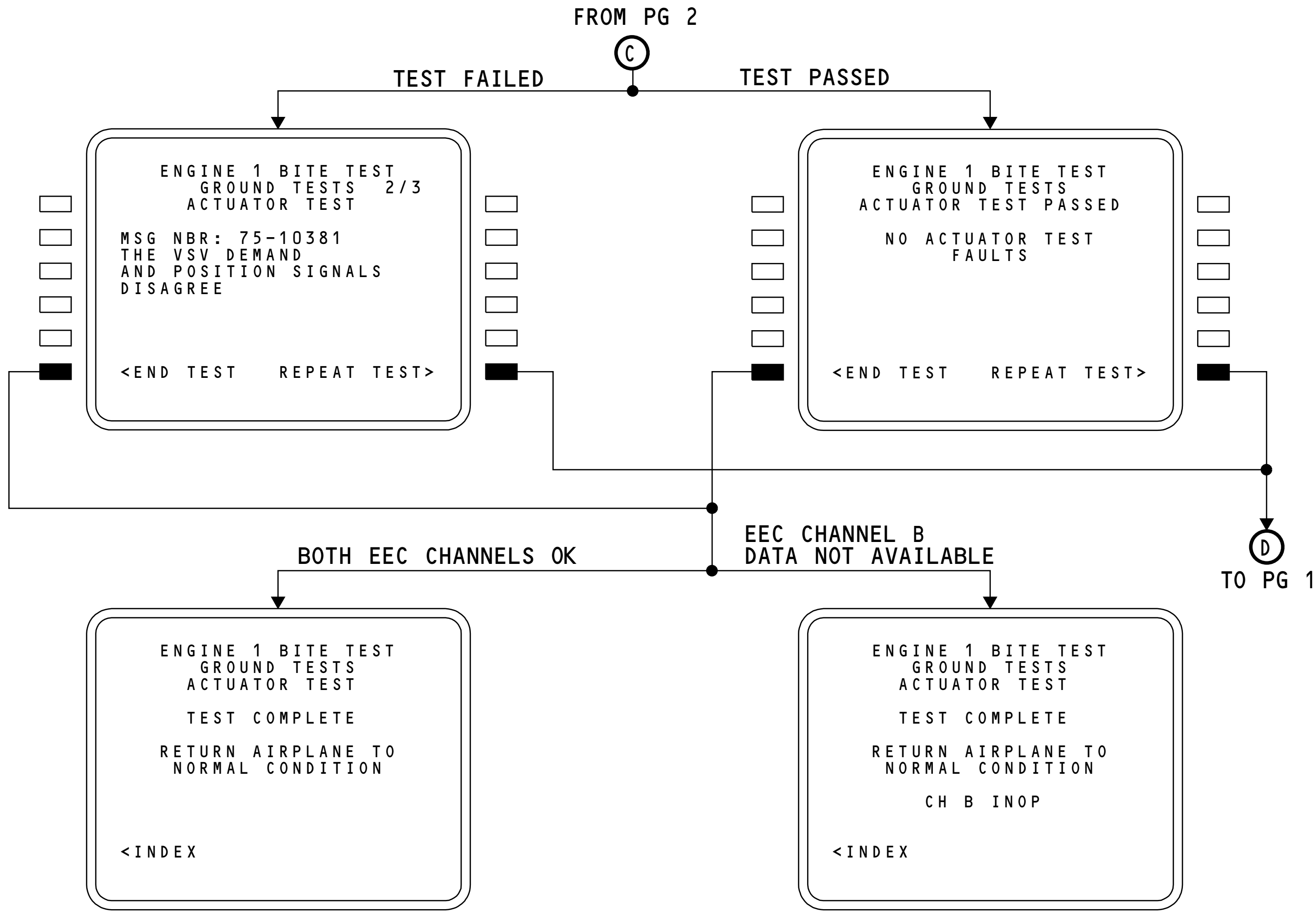
ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - ACTR TST2

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - ACTR TST3

General

These are additional CDU screens for the ACTUATOR TEST.



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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - ACTR TST3

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IGNITER TST1

General

The L IGNITER TEST operates the left igniter with each EEC channel. The R IGNITER TEST operates the right igniter with each EEC channel. The R IGNITER TEST is almost the same as the L IGNITER TEST.

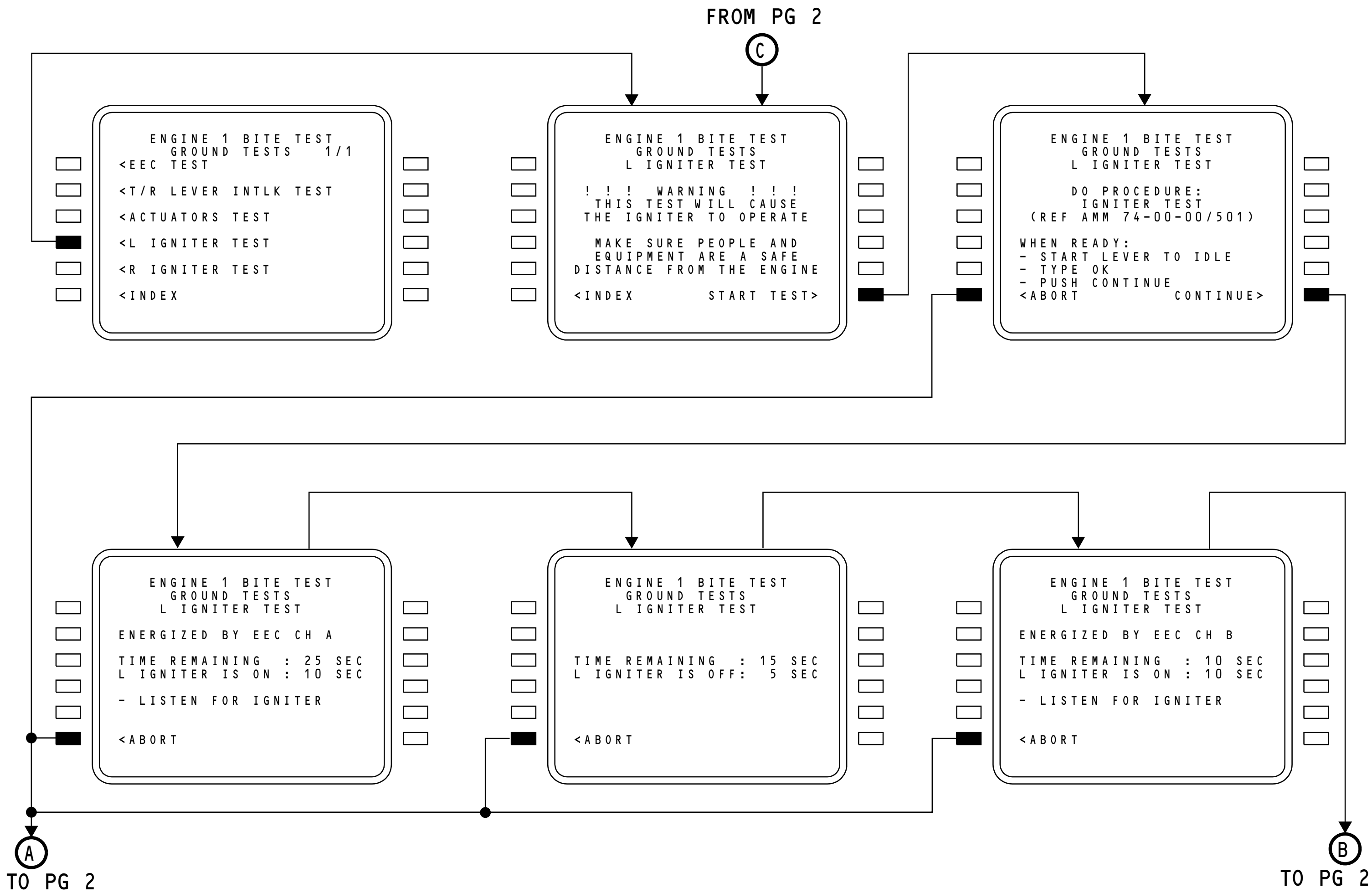
NOTE: The CDU screen will show a warning about operation of the ignition during this test.

You select START TEST on the GROUND TEST IGNITERS TEST page and follow the procedure in 74-00 of the AMM part II and the steps on the CDU to do the test.

The L IGNITER TEST does a test of the left igniter with channel A and then channel B. The EEC shows the faults that were found or shows the TEST PASSED message. If you select END TEST, the TEST COMPLETE page shows on the CDU. If one channel of the EEC does not operate, the TEST COMPLETE page tells you which channel does not operate.

If you select abort during the test, the test stops and the CDU shows the test abort page.

The R IGNITER TEST is almost the same as the L IGNITER TEST.

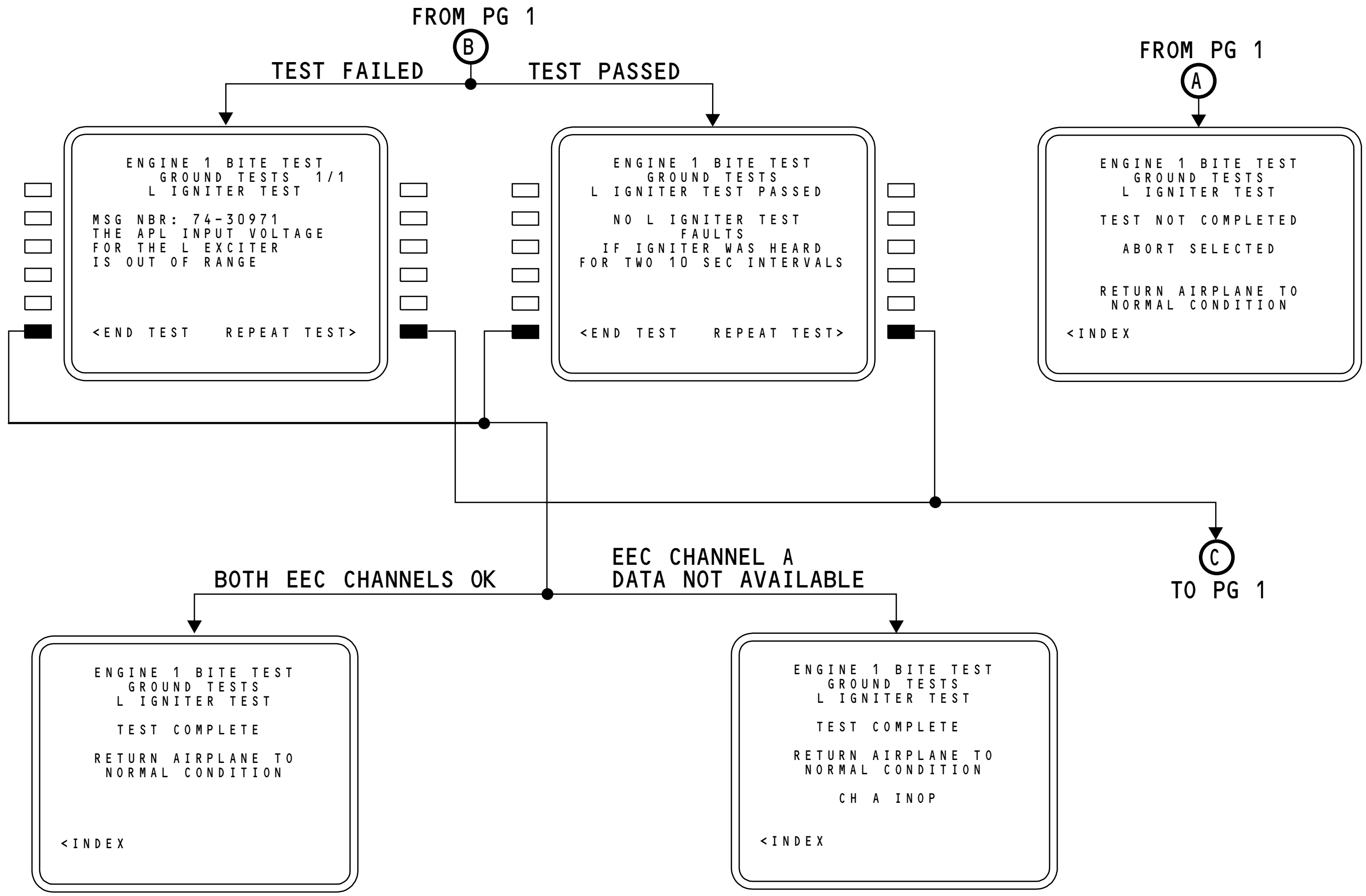


ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IGNITER TST1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IGNITER TST2

General

These are additional CDU screens for the IGNITERS TEST.



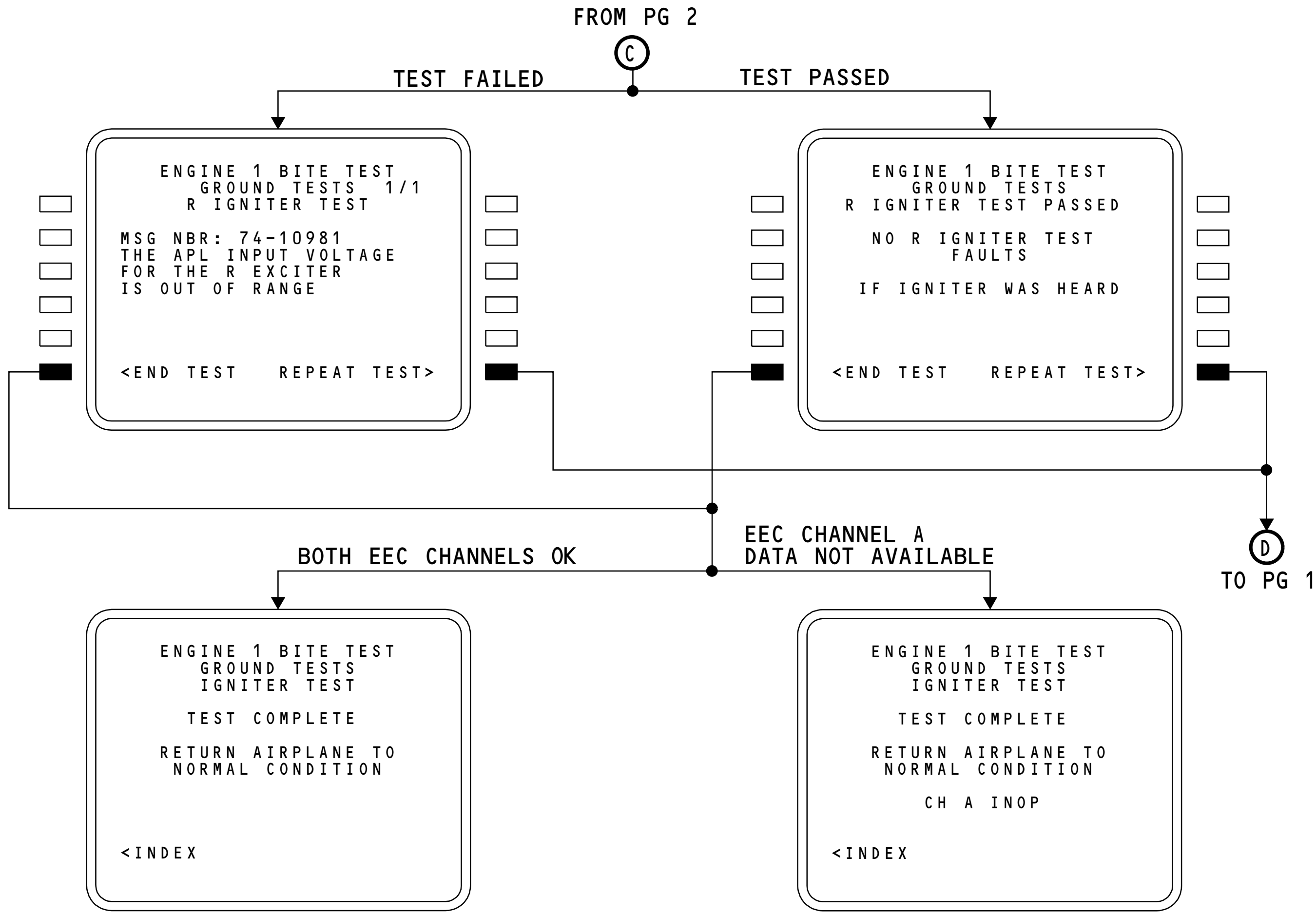
M87949 S0004632187_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IGNITER TST2

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IGNITER TST3

General

These are additional CDU screens for the IGNITER TEST.



M87950 S0004632189_V1

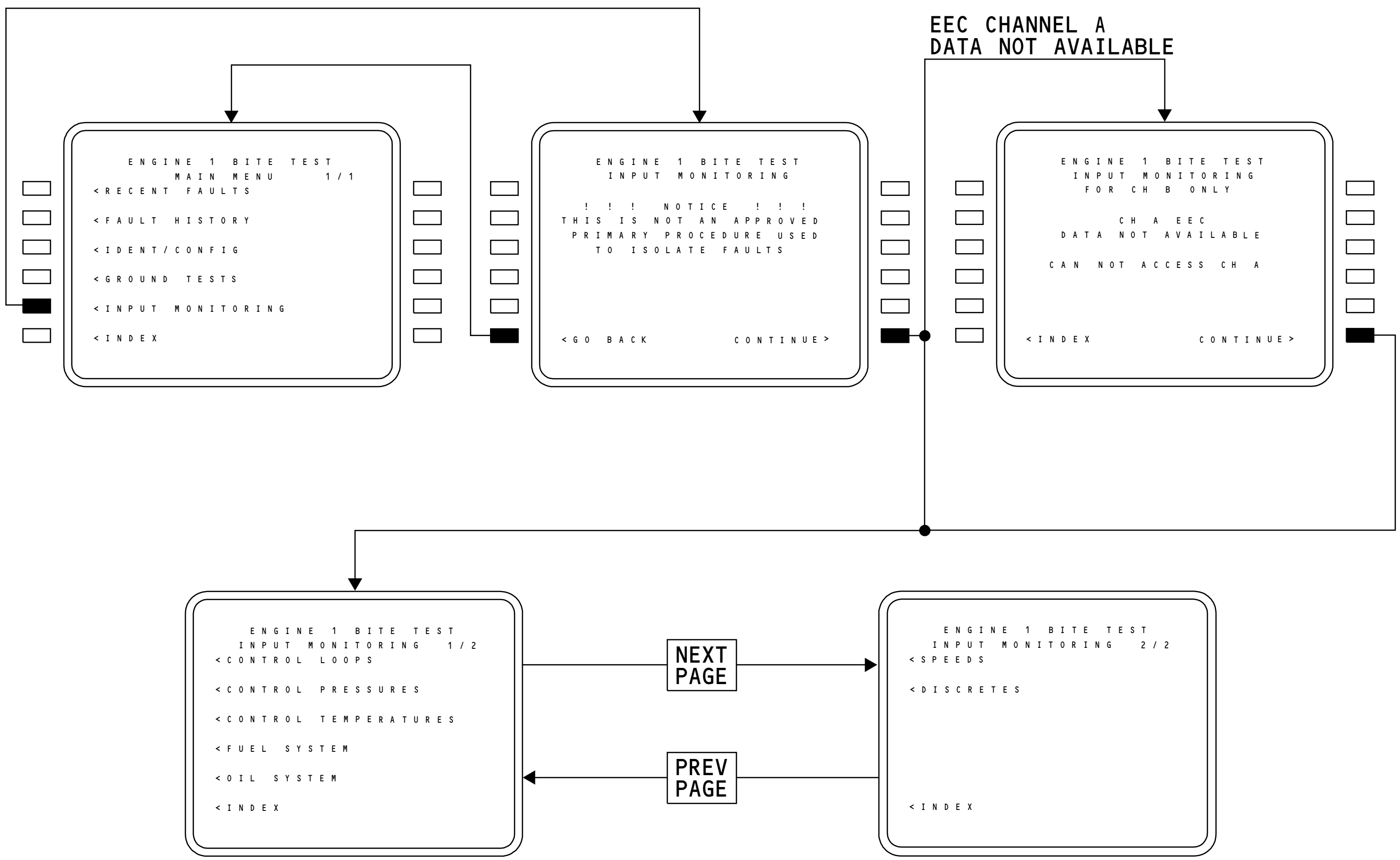
ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - IGNITER TST3

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 1

General

The INPUT MONITORING pages let you monitor engine parameters. The EEC divides the engine parameters into eight categories. You use the INPUT MONITORING MAIN MENU page to select the engine parameter category. These are the engine parameter categories:

- CONTROL LOOPS
- CONTROL PRESSURES
- CONTROL TEMPERATURES
- FUEL SYSTEM
- OIL SYSTEM
- SPEEDS
- DISCRETES.



M87951 S0004632191_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 2

General

The CONTROL LOOPS input monitoring category lets you monitor these control loops:

- Fuel metering valve (FMV)
- Variable stator vane (VSV)
- Variable bleed valve (VBV)
- High pressure turbine active clearance control (HPTACC)
- Low pressure turbine active clearance control (LPTACC)

AKS ALL PRE SB CFM56-7B 73-44

- Burner staging valve (BSV)

AKS ALL

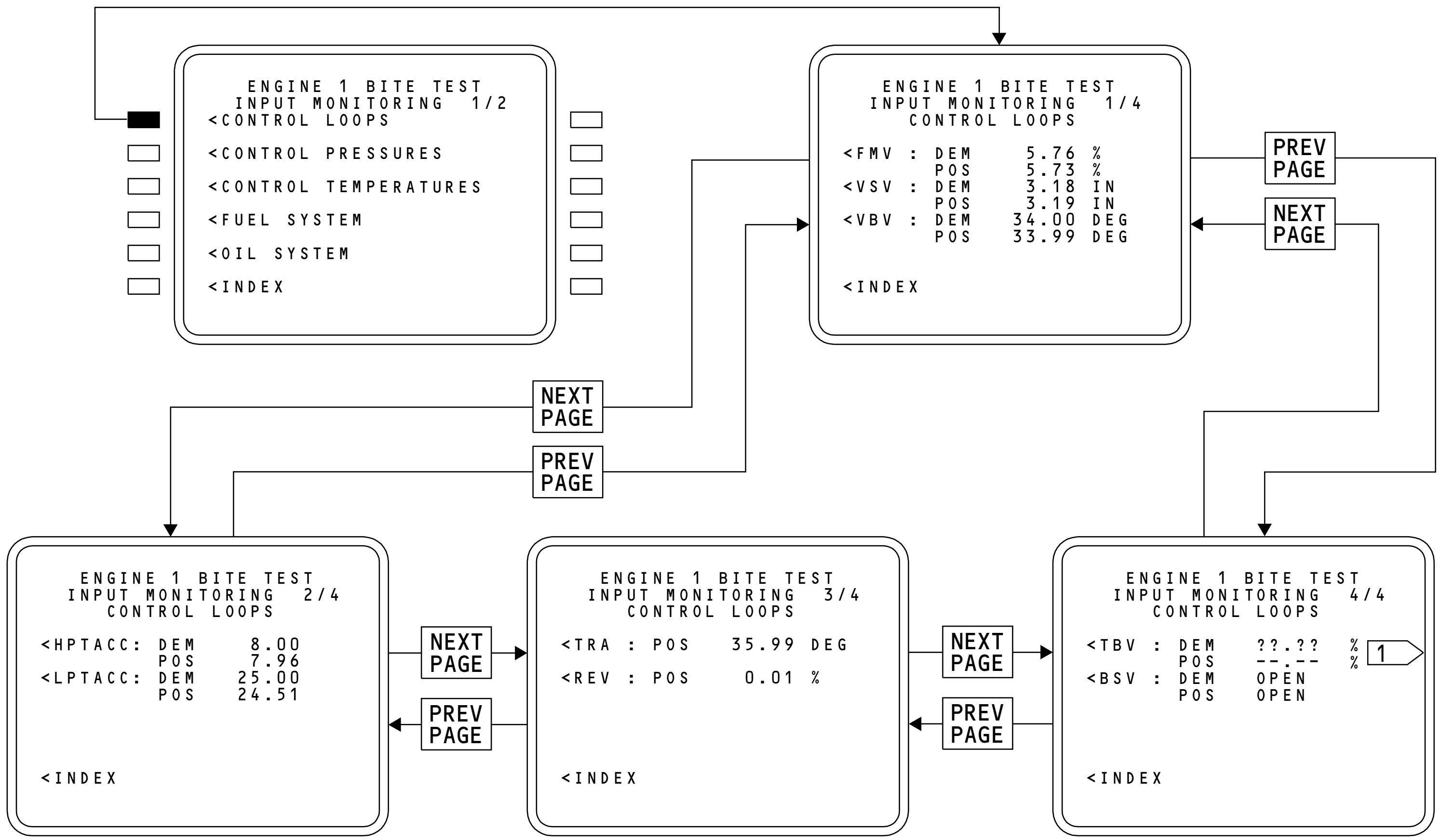
- Transient bleed valve (TBV).

The CONTROL LOOPS page gives you the demanded (DEM) position and the actual position (POS) for each of the control loops.

The CONTROL LOOPS input monitoring category also lets you monitor thrust resolver angle (TRA) and thrust reverser position (REV).

Training Information Point

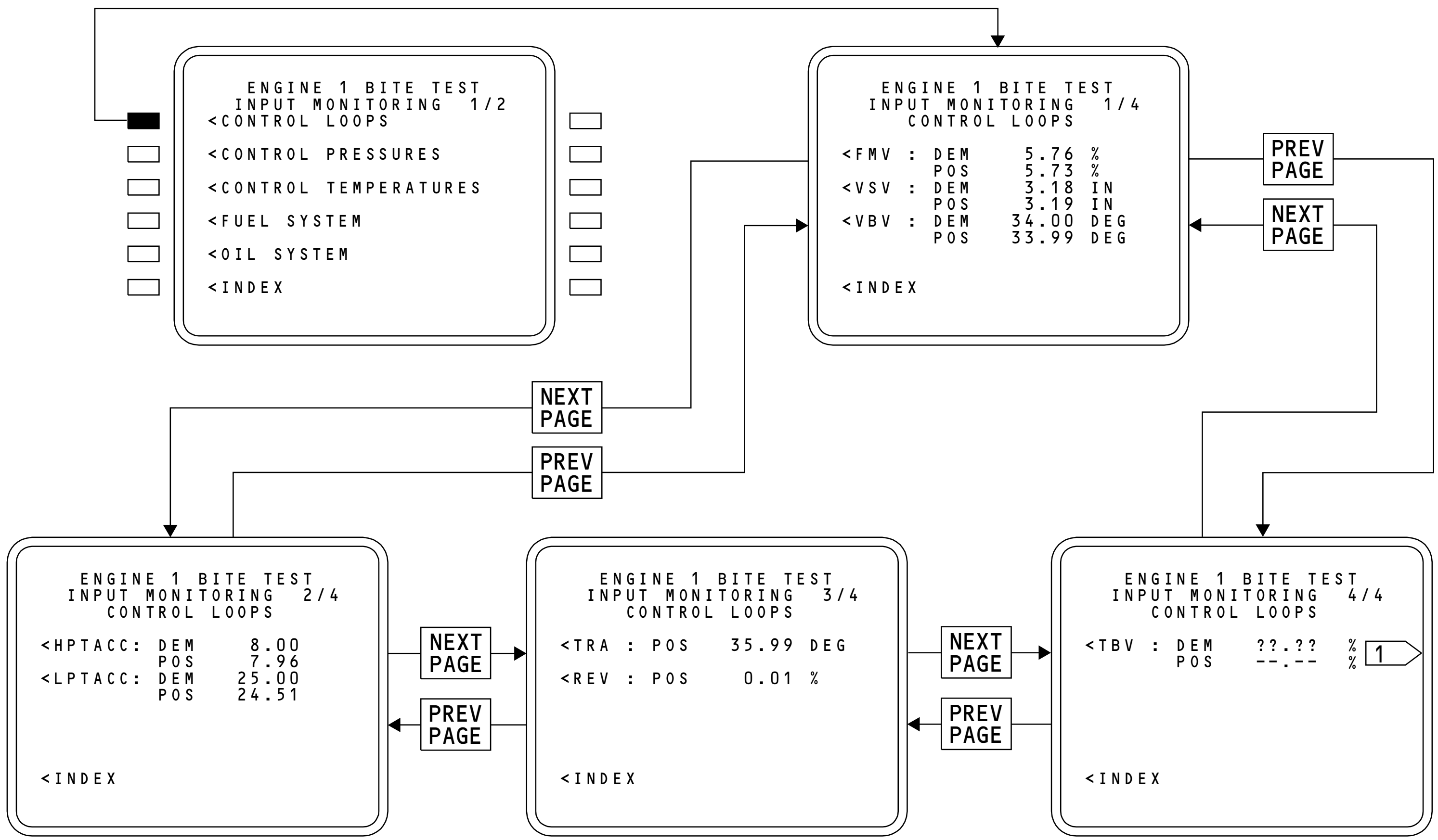
If a parameter is not available, (?) symbols show for the parameter. If the parameter is out of range, (-) symbols shows for the parameter.



1 IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87955 S0004632193_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 2



1 IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87953 S0004632194_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 2

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 3

General

Additional fuel metering valve (FMV) and variable stator vane (VSV) parameters show on these CDU pages. You see these pages when you select FMV or VSV from the INPUT MONITORING CONTROL LOOPS page.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

FMV

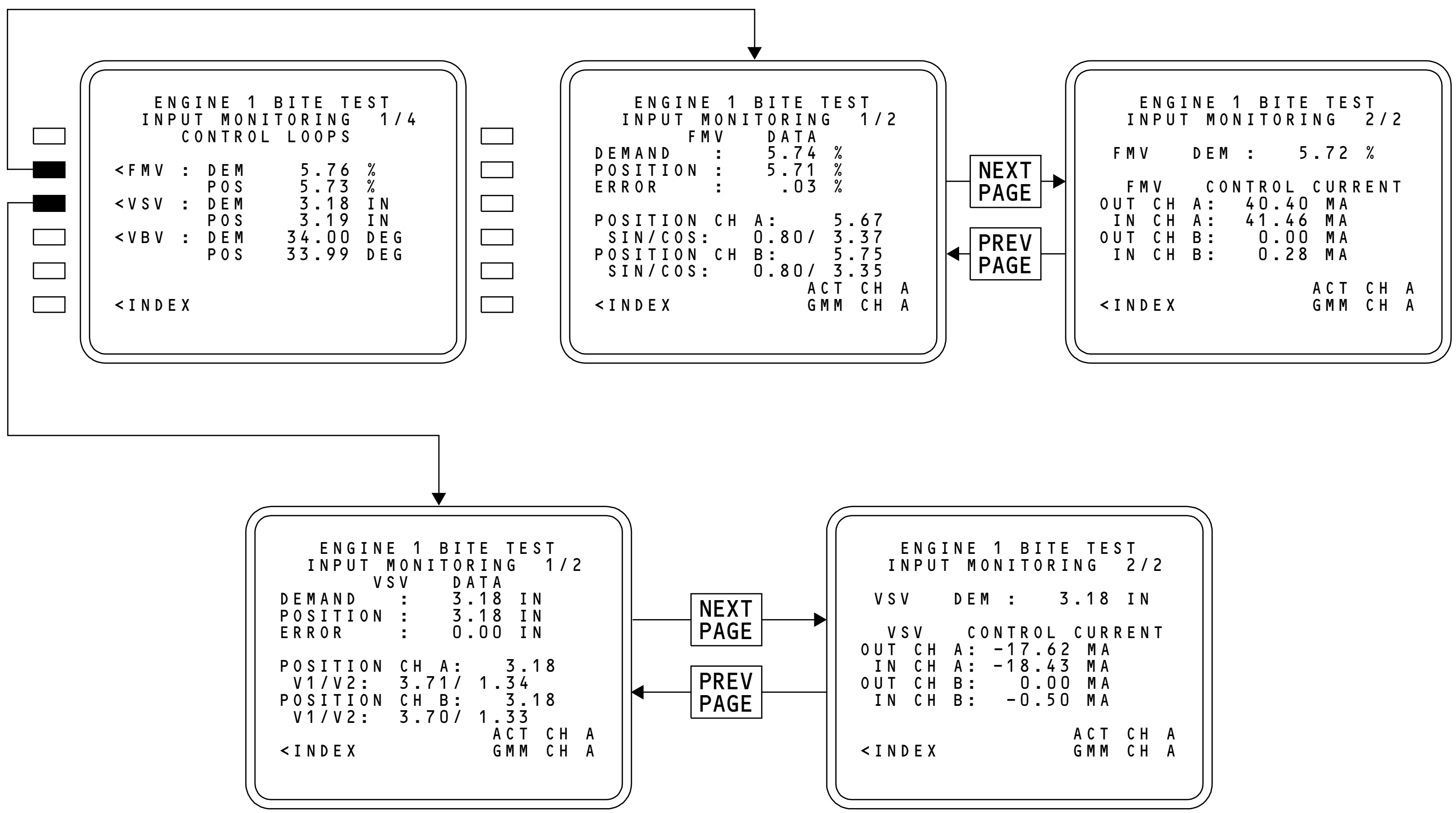
The FMV pages show you the fuel metering valve demand and position values for channel A and B. The SIN and COS values are voltages from the resolver feedbacks. The OUT and IN values for channels A and B are the torque motor demand and return path current values.

VSV

The VSV pages give you the variable stator vane demand and position the EEC senses for channel A and B. The V1 and V2 values are voltages from the linear variable differential transformer (LVDT) feedbacks. The OUT and IN values for channels A and B are the torque motor demand and return path current values.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87956 S0004632197_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 3

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 4

General

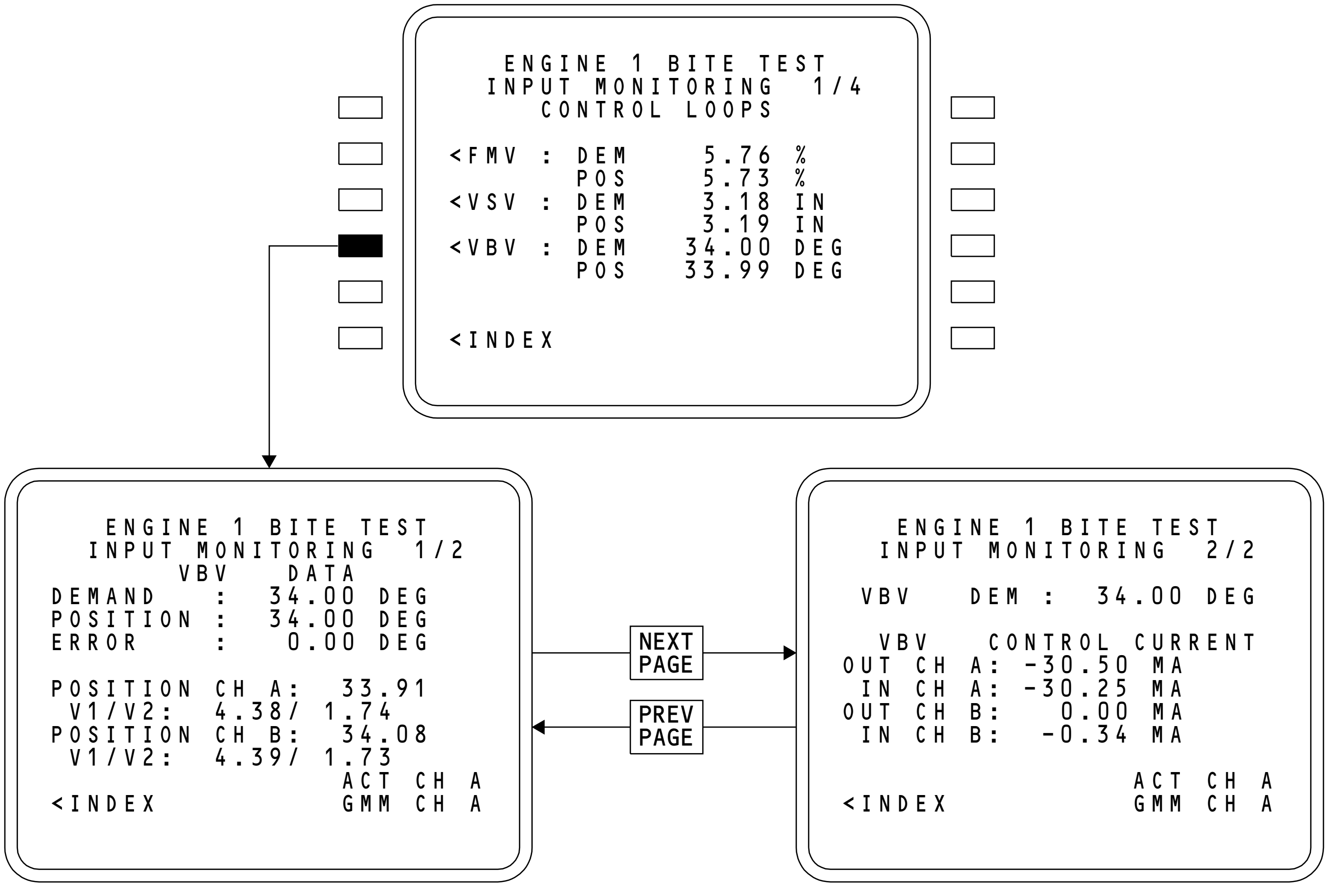
More variable bleed valve (VBV) parameters show on these CDU pages. The VBV DATA pages give you the VBV demand and position values for channel A and B. You see these pages when you select VBV from the INPUT MONITORING CONTROL LOOPS page.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

The V1 and V2 values are voltages read from the LVDT feedback. The OUT and IN values for channels A and B are the torque motor demand and return path current values.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87957 S0004632199_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 4

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 5

General

More high pressure turbine active clearance control (HPTACC) and low pressure turbine active clearance control (LPTACC) parameters show on these CDU pages. You see these pages when you select HPTACC or LPTACC from the INPUT MONITORING CONTROL LOOPS page.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

HPTACC DATA

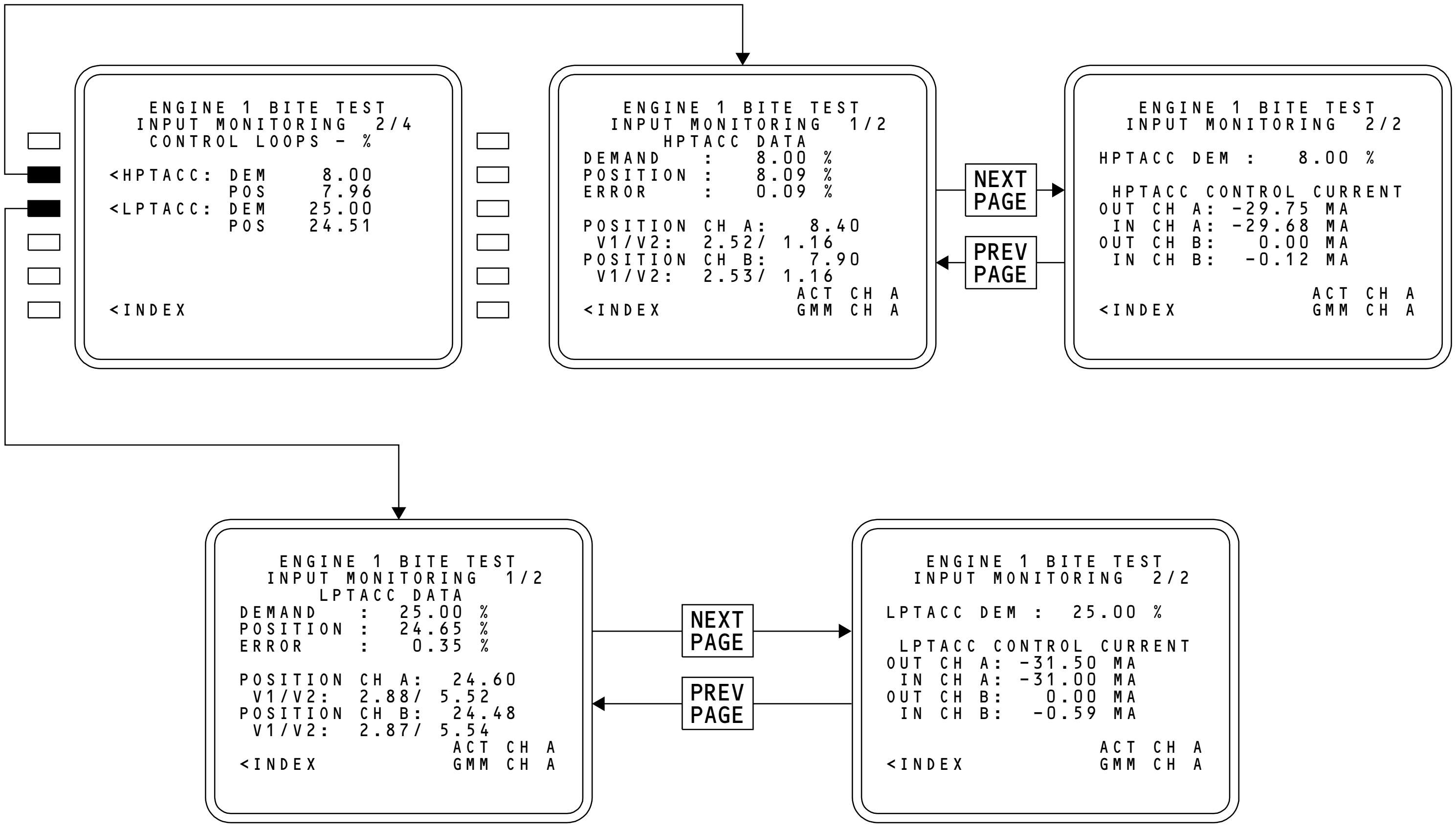
The HPTACC DATA pages give you the high pressure turbine active clearance control demand and position values for channel A and B. The V1 and V2 values are voltages from the linear variable differential transformer (LVDT) feedbacks. The OUT and IN values for channels A and B are the torque motor demand and return path current values.

LPTACC DATA

The LPTACC DATA pages give you the low pressure turbine active clearance control demand and position values for channel A and B.The V1 and V2 values are voltages from the linear variable differential transformer (LVDT) feedbacks. The OUT and IN values for channels A and B are the torque motor demand and return path current values.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87959 S0004632201_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 5

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 6

General

AKS ALL PRE SB CFM56-7B 73-44

More transient bleed valve (TBV) and burner staging valve (BSV) parameters show on these CDU pages. You see these pages when you select TBV or BSV from the INPUT MONITORING CONTROL LOOPS page.

AKS ALL POST SB CFM56-7B 73-44

More transient bleed valve (TBV) parameters show on these CDU pages. You see these pages when you select TBV from the INPUT MONITORING CONTROL LOOPS page.

AKS ALL

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

TBV DATA

The TBV DATA pages give you the transient bleed valve demand and position values for channel A and B. The V1 and V2 values are voltages from the linear variable differential transformer (LVDT) feedbacks. The OUT and IN values for channels A and B are the torque motor demand and return path current values.

AKS ALL PRE SB CFM56-7B 73-44

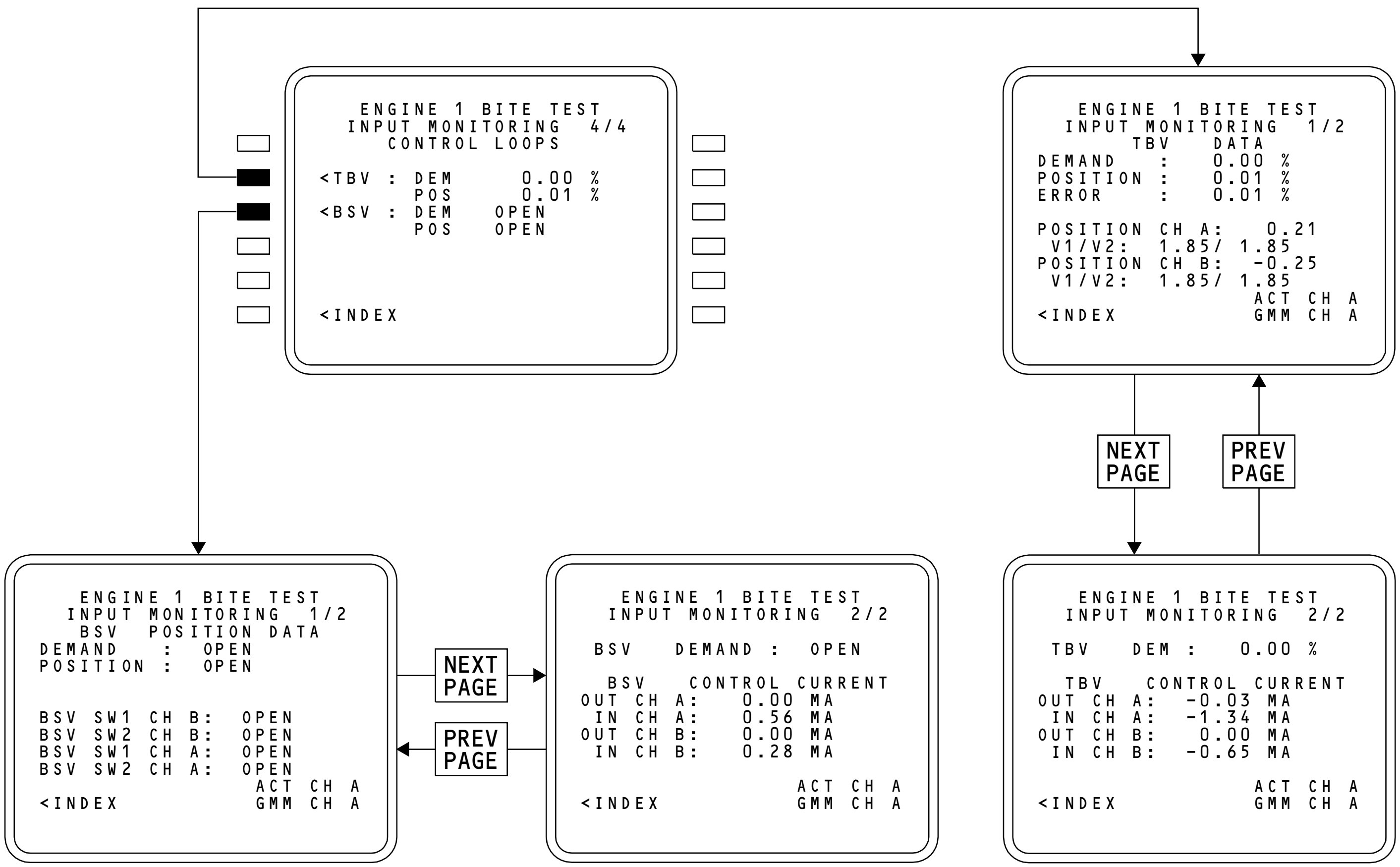
BSV POSITION DATA

The BSV POSITION DATA pages give you the burner staging valve demand and position values for channel A and B. The SW1 and SW2 values are the position switch feedback signals. The OUT and IN values for channels A and B are the solenoid demand and return path current values.

AKS ALL

Training Information Point

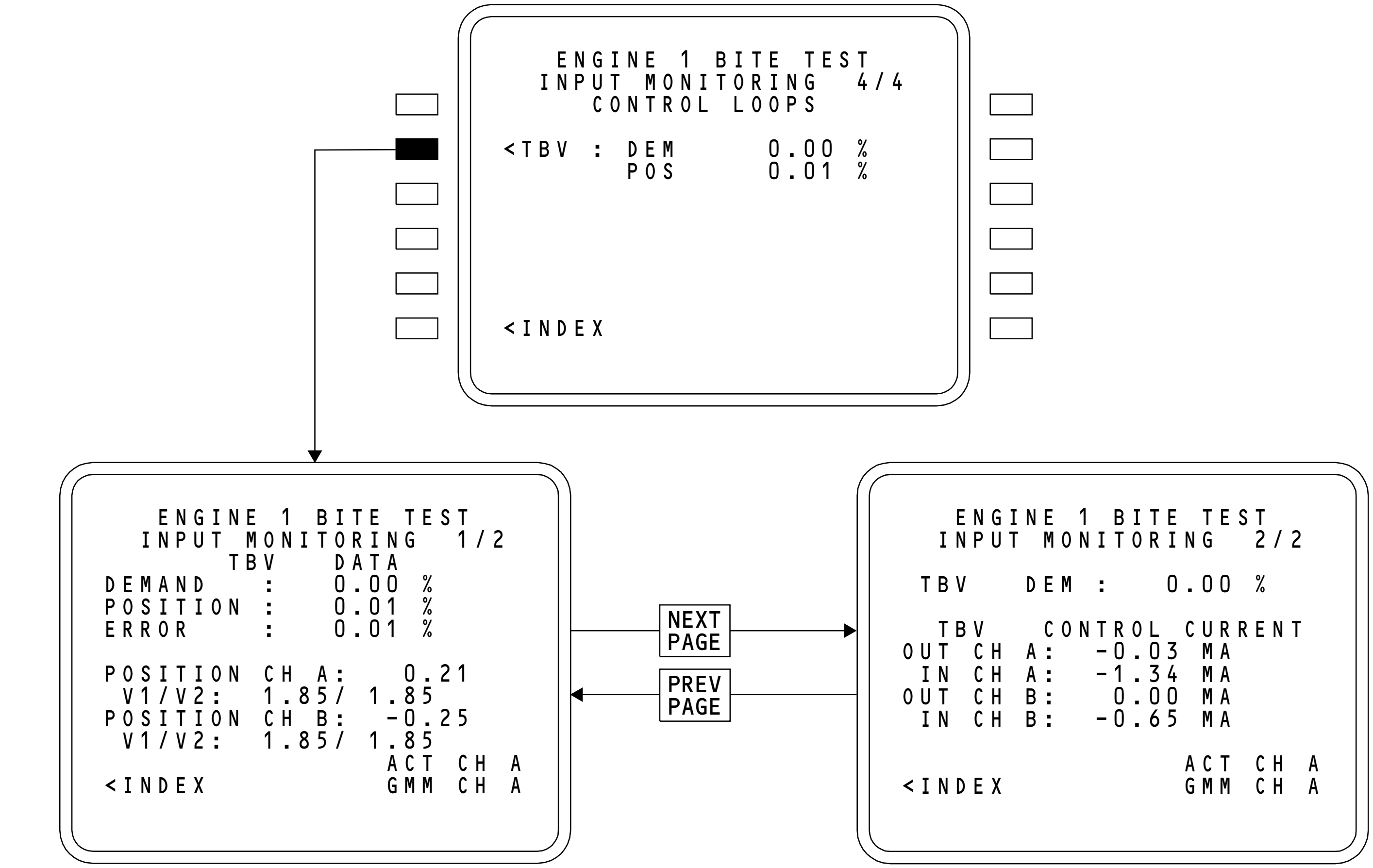
If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87962 S0004632203_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 6



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87963 S0004632204_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 6

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ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 8

General

More thrust resolver angle (TRA) and thrust reverser position (REV) parameters show on these CDU pages. You see these pages when you select TRA or REV from the INPUT MONITORING CONTROL LOOPS page.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

TRA SELECTION

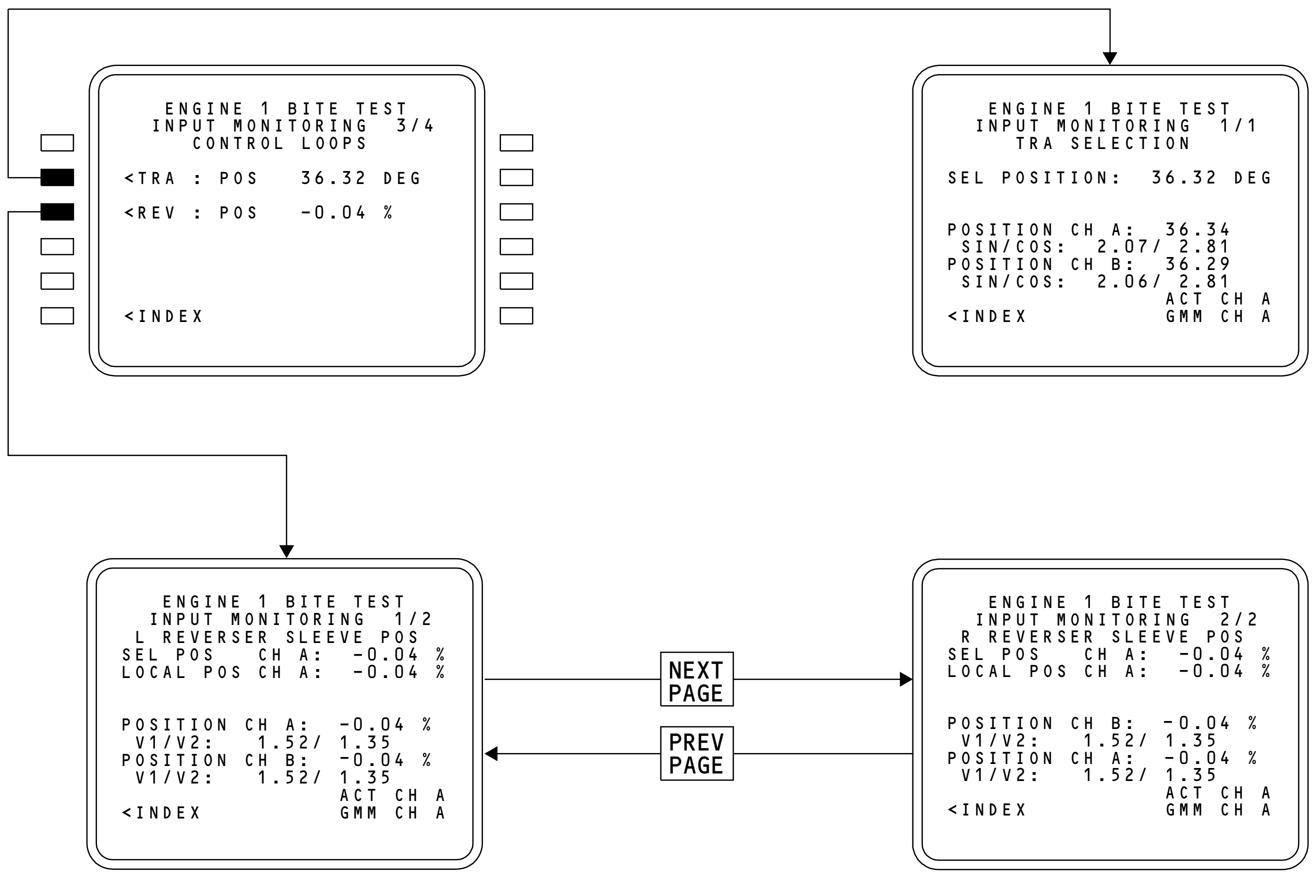
The TRA SELECTION page gives you the thrust resolver angle values for channel A and B. The SIN and COS values are voltages from the resolver feedback signals.

REVERSER SLEEVE POS

The REVERSER SLEEVE POS pages give you the left and right thrust reverser sleeve position values for channel A and B. Line 4 gives the position selection that the active channel uses to control (SEL POS CH A) the thrust reverser. Line 5 gives the position the active channel (LOCAL POS CH A) reads from its LVDT position sensor. The V1 and V2 values are voltages from the linear variable differential transformer (LVDT) feedback signals.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87965 S0004632209_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 8

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 9

General

The CONTROL PRESSURES page shows these control pressures:

- PO (free stream static pressure)
- PS3 (high pressure compressor discharge pressure)
- PT (free stream total pressure).

The CONTROL PRESSURES page gives you the pressures the EEC uses to control the engine. All pressures are shown in psia.

P0 SELECTION

The P0 SELECTION page shows P0 values for channels A and B, and P0 for air data computer (ADC) 1 and 2. SEL P0 is the pressure the EEC uses to control the engine.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

PS3 SELECTION

The PS3 SELECTION page shows PS3 values for channels A and B. SEL PS3 is the pressure the EEC uses to control the engine.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

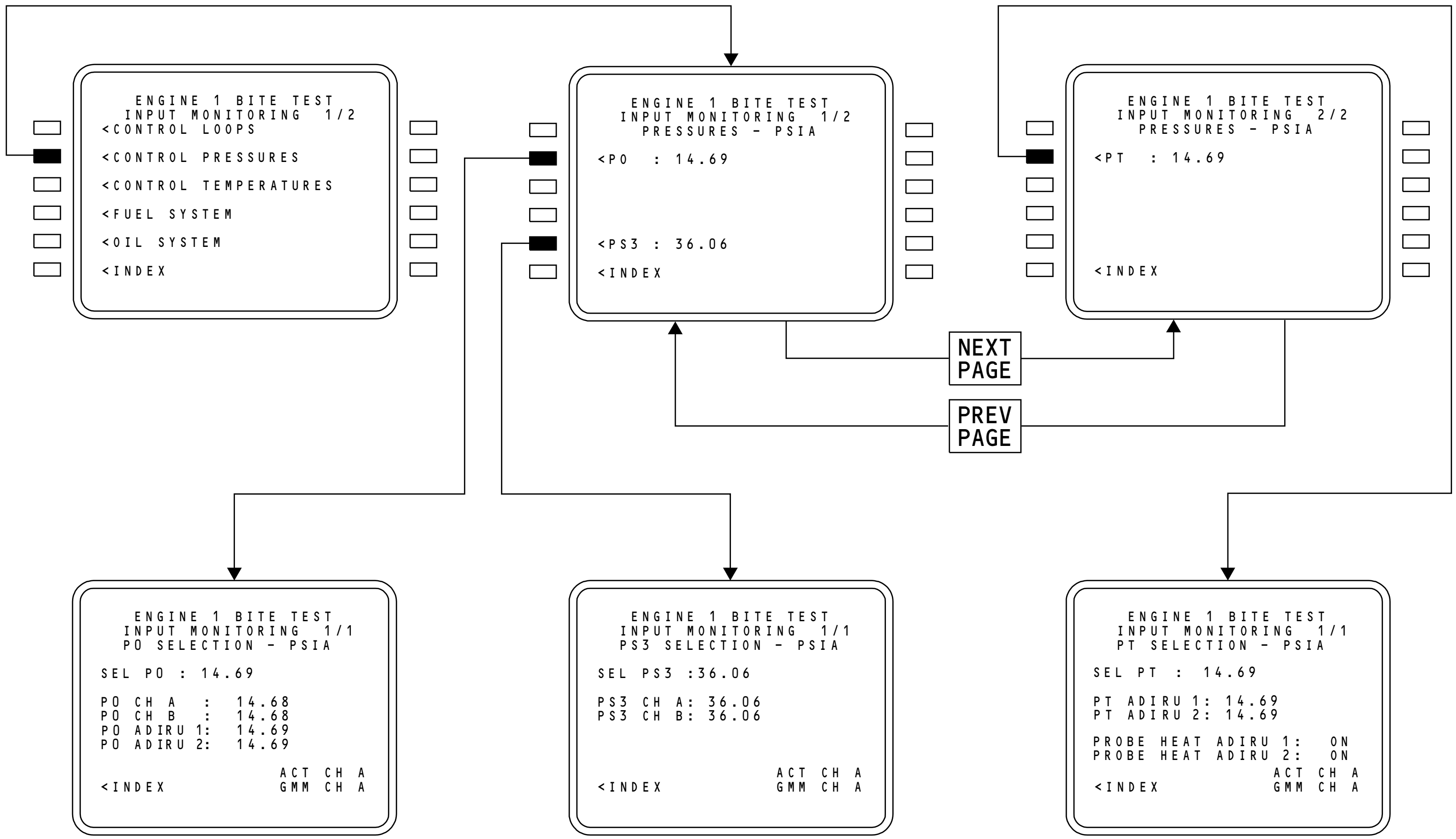
PT SELECTION

The PT SELECTION page shows PT values from air data computer (ADC) 1 and 2. SEL PT is the pressure the EEC uses to control the engine.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

Training Information Point

If a parameter is not available, (?) symbols show for the parameter. If a parameter is out of range, (-) symbols show for the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -

M87966 S0004632211_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PAGE 9

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 10

General

The CONTROL TEMPERATURES page lets you monitor these control temperatures:

- TAT (Total air temperature)
- T25 (high pressure compressor inlet temperature)
- T3 (high pressure compressor discharge temperature)
- TCC (high pressure turbine case temperature)
- T495 (low pressure turbine second stage nozzle temperature).

The CONTROL TEMPS page shows the temperatures the EEC uses to control the engine. All temperatures are shown in degrees celsius.

TAT SELECTION

The TAT SELECTION page shows T12 values for channels A and B, and TAT values for air data computer (ADC) 1 and 2. SEL TAT is the temperature the EEC uses to control the engine. T12 is the total air inlet temperature detected by the T12 engine sensors.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

T25 SELECTION

The T25 SELECTION page shows T25 values for channels A and B. SEL T25 is the temperature the EEC uses to control the engine.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

T3 SELECTION

The T3 SELECTION page shows T3 values for channels A and B. SEL T3 is the temperature the EEC uses to control the engine.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

TCC SELECTION

The TCC SELECTION page shows TCC values for channels A and B. SEL TCC is the temperature the EEC uses to control the engine.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

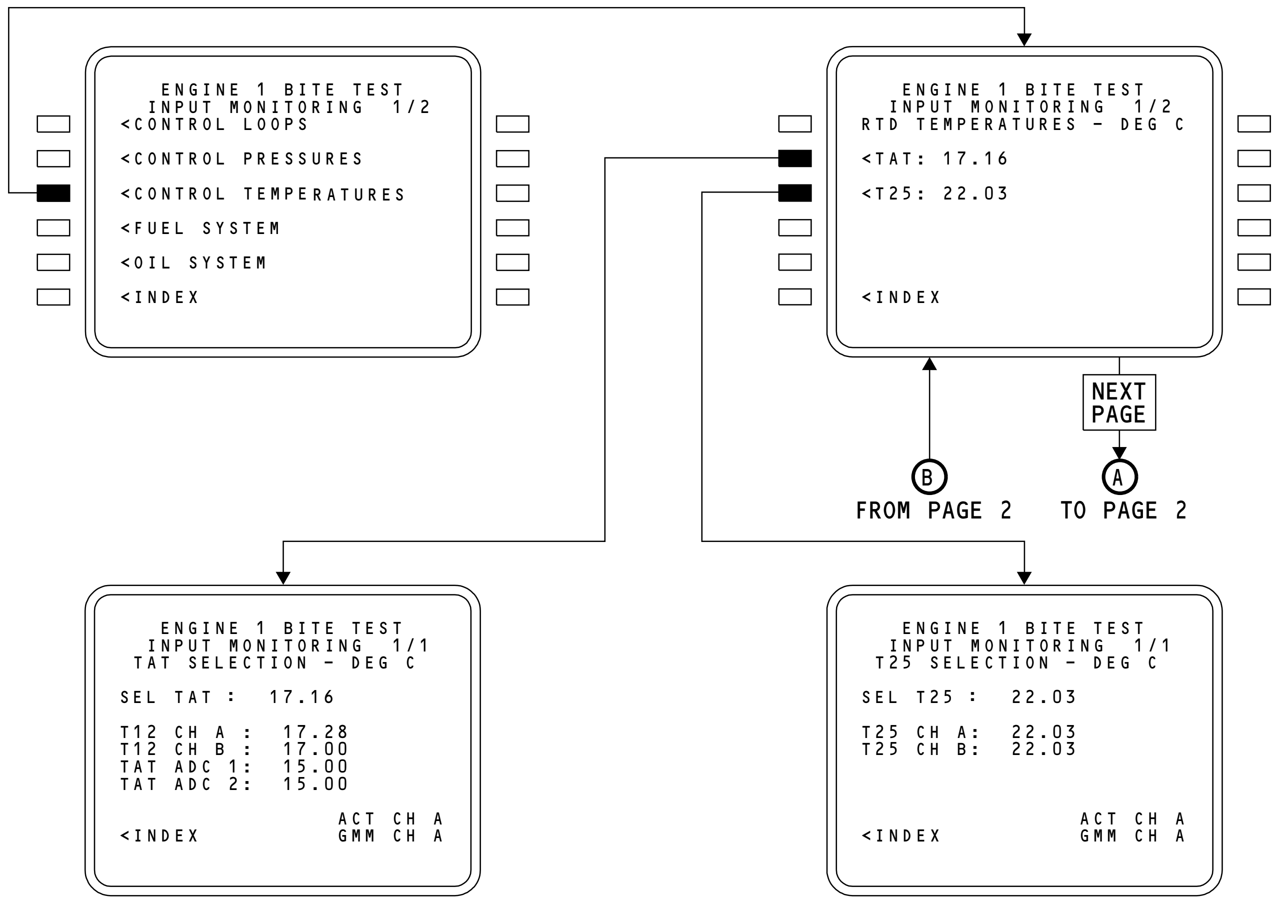
T495 SELECTION

The T495 SELECTION shows T495 values for channels A and B. SEL T495 is the temperature the EEC uses to control the engine.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

Training Information Point

If a parameter is not available, (?) symbols show for the parameter. If the parameter is out of range, (-) symbols show for the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -

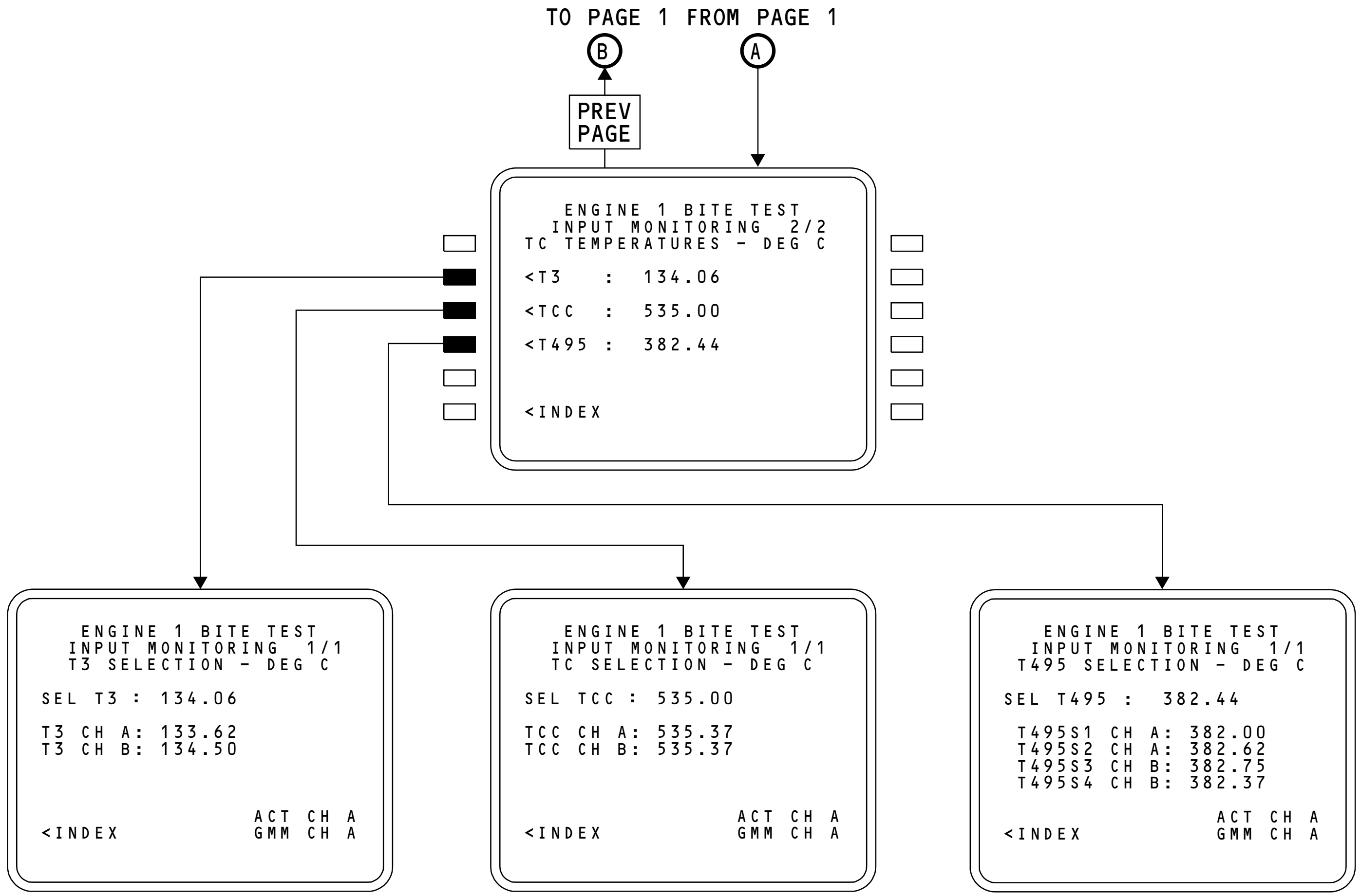
M87968 S0004632214_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 10

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 11

General

These are additional CDU screens for CONTROL TEMPS.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -

M87969 S0004632216_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 11

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 11

General

The FUEL SYSTEM input monitoring page lets you monitor these fuel system parameters:

- FUEL FLOW in pounds per hour
- FMV POS (flow metering valve position)
- FILTER BYPASSED.

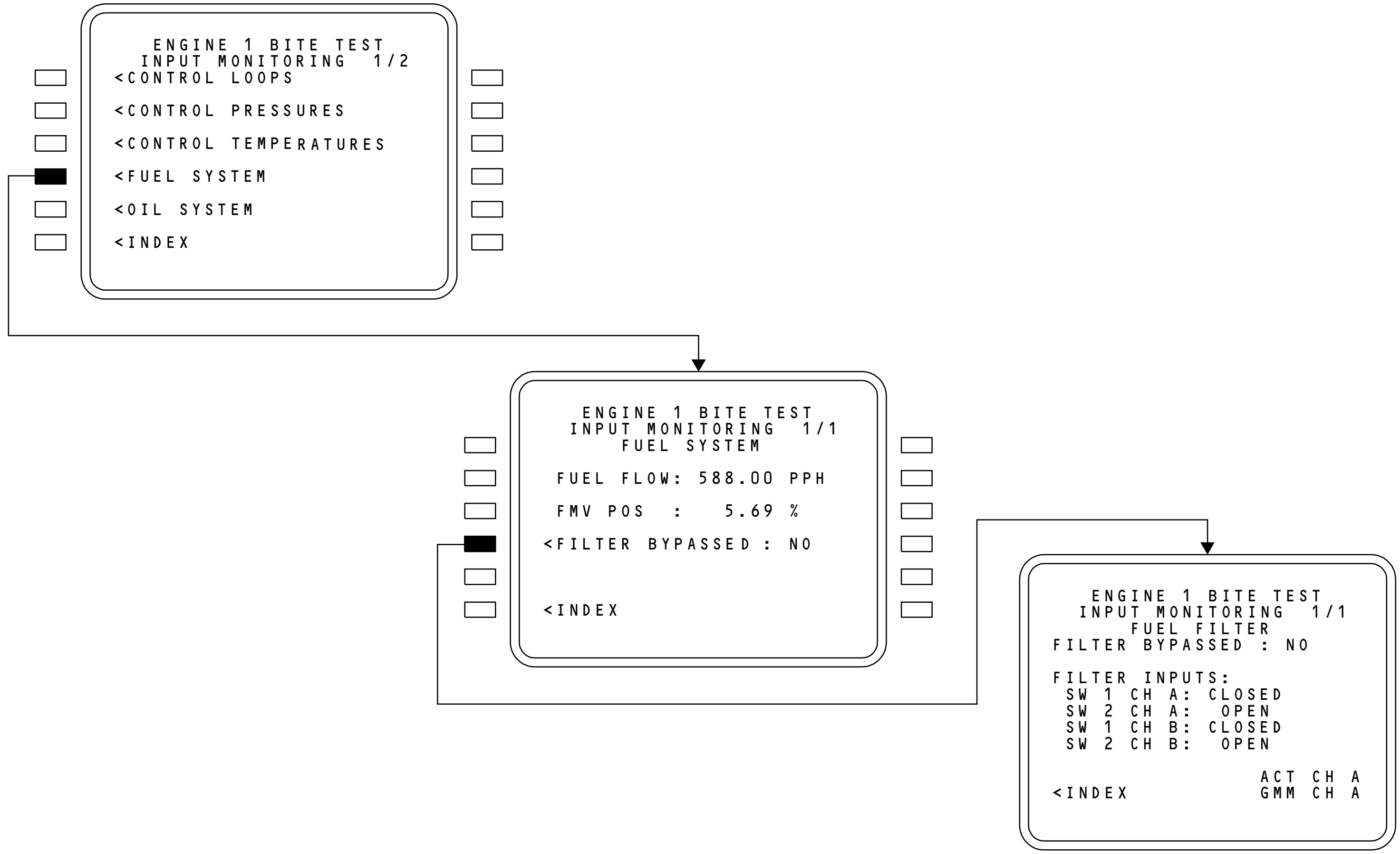
FUEL FILTER

The FUEL FILTER page gives you the fuel filter bypass switch positions for EEC channels A and B. FILTER BYPASSED shows the fuel filter bypass position the EEC sends to the DEUs.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RAMGE, THE CDU SHOWS - -.

M87972 S0004632219_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 11

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 13

General

The OIL SYSTEM input monitoring page lets you monitor these oil system parameters:

- PEO (oil pressure)
- TEO (engine oil temperature)
- FILTER BYPASSED.

The OIL SYSTEM page shows you the oil system values the EEC sends to the DEUs.

OIL PRESSURE SELECTION

The OIL PRESSURE SELECTION page shows oil pressure values for both EEC channels. SEL PEO is the oil pressure the EEC sends to the DEU for engine indication. INPUT CH A and B shows the oil pressure values for channels A and B. The V1 and V2 values are voltages from the linear variable differential transformer (LVDT) feedback signals.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

OIL TEMPERATURE

The OIL TEMPERATURE page shows engine oil temperature values for both EEC channels. SEL TEO shows the oil temperature the EEC sends to the DEU for engine indication. TEO CH A and B shows the oil temperature values for EEC channels A and B.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

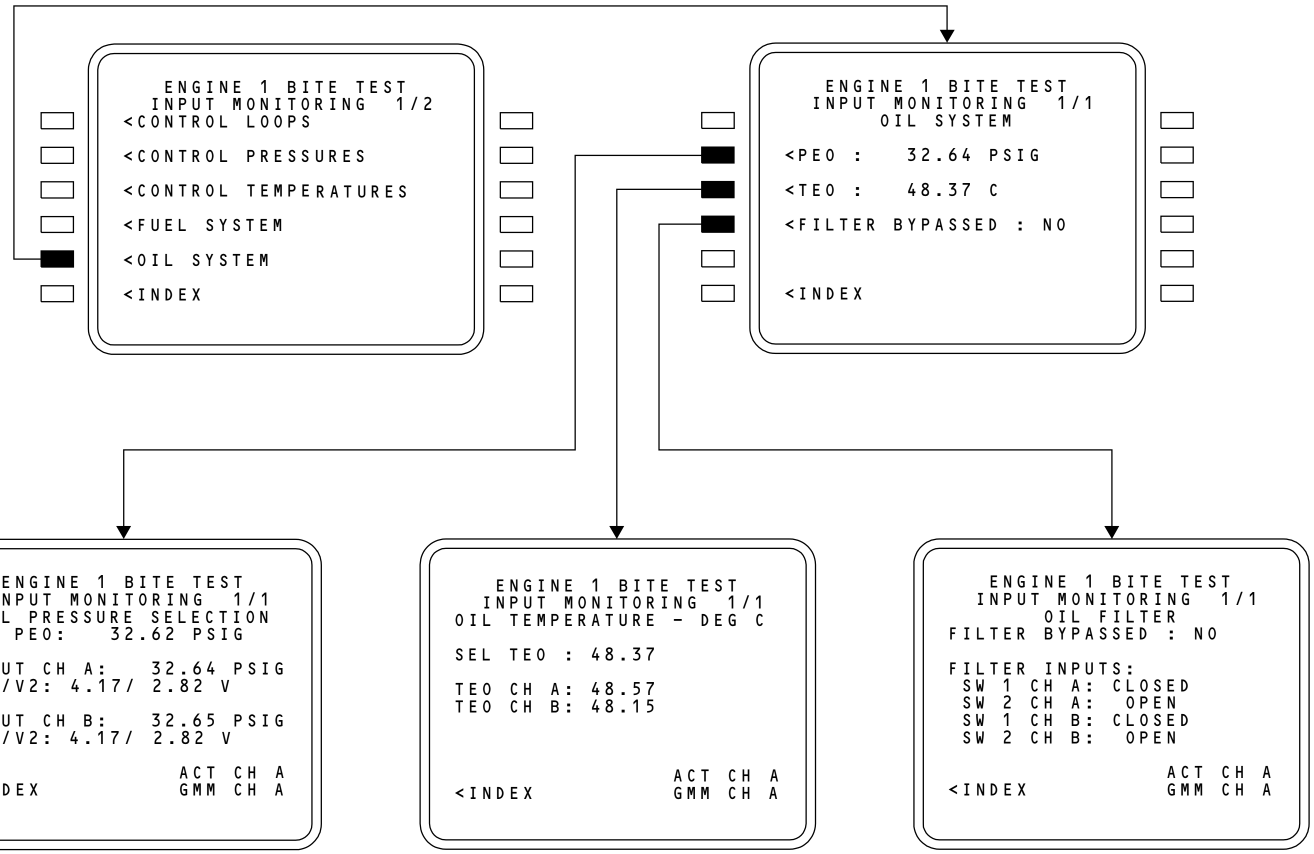
OIL FILTER

The OIL FILTER page shows the oil filter bypass switch position values for channels A and B. FILTER BYPASSED is the oil filter bypass status the EEC sends to the DEUs for engine indication.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87974 S0004632222_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 13

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 14

General

The SPEEDS input monitoring page lets you monitor the N1 and N2 engine speeds. Engine speed is in RPM.

The SPEEDS page shows the N1 and N2 speeds the EEC uses for engine indication and control.

N1 SELECTION

The N1 SELECTION page shows N1 speed values for both EEC channels. SEL N1 is the N1 speed the EEC uses for engine indication and control.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

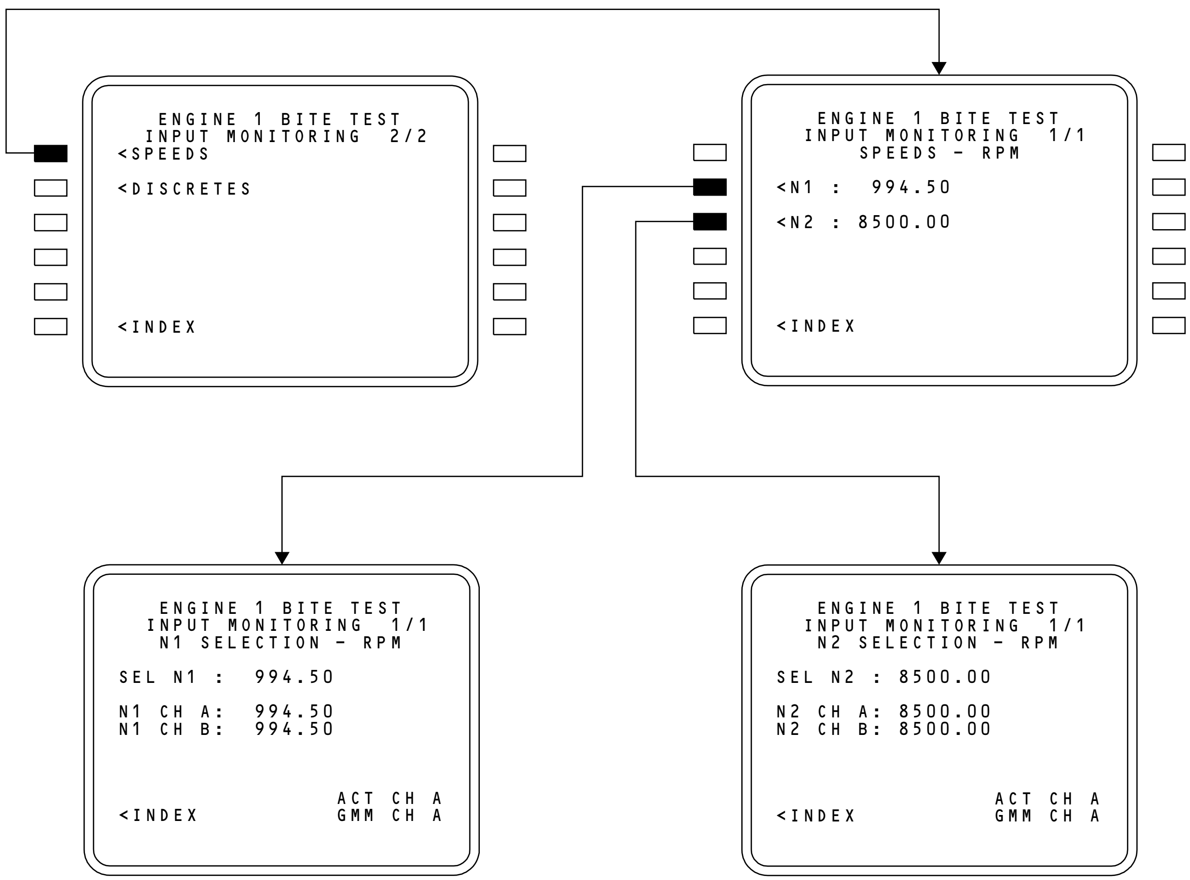
N2 SELECTION

The N2 SELECTION page shows N2 speed values for both EEC channels. SEL N2 is the N2 speed the EEC uses for engine indication and control.

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87975 S0004632224_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 14

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 15

General

The DISCRETES input monitor pages let you monitor selected values of engine integers and discretes.

DISCRETES Page 1

The DISCRETES page 1 lets you see these engine integers and discretes:

- REGULATOR
- N2 AT/ABOVE IDLE (YES/NO)
- ENGINE START LEVER POSITION (IDLE or RUN/CUTOFF)
- ENGINE START LEVER SELECTION (IDLE or RUN/CUTOFF)
- OK TO LOAD GCU (YES/NO)
- N1 TARGET (DEU1) (N1 target speed calculated by the FMC and transmitted by the DEUs)
- ALTERNATE MODE SWITCH POSITION (OFF/ON)
- ALTERNATE MODE SELECTED (NONE/SOFT/HARD).

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

DISCRETES Page 2

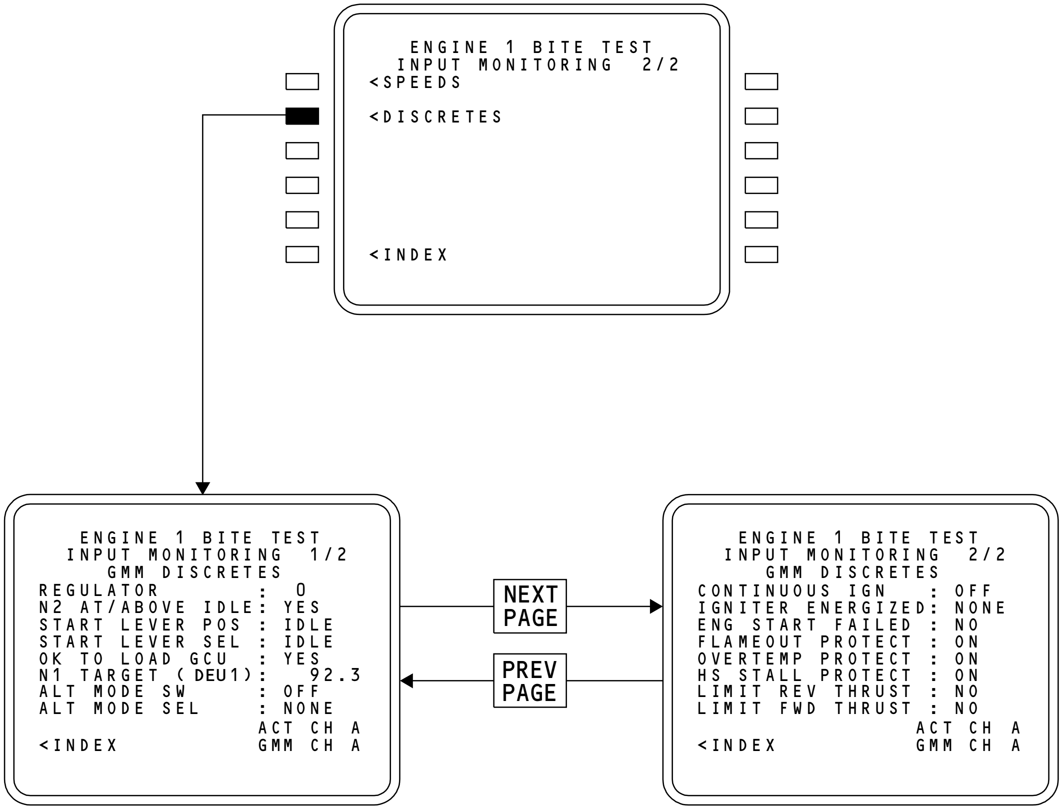
The DISCRETES page 2 lets you see these engine integers and discretes:

- CONTINUOUS IGNITION (OFF/ON)
- IGNITER ENERGIZED (NONE/LT/RT/BOTH)
- ENGINE START FAILED (NO/YES)
- FLAMEOUT PROTECTION (OFF/ON)
- OVERTEMP PROTECTION (OFF/ON)
- HIGH STAGE STALL PROTECTION (OFF/ON)
- LIMIT REVERSER THRUST (YES/NO)
- LIMIT FORWARD THRUST (YES/NO).

The ACT CH A shows the active channel or the channel that controls the engine. The GMM CH A shows the ground maintenance mode (GMM) channel or the channel that controls CDU BITE.

Training Information Point

If a parameter is not available, (?) symbols are put in place of the parameter. If the parameter is out of range, (-) symbols are put in place of the parameter.



NOTE: IF A VALUE IS NOT AVAILABLE, THE CDU SHOWS ? ?
IF A VALUE IS OUT OF RANGE, THE CDU SHOWS - -.

M87976 S0004632226_V1

ENGINE FUEL AND CONTROL - ENGINE CONTROL - TRAINING INFORMATION POINT - EEC BITE - INPUT PG 15

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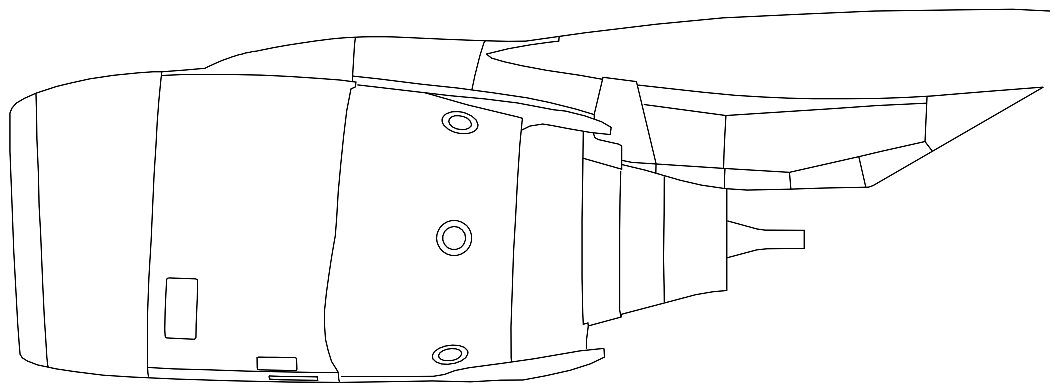
ENGINE FUEL AND CONTROL - FUEL INDICATING - INTRODUCTION

General

The fuel indication system supplies data for these indications:

- Fuel flow rate
- Fuel used
- High pressure fuel shutoff valve (HPSOV) position
- Fuel filter impending bypass warning.



ENGINE FUEL AND CONTROL SYSTEM

FUEL DISTRIBUTION
- FUEL PUMP ASSEMBLY
- IDG OIL COOLER
- BSV

FUEL CONTROL
- AIRPLANE INTERFACES
- SENSORS
- EEC
- HMU

FUEL INDICATING
- FUEL FLOW RATE
- FUEL USED
- HPSOV POSITION
- FILTER BYPASS LIGHT

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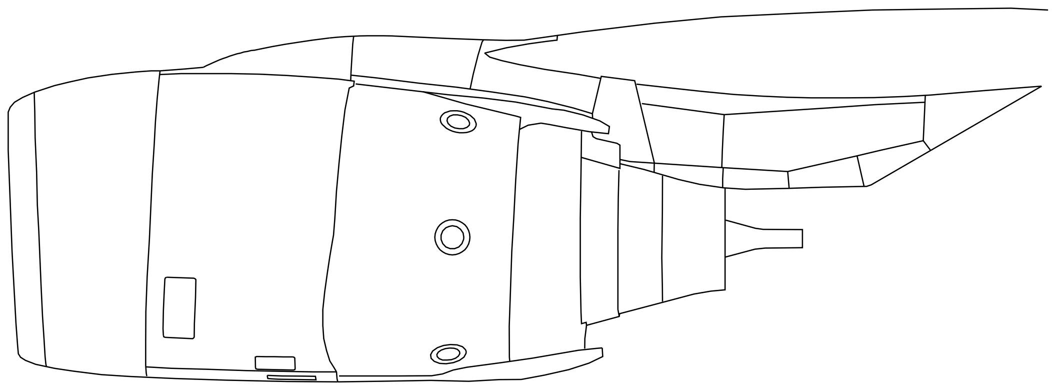
ENGINE FUEL AND CONTROL - FUEL INDICATING - INTRODUCTION



ENGINE FUEL AND CONTROL SYSTEM

FUEL DISTRIBUTION
- FUEL PUMP ASSEMBLY
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ENGINE FUEL AND CONTROL - FUEL INDICATING - INTRODUCTION

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ENGINE FUEL AND CONTROL - FUEL INDICATING - GENERAL DESCRIPTION

Purpose

The fuel indicating system supplies data for these indications:

- Fuel flow rate
- Fuel used
- High pressure shutoff valve (HPSOV) position
- Fuel filter bypass.

Fuel Indicating System Components

These are some of the fuel indicating system components:

- Fuel flow transmitter
- Fuel flow indication control switch
- Fuel filter differential switch
- High pressure shutoff valve (HPSOV).

The flow transmitter supplies fuel flow data through the EEC to the DEUs. The EECs calculate the fuel flow rate and the DEUs calculate fuel used. The fuel flow data shows on the primary and secondary engine displays. The primary engine display usually shows on the upper center display unit (DU) and the secondary engine display usually shows on the lower center DU.

The fuel flow indication control switch is on the engine display control panel in the flight compartment. This switch controls the operation of the fuel flow rate and fuel used indications in the engine display on the display unit. The engine display control panel is on the P2-2 center main panel. The fuel flow indication switch is usually in the center or RATE position. A spring sets the switch back to RATE from the other two positions. These are the three positions of the fuel flow indication control switch:

- RESET
- RATE
- USED.

The RATE position is the usual switch position and shows the fuel flow indication.

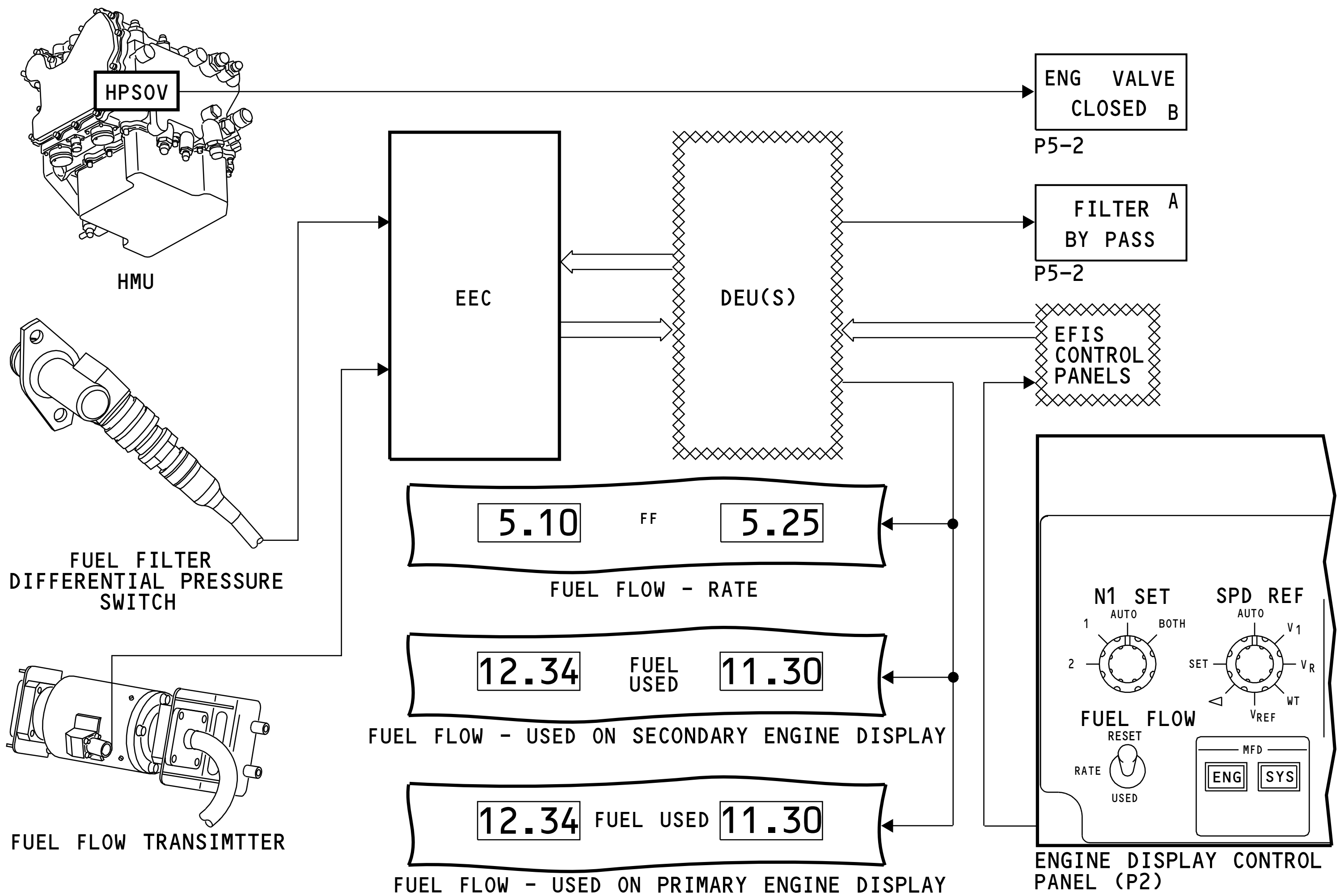
The USED position changes from the usual fuel flow indication to the quantity of fuel used since the counter was set to zero. The fuel used only shows on the digital display. The analog indication does not show in used. The used indication goes back to the digital and analog rate indication 10 seconds after the indication control switch goes back to RATE.

The RESET position sets the fuel used display digital counter to zero.

NOTE: The counter also sets to zero when you remove electrical power from, then again connect power to the DEUs.

The EEC monitors a fuel filter differential pressure switch on the engine. The switch measures the difference between the filter inlet pressure and outlet pressure. If the pressure difference becomes too large, a bypass signal goes through the EEC to the CDS/DEUs. The DEUs cause the amber FILTER BYPASS light to come on.

The blue ENGINE VALVE CLOSED light shows the position of the HPSOV. With the valve closed, the light is on dim. With the valve open, the light is off. The light is on bright when the actual and commanded positions of the valve do not agree.



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ENGINE FUEL AND CONTROL - FUEL INDICATING - GENERAL DESCRIPTION

ENGINE FUEL AND CONTROL - FUEL INDICATING - FUEL FLOW TRANSMITTER

Purpose

The fuel flow transmitter measures the fuel mass-flow that goes to the manifolds and fuel nozzles. This data goes to the EEC. The EEC sends the data to the common display system (CDS).

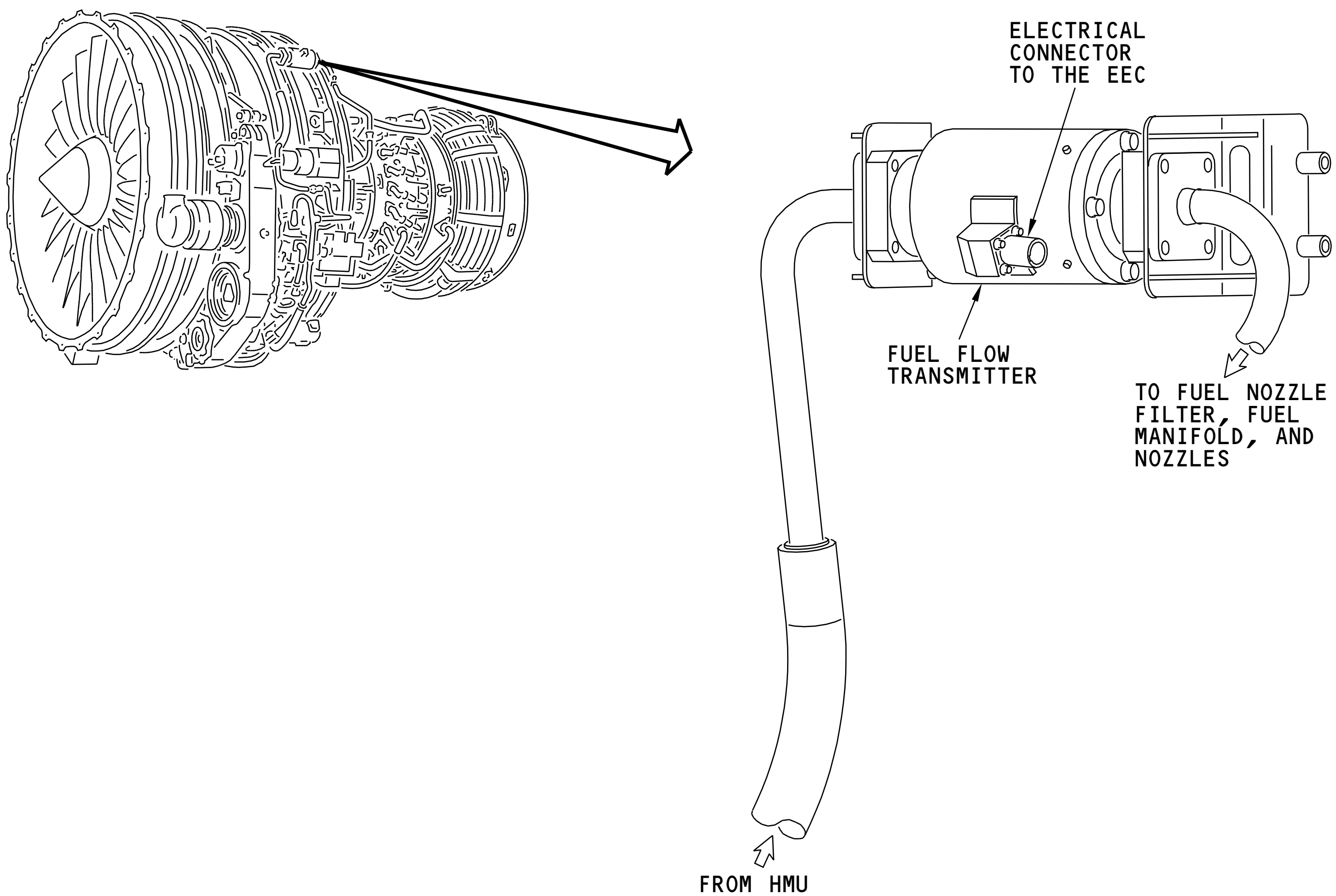
Location

The fuel flow transmitter is on the fan case at the 10:00 position. To get access to the fuel flow transmitter, open the left fan cowl.

Functional Description

Fuel flows from the HMU to the fuel flow transmitter. An aperture in the fuel flow meter moves in proportion to the mass-flow of the fuel. A turbine in the flow meter turns at a constant speed. The flow meter has two windings, one on the aperture and the other fixed in the flow meter housing. A magnet on the turbine passes close to these windings. Each time the magnet passes close to a winding it makes an electrical pulse. One pulse becomes the start pulse and the other is the stop pulse. The time between the pulses gives the position of the aperture and the fuel mass-flow. The EEC measures the time difference between the start and the stop pulses and calculates the fuel mass-flow. When the fuel mass-flow rate is low, the time difference between the pulses is small. This shows on the DU as a low fuel flow. When the fuel mass-flow rate increases, the time difference between the pulses is large. The larger the difference in time between the start and the stop pulses shows as a higher fuel flow rate on the DU. The EEC sends fuel mass-flow data to the DEUs.

NOTE: When the DEUs cannot find fuel flow data, or the fuel flow data is not correct, the fuel used stays at the last calculated value and fuel flow blanks.



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ENGINE FUEL AND CONTROL - FUEL INDICATING - FUEL FLOW TRANSMITTER

ENGINE FUEL AND CONTROL - FUEL INDICATING - FUEL FILTER DIFFERENTIAL PRESSURE SWITCH

General

The fuel filter differential pressure switch shows when a fuel filter begins to clog (almost bypassed). The fuel filter differential pressure switch sends a signal to the EEC. The EEC sends the signal to the DEUs. The DEUs cause the amber FILTER BYPASS light to come on.

Location

The fuel filter differential pressure switch is at the 8:00 position on the fan case. To get access to the fuel differential pressure switch, open the left fan cowl.

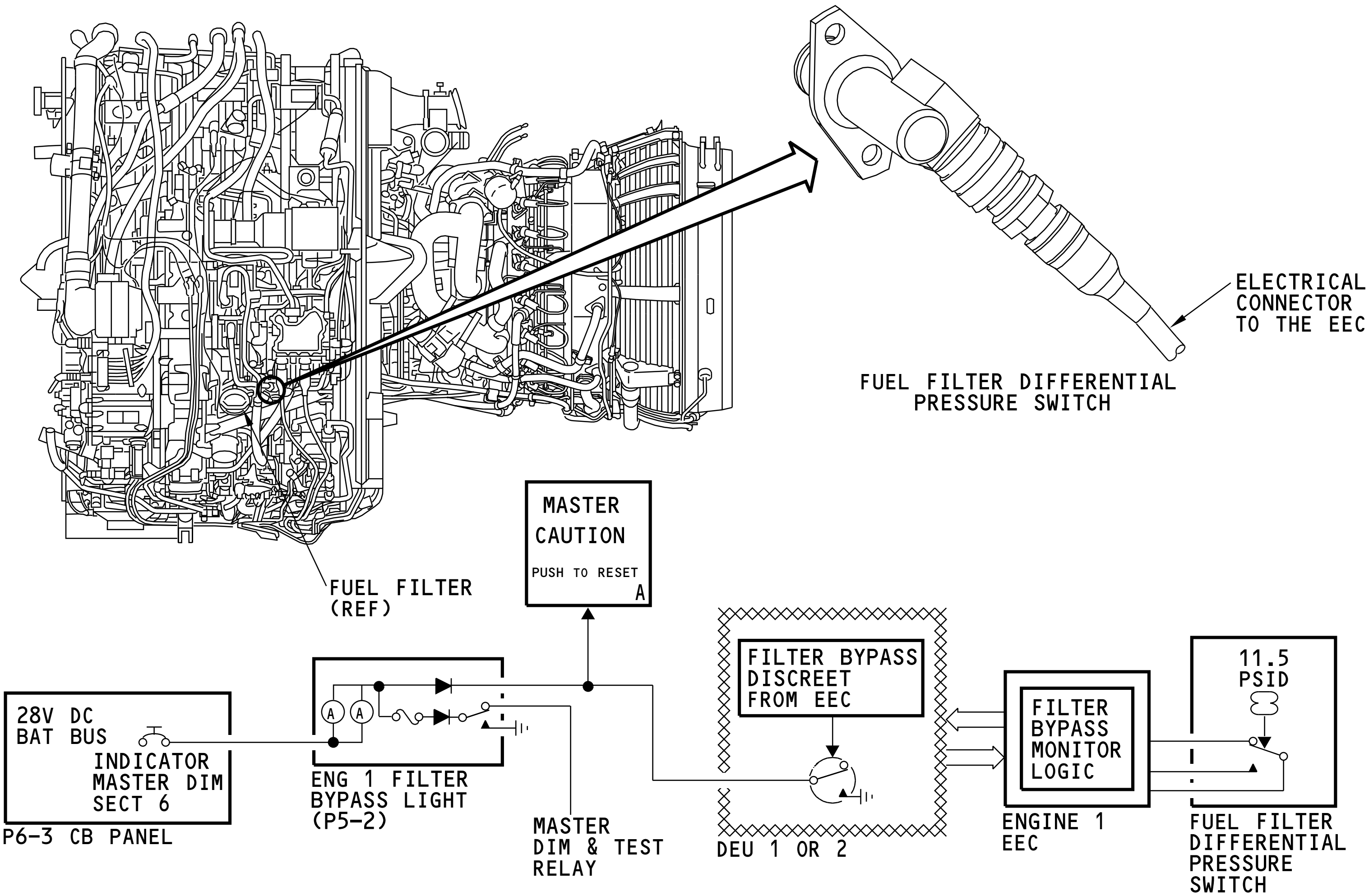
Functional Description

The differential pressure switch assembly has one switch to supply data to the EEC, channels A and B. The switch closes if the filter clog causes a difference between filter inlet pressure and outlet pressure of more than 11.5 psid. The EEC sends a signal to the DEUs. The DEUs make a ground to cause the amber FILTER BYPASS light and the MASTER CAUTION lights to come on. If the differential pressure continues to increase, the fuel filter bypass valve will open.

Training Information Point

If the fuel filter differential pressure switch signals disagree, the EEC sends a signal to DEU only if the airplane is on the ground for more than 90 seconds. If the FILTER BYPASS light comes on after the airplane lands, go to the engine maintenance pages in the control display unit (CDU). Look for the FUEL FILTER SIGNALS DISAGREE message. If you do not see the message, follow procedures in part II of the maintenance manual to change the fuel filter. If you see the message, use the FIM for the filter clogged indication system troubleshooting.

See the engine indicating section for more information on the engine maintenance pages in the CDU. (SECTION 77-00)



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ENGINE FUEL AND CONTROL - FUEL INDICATING - FUEL FILTER DIFFERENTIAL PRESSURE SWITCH

ENGINE FUEL AND CONTROL - FUEL INDICATING - FUNCTIONAL DESCRIPTION

Fuel Flow Indication

The fuel flow transmitter supplies a start and a stop pulse to the EEC. The EEC measures the difference between the start and the stop pulse. The greater the time difference between start and stop, the greater the mass-flow of metered fuel supply for combustion. The EEC transmits the fuel flow data to the DEUs on an ARINC 429 data bus.

The fuel flow indications shows on the primary and secondary engine displays. The DEUs calculate the fuel used indication. The fuel flow indication shows in kilograms per hour (kg/hr).

NOTE: Two resolvers measure the position of the fuel metering valve (FMV). The EEC uses the channel A and channel B resolver inputs to control fuel flow. If the EEC cannot read resolver inputs from both channels A and B, it can use inputs from the fuel flow transmitter. When the EEC uses fuel flow meter data for metered and servo fuel control, the engine acceleration time can increase. The ENGINE CONTROL and MASTER CAUTION lights come on when the EEC can not read either FMV resolver.

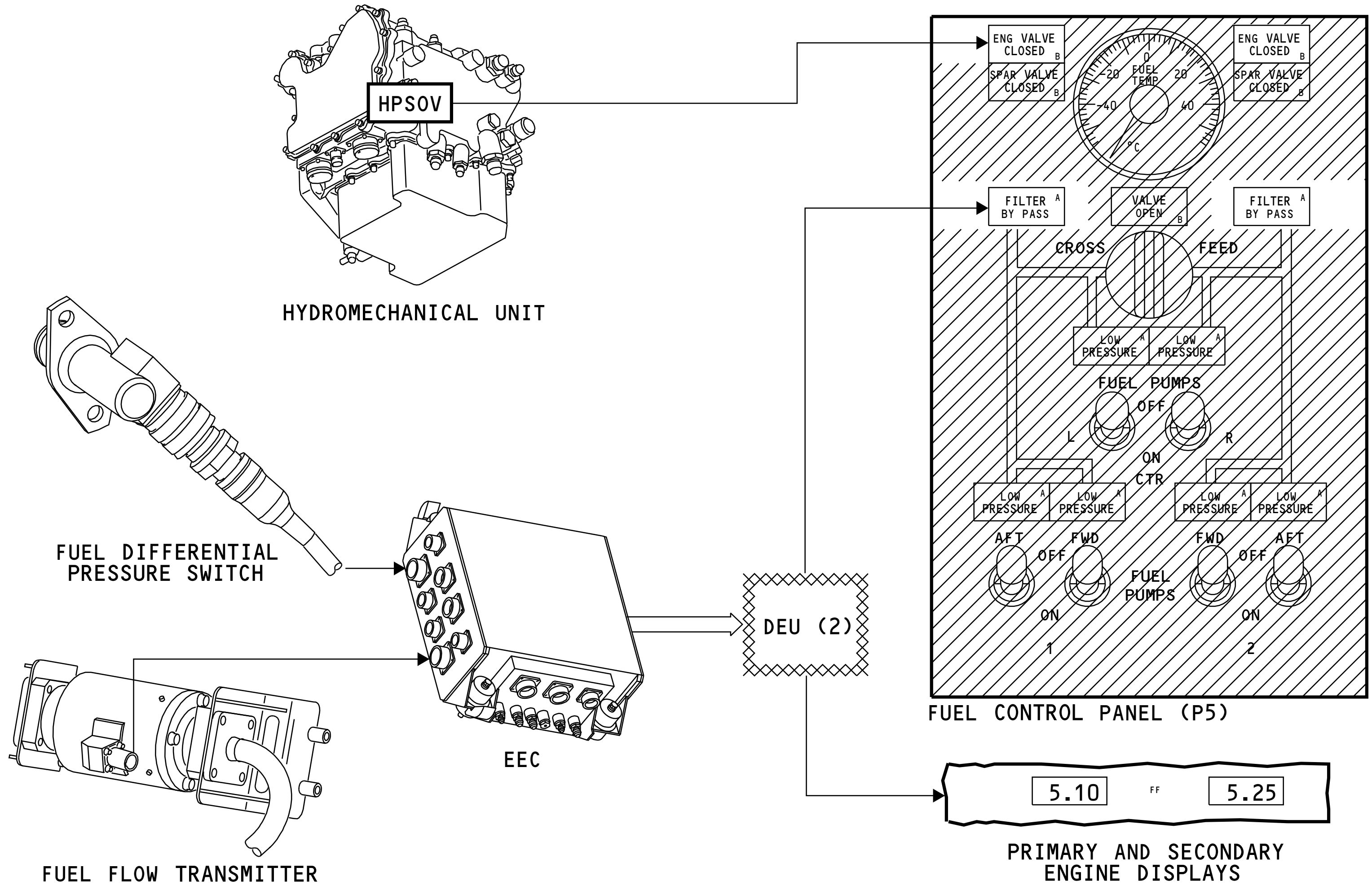
High Pressure Shutoff Valve (HPSOV)

The high pressure shutoff valve (HPSOV), in the hydromechanical unit (HMU), opens and closes to let metered fuel flow. The position of the HPSOV shows on the ENGINE VALVE CLOSED light. The light is on dim, with the valve closed. The light is off, with the valve open.

Fuel Filter Bypass Warning Indication

The EEC receives the analog signal from the fuel filter differential pressure switch. The EEC changes the analog signal to digital data. The EEC sends the signal to the DEUs using the ARINC 429 data bus.

The DEUs supply a ground to cause the FILTER BYPASS light and MASTER CAUTION lights to come on. The FILTER BYPASS light is on the fuel control panel on the P5 forward overhead panel.



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ENGINE FUEL AND CONTROL - FUEL INDICATING - FUNCTIONAL DESCRIPTION