CHAPTER

76

Engine Controls

(LEAP-1B ENGINES)

CHAPTER 76
ENGINE CONTROLS

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

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CHAPTER 76
ENGINE CONTROLS

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ENGINE CONTROLS - INTRODUCTION

Purpose

The engine control system supplies most of the signals to control the engine thrust. It also supplies signals to other airplane systems that use engine control status.

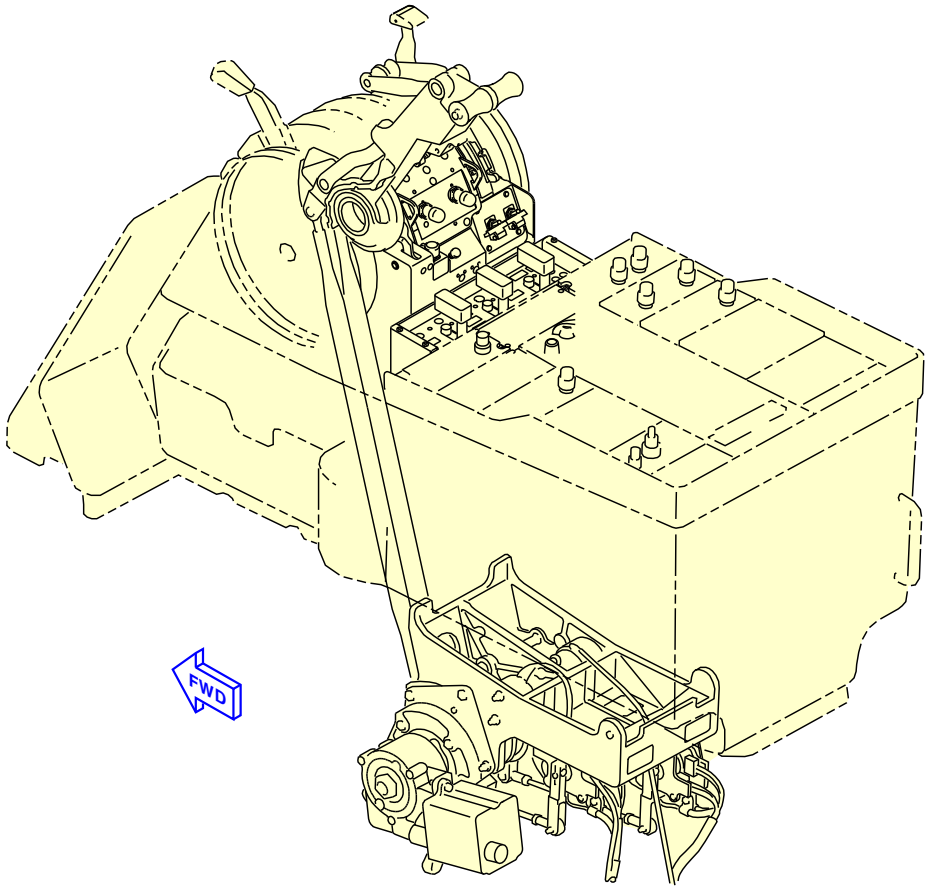
The engine control system has these components:

- Thrust lever assemblies
- Thrust lever resolvers
- Engine start levers
- Thrust lever interlock solenoids.

Abbreviations and Acronyms

- AGB - accessory gearbox
- AMM - aircraft maintenance manual
- ASM - autothrottle servomotor
- DPC - display processor computer
- EEC - electronic engine control
- FDAU - flight data acquisition unit
- HPSOV - high pressure shutoff valve
- IDG - integrated drive generator
- LVDT - linear variable differential transformer
- RLA - reverse thrust lever angle
- TLA - thrust lever angle
- TO/GA - takeoff/go-around
- TRA - thrust lever resolver angle
- T/R - thrust reverser

ENGINE CONTROLS - INTRODUCTION



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ENGINE CONTROLS - INTRODUCTION

ENGINE CONTROLS - GENERAL DESCRIPTION

General

The engine control system supplies manual and automatic control inputs to operate the engine. The engine control system has these components:

- Thrust levers (forward and reverse)
- Thrust lever resolvers
- Engine start levers
- Thrust lever interlock solenoids.

Thrust Levers

You use the thrust levers to supply the manual inputs to the engine control system. There are two thrust lever assemblies, one for each engine. For each engine, there is a forward thrust lever and a reverse thrust lever. The reverse thrust lever is on the forward thrust lever.

For each engine, the thrust levers supply a thrust command signal to the electronic engine control (EEC) through the thrust lever resolver. Each thrust lever assembly connects mechanically to the resolver through an adjustable rod.

An interlock latch prevents the operation of the forward thrust lever and the reverse thrust lever at the same time.

Thrust Lever Resolver

There are two thrust lever resolver assemblies, one for each engine. Each thrust lever resolver assembly has two resolvers, one for EEC channel A and one for EEC channel B. The thrust lever resolvers change the mechanical forward and reverse thrust lever positions to analog thrust lever resolver angle (TRA) signals. These signals go to EEC channel A and EEC channel B. The EEC uses these signals to control the engine.

See the Engine Fuel and Control section for more information on EEC engine control. (SECTION 73-21)

Engine Start Levers

There are two start levers, one for each engine. The engine start lever controls the start and shutdown sequence. The start lever supplies signals to different aircraft and engine systems and components.

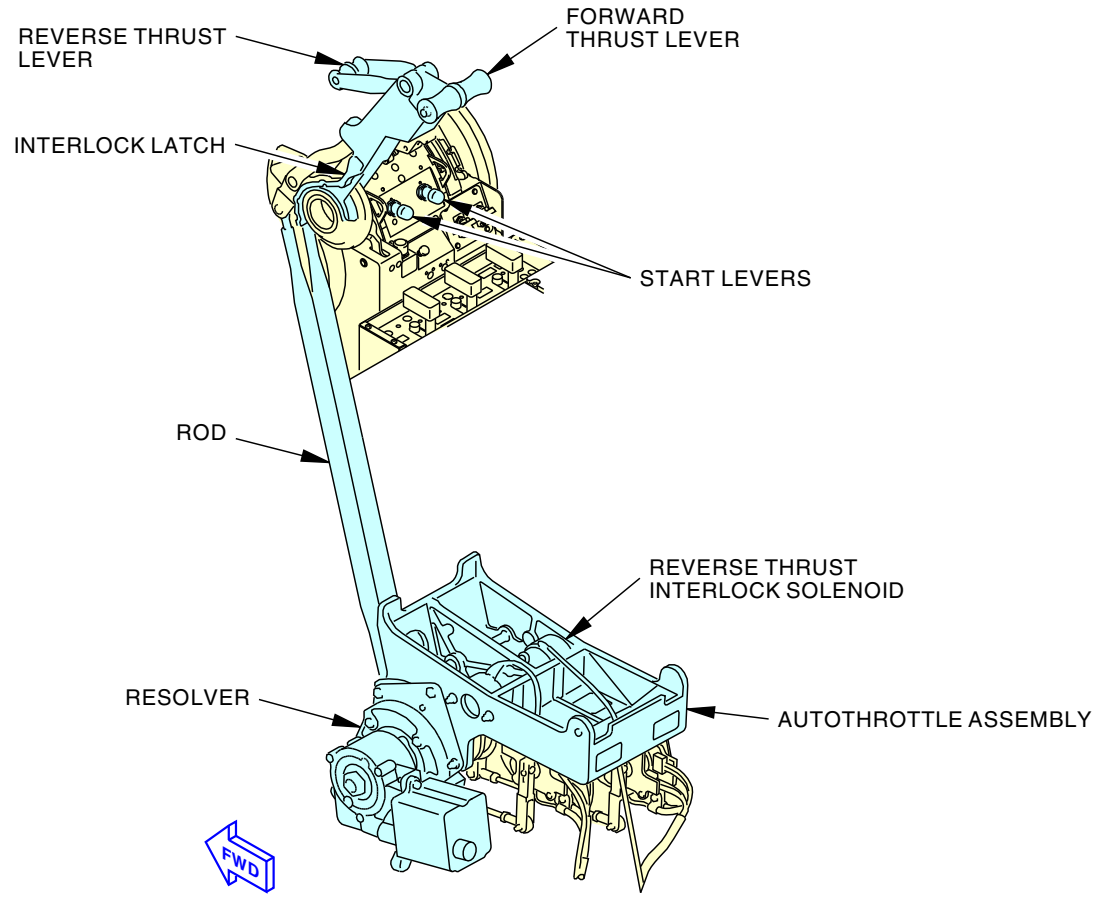
Reverse Thrust Interlock Solenoids

There are two reverse thrust interlock solenoids, one for each engine. Each reverse thrust interlock solenoid limits the range of motion of a reverse thrust lever. You can make the thrust reverser deploy, but you can not increase the reverse thrust until the thrust reverser sleeves are near the full deployed position. The EEC operates the solenoids. The thrust lever interlock solenoids are in the autothrottle assembly. You must lower the autothrottle assembly to access the thrust lever interlock solenoids.

See the thrust reverser section for more information. (SECTION 78-31)

See the autoflight chapter for more information on the autothrottle system. (CHAPTER 22)

ENGINE CONTROLS - GENERAL DESCRIPTION



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ENGINE CONTROLS - GENERAL DESCRIPTION

ENGINE CONTROLS - COMPONENT LOCATION

Component Locations

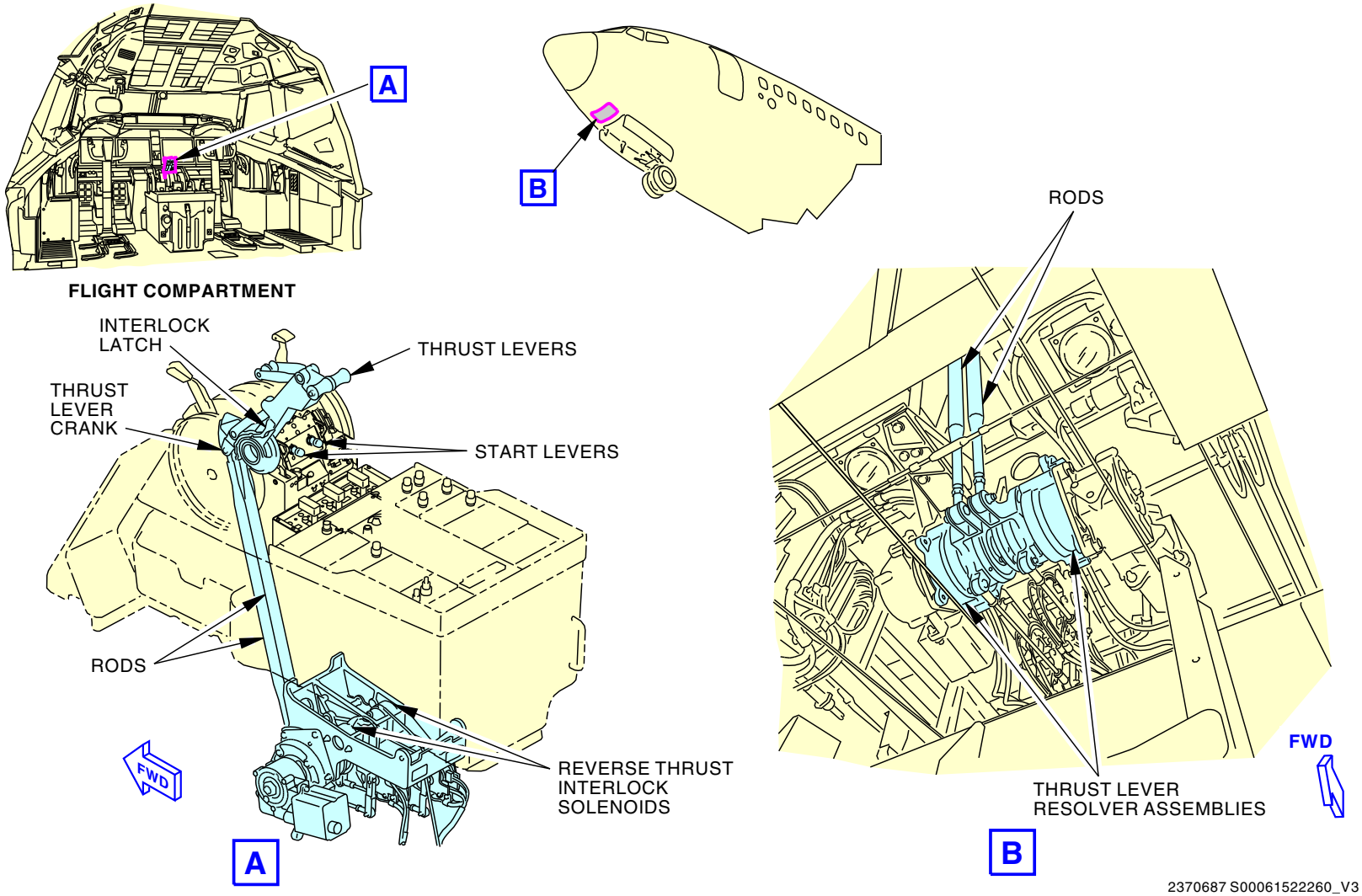
The thrust levers and the start levers are on the control stand in the flight compartment. You remove panels from the aisle stand to get access to these components:

- Start levers
- Interlock latch
- Thrust lever cranks and rods.

The reverse thrust interlock solenoids and thrust lever resolvers are in the autothrottle assembly. The autothrottle assembly is under the flight compartment floor in the forward equipment compartment. Access to the forward equipment compartment is through the access door, forward of the nose landing gear.

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

ENGINE CONTROLS - COMPONENT LOCATION



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ENGINE CONTROLS - COMPONENT LOCATION

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ENGINE CONTROLS - INTERFACES

General

These equipment and mechanisms related to the engine control system are on the control stand and below the flight compartment floor in the autothrottle assembly:

- Resolvers
- Clutch pack
- Autothrottle switch packs
- Autothrottle servomotor (ASM) and gearbox assembly
- Take off/go-around (TO/GA) switches and autothrottle disengage switches.

Resolvers

There are two resolver assemblies, one for each engine. Each thrust lever assembly drives a resolver. The resolver changes the forward and reverse thrust lever positions to an analog electric signal. This signal goes to the EECs.

Clutch Pack

The clutch pack gives a friction connection between these mechanisms:

- Thrust levers
- ASM and gearbox assembly.

The clutch allows the autothrottle system to move the resolver and the thrust levers. The clutch also provides a friction force to prevent the free movement of the thrust levers. The clutch allows the pilot to move the thrust levers independently of the autothrottle system.

See the autoflight chapter for more information on the autothrottle system. (CHAPTER 22)

Autothrottle Switch Packs

There are two autothrottle switch packs, one for each thrust lever assembly. Each thrust lever assembly moves a switch pack through a mechanical linkage. Each switch pack has nine switches which supply discrete thrust lever position signals to various systems. These are the switches and the function of each switch:

- S1 - landing gear warning
- S2 - autobrake system
- S3 - autobrake system
- S4 - engine thrust reverser control
- S5 - NC
- S6 - NC
- S7 - wing thermal anti-ice system
- S8 - aural warning - takeoff warning and weather radar and tail skid (option)
- S9 - landing gear warning.

Autothrottle Servomotor (ASM) and Gearbox Assembly

The thrust management function of the autothrottle system supplies the thrust command signal to the EEC. To do this, the ASM and gearbox assembly drives the TLA resolvers and the thrust levers through the clutch pack.

See the Autoflight chapter for more information on the ASM and gearbox assembly and on the autothrottle system. (CHAPTER 22)

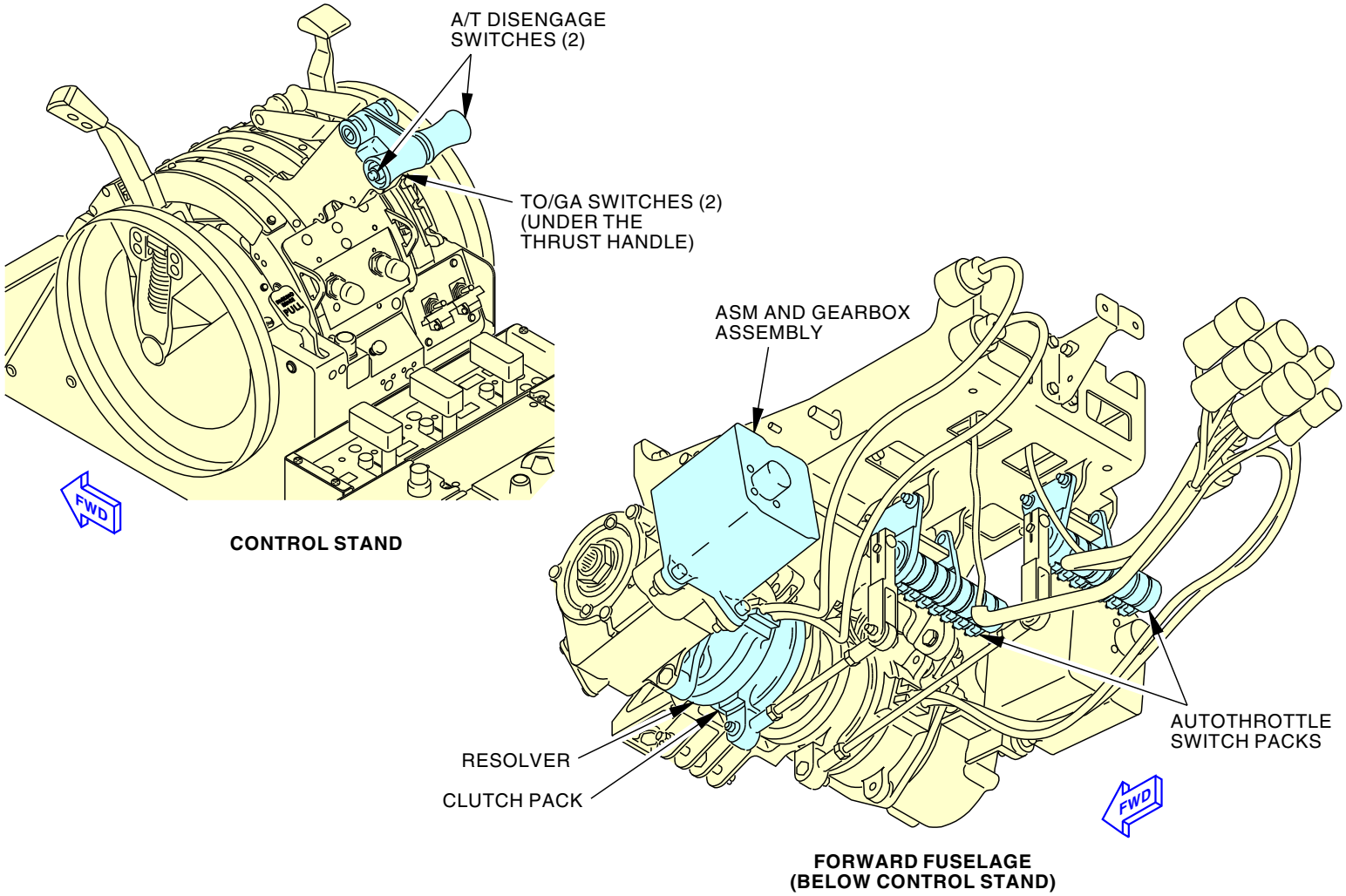
Takeoff/Go-Around (TO/GA) and Autothrottle Disengage Switches

A TO/GA switch and an autothrottle disengage switch are in each thrust lever assembly. The TO/GA switch allows the pilot to set the TO/GA function. The autothrottle disengage switch allows the pilot to disengage the autothrottle function. The command buttons for these switches are on and under the thrust lever handle.

ENGINE CONTROLS - INTERFACES

See the Autoflight chapter for more information on the go-around and autothrottle switches. (CHAPTER 22)

ENGINE CONTROLS - INTERFACES



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ENGINE CONTROLS - INTERFACES

ENGINE CONTROLS - THRUST LEVER

General

The thrust levers and the resolvers in the autothrottle assembly work together to supply a thrust command to the EEC. The autothrottle system makes the automatic inputs. The thrust levers are used to make the manual inputs.

Thrust Lever

There are two thrust lever assemblies, one for each engine. A thrust lever assembly has many parts. These parts mechanically transmit the thrust command to the resolver:

- Forward thrust lever
- Reverse thrust lever
- Control link
- Crank
- Rod.

These parts operate the crank:

- Forward thrust lever
- Reverse thrust lever
- Control link.

The crank connects with the clutch pack and the resolver in the autothrottle assembly through the rod. The forward thrust lever and the crank are on the same shaft, but they move independently. The forward thrust lever holds the reverse thrust lever. The control link directly connects the reverse thrust lever and the crank. The control link moves up when the reverse thrust lever is raised. The control link moves down when the forward thrust lever is moved forward.

When you move the forward thrust lever, the position of the reverse thrust lever locks the control link onto the forward thrust lever. The force goes to the crank through the control link.

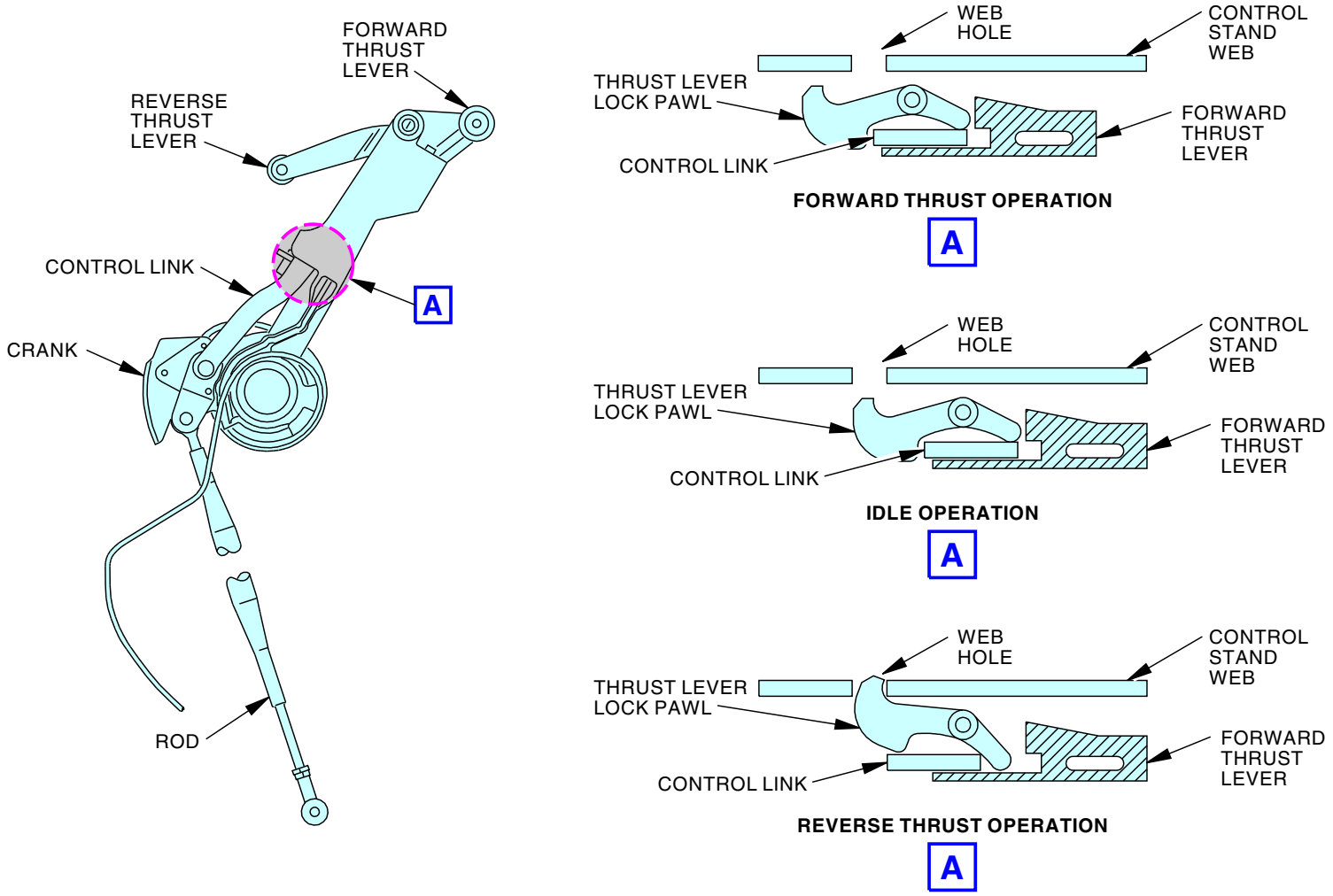
When you move the reverse thrust lever, the force goes to the crank through the control link.

The thrust lever lock pawl prevents the operation of the forward thrust lever and the reverse thrust lever at the same time. The pawl must move into a hole on the control stand web for the reverse thrust lever to move. The pawl can move into the hole only when the forward thrust lever is in the idle position.

When the forward thrust lever is not at idle, the pawl locks the reverse thrust lever at the STOW position. This prevents the movement of the reverse thrust lever when the forward thrust lever is not in the idle position.

When the forward thrust lever is at idle, the pawl unlocks the reverse thrust lever. You can move the reverse thrust lever. If you move it, the pawl locks the forward thrust lever.

ENGINE CONTROLS - THRUST LEVER



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ENGINE CONTROLS - THRUST LEVER

ENGINE CONTROLS - START LEVER

General

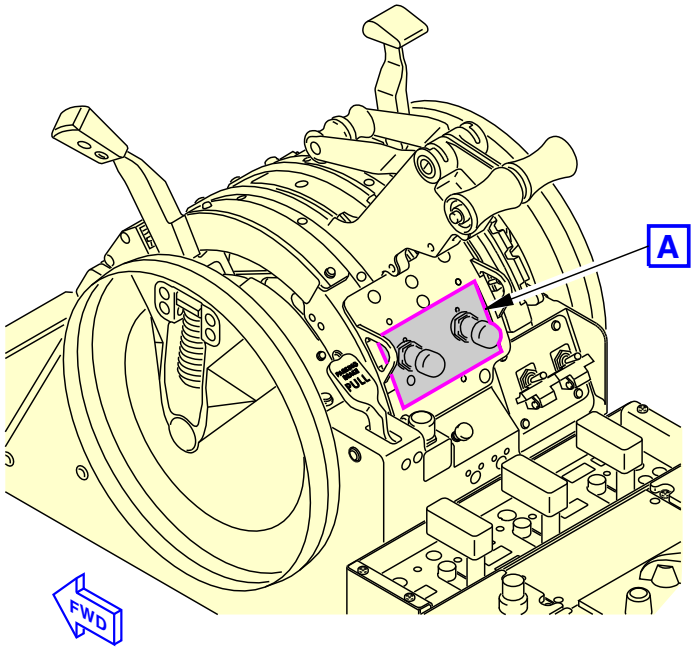
The engine start lever is used during an engine start sequence. It is also used to shut down the engine. The engine start lever sends signals to interfacing systems.

Engine Start Lever

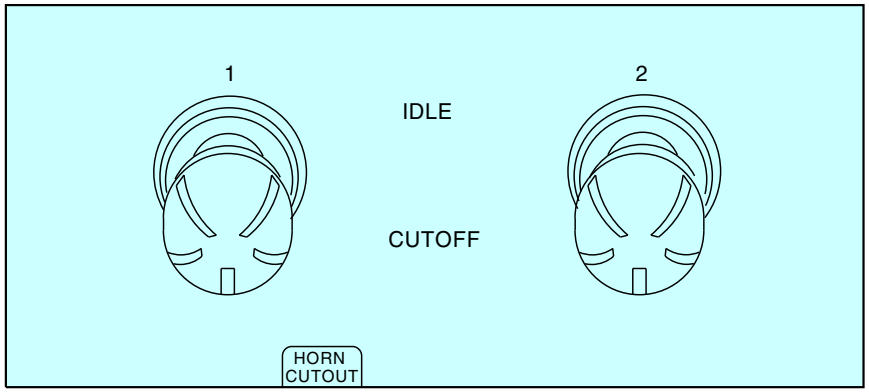
There are two start levers, one for each engine. The start lever has two positions, IDLE and CUTOFF. The lever must be pulled out of the detent to move it from one position to the other.

Each start lever operates 6 internal switches. Two of the switches send signals to the EEC channels A and B. Two of the switches interface with the engine ignition system. The other two switches send signals to valves in the engine fuel feed system.

ENGINE CONTROLS - START LEVER



CONTROL STAND



ENGINE START LEVER

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ENGINE CONTROLS - START LEVER

ENGINE CONTROLS - START LEVER - FUNCTIONAL DESCRIPTION

Functional Description

Each engine start lever operates six switches. These switches are in the engine start lever brake assembly. The switches send signals to other systems.

These actions happen when the engine start lever is moved to the IDLE position and the internal switches move to the IDLE position:

- Fuel control panel receives an input of start lever position for indication logic
- Electrical power opens the engine fuel spar valve
- Ignition power (115v ac) goes to the EECs
- Two engine start lever relays move to the idle position
- Integrated drive generator (IDG) manual disconnect circuit arms
- Flight data acquisition unit (FDAU) sees the start lever in the idle (engine run) position
- Two display processing computers (DPCs) see the start lever in the idle (engine run) position.

These actions happen when the start lever is moved to the CUTOFF position and the internal switches move to the CUTOFF position:

- Fuel control panel receives an input of start lever position for indication logic
- Electrical power closes the engine fuel spar valve
- Ignition power is removed from the EECs
- Two engine start lever relays move to the cutoff position
- Electrical power closes the high pressure shutoff valve (HPSOV) in the fuel metering unit (FMU)
- EEC channels A and B reset.

NOTE: The EEC reset feature allows EEC channels A & B to alternate between active and standby modes of operation.

NOTE: The fuel control panel logic monitors high pressure shutoff valve (HPSOV) position in the fuel metering unit (FMU), and the ENG 1 FUEL HPSOV switch position for operation of the Engine Valve Closed light.

NOTE: The fuel control panel logic monitors the fuel spar valve position and the ENG 1 START LEVER switch position for operation of the Spar Valve Closed light.

See the engine fuel and control, engine control section for more information on the HPSOV. (SECTION 73-21)

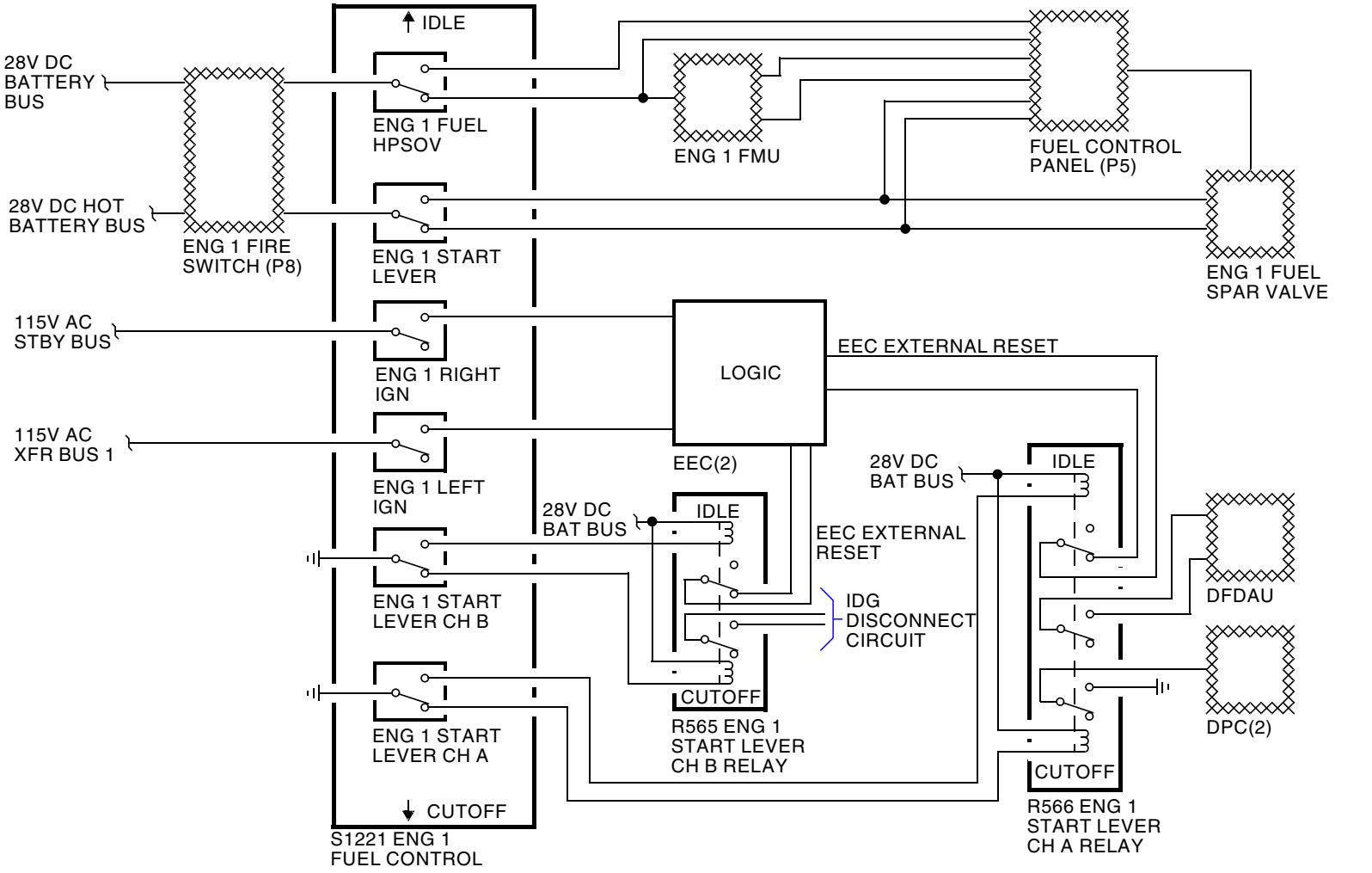
See the engine ignition chapter for more information on the ignition system. (CHAPTER 74)

The EEC reset feature lets the EEC operate correctly after a software error occurs in the EEC. See the engine fuel and control chapter for more functional description information on the EEC. (CHAPTER 73)

See the fuel chapter for more information on the fuel system. (CHAPTER 28)

See the flight controls chapter for more information on the flight data acquisition unit. (CHAPTER 27)

ENGINE CONTROLS - START LEVER - FUNCTIONAL DESCRIPTION



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ENGINE CONTROLS - START LEVER - FUNCTIONAL DESCRIPTION

ENGINE CONTROLS - REVERSE THRUST INTERLOCK SOLENOIDS

General

The reverse thrust interlock solenoids energize to permit further movement of the reverse thrust levers during a T/R deploy operation. If the reverse thrust interlock solenoid does not energize, the reverse thrust lever cannot be moved to increase reverse thrust. The solenoids energize when the T/R sleeves are 60% of travel to the full deploy position. Each EEC controls one of the solenoids. See the thrust reverser control section for more information. (SECTION 78-34)

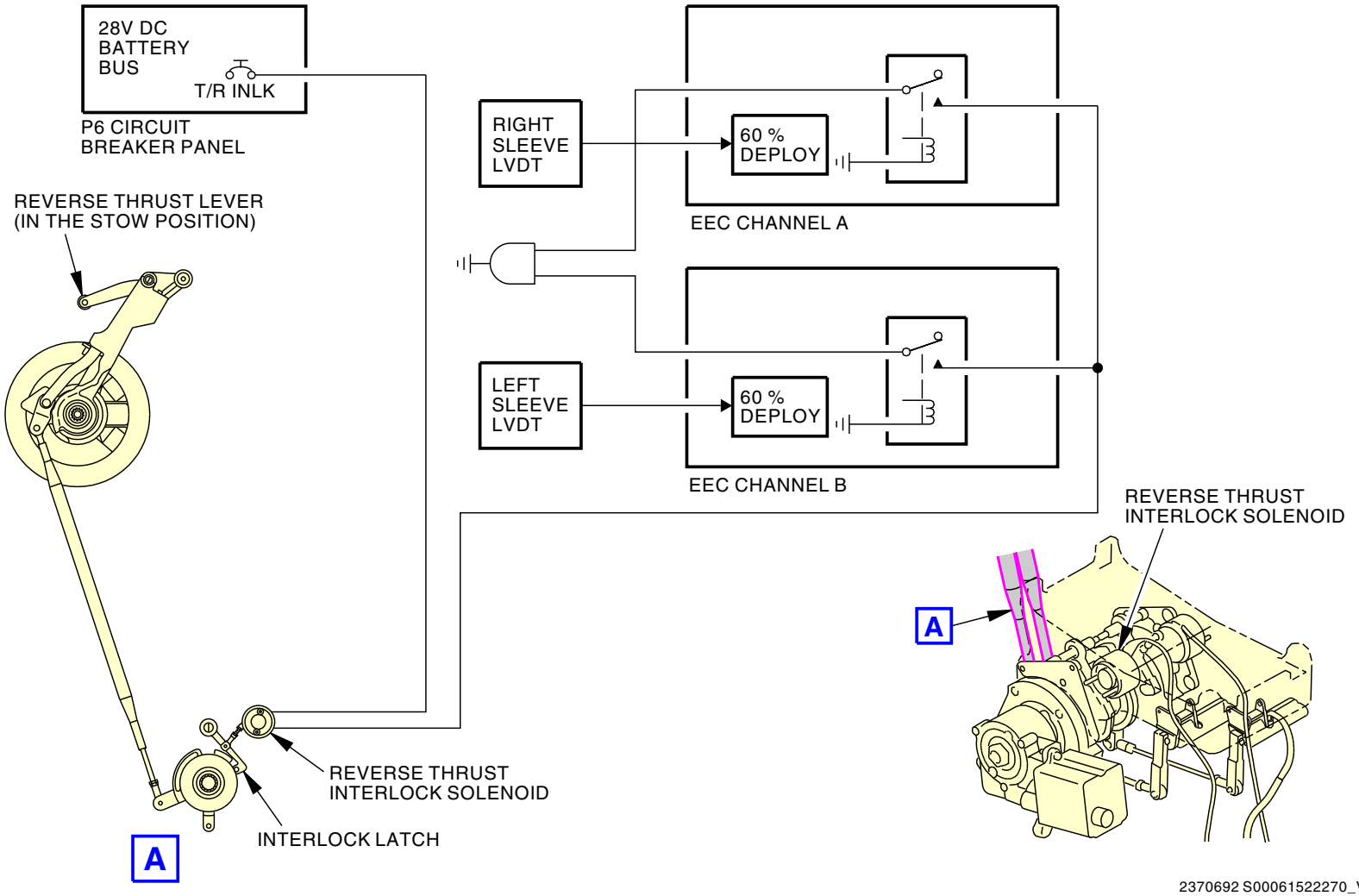
Reverse Thrust Interlock Solenoids

There are two reverse thrust interlock solenoids, one for each thrust lever assembly. They are a rotary solenoid type. Each reverse thrust interlock solenoid uses a rod to operate a latch. When a reverse thrust lever is moved to the DEPLOY position, a contour on the brake mechanism catches the latch. This stops the rotation of the brake mechanism and limits the motion of the reverse thrust lever and the reverse thrust lever moves enough to operate switches to command the thrust reverser deployment. When the EEC energizes the reverse thrust interlock solenoid, the latch disengages. This permits the motion of the reverse thrust lever towards the full reverse thrust position.

Functional Description

Each solenoid connects to both channels of the EEC. The EEC receives the T/R translating sleeve position data from the linear variable differential transformer (LVDT) of each sleeve. When both sleeves are at more than 60% of deployed, the EEC energizes the interlock solenoid. The solenoid retracts the interlock latch. The reverse thrust lever can now move past the idle position to increase reverse thrust.

ENGINE CONTROLS - REVERSE THRUST INTERLOCK SOLENOIDS



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ENGINE CONTROLS - REVERSE THRUST INTERLOCK SOLENOIDS