CHAPTER

73

Engine Fuel and Controls GE 115

(GE90-100 SERIES ENGINES)

CHAPTER 73
ENGINE FUEL AND CONTROLS GE 115

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

73-EFFECTIVE PAGES

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ENGINE FUEL AND CONTROLS GE 115

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73-EFFECTIVE PAGES

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ENGINE FUEL AND CONTROLS GE 115

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ENGINE FUEL AND CONTROLS GE 115

73-CONTENTS

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ENGINE FUEL AND CONTROL - INTRODUCTION

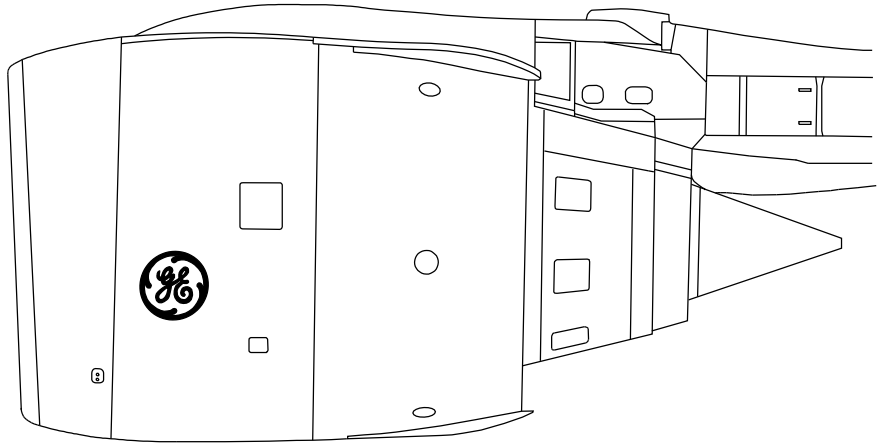
General

The engine fuel and control system supplies airplane fuel to the engine at the correct pressure and rate. The system has these subsystems:

- Distribution
- Control
- Indicating.

Abbreviations and Acronyms

- ACC - active clearance control
- ACMS - airplane condition monitoring system
- AIMS - airplane information management system
- ARINC - Aeronautical Radio, Inc.
- ASCPC - air supply and cabin pressure controller
- CCC - core compartment cooling
- CDU - control display unit
- CH - channel
- DP - differential pressure
- DRV - driver
- EDIU - engine data interface unit
- EEC - electronic engine control
- EGT - exhaust gas temperature
- EHSV - electro-hydraulic servo valve
- EICAS - engine indication and crew alerting system
- ELMS - electrical load management system
- ENG - engine
- F/0 HX - fuel/oil heat exchanger
- FMV - fuel metering valve
- FSEU - flap/slat electronics unit
- GSE - ground support equipment
- HMU - hydromechanical unit
- HPC - high pressure compressor
- HPT - high pressure turbine
- ID - identification
- IDG - integrated drive generator
- LPC - low pressure compressor
- LPT - low pressure turbine
- MFD - multi-functional display
- OPAS - overhead panel ARINC system
- OSG - overspeed governor
- PDS - primary display system
- PHS - pressure of heated servo
- RVDT - rotary variable differential transducer
- SOV - shutoff valve
- STB - start/transient bleed
- SV - staging valve
- TCMA - thrust controls malfunction accommodation
- TLA - thrust lever angle
- T/R - thrust reverser
- VBV - variable bypass valve
- VSV - variable stator vane



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ENGINE FUEL AND CONTROL - INTRODUCTION

ENGINE FUEL AND CONTROL - INTERFACES

General

The engine fuel and control system has interfaces with many systems and components. The interfaces with other engine systems are primarily analog. The interfaces with airplane systems and components are primarily on the ARINC 629 buses.

Analog Interfaces

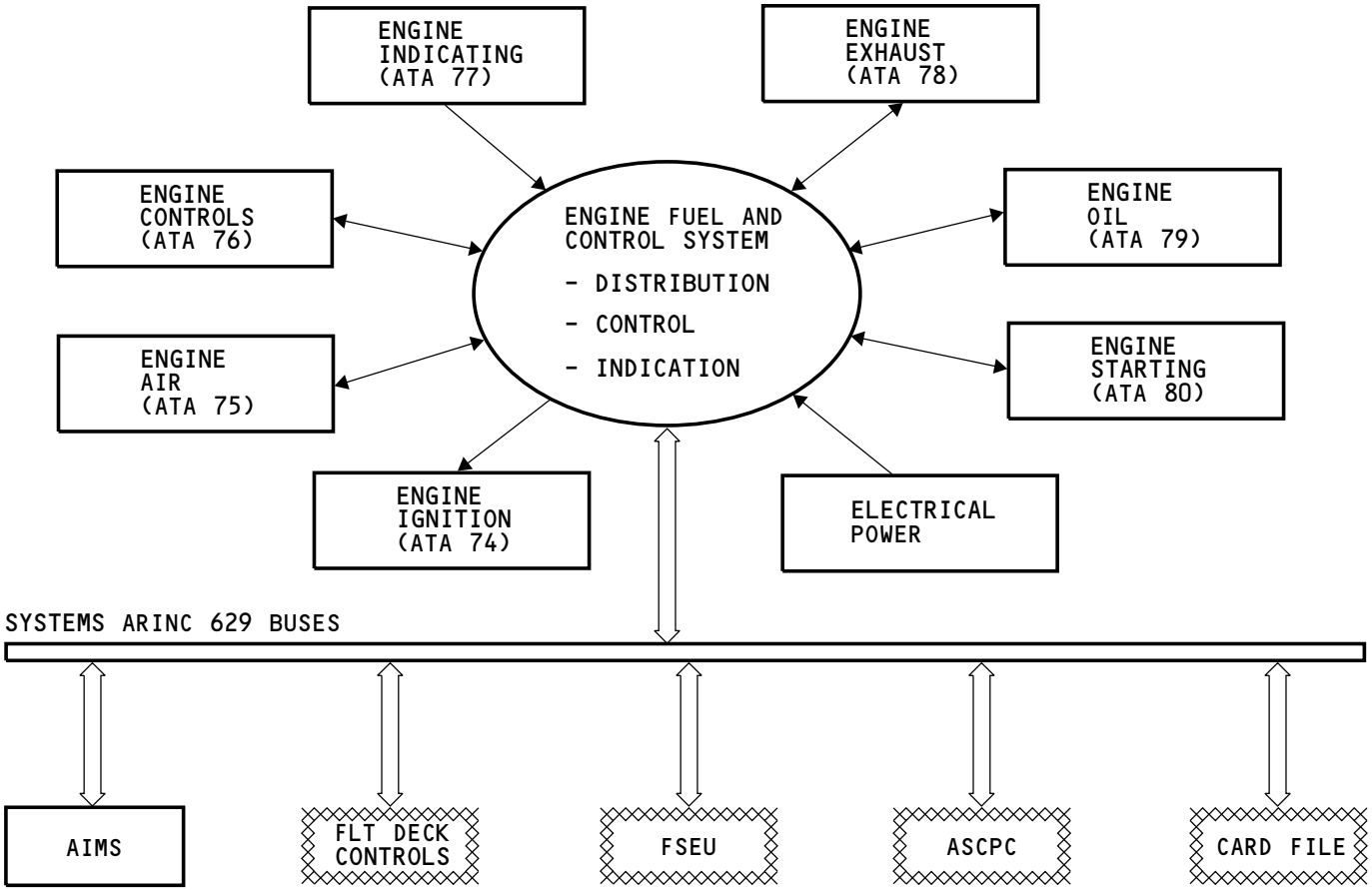
These analog engine fuel and control system interfaces supply control and feedback:

- Engine ignition - exciter power
- Engine air - actuator positions
- Engine controls - resolver excitation
- Engine indicating - engine parameter data
- Engine exhaust - thrust reverser operation
- Engine oil - indication
- Engine starting - starter pneumatic supply
- Electrical power - airplane power application.

ARINC 629 Interfaces

These ARINC 629 engine fuel and control system interfaces supply and receive control and indication data:

- AIMS - indication, air data, and flight management control
- Flight deck controls - switch position and indication
- FSEU - flap position
- ASCPC - pneumatic supply status
- Card file - air driven pump and anti-ice status.



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ENGINE FUEL AND CONTROL - INTERFACES

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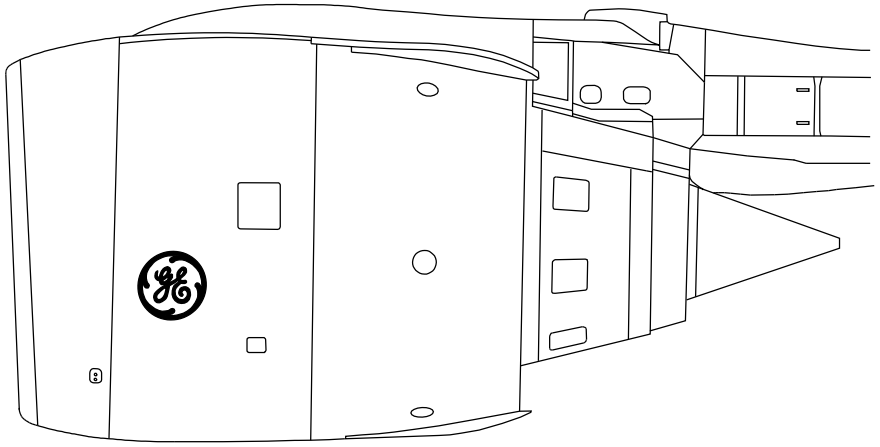
ENGINE FUEL DISTRIBUTION - INTRODUCTION

Purpose

The engine fuel distribution system components pressurize and clean (filter) fuel from the airplane. They also put (inject) metered fuel into the engine.



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ENGINE FUEL DISTRIBUTION - INTRODUCTION

ENGINE FUEL DISTRIBUTION - GENERAL DESCRIPTION

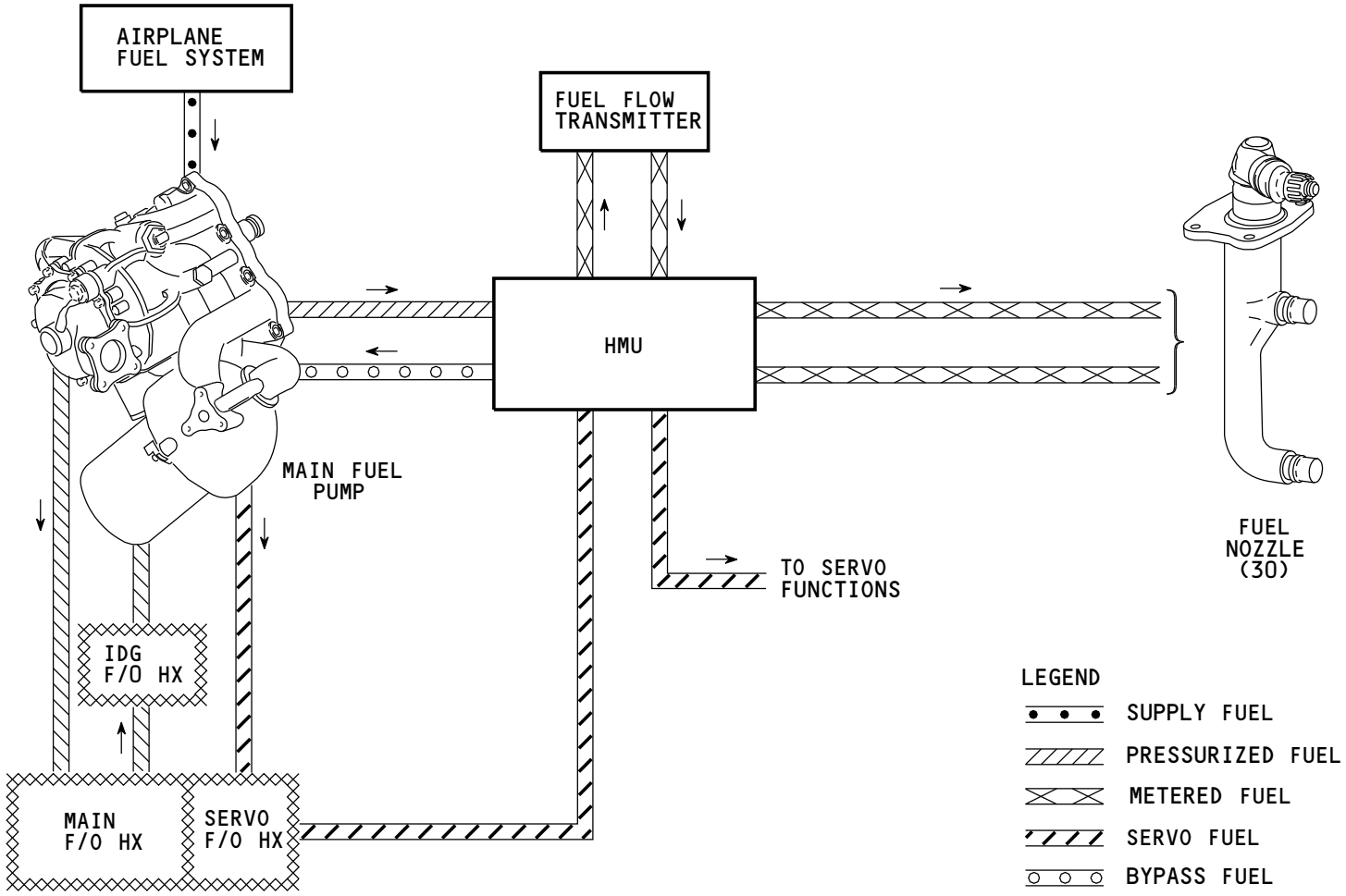
General

The main fuel pump gets fuel from the airplane fuel system. The pump pressurizes the fuel and sends it through the main and IDG fuel/oil heat exchangers. After the fuel goes through the heat exchangers, it flows back to the pump where it goes through the fuel filter element.

After the fuel goes through the fuel filter element, it goes to the hydromechanical unit (HMU). The HMU meters the fuel. The fuel goes from the HMU, through the fuel flow transmitter, then back into the HMU. The HMU distributes the fuel into two fuel supply manifolds. The supply manifolds send the fuel to 30 fuel nozzles.

The HMU gets more fuel from the pump than the engine needs. The fuel that the HMU does not use goes back to the main fuel pump. This fuel is called bypass fuel.

Downstream from the fuel filter, a small amount of fuel also goes to the servo fuel/oil heat exchanger then to the HMU. The servo fuel/oil heat exchanger increases the temperature of the servo fuel before it goes to the HMU. The HMU uses servo fuel pressure to move internal valves and engine air system components (not shown).



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ENGINE FUEL DISTRIBUTION - GENERAL DESCRIPTION

ENGINE FUEL DISTRIBUTION - COMPONENT LOCATIONS

General

These are the fuel distribution system components:

- Main fuel supply hose
- Main fuel pump
- Fuel filter element
- Fuel supply manifolds
- Fuel nozzles.

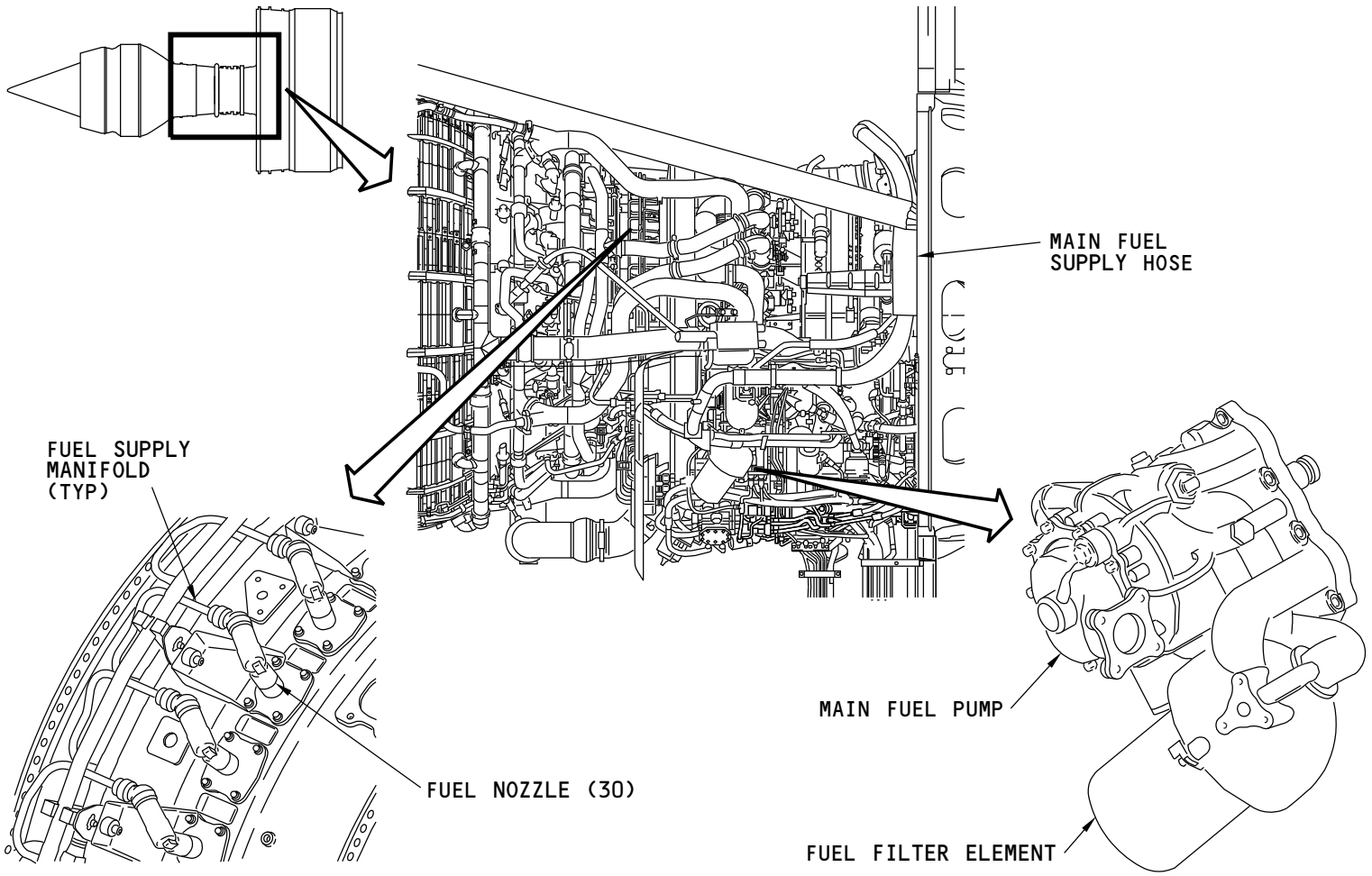
Component Locations

The main fuel supply hose is on the right side of the engine core. It goes from the forward engine strut to the main fuel pump.

The main fuel pump attaches to the aft, right face of the main gearbox. The fuel filter element attaches to the main fuel pump.

The two fuel supply manifolds attach to the compressor rear frame around the engine.

The 30 fuel nozzles attach to the combustor diffuser nozzle case around the engine.



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ENGINE FUEL DISTRIBUTION - COMPONENT LOCATIONS

ENGINE FUEL DISTRIBUTION - MAIN FUEL PUMP

General

The main fuel pump pressurizes and cleans fuel from the airplane fuel system. It is on the aft face of the gearbox. The pump has external and internal connections for fuel flow.

The main fuel pump has a pump and a filter assembly element.

Fuel Pump

The fuel pump is a two-stage pump. The main gearbox turns the pump. The pump has an external connection for fuel from the airplane tanks. The other fuel flow into and out of the pump is through the fuel adapter on the gearbox (not shown).

The pump has an inlet drain plug. You remove this plug to get access to the strainer between the two pump stages and to drain fuel from the pump.

Fuel Filter Assembly

The fuel filter assembly has these parts:

- Housing
- Filter element
- Bypass valve.

You remove the filter housing to change or inspect the filter element. The filter housing has a ratchet lock. To remove the housing, you must push the ratchet lock while you turn the housing. You drain the fuel from the housing with the drain plug before you remove the housing.

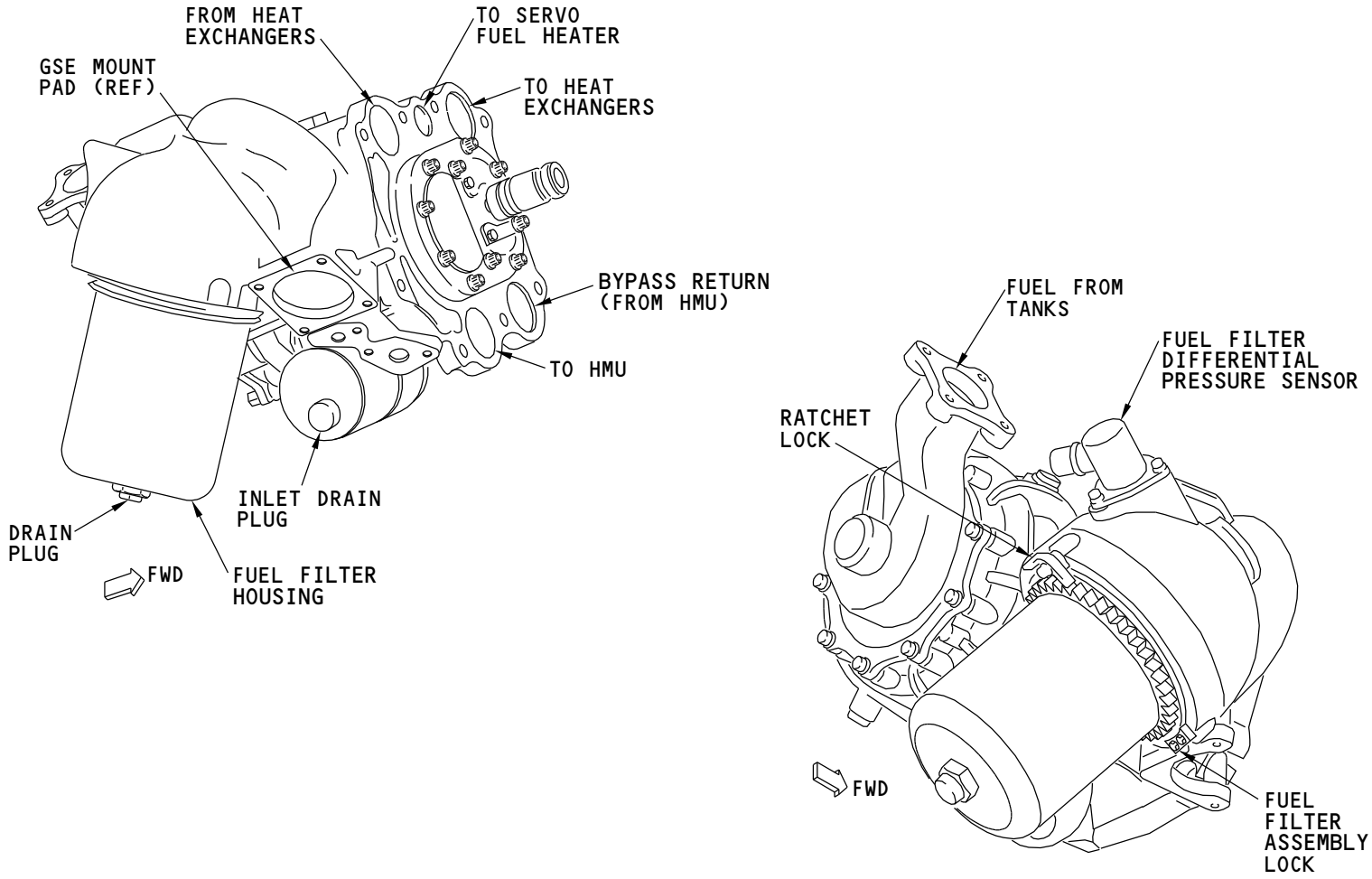
You can remove the filter assembly as a unit. You must remove the filter assembly lock and use a special tool to remove the filter assembly.

Pressure Sensors

The fuel manifold pressure sensor mounts to the forward side of the HMU. This sensor provides the fuel pressure in the HMU manifold 2. The EEC uses this information for fuel system fault monitoring.

The fuel pump has a fuel filter differential pressure sensor on the aft end of the MFP just above the filter bowl.

See the fuel control system section for more information on these sensors (SECTION 73-21).



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ENGINE FUEL DISTRIBUTION - MAIN FUEL PUMP

ENGINE FUEL DISTRIBUTION - FUEL SUPPLY MANIFOLDS AND NOZZLES

General

Fuel goes through the fuel supply manifolds to 30 fuel nozzles. The fuel nozzles spray fuel into the combustion chamber.

Fuel Supply Manifolds

There is one dual fuel supply manifold which includes these:

- Manifold 1
- Manifold 2.

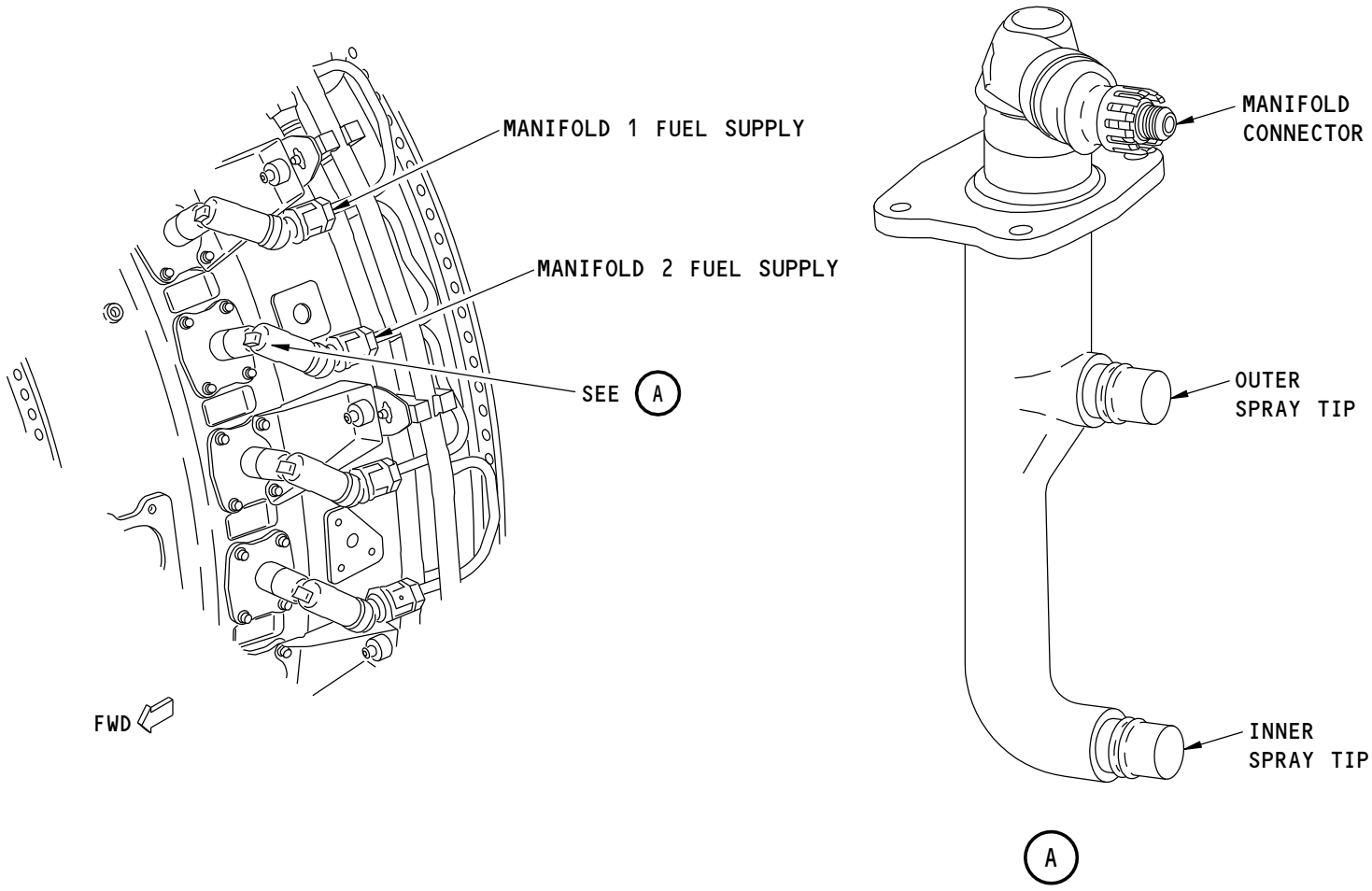
The fuel supply manifold has two halves to make it easy to remove and install it.

Fuel Nozzles

There is one kind of fuel nozzle. Each fuel nozzle has one connector and two spray tips. Twenty fuel nozzles use fuel from manifold 1. Manifold 2 supplies fuel to the other ten fuel nozzles. There are two nozzles with fuel from manifold 1 between each nozzle with fuel from manifold 2.

Fuel comes out of all 60 tips except for these conditions when 40 tips, connected to manifold 1, supply fuel:

- Decel (transient condition)
- Cold day decent idle.



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ENGINE FUEL DISTRIBUTION - FUEL SUPPLY MANIFOLDS AND NOZZLES

ENGINE FUEL DISTRIBUTION - FUNCTIONAL DESCRIPTION

General

The main fuel pump pressurizes and cleans fuel from the airplane fuel tanks. The pump supplies the fuel to the HMU and the servo fuel heater. The HMU sends metered fuel to the fuel flow transmitter, then to the fuel supply manifolds. The manifolds connect to the fuel nozzles. The fuel nozzles spray the fuel into the engine for combustion.

Main Fuel Pump

The main fuel pump has two pump stages and a fuel filter element. The boost stage is a centrifugal-type pump. The main stage is a gear-type pump. Fuel goes through both stages of the pump, then to the main and IDG fuel/oil heat exchangers. Fuel then goes back into the pump and through the filter.

After the filter, fuel goes to the HMU. A small amount of fuel also goes through the servo fuel/oil heat exchanger to the HMU. This fuel supplies servo pressure to move HMU valves and engine air system actuators.

The main fuel pump has one sensor, the Fuel filter differential pressure sensor. It sends signals to the EEC.

HMU

The HMU has these valves to control and distribute the fuel:

- Fuel metering valve (FMV)
- Bypass valve (BPV)
- Engine fuel shutoff valve (SOV)
- Staging valve (SV).

The fuel metering valve controls the amount of fuel that goes to the engine for combustion.

The HMU sends fuel that is not necessary for combustion (bypass fuel) through the bypass valve, back to the gear stage inlet.

The engine fuel shutoff valve opens to permit fuel to go to the engine for combustion. After the engine fuel shutoff valve, the fuel goes through the fuel flow transmitter.

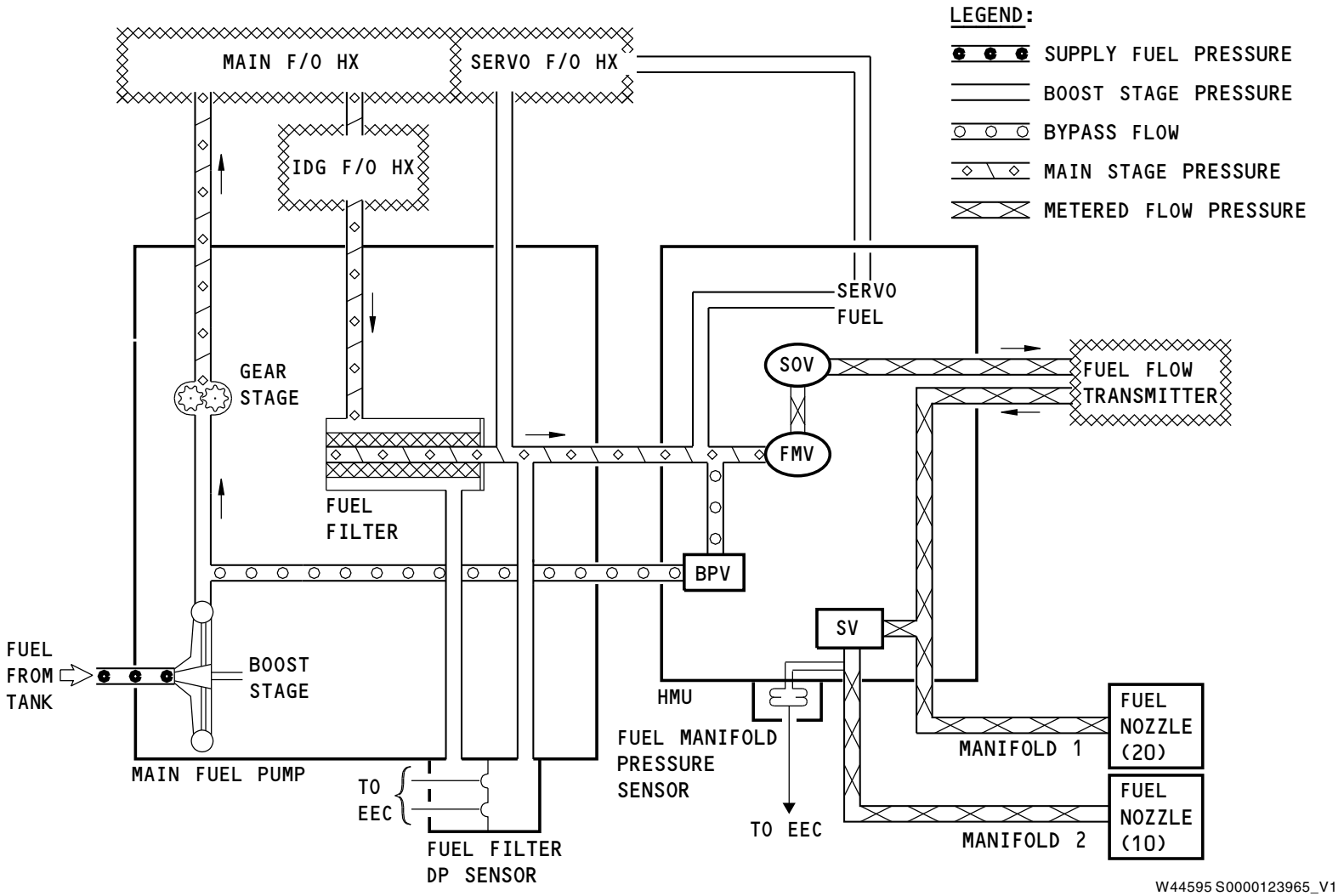
See the fuel control system section for more information on the HMU (SECTION 73-21).

Fuel Flow

Fuel returns to the HMU from the fuel flow transmitter. The HMU distributes the fuel to the two manifolds. Fuel flow to manifold 2 is controlled by the staging valve (SV).

The manifolds distribute fuel to 30 nozzles. Fuel in manifold 1 goes to 20 fuel nozzles. Fuel in manifold 2 goes to the other ten fuel nozzles.

When the engine is at idle and above, fuel goes to both manifolds. The staging valve closes during cold day descent idle and transient rapid decel operations.



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ENGINE FUEL DISTRIBUTION - FUNCTIONAL DESCRIPTION

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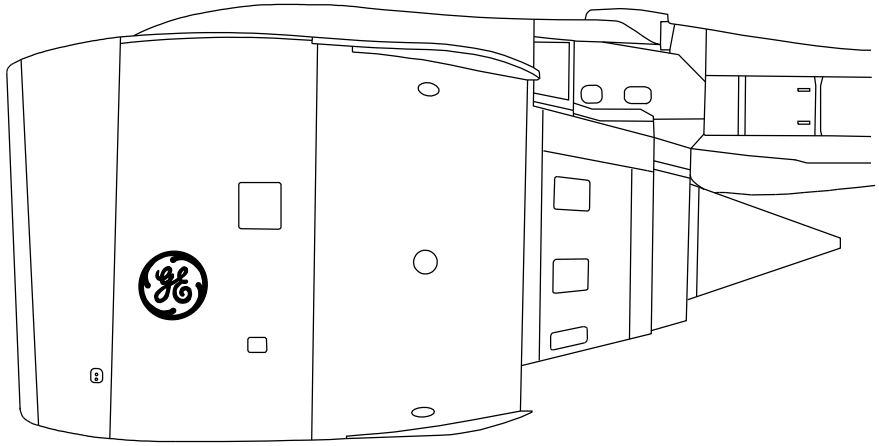
ENGINE FUEL CONTROL - INTRODUCTION

General

The engine fuel control system controls the flow of fuel to the engine for combustion.

System sensors supply information necessary for correct operation.



ENGINE FUEL AND CONTROL

DISTRIBUTION
- PRESSURIZING
- FILTERING
- INJECTING

CONTROL
- METERING
- SENSING
- POWER
- INTERFACES

INDICATING
- FUEL FLOW

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ENGINE FUEL CONTROL - INTRODUCTION

ENGINE FUEL CONTROL - GENERAL DESCRIPTION

General

The EEC is the primary component of the engine fuel control system. The EEC uses data from engine sensors and airplane systems to control the engine operation.

Power

The EEC gets power from two sources, the airplane or the engine. When the engine is not running, the electrical load management system (ELMS) supplies airplane power to the EEC. The ELMS supplies power to the EEC when any of these conditions occur:

- Fuel control switch is in the RUN position
- Start/ignition selector is in the START position
- EEC maintenance switch is in the TEST position.

When the engine is running, the control alternator supplies power to the EEC. If the control alternator has a failure, the ELMS supplies power to the EEC.

EEC

The EEC is a two channel computer that controls the operation of the engine. Each channel can completely control the operation of the engine.

The EEC uses N1 to calculate thrust. The EEC controls thrust in three different modes:

- Normal
- Soft reversionary
- Hard reversionary (alternate).

When the EEC is in the soft or hard reversionary mode, the thrust calculations are less accurate. The EEC goes into soft reversionary mode automatically. You push the EEC mode switch to put the EEC in hard reversionary mode.

The EEC also controls many components in other engine subsystems and gets feedback of their status.

The EEC monitors engine sensors to get data. It is also the interface for some sensors with their systems.

When you move the fuel control switch from RUN to CUTOFF, the EEC resets. When the EEC resets, it writes all fault data in its non-volatile memory (NVM). The reset also sets the engine start logic to run from the start of the program.

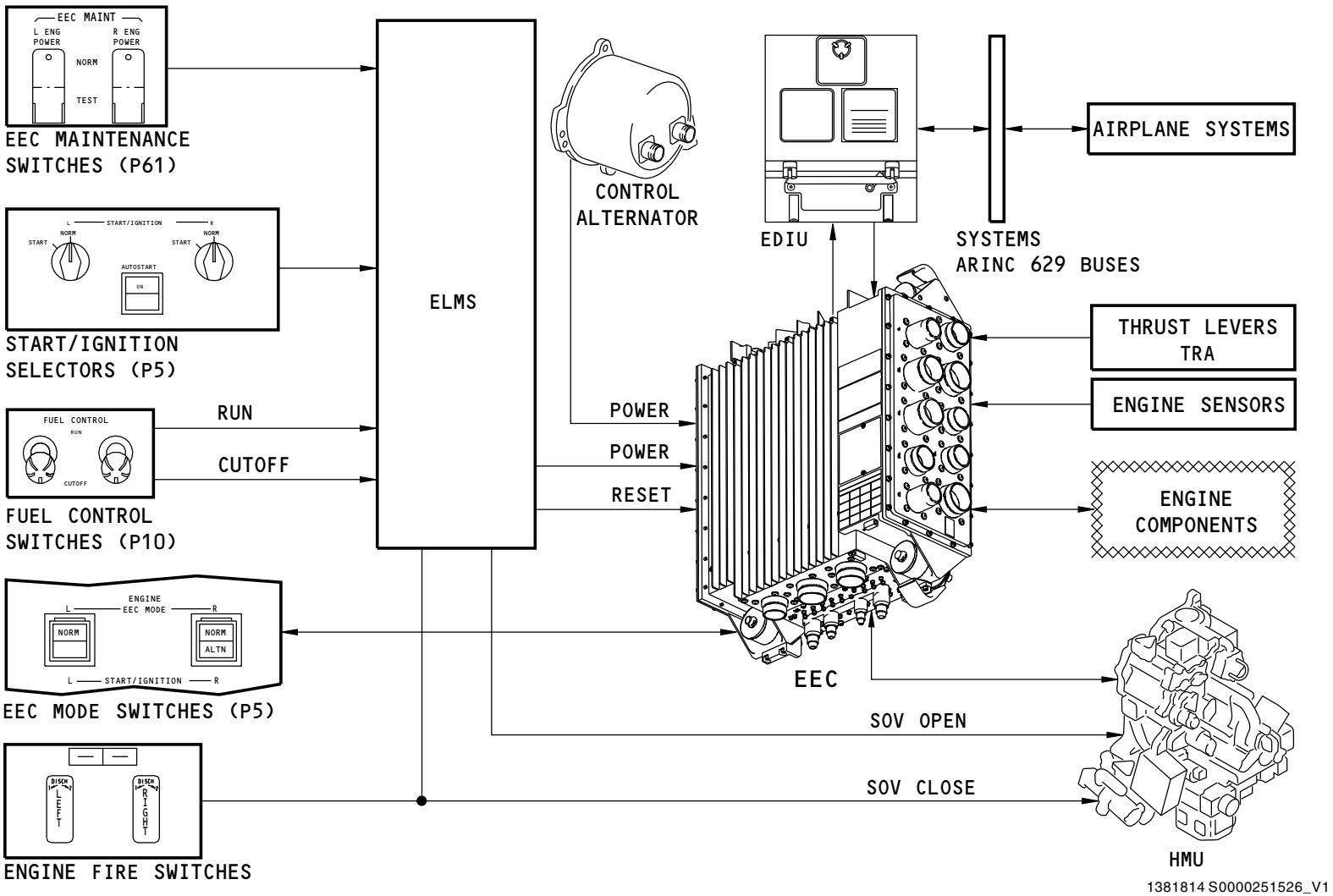
HMU

The EEC controls valves in the HMU to supply metered fuel flow to the engine and to distribute fuel to the fuel nozzles. The EEC also controls torque motors in the HMU to supply servo fuel to engine air system actuators (not shown). The HMU gives the EEC feedback about valve and torque motor positions.

The fuel control switch controls the engine fuel shutoff valve (SOV) in the HMU to start and stop fuel flow to the engine. When you move the fuel control switch to the RUN position, the ELMS sends power to open the valve. When you move the fuel control switch to the CUTOFF position, the ELMS sends power to close the valve. The valve also closes when you pull up on the engine fire switch.

EDIU

The engine data interface unit (EDIU) changes the ARINC 429 formatted data of the EEC to ARINC 629. It also changes ARINC 629 data to ARINC 429. This permits the EEC to transmit data to and receive data from airplane systems.



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ENGINE FUEL CONTROL - GENERAL DESCRIPTION

ENGINE FUEL CONTROL - ENGINE COMPONENT LOCATIONS - 1

Component Locations - Engine Right Side

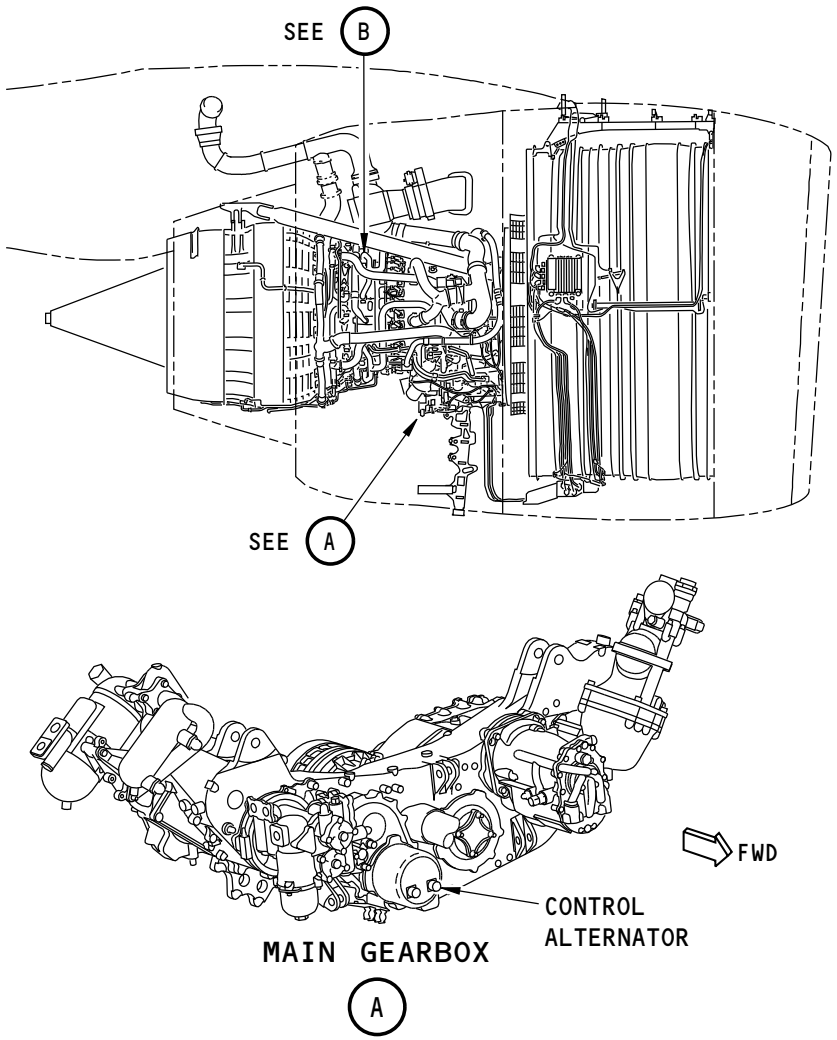
These components are located on the right side of the engine:

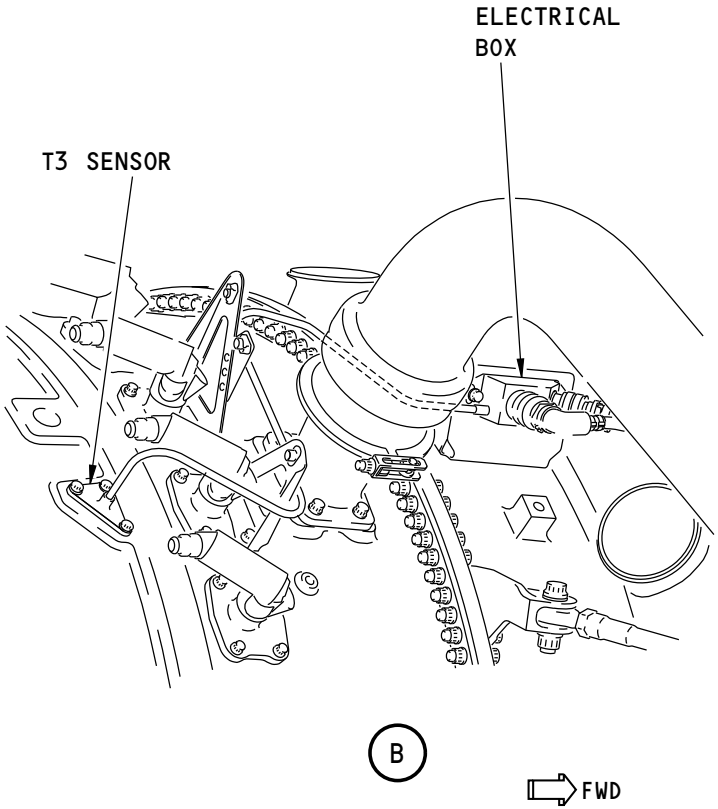
- EEC
- Engine rating plug
- T12 sensor
- T3 sensor
- Bleed bias flow sensor.

The EEC attaches to the fan case. The engine rating plug is on the EEC.

Component Locations - Main Gearbox Front Face

The control alternator is on the front face of the main gearbox.





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ENGINE FUEL CONTROL - ENGINE COMPONENT LOCATION -1

ENGINE FUEL CONTROL - ENGINE COMPONENT LOCATIONS - 2

Engine Left Side Component Locations

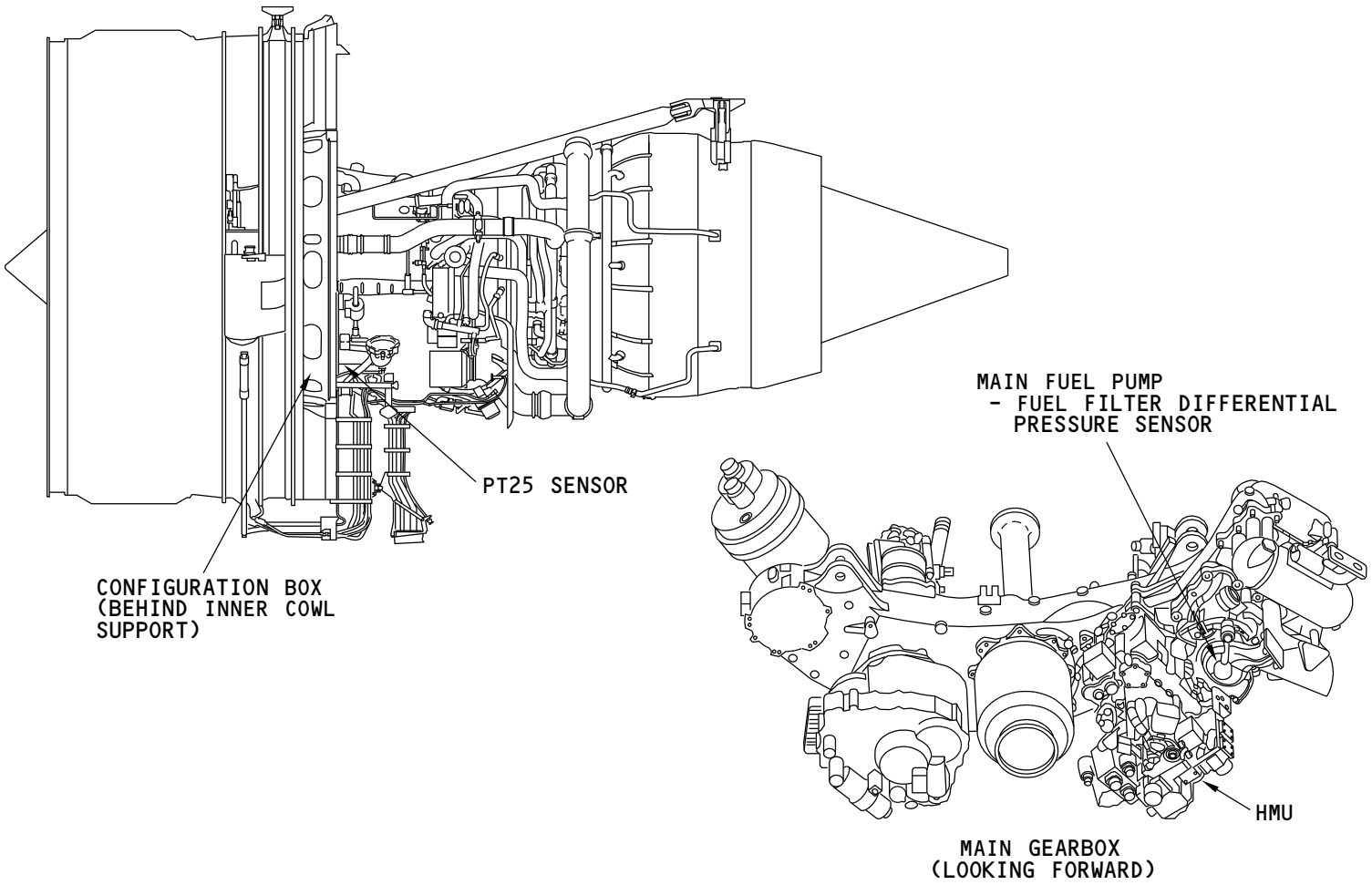
These components are on the left side of the engine:

- Configuration Box

Main Gearbox Aft Face Component Locations

The HMU is on the aft face of the main gearbox.

The main fuel pump is mounted to the aft side of the main gearbox. The Fuel filter differential pressure sensor is on the main fuel pump.



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ENGINE FUEL CONTROL - ENGINE COMPONENT LOCATIONS - 2

ENGINE FUEL CONTROL - AIRPLANE COMPONENT LOCATIONS

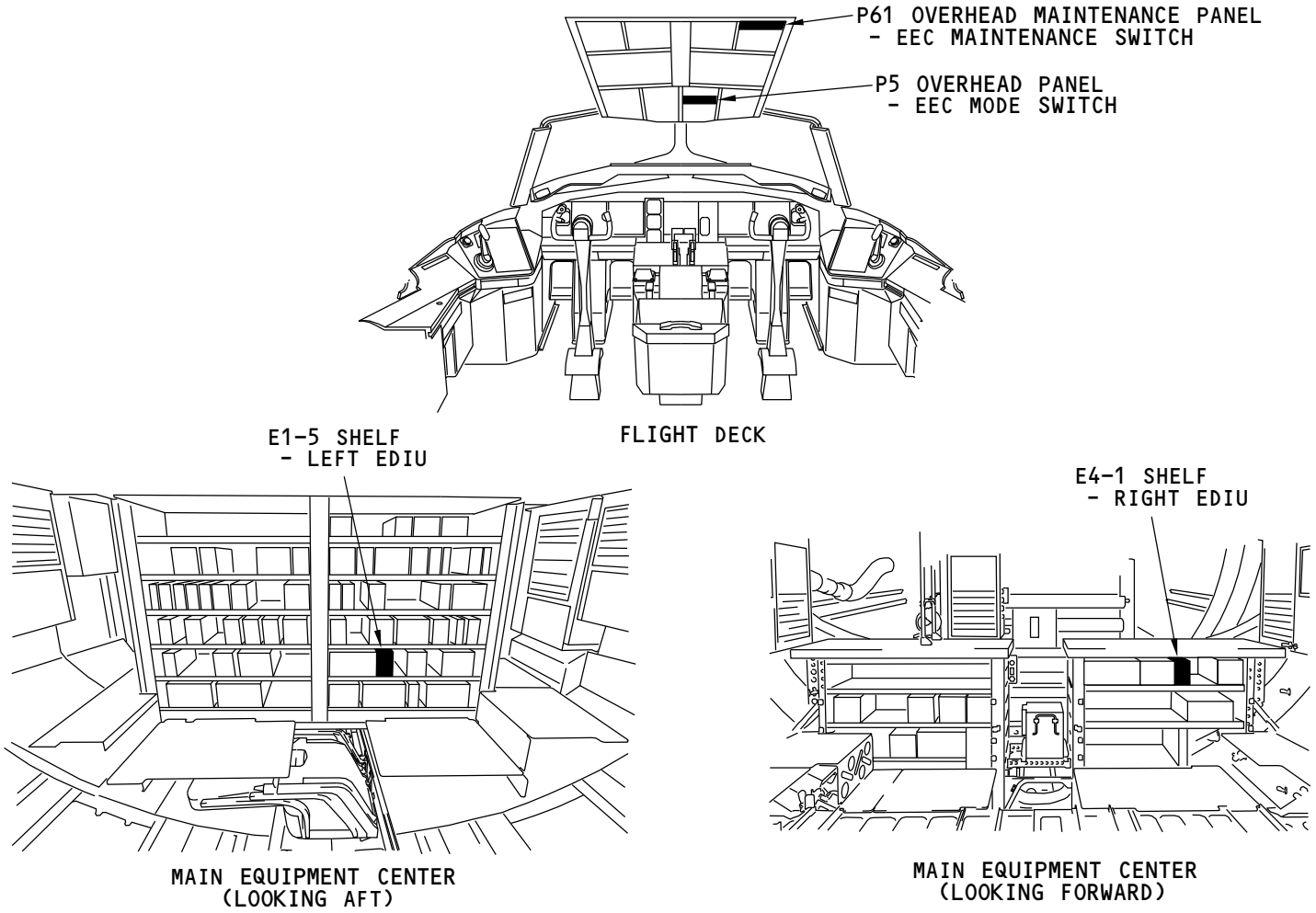
Flight Deck

The EEC mode switches are part of the start/ignition controls on the P5 overhead panel.

The EEC maintenance switches are on the P61 overhead maintenance panel.

Main Equipment Center

The two EDIUs are in the main equipment center. The left EDIU is on the E1-5 shelf. The right EDIU is on the E4-1 shelf.



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ENGINE FUEL CONTROL - AIRPLANE COMPONENT LOCATIONS

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ENGINE FUEL CONTROL - AIRPLANE INTERFACES

General

The engine fuel control system has many interfaces with airplane components and systems. Most of the interfaces are digital, but some are analog. The interfaces are with the EEC and EDIU. The EDIU permits digital interfaces with the EEC.

Analog Interfaces

These components have analog interfaces with the engine fuel control system:

- EEC mode switch
- Thrust lever angle (TLA) resolver
- Thrust reverser interlock actuator
- Fuel control switch
- EEC maintenance switch
- Start/ignition selector
- ELMS.

EEC Mode Switch

The EEC mode switch sends a signal to the EEC to put it into the normal or alternate mode of control. The EEC turns on the ALTN light in the mode switch to tell you to put the switch into the alternate position.

Thrust Lever Angle Resolver

The TLA resolver supplies the EEC with a signal in proportion to the thrust lever position. The EEC supplies power to the resolvers.

Thrust Reverser Interlock Actuator

The EEC energizes the thrust reverser (T/R) interlock actuator during reverser operation when the reverser extends. The EEC supplies a ground through the ELMS to energize the actuator.

Fuel Control Switch

When you move the fuel control switch to the RUN position, a signal permits the ELMS to supply ac power to the EEC. When you move the fuel control switch from RUN to CUTOFF, the ELMS sends a reset signal to each EEC channel. The reset signal stops the programs of the EEC and sets them to run from the start (boots the computer).

EEC Maintenance Switch

The EEC maintenance switch permits the ELMS to supply ac power to the EEC during maintenance operations.

Start/Ignition Selector

The start/ignition selector sends a start signal to the EEC and permits the ELMS to supply ac power to the EEC. The selector is held in the START position by a ground in the AIMS.

AIMS

The AIMS transmits and receives a large amount of data to and from the EEC. This is a summary of that data and its function:

- Bleed status - EEC thrust limit calculations
- Air data - EEC thrust limit calculations
- Engine data - system data requirements
- Autothrottle trim - thrust balancing
- Condition monitoring - performance tracking
- Maintenance data - fault isolation
- EICAS data - indication.

FSEU

The FSEU supplies the EEC with flap position data for idle and ignition logic.

ENGINE FUEL CONTROL - AIRPLANE INTERFACES

Card File

The card file supplies the EEC anti-ice bleed status and air driven pump status for idle logic.

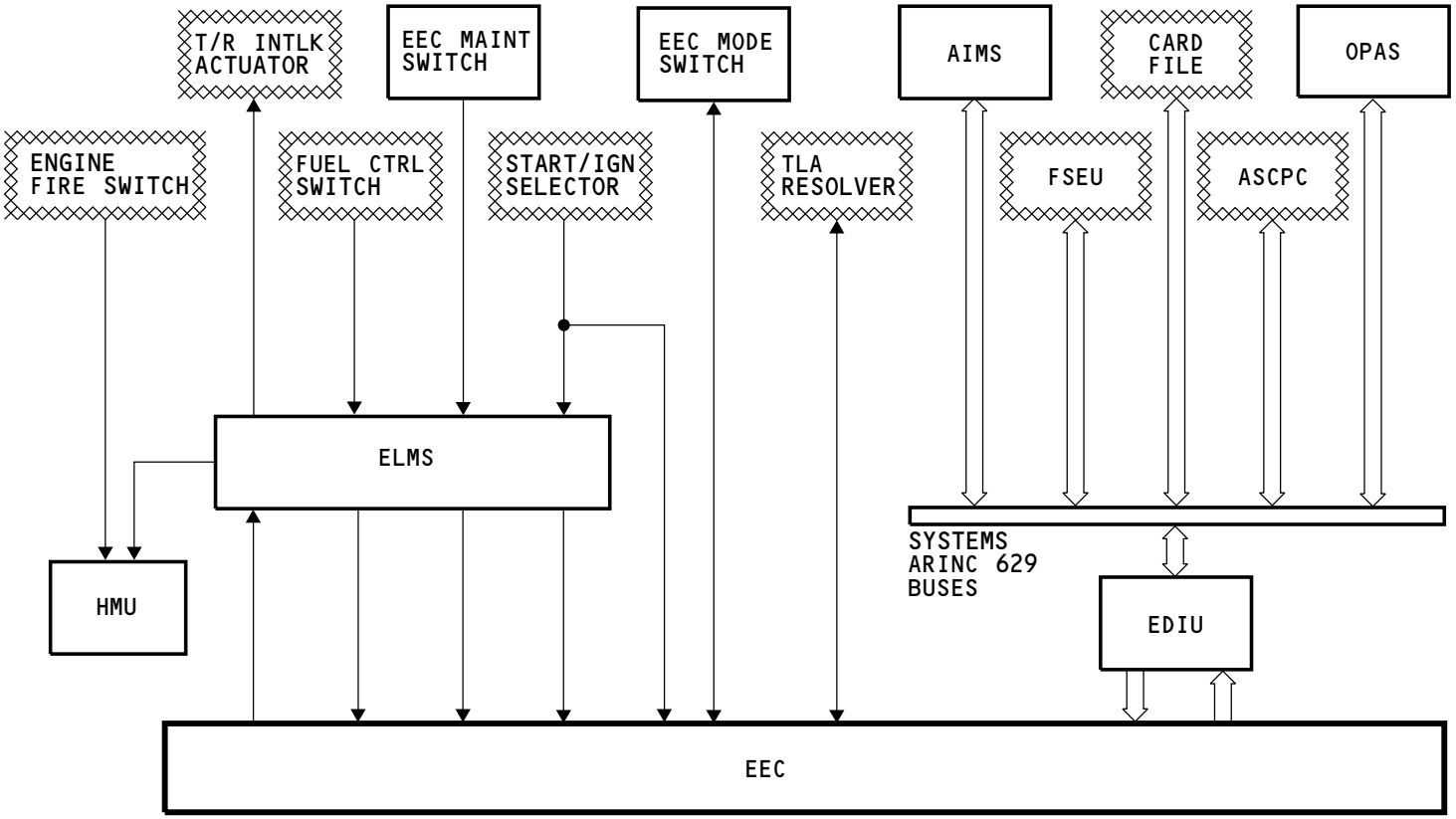
ASCPC

The ASCPC supplies the EEC with duct pressure, and pressure regulating and shutoff valve status. The EEC uses this information for thrust calculations, start control, and idle speed control.

OPAS

The OPAS sends a digital signal of these switch positions to the EEC:

- Autostart switch
- EEC maintenance switch
- Start/ignition selector.



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ENGINE FUEL CONTROL - AIRPLANE INTERFACES

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ENGINE FUEL CONTROL - ENGINE INTERFACES

General

The EEC controls most engine components and receives feedback from them. Many components send data to the EEC for engine operation.

The EEC uses torque motor drivers to move multiple-position actuators. It uses solenoid drivers to move two-position open/close valves.

Engine Rating Plug

The engine rating plug selects the software in the EEC that corresponds to the thrust rating of the engine. It connects to the EEC.

Configuration Box

The configuration box supplies data on the correct version of the engine hardware to the EEC.

Engine Identification

To set the engine ID when a new EEC is installed, use the MAT special functions menu and the MAT keyboard.

Control Alternator

The control alternator supplies the EEC with dedicated electrical power.

HMU

The EEC controls these valves in the HMU:

- Fuel metering valve
- Staging valve
- Selector Valve
- HPSOV
- LPC AI Valve

The EEC also controls torque motors in the HMU that send servo fuel to operate these engine air system components:

- VSVs
- VBVs
- HPT ACC valve.

All these valves and components send position feedback signals to the EEC.

Starter Air Valve

The EEC energizes the starter air valve solenoid to open the valve. The EEC receives feedback of the valve position from the starter air pressure sensor.

Ignition Exciters

The EEC sends 115v AC power to the ignition exciters.

CCC Valve

The EEC energizes the core compartment cooling (CCC) valve solenoid to close the valve. The EEC receives feedback of the valve position from a switch.

LPT ACC Valve

The EEC energizes the LPT active clearance control (ACC) valve solenoid to open the valve. The EEC receives feedback of the valve position from a switch.

T/R Test Enable Switch

The T/R test enable switch puts the EEC into a maintenance mode. This lets the thrust reverser extend or retract without running the engine.

T/R Isolation Valve

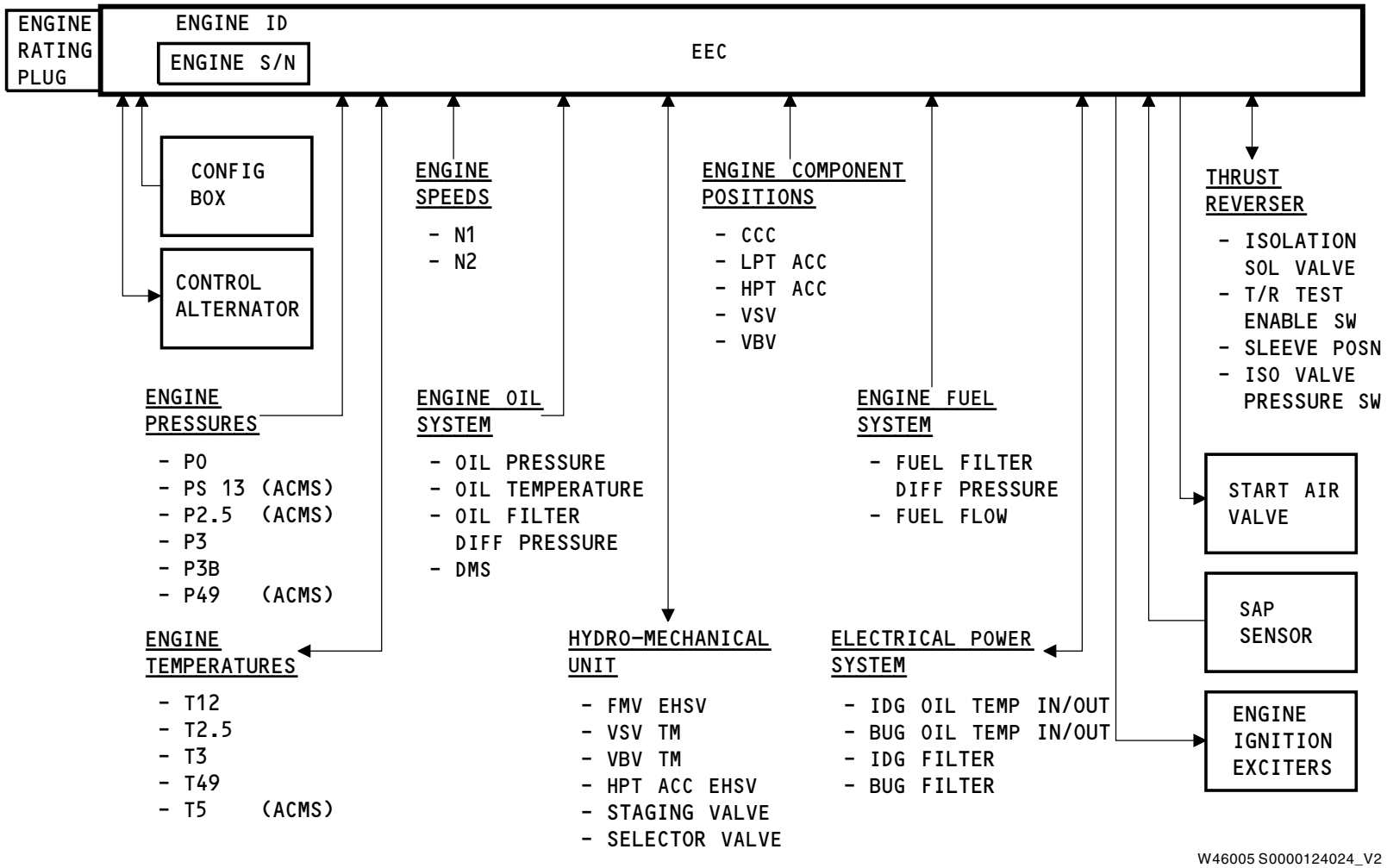
The EEC energizes the T/R isolation solenoid valve to open the valve. The EEC receives feedback of the valve position from a pressure switch.

ENGINE FUEL CONTROL - ENGINE INTERFACES

Sensors

Many engine sensors supply these information to the EEC:

- Rotor speeds
- Pressures
- Temperatures
- Valve and actuator positions
- Oil data
- Fuel data.



ENGINE FUEL CONTROL - ENGINE INTERFACES

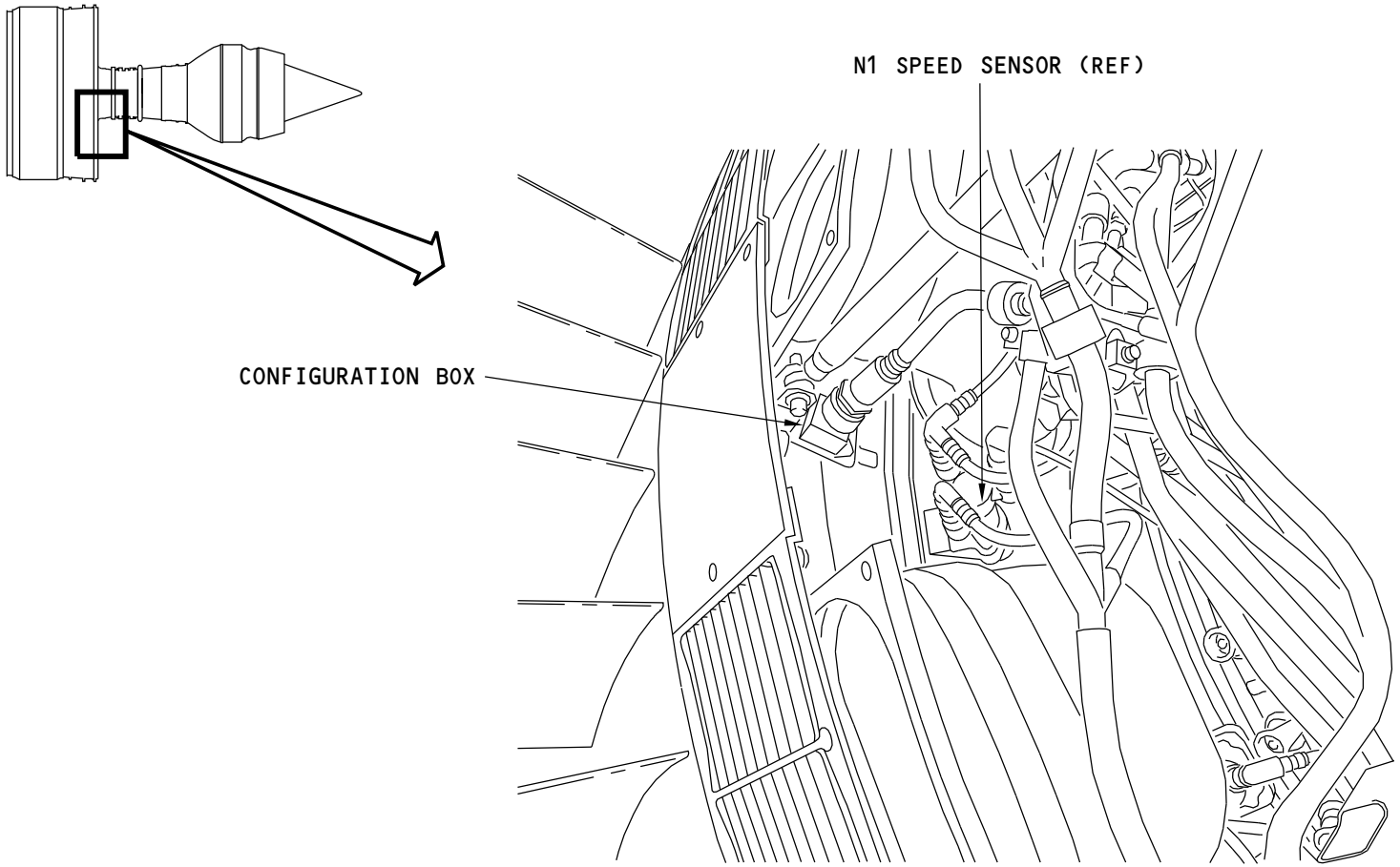
ENGINE FUEL CONTROL - CONFIGURATION / IDENTIFICATION

General

The configuration box is on the left side of the engine on the fan hub frame. The engine serial number (ESN) is input into the EEC through the Special Functions page on the MAT.

Configuration Box

The configuration box supplies data on the correct version of the engine hardware to the EEC. An electrical connector on the box attaches it to the EEC.



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ENGINE FUEL CONTROL - CONFIGURATION / IDENTIFICATION

ENGINE FUEL CONTROL - EEC - INTRODUCTION

General

The EEC is a computer that controls the operation of the engine. It attaches to the upper-right fan case with shock mounts. It is cooled by convection.

Electrical Connections

The EEC has fifteen electrical connections labeled J1-J15. J1-J4 connect the EEC to airplane systems. J5-14 are engine inputs to the EEC. The odd numbered connections go to channel A. The even numbered connections go to channel B.

J15 is the engine rating plug connection. The engine rating plug selects the software in the EEC that corresponds to the thrust rating of the engine. The plug attaches to the engine fan case with a lanyard. When you remove the EEC, the plug stays with the engine fan case.

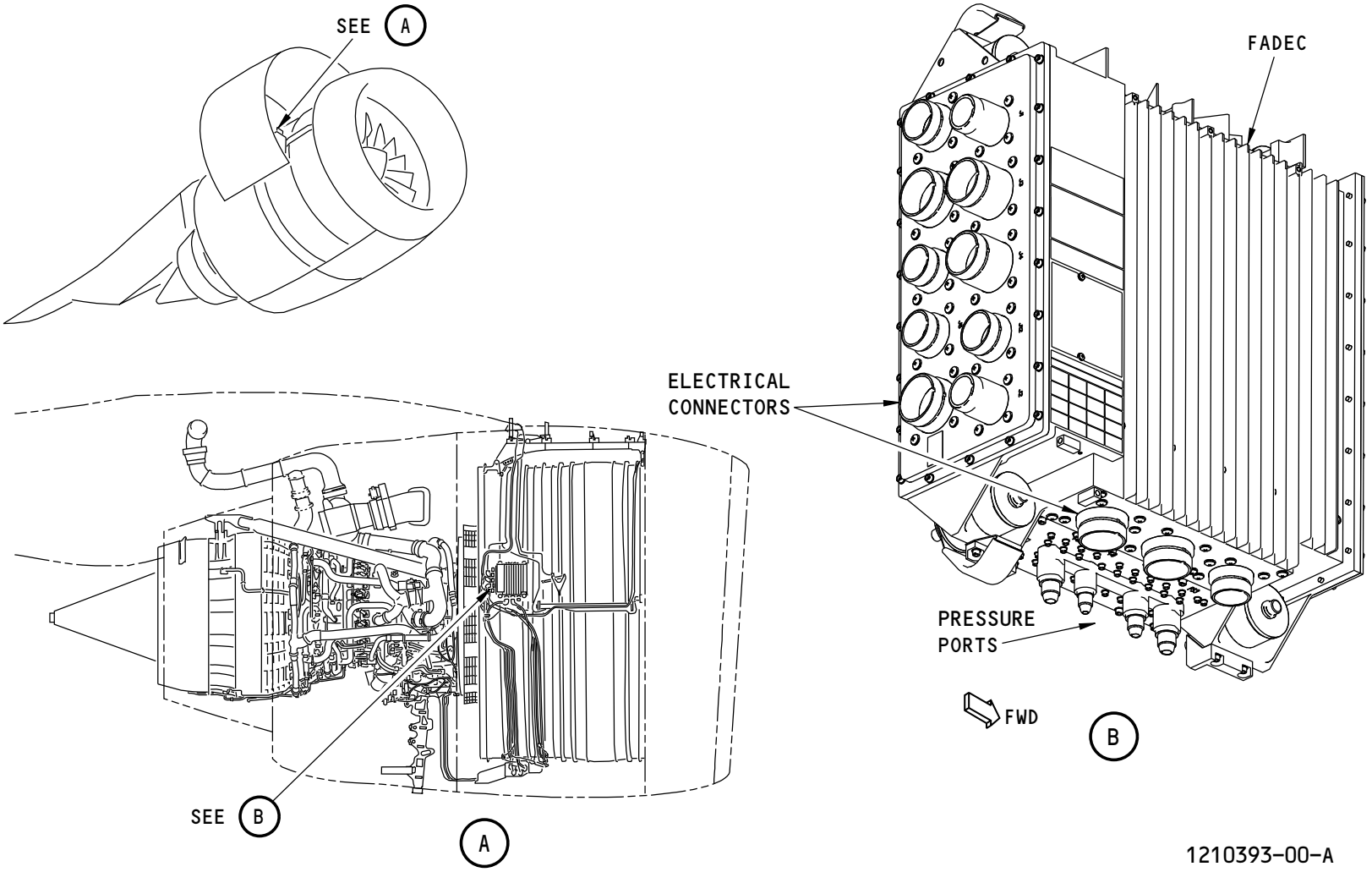
Pneumatic Connections

There are four pneumatic connections on the bottom of the EEC. The transducers inside the EEC change the pneumatic signals to electrical signals. These are the pneumatic connections:

- PS3 (combustion inlet static pressure)
- P3B (HP bleed duct pressure)
- P25 (LPC exit pressure)
- P0 (ambient pressure).

Training Information Point

The EEC mount (not shown) has hooks that permit you to hang the EEC on the engine. The hooks support the weight of the EEC while you install the mount bolts.



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W44636 S0000123983_V2

ENGINE FUEL CONTROL - EEC - INTRODUCTION

ENGINE FUEL CONTROL - EEC - FUNCTIONAL DESCRIPTION

General

The EEC is a two-channel computer that controls the operation of the engine. It has two channels, but only one is in control at a time (active channel). The active channel changes each time you start the engine.

Power

Each channel of the EEC gets power from two sources: airplane and engine. The EEC gets power from the airplane when one or more of these conditions occur:

- Fuel control switch in RUN
- Start/ignition selector in START
- EEC maintenance switch in TEST.

Engine power for the EEC comes from the control alternator. The control alternator has a separate winding for each channel of the EEC. The control alternator starts to supply power at approximately 7 percent N2. The control alternator has priority over airplane power.

Computer

The EEC has two channels with these main sections:

- Processor
- Cross-talk logic
- Input/Output (I/O)
- Memory
- Pressure transducers.

The processor does all of the control calculations. It supplies all the data for the I/O section and control signals to the drivers.

For some inputs, the cross-talk logic compares the signals to channels A and B. If both channels get a good signal, the EEC uses the average of the two signals. If one channel does not get a good signal, the EEC uses only the other channel signal. If both channels get good a signal but they do not agree, the EEC uses a calculated value.

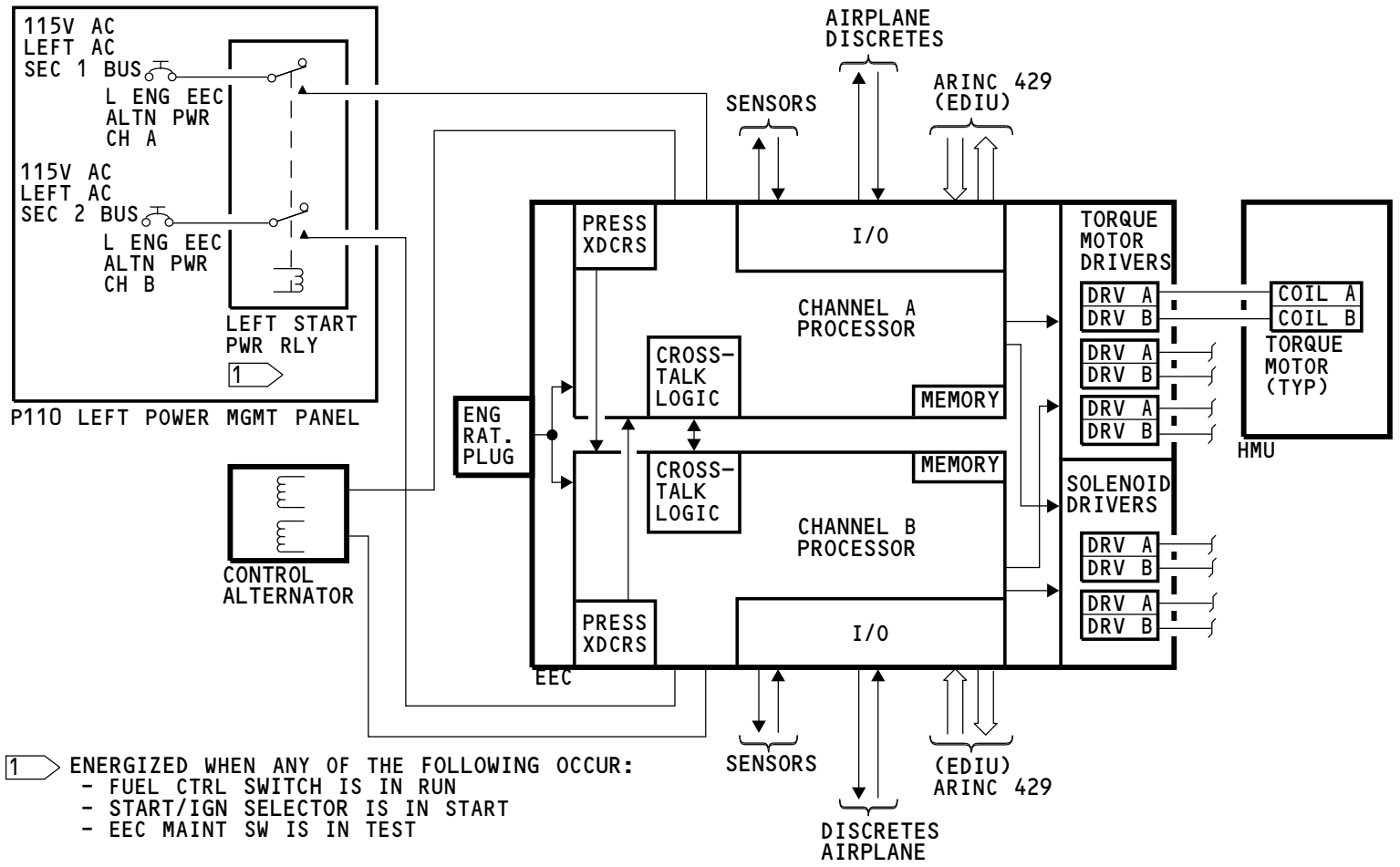
The I/O section receives and transmits digital and analog data.

The EEC has both non-volatile and volatile memory to keep performance and maintenance data.

Each channel has four pressure transducers. They send signals in proportion to the pressure in the lines connected to the EEC. The transducers also send the signals to the other channel. One transducer in each channel is not used.

Output Drivers

The EEC has output drivers that send the control signals to engine components. The active channel of the EEC sends control signals to the drivers. There are torque motor drivers and solenoid drivers.



M43686 S000621320_V1

ENGINE FUEL CONTROL - EEC - FUNCTIONAL DESCRIPTION

ENGINE FUEL CONTROL - CONTROL ALTERNATOR

General

The control alternator supplies power to the EEC. It attaches to the front of the main gearbox.

Physical Description

The control alternator has a rotor and a stator. The rotor attaches to a shaft on the main gearbox. The stator goes over the rotor and attaches to the gearbox housing.

Engine oil cools the control alternator.

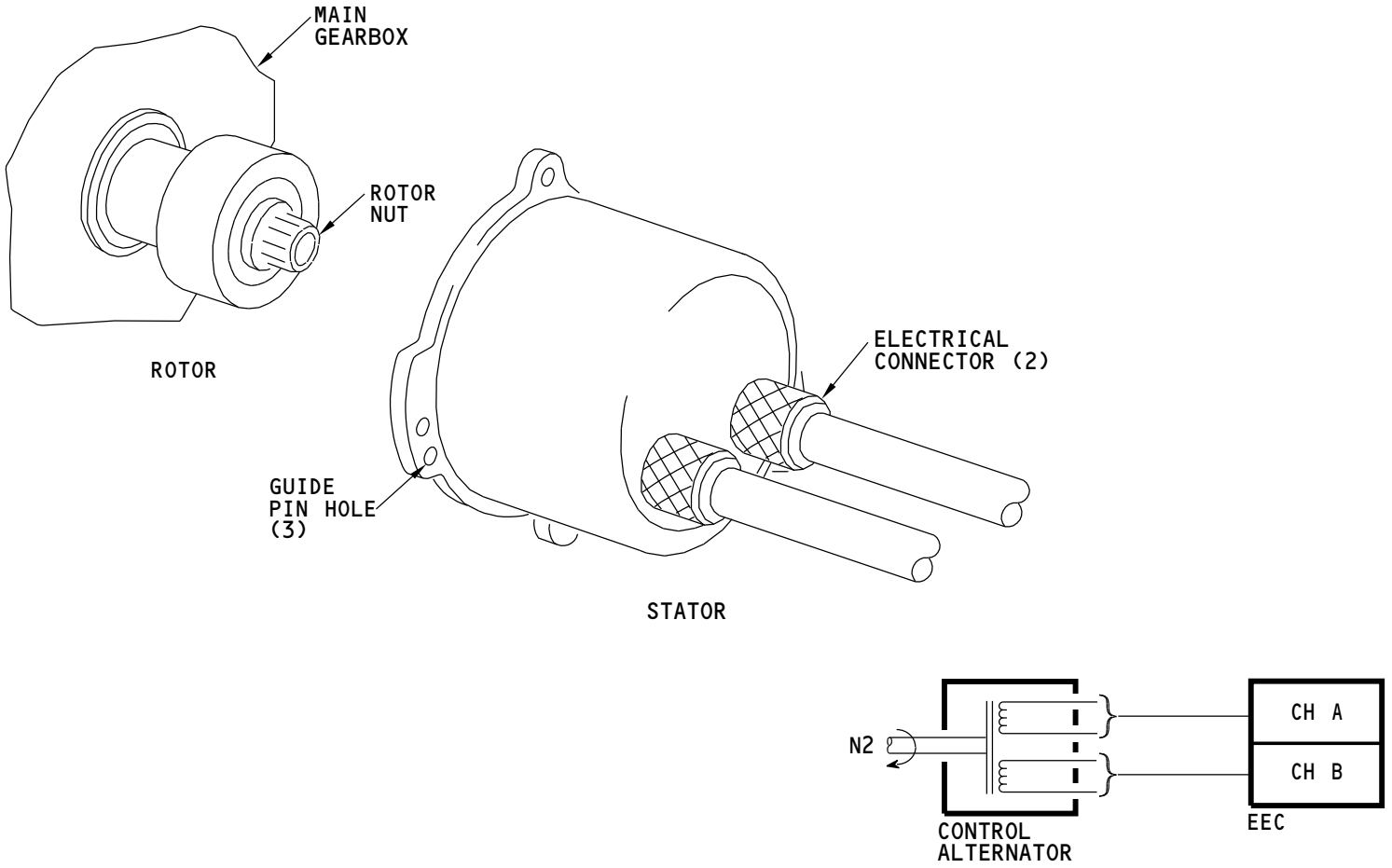
Functional Description

The control alternator makes electrical power when the gearbox turns the rotor inside the stator. The stator has two coils. Each EEC channel gets power from one of the coils when the engine reaches approximately 7 percent N2.

Training Information Point

You use guide pins when you remove or install the stator. The guide pins prevent the stator windings from hitting the rotor. The guide pins install in two places.

A nut holds the rotor on the gearbox shaft. You use a special tool to prevent the rotor drive shaft from turning when you turn the nut.



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ENGINE FUEL CONTROL - CONTROL ALTERNATOR

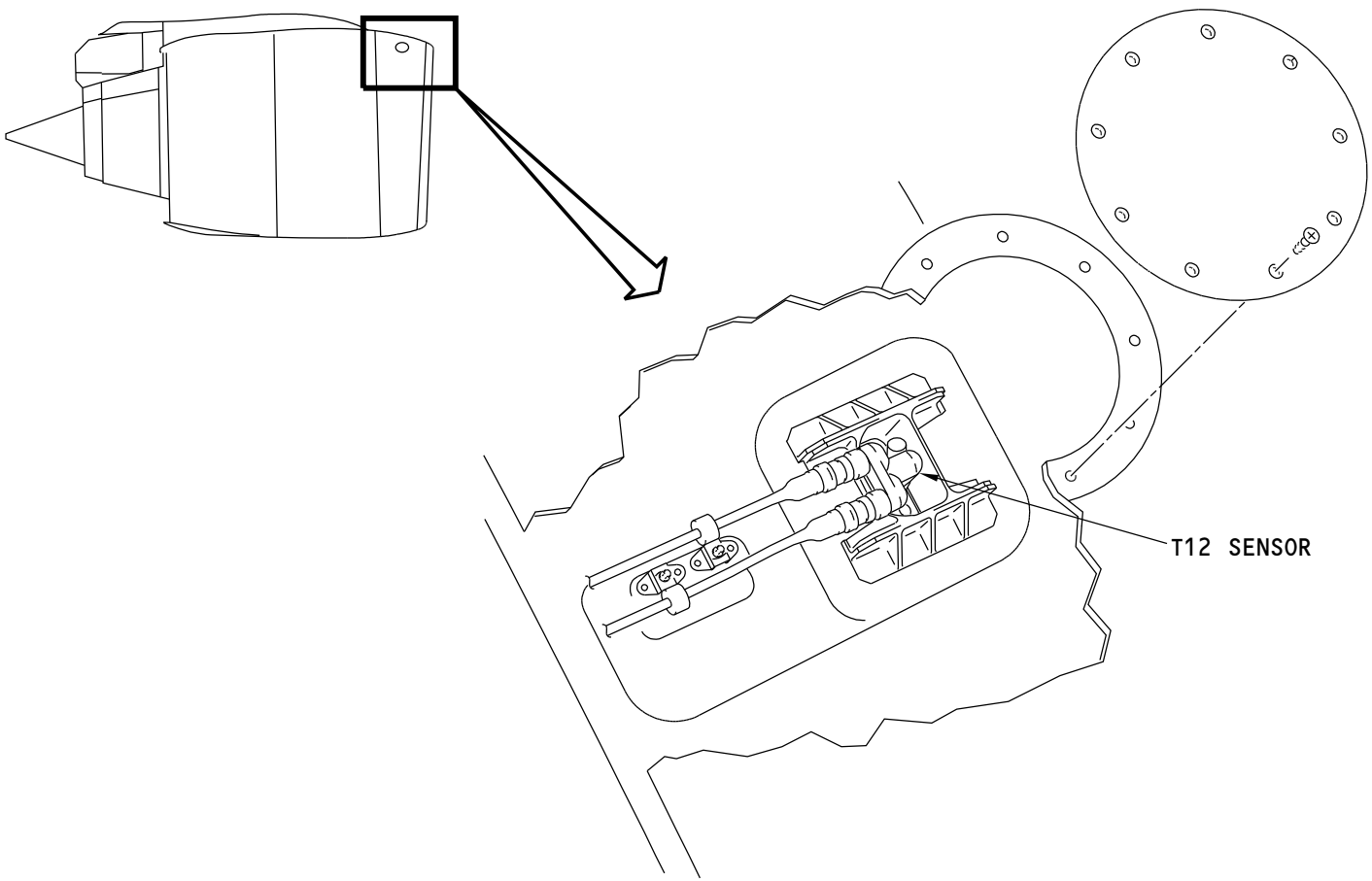
ENGINE FUEL CONTROL - T12 SENSOR

General

The T12 sensor sends the fan inlet air temperature to the EEC. The EEC uses T12 as an input to control fuel flow.

The T12 sensor is on the inlet cowl at the 12:30 position. You get access to the sensor through a panel on top of the inlet cowl.

The T12 sensor has two outputs, one to each channel of the EEC. It is a resistive thermal sensor. The EEC monitors the T12 sensor for faults.



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ENGINE FUEL CONTROL - T12 SENSOR

ENGINE FUEL CONTROL - PT25 SENSOR

General

The PT25 sensor supplies HPC inlet pressure and temperature to the EEC. The EEC uses T25 as one of the inputs to control the variable bypass valves (VBV) and variable stator vanes (VSV). The EEC sends P25 to the AIMS as part of the airplane condition monitoring system (ACMS).

The EEC monitors the PT25 sensor for faults.

Ice Shield

The PT25 sensor has an ice shield on the forward edge of the sensor. The purpose is to prevent large chunks of ice which could damage the HPC airfoils when the ice sheds.

Location

The PT25 sensor is on the fan hub frame at the 7:00 position.

Temperature Sensing

The PT25 sensor has two resistive thermal sensors. There are two outputs, one to each channel of the EEC.

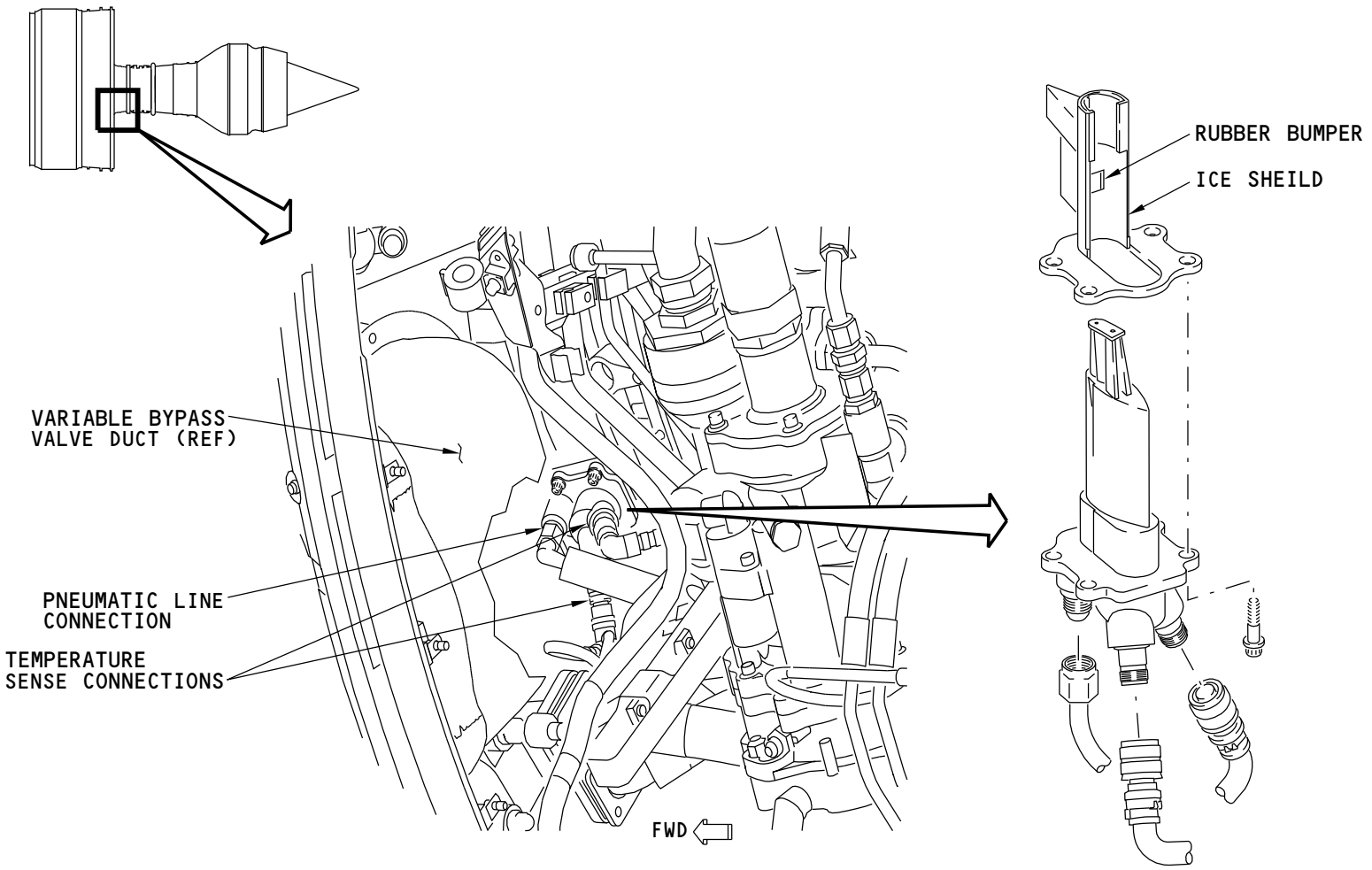
Pressure Sensing

The PT25 sensor has a pneumatic line that goes to a pressure transducer in the EEC. The transducer sends an electrical signal to each channel of the EEC. The electrical signal is proportional to P25.

Training Information Point

You must remove the oil/oil heat exchanger before you can remove the PT25 sensor.

When you change the PT25 sensor, you must remove the ice shield and install it on the new sensor. You must modify the rubber bumbers on the ice shield to fit the new sensor to obtain a proper fit.



M43689 S000621323_V1

ENGINE FUEL CONTROL - PT25 SENSOR

ENGINE FUEL CONTROL - T3 SENSOR

General

The T3 sensor supplies combustion inlet (HPC exit) temperature to the EEC. The EEC uses T3 in some of its calculations.

It is on the combustor diffuser nozzle case at the 1:30 o'clock position

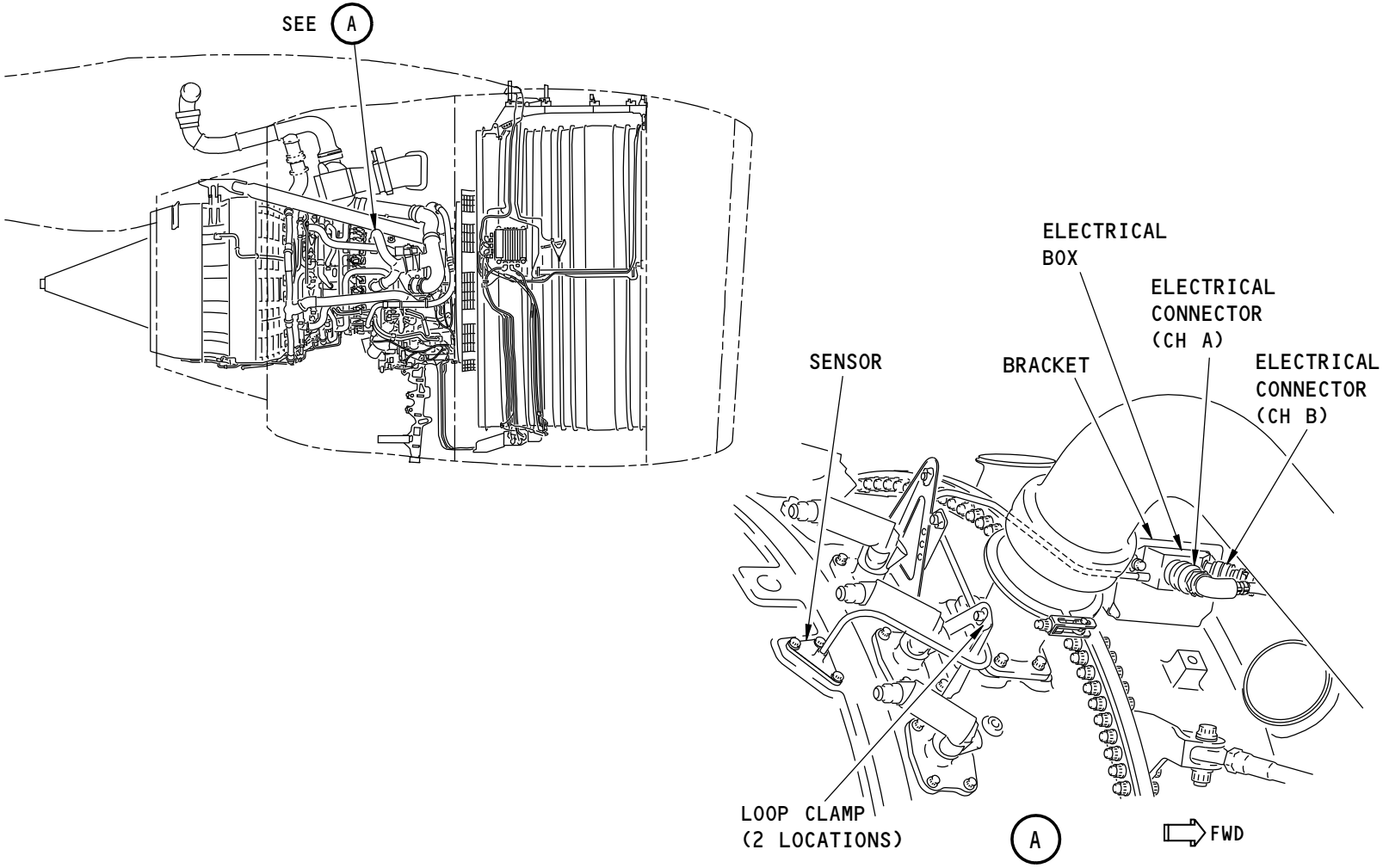
Physical Description

The T3 sensor has two thermocouples. One thermocouple goes to each channel of the EEC. The wires go from the sensor, through a metal shroud, to the electrical box. The electrical box is part of the T3 sensor.

Functional Description

The air from the combustion inlet flows into the T3 sensor and over the thermocouples.

The EEC monitors the T3 sensor for faults.



2072423 S0000430800_V1

ENGINE FUEL CONTROL - T3 SENSOR

ENGINE FUEL CONTROL - BLEED BIAS FLOW SENSOR

General

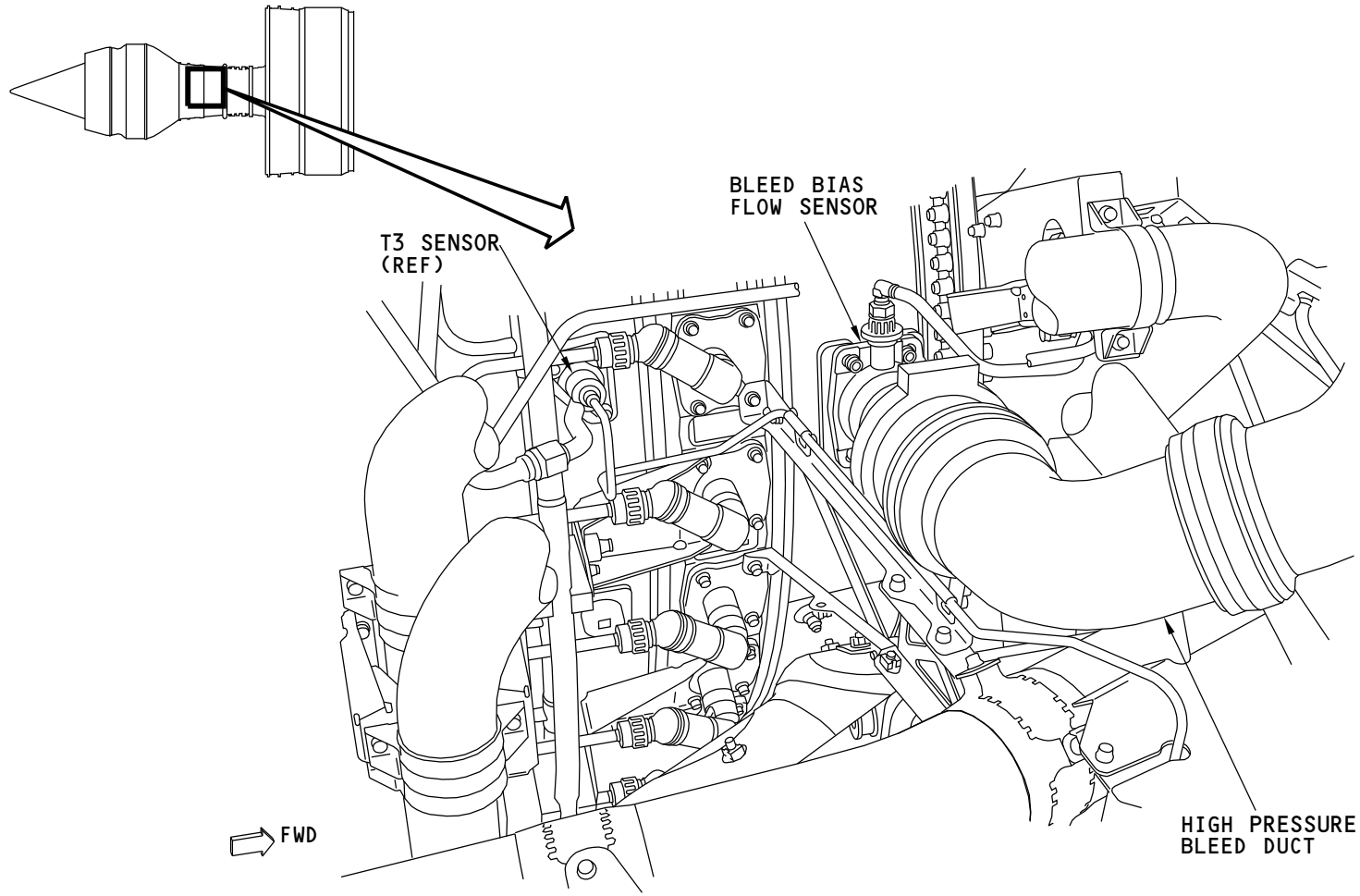
The bleed bias flow sensor has a venturi in the high pressure bleed duct. It supplies the EEC with the static pressure at the throat of the venturi. This pressure is called P3B.

The EEC uses P3B and PS3 (not shown) to calculate the high stage bleed flow rate. The EEC also uses P3B to make adjustments to improve engine acceleration.

It is on the combustor diffuser nozzle case at the 3:30 position. It attaches between the case and the lower high pressure bleed duct.

The bleed bias flow sensor has a pneumatic line that goes to a pressure transducer in the EEC.

The EEC monitors the bleed bias flow sensor for faults.



M43693 S000621327_V1

ENGINE FUEL CONTROL - BLEED BIAS FLOW SENSOR

ENGINE FUEL CONTROL - FUEL PRESSURE SENSORS

General

The fuel control system has two pressure sensors. One on the main fuel pump and one on the hydromechanical unit (HMU). Signals from the pressure sensors go to the EEC. The EEC uses the information to monitor the fuel filter, fuel pump and HMU for faults.

These are the pressure sensors:

- Fuel filter differential pressure
- Fuel manifold pressure sensor.

Each sensor has two sensing elements, one for each channel of the EEC. The EEC monitors the sensors for faults.

Fuel Filter Differential Pressure Sensor

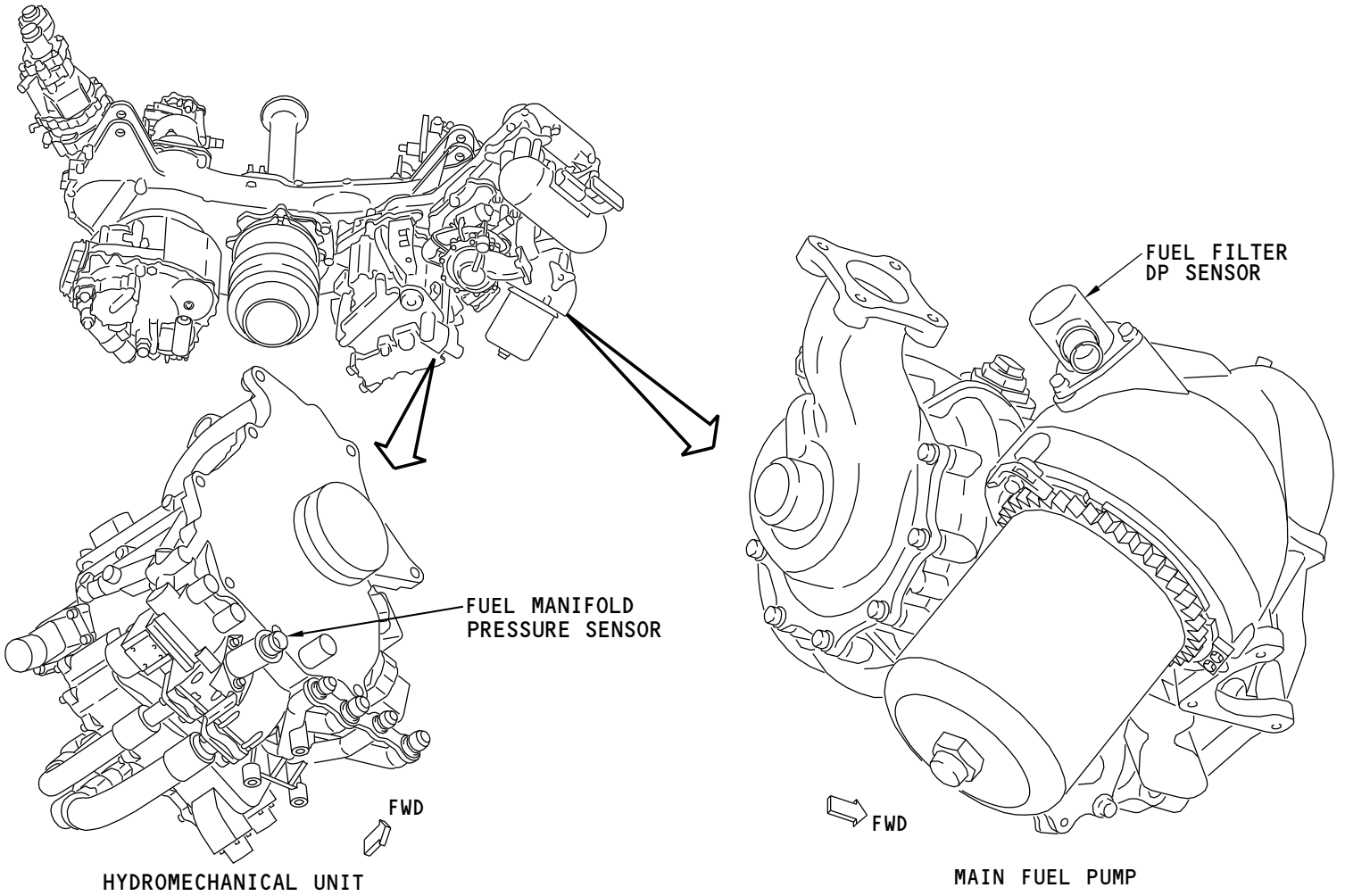
The fuel filter differential pressure sensor measures the fuel pressure on each side of the filter. The EEC sends a signal to the AIMS when the filter begins to clog. The fuel filter will bypass fuel if it becomes clogged.

It is on the aft side of the fuel pump, just above the filter.

Fuel Manifold Pressure Sensor

The fuel manifold pressure sensor (FMPS) measures the fuel pressure in the HMU output to manifold 2. The pressure signal provides the staging valve and pressurizing and shutoff valve position feedback to the EEC. The EEC sends a signal to the AIMS when the sensor has a fault.

It is on the bottom of the hydromechanical unit, just forward of the fuel feeder hoses.



M43695 S000621330_V1

ENGINE FUEL CONTROL - FUEL PRESSURE SENSORS

ENGINE FUEL CONTROL - HMU - INTRODUCTION

Purpose

The hydromechanical unit (HMU) meters and distributes the proper amount of fuel needed for combustion. It also supplies servo fuel to move actuators and valves of the engine air system.

Location

The HMU is on the aft face of the main gearbox.

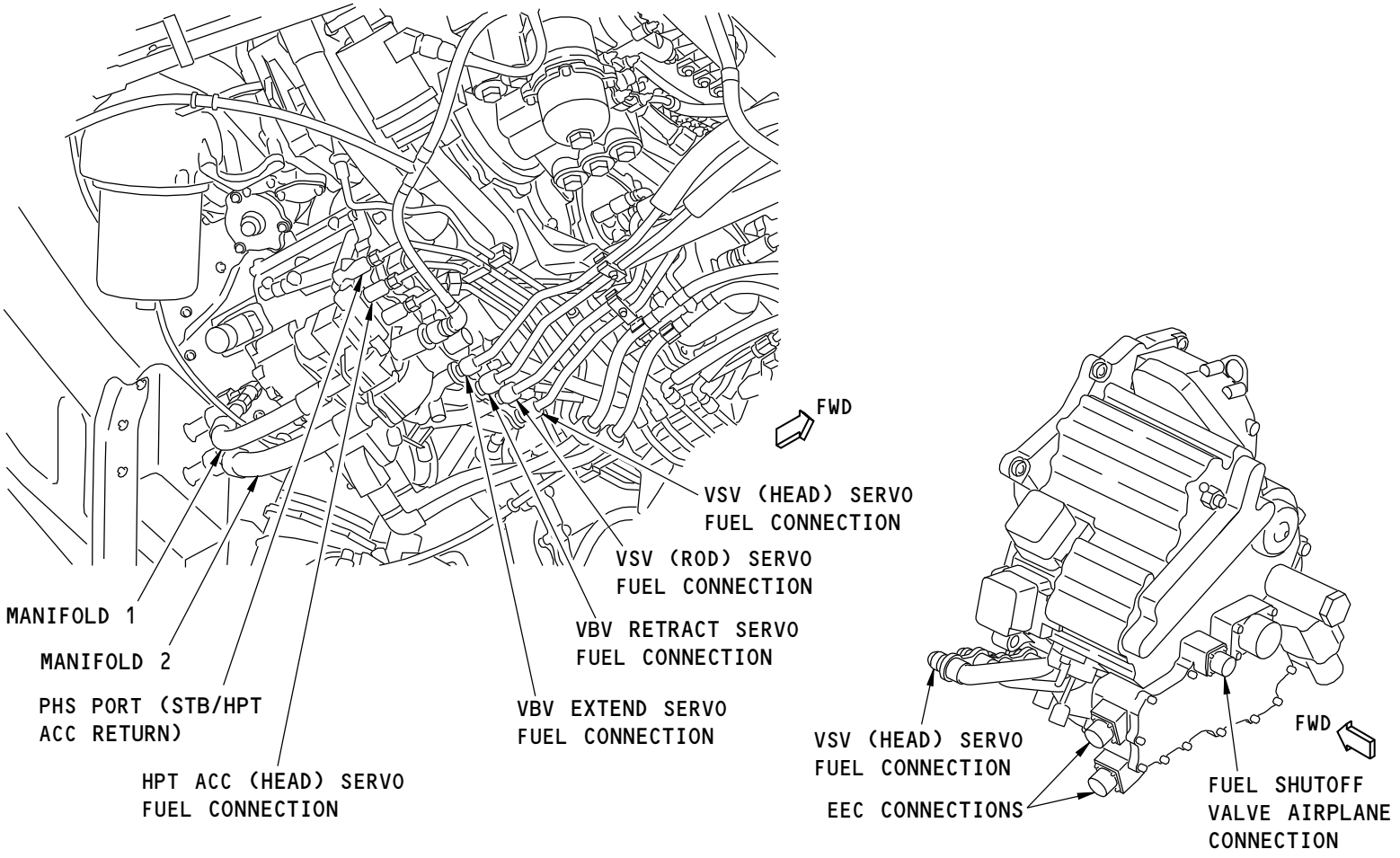
Physical Description

These electrical connections are on the left side of the HMU:

- EEC Connections (2)
- Fuel shutoff valve.

These servo fuel tube and fuel manifold connections are on the bottom of the HMU:

- Manifold 1
- Manifold 2
- PHS port (STB/HPT ACC return)
- HPT active clearance control (ACC)
- Variable bypass valve (VBV) (2)
- Variable stator vane (VSV) (2).



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ENGINE FUEL CONTROL - HMU - INTRODUCTION

ENGINE FUEL CONTROL - HMU FUNCTIONAL DESCRIPTION

General

The HMU has these functions:

- Permits only the correct amount of fuel to flow to the engine for combustion
- Turns fuel flow to the engine on or off
- Distributes fuel to the manifolds
- Supplies servo fuel to actuators and valves of other engine systems.

Metered Fuel Flow Control

Fuel flows into the HMU from the fuel pump. The fuel metering valve (FMV) controls how much fuel goes to the engine (metered fuel). The fuel not used for combustion (bypass fuel) returns to the fuel pump through the bypass valve (BPV).

The EEC controls a torque motor in the HMU (not shown) to control the FMV position. The torque motor controls servo fuel pressure to the FMV. The EEC gets FMV position feedback.

An overspeed governor (OSG) mechanically connects the differential pressure regulator to the main gearbox. If the engine overspeeds, the OSG causes the differential pressure regulator to open the bypass valve to send most of the fuel back to the fuel pump.

Run/Cutoff Control

The engine fuel shutoff valve (SOV) turns fuel flow to the engine on or off. The ELMS energizes the run and cutoff solenoids (not shown) to open or close the SOV. The cutoff solenoid also energizes when you pull the fire switch.

When the run solenoid energizes, fuel pressure opens the SOV. The valve stays open until the ELMS energizes the cutoff solenoid. This permits fuel pressure to close the SOV.

Fuel Distribution

After fuel goes through the fuel flow transmitter, it goes to manifold 1 and to the staging valve (SV).

Fuel to manifold 2 goes through the SV. The EEC controls the SV. The fuel manifold pressure sensor (FMPS) provides feedback to the EEC about the positions of the SV and the SOV.

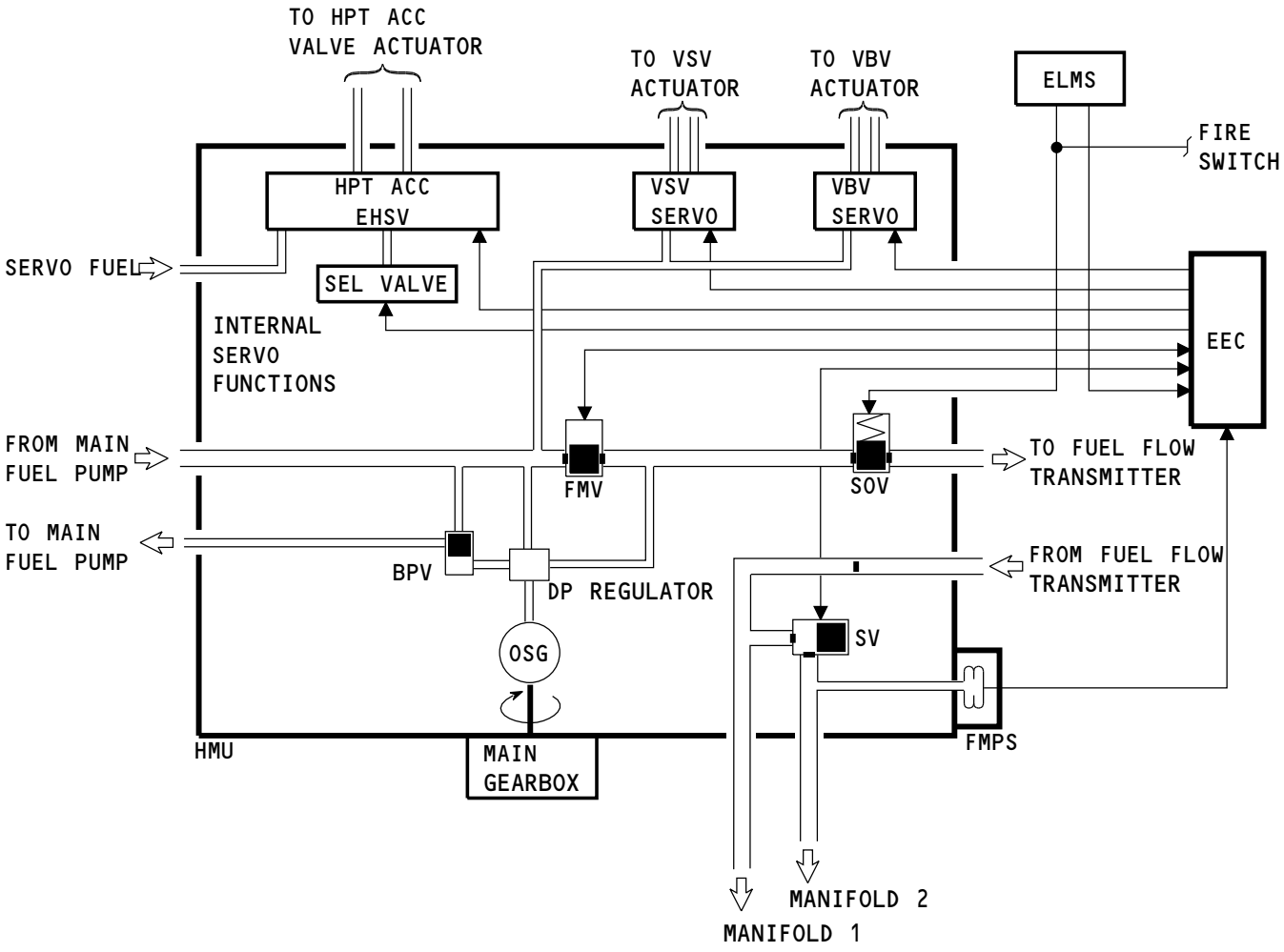
Servo Fuel

The HMU supplies servo fuel pressure to move these engine air system actuators:

- HPT ACC valve
- Variable stator vanes (VSVs)
- Variable bypass valves (VBVs)

The EEC controls torque motors and an electro-hydraulic servo valve (EHSV) to let servo fuel pressure go to the actuators.

The HMU also uses servo fuel pressure to move internal HMU valves.



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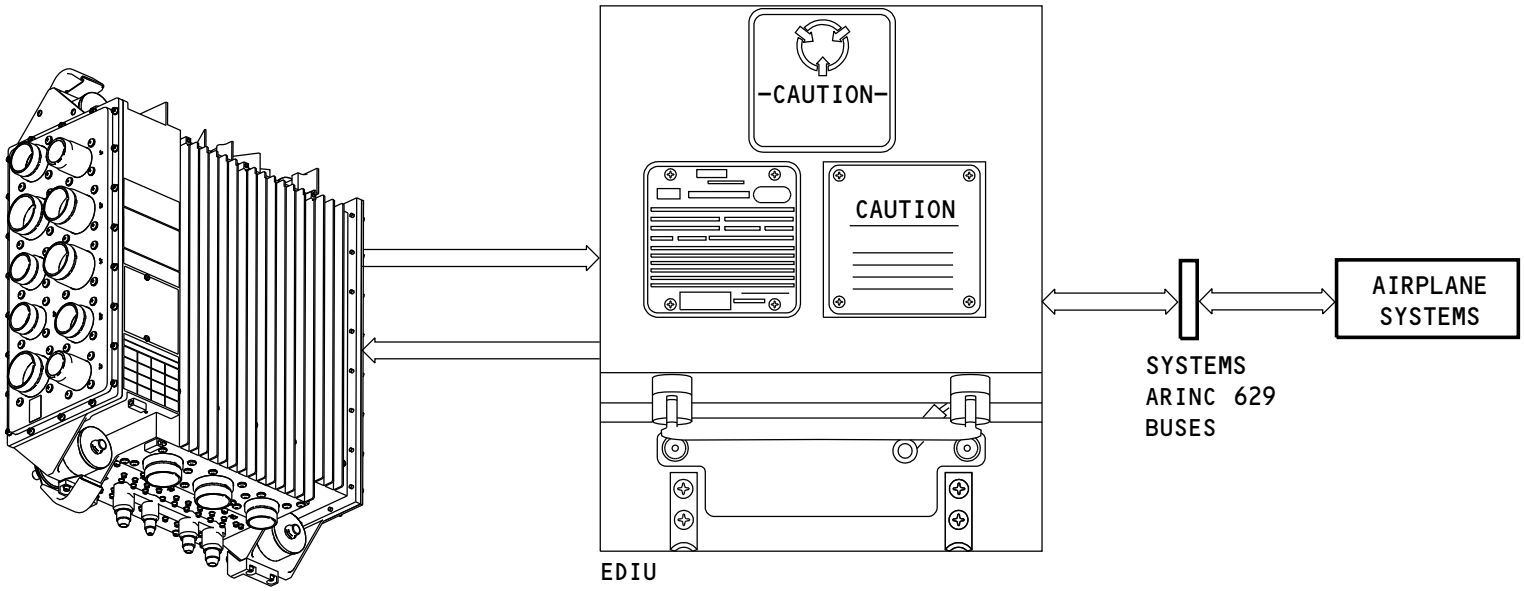
ENGINE FUEL CONTROL - HMU FUNCTIONAL DESCRIPTION

ENGINE FUEL CONTROL - EDIU

General

The EDIU changes the ARINC 429 formatted data to ARINC 629. The EDIU also changes ARINC 629 data to ARINC 429. This permits the EEC to transmit and receive data to and from airplane systems. Each engine has its own EDIU.



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ENGINE FUEL CONTROL - EDIU

ENGINE FUEL CONTROL - CONTROL - EEC POWER MANAGEMENT - FUNCTIONAL DESCRIPTION

General

The EECs get airplane power when one of these conditions occur:

- Fuel control switch is in RUN position
- Start/ignition selector is in START position
- EEC maintenance switch is in TEST position.

The left EEC gets power from the left ac bus. The right EEC gets power from the right ac bus. Each channel of the EEC has a separate source. Channel A gets power from section 1 of the ac bus. Channel B gets power from section 2.

The EEC gets airplane power when the start power relay in the P110 left power management panel energizes. The start power relay coil gets power from the captain's flight instrument bus. The switches control the ground for the start power relay coil.

The control alternator supplies each channel of the EEC with power at approximately 7 percent N2.

Fuel Control Switch

The fuel control switch energizes the ignition/fire detection relay when it is in the RUN position. The ignition/fire detection relay supplies a ground for the start power relay. This permits the EEC to get airplane power during engine operation when there is a control alternator failure. The control alternator (not shown) is the normal power source when the engine is running.

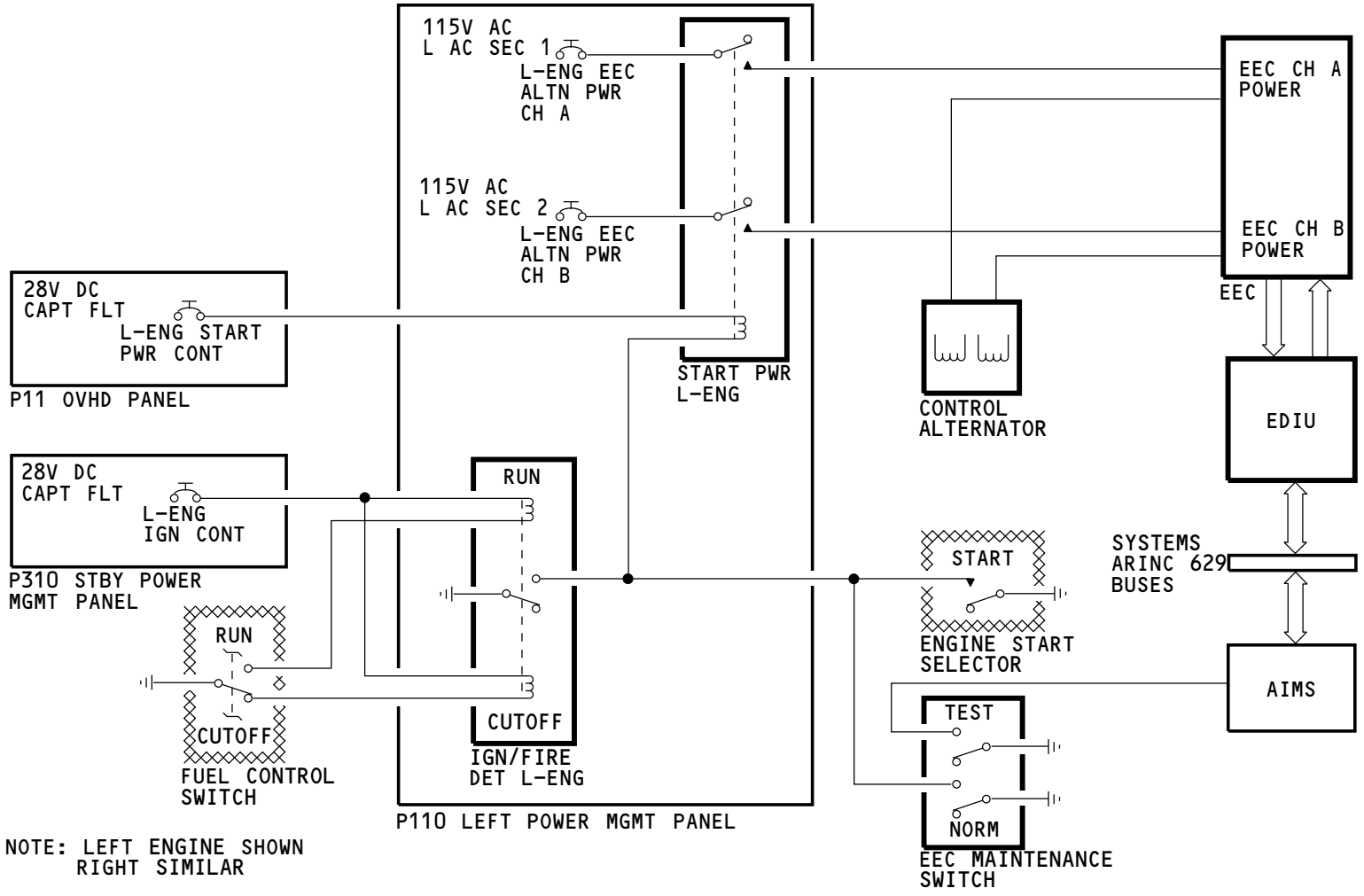
Engine Start/Ignition Selector

The engine start/ignition selector supplies a ground for the start power relay when it is in the START position. This gives the EEC power during engine starts.

EEC Maintenance Switch

The EEC maintenance switch supplies a ground for the start power relay when it is in the TEST position. This gives the EEC power during tests and maintenance operations.

The AIMS sends the position of the switch to the EEC.



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ENGINE FUEL CONTROL - CONTROL - EEC POWER MANAGEMENT - FUNCTIONAL DESCRIPTION

ENGINE FUEL CONTROL - EDIU - FUNCTIONAL DESCRIPTION

General

The EDIU controls data flow between the airplane and the engine.

EDIU

The EDIU is a three-channel data converter. A data converter changes data. Each channel has two data conversion circuits. Two channels (A and B) receive and transmit both ARINC 429 and 629 data. The center channel (C) only receives ARINC 429 data and transmits ARINC 629 data.

Two different dc power sources supply power to each channel of the EDIU.

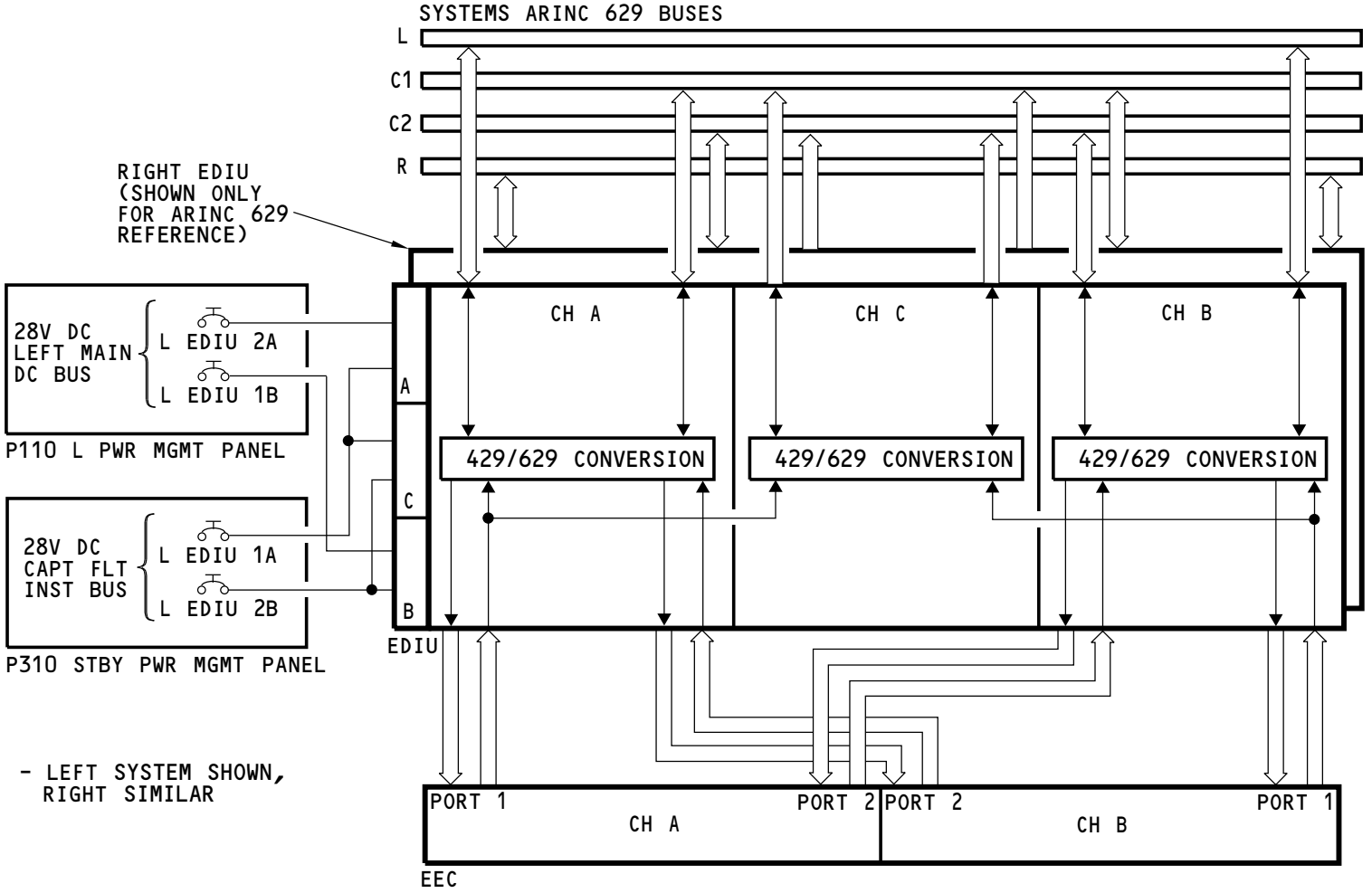
ARINC 629 Interfaces

The left EDIU channels A and B transmit and receive on the left, center 1 (C1), and center 2 (C2) systems ARINC 629 buses. Channel C transmits on the center 1 and center 2 buses.

The right EDIU channels A and B transmit and receive on the right, center 1, and center 2 systems ARINC 629 buses. Channel C transmits on the center 1 and center 2 buses.

ARINC 429 Interfaces

Each EEC channel has two ARINC 429 data ports. This permits the EDIU channels A and B to talk to both EEC channels.



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ENGINE FUEL CONTROL - EDIU - FUNCTIONAL DESCRIPTION

ENGINE FUEL CONTROL - OPERATION

Controls

You operate the engine fuel and control system with these flight deck controls:

- EEC maintenance switch
- EEC mode switch
- Thrust lever
- Fuel control switch
- Fire switch.

EEC Maintenance Switch

The EEC maintenance switch is on the P61 overhead maintenance panel. The switch is a two-position, guarded, toggle switch.

When the switch is in the NORM position, it permits power to go from normal operating power sources to the EEC. When the switch is in the TEST position, it connects airplane ac power to the EEC without starting any EEC control logic. It also sends a ground test discrete signal to the AIMS.

EEC Mode Switch

The EEC mode switch is on the engine start/ignition panel on the P5 overhead panel. The switch is a two-position, guarded, alternate-action switch.

The switch permits the pilots to set the EEC control mode. You should always operate the engines in the same control mode.

Normal Mode (N1)

The normal position of the EEC mode switch is in. When the switch is in, the EEC is in normal mode (NORM). In normal mode, the EEC uses N1 corrected for inlet temperature as the main thrust parameter.

You can put the thrust levers at specified positions to set thrust ratings. When the thrust levers are all the way forward, the engine is at takeoff thrust or maximum continuous thrust. The maximum climb and cruise thrust ratings are set at thrust lever positions less than all the way forward.

Alternate Mode (N1)

The non-normal position of the EEC mode switch is out. When the switch is out, the EEC is in alternate mode (ALTN). In alternate mode, the EEC uses N1 and a TLA schedule to control the engine thrust.

In alternate mode with the thrust levers at a specific position, the thrust changes as the flight condition changes. This requires adjustment of the thrust levers as the airplane flies in order to keep the correct thrust.

The EEC turns on the ALTN light on the EEC mode switch if it does not get the aircraft total pressure signal. Then, you must put the switch in the ALTN position to put the EEC in alternate mode.

Thrust Lever

The thrust levers move the TLA resolvers. The resolver sends the EEC a position signal to permit it to set the proper thrust.

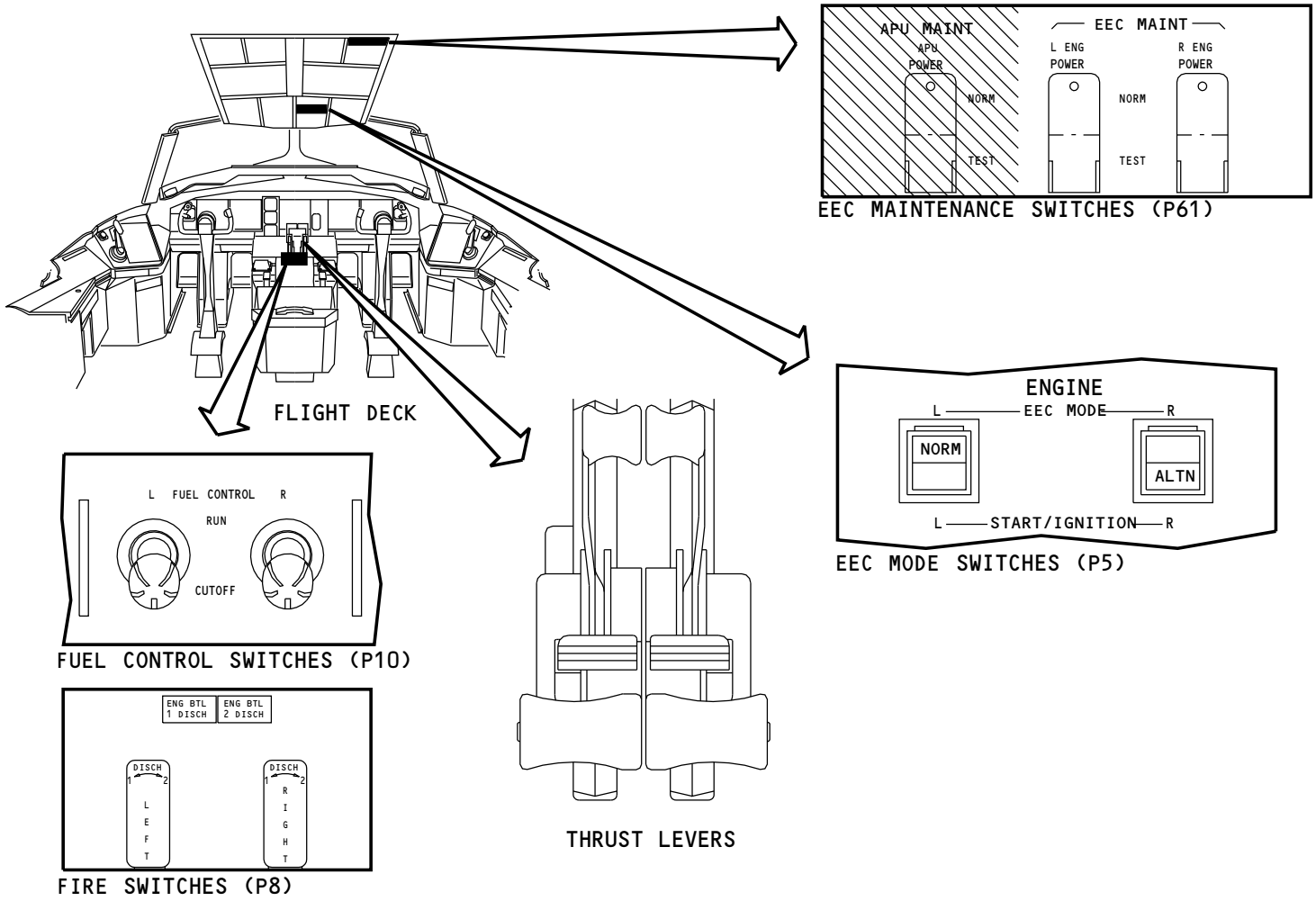
Fuel Control Switch

The fuel control switches have two positions: RUN and CUTOFF. The switches control the shutoff valve in the HMU to control fuel flow to the engine.

In addition, when you move the fuel control switch from RUN to CUTOFF, the EEC resets. This stops the EEC programs and sets them to run from the start.

Fire Switch

The fire switch permits power to go to the shutoff valve relays when the switch is in. When the switch is in the out position, power connects directly to the HMU cutoff solenoid to stop fuel flow to the engine.



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ENGINE FUEL CONTROL - OPERATION

ENGINE FUEL CONTROL - CONTROL - EEC RESET/ENGINE FUEL SHUTOFF VALVE CONTROL

General

The EEC gets a reset signal when you move the fuel control switch from the RUN to the CUTOFF position. When the EEC resets, it writes all fault data in its non-volatile memory (NVM). It also sets the engine start logic to run from the start of the program.

The fuel control switch controls relays in the P110 to open or close the engine fuel shutoff valve (SOV). The SOV gets power to open or to close. Power to operate the SOV comes from the captain's flight instrument bus.

EEC Reset Control

Each channel of the EEC gets a reset signal from a relay in the P110. When you put the fuel control switch in the CUTOFF position, the two EEC reset relays energize after a short time dalay. This energizes the cutoff coils in the reset/fuel spar relay and the EEC reset/IDG disconnect relay. The relay contacts close a circuit to the EEC, which causes the EEC to reset.

Engine Fuel Shutoff Valve Control

When the fuel control switch is in the RUN position, power goes through the generator control/ignition relay to open the SOV. When the fuel control switch is in the CUTOFF position, the generator control/ignition relay energizes to the cutoff position and then, after a short time delay, the fuel control T/D relay energizes and power goes to close the SOV.

The fire switch must be in the NORMAL position to permit power to go through the P110 to operate the SOV. When the fire switch is in the FIRE position, power to close the SOV goes directly to the SOV. It does not go through the P110.

Thrust Control Malfunction Accommodation (TCMA)

TCMA is an EEC function designed to prevent an uncontrollable asymmetric thrust event caused by a loss of engine thrust control.

TCMA will automatically shut off the fuel supply to the engine by closing the HMU fuel shutoff valve.

TCMA will close the fuel shutoff valve when ALL of the following conditions are present:

· The airplane is on the ground.

· Engine thrust is greater than 50 percent of the maximum rated thrust.

· The engine has been commanded to idle by moving the thrust lever to the idle position.

· The engine is not responding to the idle command.

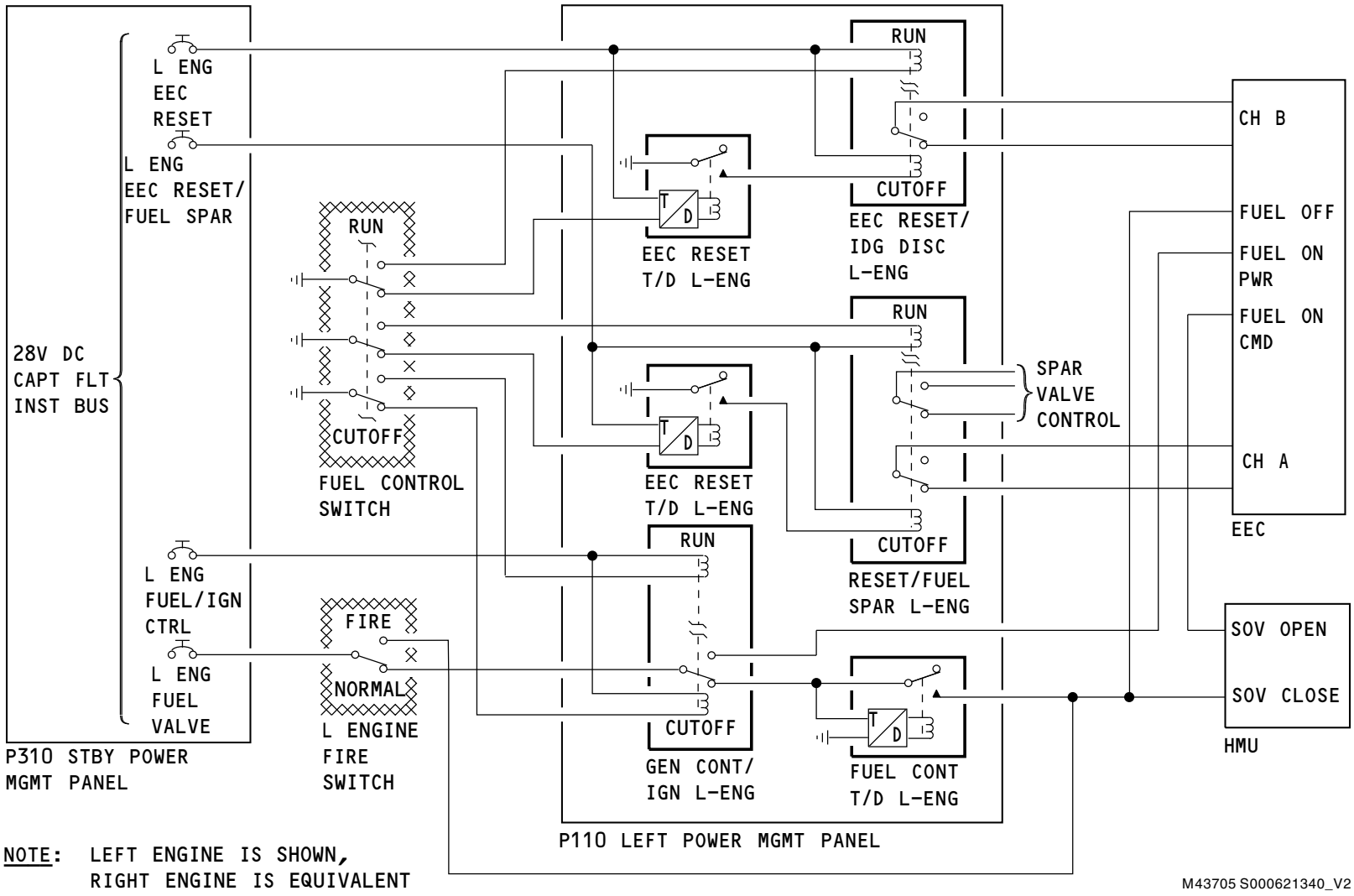
If ALL of the above conditions are present, TCMA will remove fuel from the engine by closing the fuel shutoff valve, and an EICAS caution level message ENG FAIL L(R) will be set.

The TCMA function is built into the internal hardware and control software of the EEC.

The EEC has a set of internal relays dedicated to the TCMA function. These relays are used to provide the 'close' command to the HMU fuel shutoff valve. 28 volt DC electrical power to the relays is provided by external (airplane) power. This power comes through the fuel control relays in the left and right power management panels.

The TCMA function is checked during the EEC engine start BITE check to make sure the TCMA function is available. If the BITE check finds that the TCMA function is not available, due to either a failed TCMA relay internal to the EEC, or due to a failure of airplane supplied 28 volt DC power, the EICAS status level message ENG TCMA L(R) will be set.

The TCMA function uses digital airplane signals from the primary flight computer and low range radio altimeters to determine 'airplane on ground' status. These digital signals are provided via the ARINC 629 buses and the EDIU. If the EEC determines that the digital signals are invalid, the EICAS status level message ENG TCMA L(R) will be set.



NOTE: LEFT ENGINE IS SHOWN,
RIGHT ENGINE IS EQUIVALENT

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ENGINE FUEL CONTROL - CONTROL - EEC RESET/ENGINE FUEL SHUTOFF VALVE CONTROL

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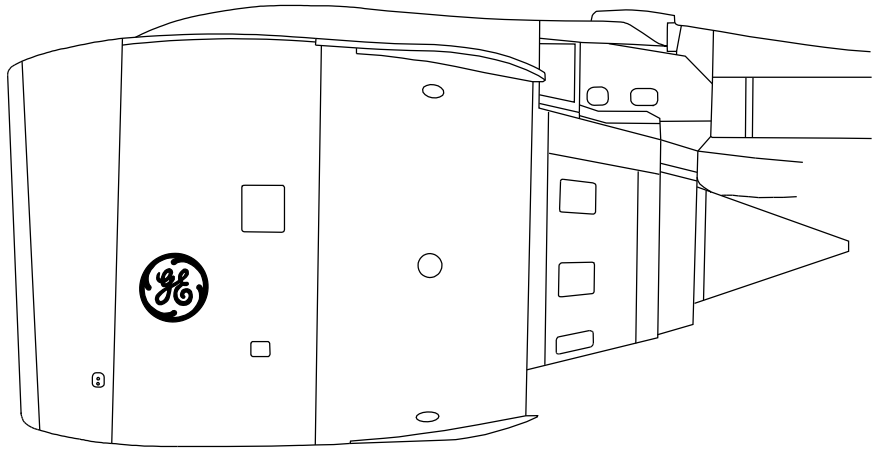
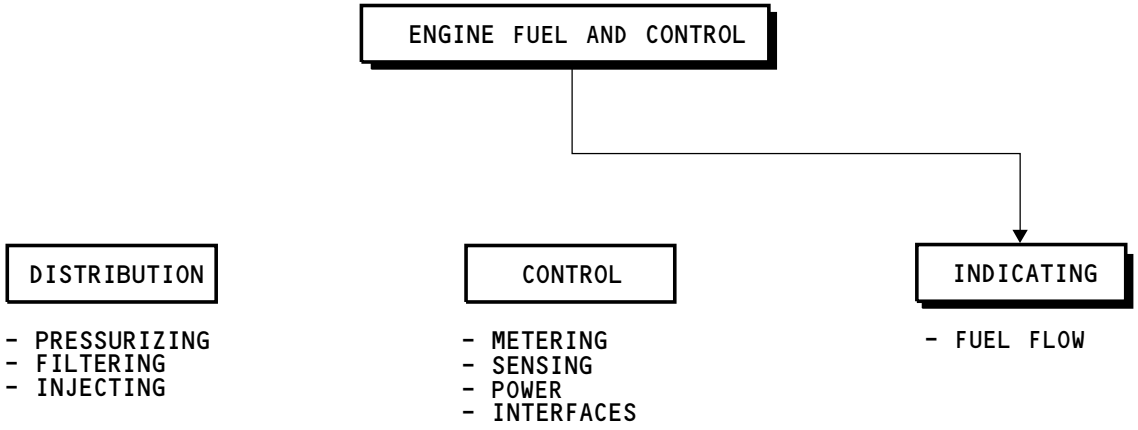
ENGINE FUEL FLOW INDICATING - INTRODUCTION

Purpose

The engine fuel indicating system supplies fuel flow data to the EEC. The EEC transmits this data to the AIMS.





M43747 S000621376_V1

ENGINE FUEL FLOW INDICATING - INTRODUCTION

ENGINE FUEL FLOW INDICATING - GENERAL DESCRIPTION

Purpose

The fuel flow indicating system measures the engine fuel flow rate. It also supplies the airplane with the information for indication and flight management.

Fuel Flow Transmitter

The fuel flow transmitter is on the right side of the engine at approximately the 5:00 position. Fuel flows from the HMU to the transmitter, then back to the HMU.

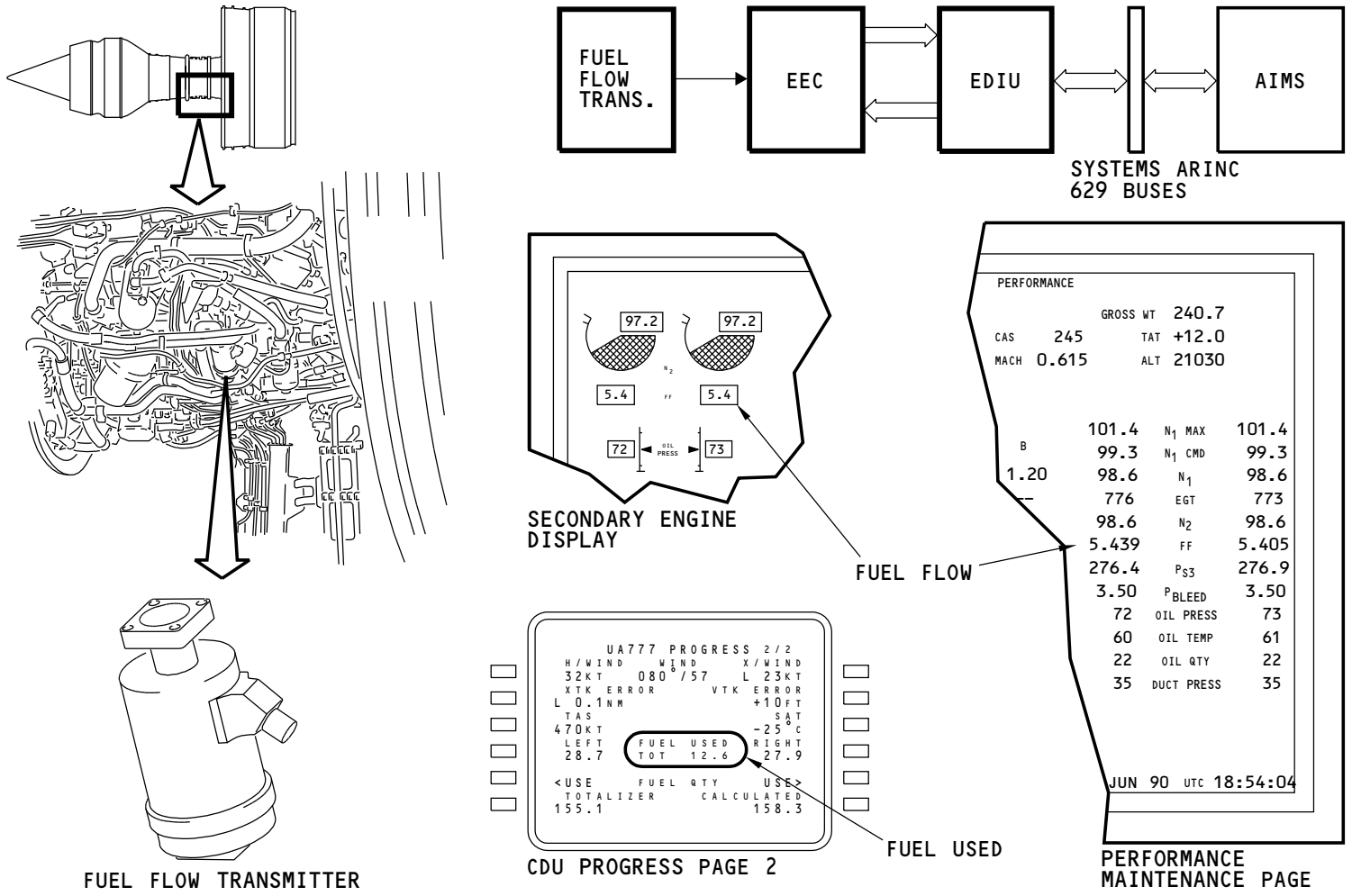
The transmitter does not have a motor. It sends analog pulse signals to the EEC that are in proportion to the fuel mass flow rate.

Functional Description

The EEC uses the signals from the fuel flow transmitter to calculate the fuel mass flow rate. The EEC sends this data to the AIMS.

The AIMS shows the fuel flow rate, in thousands of kilograms per hour, on the secondary engine display and performance maintenance page.

The flight management function of the AIMS uses the data to calculate fuel-used data. The control display unit (CDU) shows the fuel used on the CDU progress page 2.



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ENGINE FUEL FLOW INDICATING - GENERAL DESCRIPTION