2A-76-10: General

The Full Authority Digital Engine Control (FADEC) provides independent engine performance control and monitoring in response to flight crew switch position and power lever position commands. Each FADEC communicates with the Modular Avionics Units (MAUs) over ARINC-429 data buses to receive Air Data Module (ADM) information from aircraft environmental systems such as the pitot static and Total Air Temperature (TAT) probes. Each FADEC also transmits data to the MAUs and Monitor and Warning System (MWS) for use in providing synoptic and system window displays of engine performance as well as engine related Crew Alerting System (CAS) messages.

Although the flight crew monitors engine performance on cockpit displays, FADEC control of the engine is not transparent to the crew. The FADEC uses dedicated sensor and control circuits to gage engine operation and independently modulate engine components such as the Fuel Metering Unit (FMU), engine handling bleed valves, fuel heating and the position of the variable inlet guide vanes and stator vanes to maintain engine performance at the desired level.

FADEC control of engine operation is accomplished by the following subsystems:

- 2A-76-20: Electronic Engine Control
- 2A-76-30: Engine Thrust Management System

2A-76-20: Electronic Engine Control

1. **General:**

   FADEC engine control functions are hosted within the Electronic Engine Control (EEC). The EEC, mounted on the engine exterior at the twelve (12) o'clock position, is a dual channel fully redundant unit. The channels are denoted as A and B. Each channel of the EEC has two circuit boards that contain the software for engine control. One circuit board is the Central Processor Unit (CPU) and the other contains the interface to the dedicated power supply and the independent overspeed monitoring function. Both channels of the EEC have independent connections to engine pressure and temperature sensors as well as independent electronic circuits for control of engine operation. Although both A and B channels are powered whenever the engine is operating, only one channel controls the engine. (The FADEC switches control authority between the channels at each engine shutdown.) The redundant channel acts as a standby unit, available to assume engine control in the event of failure of the active channel. The active channel is continually monitored for performance by an internal circuit termed a "watchdog timer". The timer actively interrogates the controlling channel and requires a response within a specified time frame. If the timer does not receive the expected response, engine control is temporarily shifted to the alternate channel while the previously controlling channel is reset. If four (4) resets occur, engine control is permanently shifted to the alternate channel.

2. **Description Of Subsystems Units And Components:**

   (See Figure 1.)

   A. **Power Supply Unit (PSU):**

   The EEC channels are powered by a dedicated generator attached to the engine accessory gearbox. The generator consists of rotating permanent magnets within a field winding that produces three phase (3ϕ) Alternating

Current (AC). Some of the output of one phase is used to power the Independent Overspeed Protection (IOP) circuit prior to all three phases being rectified by the PSU into twenty-eight volt Direct Current (28v DC) that is the normal power source for the EEC. Since power from the dedicated EEC generator is not available until the engine is running, aircraft electrical system DC power is provided to the active EEC channel by the PSU during engine starts. The left essential DC bus powers EEC channel A and the right essential DC bus powers channel B of both engine FADEC EECs until the engine being started reaches approximately thirty-five percent (35%) High Pressure (HP) rpm. As the engine accelerates, sufficient power is produced by the EEC generator to support control of engine functions for the remainder of the starting process. The PSU switches power sources with no interruption of voltage to the EEC channel. At engine shutdown, the process is reversed, with the PSU acquiring aircraft system power to complete shutdown monitoring.

B. Central Processor Unit (CPU):

The Central Processor Unit (CPU) circuit card receives external engine power requirement data though direct electrical analog and data bus connections to cockpit switches and aircraft systems. The CPU embedded software controls engine response to commands for engine starting, acceleration, deceleration, reverse thrust and automatic relight. Engine requirements are sourced from:

- Fuel Control switch
- Master Start and Crank switches
- Engine (L or R) Start switch
- Continuous Ignition switch
- Reverse Lever Position
- Power Lever Rotary Variable Displacement Transducer (RVDT)
- Pneumatic Bleed Air switches (Engine Bleed, Air Conditioning Pack, Wing and Cowl Anti-ice)
- Internal engine monitoring sensors

Additional data is received from the Weight-On-Wheels (WOW) switch system for thrust reverser operation and from the Display Controller (DC) in the event that the flight crew selects the Alternate Engine Control mode that regulates Low Pressure (LP) turbine speed.

The CPU compares engine demands with the existing engine thrust state by sampling engine information derived from electrical and pneumatic sensor connections distributed throughout the engine interior. Internal engine data are provided by:

- Low Pressure (LP) or N_1 speed sensors
- High Pressure (HP) or N_2 speed sensors
- Turbine Gas Temperature (TGT) thermocouples
- Pressure probes within the HP compressor
- Starter Air Valve position
- Thrust Reverser position

If the CPU determines that a change in engine thrust is necessary to satisfy power requirements, the CPU modifies engine thrust by altering the position of the one or more of the following engine controls:

- Fuel Metering Valve
- Engine Handling Valves
- Variable Inlet Guide Vane and Variable Stator Vanes
- High Pressure Shutoff Valve (HPSOV)
- Starter Air Valve
- Ignitor(s)
- Thrust Reverser position (in conjunction with system hydraulic pressure)

The same sensors and controls are employed by the CPU to maintain the engine at a steady thrust setting during changing atmospheric conditions. Changes in the external environment are detected by the CPU from data collected by the Modular Avionics Units (MAUs) from the pitot static probes and Air Data Modules (ADMs) and through direct connections to the Total Air Temperature (TAT) probes.

Additional functions performed by the CPU include providing limit protection for LP and HP rotor speed and TGT, monitoring the status of the engine oil system and operation of the Heated Fuel Return System (HFRS) to maintain fuel tank temperature within limits.

Data from the CPU internal engine sensors is relayed back to the MAUs for transmission to the Monitor and Warning System (MWS) for generation of the engine instrumentation displays on the Engine, Alternate (Secondary) Engine, Compacted Engine and Engine Start system 1/6 windows. CPU data is also used by the MWS for prompting the display of Crew Alerting System (CAS) messages related to engine performance. An additional discrete path of engine sensor data is provided to Multi-function Control and Display Units (MCDUs) #1 and #2 to provide a source of engine control information in the event of failure of the normal aircraft display system.

C. Independent Overspeed Protection (IOP) Circuit:

A specific software function embedded in the EEC circuit boards independently monitors the LP and HP rotors. If the speed of the LP rotor (N_1) exceeds 8,248 rpm or one hundred eleven percent (111%) and/or the HP rotor (N_2) speed reaches 17,424 rpm or one hundred nine point six percent (109.6%), the EEC will command the shutdown of the engine by signaling the closure of the fuel system High Pressure Shut Off Valve (HPSOV). (See Section 2A-73-10 regarding the HPSOV.) In order for the EEC to shut down the engine, the overspeed condition must be detected by IOP function of both the actively controlling EEC channel and the standby EEC channel.

D. Data Entry Plug (DEP):

A data entry plug is installed on the engine to program engine performance values into the EEC. Programming is required only after an engine change or after major engine repairs. Data entered via the plug include TGT limits, Engine Pressure Ratio (EPR) to engine thrust produced as determined by calculated and engine testing values and thrust relationship to power lever RVDT values. Entering this data into each engine contributes to symmetrical engine response to autothrottle and power lever inputs.

If faulty data is programmed into the EEC, the engine will revert to the alternate control mode where thrust is set using LP (N_1) speed. The alternate control mode is discussed in Section 2A-76-30.

3. FADEC Modification to Software Version S2.1:

The following is applicable to airplanes SNs 5001 - 5031 with ASC 019 and SN 5032 and subsequent. This modification installs the updated S2.1 software for the FADEC Electronic Engine Controller (EEC).

A. Keep Out Zone:

An automatic “Keep Out Zone” (KOZ) is used with the S2.1 upgrade, which prevents engine ground speed from lingering in 66% and 80% LP speed range. It is controlled by the EEC as an LP function and its operation is completely transparent to the flight crew.

In addition to the KOZ function, fuel flow demand calculation is changed to improve quick relight functionality. The calculation for a “Lane Disconnect Fault” has also been improved, which eliminates a Do Not Dispatch (DND) Box 1 fault from being erroneously flagged.

The following are the parameters for activation:

- LP operating in the 66-80% RPM range
- Weight On Wheels (WOW) in GND mode
- PARK/EMER BRAKE in the ON position (if airplane is static)
- Ground speed less than 31 knots (if airplane is moving)

B. Typical Operating Scenarios:

- **Scenario 1 (Airplane Static):** (LP RPM is less than 66% and KOZ parameters are met.) If the airplane power lever(s) is advanced into the 66-80% LP RPM band and is allowed to linger there, KOZ will automatically increase LP RPM to 80%. (The power levers do not move.) To retard power below 66% or advance power above 80%, the power levers must be advanced until Power Lever Angle (PLA) is equal to the current LP RPM. When this is achieved, the engine will then respond to power lever inputs. If the power levers are retarded and linger in the 66-80% LP RPM band, the KOZ function will be repeated.
- **Scenario 2 (Airplane Static):** (LP RPM is greater than 80% and KOZ parameters are met.) If the airplane power lever(s) is retarded in the 66-80% LP RPM band and is allowed to linger there, KOZ will automatically decrease LP RPM to 66%. (The power levers do not move.) To advance power above 80% or retard power below 66%, the power levers must be retarded until PLA is equal to the current LP RPM. When this is achieved, the engine will then respond to power lever inputs. If the power levers are advanced and linger in the 66-80% LP RPM band, the KOZ function will be repeated.
- **Scenario 3 (Airplane Moving):** If airplane is left in MAX REVERSE (70%) and ground speed decreases to less than 31 knots, KOZ will automatically decrease LP RPM to 66%. (The power levers do not move.) To advance power above 80% or retard power below 66%, the reverser levers must be stowed and the power levers must be retarded until PLA is equal to the current LP RPM. The engine will

then respond to power lever inputs. If the power levers are advanced and linger in the 66-80% LP RPM band, the KOZ function will be repeated.

4. Controls and Indications:

A. Circuit Breakers (CBs):

The electronic engine control system is powered by the following CBs:

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
L FADEC A	LEER	A-14	L Essential DC Bus
L FADEC B	REER	A-10	R Essential DC Bus
R FADEC A	LEER	A-13	L Essential DC Bus
R FADEC B	REER	A-11	R Essential DC Bus

B. Crew Alerting System (CAS) Messages:

CAS messages associated with the electronic engine control system are:

Area Monitored:	CAS Message:	Message Color:
EEC	L-R Engine Exceedance	Red
EEC	L-R Engine Fail	Red
EEC	L-R Engine Hot	Red
EEC	L-R Engine Data Miscompare	Amber
EEC	L-R Engine Exceedance	Amber
EEC	L-R Engine Maintenance	Amber
EEC	L-R Engine Maintenance STD	Amber
EEC	L-R Engine Off	Amber
EEC	L-R FADEC A-B Bus Fail	Amber
EEC	L-R FADEC Hot	Amber
EEC	L-R SAV Maintenance	Amber
EEC	Exceedance Record	Blue
EEC	L-R Engine Backup AirData	Blue
EEC	L-R ENG Maintenance ###	Blue
EEC	L-R Engine Maintenance LTD	Blue
EEC	L-R FADEC A Bus Fail	Blue
EEC	L-R FADEC B Bus Fail	Blue

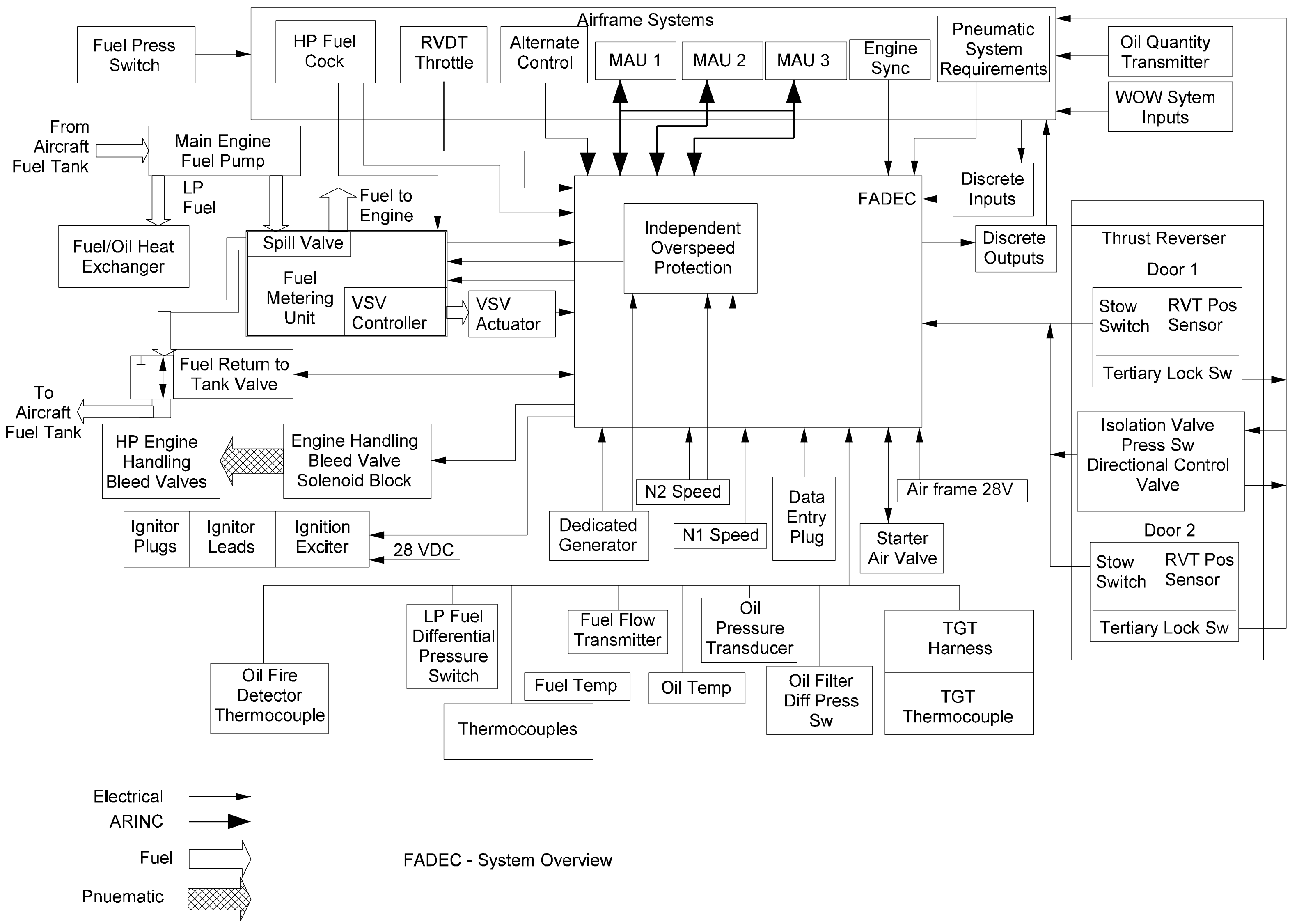
Other CAS messages generated by the electronic engine control system related to other sections in this chapter are:

CAS Message:	Message Color:	Section Discussed:
L-R Oil Pressure Low	Red	2A-79-00
L-R Oil Temperature High	Red	2A-79-00

CAS Message:	Message Color:	Section Discussed:
L-R Oil Temperature Low	Red	2A-79-00
L-R Thrust Reverser Unlock	Red	2A-78-00
L-R Autostart Abort	Amber	2A-80-00
L-R Oil Pressure Low	Amber	2A-79-00
L-R Oil Temperature Low	Amber	2A-79-00
L-R Throttle Configuration	Amber	2A-80-00
L-R Thrust Reverser Fail	Amber	2A-78-00
L-R Thrust Reverser Maint	Amber	2A-78-00
L-R Thrust Reverser Unlock	Amber	2A-78-00
Assisted Airstart	Blue	2A-80-00
L-R Engine ALT Control	Blue	2A-76-30
L-R Engine Fuel Pressure	Blue	2A-73-00
L-R Fuel Filter	Blue	2A-73-00
L-R Fuel Return Fail	Blue	2A-73-00
L-R TR Switch Miscompare	Blue	2A-78-00
Start Switch Configuration	Blue	2A-80-00

5. Limitations:

There are no limitations established for the electronic engine control system at the time of this writing.



FADEC - System Overview

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FADEC Block Diagram
Figure 1

2A-76-30: Engine Thrust Management System

1. General Description:

Flight crew management of engine thrust is accomplished by manual or autothrottle movement of the power levers on the center console. Thrust settings are monitored by reference to the indications on the selected display window (Engine, Alternate Engine or Compacted Engine 1/6 windows). The power levers signal thrust commands through Rotary Variable Displacement Transducers (RVDTs) incorporated into the power lever mounts beneath the cockpit console panel. Each engine power lever RVDT has two channels linked to the corresponding channels of the Electronic Engine Controller (EEC) within the Full Authority Digital Engine Control (FADEC). See Figure 3. Power lever movement thus results in the controlling EEC channel adjusting fuel flow to the engine to match the thrust setting dictated by the power lever. (See Sections 2A-76-20: Electronic Engine Control System and 2A-73-10: Engine Fuel System.) When the autothrottle is controlling thrust management, servos on the power lever mounts move the power levers through commands from the Flight Management System (FMS) communicated over ARINC-429 bus connections. Autothrottle power lever movement is communicated by the RVDTs to the controlling EEC channel that directs the appropriate engine response.

Since actual engine thrust can only be measured in a test facility, a surrogate measurement of thrust is used to manage engine power. The primary thrust setting reference on the Engine window(s) display is Engine Pressure Ratio (EPR). EPR is defined as the ratio of pressure sensed at the rear of the Low Pressure (LP) turbine to the pressure of the ambient atmosphere. The ratio measures the increase in ambient pressure generated by the action of the engine compressor stages and the energy of combustion driving the engine turbine stages. EPR is measured by the engine EEC and communicated to the Modular Avionics Units (MAUs) for use by the display systems.

A typical EPR value for takeoff thrust at an airport near sea level on a standard day is one point five three (1.53). The EPR value is not a true indication of actual engine thrust since it does not measure the propulsive force generated by the LP fan stage air that effectively contributes a thrust component equivalent to some turbopropellers. EPR is used for thrust management because it most accurately measures the internal forces of the engine compressor and turbine stages.

If a malfunction prohibits EPR measurement by the engine EEC, an alternate method of thrust management is control of the speed of the LP rotor (N_1). LP rotor rpm provides a convenient method of engine control since it is easily measured, however, like EPR, it does not reflect actual engine thrust and has the additional disadvantage of being unable to directly determine engine combustion forces since the LP rotor is not mechanically driven by the High Pressure (HP) turbine.

2. Forward Trust Management:

A. Engine Pressure Ratio (EPR) Control:

Engine Pressure Ratio is computed by the EEC by comparing ambient air pressure to the pressure within the engine aft of the turbine stages. Four ambient air pressure data sources are averaged by the EEC: three (3) from each of the aircraft Air Data Modules (ADMs) as communicated by the MAUs, and one direct engine sample derived from an inlet forward of the LP fan stage. The net effect of engine air compression and combustion is sensed by four (4) inlets incorporated into the turbine outlet guide vanes. The inlets are plumbed together and are connected directly to the EEC.

The ratio of ambient air pressure to turbine outlet pressure is measured by the EEC as EPR.

The EEC provides a reference electrical signal to the power lever RVDTs. The RVDTs return a voltage to the EECs proportional to power lever position between idle and maximum (full) forward. The EEC software interprets the return voltage as an EPR power setting command and adjusts engine fuel flow accordingly.

B. Low Pressure Rotor Speed (N_1) Control:

If a malfunction or failure results in the loss of EPR data to the EEC, an alternate means of controlling thrust by regulating Low Pressure (LP) rotor speed (N_1) is available. LP speed is monitored by sensors mounted in the front bearing housing of the LP rotor. The sensors magnetically measure rotor speed and electrically signal the rpm value to the EEC. Software within the EEC will revert to a programmed relationship between power lever RVDT position and LP speed control. If a failure causes an EEC reversion to LP engine control, the EPR value for that engine will no longer be available on any of the selected display windows and a Crew Alerting System (CAS) blue “L-R Engine ALT Control” advisory message will be shown on the CAS display. (See Figure 5.)

If one engine reverts to alternate LP thrust control, the other engine should be manually selected to LP control in order to maintain symmetric thrust. Manual selection of alternate engine control is accomplished using the Display Controller (DC). The DC Sensor menu contains a Line Select Key (LSK) for engine data on the lower left of the menu. Depressing the engine data LSK results in the display of the ENG DATA menu. The first and second LSKs on the menu, labelled RCTL and LCTL, may be used to select ALT control for the right and left engines. See Section 2B-02-00 for a description of the Display Controller.

C. Autothrottle System:

The autothrottle system is a function of software integrated into the Flight Management System (FMS). The autothrottles are engaged and disengaged by manual selection of switches located on the power levers. The autothrottles will also disengage if the flight crew manually changes the power lever position set by the autothrottles. The power levers additionally incorporate a pushbutton on the outside of each power lever knob that immediately selects the takeoff or go around power lever position.

(See Figure 6 and Figure 7.)

When the autothrottle system is engaged for takeoff, the FMS will drive the power levers forward to the thrust setting selected on the Multi-Function Control and Display Unit (MCDU) takeoff initialization page. During takeoff, the FMS will maintain a constant power lever position after the aircraft has accelerated through sixty (60) knots. The fixed power lever position is maintained until four hundred (400) feet, at which time the FMS will position the power levers to the climb power setting selected on the PERFORMANCE INIT page of the MCDU. Because of the close integration of the FMS and the autothrottle system, aircraft speed can be controlled by the FMS according to standard regulatory limits - i.e. maintaining two hundred fifty (250) knots below ten thousand (10,000) feet or until passing into uncontrolled airspace. When speed is no longer restricted, the FMS will command the power levers to the selected appropriate climb speed schedule and when cruise altitude is reached, reduce power to long range cruise or other selected setting.

With both autopilot and autothrottle engaged, the flight crew can control aircraft speed by entries made on the MCDU or by manual selections made on the Flight Guidance Panel. Guidance panel entries are made by depressing the pushbutton below the speed window (the legend within the button will illuminate ON), and manually rotating the CHG knob between the pushbutton and the speed window. The autothrottle will change power lever position to achieve the selected speed. Any manual selection made on the guidance panel will override selections programmed with the MCDU.

For a complete description on the use of the autothrottle and autopilot including descent and approach modes, see Sections 2B-04-00 through 2B-06-00.

A sub-function of the autothrottle system called the Electronic Thrust Trim System (ETTS) enables the flight crew to synchronize the engines in order to reduce noise in the aircraft cabin. The crew can select synchronization of either EPR, LP rpm or HP rpm using the Display Controller TRS menu. The lower left LSK on the menu page is used to select the controlling engine parameter. When synchronization is selected, the FMS uses a discrete ARINC-429 bus signal to increase the power setting at the EEC of the lower performing engine to match the selected criteria of the other engine. The control authority of the ETTS is limited to plus or minus five percent (± 5%) change. See Section 2B-05-00 for more information.

NOTE:

The autothrottle system cannot be used if the engines are in alternate LP rotor speed control.

D. Reduced Takeoff (FLEX) Thrust Settings:

If aircraft takeoff gross weight, airport density altitude and runway length do not require the use of maximum rated thrust to safely perform a takeoff, a method incorporating an assumed higher ambient temperature may be employed in order to reduce the amount of thrust (EPR) used for takeoff. The lower thrust setting is derived by determining the maximum allowable temperature condition for the existing gross weight and runway length (adjusted), and using the EPR setting of the elevated temperature. (High ambient temperatures result in lower rated EPR values because of turbine temperature limits.) See Figure 4. This reduced or flexible EPR setting prolongs engine life, provides increased fuel efficiency and reduces engine noise. A full discussion of the method of determining FLEX EPR, along with the limitations that must be met in order to utilize less than rated thrust, are contained in Appendix A of the G550 Airplane Flight Manual.

NOTE:

FLEX EPR must be at least seventy-five percent (75%) of the maximum rated EPR for actual ambient conditions

3. Idle Thrust Management:

The engine EEC controls HP rpm when the power lever is positioned to idle. The idle power lever setting has two ranges: high idle and low idle. High idle has an HP rpm range of seventy to eighty-five percent (70% - 85%). Low idle has a range of sixty-four to eighty-five percent (64% - 85%) HP rpm. The EEC will control the engine at the high idle setting if data from the MAUs indicate that the aircraft is in approach mode. Approach mode is indicated if the flaps are set to more than twenty-two degrees (22°), the Weight-On-Wheels (WOW) system is in the air mode, and the anti-skid wheel speed sensors detect wheel rotation less than fifty-three (53) knots. If a data failure prevents the EEC from determining the approach configuration, the EEC will default to the high idle mode. High idle during an approach ensures a more rapid engine response in the event of a go around. The EEC will continue the high idle control mode for five (5) seconds after landing to allow rapid engine acceleration for reverse thrust if needed.

The exact HP rpm setting for both low and high idle is dependent upon pressure altitude, with a minimum rpm setting predicated upon the following engine functions:

- Supplying sufficient bleed air to meet pneumatic system and anti-icing requirements
- Prevent ice accumulation on the engine fan stage
- Maintain the engine-driven generator at operational speed
- Operation of the engine handling bleed valves during rain ingestion or other inclement conditions

4. Reverse Thrust Management:

Reverse engine thrust is available upon landing when the WOW system is in ground mode or the wheel speed sensors indicate a speed greater than forty-five (45) knots. In reverse thrust, the EEC controls engine LP rpm in response to movement of the smaller reverse levers installed on the forward section of the main power levers. The reverse levers are mechanically connected to the power lever RVDTs and communicate power commands through the normal power lever channels to the engine EECs. See the illustration in Figure 2.

In order for the reverse levers to move up and aft to command reverse thrust levels, the main power levers must be in the idle position. Selecting reverse thrust with the reverse levers will initiate hydraulic deployment of the reverser doors on the engine exhaust section. Reverse thrust is limited to idle until the engine reverser doors are open at least forty degrees (40°) - the doors are fully open at sixty degrees (60°). When the doors reach the minimum opening deployment, the EEC will adjust fuel flow to the engine to achieve the reverse thrust levels commanded by the reverser levers. Maximum reverse thrust is limited to seventy percent (70%) LP rpm.

For a description of the operation of the engine thrust reversers see Section 2A-78-20: Thrust Reverser System.

5. Controls and Indications:

The Engine system 1/6 window display contains the primary indicators for controlling engine thrust. If the Engine system window is not available, the Compacted Engine window and Alternate (Secondary) Engine window may be used to monitor engine thrust. If no display system is available, engine thrust may be controlled and monitored using entries on the Multi-Function Control and Display Unit (MCDU).

With the autothrottle system engaged, the Primary Flight Display (PFD) contains text annunciations of the autothrottle control modes selected with the display controller.

For descriptions of the engine parameters shown on the various display windows and the formats of autothrottle annunciations, see the appropriate Sections 2B-03-00 through 2B-06-00.

A. Circuit Breakers (CBs):

The following circuit breakers power elements of the engine thrust management system:

Circuit Breaker Name	CB Panel	Location	Power Source:
THROT QUAD	COP	C-2	R MAIN DC Bus
A/T SERVO	COP	E-4	R MAIN AC Bus

B. Crew Alerting System (CAS) Messages:

CAS messages associated with the engine thrust management system are:

Area Monitored:	CAS Message:	Message Color:
FMS / Autothrottle	A/T Not in Hold	Amber
EEC	L-R Engine ALT Control	Blue
FMS / Autothrottle	A/T 1-2 Fail	Blue
FMS / Autothrottle	A/T 1-2 TQA Power Fail	Blue
FMS / Autothrottle	A/T Disp Controller	Blue
FMS / Autothrottle	A/T Inhibit ADS	Blue
FMS / Autothrottle	A/T Inhibit AFCS	Blue
FMS / Autothrottle	A/T Inhibit Alternate Cont	Blue
FMS / Autothrottle	A/T Inhibit Disconnect Sw	Blue
FMS / Autothrottle	A/T Inhibit EDS	Blue
FMS / Autothrottle	A/T Inhibit EPR	Blue
FMS / Autothrottle	A/T Inhibit FADEC	Blue
FMS / Autothrottle	A/T Inhibit IRS	Blue
FMS / Autothrottle	A/T Inhibit Speed	Blue
FMS / Autothrottle	A/T Inhibit Throttle	Blue
FMS / Autothrottle	A/T Inhibit Thrust Rev	Blue
FMS / Autothrottle	A/T Manual Override	Blue
FMS / Autothrottle	A/T WOW Fault	Blue
FMS / FADEC / Autothrottle	Engine Sync Fail	Blue
FMS / FADEC / Autothrottle	Engine Sync Limit	Blue
Power Lever RVDTs / FADEC	Throttle Quadrant 1-2 Fail	Blue

6. Limitations:

A. Primary Operating Limits:

The following limitations exist for the BR710C4-11 engines installed on the Gulfstream G550:

Condition	MAX LP (%)	MAX HP (%)	MAX TGT	Time Limit
Ground Start (1)	—	—	700°C	Momentary
Airstart (Relight)	—	—	850°C	Momentary
Takeoff (2)	101.1	99.6	900°C	5 Minutes
Maximum Continuous	101.0	98.9	860°C	Unrestricted
Maximum Overspeed	101.5	99.8	—	20 Seconds
Maximum Overtemperature	—	—	905°C	20 Seconds
Reverse Thrust (3) (4) (5)	66.0	—	—	30 Seconds

NOTE(S):

(1) Maximum TGT prior to ground start is 150°C.

(2) The use of takeoff rating is limited to five (5) minutes all engines operating or ten (10) minutes in the event of an engine failure.

NOTE:

Exceedances will be recorded after five (5) minutes, but should be ignored if single engine performance is required.

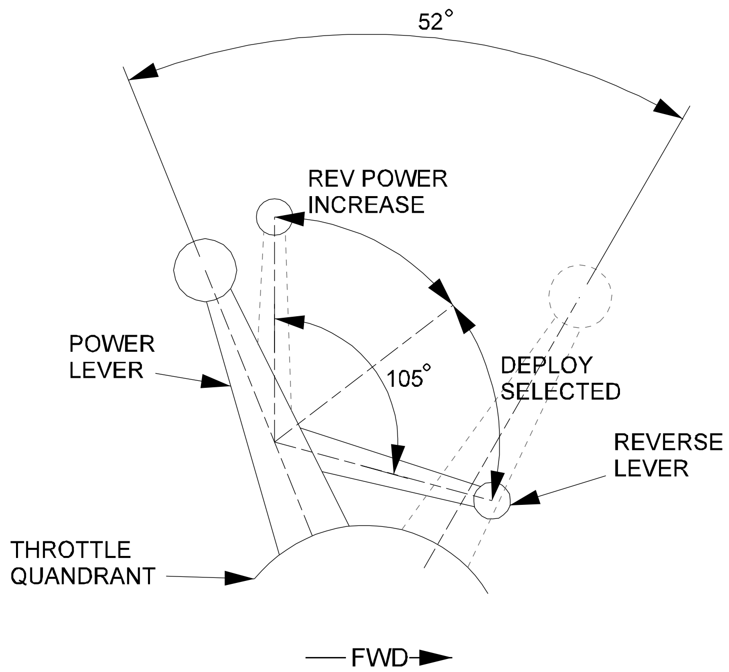
(3) Static operation of thrust reversers is limited to 30% LP maximum.

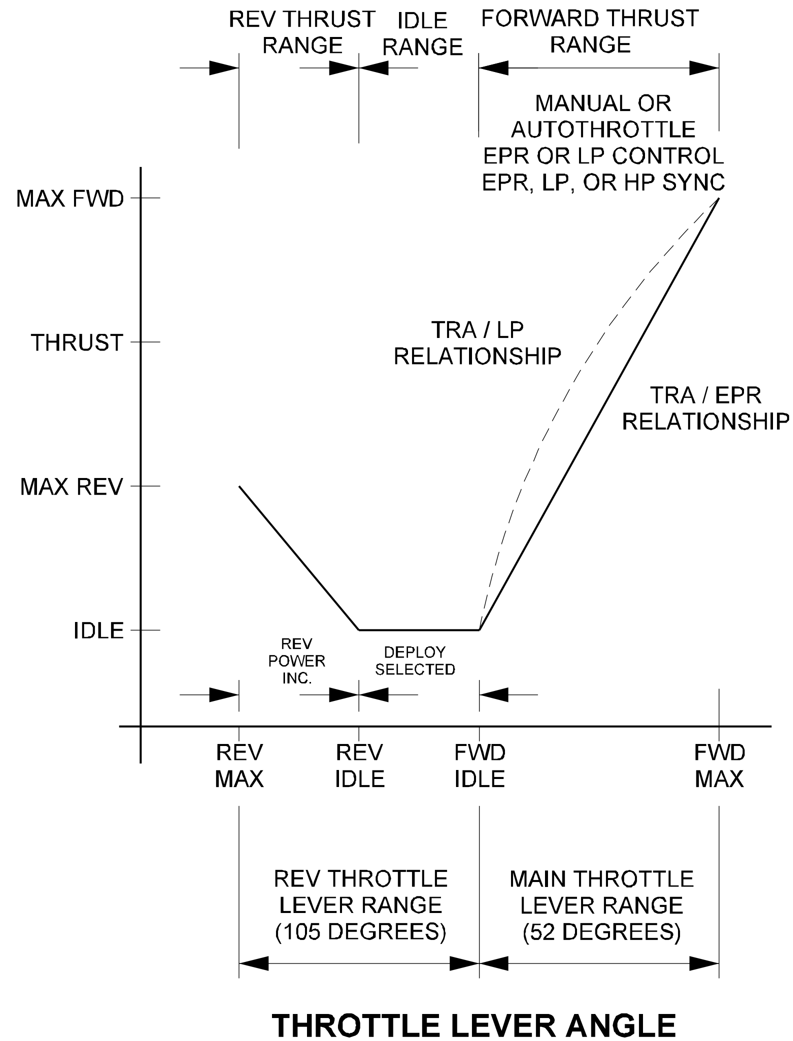
(4) Maximum reverse thrust must be selected only at airplane speeds above 60 knots.

B. Takeoff Power:

(1) Minimum acceptable power for takeoff is shown in G550 Airplane Flight Manual Section 5: Normal Takeoff Planning.

(2) Takeoff in the Alternate Control (LP) mode is prohibited.





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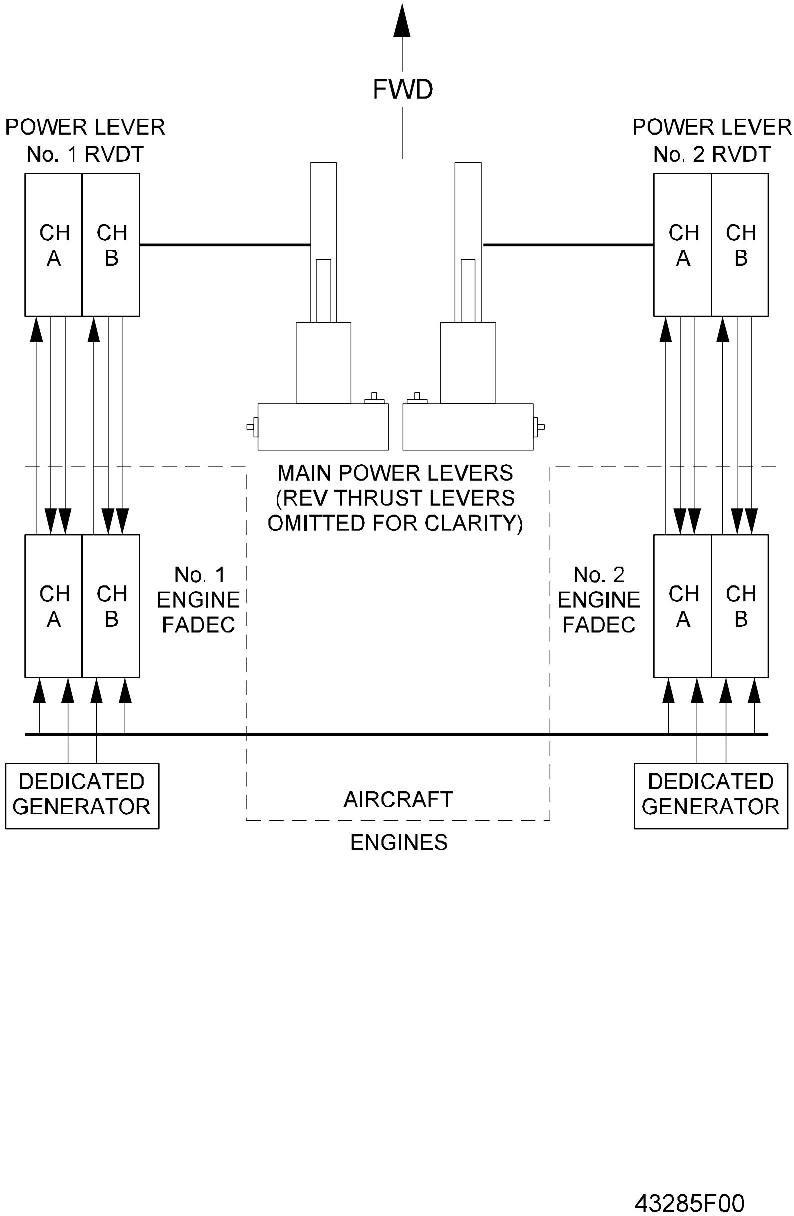
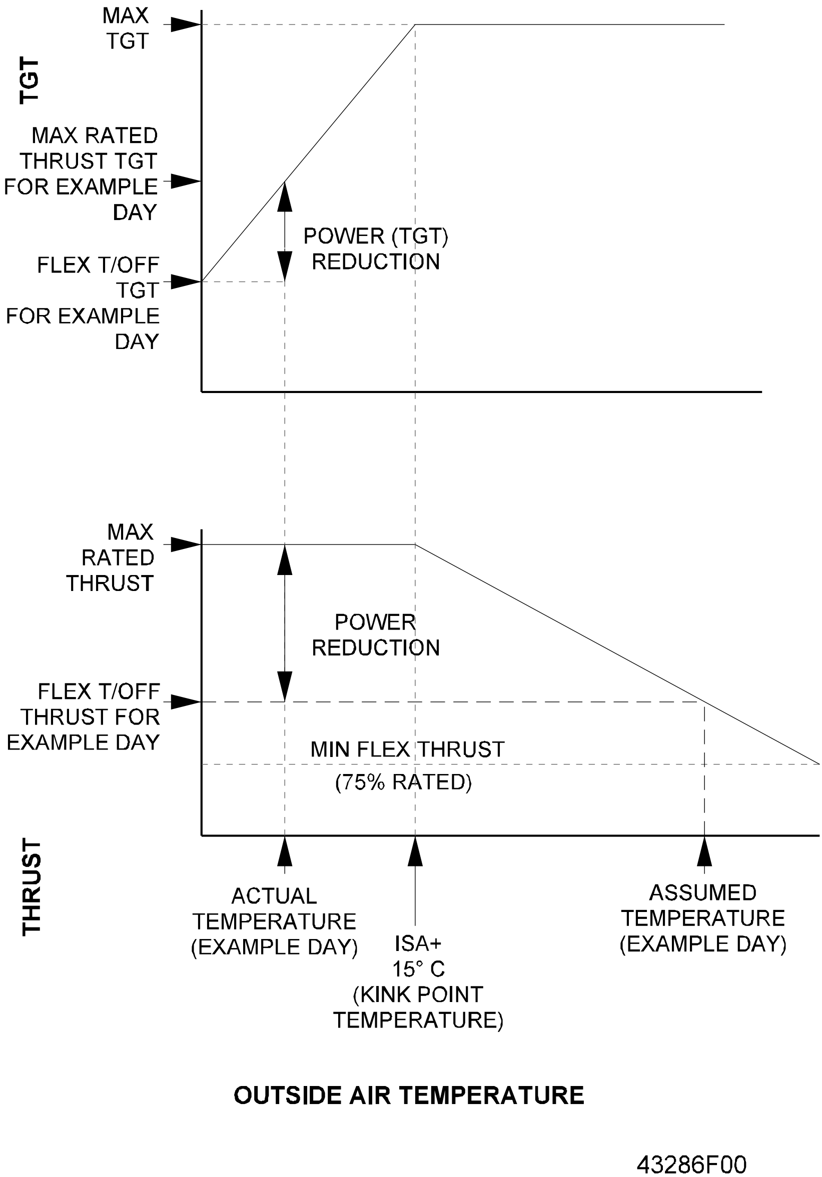
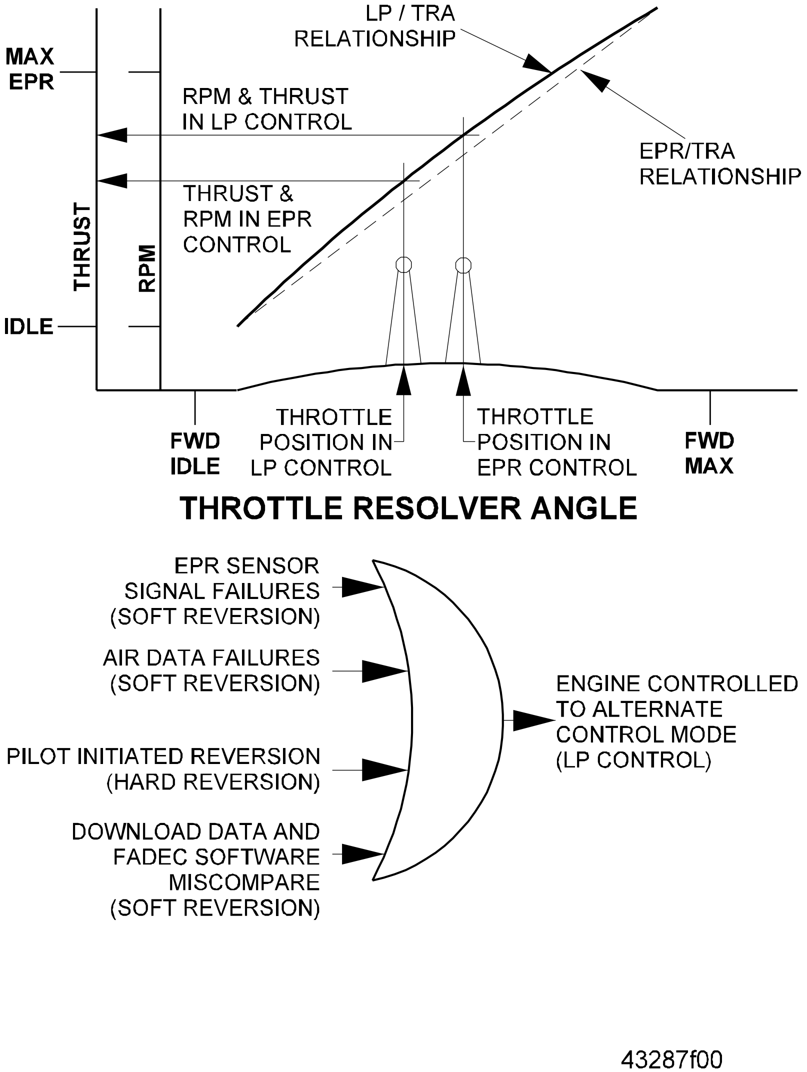
Engine Thrust
Management System
Overview
Figure 2



Power Lever/EEC Interface Simplified Block Diagram
Figure 3



Rated And FLEX Takeoff Thrust Diagram
Figure 4



Alternate Control Mode Diagram
Figure 5

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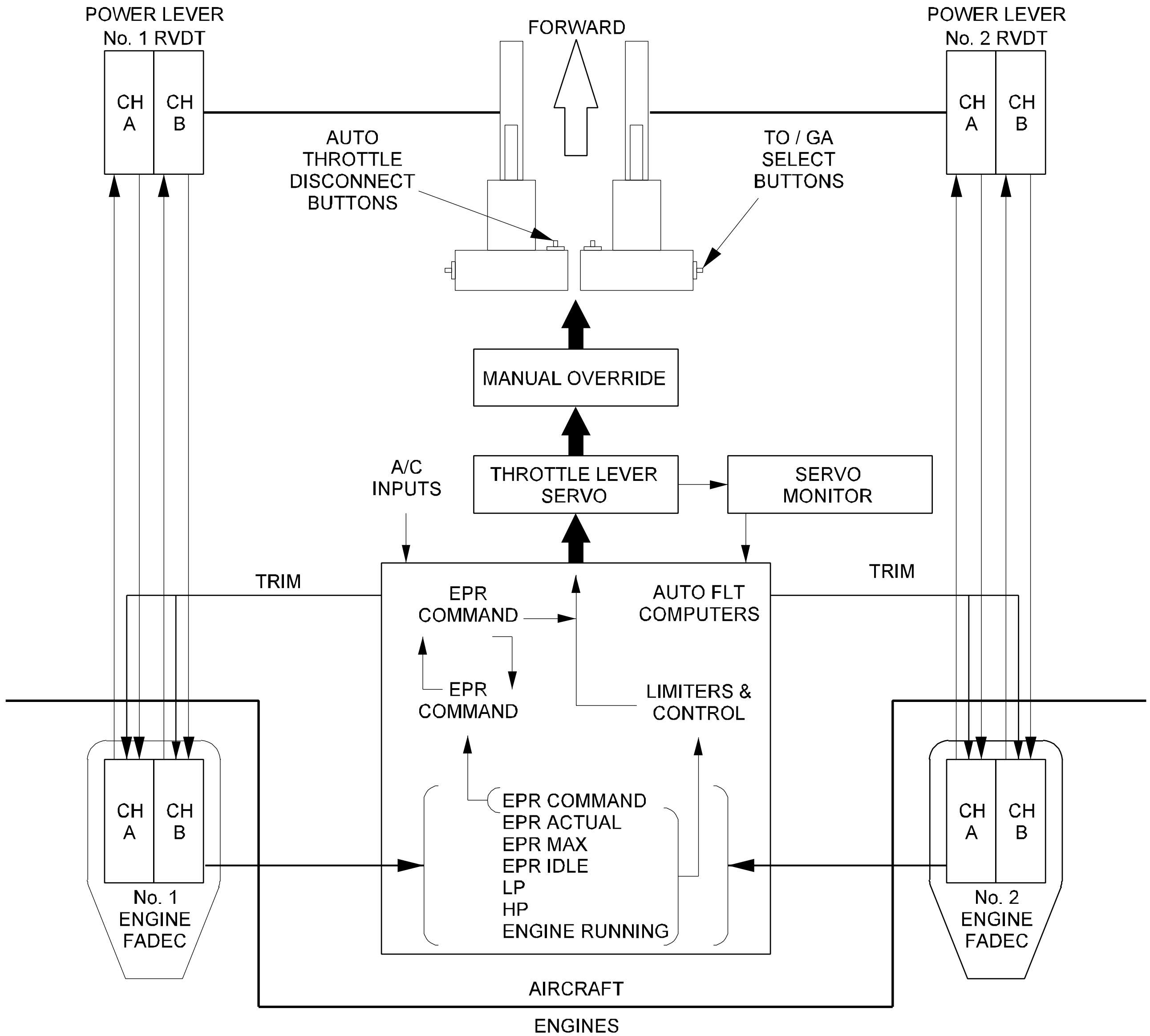

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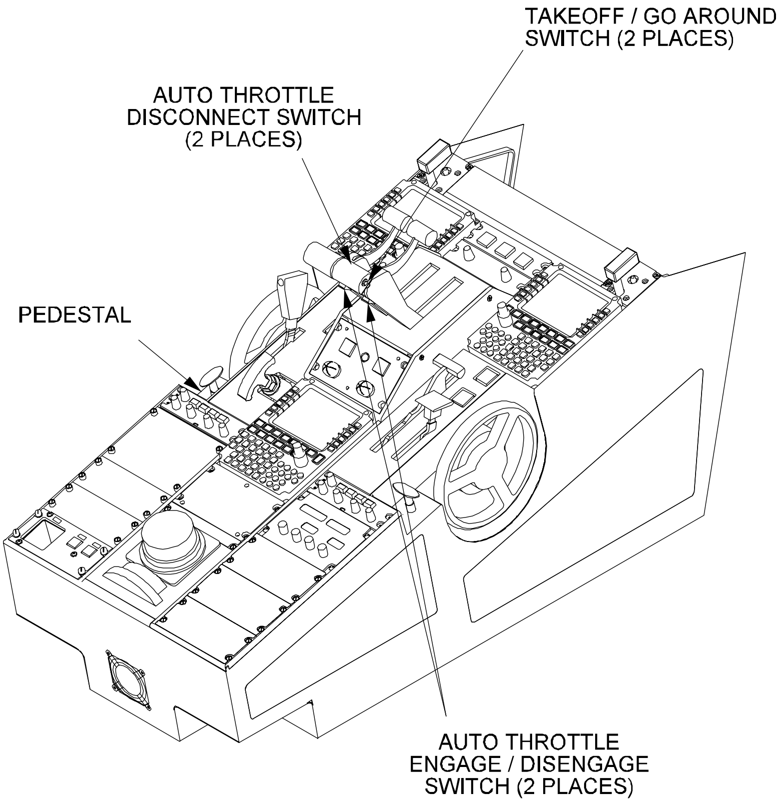
Autothrottle System
Simplified Block Diagram
Figure 6



Power Lever Installation
Figure 7

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