CHAPTER

24

Electrical Power

CHAPTER 24
ELECTRICAL POWER

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

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ELECTRICAL POWER

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ELECTRICAL POWER - INTRODUCTION

General

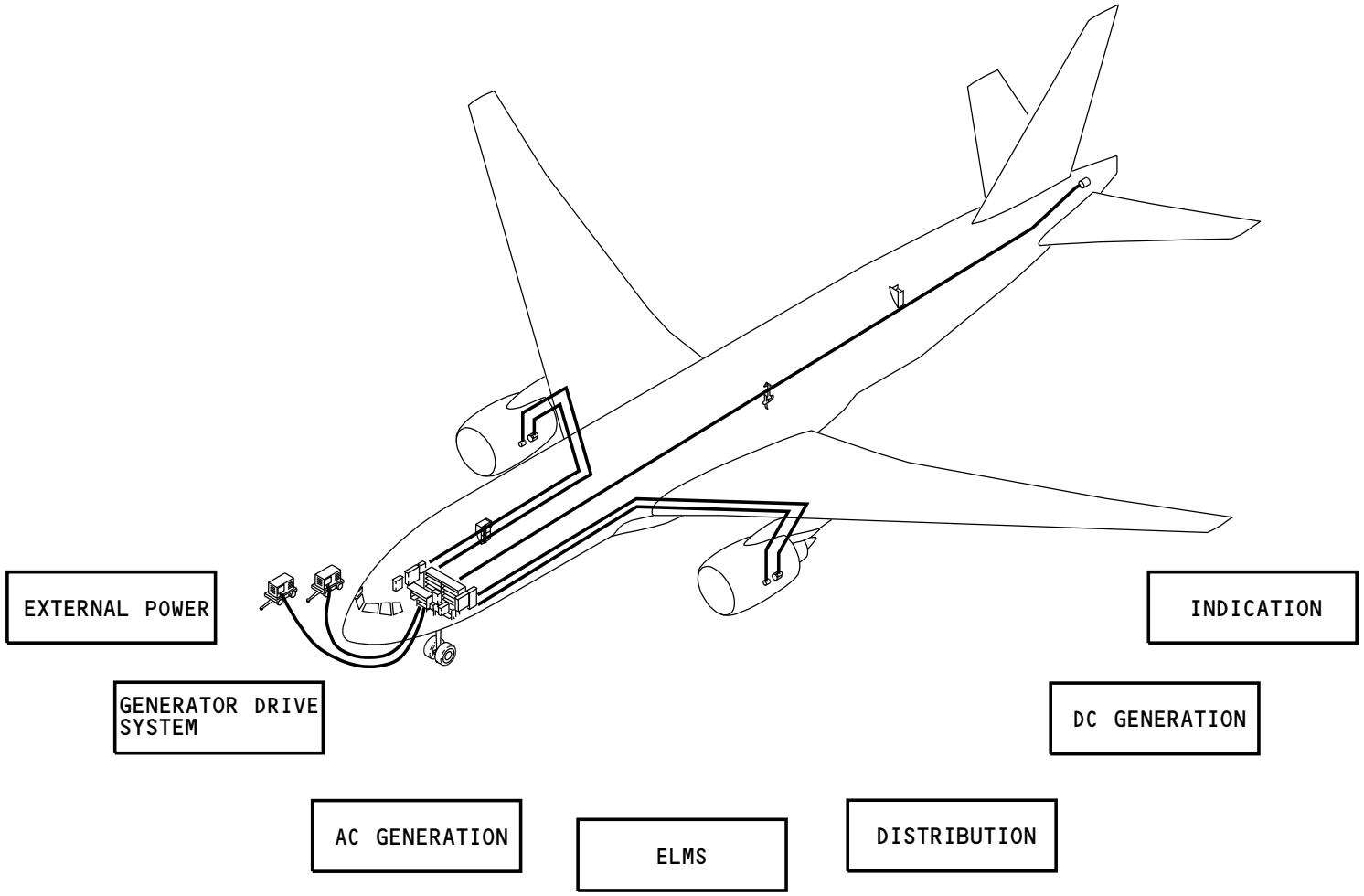
The electrical power system makes, supplies, and controls electrical power to the airplane. The system has these subsystem:

- External power
- Generator drive system
- AC generation
- ELMS
- Distribution
- DC generation
- Indication.

Abbreviations and Acronyms

- AFDC - automatic flight director computer
- AFDS - automatic flight director system
- APB - auxiliary power breaker
- AUTO - automatic
- AVAIL - available
- BAT - battery
- BPCU - bus power control unit
- BTB - bus tie breaker
- BU - backup
- CCB - converter circuit breaker
- CCU - computing and communications unit
- CMC - current monitor card
- CONV - converter
- CPT - captain
- CPU - central processing unit
- CSD - constant speed drive
- CTRL - control
- DISC - disconnect
- EDIU - engine data interface unit
- EEC - electronic engine control
- ELCU - electrical load control unit
- ELMS - electrical load management system
- EMI - electro-magnetic interference
- EP - external power
- EPC - external power contactor
- ESDS - electro-static discharge sensitive
- ETOPS - extended twin operations
- FBW - fly by wire
- FCDC - flight controls dc
- FLT - flight
- FNC - fiber nickel cadmium
- F/O - first officer
- GCB - generator circuit breaker
- GCR - generator control relay
- GCU - generator control unit
- GEN - generator
- GH - ground handling
- GHR - ground handling relay
- GND - ground
- GSSR - ground service select relay
- GSTR - ground service transfer relay
- HDLG - handling
- IDG - integrated drive generator
- ILS - instrument landing system
- INST - instrument
- I/O - input/output
- ISLN - isolation
- LRM - line replaceable module

- LRU - line replaceable unit
- PEPC - primary external power contactor
- PFC - primary flight computer
- PMG - permanent magnet generator
- PPC - power panel controller
- POR - point of regulation
- PRI - primary
- PSA - power supply assembly
- PSU - power supply unit
- PWR - power
- QAD - quick attach/detach
- RAT - ram air turbine
- RLY - relay
- SEC - secondary
- SEPC - secondary external power contactor
- SIU - signal interface unit
- STBY - standby
- SVC - service
- TBB - transfer bus breaker
- TRU - transformer rectifier unit
- UB - utility bus
- UTIL - utility
- XFR - transfer



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ELECTRICAL POWER - INTRODUCTION

Power Sources

The electrical power system has five main power sources, two backup power sources, and two standby power sources. These are the main power sources and their continuous supply capacity:

- Left integrated drive generator (IDG) (120 kva)
- Right IDG (120 kva)
- APU generator (120 kva)
- Primary external power (90 kva)
- Secondary external power (90 kva).

The backup power sources are the two backup generators. Each backup generator can continuously supply 20 kva. The standby power sources are the ram air turbine (RAT) generator and the main battery. The RAT generator can continuously supply 7.5 kva. The battery is a 47 amp-hour battery.

Control

These six electronic units control the ac power sources:

- Left generator control unit (GCU) - left IDG power
- Right GCU - right IDG power
- Backup generator converter - backup generator power
- APU GCU - APU generator power
- Bus power control unit (BPCU) - external power
- RAT GCU - RAT generator power.

The electrical load management system (ELMS) controls the main battery power.

ELMS

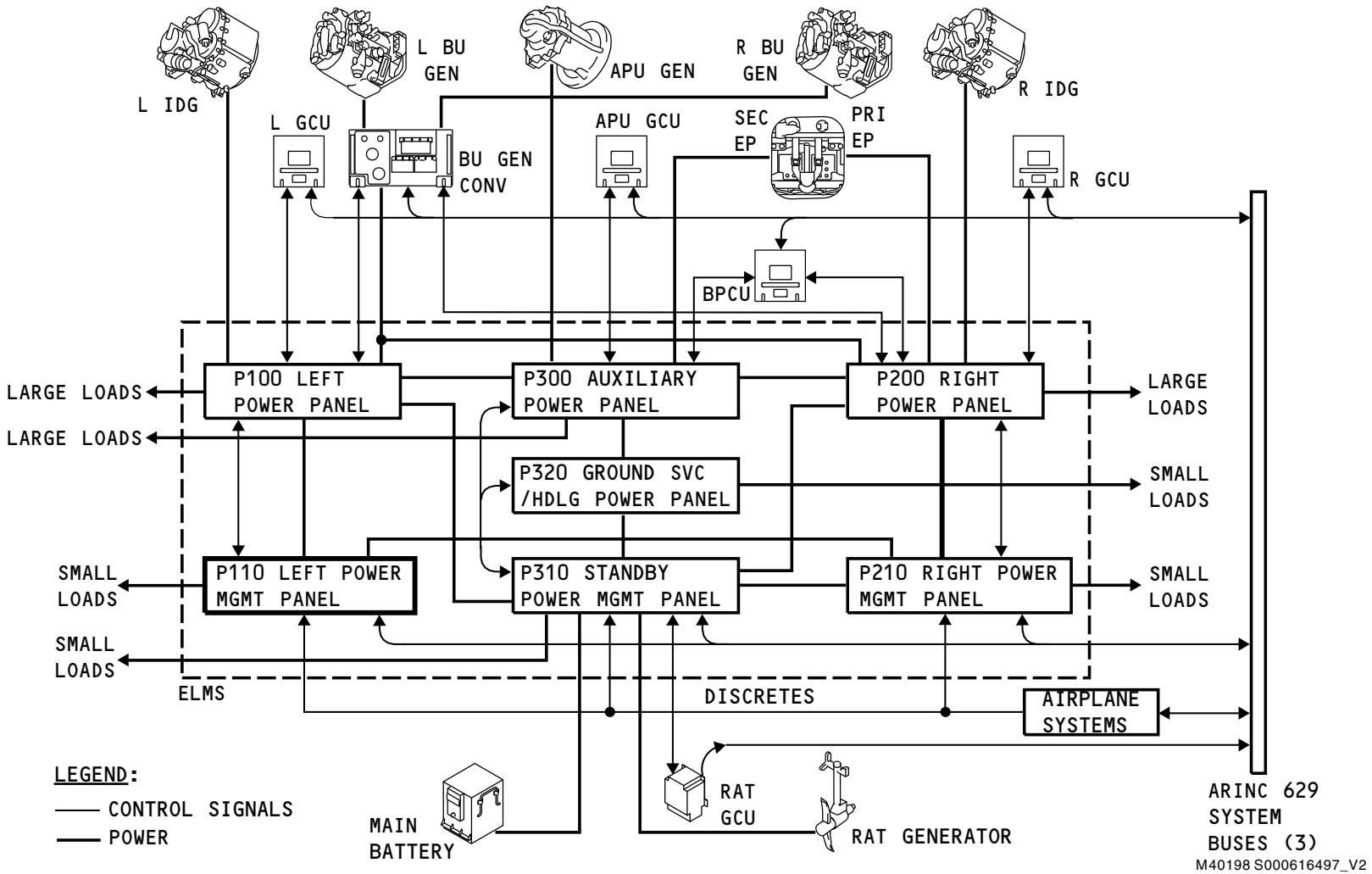
All airplane electrical power goes through the ELMS panels for distribution. The ELMS panels contain the load-switching devices that distribute this power. The ELMS also controls most of the devices. These are the ELMS panels:

- P100 Left power panel
- P200 Right power panel
- P300 Auxiliary power panel
- P110 Left power management panel
- P210 Right power management panel
- P310 Standby power management panel
- P320 Ground service/handling power panel.

Main and backup power go to the left, right, or auxiliary power panels. These power panels supply power to large loads (25 amps or more). They also supply power to the power management panels and the ground service/handling power panel. From these panels, electrical power goes to small loads (less than 25 amps).

The ELMS power management panels contain line-replaceable units. These control and monitor the load-switching devices in their related ELMS panels. However, the ELMS line-replaceable units do not control all of the large load-switching devices in the power panels. The GCUs, BPCU, and backup generator converter directly control some of the large load-switching devices.

The line-replaceable units get data from the other electrical power control units and airplane systems either directly or from the ARINC 629 system buses. They use this data to manage the loads of the electrical power system.



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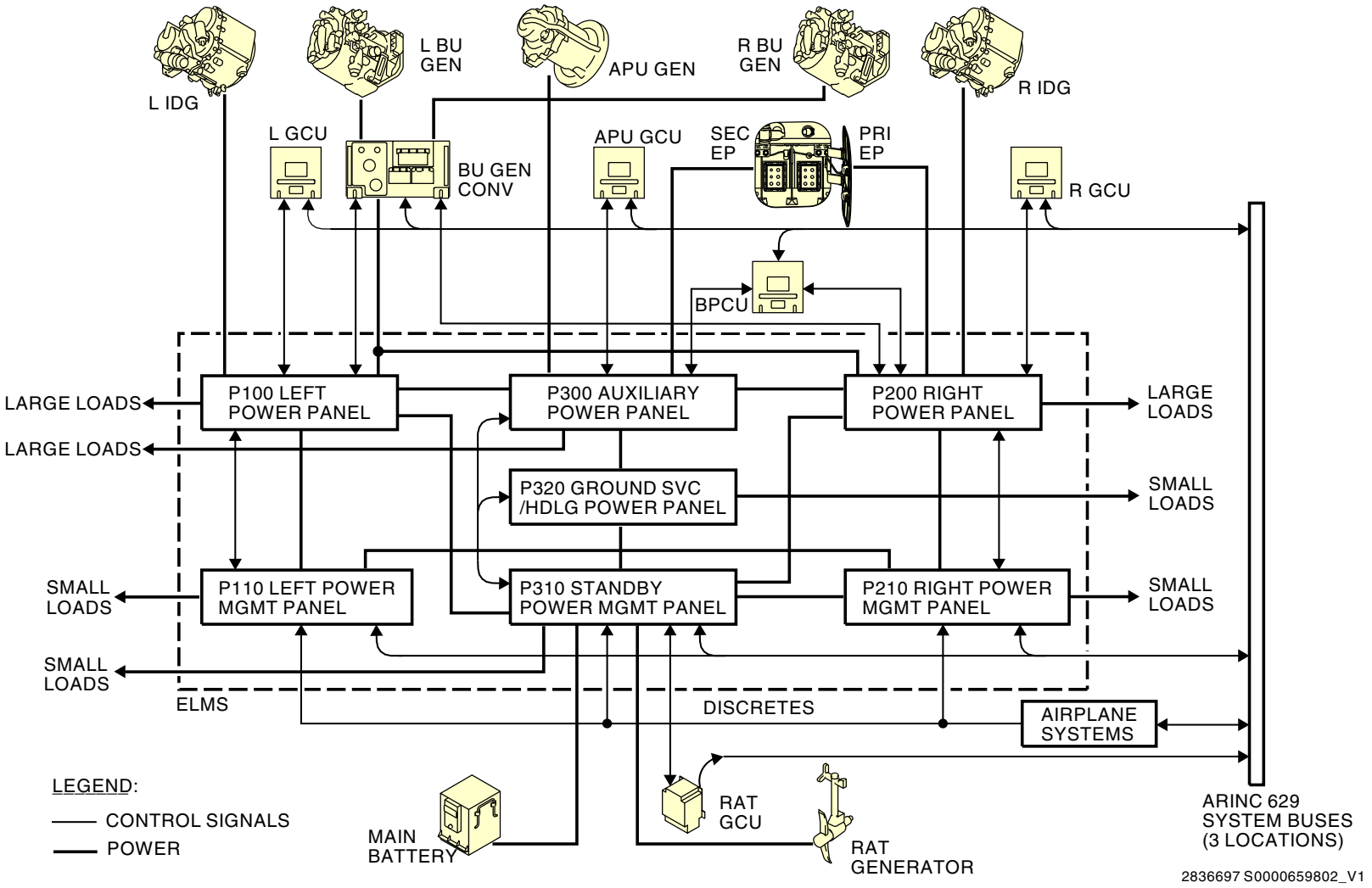
ELECTRICAL POWER - GENERAL DESCRIPTION - POWER & CONTROL



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ELECTRICAL POWER - GENERAL DESCRIPTION - POWER & CONTROL

ELECTRICAL POWER - GENERAL DESCRIPTION - DISTRIBUTION

General

The electrical power system normally operates as two independent power channels: left and right. These buses are on the left channel:

- Left main ac
- Left utility
- Left transfer
- Left dc
- Standby ac
- Captain's flight instrument
- Battery
- Battery #2.

The left channel also supplies power to the left and center flight controls dc power supply assemblies (FCDC PSA).

These buses are on the right channel:

- Right main ac
- Right utility
- Right transfer
- Right dc
- First officer's flight instrument
- Ground service
- APU battery
- Hot battery.

The right channel also supplies power to the right FCDC PSA.

Power Configurations

The buses may connect to different power sources and to each other. This depends upon which power sources are available, the flight phase of the airplane, and the configuration of the flight deck electrical panel. Breakers, contactors, and relays connect the buses to the power sources and to each other.

Ground Power

Primary external power automatically supplies power to the ground handling buses. You can also use a switch to connect primary external power to the ground service bus. When you turn primary external power on at the electrical panel, the power connects to the right main ac bus. From there, it supplies power to the rest of the electrical system.

If you need more ground power capacity, connect the secondary external power. The right bus tie breaker (BTB) opens so that the secondary external power supplies power to the left side of the electrical system while the primary supplies power to the right side.

APU Power

The APU generator can supply power to the airplane on the ground or in flight. On the ground, it can supply power to the ground handling bus. The APU generator can also supply all of the airplane power or share the load with an IDG, backup generator, or the primary external power source.

IDG Power

The IDGs normally supply the electrical power when the engines are operating. They each supply power to one side of the electrical system. If an IDG fails, the APU generator can supply power to the failed side.

Backup Generator Power

The backup generators are a variable-speed, variable-frequency type. They operate when the engines are running. They connect to the backup generator converter. The converter makes the backup generator output into satisfactory ac power. A backup generator supplies power to a transfer bus under non-normal conditions and during autoland.

Each backup generator also contains permanent magnet generators (PMGs). Two of these PMGs in each backup generator are the primary power sources for the FCDC PSAs.

Standby Power

If all normal power is lost, the RAT generator can supply the flight instrument buses with power. It does this through the two center transformer rectifier units (TRU). The captain's flight instrument bus then supplies power to the battery and standby ac buses.

If the RAT generator does not operate, the main battery supplies power to the battery buses, captain's flight instrument bus, and the standby ac bus.

Battery Power

The electrical system has these four battery buses:

- Hot battery
- Battery
- Battery #2
- APU battery.

The ground service bus normally supplies power to the hot battery and APU battery buses through their related battery chargers.

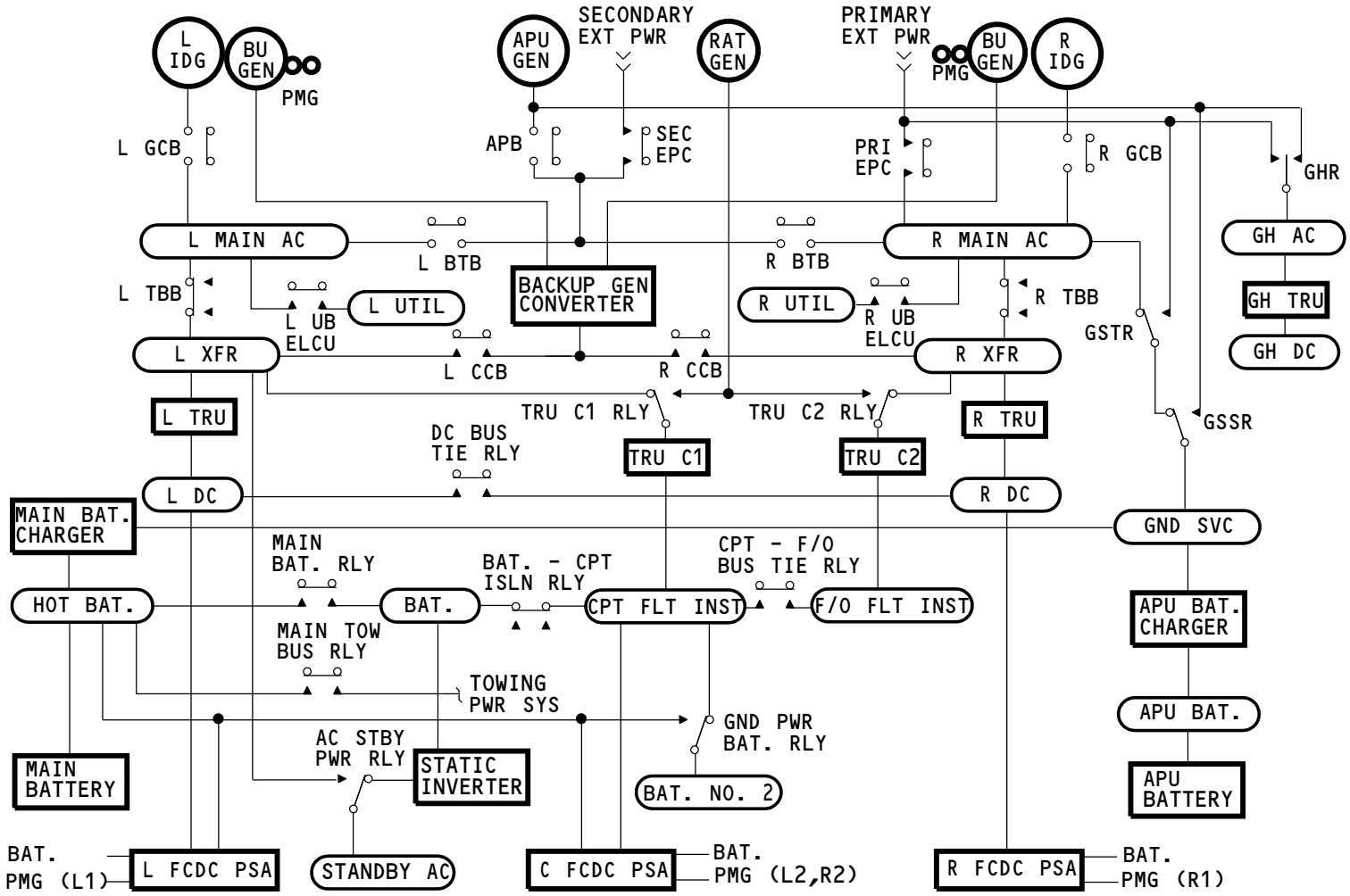
The captain's flight instrument bus normally supplies power to the battery and battery #2 buses.

Flight Control Power

Three FCDC PSAs supply power to the flight control system. The PSAs have more than one power source. Each PSA has a small battery to prevent power interruptions during power transfers.

Towing Power

The towing power system supplies power only to components that are necessary to safely tow the airplane. You operate the system manually.



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ELECTRICAL POWER - GENERAL DESCRIPTION - DISTRIBUTION

ELECTRICAL POWER - COMPONENT LOCATIONS - AIRPLANE

General

There are electrical power components in these areas:

- Flight deck
- E5 rack
- Wing-to-body fairing
- APU gearbox
- E10 rack
- Engine accessory gearbox
- Engine fan hub/compressor case
- Door 1 left
- Main equipment center
- Right-forward fuselage.

Flight Deck

The electrical power system control switches are on the P5 overhead panel and the P61 overhead maintenance panel.

E5 Rack

Some of the FCDC components are in the E5 rack just aft of the forward cargo door.

Wing-to-Body Fairing

The RAT generator is in the wing-to-body fairing aft of the right main gear.

APU Gearbox

The APU generator attaches to the APU gearbox.

E10 Rack

The APU battery and battery charger are in the E10 rack just aft of the bulk cargo door.

Engine Accessory Gearbox

A backup generator attaches to the forward side of the main gearbox on each engine. The IDG attaches to the aft side.

The IDG fuel/oil heat exchanger attaches to the right forward side of the accessory gearbox. a

Engine Fan Hub / Compressor Case

The oil/oil heat exchanger is on the fan hub frame. The backup generator/IDG air/oil heat exchanger attaches to the high compressor case.

Door 1 Left

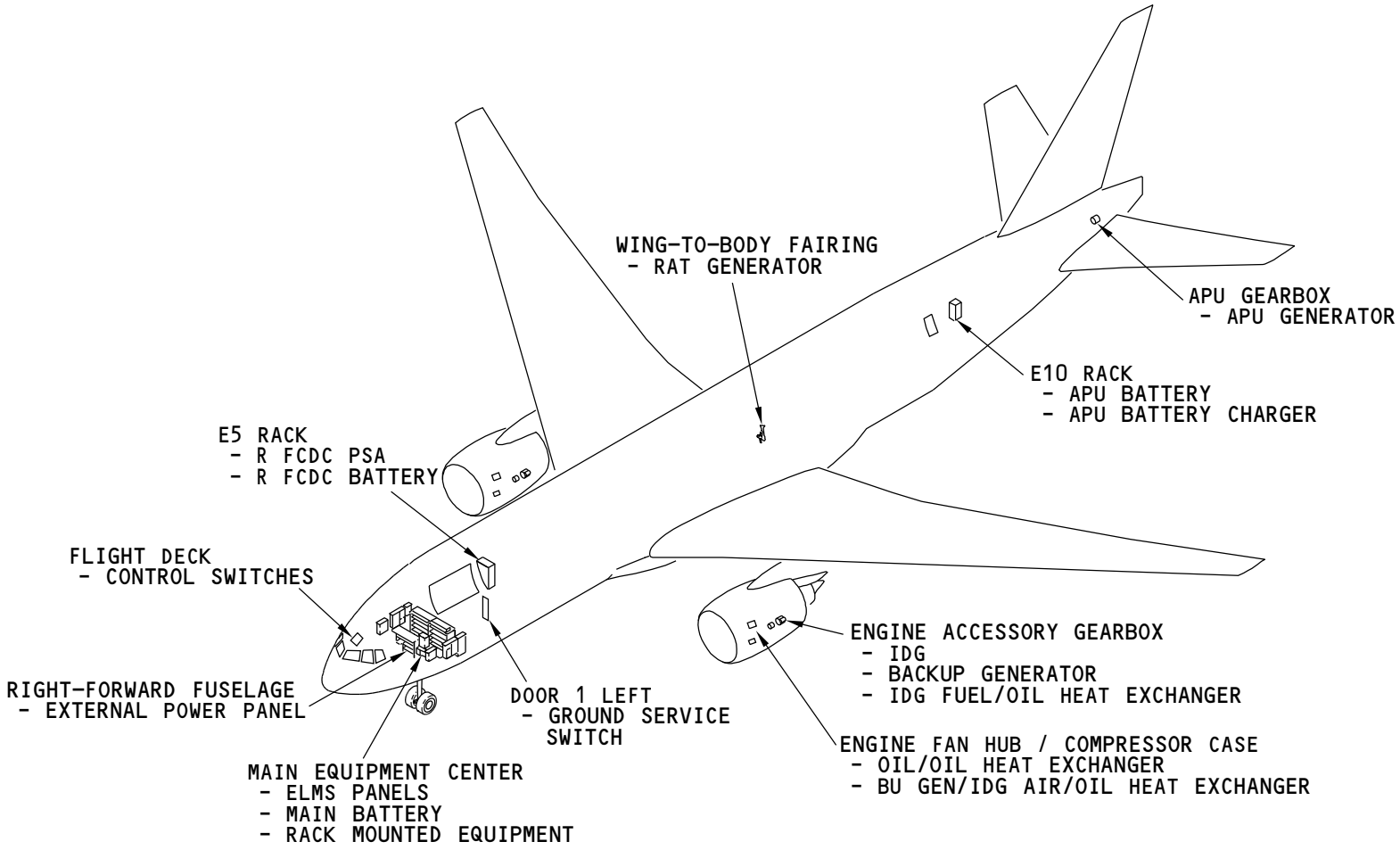
The ground service switch is on the flight attendant's panel by door 1 left.

Main Equipment Center

Most of the electrical system components are in the main equipment center. The main battery is there. The rest are in equipment racks or the ELMS panels.

Right-Forward Fuselage

The external power panel is to the right of the main equipment center access door.



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ELECTRICAL POWER - COMPONENT LOCATIONS - AIRPLANE

ELECTRICAL POWER - GENERAL COMPONENT LOCATIONS - MAIN EQUIPMENT CENTER

General

Most of the electrical system components are in equipment racks or the ELMS panels.

The specific locations of components are in their related sections.

The ELMS section shows the specific location of components inside the ELMS panels.

Panels

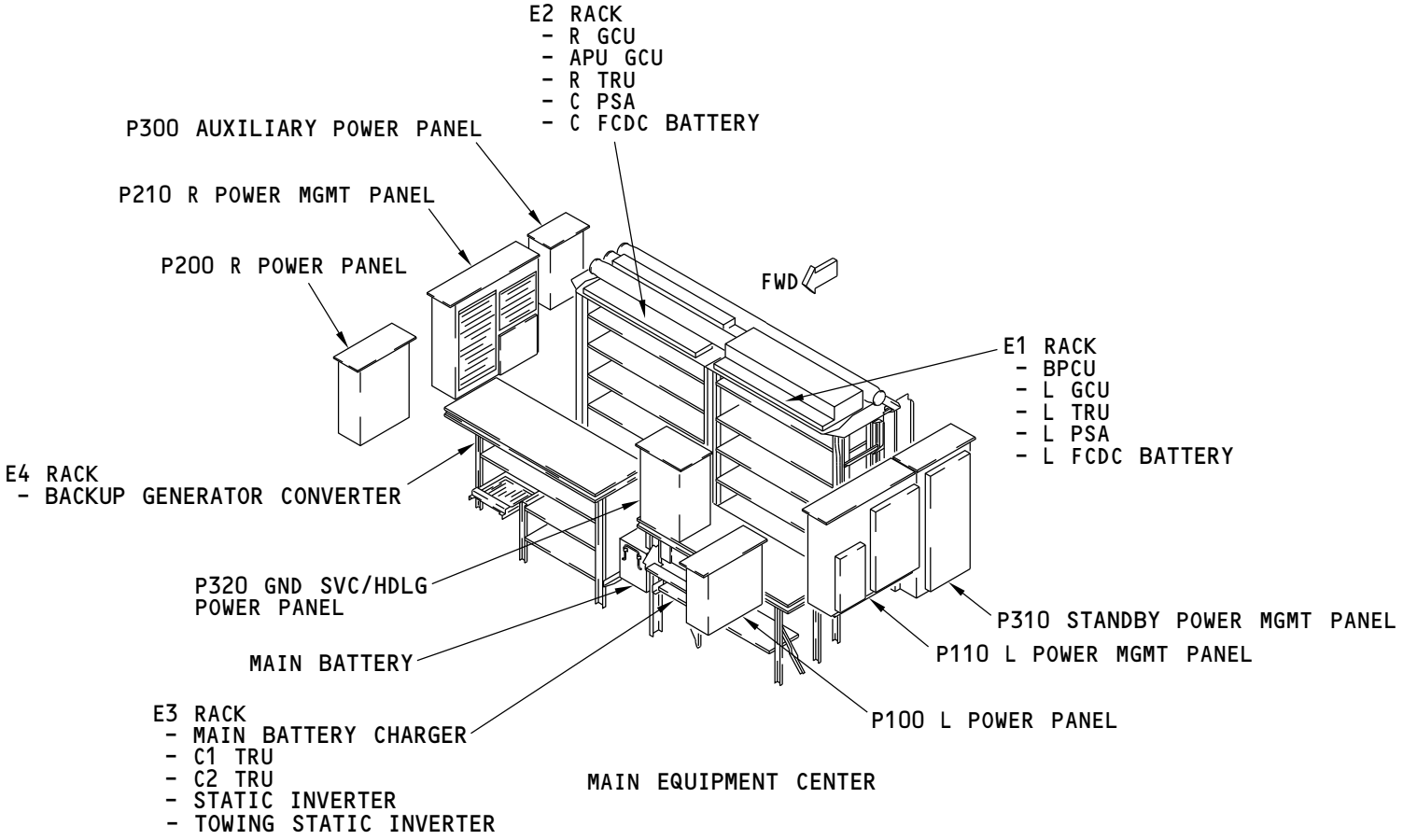
All the ELMS panels contain electrical system components. These are the ELMS panels:

- P200 right power panel
- P210 right power management panel
- P300 auxiliary power panel
- P100 left power panel
- P110 left power management panel
- P310 standby power management panel
- P320 ground service/handling power panel.

Racks

These main equipment center racks contain electrical system components:

- E1
- E2
- E3
- E4.



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ELECTRICAL POWER - GENERAL COMPONENT LOCATIONS - MAIN EQUIPMENT CENTER

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ELECTRICAL POWER - OPERATION - GENERAL

General

The electrical panel is on the P5 overhead panel. The panel has four momentary-action switches and ten alternate-action switches. You use these to operate most of the electrical system. These are the momentary-action switches:

- External power (2)
- Drive disconnect (2).

These are the alternate-action switches:

- Battery
- IFE/Pass Seats
- Cabin/Utility
- APU generator
- Bus tie (2)
- Generator control (2)
- Backup generator (2).

The standby power switch is on the P61 overhead maintenance panel. It is a guarded, toggle switch. You use it to manually control standby power.

Battery Switch

The battery switch connects the hot battery bus to the battery bus 2. ON is a mechanical indication that shows the switch is in its latched-in position. OFF is an amber light that shows when the switch is out and the airplane has ac power.

IFE/Pass Seats Switch

The IFE/pass seats switch disconnects power to some IFE and passenger seat loads. ON is a mechanical indication that shows the switch is in its latched-in position. OFF is an amber light that shows when the switch is out and the airplane has ac power.

Cabin/Utility Switch

The Cabin/utility switch disconnects power to some cabin and utility bus loads. ON is a mechanical indication that shows the switch is in its latched-in position. OFF is an amber light that shows when the switch is out and the airplane has ac power.

APU Generator Switch

The APU generator switch arms the APU GCU to automatically control APU generator electrical power. ON is a mechanical indication that shows the switch is in its latched-in position. OFF is an amber light that shows when the switch is out. If the APU is on, the light also comes on when the auxiliary power breaker (APB) opens except for when you apply secondary external power to the airplane. The switch is normally in the ON position.

Bus Tie Switches

Each bus tie switch controls the operation of its related BTB. AUTO is a mechanical indication that shows the switch is in its latched-in position. ISLN is an amber light that shows when the switch is out and the BTB is open. The isolation (ISLN) light also comes on if the switch is in AUTO, and the GCU opens the BTB for a fault. The switches are normally in the AUTO position.

External Power Switches

Each external power switch controls the operation of its related external power contactor (EPC). AVAIL is a green light that shows good power quality of the ground power source. ON is a green light that shows a closed EPC. The available (AVAIL) light goes off when the EPC closes.

Generator Control Switches

Each generator control switch arms its GCU to control IDG electrical power. ON is a mechanical indication that shows the switch is in the latched-in position. OFF is an amber light that shows when the related generator circuit breaker (GCB) is open. The switches are normally in the ON position.

Backup Generator Switches

Each backup generator control switch arms the backup generator converter to control backup electrical power. ON is a mechanical indication that shows the switch is in its latched-in position. OFF is an amber light that comes on for these conditions:

- Generator control relay (GCR) opens for a fault
- Engine is shut down
- Related engine fire switch is pulled out
- Switch is out.

The switches are normally in the ON position.

Drive Disconnect Switches

The drive disconnect (DISC) switch removes engine gearbox power from the IDG. When you press the switch, the two-piece IDG input shaft moves apart. DRIVE is an amber light that shows that the related IDG has low oil pressure. Plastic guards cover the drive disconnect switches to prevent accidental operation.

Standby Power Switch

The standby power switch has these three positions:

- OFF
- AUTO
- BAT (momentary).

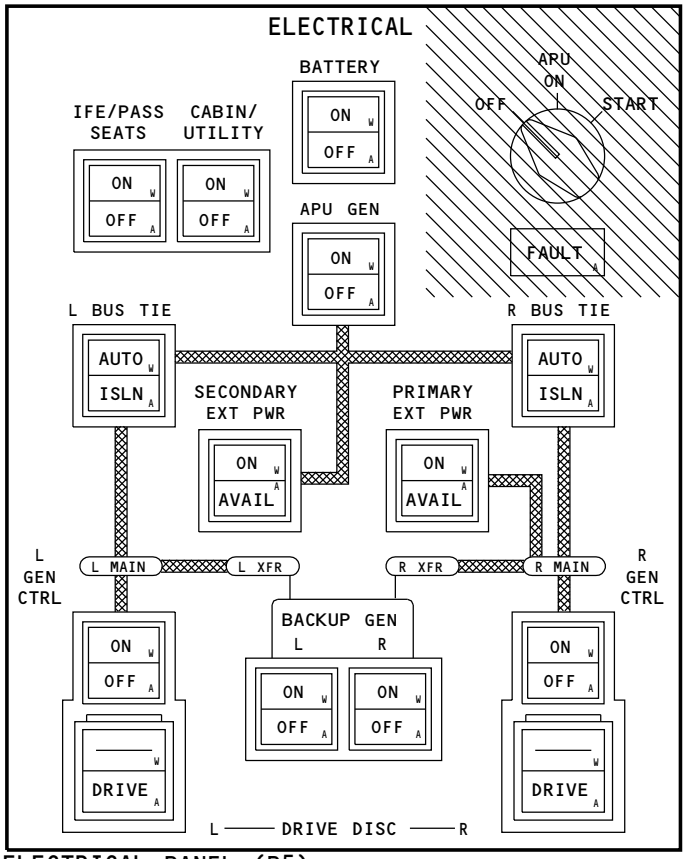
On the ground, the off position makes the static inverter stay off. In the air, the off position has no effect.

The automatic (AUTO) position puts the standby electrical power system under the ELMS control. A guard over the switch moves it to AUTO. The switch is normally in the AUTO position.

To use the battery (BAT) position, you must first push the battery switch to ON. When there is no ac power on the airplane, the switch in BAT turns the static inverter on and makes it supply power to the standby ac bus. When ac power is on, the switch in BAT starts a dc/standby self-test.

Towing Power Switch

The towing power switch lets you supply power only to components that are necessary to safely tow the airplane. When you put the switch in the battery (BAT) position, the towing power light comes on. A guard over the switch moves it to OFF. The switch is normally in the OFF position.



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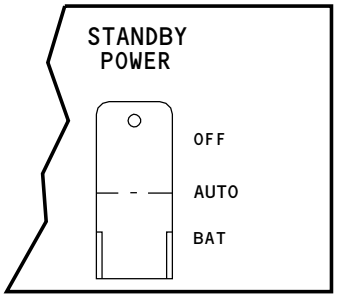
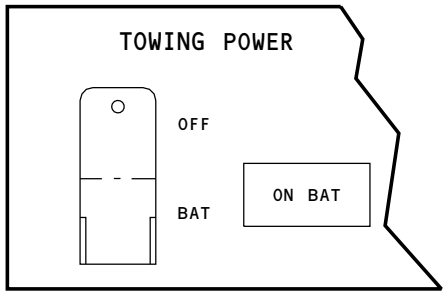
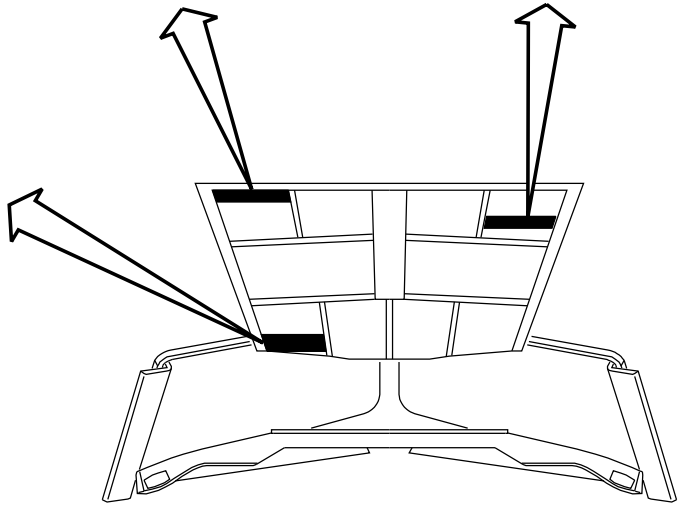


BACKUP WINDOW HEAT PANEL (P61)



GROUND TEST PANEL (P61)



FLIGHT DECK OVERHEAD PANELS

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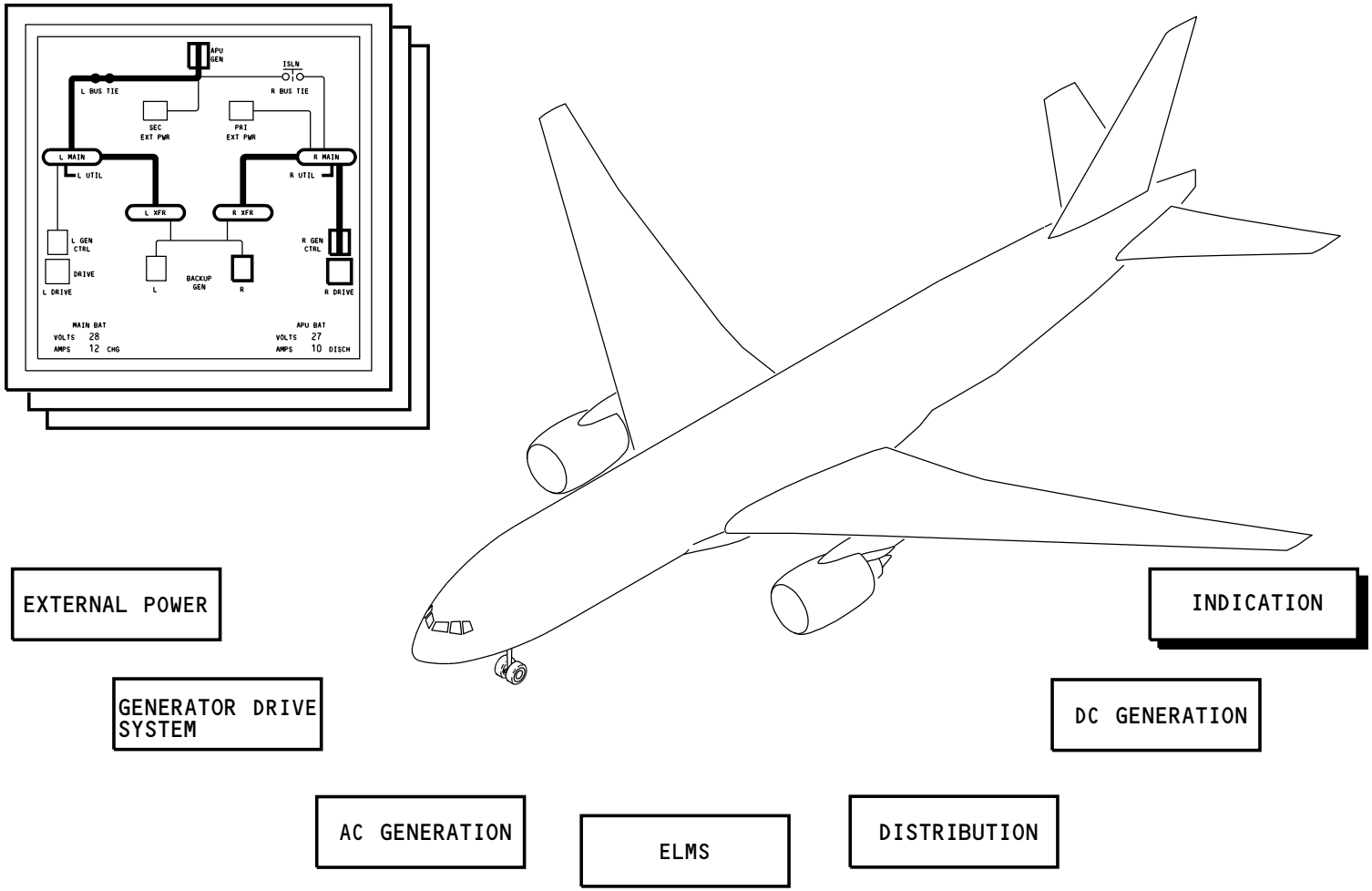
ELECTRICAL POWER - INDICATION - INTRODUCTION

General

The EICAS shows electrical power system indications on these formats:

- Electrical synoptic
- Electrical maintenance page 1
- Electrical maintenance page 2.



M40210 S000616513_V1

ELECTRICAL POWER - INDICATION - INTRODUCTION

ELECTRICAL POWER - INDICATION - ELECTRICAL SYNOPTIC DISPLAY

General

The electrical synoptic display is a simplified schematic of the electrical system. It shows the system configuration for these parts of the ac and dc generation systems:

- Power sources
- Buses
- BTBs
- Generator drives
- Main and APU batteries.

Green flow segments show electrical power flow from power sources to buses.

Power Sources

The electrical synoptic display shows power flow from these power sources:

- IDG
- APU generator
- Backup generator
- Primary and secondary external power.

It also shows the position of the breakers for the power sources.

A white box shows when the power source is off or the breaker is open. A green box shows when the power source is on or the breaker is closed. An amber box and X show if there is a fault with the power source or a fault with the breaker.

Buses

The electrical synoptic display shows these buses green when they receive power:

- Main ac buses
- Transfer buses
- Utility buses.

The utility bus shows white when the cabin/utility switch is in the OFF position.

When the ELMS does a load shed, the message, LOAD SHED shows below the utility bus indication for the related channel.

BTB Status

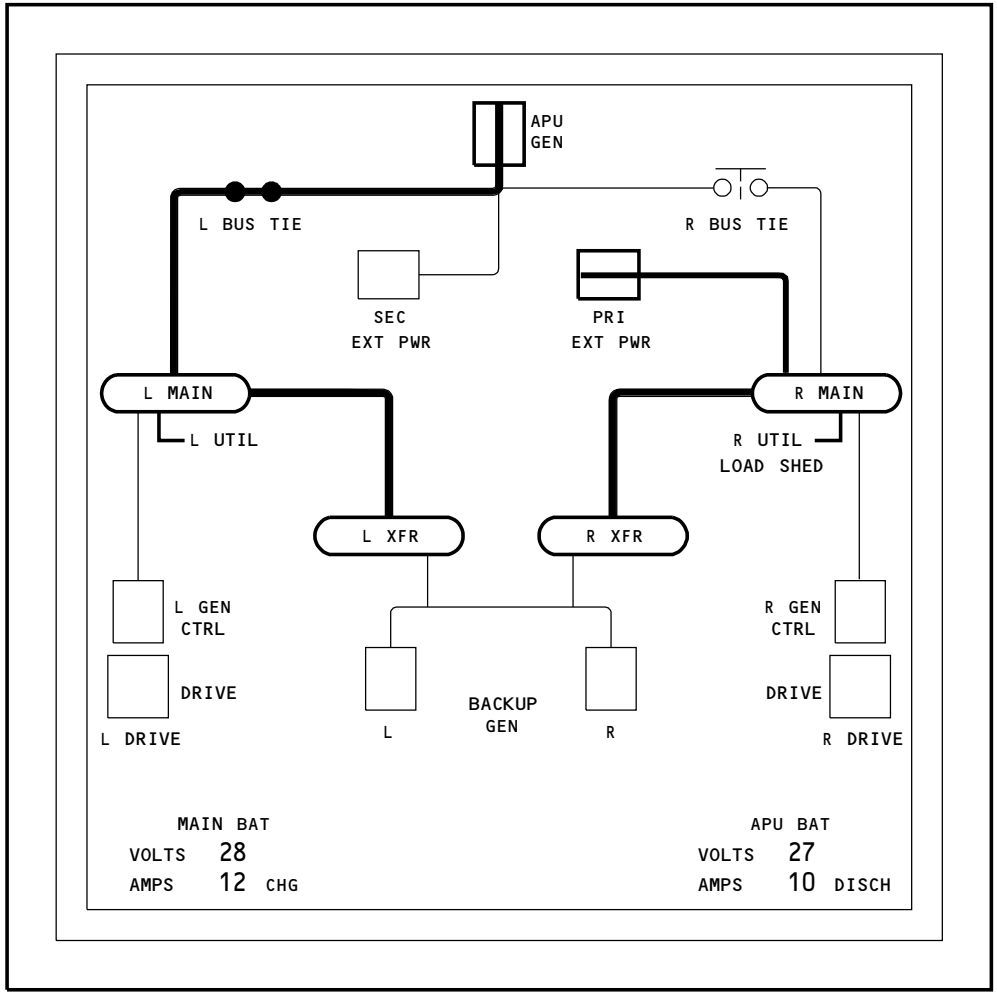
The electrical synoptic display shows the BTB positions. An amber ISLN shows when a BTB is open because of a fault.

Drive Status

The electrical synoptic display shows the IDG drive condition. The amber word DRIVE shows when the IDG has low oil pressure. An amber box and X show if the IDG is disconnected and the engine is running.

Main and APU Battery Output

The electrical synoptic display shows the voltage and current output for the main and APU batteries. It also shows indications for battery charge and discharge.



M40211 S000616514_V1

ELECTRICAL POWER - INDICATION - ELECTRICAL SYNOPTIC DISPLAY

General

The electrical system has two maintenance pages. Page 1 has information on these items:

- AC generation
- DC generation
- Generator oil information
- Fly-by-wire (FBW) output
- Auto-event messages.

AC Generation

The maintenance page shows these indications for the ac generation system power sources:

- Voltage
- Frequency
- Load.

The load is a percent of maximum output.

DC Generation

The maintenance page shows the voltage, and the load in amps, for the dc generation system power sources. Charge (CHG) and discharge (DIS) also show for the batteries.

Generator Oil Information

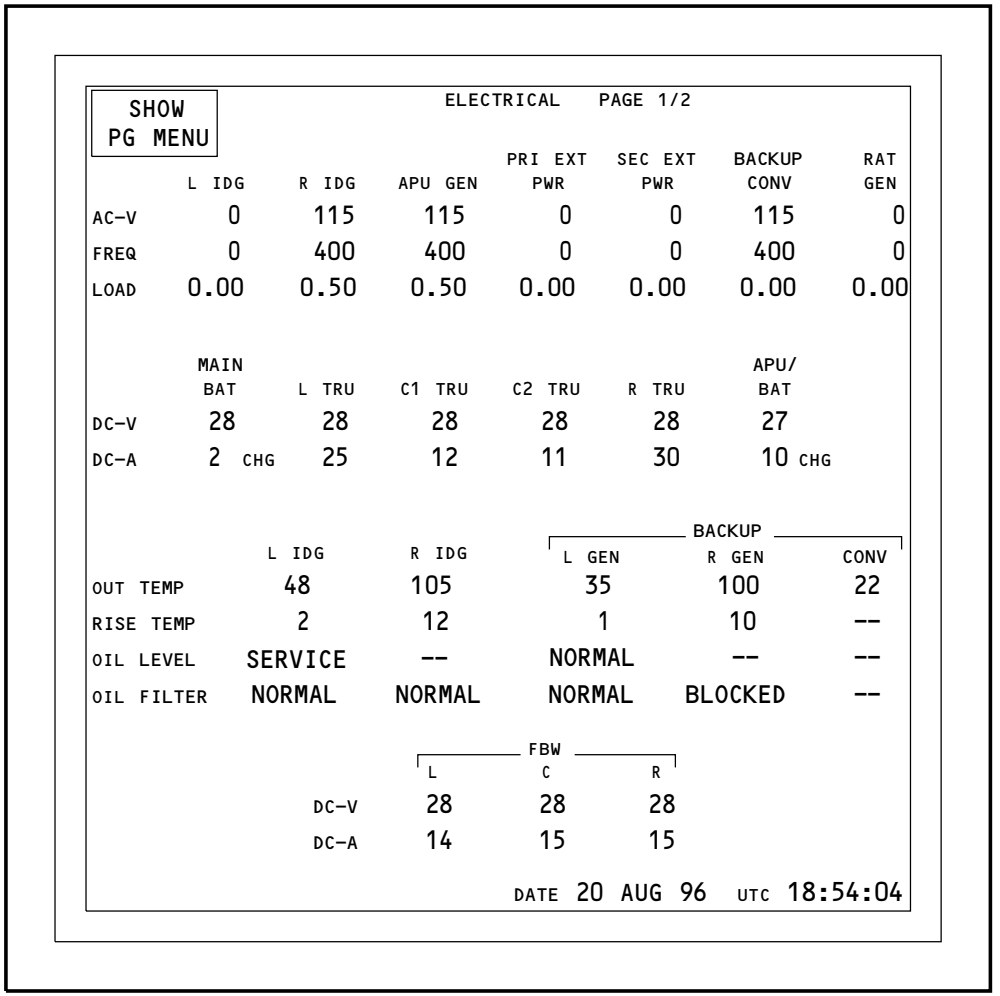
The maintenance page shows these indications for the IDGs and backup generators:

- Oil outlet temperature
- Oil rise temperature
- Oil level
- Oil filter message.

See the generator drive section for more information about generator oil indications (SECTION 24-10).

FBW Output

The maintenance page shows the voltage, and load in amps, for the FCDC buses.



M40213 S000616516_V1

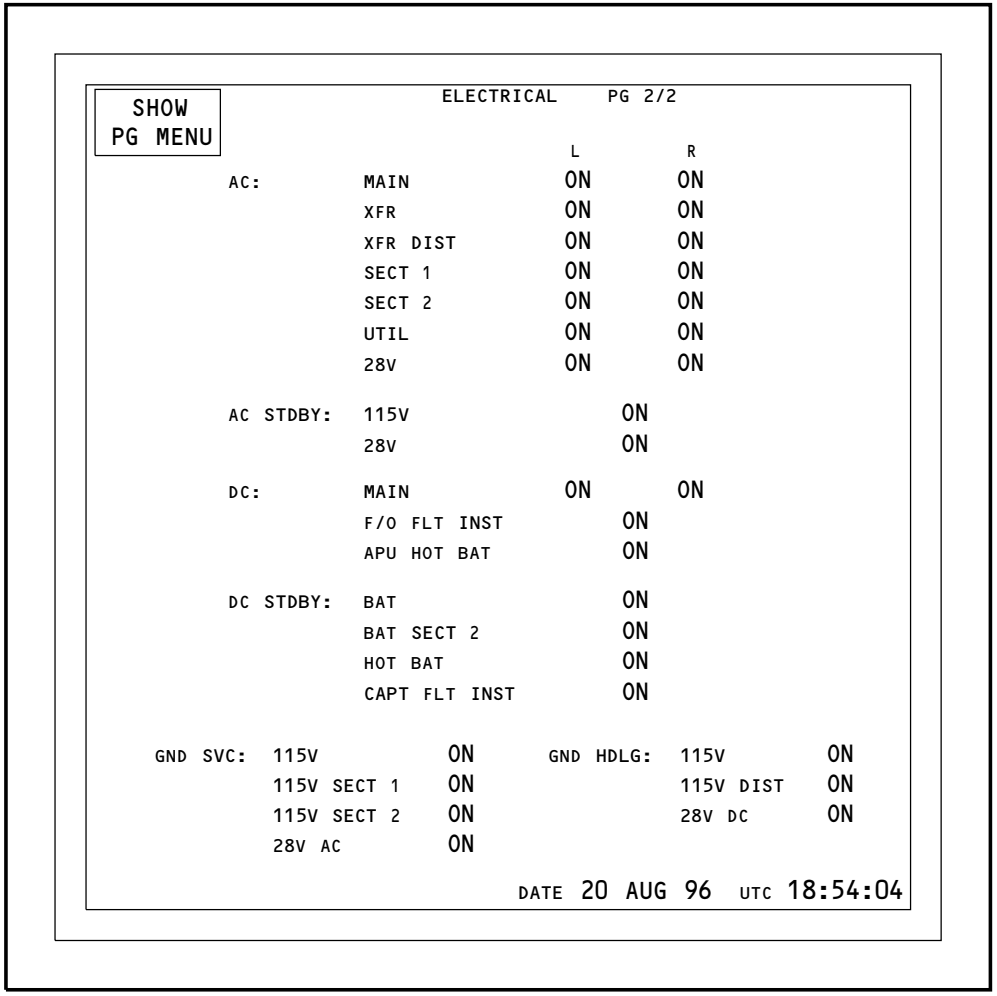
ELECTRICAL POWER - INDICATION - ELECTRICAL MAINTENANCE PAGE 1

ELECTRICAL POWER - INDICATION - ELECTRICAL MAINTENANCE PAGE 2

General

The electrical system has two maintenance pages. Page 2 is shown below. This page shows which buses are receiving power.

An ON next to the name of the bus means that it is receiving power. An OFF means that it is not receiving power.



M40215 S000616518_V1

ELECTRICAL POWER - INDICATION - ELECTRICAL MAINTENANCE PAGE 2

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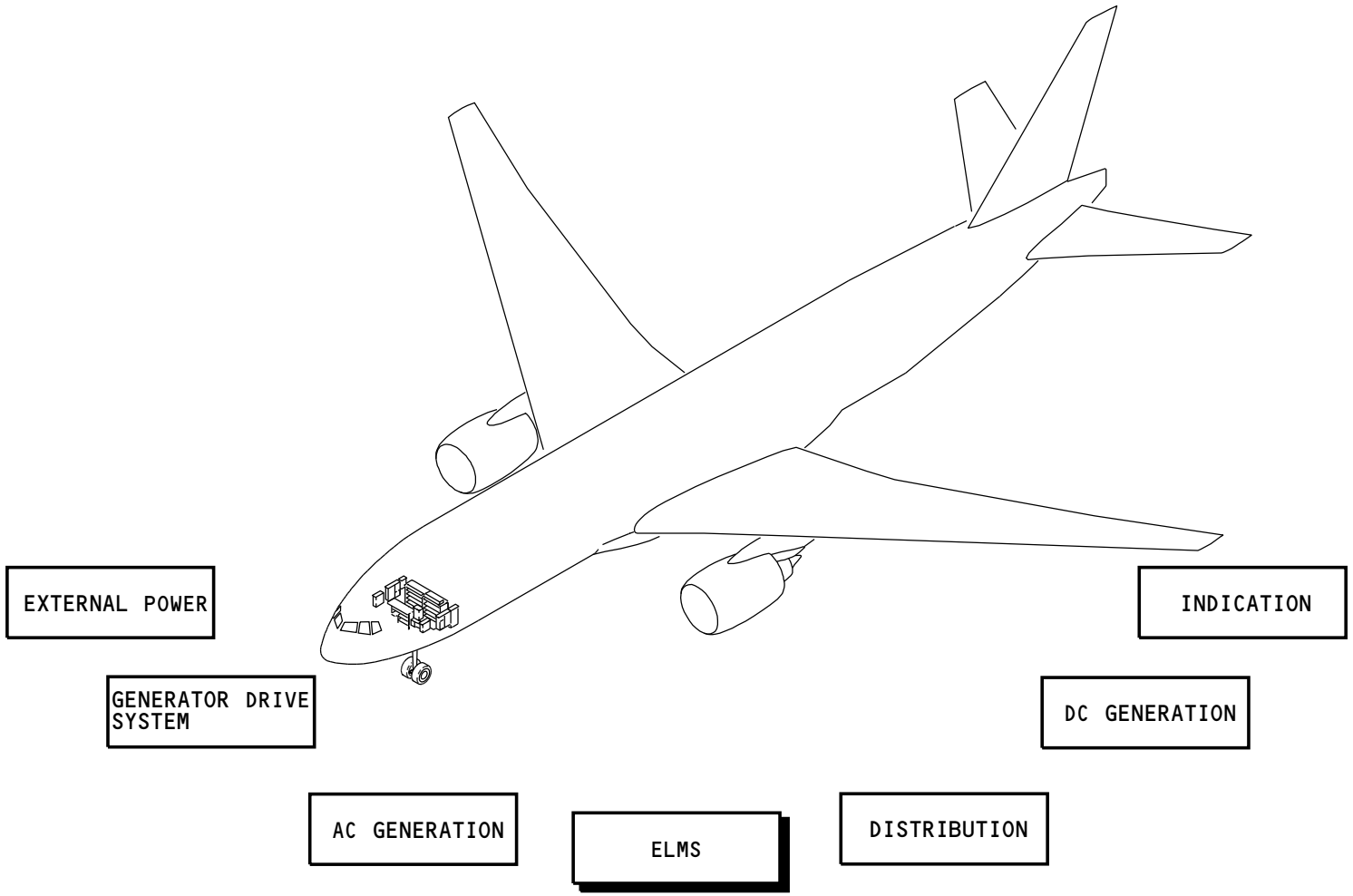
ELMS - INTRODUCTION

General

The electrical load management system (ELMS) has two basic functions that are independent of each other. First, the ELMS is a physical container for electrical equipment that it may or may not control. Second, the ELMS is a control system for many electrical components.



M40216 S000616519_V1

ELMS - INTRODUCTION

ELMS - GENERAL DESCRIPTION

General

The ELMS has seven panels that contain components to distribute electrical power. The ELMS also protects the electrical power system and controls many load-switching devices.

Distribution

All airplane electrical power goes through the ELMS panels for distribution. These are the ELMS panels:

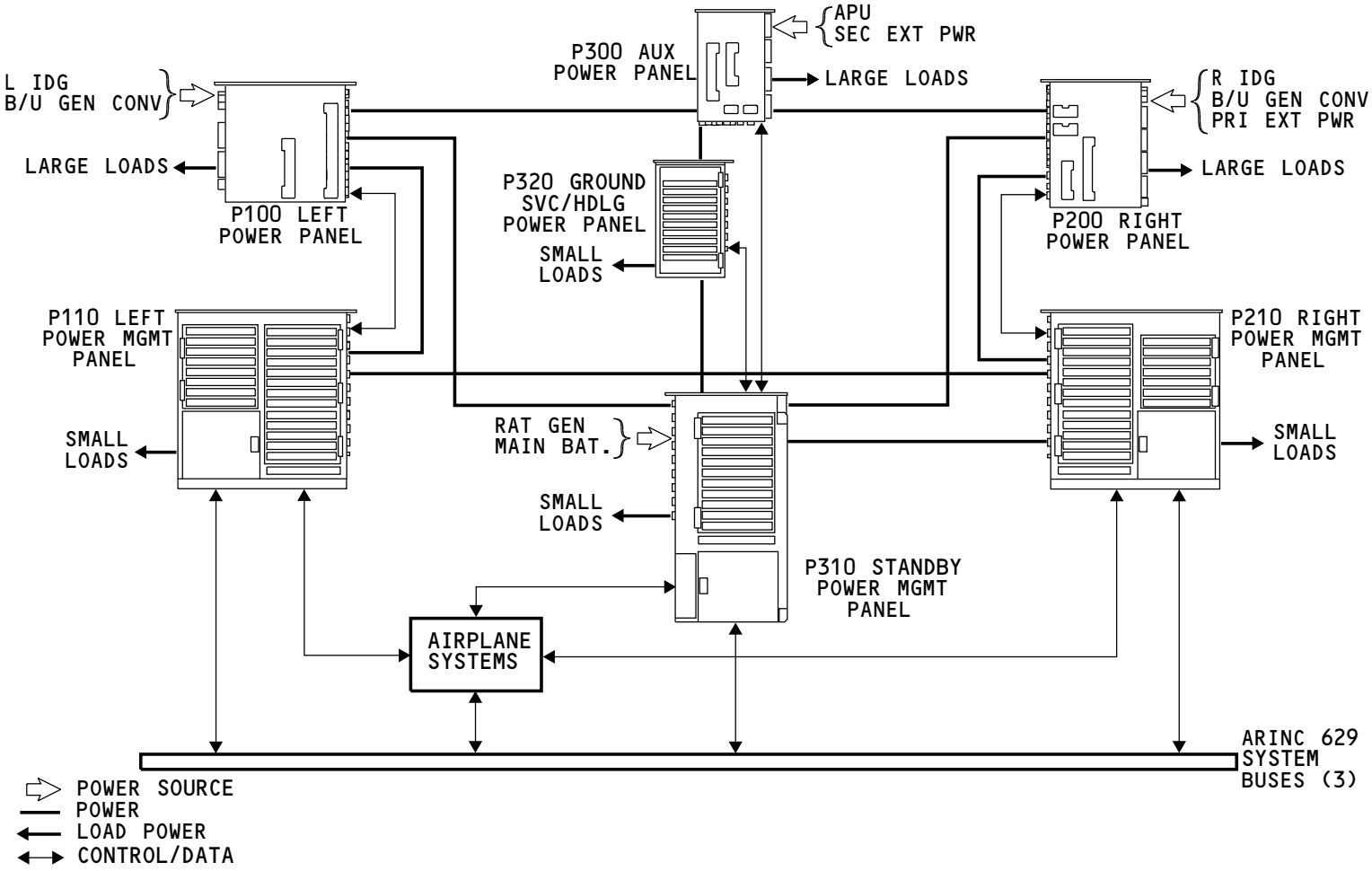
- P100 Left power panel
- P200 Right power panel
- P300 Auxiliary power panel
- P320 Ground service/handling power panel
- P110 Left power management panel
- P210 Right power management panel
- P310 Standby power management panel.

Main and backup power go to the left, right, or auxiliary power panels. These power panels supply power to large loads (usually 25 amps or more). They also supply power to the power management panels and the ground service/handling power panel. The power management panels and the ground service/handling power panel supply power to small loads (usually less than 25 amps).

Load Switching

The ELMS power management panels contain line-replaceable units (LRUs). These LRUs control and monitor the load-switching devices in their related ELMS panels. However, the ELMS LRUs do not control all of the large load-switching devices in the power panels. The GCUs, BPCU, and backup generator converter directly control some of the large load-switching devices.

The LRUs get data from the other electrical power control units and airplane systems either directly or from the ARINC 629 system buses. They use this data to manage the loads of the electrical power system.



M40217 S000616520_V1

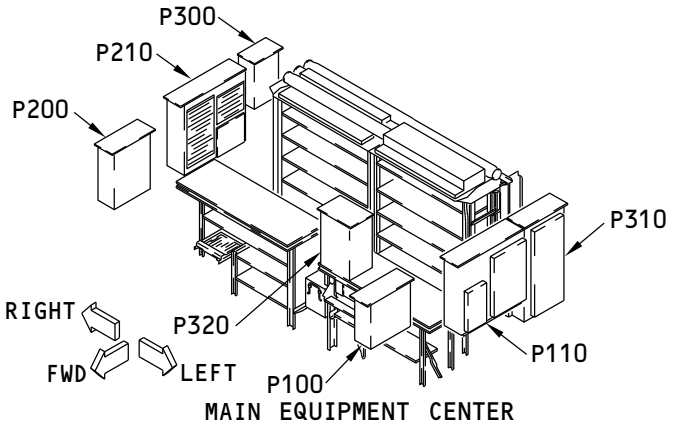
ELMS - GENERAL DESCRIPTION

ELMS - COMPONENT LOCATIONS

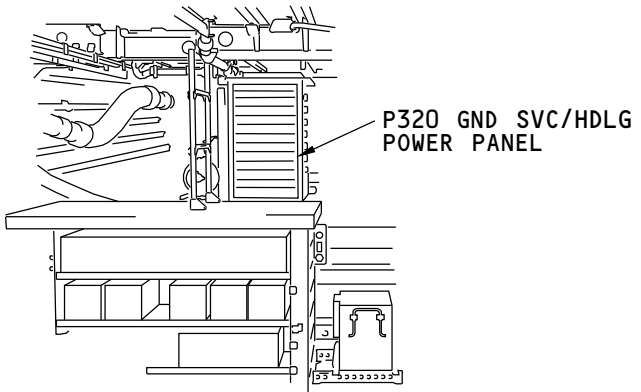
Component Locations

All of the ELMS panels are in the main equipment center. Other ELMS components are in these panels. These are the ELMS panels:

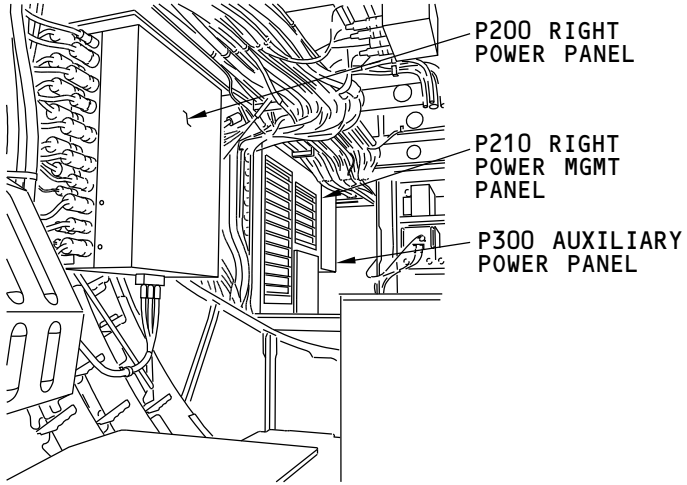
- P320 Ground service/handling power panel
- P200 Right power panel
- P210 Right power management panel
- P300 Auxiliary power panel
- P100 Left power panel
- P110 Left power management panel
- P310 Standby power management panel.



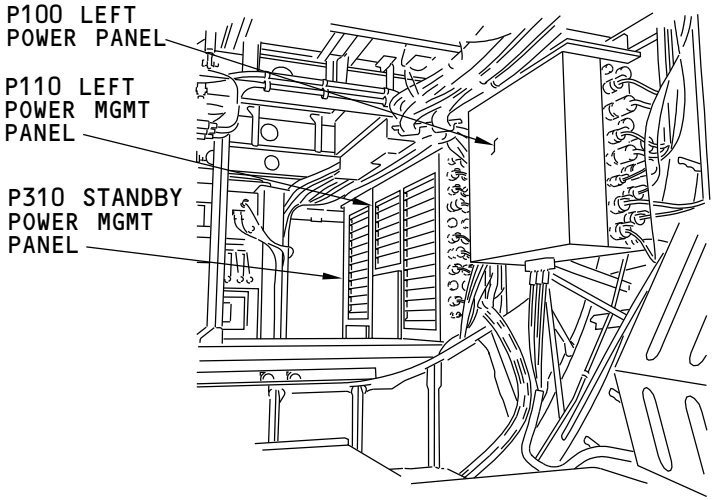
MAIN EQUIPMENT CENTER



MAIN EQUIPMENT CENTER
(LEFT, LOOKING FORWARD)



MAIN EQUIPMENT CENTER
(RIGHT, LOOKING AFT)



MAIN EQUIPMENT CENTER
(LEFT, LOOKING AFT)

M40218 S000616521_V1

ELMS - COMPONENT LOCATIONS

ELMS - P100/P200 POWER PANELS

P100 Left Power Panel

P100 contains switching devices and circuit breakers for large electrical loads. You remove the panel cover to get access to these components in P100:

- Electrical load control units (ELCUs)
- L GCB
- L BTB
- L TBB
- L CCB
- PPC
- Circuit breakers.

Holes in the panel cover permit access to the circuit breakers. Labels on the cover identify the circuit breakers.

ARO 001-010

There are bus power lights on the lower-right side of the panel. The red lights have numbers on them. A placard on the side of the panel identifies the lights by number.

ARO 011-999

There are bus power lights on the lower left side of the panel. The legend near the lights identifies them by number.

ARO ALL

Stud connectors for the large power cables are on the aft side of the panel. Electrical connectors for smaller circuits are on the forward side of the panel.

P200 Right Power Panel

P200 contains switching devices and circuit breakers for large electrical loads. You remove the panel cover to get access to these components in P200:

- R CCB
- ELCUs
- R GCB
- R BTB
- GSTR
- Primary external power contactor (PEPC)
- Circuit breakers
- PPC
- R TBB.

Holes in the panel cover permit access to the circuit breakers. Labels on the cover identify the circuit breakers.

ARO 001-010

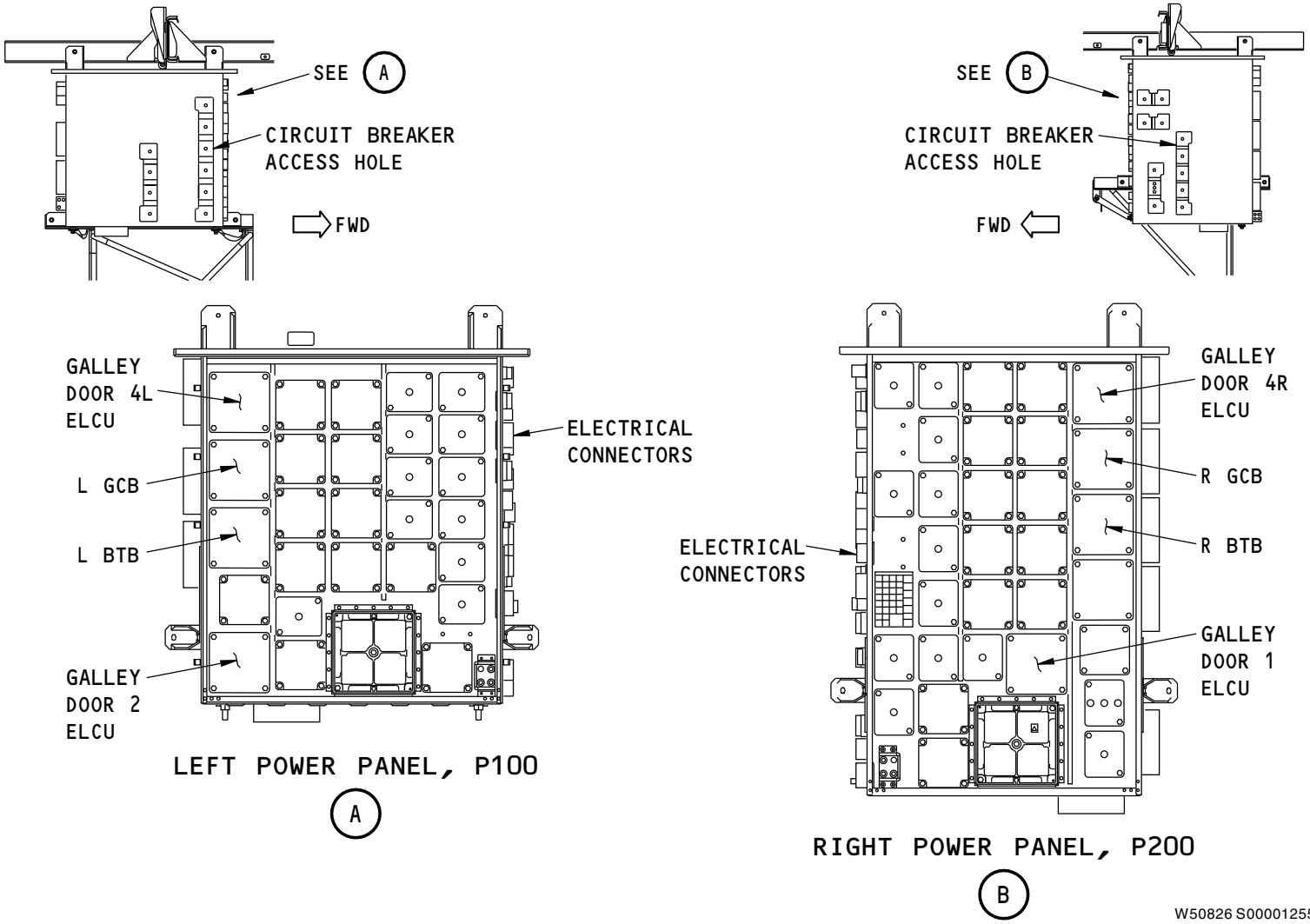
There are bus power lights on the lower-left side of the panel. The red lights have numbers on them. A placard on the side of the panel identifies the lights by number.

ARO 011-999

There are bus power lights on the lower left side of the panel. The legend near the lights identifies them by number.

ARO ALL

Stud connectors for the large power cables are on the aft side of the panel. Electrical connectors for smaller circuits are on the forward side of the panel.



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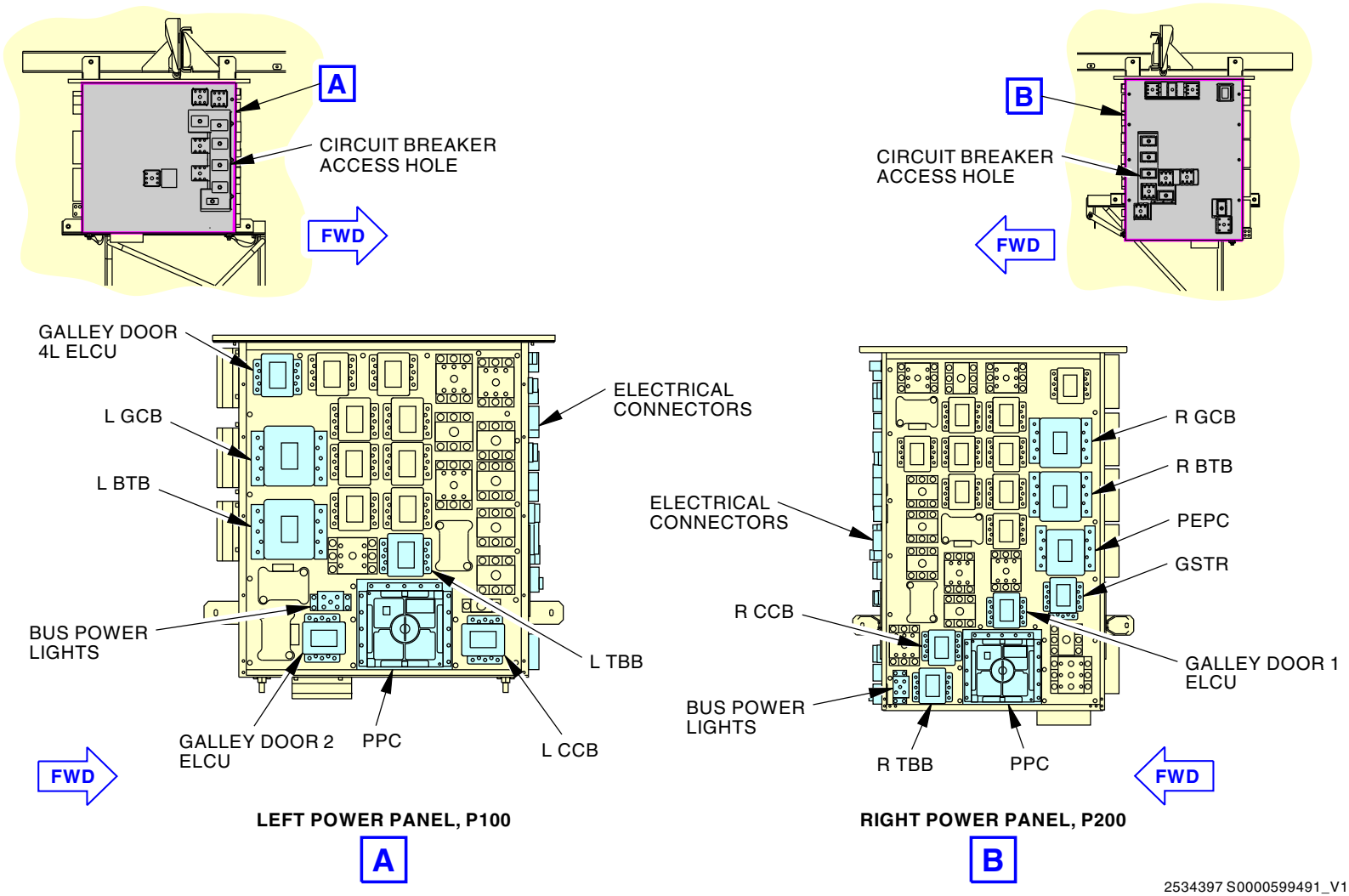
ELMS - P100/P200 POWER PANELS



ELMS - P100/P200 POWER PANELS

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P300 Auxiliary Power Panel

P300 contains switching devices and circuit breakers for large electrical loads. You remove the panel cover to get access to these components in P300:

- APB
- GHR
- GSSR
- Secondary external power contactor (SEPC)
- Circuit breakers.

Holes in the panel cover permit access to the circuit breakers. Labels on the cover identify the circuit breakers.

ARO 001-010

There are bus power lights on the lower, right side of the panel. The red lights have numbers on them. A placard on the front of the panel identifies the lights by number.

ARO 011-999

There are bus power lights on the lower left side of the panel. The legend near the lights identifies them by number.

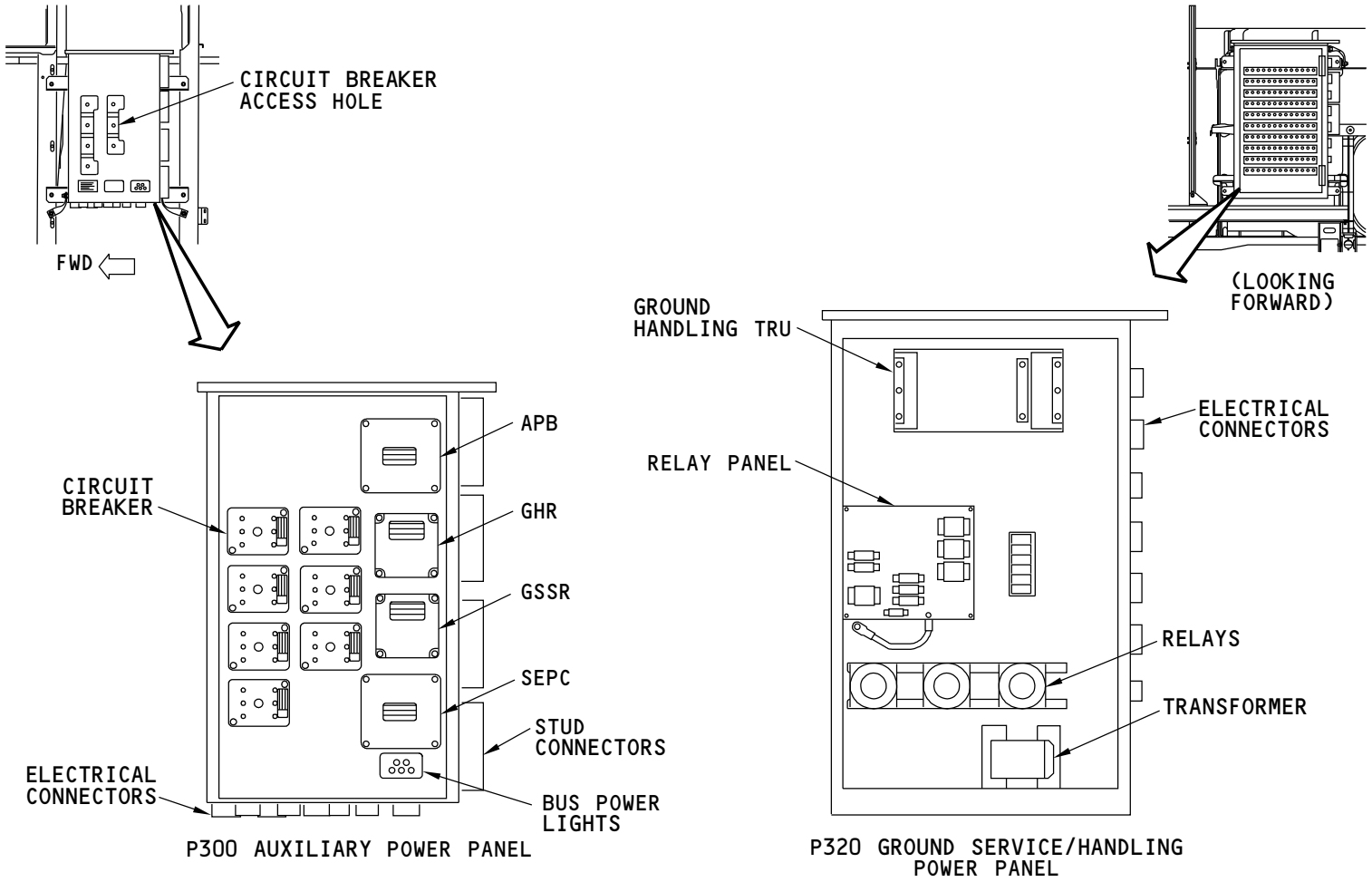
ARO ALL

Stud connectors for the large power cables are on the aft side of the panel. Electrical connectors for smaller circuits are on the bottom of the panel.

P320 Ground Service/Handling Power Panel

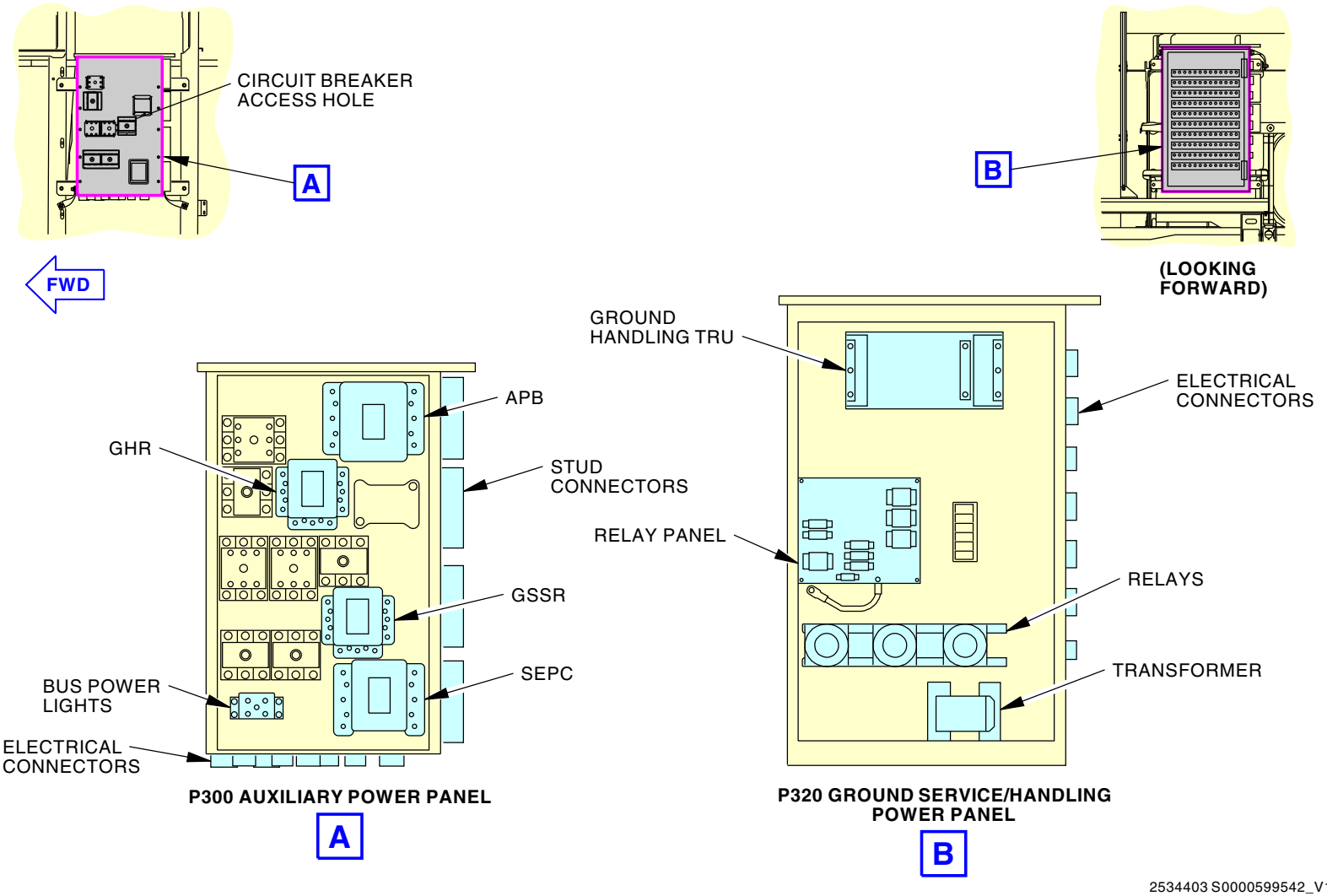
P320 contains switching devices and circuit breakers for smaller electrical loads. You open the panel door to get access to these components in P320:

- Ground handling TRU
- Relay panel
- Relays
- Transformer.



M40220 S000616523_V1

ELMS - P300/P320 AUXILIARY AND GROUND SERVICE/HANDLING POWER PANELS



2534403 S0000599542_V1

ELMS - P300/P320 AUXILIARY AND GROUND SERVICE/HANDLING POWER PANELS

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ELMS - P110 LEFT POWER MANAGEMENT PANEL

General

The P110 left power management panel contains switching devices and circuit breakers for smaller electrical loads.

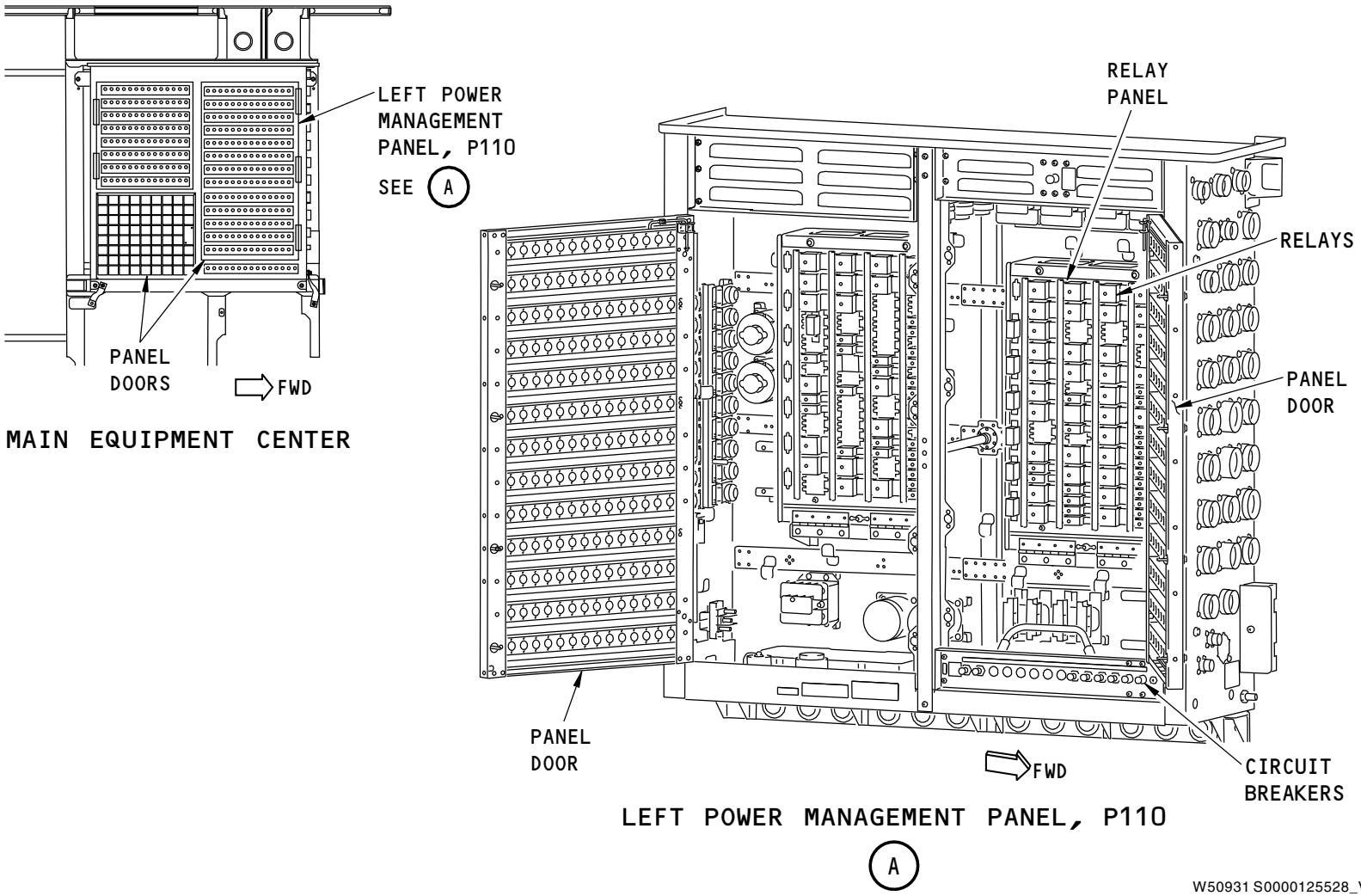
Physical Description

You open the panel doors to get access to these components in the P110:

- Relays
- Relay panels
- CCU
- SIU.

Training Information Point

You can remove the CCU and SIU. Exposed connector pins make the cards electrostatic discharge sensitive (ESDS) components.



ELMS - P110 LEFT POWER MANAGEMENT PANEL

ELMS - P210 RIGHT POWER MANAGEMENT PANEL

General

The P210 right power management panel contains switching devices and circuit breakers for smaller electrical loads.

Physical Description

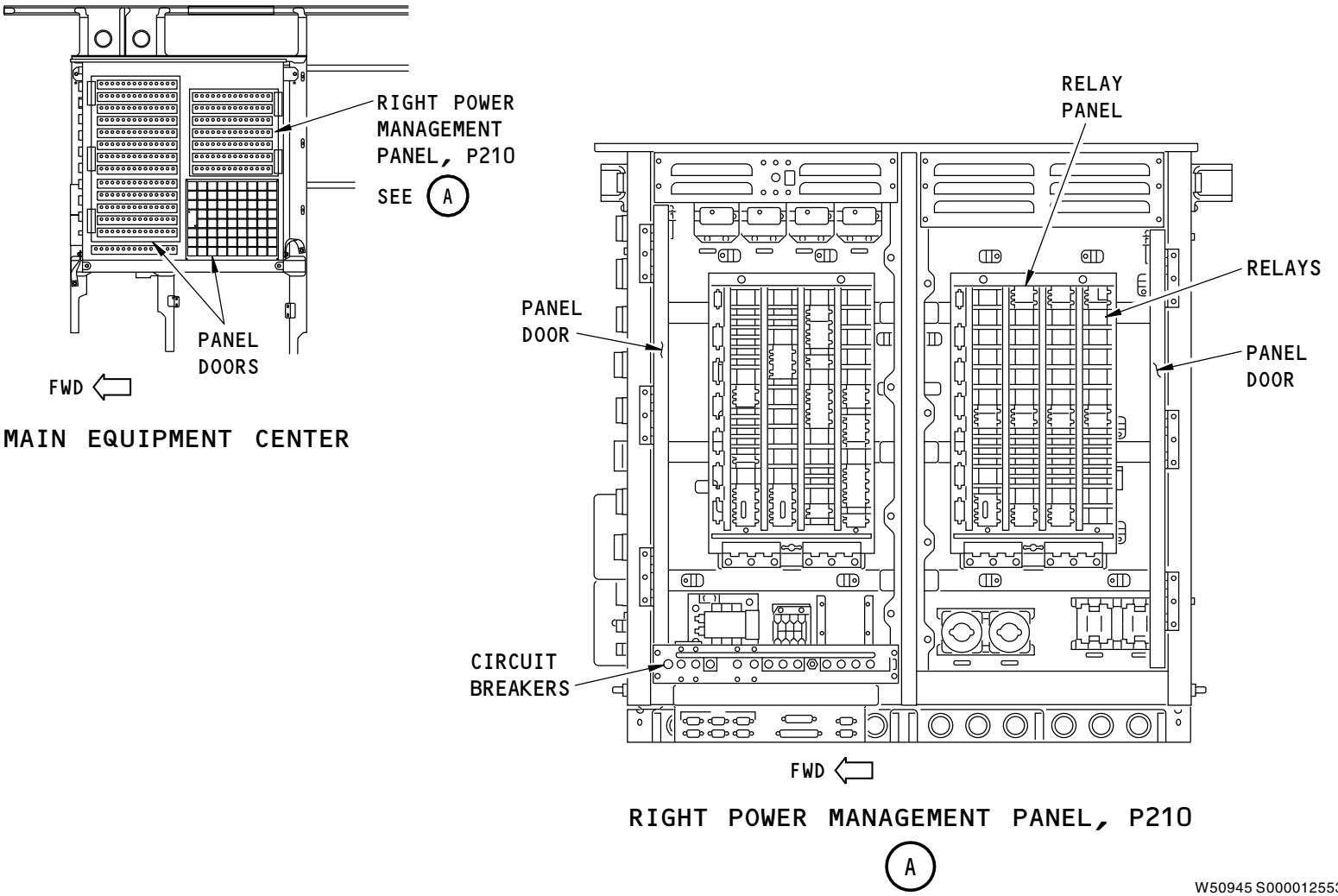
You open the panel doors to get access to these components in P210:

- Transformer
- SCMs
- Relays
- Relay panels
- CCU
- SIU
- DC tie relay.

Circuit breakers are in the doors of the panel.

Training Information Point

You can remove the CCU and SIU. Exposed connector pins make the cards ESDS components.



ELMS - P210 RIGHT POWER MANAGEMENT PANEL

ELMS - P310 STANDBY POWER MANAGEMENT PANEL

General

The P310 standby power management panel contains switching devices and circuit breakers for smaller electrical loads.

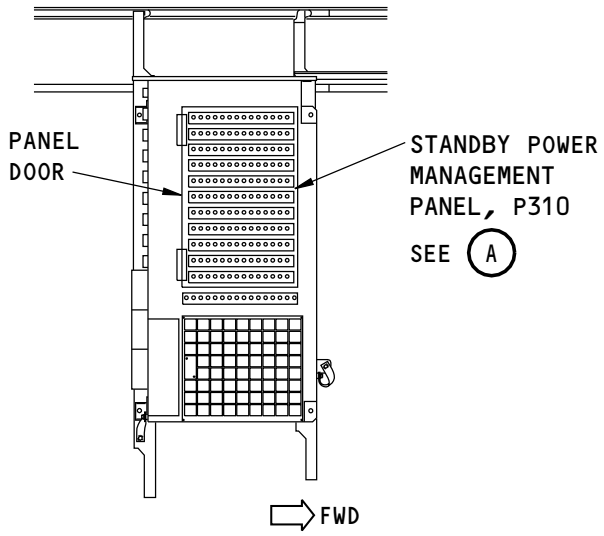
Physical Description

You open the panel door to get access to these components in P310:

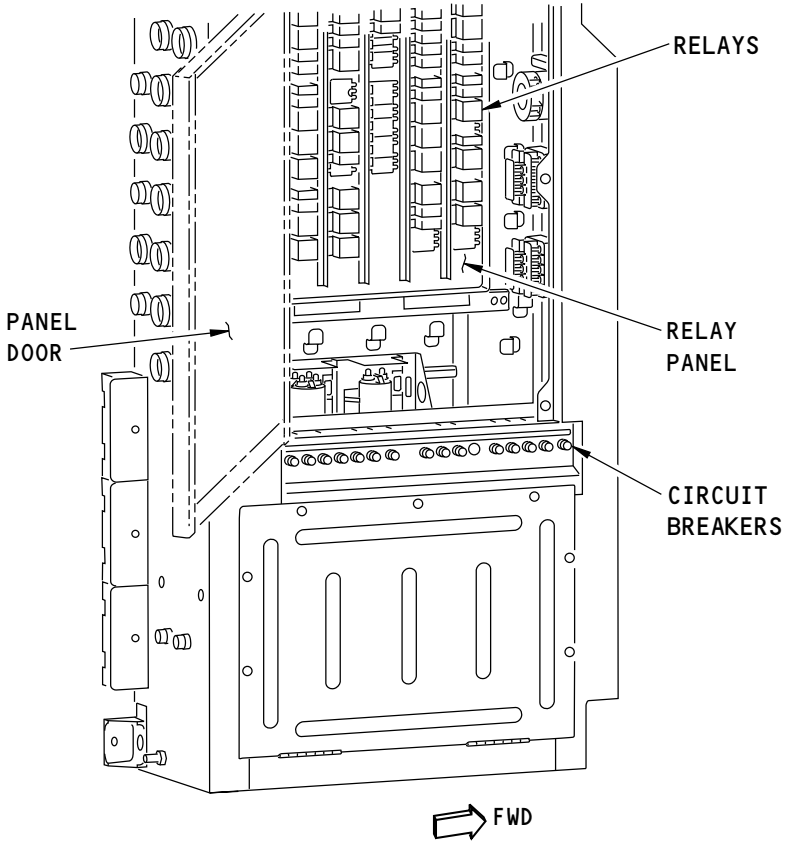
- SCMs
- Relay panel
- Relays
- CCU
- SIU

Training Information Point

You can remove the CCU and SIU. Exposed connector pins make the cards ESDS components.



MAIN EQUIPMENT CENTER



STANDBY POWER MANAGEMENT PANEL, P310

A

W50960 S0000125531_V1

ELMS - P310 STANDBY POWER MANAGEMENT PANEL

ELMS - FUNCTIONAL DESCRIPTION - PANELS

General

Each of the ELMS panels has self-contained wiring. All of the airplane wiring connects to the panels with external connectors. Line replaceable modules (LRMs) are inside the ELMS panels.

Power Panels

The power panels contain the large electrical load switching devices. One side of each panel has connecting studs for the large power cables. The other side has electrical connectors for smaller circuits. Bus power lights show when buses in the panel have power.

Inside each power panel is a backplane. Panel wiring and current transformers are behind the backplane. LRM mounting bases are part of the backplane. No wire connections are in front of the backplane.

LRMs plug into the mounting bases. The LRM power contacts are spring-loaded to ensure good contact with the mounting bases. Screws hold the LRMs in position. Plates cover any mounting bases that are not used.

The P100 and P200 panels contain a power panel controller (PPC). The PPC is secured by two bolts and a hand-turn center fastener.

Power Management Panels

The power management panels contain the smaller electrical load switching devices and the electronic modules. These LRMs are in the panels:

- CCU
- Current monitors
- Relays
- Circuit breakers
- SIU
- Breaker.

The SIUs change many input signals into a digital format and transmit data to the CCU via RS485 data buses.

Relays are inside the panels. Smaller relays attach to relay panels that rotate down to expose the back of the relay panel. Larger relays attach to rails.

Circuit breakers are in the doors of the panels. Those monitored by the ELMS have a small circuit card attached to their base on the back of the panel door. One row of high ampere dc circuit breakers attach to the bottom face of the panels.

Each management panel contains a CCU and two SIUs. On the P110 and P210 panel, access to the CCU and SIUs can be obtained by opening the large panel doors. On the P310 panel, access to the CCU and SIUs can be obtained by opening the lower access door.

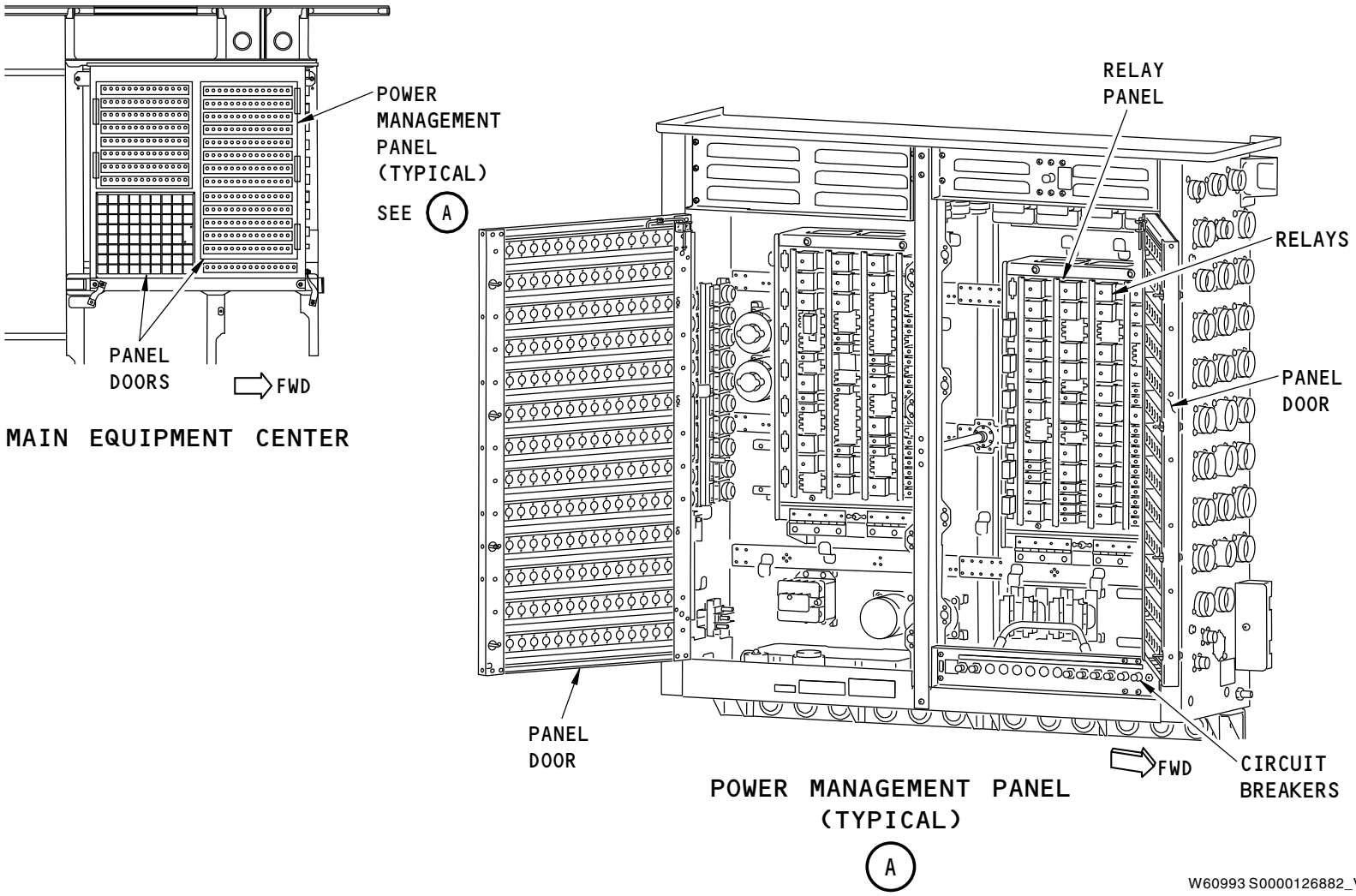
Training Information Point

The screws of the power panel LRMs are captive (stay with the LRM).

Exposed connector pins on the circuit cards make them ESDS components.

Circuit breakers for the ELMS panels are below the surface of the panel cover or are in a recess in the panel doors. This prevents accidental damage to the circuit breakers, but you cannot easily see when a circuit breaker is open. Attach circuit breaker clips when you manually pull a circuit breaker to clearly show that it is open. Also supply power through the circuit breaker after you reset it to make sure it stays in.

Discoloration of the wire bundles may occur where anti-abrasion tape is comes in contact with cable clamp pad material that is colored black. The black pigment may be absorbed by the tape, causing the tape to appear brown on the surface. This discoloration is normal and does not affect the wire bundle or indicate damage to the bundle.



ELMS - FUNCTIONAL DESCRIPTION - PANELS

ELMS - FUNCTIONAL DESCRIPTION - CCU AND SIU

General

The ELMS 2 power management panels contain one Computing and Communication Unit (CCU) and two Signal Interface Units (SIUs).

Physical Description

You open the panel door to get access to the CCU and SIUs. You can remove the CCU and SIUs from the panel.

CCU

The CCU is a dual redundant processor and communications unit. Each CCU contains a Computing and Communications Card (CCC) and a Power Supply Card (PSC). The PSC is a smaller double-sided board and is located above the CCC. The CCC and PSC is separated by pillars. A single header connector is located at the center of the bottom edge of the two card assemblies and this header connector connects the two boards together.

There are two central processing unit (CPU) cards in each CCU. One is for channel A and the other for channel B. The CPUs contain the software that controls and monitors the ELMS functions.

There are two ARINC 629 cards in each CCU. The ARINC 629 cards transmit and receive data across the airplane systems ARINC 629 buses. One card is for the left systems bus and the other for the right systems bus.

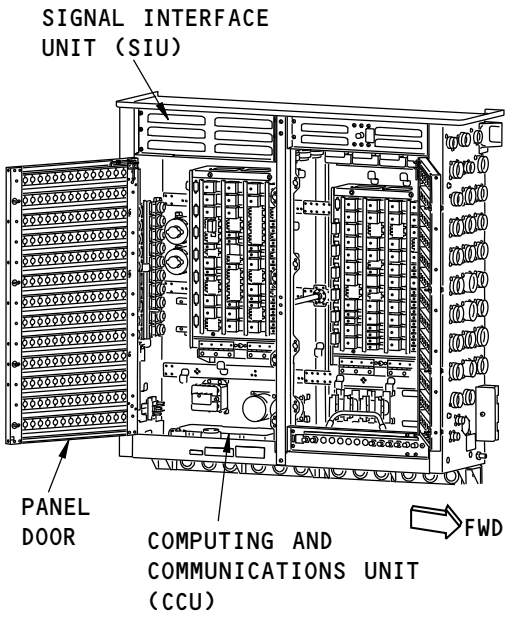
The power supply card gets the airplane dc power and provides the power to the cards in ELMS.

SIU

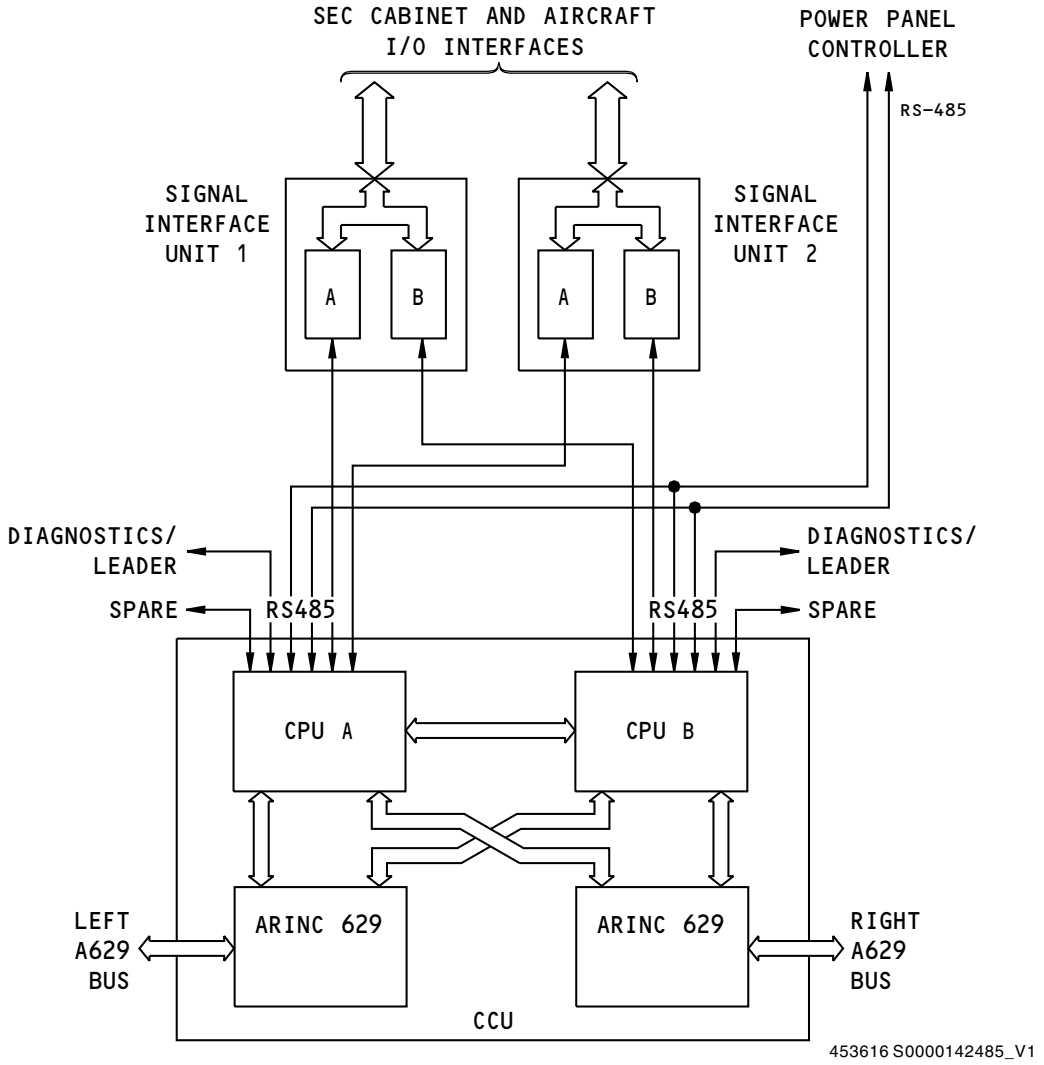
The SIU is an electronic LRU used to provide a multi function I/O capability via the RS485 databus. Two identical SIUs are in each power management panels to handle the volume of signals. Each SIU is a separate LRU. The SIUs connect to all the input and output signals required to control the ELMS 2 panel functionality. The SIUs provide two independent, dual redundant channels for these signals.

Training Information Point

The CCU and SIUs cards are ESDS components. You must use a wrist strap when you remove the cards.



POWER MANAGEMENT PANEL (TYPICAL)



ELMS - FUNCTIONAL DESCRIPTION - CCU AND SIU

ELMS - FUNCTIONAL DESCRIPTION - POWER

General

The ELMS power management panels operate with 28v dc power. Each power management panel has power supply unit (PSU) to control the power. The PSUs are circuit cards in the ELMS. Two different dc power sources supply power to each PSU.

P110

The left power management panel gets power from the left and right dc buses.

P210

The right power management panel gets power from the left and right dc buses.

P310

The standby power management panel gets power from the battery #2 bus and the hot battery bus. The hot battery bus can supply power to P310 when any of these conditions occur:

- Battery switch is on
- Airplane is in the air
- RAT is deployed
- Refuel panel door is open.

The hot battery bus supplies control power to all of the relays that connect hot battery bus power to the P310.

Start Power Control

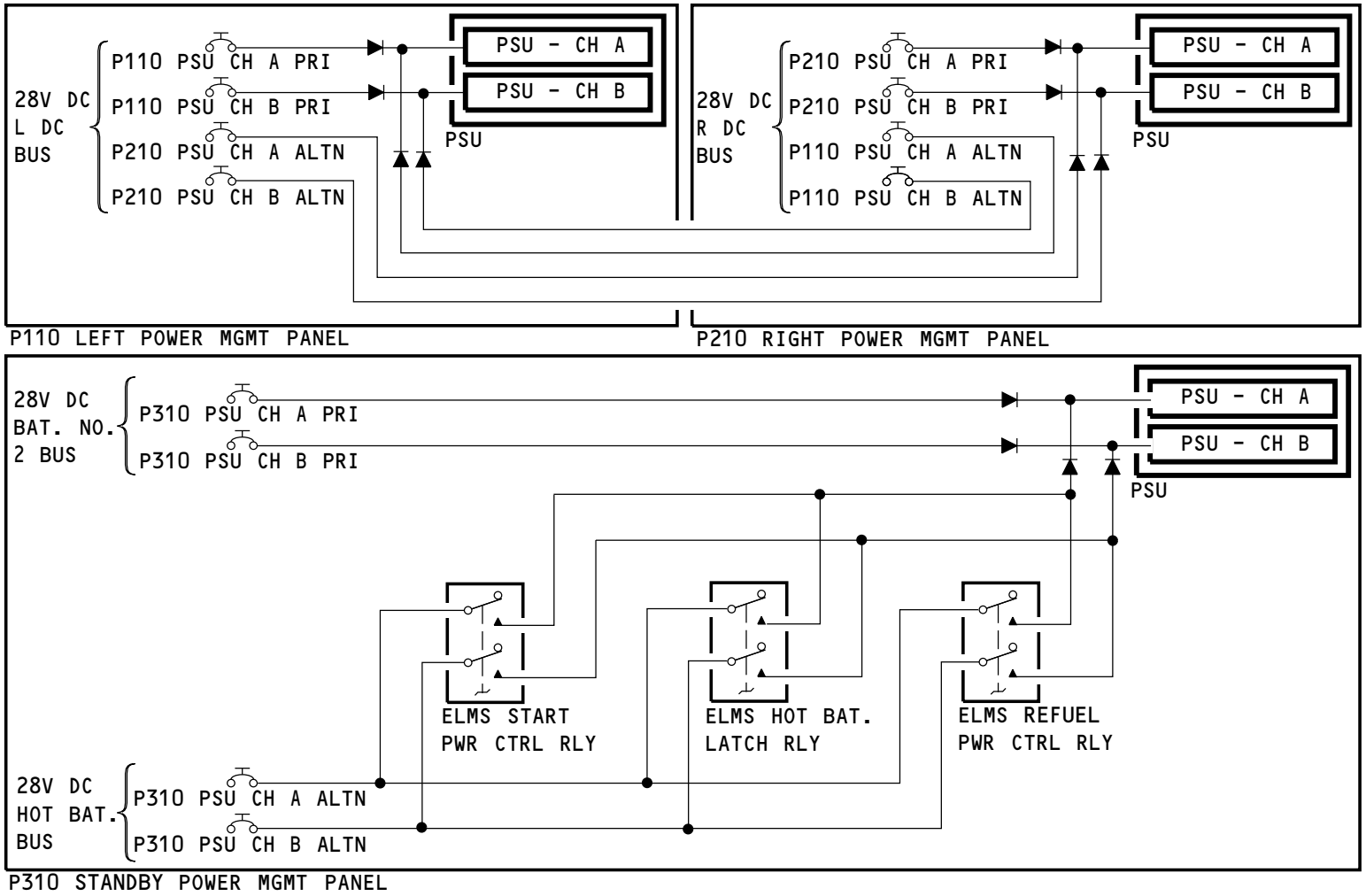
When the airplane has no power and you push the battery switch on, the ELMS start power control relay energizes. This supplies power to the P310 so that it can energize the ground power battery relay. The ground power battery relay connects the hot battery bus to the battery No. 2 bus.

Hot Battery Latch

When the airplane is in the air or the RAT deploys, the hot battery latch relay energizes. This makes sure that the P310 has power to control standby power operations even if the battery switch receives damage.

Refuel Power Control

When the integrated refuel panel door is open, the refuel power control relay energizes. This supplies power to the P310 so that it can control the refuel valves.



M40225 S000616528_V2

ELMS - FUNCTIONAL DESCRIPTION - POWER

ELMS - FUNCTIONAL DESCRIPTION - CONTROL

General

In addition to the distribution of electrical power, the ELMS also controls the switching of many electrical loads.

Control

Switching devices control the flow of electrical power to electrical loads. The ELMS controls these devices in one of these three ways:

- External control
- Remote control.
- CCU and SIU control

ELMS receives control signal inputs. ELMS software decides when the switching device should operate. ELMS then directly controls the power switching device.

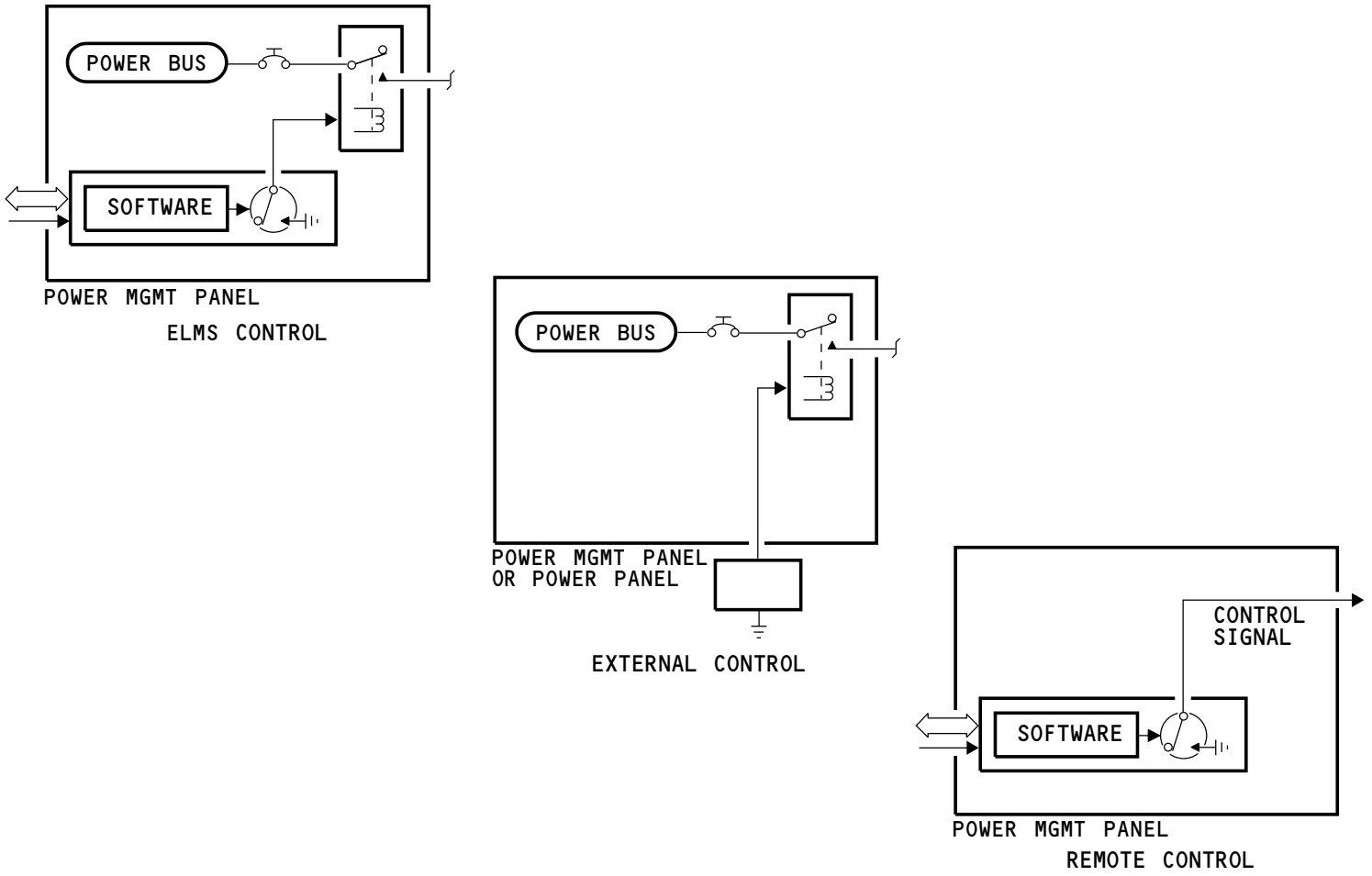
Other systems, external to the ELMS, also control switching devices in the ELMS panels. In these cases the ELMS has no control over the switching device.

For remote control, ELMS controls switching devices that are not in the power management panels. ELMS supplies a control signal that is either a ground for a remote relay or a logic discrete for a control unit.

Software

ELMS control software for a switching device can be simple or complex. For some devices, the software just repeats a command input with no processing. For other devices, the software requires many inputs and does much processing.

ELMS software is data-loadable.



M40226 S000616529_V2

ELMS - FUNCTIONAL DESCRIPTION - CONTROL

ELMS - FUNCTIONAL DESCRIPTION - MONITORING

General

In addition to the distribution of electrical power, the ELMS also monitors the status of the power to many electrical loads for control purposes.

Monitor

ELMS monitors electrical loads in several different ways. ELMS can use different combinations of these ways to monitor the electrical loads:

- Bus voltage
- Circuit breaker position
- Relay position by voltage (option A)
- Relay position by ground (option B)
- Load current
- Analog discrete signal.

ELMS uses this load data to control the loads and to report faults. ELMS also supplies external control units with load data.

Bus Status

ELMS monitors the power on buses by sensing the bus voltage. This is done with a voltage sensor (V SEN).

Bus/CB Status

ELMS monitors the position of circuit breakers by sensing the voltage downstream of the circuit breaker. This is done with a circuit breaker monitor (CB MON).

Bus/CB/Relay Status - Opt A

Additionally, ELMS can monitor the position of relays by sensing the voltage downstream of the relay contact. The signal interface unit (SIU) changes input signals into a digital format and transmits data to the CCU.

Bus/CB/Relay Status - Opt B

ELMS sometime uses an alternative to option A by sensing a ground (or power) through one contact of the relay. The SIU transmits data to the CCU.

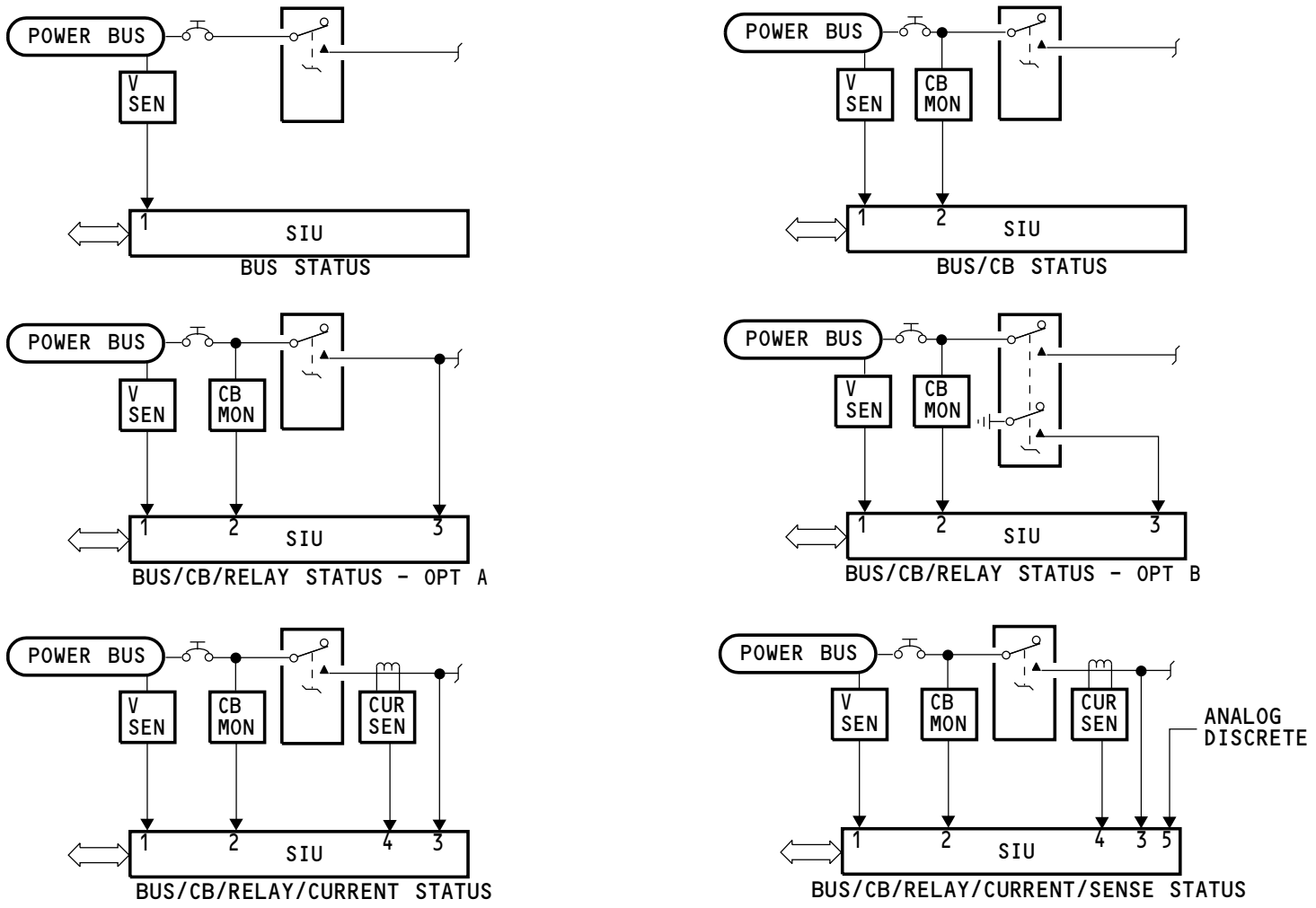
Bus/CB/Relay/Current Status

ELMS can also monitor load current with a current sensor (CUR SEN).

Bus/CB/Relay/Current/Sense Status

In addition to the above, the ELMS can monitor load status with an analog discrete supplied by the load.

NOTE: These are examples. They only show, in increasing complexity, ways the ELMS can monitor electrical loads. The ELMS may not use some of these combinations.



455388 S0000142598_V1

ELMS - FUNCTIONAL DESCRIPTION - MONITORING

ELMS - FUNCTIONAL DESCRIPTION - LOAD SHEDDING - 1

General

The ELMS protects the electrical power system. It sheds (disconnects) electrical loads to keep the load levels below the power supply levels.

Power Sources

The ELMs monitors the status of these five power sources for load shed control:

- Left IDG (120 kva)
- APU generator (120 kva)
- Secondary external power (90 kva)
- Primary external power (90 kva)
- Right IDG (120 kva).

The ELMS does not monitor the backup generators for load shed control.

The GCUs and the BPCU digitally supply the ELMS with the power source status information. The ELMS also monitors the status of the power sources with hard-wired signals (configuration load shed signals). These signals come from circuits that go through the auxiliary contacts of the breakers and contactors in the power panels.

Load Shed Control

The P110 left power management panel and the P210 right power management panel control load shedding. P110 and P210 can shed loads independently or operate together (interpanel operation). If two power sources supply power to the airplane, the panels operate independently. If only one power source supplies power to the airplane, the panels operate together.

Independent Operation

If two power sources supply power to the airplane, P110 controls left side load shedding, and P210 controls right side load shedding. These are the loads that the ELMS can shed and the general sequence it sheds them:

- Galley loads
- Utility buses
- Equipment cooling vent fan
- Galley chillers
- Recirculation fans
- Lavatory/galley fans
- Electronic seat equipment
- Hydraulic pumps.

During independent operation, more important loads on one side can be shed while less important loads on the other side remain.

When you use external power, the ELMS reverses the load shed sequence for hydraulic pumps and electronic seat equipment.

Interpanel Operation

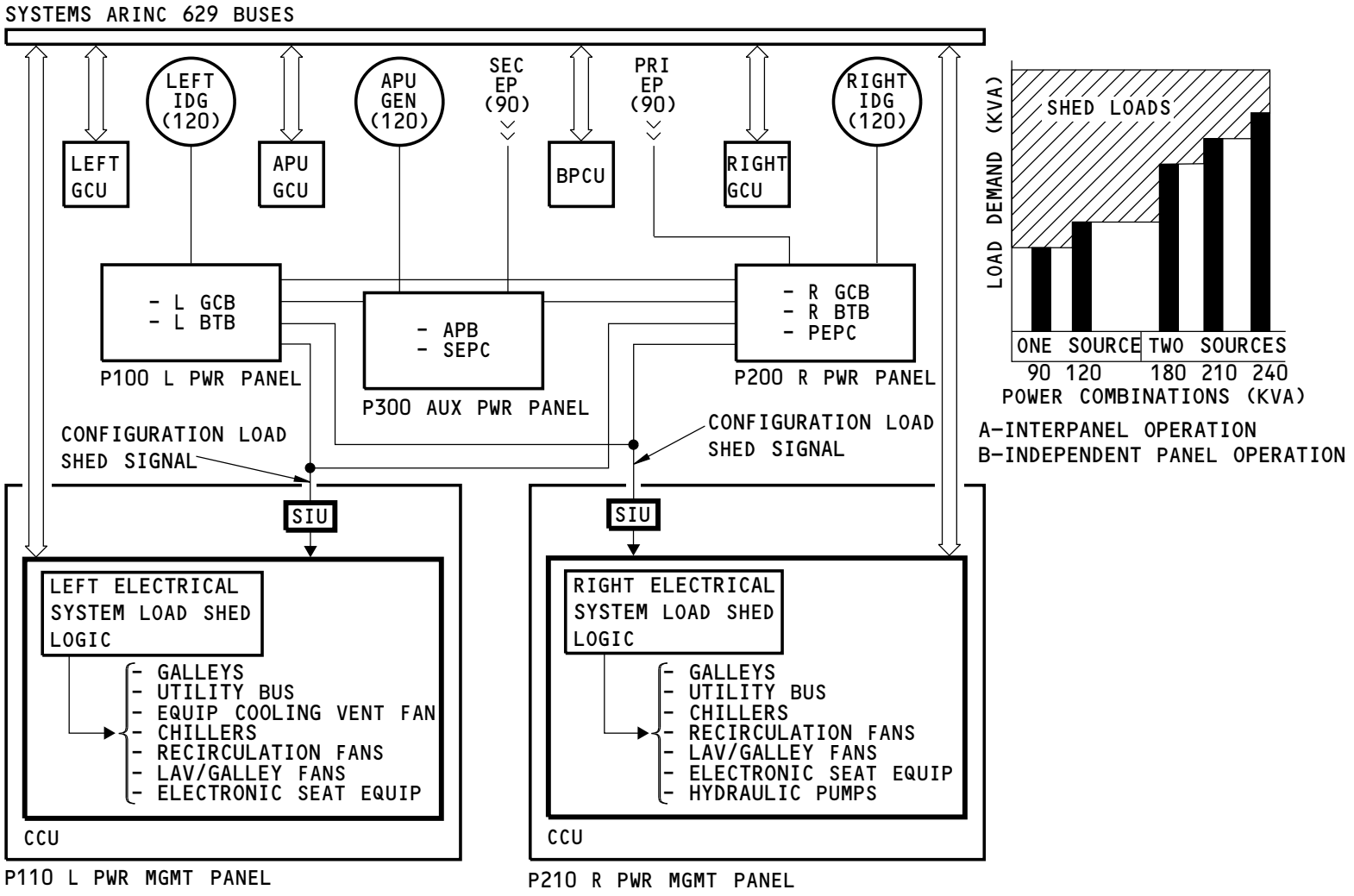
If only one power source supplies power to the airplane, P110 and P210 control load shedding together. They use a combined load shed sequence so that all the less important loads shed first and all the most important loads shed last.

Load Shed Limits

Since the power sources can supply different levels of power, there are several load shed limits. These are the conditions that define the load shed limits:

- Power source configuration
- Value of the overload
- Sustained time of the overload.

The ELMS gets load level data from the GCUs and BPCU across the systems ARINC 629 data buses.



465218 S0000142661_V1

ELMS - FUNCTIONAL DESCRIPTION - LOAD SHEDDING - 1

ELMS - FUNCTIONAL DESCRIPTION - LOAD SHEDDING - 2

Configuration Load Shed

A change in the source(s) of power for the airplane is called a change in the power source configuration. If the configuration change will result in a lower power supply capacity, the ELMS quickly sheds specified loads. This protects the new power source from overloading. The normal computer processing time does not occur fast enough to adequately do this function. Configuration load shed logic uses a hard-wired signal from the power management panel through auxiliary contacts in the BTBs, GCBs, APB, and EPCs to quickly detect a power source configuration change.

Configuration load shed logic sheds loads in groups. If the ELMS needs to shed more loads, it uses its normal computer processing.

Sequential Load Shed

If there is a large overload not due to a power source change , the ELMS sheds loads in groups like a configuration load shed.

If an overload is not large, the ELMS sheds individual loads until the electrical load demand level is below the available power supply level.

The ELMS sheds all loads on a main bus for these conditions:

- There is no power on the bus for over 2.5 seconds
- A failure of interpanel operations
- Loss of load level data from the GCUs and BPCU.

Load Restoration

After a load shed occurs, the ELMS adds loads in the reverse sequence they were shed. The ELMS continues to add loads until the electrical load demand level would exceed the available power supply level.

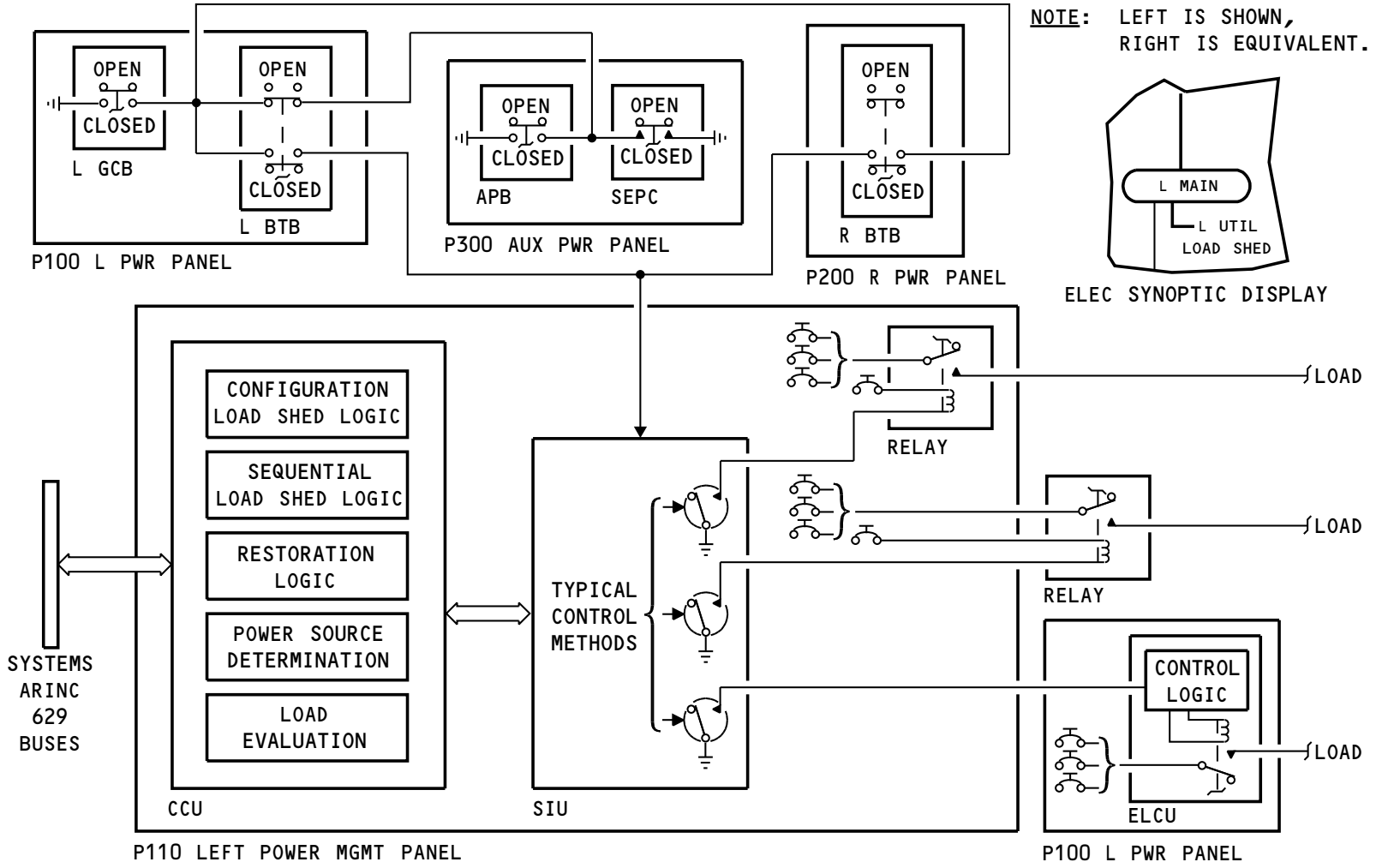
The ELMS staggers the starting of the hydraulic ac motor pumps.

After a configuration load shed, loads do not come back on for approximately 3 seconds.

Failure of interpanel operations, prevents any load restoration.

Training Information Point

If you use an external power source with less than a 90 kva capacity at an external power receptacle, the ELMS can possibly shed and restore all loads four times in about one minute. It then sheds all loads until you supply more power to the airplane.



W69590 S0000128534_V1

ELMS - FUNCTIONAL DESCRIPTION - LOAD SHEDDING - 2

ELMS - SPECIAL FUNCTION TESTS

General

There is one special function test for each power management panel. These are the special function tests:

- Initiate P110 CCU self test
- Initiate P210 CCU self test
- Initiate P310 CCU self test.

Initiate P110 CCU Self Test

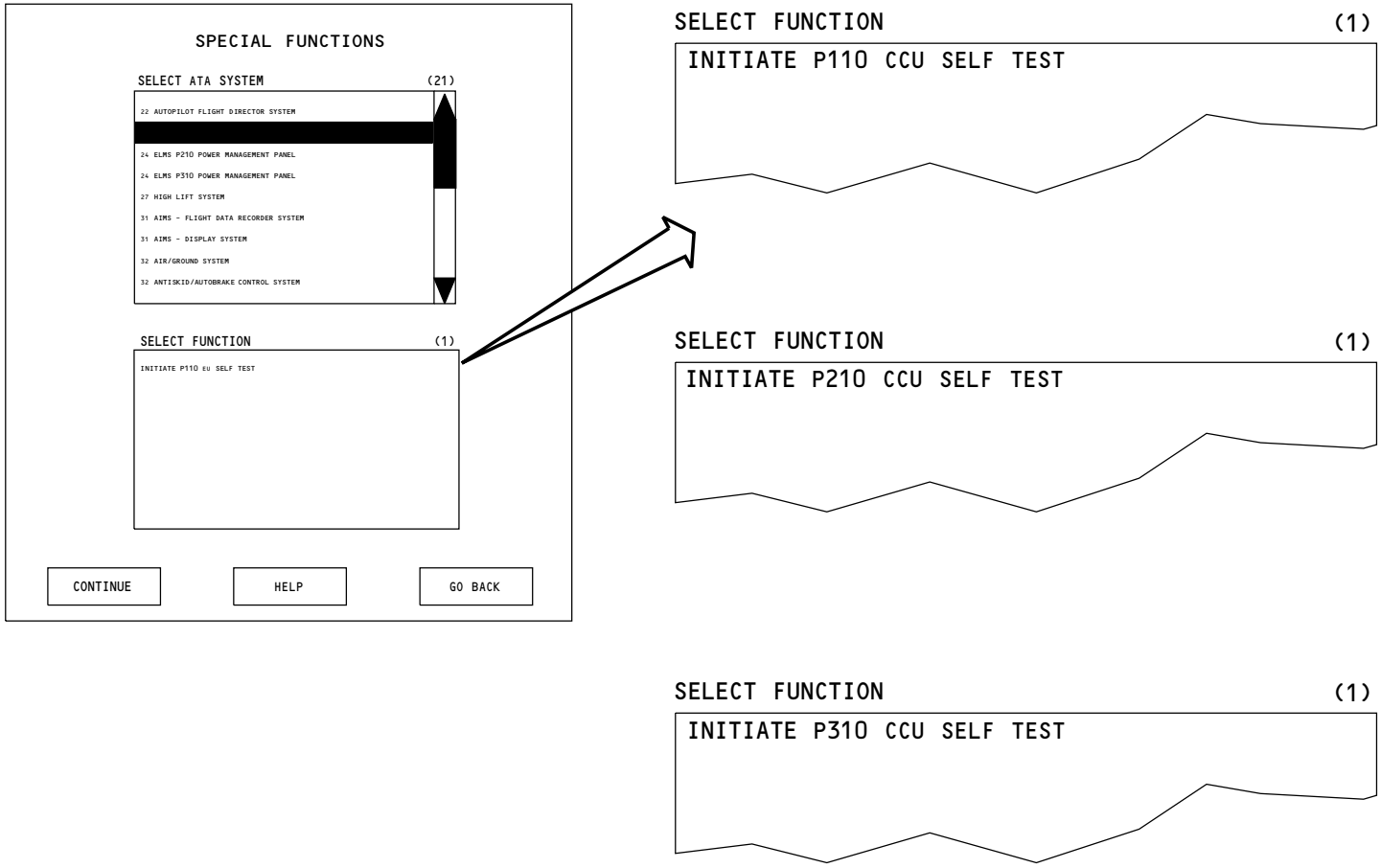
This test makes sure that all Electronic LRMs in the P110 power management panel operate correctly.

Initiate P210 CCU Self Test

This test makes sure that all Electronic LRMs in the P210 power management panel operate correctly.

Initiate P310 CCU Self Test

This test makes sure that all Electronic LRMs in the P310 power management panel operate correctly.



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ELMS - SPECIAL FUNCTION TESTS

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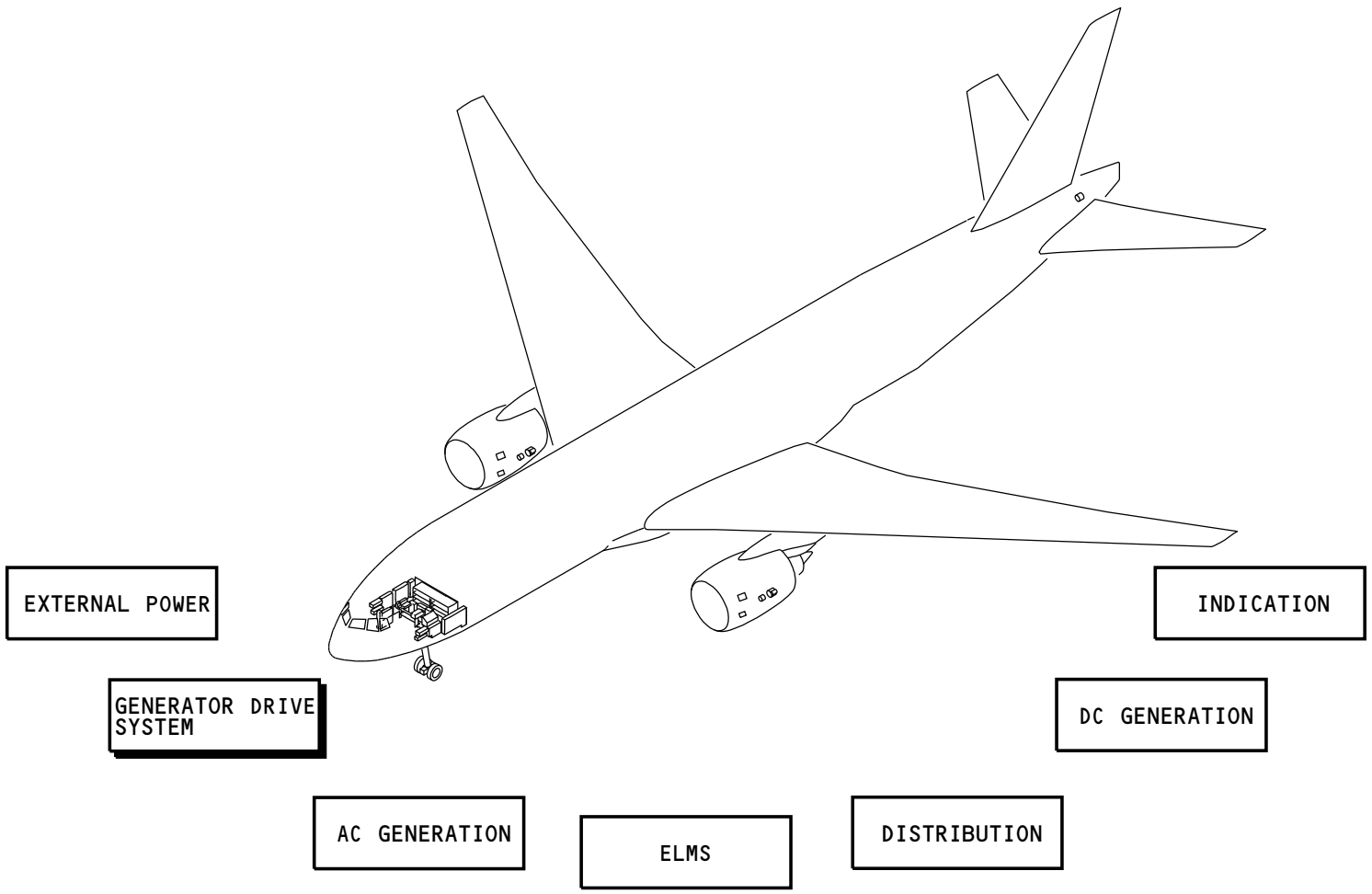
GENERATOR DRIVE - INTRODUCTION

General

The generator drive system normally supplies electrical power to all of the electrical loads while the engines operate. The integrated drive generators (IDGs) are the primary sources of electrical power. The APU generator and the backup generators are secondary sources of electrical power.



M40232 S000616538_V1

GENERATOR DRIVE - INTRODUCTION

GENERATOR DRIVE - GENERAL DESCRIPTION

General

Two IDGs are primary power sources. The APU generator, and two backup generators are secondary power sources.

Heat exchangers remove heat from the generators.

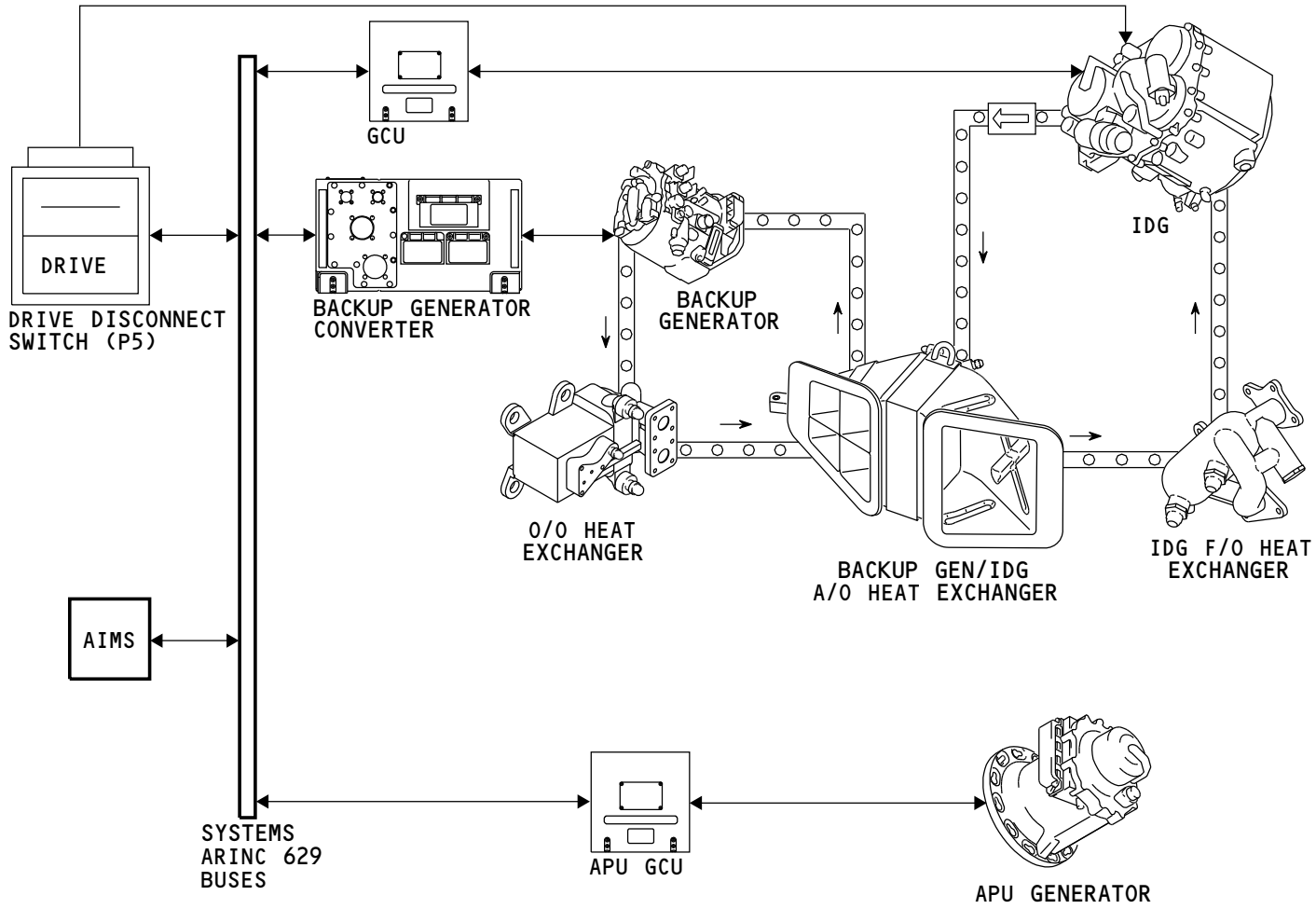
Electrical Interfaces

Switches on the electrical panel control the IDG disconnect operations. GCUs control the IDGs and the APU generator. One backup generator convertor controls the two backup generators. Lights on the electrical panel and EICAS messages show generator drive system information.

Mechanical Interfaces

Each engine mechanically turns an IDG and a backup generator. The IDGs change the mechanical power to constant-frequency ac electrical power. The backup generators change the mechanical power to variable-frequency ac electrical power. The backup generator converter changes the variable-frequency ac power to constant frequency ac power.

A continuous flow of fuel through the IDG fuel/oil heat exchanger cools the IDG oil. A continuous flow of fan air through the backup generator/IDG air/oil heat exchanger cools the oil for the backup generator and the IDG. The oil/oil heat exchanger heats the backup generator oil with engine oil.



M40236 S000616542_V1

GENERATOR DRIVE - GENERAL DESCRIPTION

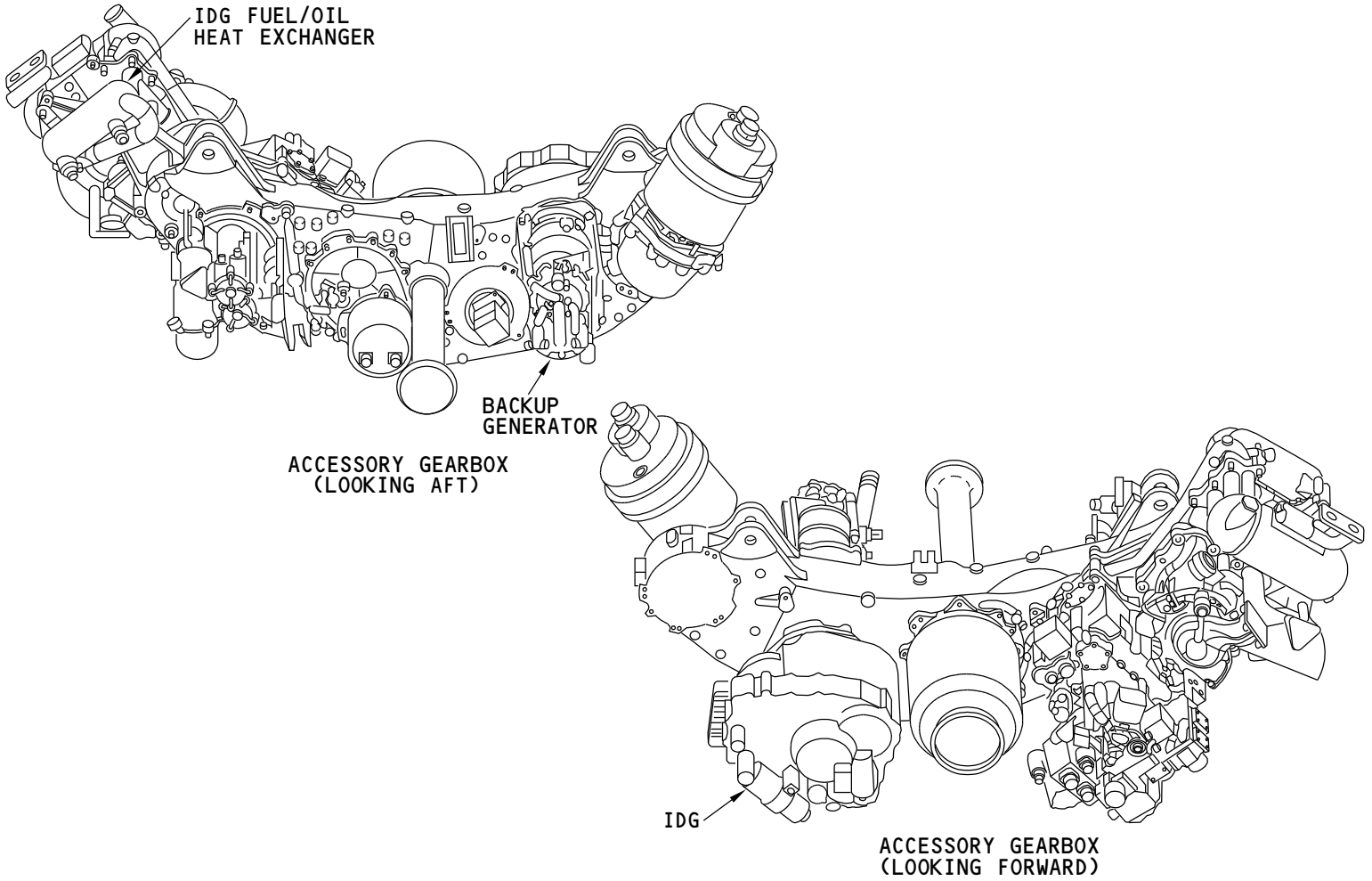
GENERATOR DRIVE - COMPONENT LOCATIONS - GEARBOX

General

These are the generator drive components that attach to the accessory gearbox of each engine:

- IDG fuel/oil heat exchanger
- Backup generator
- IDG.

The IDG fuel/oil heat exchanger attaches to the front of the gearbox at the 4:30 position. The backup generator attaches to the front of the gearbox at the 6:30 position. The IDG attaches to the aft side of the gearbox at the 6:30 position.



M40240 S000616546_V1

GENERATOR DRIVE - COMPONENT LOCATIONS - GEARBOX

GENERATOR DRIVE - COMPONENT LOCATIONS - ENGINE

General

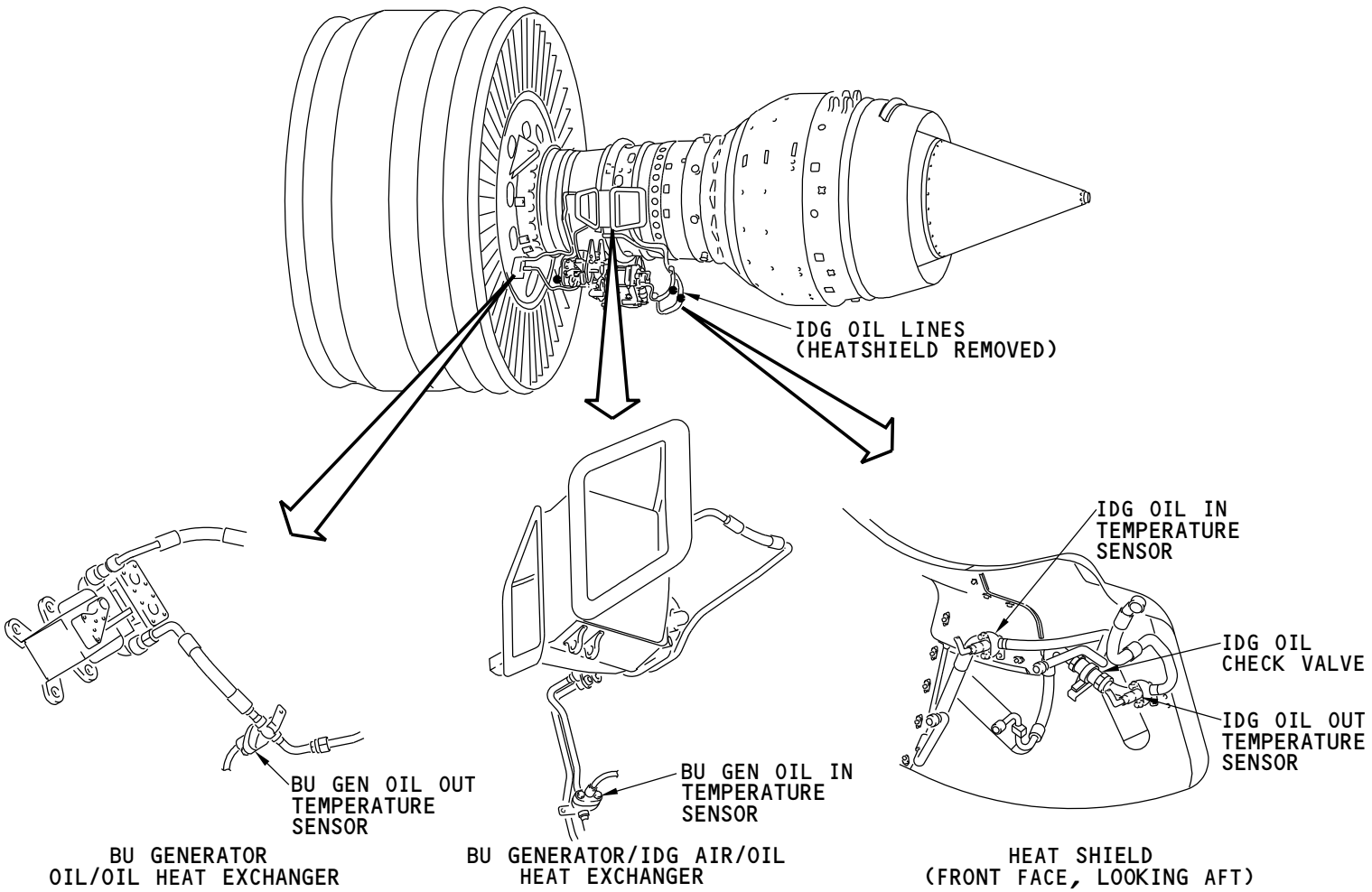
Each engine has these generator system components:

- Backup generator oil/oil heat exchanger
- Backup generator oil in and oil out temperature sensors
- Backup generator/IDG air/oil heat exchanger
- IDG oil in and oil out temperature sensors.

Component Locations

The backup generator oil/oil heat exchanger attaches to the fan hub frame at the 7:30 position. The backup generator oil out temperature sensor is in an oil line to the right of the oil/oil heat exchanger in the fan hub frame area. It is just in front of the BU generator (not shown). The oil in sensor is in an oil line forward and below the air/oil heat exchanger. It is just above and behind the left variable stator vane actuator (not shown).

The backup generator/IDG air/oil heat exchanger attaches to the high pressure compressor case at the 9:00 position. The IDG oil temperature sensors and the IDG oil check valve are aft of the IDG on the front face of the heat shield.



M40241 S000616547_V1

GENERATOR DRIVE - COMPONENT LOCATIONS - ENGINE

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GENERATOR DRIVE - INTEGRATED DRIVE GENERATOR

General

The IDG supplies electrical power to the airplane. It is a combination of a constant speed drive (CSD) and an ac generator. The CSD turns the generator at a constant speed to make constant frequency electrical power. Oil lubricates the IDG and makes it cool.

Electrical Connections

These are the four electrical connections on the IDG:

- Terminal block
- Electrical connector A
- Electrical connector B
- Electrical connector C.

The terminal block connects the power feeder cables to the IDG. The other connectors transmit control and monitoring inputs and outputs. They also transmit the PMG output.

Mechanical Items

You can get access to these mechanical items on the IDG:

- Input shaft (with aneroid valve)
- Aspirator
- Check valve
- Disconnect solenoid with thermal plug
- Case relief valve
- Oil out port
- Oil filters
- Oil in port
- Case drain
- Charge relief valve.

The aneroid valve, aspirator, and check valve keep a positive pressure inside the IDG when it operates. The aspirator pulls air in through the check valve. The air goes out through the aneroid valve. This prevents the collection of moisture in the IDG.

The case relief valve prevents the rupture of the IDG case if the IDG fuel/oil heat exchanger leaks.

The charge relief valve regulates the oil pressure of the IDG.

Maintenance Items

You use these items to maintain the IDG:

- Disconnect reset ring
- Oil level sightglass
- Overfill drain port
- Pressure fill port.

The disconnect reset ring lets you reset the drive disconnect mechanism. A solenoid operates the disconnect mechanism. You pull on the ring while the engine is shutdown to connect the drive shaft halves.

NOTE: The IDG can automatically disconnect if the IDG oil gets too hot. A thermal plug melts and operates the disconnect mechanism. If the IDG disconnects automatically with the thermal plug, the reset ring cannot connect the drive shaft halves. The IDG must be reset at the repair shop.

You use the sightglass, fill port, and drain port to service the IDG oil.

Indication Items

These items supply data you use to make a check of the operational status of the IDG:

- Differential pressure switch (internal)
- Differential pressure indicator
- Remote oil level sensor
- Charge pressure switch (internal).

The differential pressure switch monitors the oil pressure upstream and downstream of the oil filter. The switch sends a signal that tells if the oil filter is clogged.

The differential pressure indicator has a red button. The red button moves out when the oil filter is clogged.

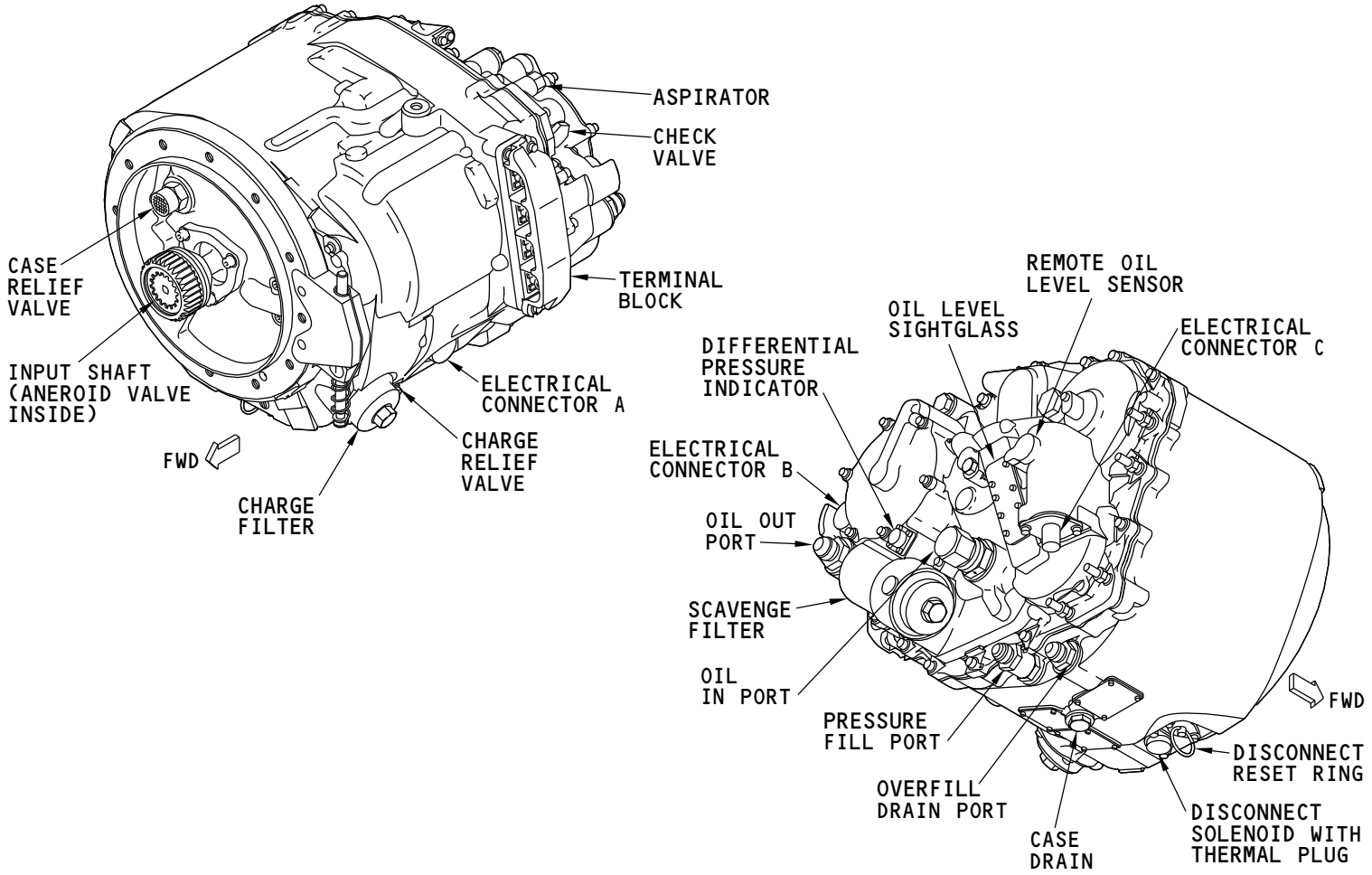
Only the Scavenge filter has a differential pressure switch and indicator.

The remote oil level sensor sends the IDG oil level status to the GCU. The GCU supplies the primary display system with this data.

The charge pressure switch connects to the GCU. The switch monitors the oil pressure inside the IDG.

Training Information Point

The only LRMs on the IDG are the oil filters and the remote oil level sensor.



M40247 S000616553_V1

GENERATOR DRIVE - INTEGRATED DRIVE GENERATOR

GENERATOR DRIVE - IDG QAD COUPLING

General

The QAD coupling attaches the IDG to the gearbox. It has an adapter plate, a ring, index marks, and a tension bolt. You turn the tension bolt to turn the ring. When the ring releases the IDG, the ring index mark aligns with the adapter plate index mark and the IDG index mark.

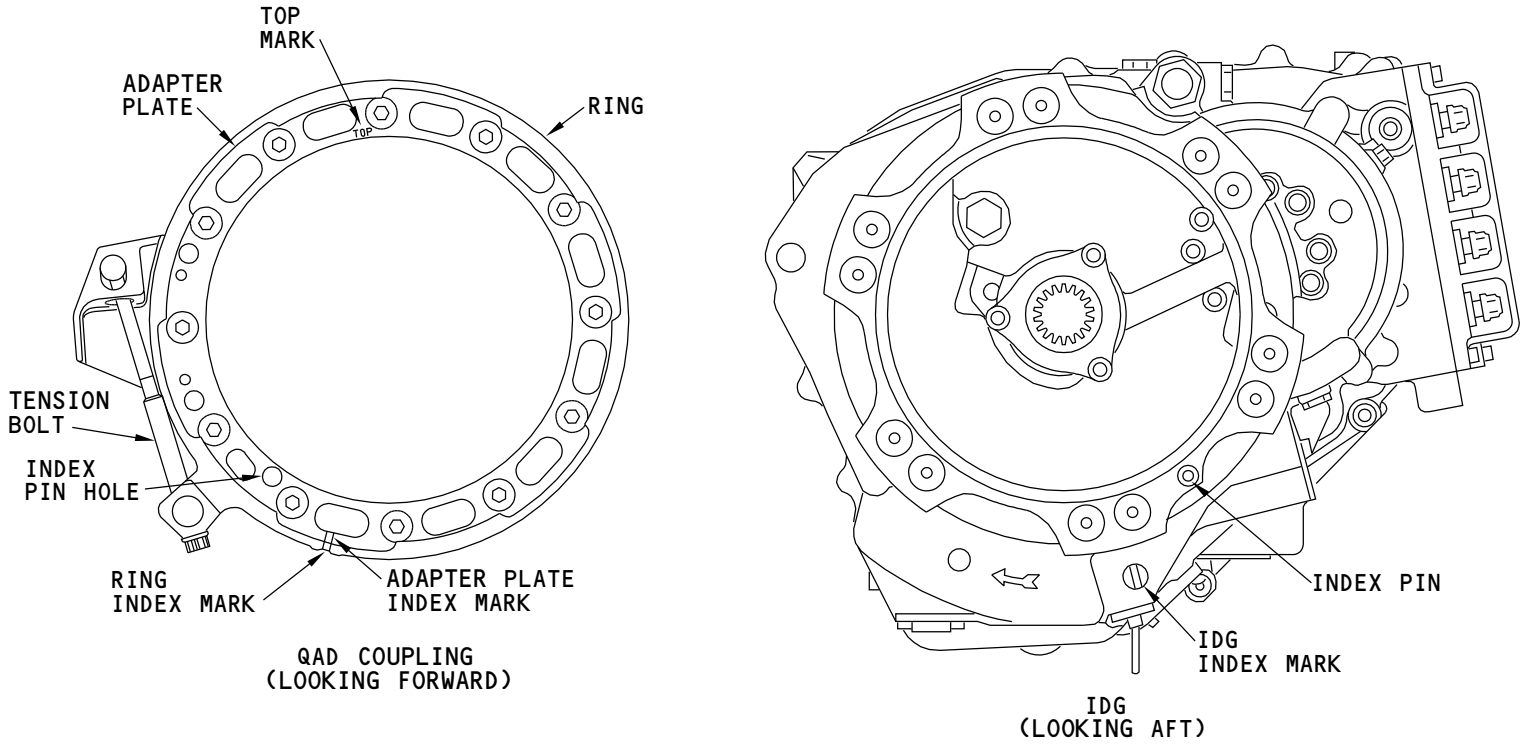
Training Information Point

There is a TOP mark that shows you how to put a new QAD coupling on the gearbox. You put the TOP mark at the 12:00 position.

When you install a new QAD coupling, align the ring index mark and the adapter index mark so the IDG can go in. When you install an IDG, turn it so that the IDG index mark aligns with the ring index mark. This should align the IDG index pin with the QAD coupling index pin hole.

The IDG is very heavy. It weighs approximately 140 lbs (63 kgs). You must get the correct torque on the ring to prevent damage to the mating surfaces of the QAD coupling and the IDG.

At regular times, you must make a check of the QAD coupling. You must make sure that the IDG is locked in the QAD ring. You must make sure the tension bolt torque is correct. If the IDG is loose in the QAD coupling, vibration can cause damage to the QAD ring, the IDG mounting flange, and the IDG input seal.



M40249 S000616555_V1

GENERATOR DRIVE - IDG QAD COUPLING

GENERATOR DRIVE - IDG - FUNCTIONAL DESCRIPTION

General

The GCU and the drive disconnect switch control the IDG. The GCU sends information about the IDG to the systems ARINC 629 buses. The EEC sends oil temperature and oil filter data to the systems ARINC 629 buses. This permits the AIMS to show EICAS messages and maintenance data.

Generator Drive Light

The GCU controls the DRIVE light in the disconnect switch. The GCU sends a signal that causes the DRIVE light to come on when the IDG charge pressure is low. If the engine is running, the low oil pressure also causes the ELEC GEN DRIVE advisory message to show. When you see the ELEC GEN DRIVE message, you should immediately disconnect the IDG. This protects the IDG from damage. The drive disconnect switch on the P5 panel controls the IDG drive disconnect solenoid.

Drive Disconnect

The EEC reset/IDG disconnect relay arms the disconnect switch while the related engine fuel cutoff switch is in the RUN position. If the disconnect switch is in, the IDG disconnect solenoid energizes. This causes the spring-loaded disconnect mechanism to disconnect the IDG from the drive shaft.

The IDG can automatically disconnect if the IDG oil gets too hot. A thermal plug in the disconnect mechanism melts. This causes the spring-loaded disconnect mechanism to disconnect the IDG from the drive shaft.

Oil Level Sensing

The remote oil level sensor sends an oil level signal to the GCU. The sensor sends data only when the IDG charge pressure is low (IDG is shutdown). The electrical maintenance page shows the oil level data of the IDG. The oil level data shows two dashes when the IDG operates.

If oil does not cover the underfill sensor for the related IDG, the IDG oil level is too low. The maintenance page will show SERVICE when the IDG is shutdown.

If oil covers the underfill sensor, but not the overfill sensor, the IDG has sufficient oil. The maintenance page will show NORMAL when the IDG is shutdown.

If oil covers the overfill sensor and the related underfill sensor, the IDG oil level is too high. The maintenance page will show SERVICE when the IDG is shutdown.

Frequency Trim Control

The GCU controls the trim coil to increase or reduce the speed of the IDG drive. The speed change changes the frequency of the power output. The GCU uses the trim coil to match the IDG power frequency to the frequency of an other power source during no-break power transfers.

Oil Filter Status

The differential pressure switch monitors the difference between the pressures upstream and downstream of the oil filter. The switch sends a filter status signal through the EEC and the systems ARINC 629 buses to the GCU. The GCU causes the electrical maintenance page to show the status of the oil filter. The usual status on the maintenance page is NORMAL.

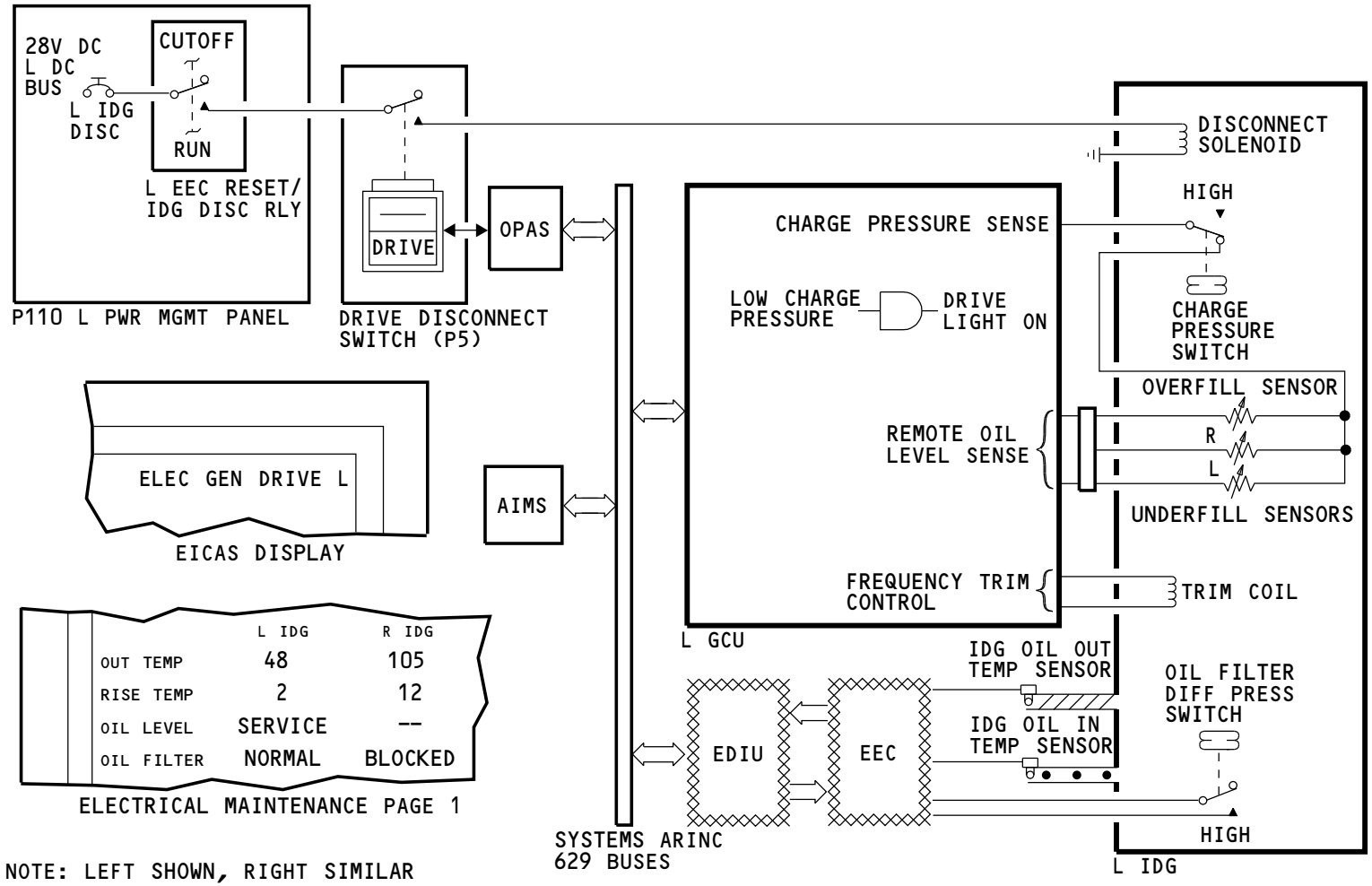
When the oil filter is clogged, the differential pressure switch closes. The GCU causes the electrical maintenance page to change the filter status to BLOCKED. The GCU inhibits the filter status signal when the oil out temperature is colder than 145F (62C).

Temperature Data

Oil temperature sensors in the inlet and outlet tubing send data to the EEC. The EEC sends the data to AIMS. The electrical maintenance page shows OUT TEMP, the temperature of the oil at the IDG outlet. And, it shows RISE TEMP, the difference between the inlet and the outlet temperatures. The data are in degrees C.

Training Information Point

The IDG oil level data on the electrical maintenance page is not accurate until the engine is cold (a minimum of 5 minutes after engine shutdown).



M40252 S000616558_V1

GENERATOR DRIVE - IDG - FUNCTIONAL DESCRIPTION

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Oil Level Indication

The signal from the remote oil level sensor causes the IDG oil level data to show on the electrical maintenance page. The maintenance page shows the oil level data as NORMAL or SERVICE.

The IDG sightglass shows the oil level. You must open the left thrust reverser cowl to see the sightglass.

If the oil level is in the silver area of the sightglass, the IDG oil level is satisfactory. The black zone at the bottom of the sightglass is the low oil zone. The low oil zone is different for the left and right engine. You must add oil to the IDG if the oil level is in the low oil zone.

Add Oil to the IDG

You can add oil to the IDG through the IDG pressure fill valve. It is above an access door in the thrust reverser at the 6:00 position.

When you add oil, you must attach a drain hose to the IDG overflow drain valve. Add oil until at least one quart (liter) of oil comes out of the drain valve hose, then stop. When the flow out of the overflow hose is within limits, disconnect the pressure fill hose and the drain valve hose.

WARNING DO NOT LET HOT OIL GET ON YOU. PUT ON CLOTHES, GOGGLES, AND EQUIPMENT FOR PROTECTION OR LET THE IDG BECOME COOL. HOT OIL CAN BURN YOU.

CAUTION DO NOT DO THIS TASK FOR A DISCONNECTED IDG. THE OPERATION OF A DEFECTIVE IDG CAN CAUSE DAMAGE TO EQUIPMENT.

WARNING WHEN YOU CONNECT THE OVERFLOW COUPLING TO THE OVERFLOW DRAIN VALVE, USE A RAG AROUND THE FITTING. THIS WILL PREVENT A SPRAY CAUSED BY PRESSURE IN THE IDG CASE. HOT OIL CAN BURN YOU.

CAUTION THE OIL OVERFLOW HOSE AND COUPLING MUST BE CONNECTED TO THE OIL OVERFLOW DRAIN VALVE TO RELEASE INTERNAL PRESSURE IN THE IDG. THE OVERFLOW HOSE AND COUPLING MUST REMAIN CONNECTED TO THE OVERFLOW DRAIN VALVE UNTIL SERVICING IS COMPLETED AND OIL OVERFLOW HAS SLOWED TO A FEW DROPS A MINUTE. FAILURE TO DO THIS CAN RESULT IN OVERFILLING WITH OIL, WHICH CAN CAUSE THE IDG TO BE DAMAGED DURING OPERATION.

CAUTION DO NOT MIX TYPES OR BRANDS OF OIL WHEN YOU ADD OR REPLACE THE OIL IN THE IDG. INCORRECT OILS CAN CAUSE DAMAGE TO THE IDG.

CAUTION MAKE SURE THE DRAIN VALVE HOSE IS CONNECTED TO LET THE OIL DRAIN TO THE CORRECT LEVEL IN THE IDG. TOO MUCH HEAT CAN OCCUR IF THE IDG IS FILLED WITH TOO MUCH OIL.

CAUTION DO NOT REMOVE THE OIL OVERFLOW HOSE AND COUPLING FROM THE OVERFLOW DRAIN VALVE UNTIL SERVICING IS COMPLETED AND OIL OVERFLOW HAS SLOWED TO A FEW DROPS A MINUTE. FAILURE TO DO THIS CAN RESULT IN OVERFILLING WITH OIL, WHICH CAN CAUSE THE IDG TO BE DAMAGED DURING OPERATION.

Training Information Point

The IDG oil level data on the electrical maintenance page and the sightglass is not accurate until you wait a minimum of 5 minutes after engine shutdown.

When the IDG operates, the electrical maintenance page does not get new oil level data. The oil level data shows as two dashes.

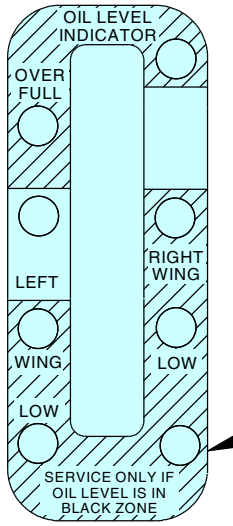
GENERATOR DRIVE - IDG - OIL SERVICING

The oil level data is blank for any of these conditions:

- Engine shutdown (blank for approximately 10 minutes)
- Initial GCU power-up (blank for approximately 10 minutes)
- Data is invalid due to a fault.

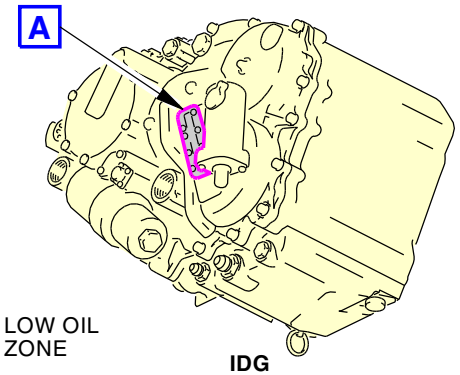
	L IDG	R IDG
OUT TEMP	48	105
RISE TEMP	2	12
OIL LEVEL	SERVICE	--
OIL FILTER	NORMAL	BLOCKED

ELECTRICAL MAINTENANCE PAGE 1

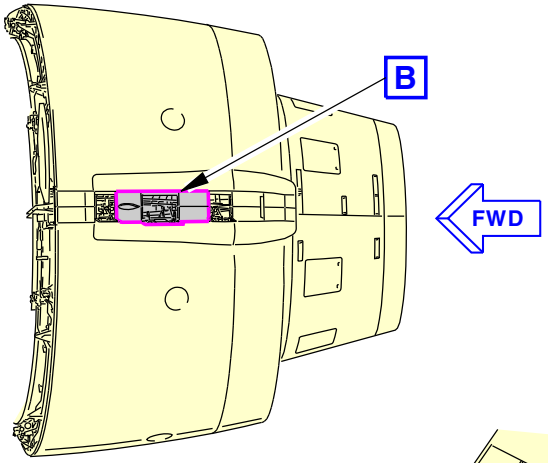


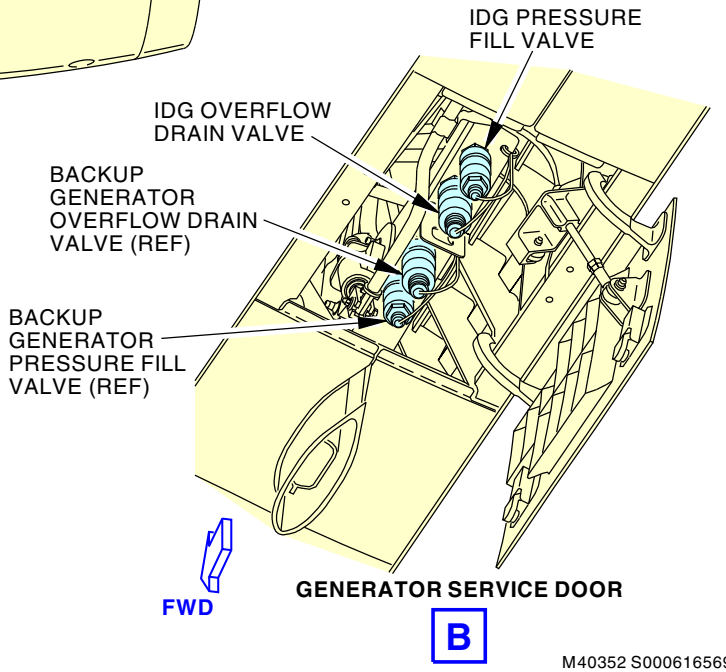
OIL LEVEL SIGHTGLASS

A



IDG





GENERATOR SERVICE DOOR

B

M40352 S000616569_V2

GENERATOR DRIVE - IDG - OIL SERVICING

GENERATOR DRIVE - BACKUP GENERATOR

General

The backup generator is an alternative power source. It can supply 115v ac, 400 Hz, electrical power to the transfer buses.

The backup generator also has permanent magnet generators (PMGs). One PMG supplies the field power for the backup generator. Two PMGs are power sources for the flight control power supply assemblies (PSAs).

Electrical Connections

These are the four electrical connections on the backup generator:

- Terminal block
- Electrical connector J1
- Electrical connector J2
- Electrical connector J3.

The terminal block connects the power feeder cables to the backup generator. Electrical connector J1 transmits the control inputs and the data outputs of the backup generator. Electrical connectors J2 and J3 connect the backup generator PMG power to the PSAs.

Mechanical Items

You can get access to these mechanical items on the backup generator:

- Oil in port
- Oil out port
- Overtemperature dump valve port
- Case drain plug
- Oil filter.

The overtemperature dump valve opens when the generator gets too hot. Generator oil drains through the open valve to the accessory drain.

Maintenance Items

You use these items to maintain the backup generator:

- Oil level sightglass
- Overfill drain port
- Pressure fill port.

Indication Items

These items supply data you use to make a check of the operational status of the backup generator:

- Differential pressure indicator
- Differential pressure switch (internal)
- Charge pressure switch (internal)
- Remote oil level sensor (internal).

The differential pressure indicator has a red button. The red button moves out when the filter is clogged.

The differential pressure switch monitors the oil pressure upstream and downstream of the oil filter. The switch sends a signal that tells if the oil filter is clogged.

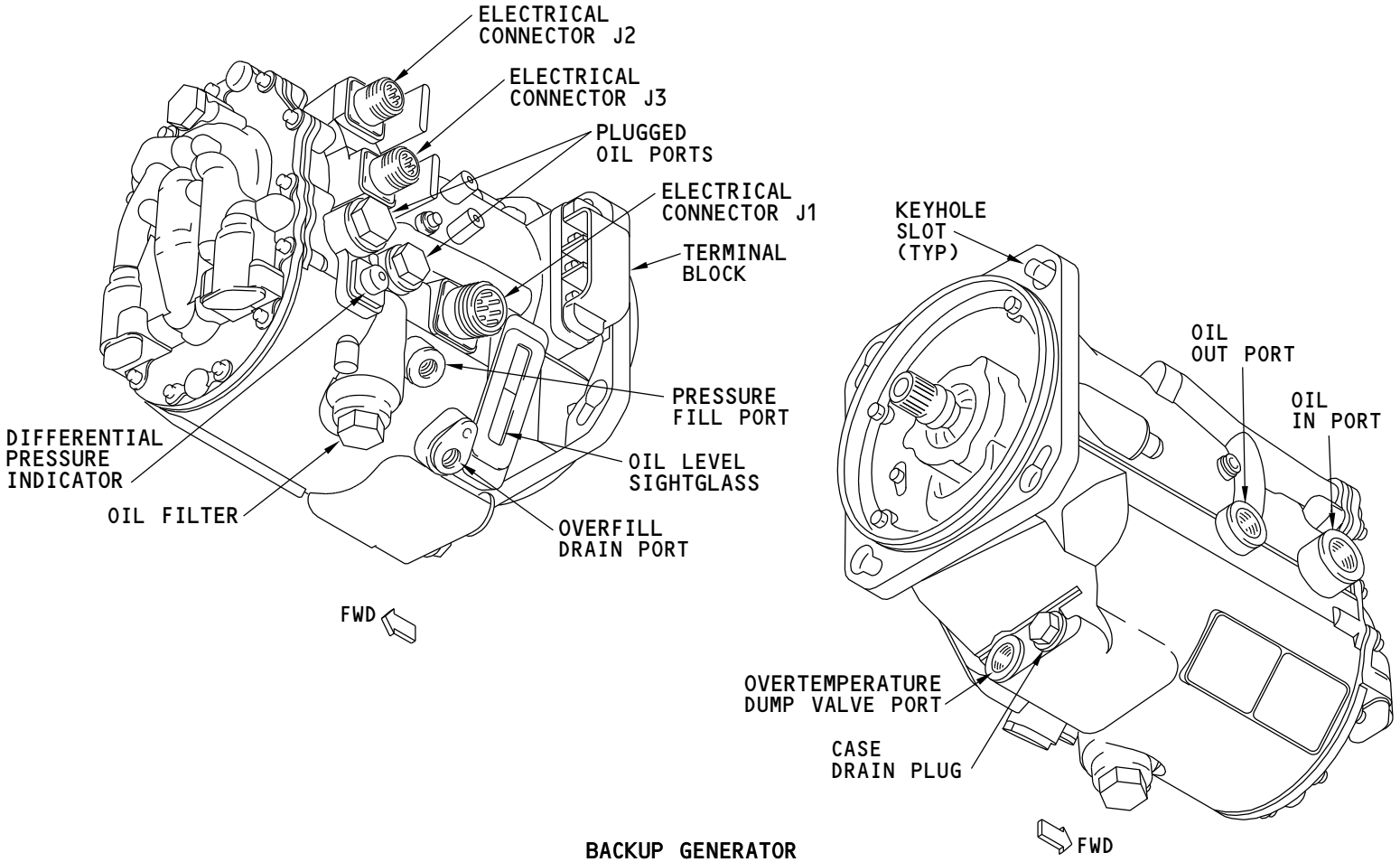
The charge pressure switch connects to the backup generator converter. The switch monitors the oil pressure inside the backup generator.

Two probes in the remote oil level sensor send the backup generator oil level status to the backup generator converter. The electrical maintenance page shows the oil level status from the remote oil level sensor.

Training Information Point

The generator has keyhole mounting holes in its mounting flange. This lets you leave the nuts and washers on the mounting bolts while you remove or install a generator.

The only LRM on the backup generator is the oil filter.



BACKUP GENERATOR

M40253 S000616571_V1

GENERATOR DRIVE - BACKUP GENERATOR

GENERATOR DRIVE - BACKUP GENERATOR - FUNCTIONAL DESCRIPTION

General

The backup generator converter sends data from backup generator components to the systems ARINC 629 buses. The EEC puts oil temperature and oil filter data on the systems ARINC 629 buses. This permits AIMS to show EICAS messages and maintenance data.

Charge Pressure Switch

If the backup generator has low oil pressure, the charge pressure switch closes. If the charge pressure switch closes while the related engine is running and the backup generator oil temperature is above 20C, the backup converter trips the generator field. This causes the BACKUP GEN OFF light to come on. Low oil pressure also causes the ELEC BACKUP GEN message.

Oil Level Sensing

The remote oil level sensors send an oil level signal to the backup generator converter. The sensors send data only when the oil pressure is low (generator is shutdown). The electrical maintenance page shows the oil level data of the backup generator. The oil level data shows two dashes when the backup generator operates.

If oil does not cover the underfill sensor, the backup generator oil level is too low. The maintenance page will show SERVICE when the backup generator is shutdown.

If oil covers the underfill sensor, but not the overfill sensor, the backup generator has sufficient oil. The maintenance page will show NORMAL when the backup generator is shutdown.

If oil covers the two oil level sensors, the backup generator oil level is too high. The maintenance page will show SERVICE when the backup generator is shutdown.

The oil level data is blank for any of these conditions:

- Engine shutdown (blank for approximately 10 minutes)
- Initial converter power-up (blank for approximately 10 minutes)
- Data is invalid due to a fault.

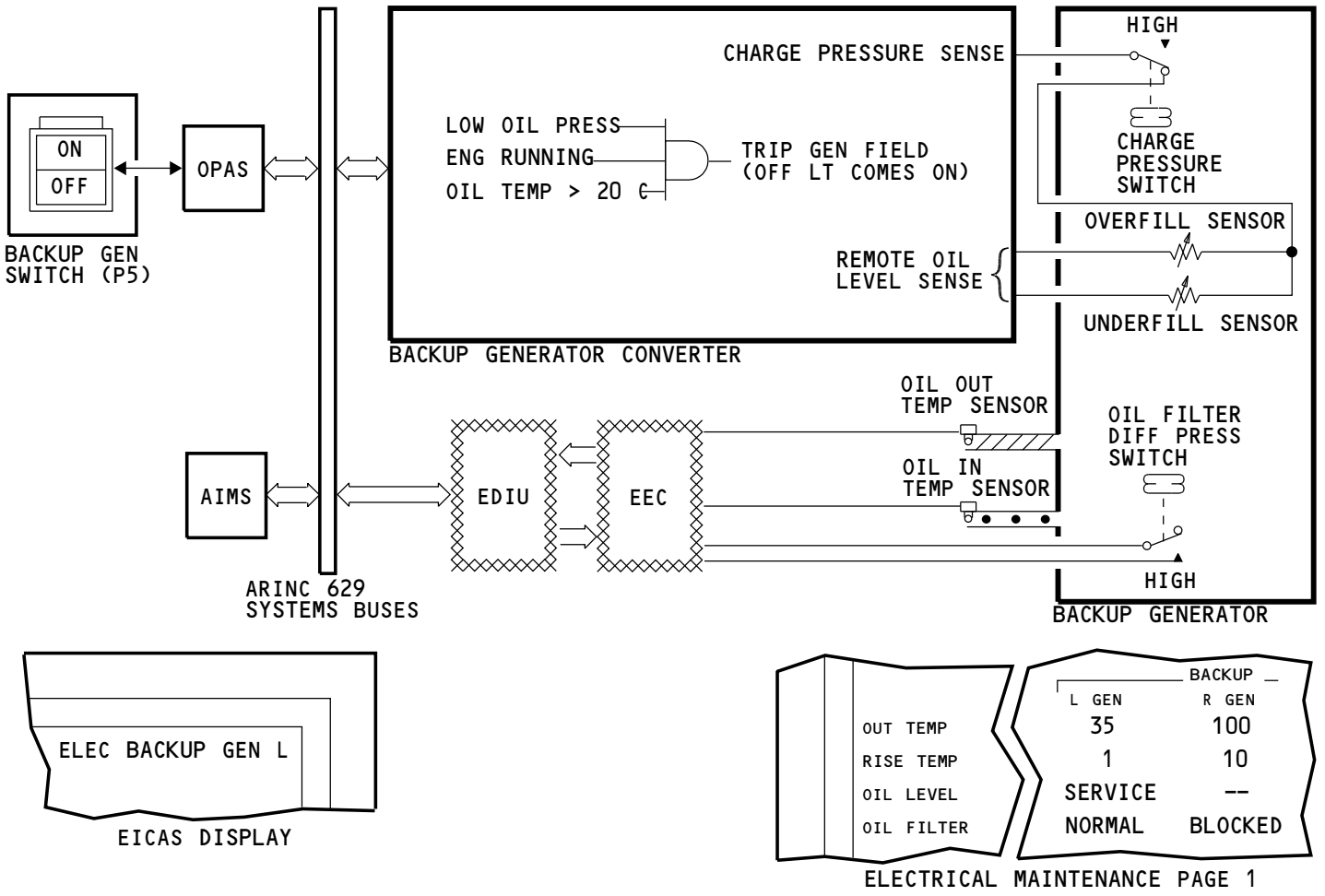
Oil Filter Status

The differential pressure switch monitors the difference between the pressures upstream and downstream of the oil filter. The switch sends a filter status signal through the EEC and the systems ARINC 629 buses to the backup generator converter. The backup generator converter causes the electrical maintenance page to show the status of the oil filter. The usual status on the maintenance page is NORMAL.

When the oil filter is clogged, the differential pressure switch closes. The backup generator converter causes the electrical maintenance page to change the filter status to BLOCKED. The backup generator converter inhibits the filter status signal when the oil out temperature is less than 145F (62C).

Temperature Data

Oil temperature sensors in the inlet and outlet tubing send data to the EEC. The EEC sends the data to AIMS. The electrical maintenance page shows OUT TEMP, the temperature of the oil at the backup generator outlet. It also shows RISE TEMP, the difference between the inlet and the outlet temperatures.



M40256 S000616574_V1

GENERATOR DRIVE - BACKUP GENERATOR - FUNCTIONAL DESCRIPTION

Oil Level Indication

The signal from the remote oil level sensor causes the electrical maintenance page to show the backup generator oil level data. The maintenance page shows the oil level data as NORMAL or SERVICE.

The sightglass on the backup generator shows the oil level also. You must open the left thrust reverser cowl to see the sightglass.

The sightglass has two sets of oil level zones. You use one set when the generator is on the left engine. You use the other set when the generator is on the right engine.

The related center area of the sightglass is the normal zone. If the oil level is in the normal zone, the backup generator oil quantity is satisfactory. The related black zone at the top of the sightglass is the overfull zone. You must drain some oil from the generator if the level is in the overfull zone. The black zone at the bottom of the sightglass is the low oil zone. You must add oil to the generator if the oil level is in the low oil zone.

Add Oil to the Generator

You add oil to the generator through the backup generator pressure fill valve. It is above an access door in the thrust reverser at the 6:00 position.

When you add oil, you must attach a drain hose to the backup generator overflow drain valve. Add oil until at least one quart (liter) of oil comes out of the drain valve hose, then stop. When the flow out of the overflow hose is within limits, disconnect the pressure fill hose and the drain valve hose.

WARNING DO NOT LET HOT OIL GET ON YOU. PUT ON CLOTHES, GOGGLES, AND EQUIPMENT FOR PROTECTION OR LET THE ENGINE BECOME COOL. HOT OIL CAN BURN YOU.

WARNING WHEN YOU CONNECT THE OVERFLOW COUPLING TO THE OVERFLOW DRAIN VALVE, USE A RAG AROUND THE FITTING. THIS WILL PREVENT A SPRAY CAUSED BY PRESSURE IN THE BACKUP GENERATOR CASE. HOT OIL CAN BURN YOU.

CAUTION THE OIL OVERFLOW HOSE AND COUPLING MUST BE CONNECTED TO THE OIL OVERFLOW DRAIN VALVE TO RELEASE INTERNAL PRESSURE IN THE BACKUP GENERATOR. THE OVERFLOW HOSE AND COUPLING MUST REMAIN CONNECTED TO THE OVERFLOW DRAIN VALVE UNTIL SERVICING IS COMPLETED AND OIL OVERFLOW HAS SLOWED TO A FEW DROPS A MINUTE. FAILURE TO DO THIS CAN RESULT IN OVERFILLING WITH OIL, WHICH CAN CAUSE THE BACKUP GENERATOR TO BE DAMAGED DURING OPERATION.

CAUTION DO NOT MIX TYPES OR BRANDS OF OIL IN THE BACKUP GENERATOR. INCORRECT OILS CAN CAUSE DAMAGE TO THE BACKUP GENERATOR.

CAUTION DO NOT REMOVE THE OIL OVERFLOW HOSE AND COUPLING FROM THE OVERFLOW DRAIN VALVE UNTIL SERVICING IS COMPLETED AND OIL OVERFLOW HAS SLOWED TO A FEW DROPS A MINUTE. FAILURE TO DO THIS CAN RESULT IN OVERFILLING WITH OIL, WHICH CAN CAUSE THE BACKUP GENERATOR TO BE DAMAGED DURING OPERATION.

Training Information Point

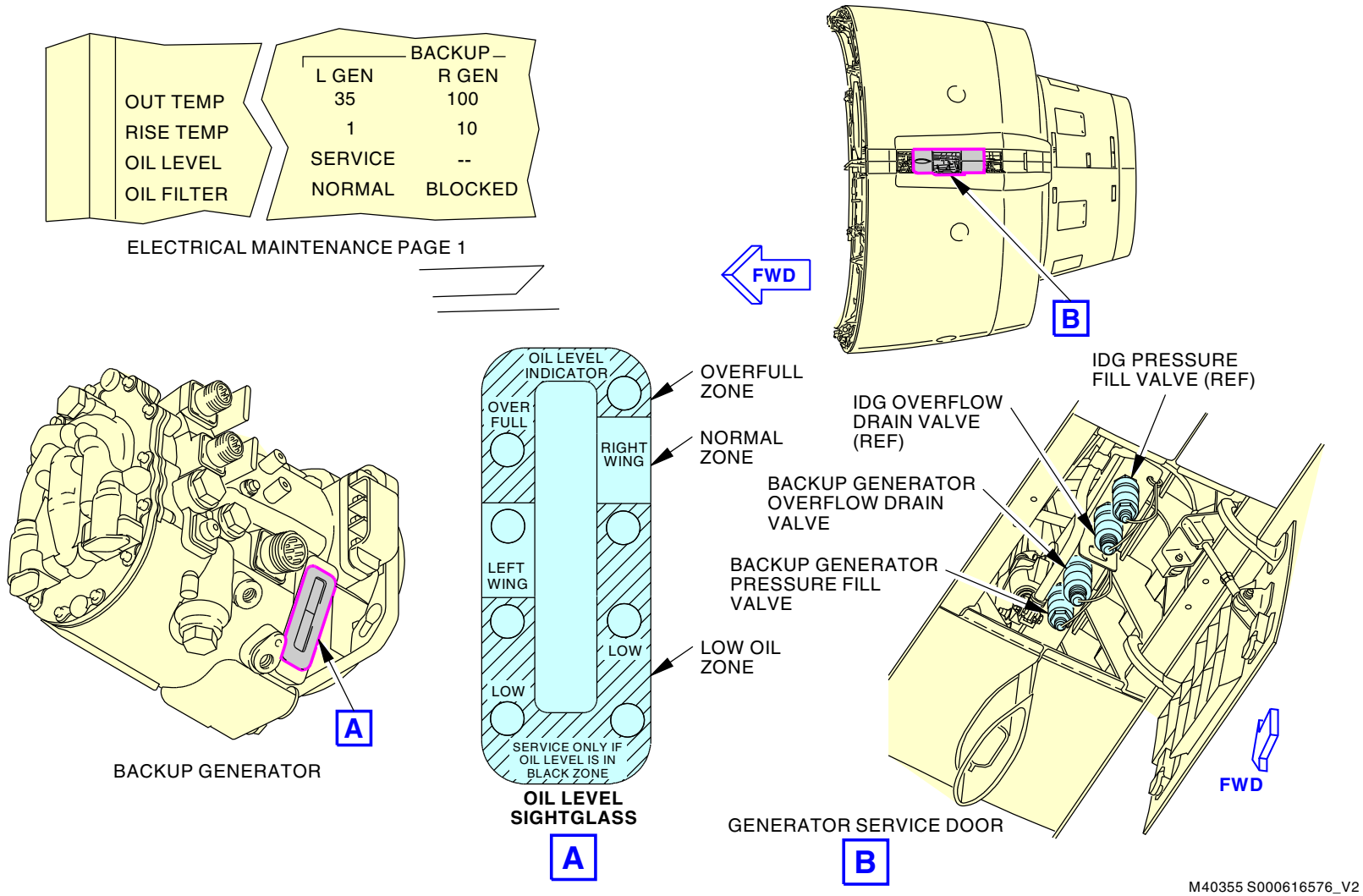
When the backup generator operates, the maintenance page does not get new oil level data. The oil level data shows as two dashes.

The oil level data shows blank for any of these conditions:

- Engine shutdown (blank for approximately 10 minutes)
- Initial converter power-up (blank for approximately 10 minutes)
- Data is invalid due to a fault.

EFFECTIVITY

ARO ALL



GENERATOR DRIVE - BACKUP GENERATOR - OIL SERVICING

GENERATOR DRIVE - APU GENERATOR

Purpose

The APU generator is a secondary source of electrical power for airplane systems. It can supply electrical power when the airplane is on the ground or during flight. It can supply 120 kva of ac power.

Location

The APU generator is in the APU compartment. It attaches to the accessory pad of the APU gearbox. A seal plate is between the APU generator and the APU gearbox.

Interfaces

The APU GCU controls the APU generator.

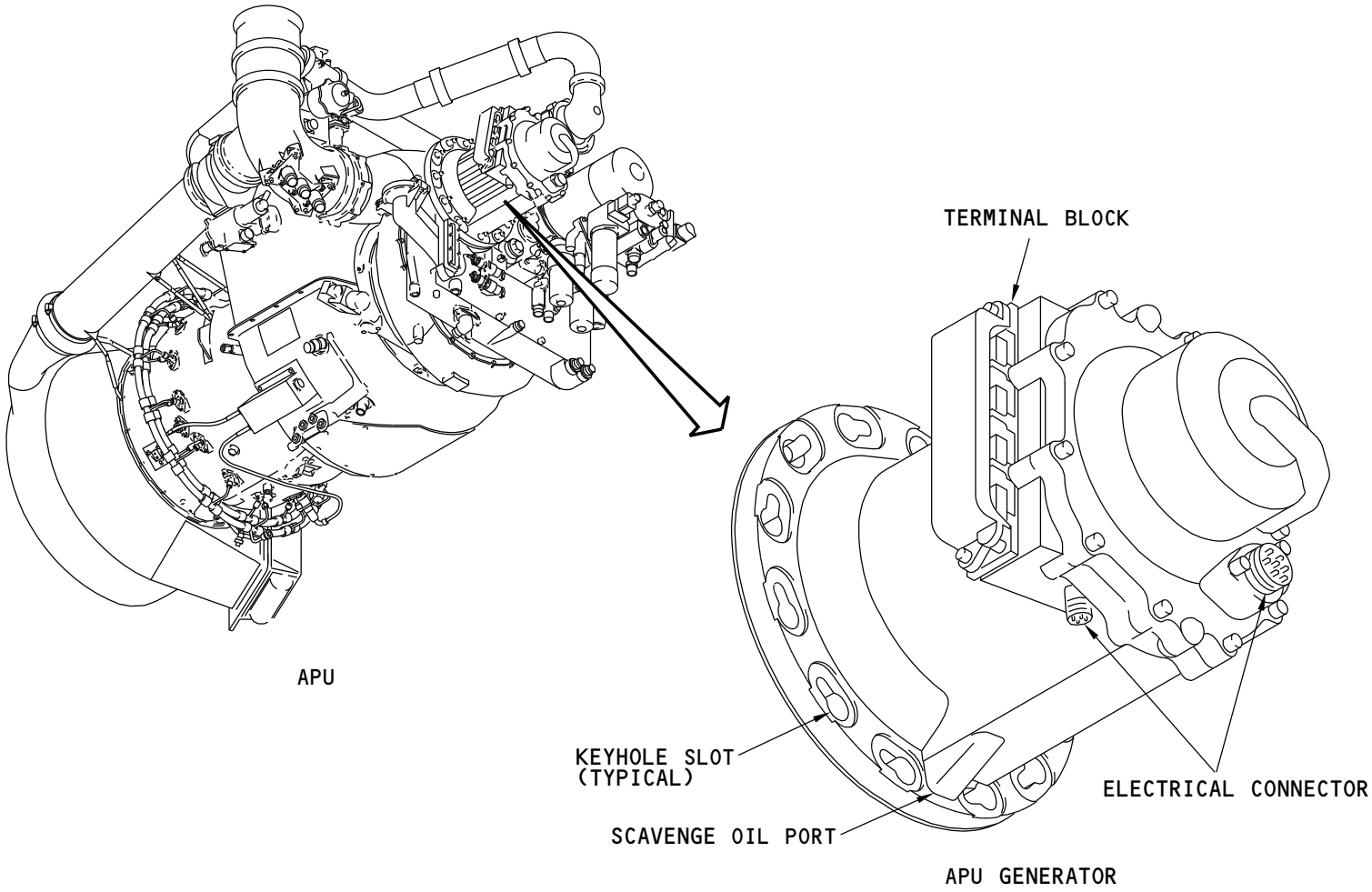
The APU gearbox turns the APU generator. The APU oil system lubricates the APU generator and keeps it cool.

The APU generator has a terminal block and two electrical connectors. The oil ports are part of the mounting flange to the accessory pad. The seal plate prevents oil leakage at the mounting flange.

Training Information Point

The APU generator has keyhole slots in the mounting flange. You do not remove the fasteners to remove or replace the generator.

An indexing pin (not shown) on the APU generator helps you align it with the APU gearbox when you install it.



M40257 S000616578_V1

GENERATOR DRIVE - APU GENERATOR

GENERATOR DRIVE - FUNCTIONAL DESCRIPTION

General

The gearbox of each engine turns an IDG and a backup generator. The related GCU controls the IDG. The backup generator converter controls the backup generators on both engines. Oil goes through the generators to make them cool. Heat exchangers take the heat from the oil. The IDG oil subsystem operates independently of the backup generator oil subsystem.

IDG Operation

The GCU causes the flight deck effects for the IDG. If the IDG has low pressure during operation, the GCU turns on the DRIVE light and makes an EICAS message. The drive disconnect switch on the electrical panel controls the disconnect solenoid.

The pumps in the IDG move the IDG oil. The oil filter removes unwanted particles from the oil. The differential pressure indicator and the MFD electrical maintenance page tell you if the filter is clogged. The GCU causes the maintenance page to show the oil level status.

Backup Generator Operation

The backup generator converter causes the flight deck effects for the backup generator. The supply pump in the backup generator moves the backup generator oil. The oil filter removes unwanted particles from the oil. The differential pressure indicator and the MFD electrical maintenance page tell you if the filter is clogged. The backup generator converter causes the maintenance page to show the oil level status.

APU Generator Operation

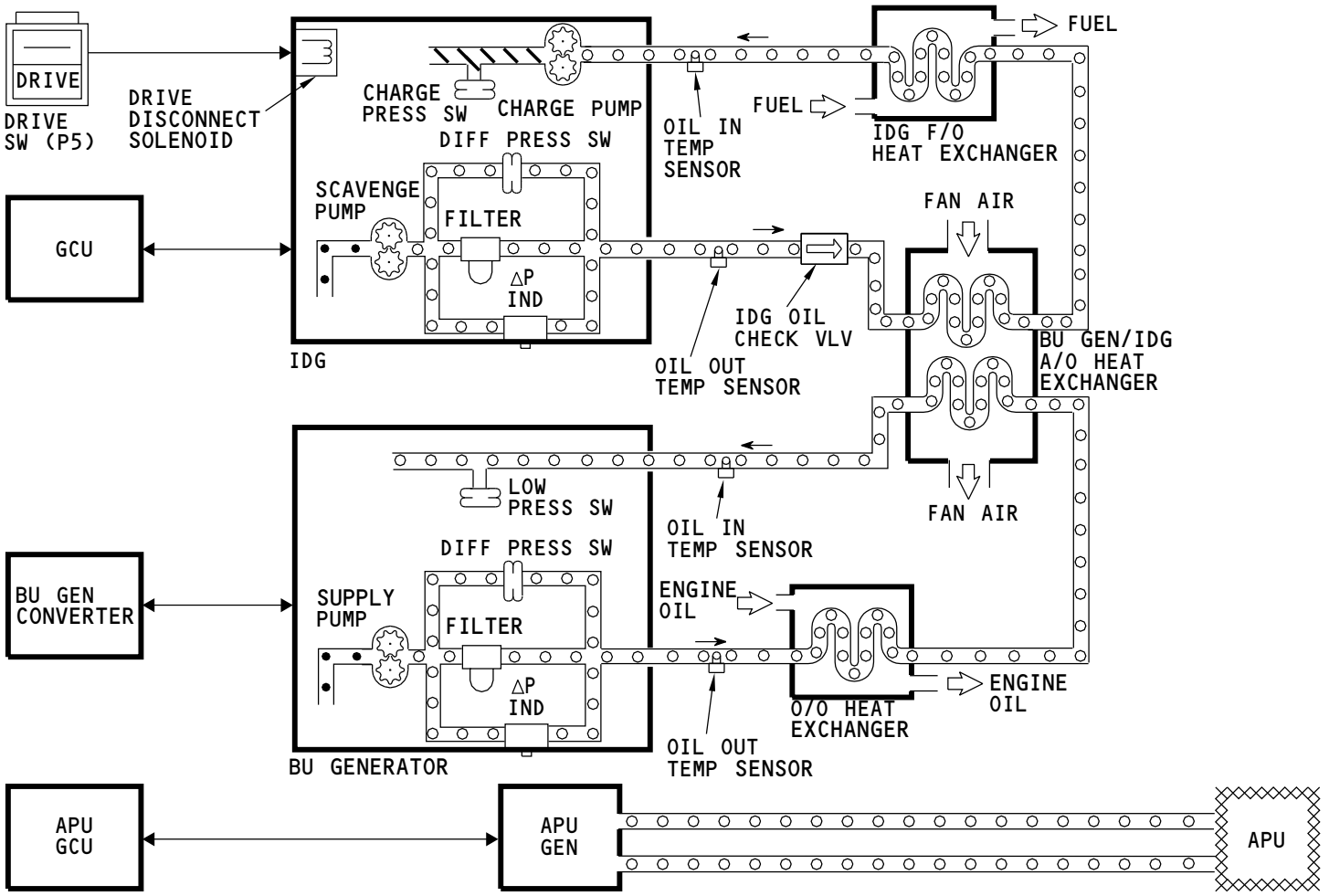
The APU gearbox turns the APU generator. The APU GCU controls and monitors the operation of the APU generator.

Generator Cooling

The IDG oil goes through the backup generator/IDG air/oil heat exchanger first. Then it goes through the IDG fuel/oil heat exchanger.

The backup generator oil goes through the oil/oil heat exchanger first. Then it goes through the backup generator/IDG air/oil heat exchanger.

The APU oil cools the APU generator. See the APU and generator lubrication system section for more information (SECTION 49-27).



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GENERATOR DRIVE - FUNCTIONAL DESCRIPTION

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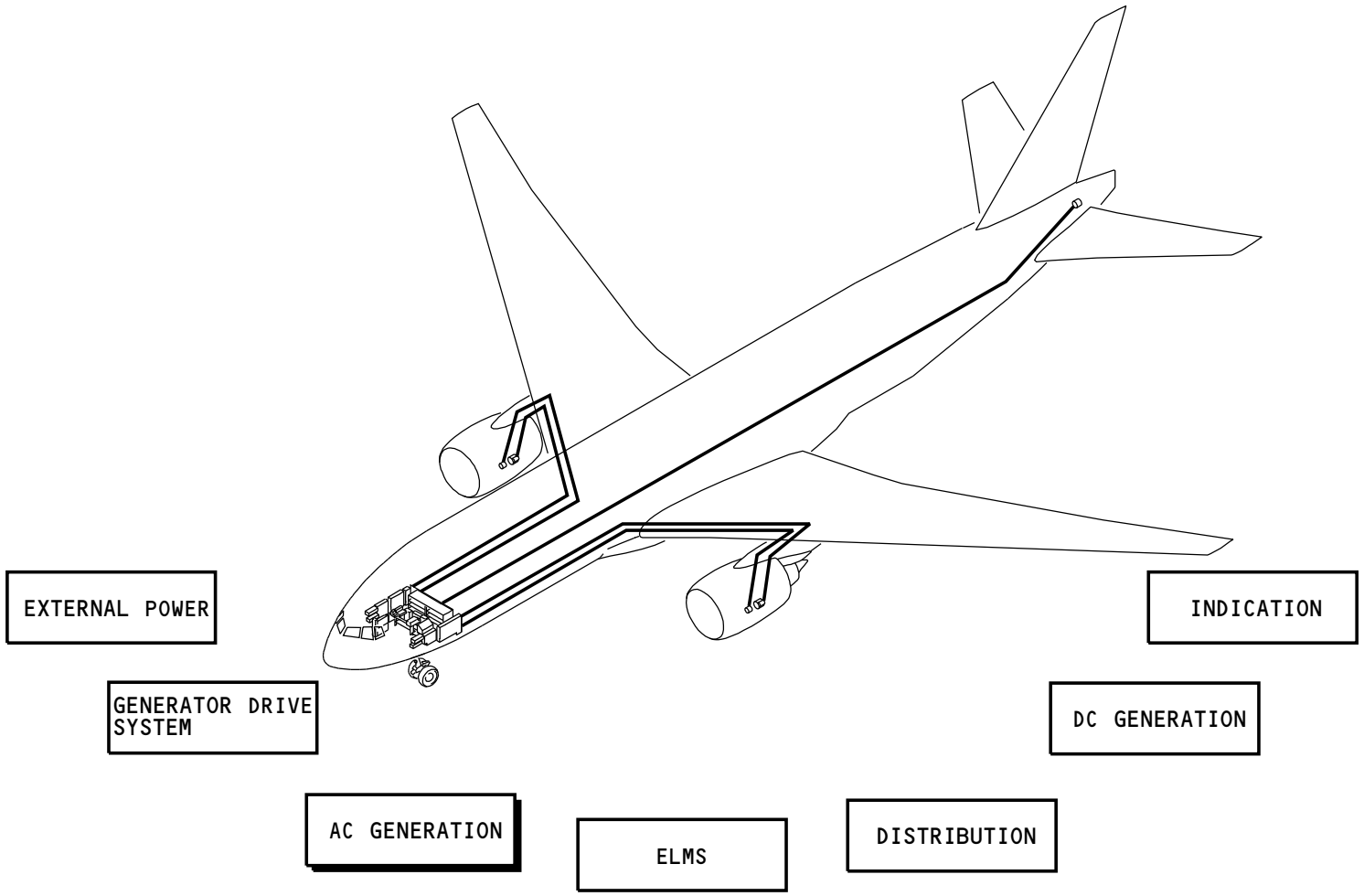
AC GENERATION - INTRODUCTION

General

The AC generation system supplies 115v ac power to the airplane. The ac generation system has these sub-systems:

- IDG power
- APU generator power
- Backup generator power.



M40262 S000616586_V1

AC GENERATION - INTRODUCTION

AC GENERATION - APU GENERATOR AND IDG POWER SYSTEMS - GENERAL DESCRIPTION

General

The IDGs and APU generator supply 115v ac, 400 Hz power to the left and right main ac buses. See the generator drive section for more inforation about the APU generator and the IDGs (SECTION 24-10).

APU Power

The APU generator supplies power through the APB to the tie bus. Power goes from the tie bus, through the BTBs, to one or both main ac buses.

The APU generator supplies power through the GSSR to the ground service bus. The APU generator also supplies power through the GHR to the ground handling bus.

The APU generator has a GCU that controls, monitors, and protects the APU power system. The APU GCU gets an input from the APU generator (APU GEN) switch. When the switch is in, the GCU automatically controls the APB. When the switch is out, the GCU opens the APB and trips the field of the generator. The OFF light comes on when the switch is out, or when the APB is open because of a fault.

IDG Power

The left IDG supplies power to the left main ac bus. The right IDG supplies power to the right main ac bus. Power goes through the GCBs.

There is a GCU for each IDG. The left and right GCUs control, monitor, and protect the IDG power system. Each GCU gets inputs from a generator control (GEN CTRL) switch and a BUS TIE switch.

When the GEN CTRL switch is in, the GCU automatically controls the GCB. When the switch is out, the GCU opens the GCB and trips the field of the generator.

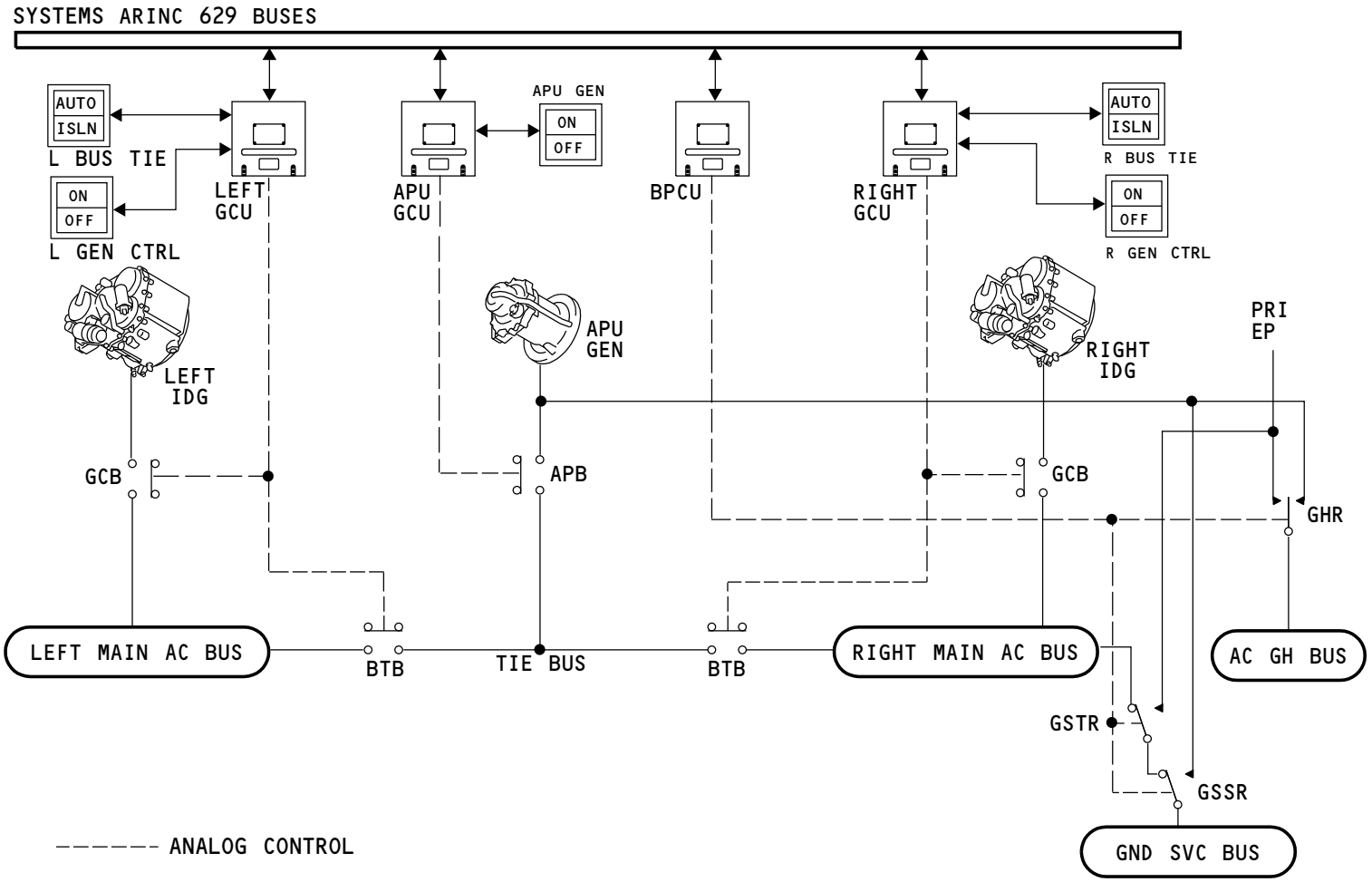
When the BUS TIE switch is in, the GCU automatically controls the BTB. When the switch is out, the GCU opens the BTB.

The GCU turns the switch light (ISLN or OFF) on for each switch when the switch is out, or the breaker is open because of a fault.

No-Break Power Transfers

The BPCU coordinates power transfers between the APU generator and IDGs. The BPCU and GCUs communicate on the systems ARINC 629 buses.

When the ac system changes from one power source to another in the air, it does break power transfers. On the ground, it does no-break power transfers. The system momentarily connects two power sources to one bus so there is no interruption in power. A GCU electronically adjusts an IDG speed to match the power of the two sources to do a no-break power transfer. For transfers between external power and the APU, the APU controller adjusts the APU speed to do the no-break power transfer.



M40263 S000616587_V1

AC GENERATION - APU GENERATOR AND IDG POWER SYSTEMS - GENERAL DESCRIPTION

AC GENERATION - BACKUP GENERATOR POWER SYSTEM - GENERAL DESCRIPTION

General

The backup power system supplies 115v ac, 400 Hz power to the left, right, or both transfer buses. The transfer buses usually get power from the main ac buses. If a main ac bus loses power, the backup power system supplies power to the related transfer bus.

The backup power system also supplies power during autoland operations.

The backup power system has two backup generators and a backup generator converter. The system is independent of other airplane systems. There is no time limit for backup power system operation.

Backup Generator Power

The backup converter gets power from only one ot the backup generators at any time. The converter changes the variable frequency power to 115v, 400 Hz ac power and sends it to the transfer buses. Power goes through the converter circuit breakers (CCB).

Only one backup generator supplies power at a time. Normally, the left backup generator supplies power to the left transfer bus and the right backup generator supplies power to the right transfer bus. If the left and right transfer buses need power, the right backup generator supplies the power if it is available.

The backup generator converter also controls, monitors, and protects the backup power system. The converter gets an input from each backup generator (BACKUP GEN) switch. When the switch is in, the converter controls the related CCB and transfer bus breaker (TBB) automatically. When the switch is out, the converter opens the CCB, closes the TBB, and trips the field of the generator. The converter causes the OFF light to come on for each switch for any of these conditions:

- Switch is out
- Backup generator field relay opens because of a fault
- Engine fire switch is pulled out
- Engine is shutdown.

Training Information Point

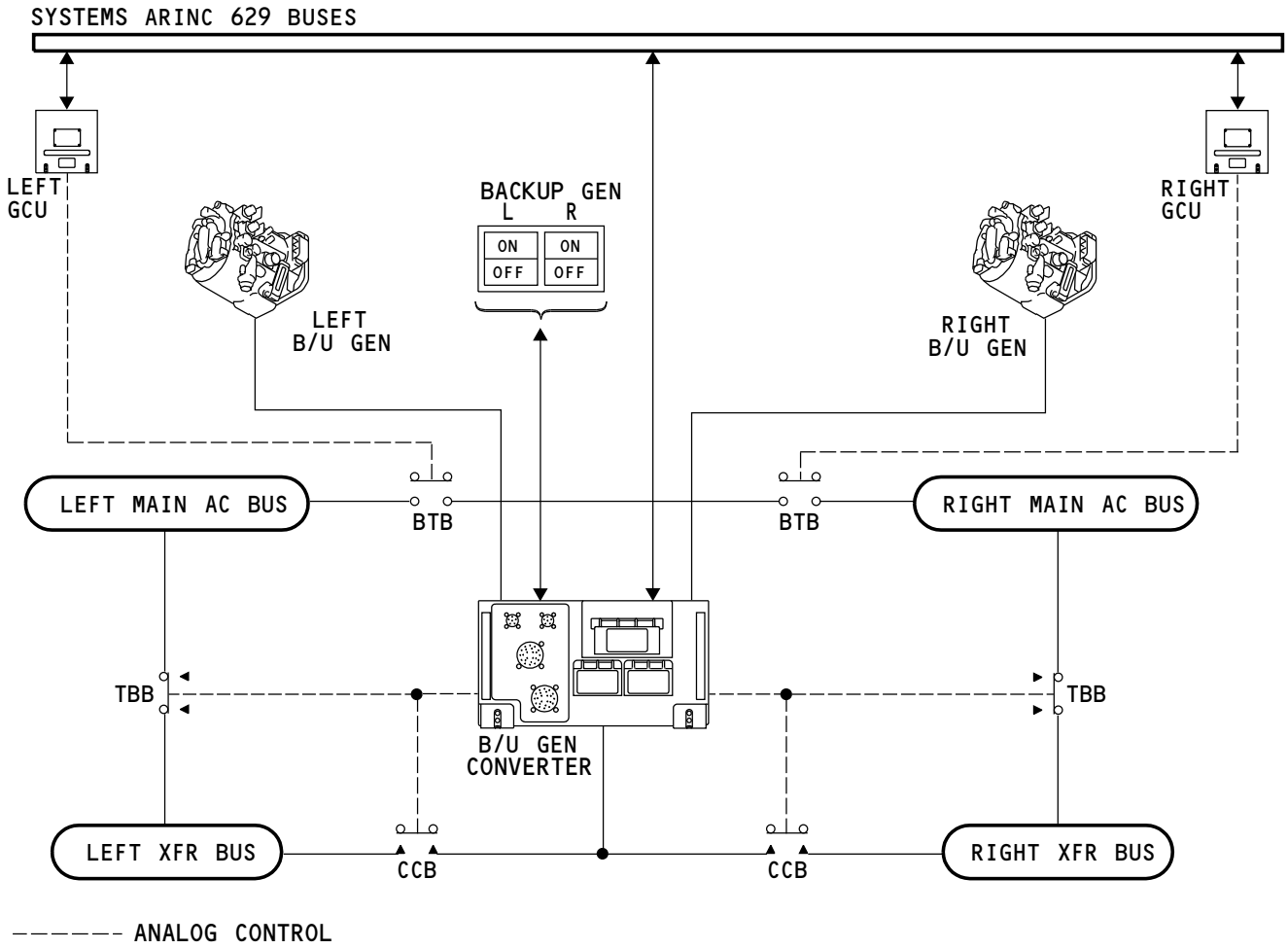
The backup converter defaults to the right backup generator. If the right backup generator is not available or faulty, the converter uses the left backup generator.

No-Break Power Transfers

The backup generator converter controls the CCB and TBB to do no-break power transfers to the transfer buses. When a main ac bus loses power, the BTBs close to permit the opposite main ac bus to supply power to the main ac bus that lost power and its related transfer bus. The backup generator power system then momentarily connects the main ac bus power and the backup generator converter power on the transfer bus so there is no interruption in power. The backup generator converter electronically matches the power on the transfer bus to do a no-break power transfer.

Engine Start Test

After an engine starts, the backup generator supplies power to its transfer bus for approximately 15 seconds. This makes sure the system operates before each flight.



M40264 S000616588_V1

AC GENERATION - BACKUP GENERATOR POWER SYSTEM - GENERAL DESCRIPTION

AC GENERATION - COMPONENT LOCATIONS - GENERATORS

General

The ac generation system has these five generators:

- IDG (2)
- Backup generator (2)
- APU generator.

IDG

There is one IDG on each engine. The IDG attaches to the aft face of the gearbox.

Each IDG supplies a maximum of 120 kva of power.

Backup Generator

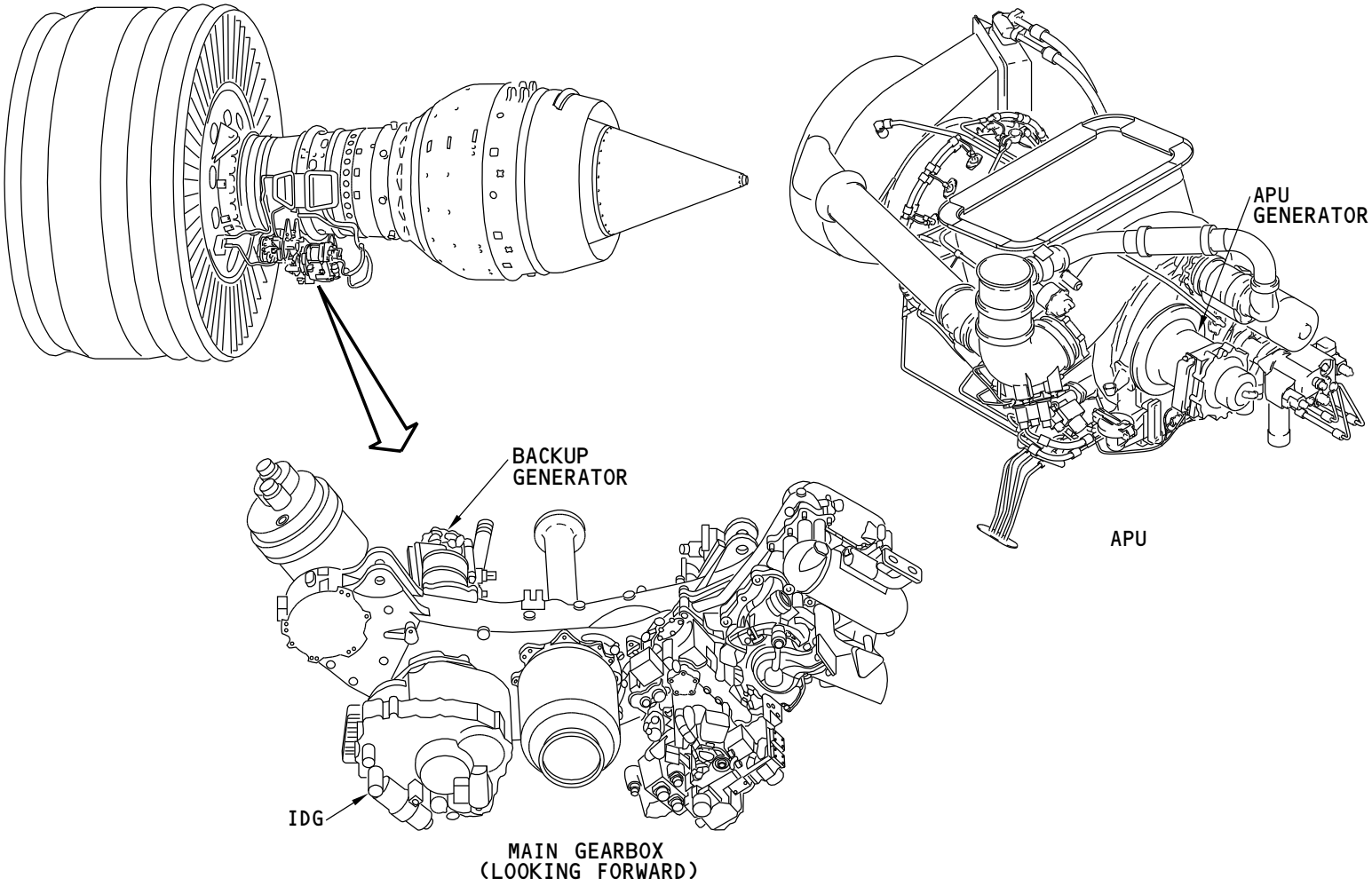
There is one backup generator on each engine. The backup generator attaches to the forward face of the gearbox.

Each backup generator supplies a maximum of 20 kva of power.

APU Generator

The APU generator is in the APU compartment. It attaches to the APU gearbox.

The APU generator supplies a maximum of 120 kva of power.



M40266 S000616590_V1

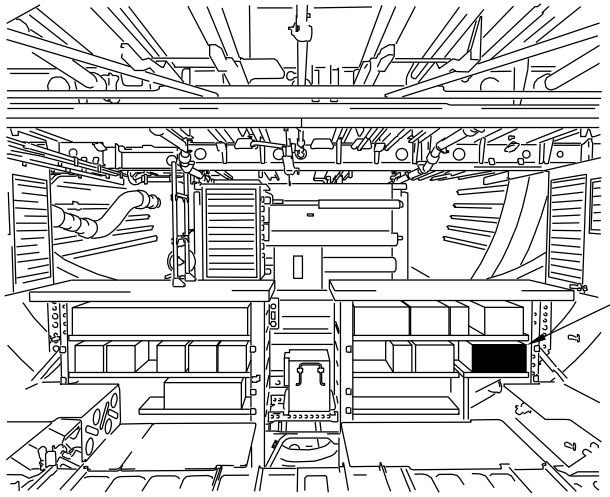
AC GENERATION - COMPONENT LOCATIONS - GENERATORS

AC GENERATION - MAIN EQUIPMENT CENTER - COMPONENT LOCATIONS

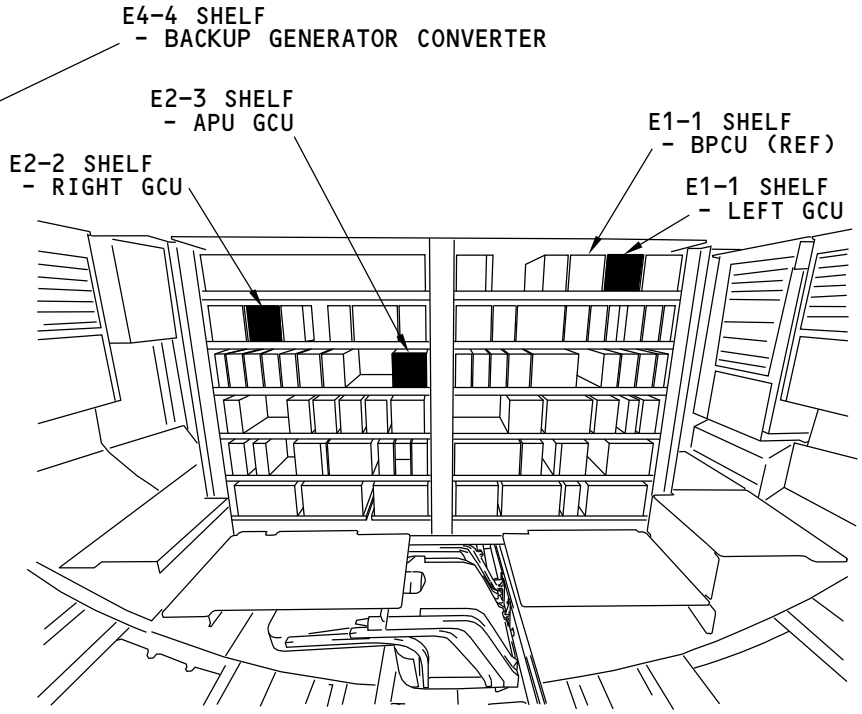
General

These ac generation system components are in the main equipment center:

- Backup generator converter
- Right GCU
- APU GCU
- Left GCU.



MAIN EQUIPMENT CENTER
(LOOKING FORWARD)



MAIN EQUIPMENT CENTER
(LOOKING AFT)

M40268 S000616592_V1

AC GENERATION - MAIN EQUIPMENT CENTER - COMPONENT LOCATIONS

AC GENERATION - ELECTRICAL PANELS - COMPONENT LOCATIONS

General

The ac generation system has components in these ELMS panels:

- P100 left power panel
- P200 right power panel
- P300 auxiliary power panel.

See the electrical load management system section for more information on the location, removal, and installation of panel components (SECTION 24-09).

P100 Left Power Panel

These are the components in the left power panel:

- L GCB
- L BTB
- L TBB
- L CCB.

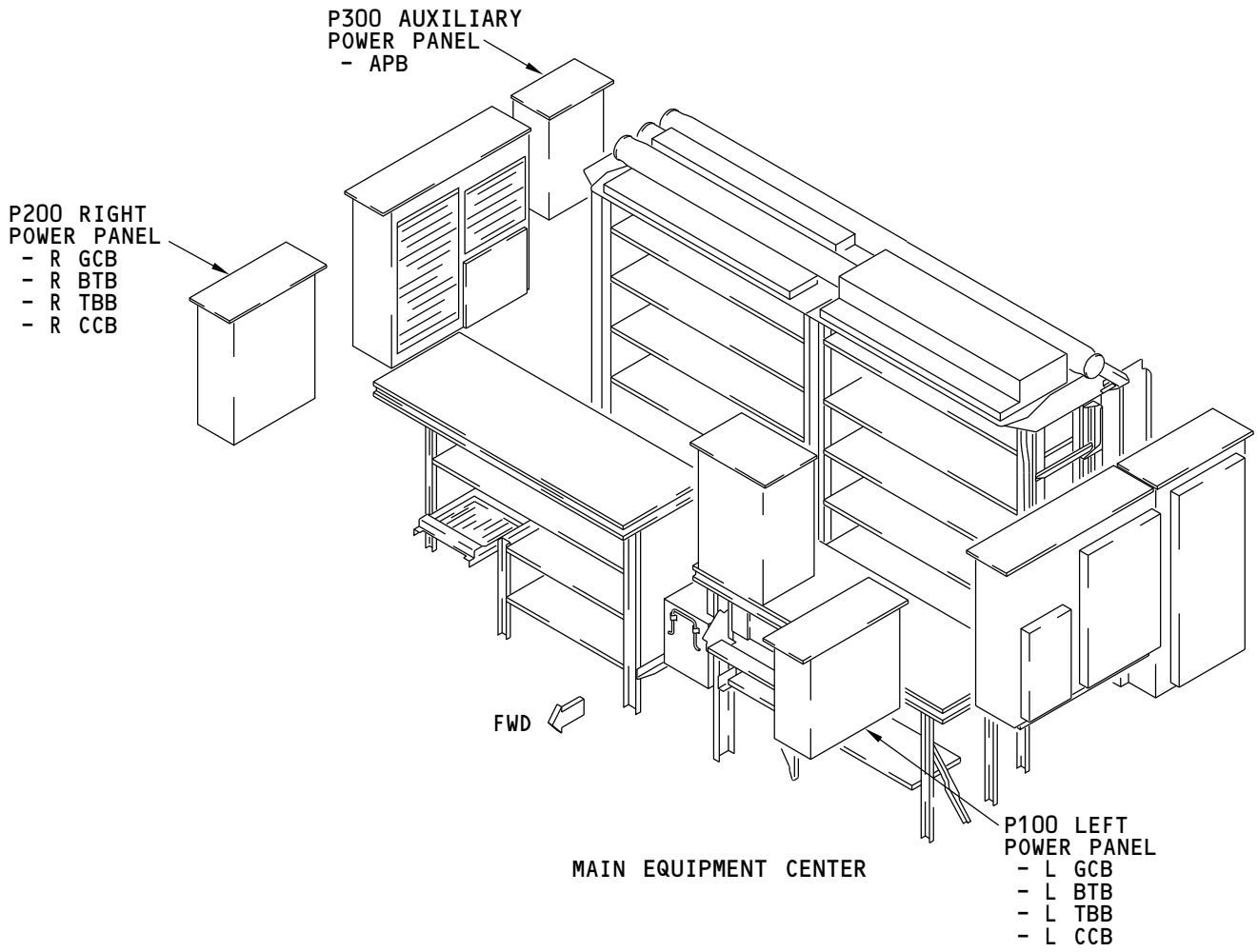
P200 Right Power Panel

These are the components in the right power panel:

- R GCB
- R BTB
- R TBB
- R CCB.

P300 Auxiliary Power Panel

The APB is in the auxiliary power panel



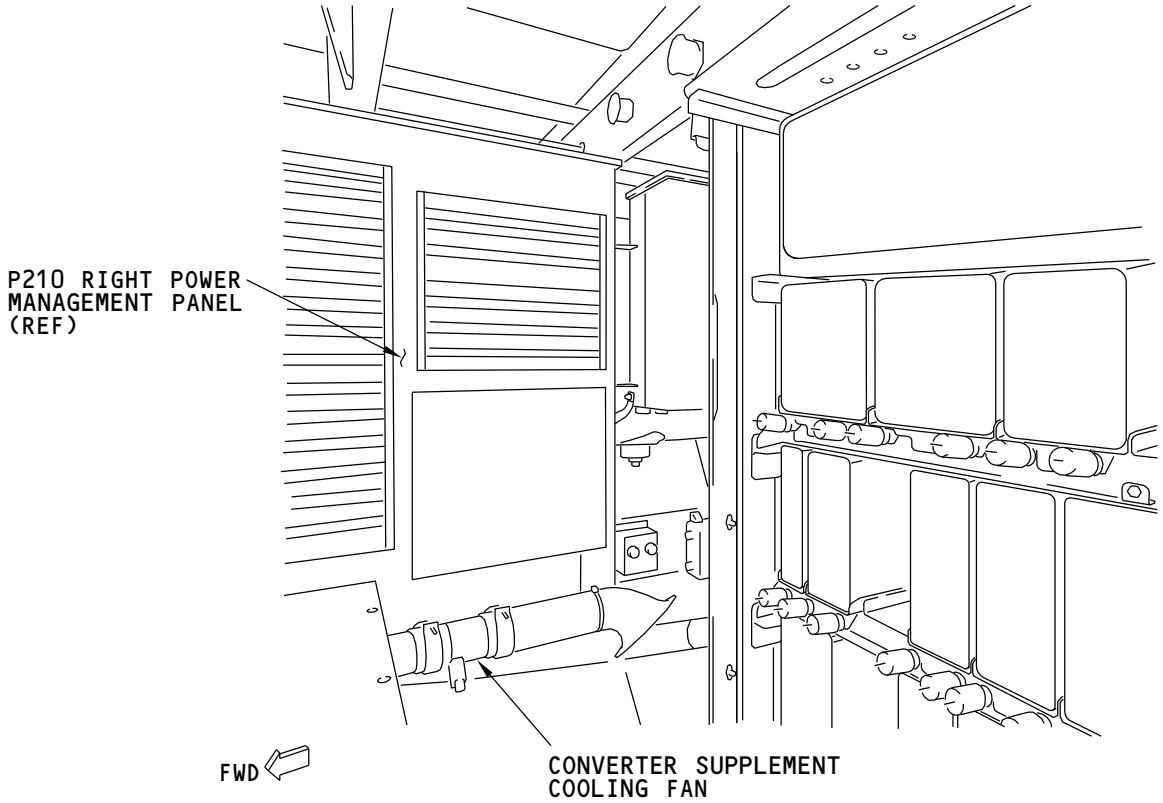
M40269 S000616593_V1

AC GENERATION - ELECTRICAL PANELS - COMPONENT LOCATIONS

AC GENERATION - CONVERTER SUPPLEMENT COOLING FAN - COMPONENT LOCATION

Converter Supplement Cooling Fan

The converter supplement cooling fan is on the right side of the MEC below the P210 right power management panel.



M40270 S000616594_V1

AC GENERATION - CONVERTER SUPPLEMENT COOLING FAN - COMPONENT LOCATION

Backup Generator Converter

The backup generator converter gets variable frequency ac power from both backup generators. It changes the variable frequency power into 115v, 400 hz, ac power. The converter supplies power to one or both transfer buses.

The converter also controls, monitors, and protects the backup electrical power system. The converter does an automatic test of the backup system immediately after an engine start. These are some of the protective functions of the converter:

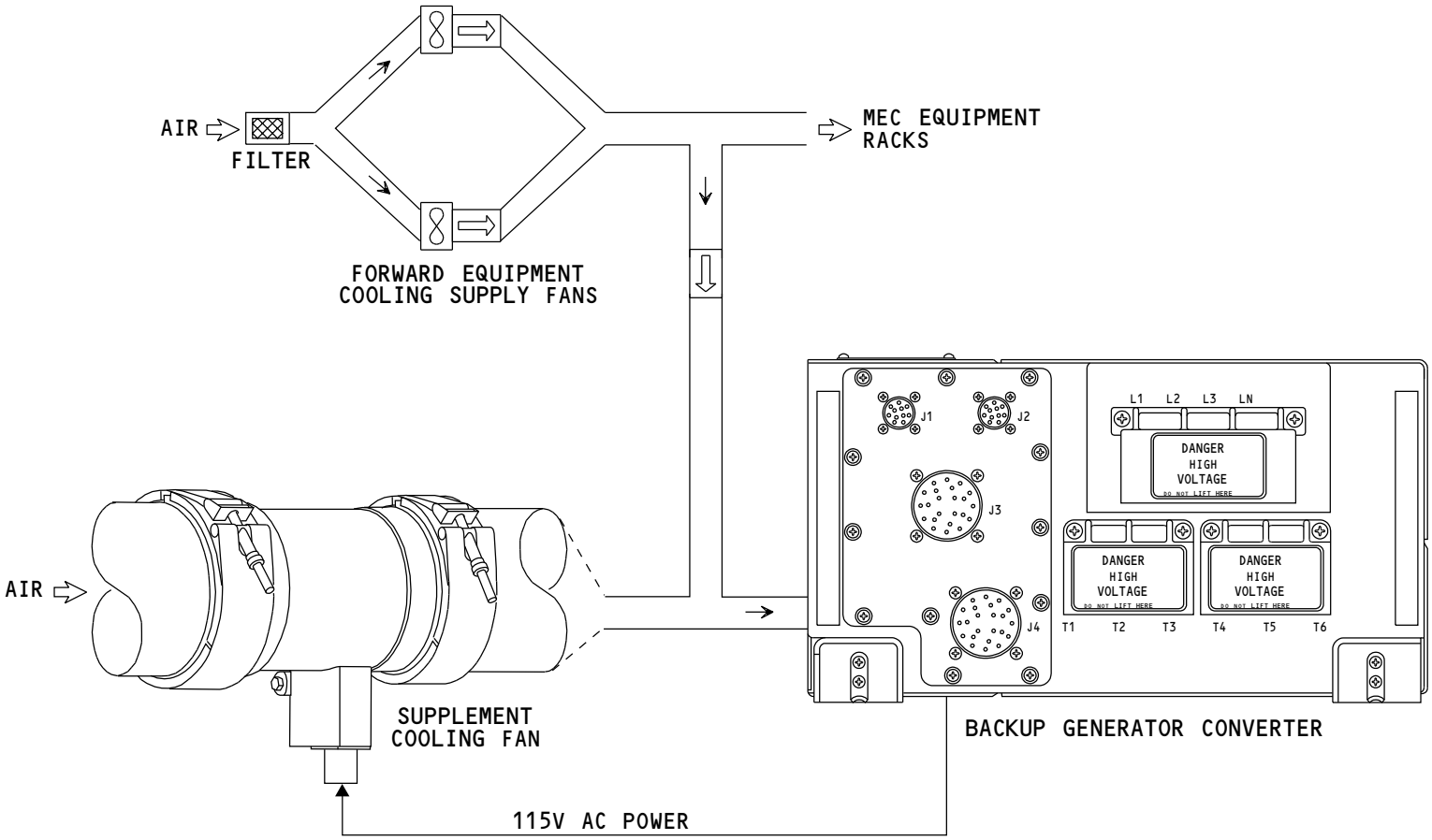
- Over/undervoltage
- Over/underfrequency
- Overcurrent
- Differential protection
- Converter fault.

Supplement Cooling Fan

The backup generator converter gets cooling air from the forward equipment cooling supply fans. It also gets cooling air from the supplement cooling fan.

The supplement cooling fan is an axial flow blower with an integral discharge check valve. The backup generator converter turns the fan on when it supplies it with 115v ac power during these conditions:

- Backup system test after an engine start
- Backup system supplies power to both transfer buses
- High temperature difference across the converter
- Inlet air temperature is greater than 40 degrees C and the backup system supplies power to one transfer bus
- Forward equipment cooling failure.



M40271 S000616595_V1

AC GENERATION - BACKUP POWER - BACKUP GENERATOR CONVERTER & SUPPLEMENT COOLING FAN

AC GENERATION - APU GENERATOR POWER - GENERATOR CONTROL

General

The APU GCU controls, protects, and monitors the APU power.

The forward equipment cooling system actively cools the GCU.

GCU Power

The APU GCU power supply gets power from two different sources. One source is the PMG in the APU generator. The other source is the captain's flight instrument bus.

Generator Excitation

The voltage regulator controls the power level to the exciter field in the generator. The voltage regulator rectifies ac power from the PMG to make dc current for the exciter field. Power to the voltage regulator goes through the generator control relay (GCR).

The generator uses the exciter field current to make the ac current in the power feeders. The feeder cables go to the APB, the ground handling relay, and the ground service select relay in the auxiliary power panel.

The voltage regulator monitors the generator output voltage. This is called the point-of-regulation (POR) voltage. POR voltage is on the generator side of the APB. The voltage regulator adjusts the dc current to the exciter field to keep the POR voltage at 115 volts.

Protection

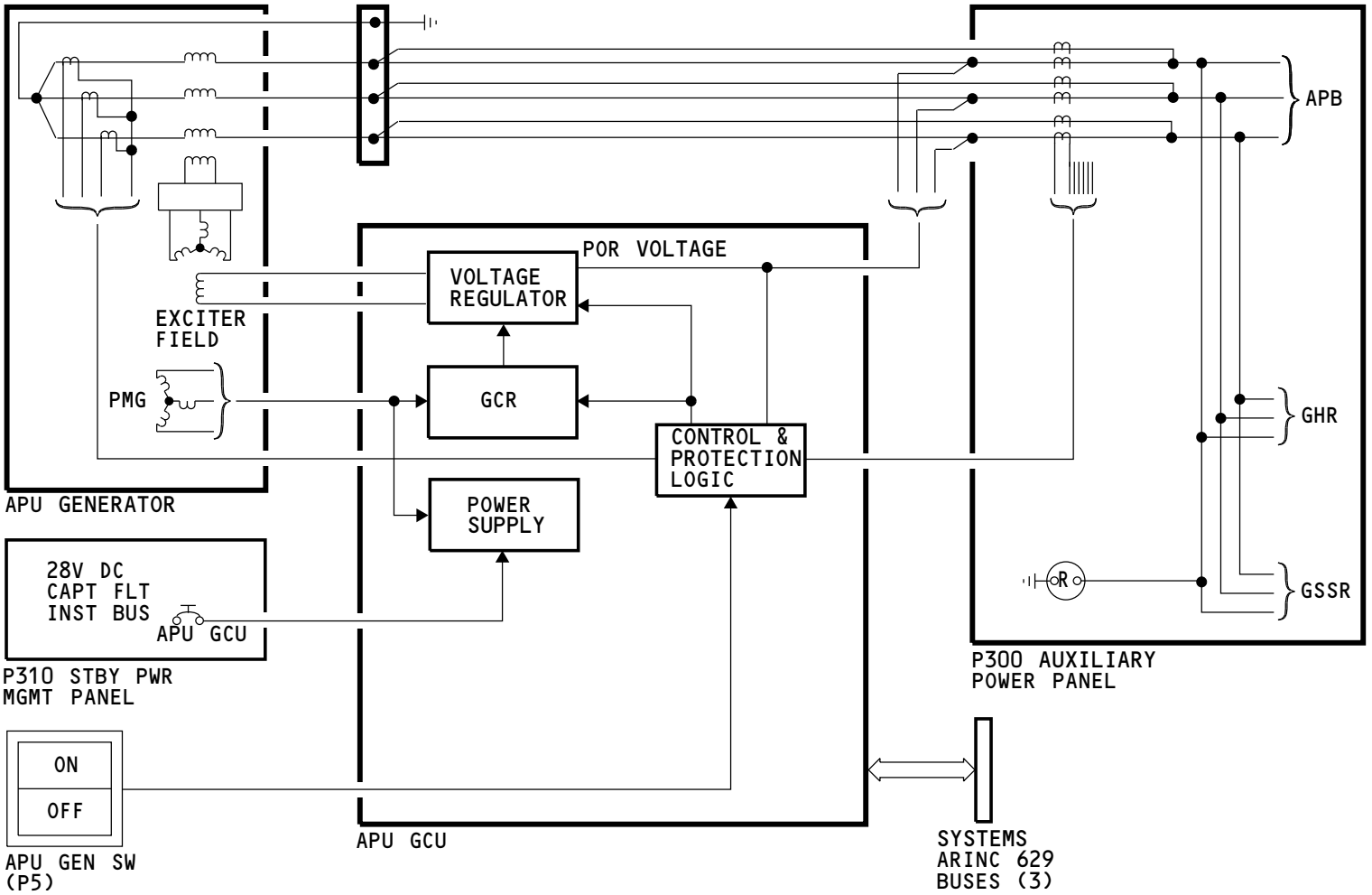
The GCU monitors the APU generator power and control inputs. It opens the GCR for any of these causes:

- Control switch off
- Fire switch pulled
- Over/under voltage
- Over/under frequency
- Differential fault
- Open phase
- Generator diode failure
- Parallel feeder open
- Unbalanced current
- Computer failure.

A protective trip is reset when you push the control switch off and then on.

Power Feeders

Copper feeders go from the APU to a terminal block at the aft stabilizer pivot bulkhead. From there, double-wire aluminum feeders go to the auxiliary power panel. The feeders reconnect in the power panel.



M40272 S000616596_V1

AC GENERATION - APU GENERATOR POWER - GENERATOR CONTROL

APB Control

The APU GCU controls the automatic operation of the APB. The GCU gets a switch position signal from the APU generator (APU GEN) switch.

When the switch is in, the GCU operates the APB automatically. The GCU uses power transfer logic to make a decision when to close the APB. In the air, with a single IDG operating, the APB closes if the APU is running (a break-power transfer). On the ground, the APB closes for no-break power transfers.

The GCU opens the APB for any these conditions:

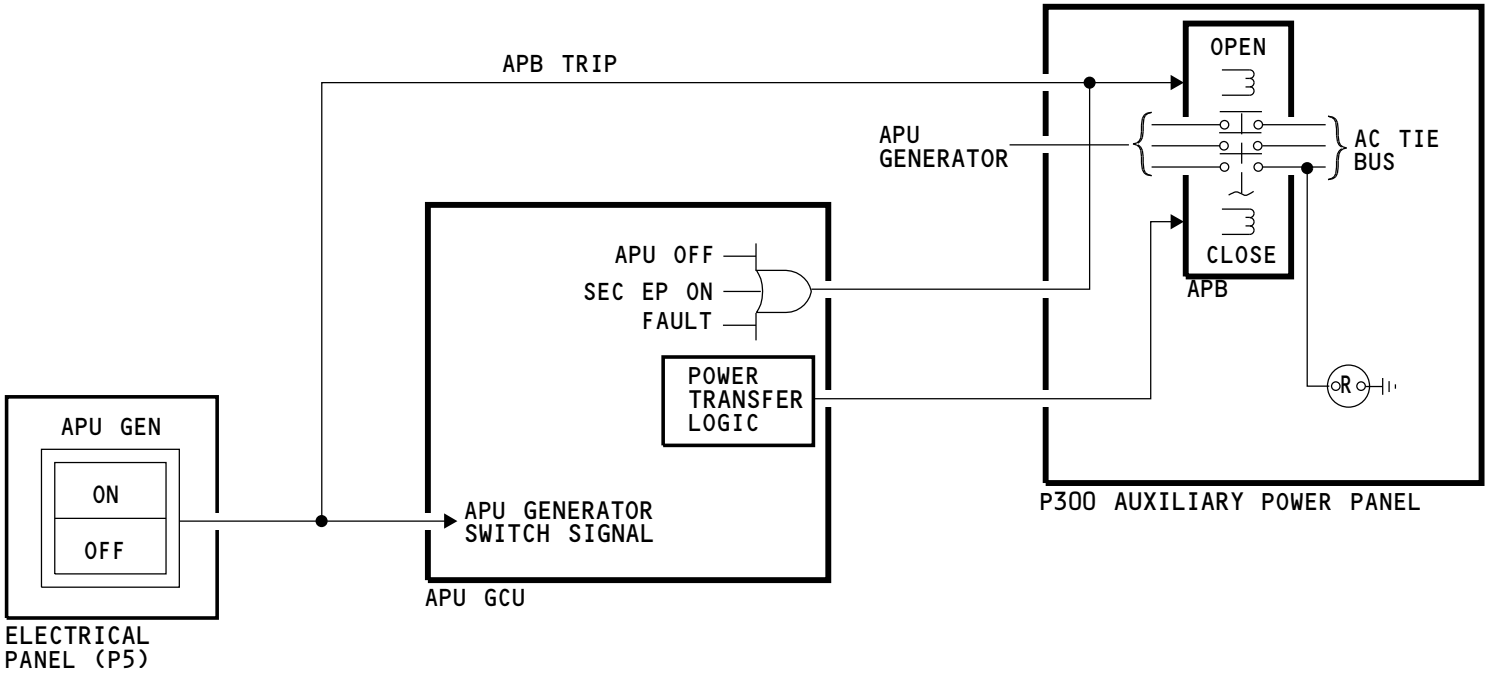
- The APU is off
- Secondary external power is on
- An APU power system fault occurs.

When the switch is out, a direct wire to the APB supplies power to open the breaker.

Switch Light

The OFF light on the APU GEN switch comes on for any of these conditions:

- The switch is out and the APB is open
- The APU is running and the GCU opens the APB because of a fault.



M40273 S000616597_V1

AC GENERATION - APU GENERATOR POWER - APB CONTROL

AC GENERATION - IDG POWER - GENERATOR CONTROL

General

The IDG GCU controls, protects, and monitors the IDG power.

The forward equipment cooling system actively cools the GCU.

GCU Power

The GCU gets power for control, protection, and BITE functions from these sources:

- IDG PMG
- Battery bus #2
- Right dc bus.

Generator Excitation

The voltage regulator controls the power level to the exciter field in the IDG. The voltage regulator rectifies ac power from the PMG to make dc current for the exciter field. Power to the voltage regulator goes through the generator control relay (GCR).

The generator uses the exciter field current to make the ac current in the power feeders. The power feeders go to the GCB in the power panel.

Point-of-Regulation (POR) Voltage

The voltage regulator monitors the voltage at the POR. POR is on the generator side of the GCB. The voltage regulator adjusts the dc current to the exciter field to keep the POR voltage at 115 volts.

Protection

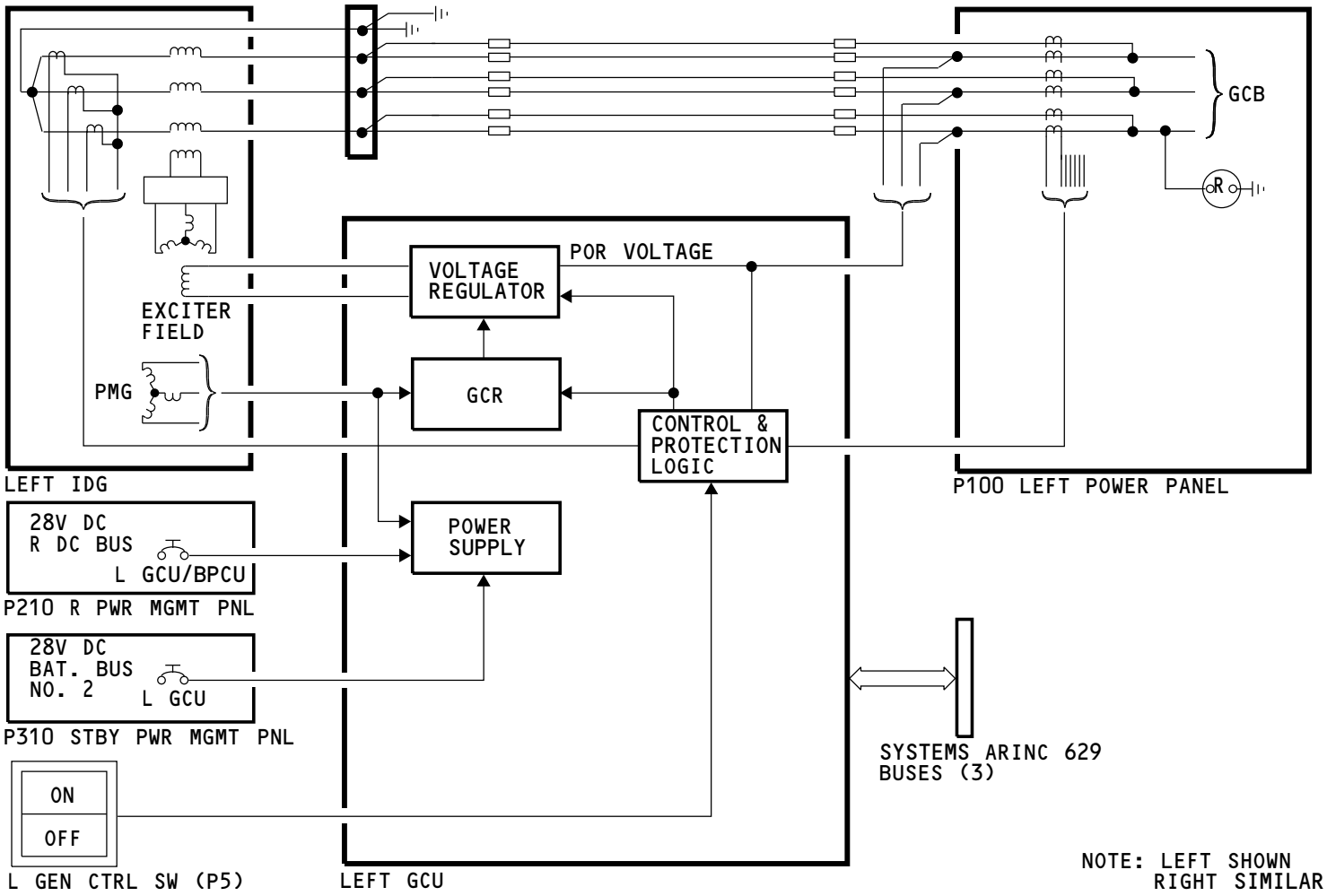
The GCU monitors the IDG generator power and control inputs. It opens the GCR for any of these causes:

- Control switch off
- Fire switch pulled
- IDG disconnect switch pushed
- Over/under voltage
- Over/under frequency
- Differential fault
- Open phase
- Generator diode failure
- Parallel feeder open
- Unbalanced current
- Computer failure.

A protective trip is reset when you push the control switch off and then on.

Power Feeders

Copper feeders go from the IDG to a terminal block under the strut. From there, double-wire copper feeders go through the strut to a splice in the wing leading edge. At the splice, the feeders change from copper to aluminum. Another splice is at the wing-to-body join. The feeders reconnect in the power panel.



M40274 S000616598_V1

AC GENERATION - IDG POWER - GENERATOR CONTROL

AC GENERATION - IDG POWER - BREAKER CONTROL

General

The GCU controls the GCB and BTB. When the GCB closes, the IDG connects to the main ac bus. When the BTB closes, the tie bus connects to the main ac bus.

The GCU gets switch position signals from the generator control (GEN CTRL) and BUS TIE switches.

GCB Control

When the GEN CTRL switch is in, the GCU operates the GCB automatically. The GCU closes the GCB when the IDG is available. This permits the left main ac bus to get power from the IDG. The GCU opens the GCB for any of these conditions:

- Secondary external power is on
- A fault occurs
- The IDG is not available.

When the GEN CTRL switch is out, a direct wire to the GCB open coil supplies power to open the GCB.

The OFF light on the GEN CTRL switch comes on when the GCB is open.

BTB Control

When the BUS TIE switch is in, the GCU operates the BTB automatically. The GCU closes the BTB to permit either of these conditions:

- The main ac bus gets power from the tie bus
- The main ac bus supplies power to the tie bus.

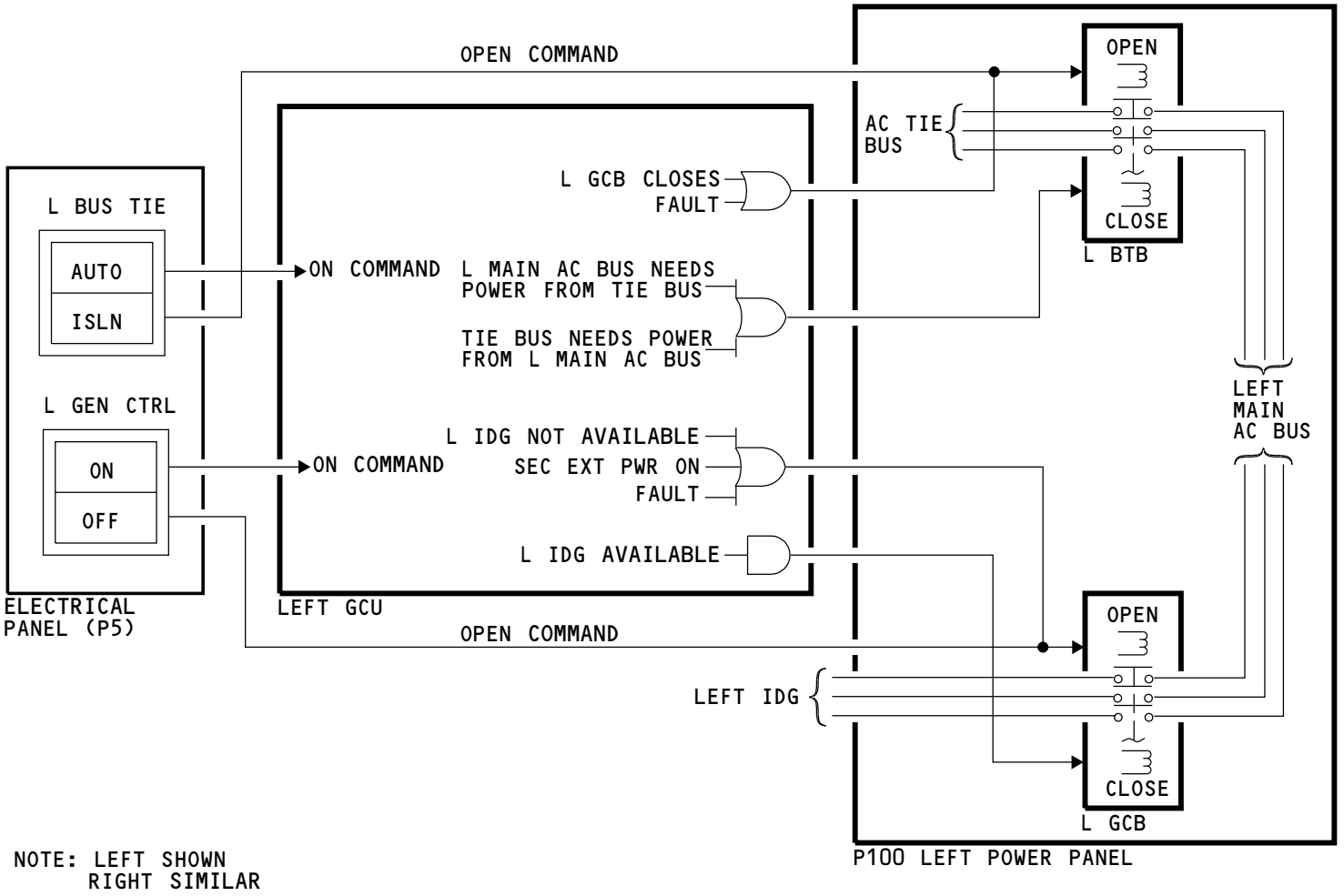
The GCU opens the BTB for either one of these conditions:

- The left GCB closes
- A fault occurs.

When the BUS TIE switch is out, a direct wire to the BTB open coil supplies power to open the BTB.

The ISLN light on the BUS TIE switch comes on for either of these conditions:

- The switch is out and the BTB is open
- The GCU opens the BTB because of a fault.



M40275 S000616599_V1

AC GENERATION - IDG POWER - BREAKER CONTROL

Converter Power

The converter power supply gets power from a PMG in the backup generator or from the captain's flight instrument bus.

Generator Excitation

The voltage regulator controls power to the exciter field in the backup generator. The voltage regulator rectifies ac power from the PMG to make dc power for the exciter field. It sends power through the GCR to the exciter field. The generator uses the exciter field current to make variable frequency ac power. The generator sends variable frequency ac power to the converter.

Main Feeder Power

The rectifier changes the variable frequency ac power to dc power. The inverter changes dc power to constant frequency 115v ac power. The inverter sends the 115v ac power through the power feeders to the CCB.

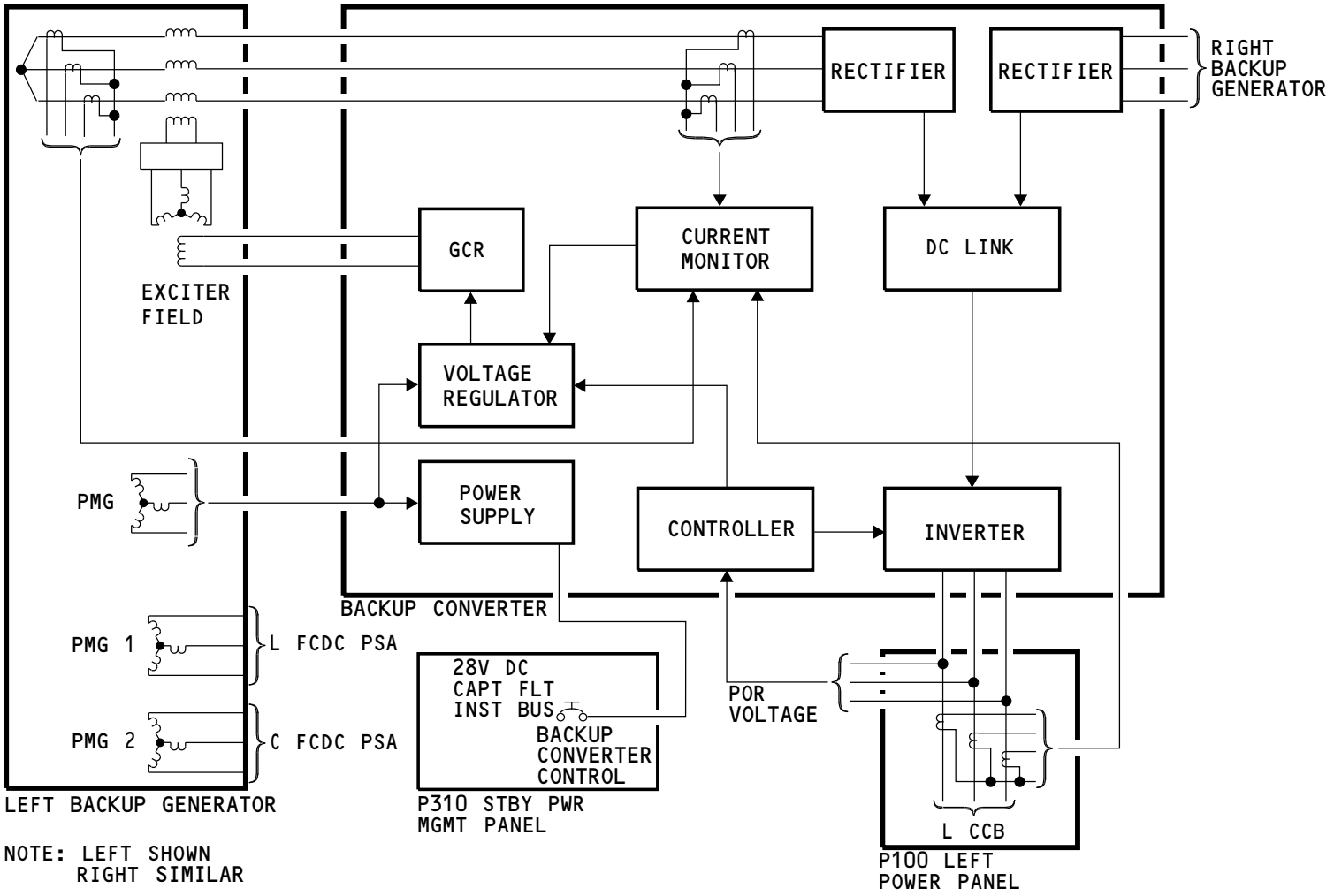
The controller monitors the POR voltage. The POR is on the generator side of the CCB. The controller adjusts the output from the inverter to keep the POR voltage at 115v.

Protection

The backup generator converter monitors the backup generator power and control inputs. It opens the GCR for the related backup generator for any of these causes:

- Control switch off
- Fire switch pulled
- Over/under-voltage
- Over/under-frequency
- Differential fault
- Computer failure
- Converter fault
- Generator over-temperature
- Low oil pressure
- DC link over-voltage
- Converter harmonic output distortion
- DC content out of range
- Converter over-current.

Under certain conditions the converter over-current fault does not trip the GCR.



M40276 S000616600_V1

AC GENERATION - BACKUP POWER - GENERATOR CONTROL

TBB and CCB Control

The backup generator converter controls the automatic operation of the TBB and CCB. The converter gets a switch position signal from the backup generator (BACKUP GEN) switch.

When the switch is in, the converter controls the TBB and CCB. The TBB and CCB are normally not energized. A spring holds the TBB closed when it is not energized. A spring holds the CCB open when it is not energized.

The converter energizes the TBB and CCB to permit the backup system to supply power to the transfer buses. The TBB opens when it energizes. The CCB closes when it energizes.

When the switch is out, the TBB and CCB are relaxed.

Power Transfer

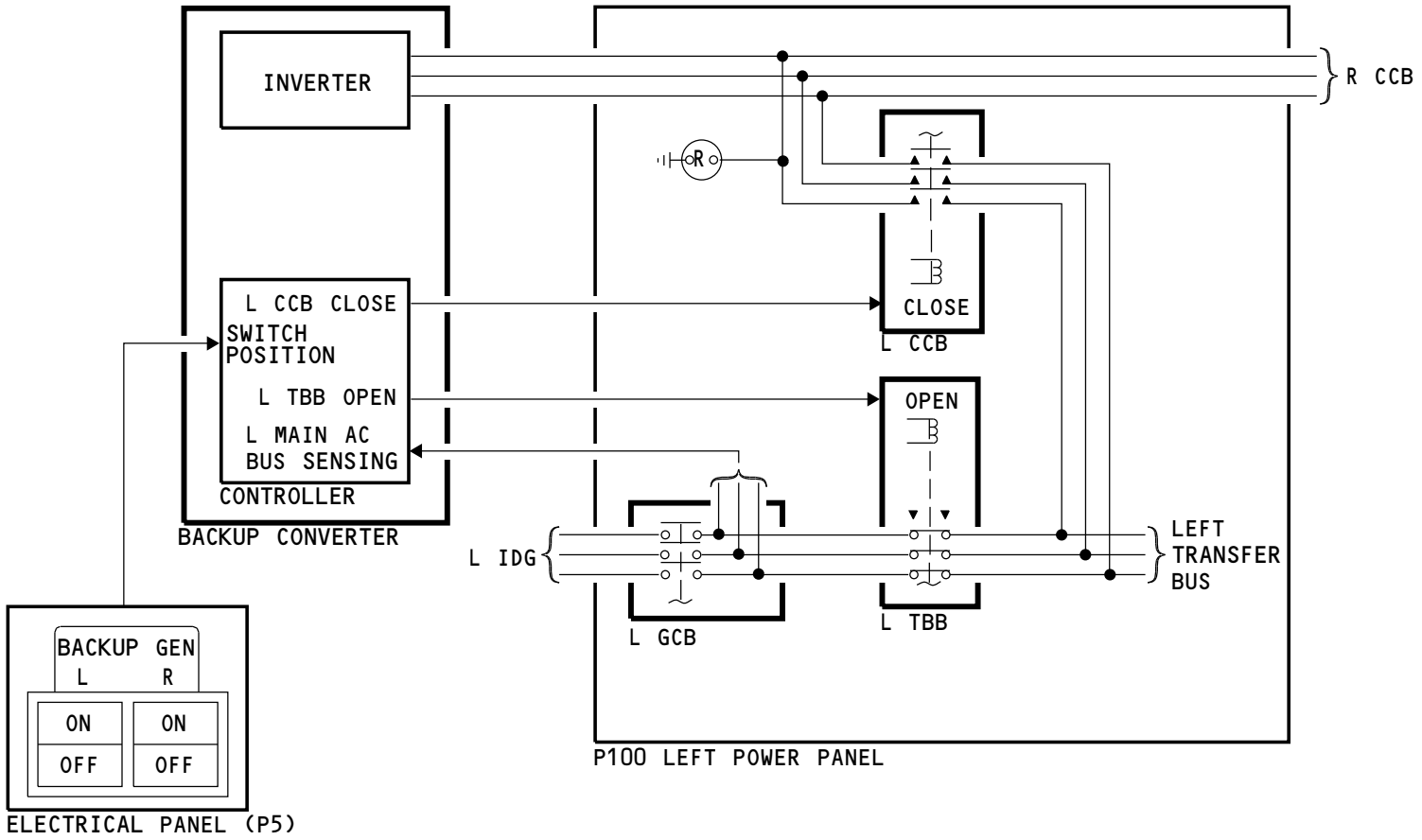
The left transfer bus normally gets power from the left IDG, through the left GCB and left TBB. When the converter senses no power at the left main ac bus, it opens the left TBB and closes the left CCB. This permits power to go from the converter to the left transfer bus.

If necessary, the converter supplies power to the right transfer bus through the right CCB.

Indication

The OFF light on the BACKUP GEN switch comes on for these conditions:

- Switch is out
- Backup generator field relay opens because of a fault
- Engine fire switch is pulled out
- Engine is shutdown.



M40277 S000616601_V1

AC GENERATION - BACKUP POWER - BREAKER CONTROL

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AC GENERATION - FUNCTIONAL DESCRIPTION

General

The BPCU and GCUs automatically control the power source selection for each main ac bus. The power sources for a main ac bus have this priority:

- Related IDG
- APU generator
- Opposite IDG.

External power has priority over other sources when you manually choose it with the external power switch.

APB Control

When the APU is running, the APU GCU closes the APB. This permits the APU to supply power to the tie bus. If the left main ac bus has no power, the left GCU closes the left BTB. This connects the tie bus to the left main ac bus.

If the right main ac bus has no power, the right GCU closes the right BTB. This connects the tie bus to the right main ac bus.

GCB Control

When the left IDG operates, the left GCU closes the left GCB. This permits the IDG to supply power to the left main ac bus.

When the right IDG operates, the right GCU closes the right GCB. This permits the IDG to supply power to the right main ac bus.

BTB Control

One IDG can supply power to both main ac buses at the same time. For example, if the right IDG fails, the right GCU opens the right GCB and closes the right BTB. The left GCU closes the left BTB. This connects the left main ac bus to the right main ac bus.

Ground Service and Ground Handling Buses

When the right main ac bus has power, it supplies power to the ground service bus. When the right main ac bus has no power, the BPCU selects primary external power or the APU generator as the power source.

Primary external power or the APU generator also supply power to the ground handling bus through the ground handling relay.

If both the APU generator and primary external power are available, primary external power has priority.

Backup Generator Power

The backup power system supplies power to one or both transfer buses during these conditions:

- Loss of all main ac power
- Single main generator operation
- Autoland
- Backup system test after engine start.

The backup generator converter controls the TBBs and CCBs. For example, if the left main ac bus has no power, the converter opens the left TBB and closes the left CCB. This permits the converter to supply power to the left transfer bus.

BITE

The GCUs and backup converter protect and monitor the ac power systems for faults. They perform three kinds of tests:

- Continuous
- Power-up/manually-initiated
- Fault-initiated.

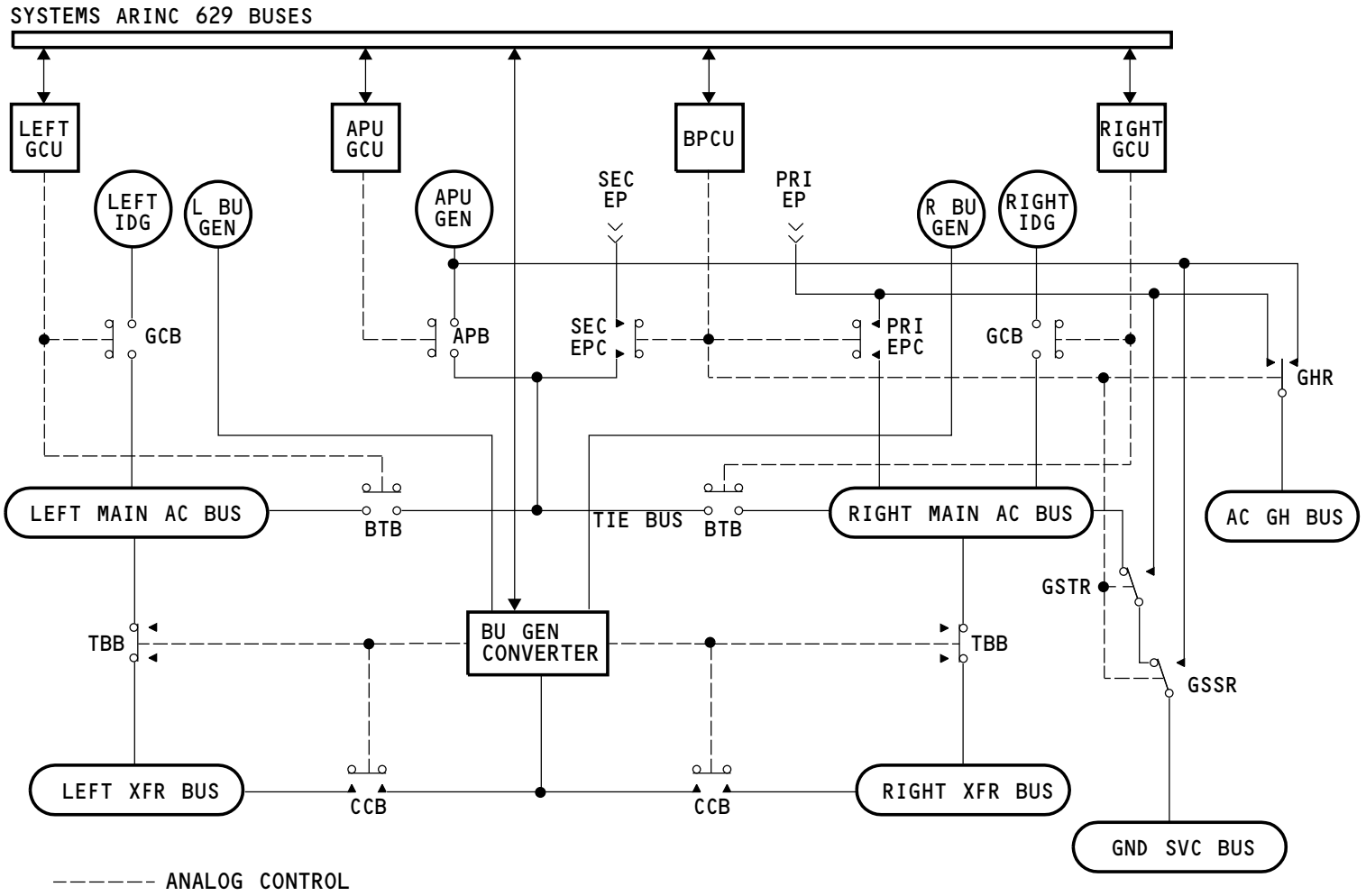
The GCUs and the converter send the test fault data to the AIMS.

Training Information Point

There is a short time delay between when the engine reaches idle and when the IDG starts to supply power. The length of the time delay depends on engine idle speed data from the engine data interface unit (EDIU).

On the ground, if the GCU gets a satisfactory engine idle speed signal from the EDIU, the IDG starts to supply power in 6 seconds. If there is not a satisfactory engine idle speed signal from the EDIU, the GCU gets a different engine speed signal from its own PMG. In this case, the IDG starts to supply power in 16 seconds.

In the air, if the GCU gets a satisfactory engine idle speed signal from the EDIU, the IDG starts to supply power in 10 seconds. If it must get an engine speed signal from the PMG, the IDG starts to supply power in 20 seconds.



M40278 S000616602_V1

AC GENERATION - FUNCTIONAL DESCRIPTION

AC GENERATION - IDG AND APU POWER CMCS GROUND TESTS

General

There are three operational tests for the main ac electrical power generation system:

- Unlatch Sustained Parallel Fault (AGCU)
- Unlatch Sustained Parallel Fault (LGCU)
- Unlatch Sustained Parallel Fault (RGCU).

There are four replacement tests for the main ac electrical power generation system:

- Auxiliary Generator Control Unit
- Bus Power Control Unit
- Left Generator Control Unit
- Right Generator Control Unit.

Unlatch Sustained Parallel Fault (AGCU)

When the APU generator control unit detects a fault in its sustained-parallel-source protection circuits, it latches a related fault message. You run this test to clear the latched fault message.

Unlatch Sustained Parallel Fault (LGCU)

When the left generator control unit detects a fault in its sustained-parallel-source protection circuits, it latches a related fault message. You run this test to clear the latched fault message.

Unlatch Sustained Parallel Fault (RGCU)

When the right generator control unit detects a fault in its sustained-parallel-source protection circuits, it latches a related fault message. You run this test to clear the latched fault message.

Auxiliary Generator Control Unit

This test makes the APU GCU do a BITE test of its internal circuits. The test is almost equivalent to the power-up test of the APU GCU.

Bus Power Control Unit

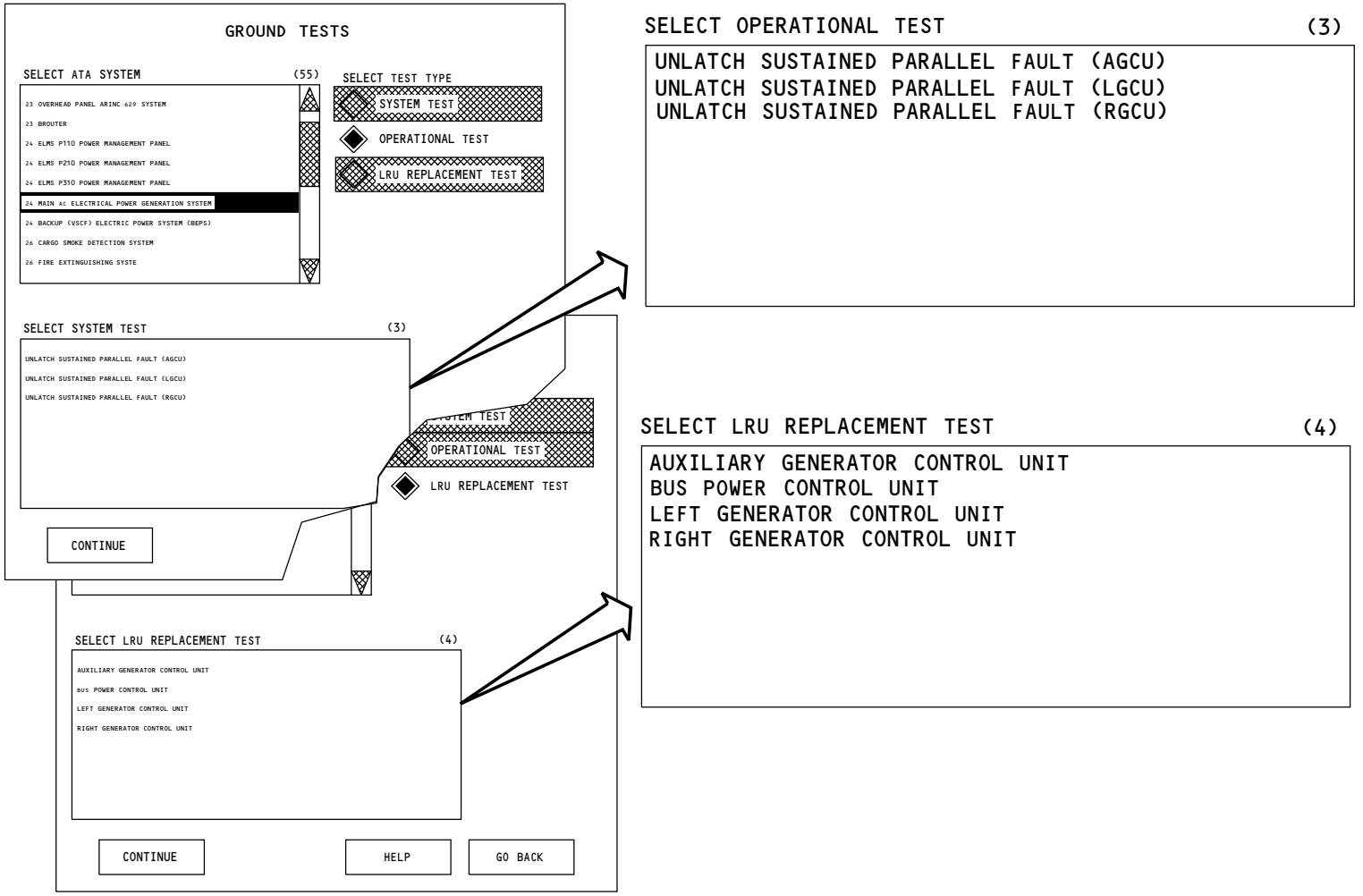
This test makes the BPCU do a BITE test of its internal circuits. The test is almost equivalent to the power-up test of the BPCU.

Left Generator Control Unit

This test makes the left GCU do a BITE test of its internal circuits. The test is almost equivalent to the power-up test of the left GCU.

Right Generator Control Unit

This test makes the right GCU do a BITE test of its internal circuits. The test is almost equivalent to the power-up test of the right GCU.



SELECT OPERATIONAL TEST (3)

UNLATCH SUSTAINED PARALLEL FAULT (AGCU)
UNLATCH SUSTAINED PARALLEL FAULT (LGCU)
UNLATCH SUSTAINED PARALLEL FAULT (RGCU)

SELECT LRU REPLACEMENT TEST (4)

AUXILIARY GENERATOR CONTROL UNIT
BUS POWER CONTROL UNIT
LEFT GENERATOR CONTROL UNIT
RIGHT GENERATOR CONTROL UNIT

M40357 S000616603_V1

AC GENERATION - IDG AND APU POWER CMCS GROUND TESTS

AC GENERATION - BACKUP POWER CMCS GROUND TESTS

General

There is one operational test for the backup electrical power system. It is the Engine Start Test.

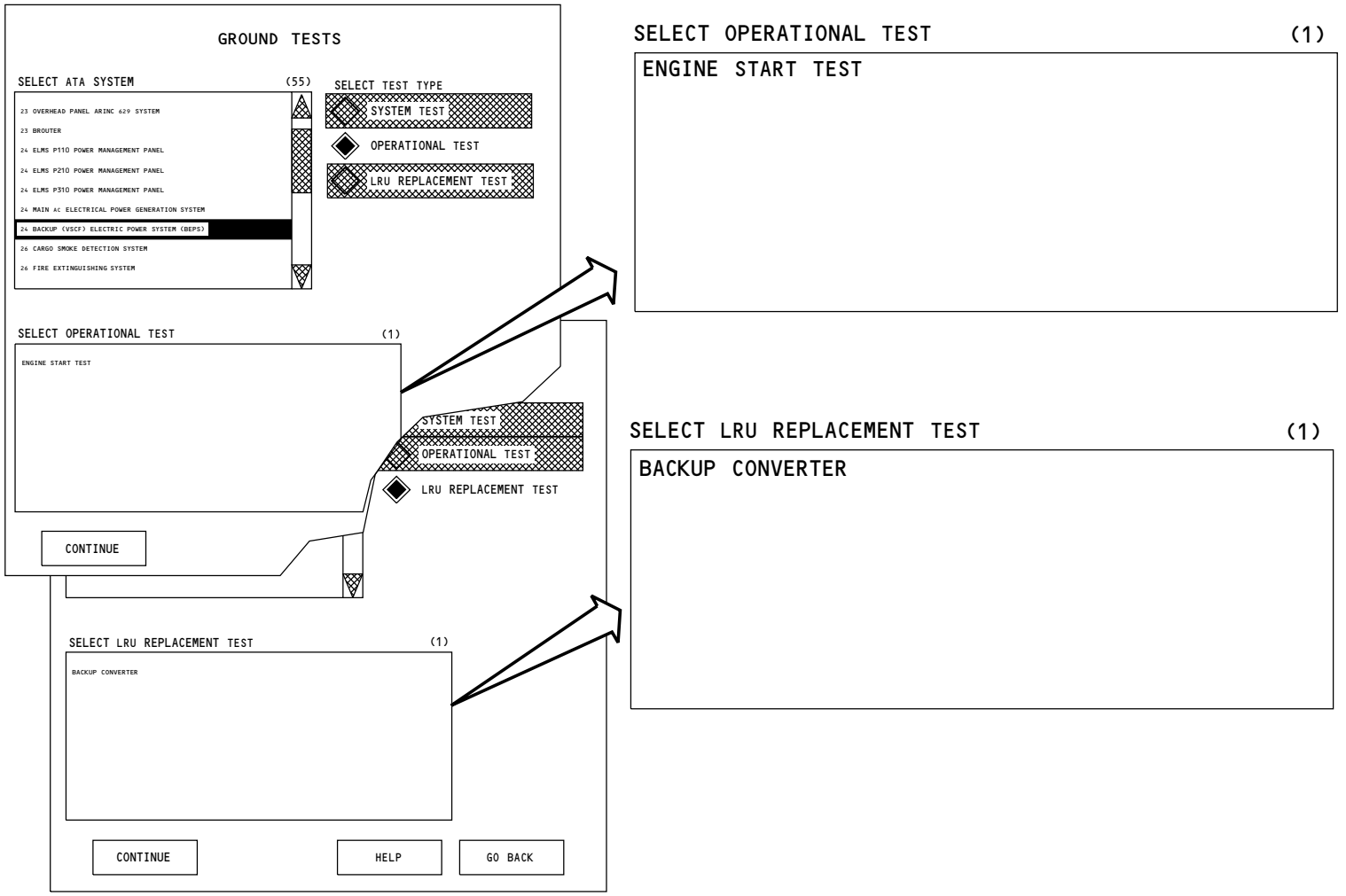
There is one LRU replacement test for the backup electrical power system. It is the Backup Converter Test.

Engine Start Test

To do this test, you must operate the engine for the backup generator you want to test. The test makes the backup converter do the engine start test that normally occurs after each engine start.

Backup Converter

This test makes the backup converter do a BITE test of its internal circuits. The test is almost equivalent to the power-up test of the backup converter.



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AC GENERATION - BACKUP POWER CMCS GROUND TESTS

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TOWING POWER - GENERAL DESCRIPTION

General

The towing power system lets you supply power to items needed to safely tow the airplane. Towing power goes to these items:

- Position lights
- Audio management unit
- Captain's audio control panel
- Captain's speaker
- Captain's panels flood lights
- Accumulator brake pressure indicator
- Accumulator brake pressure indicator back-lighting
- Brake source light
- Towing battery light.

The main battery supplies the dc power. The towing static inverter supplies the ac power.

Operation

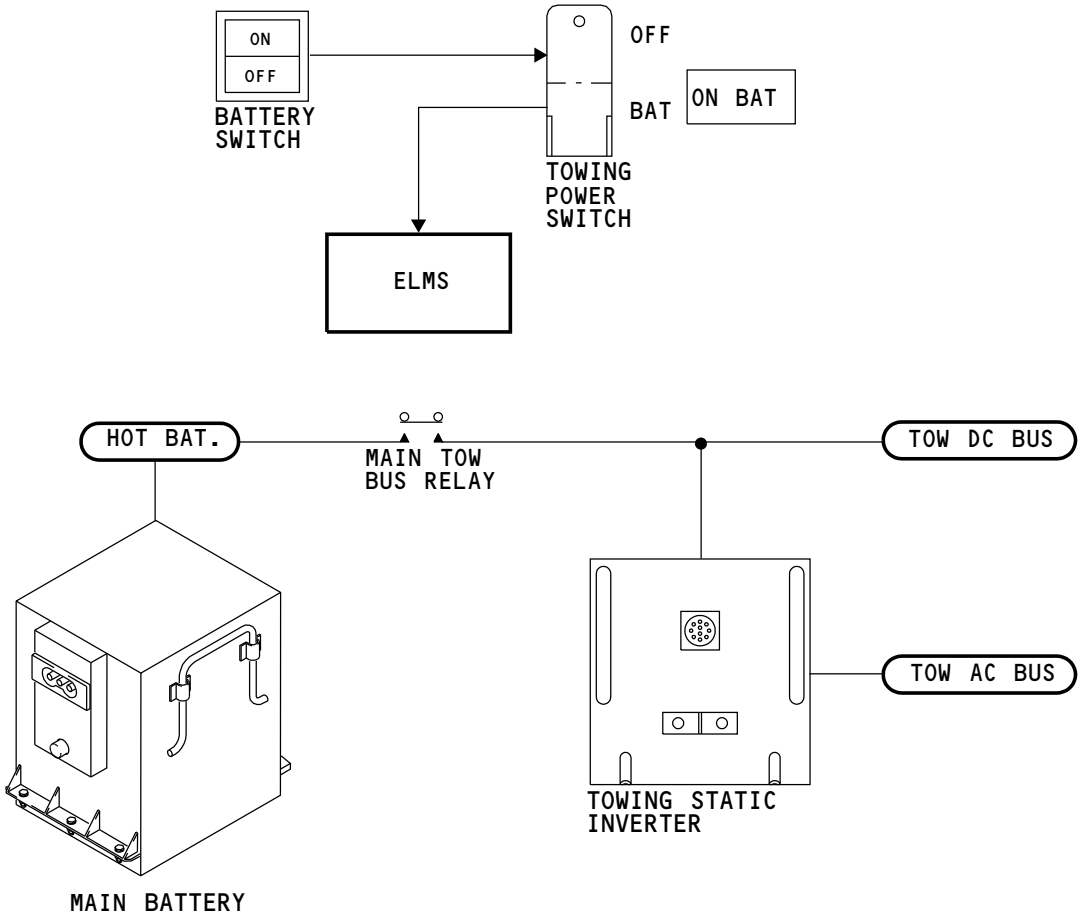
To supply towing power to the airplane, put the battery switch in the OFF position and the towing power switch in the battery (BAT) position. If there is no ground handling dc power, the main tow bus relay energizes. This supplies power to the tow dc bus and the tow ac bus through the towing static inverter.

When there is tow dc bus power, the towing power light comes on.

Training Information Point

The towing static inverter is interchangeable with the standby power static inverter.

The main battery can supply the towing bus loads for approximately 45 minutes.



M40279 S000616605_V1

TOWING POWER - GENERAL DESCRIPTION

TOWING POWER - FUNCTIONAL DESCRIPTION

General

The towing power system uses the main battery (hot battery bus) as its power source. The battery supplies dc power to the tow dc bus. The towing static inverter supplies ac power to the tow ac bus.

Static Inverter

The static inverter gets 28v dc power from the hot battery bus. The static inverter has a converter that increases the dc voltage, and an inverter that changes the dc power into single phase, 115v ac power.

Control

The towing power system operates when all of these conditions are true:

- Battery switch is off
- Towing power switch is on
- There is no ground handling dc power.

These conditions cause the main tow bus relay to energize. The hot battery bus then supplies dc power to the tow dc bus and the towing static inverter. When the main tow bus relay energizes, it also causes the two towing relays to energize. These relays switch the necessary loads to towing power.

Loads

Each load that connects to a tow bus has its own circuit breaker. These are the tow ac bus loads:

- Right position lights
- Left position lights
- Captain's panels flood lights
- Accumulator brake pressure indicator back-lighting.

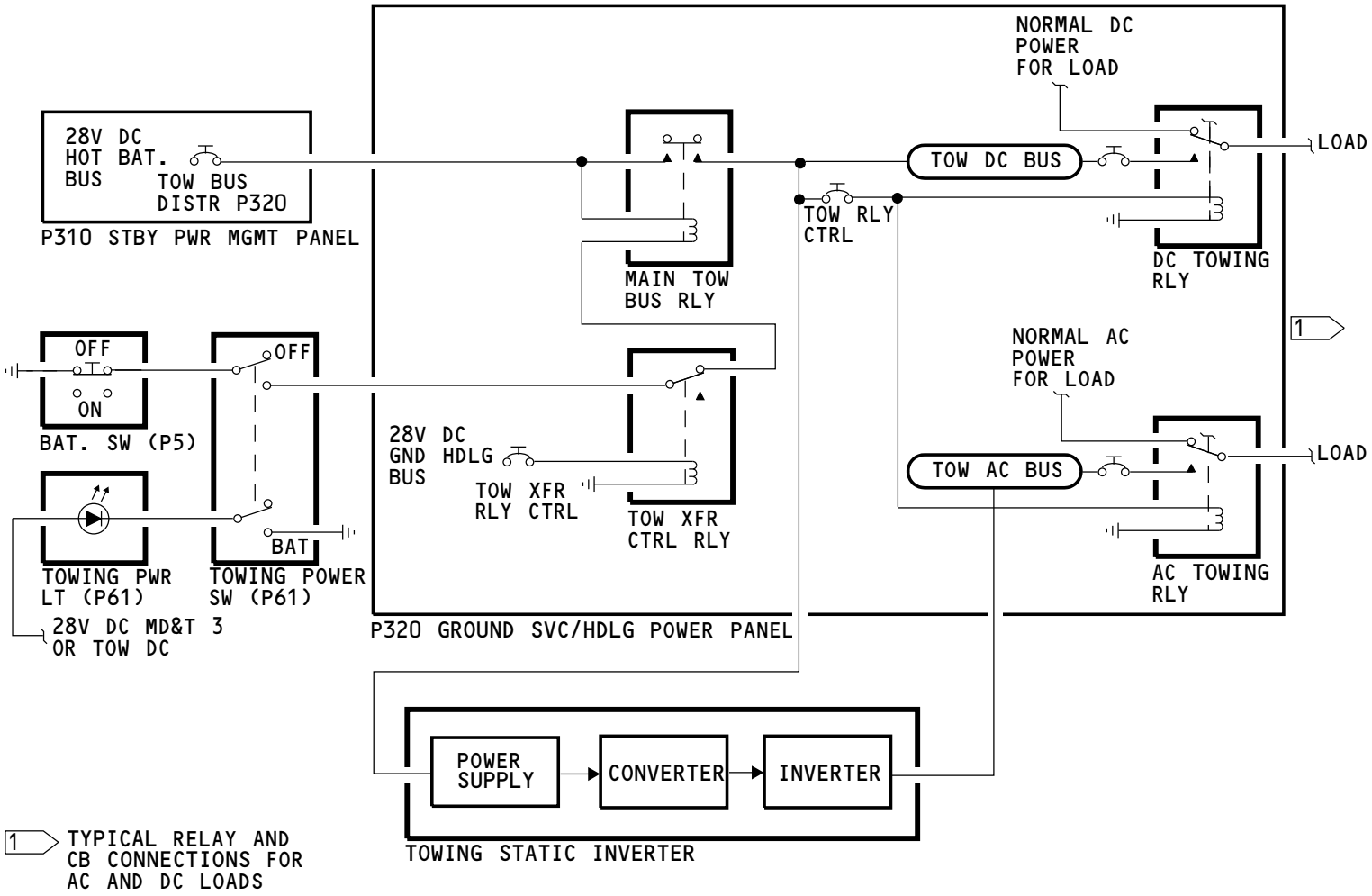
These are the tow dc bus loads:

- Audio management unit (captain's card)
- Audio management unit (connector board)
- Captain's audio control panel
- Captain's speaker
- Accumulator brake pressure indicator
- Brake source light
- Towing power light.

See the communications chapter for more information about the communications components (CHAPTER 23).

See the landing gear chapter for more information about the accumulator brake pressure indicator (CHAPTER 32).

See the lights chapter for more information about the lights (CHAPTER 33).



M40280 S000616606_V1

TOWING POWER - FUNCTIONAL DESCRIPTION

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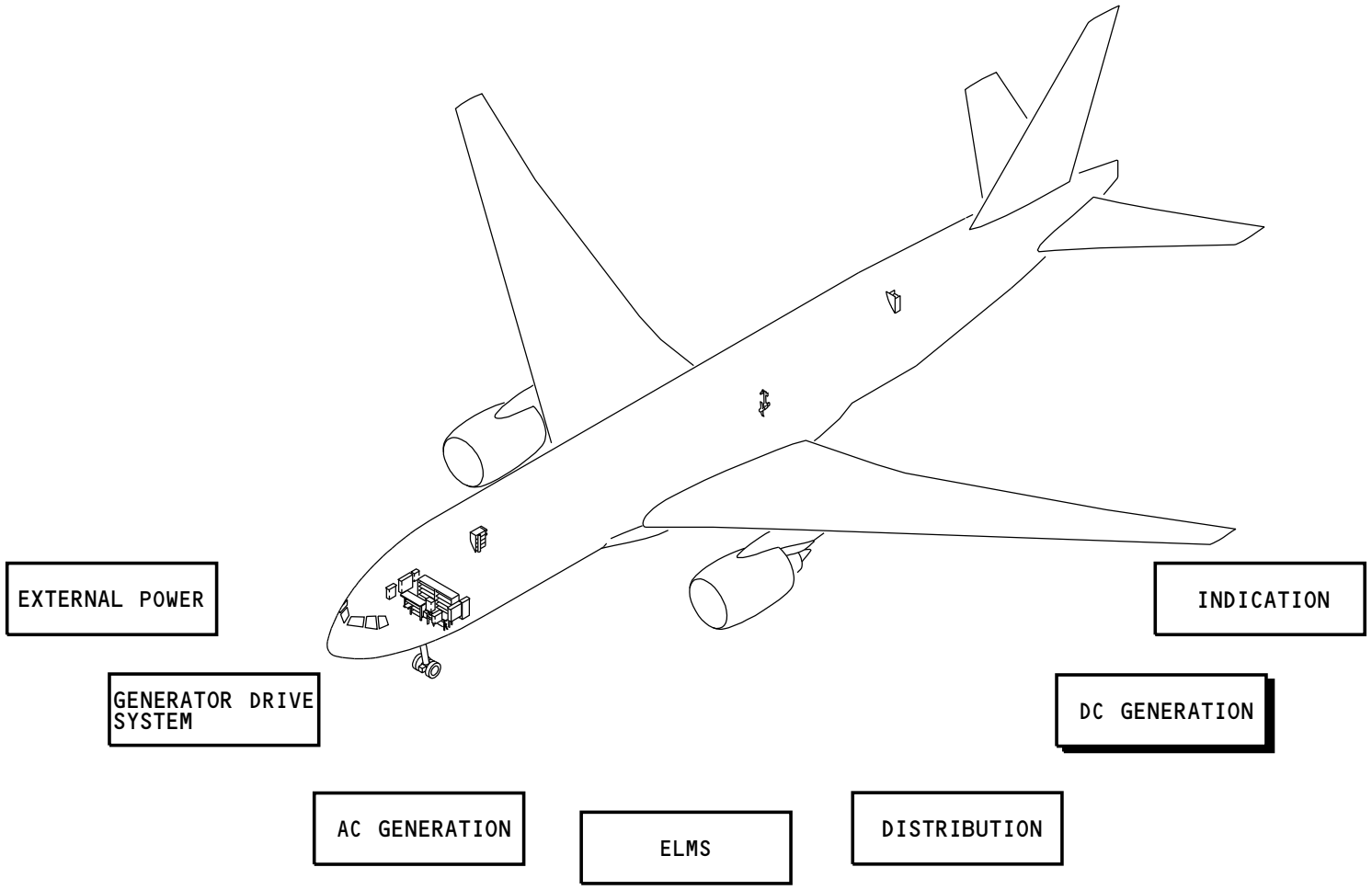
DC GENERATION - INTRODUCTION

General

The dc generation system changes ac power from the generators into dc power. It supplies power for dc loads and to charge the batteries. The batteries are an alternative power source for some loads when the generators do not operate.



M40281 S000616607_V1

DC GENERATION - INTRODUCTION

DC GENERATION - SUBSYSTEMS INTRODUCTION

General

The dc power system has these subsystems:

- Transformer rectifier units (TRUs)
- Batteries
- Standby power
- Towing power
- Flight controls dc (FCDC) power.

Transformer Rectifier Units (TRUs)

TRUs change ac power to dc power. There are four TRUs in the dc power system:

- Left
- Center 1 (C1)
- Center 2 (C2)
- Right.

Batteries

Batteries supply dc power to loads that require power when no ac power source is available.

Standby Power

Standby power supplies ac power and dc power to important systems when all normal ac power is lost. The RAT generator and the main battery are the sources of standby power.

TRUs change the RAT ac power to dc power. The static inverter changes dc power to ac power.

Towing Power

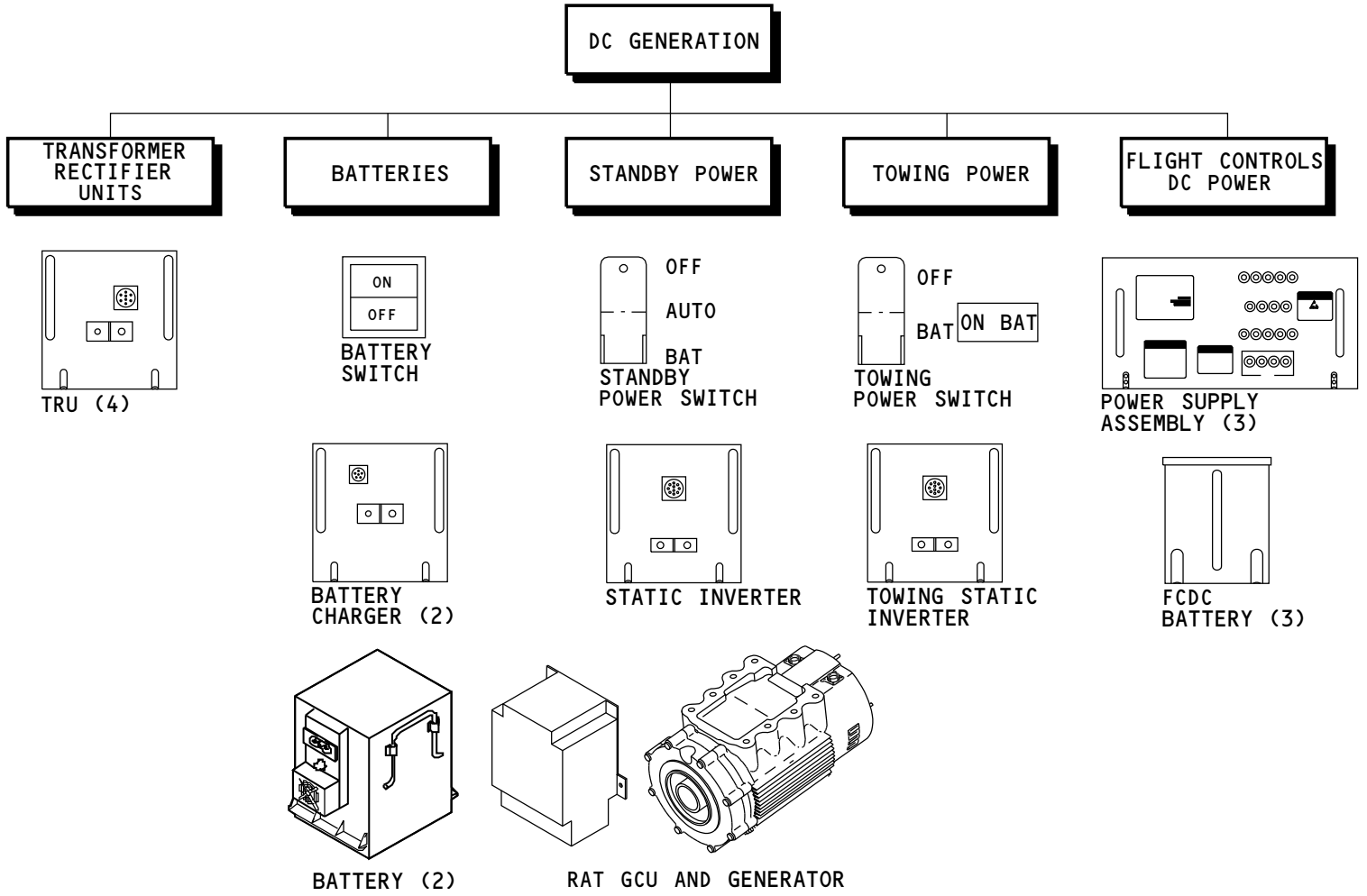
Towing power supplies ac power and dc power to components that are necessary to safely tow the airplane. The main battery is the source of towing power. A static inverter changes dc power to ac power.

Flight Controls DC (FCDC) Power

Power supply assemblies (PSAs) supply power to the flight controls system. The related FCDC battery protects the PSA from power interruptions during power transfers.

Training Information Point

The external power system also has a TRU. The ground handling TRU supplies power to the ground handling bus. See the external power system section for more information (SECTION 24-40).



M40284 S000616610_V1

DC GENERATION - SUBSYSTEMS INTRODUCTION

E3 Rack

These components are in the E3-2 shelf of the MEC:

- TRU C2
- TRU C1
- Main battery charger
- Towing static inverter
- Static inverter.

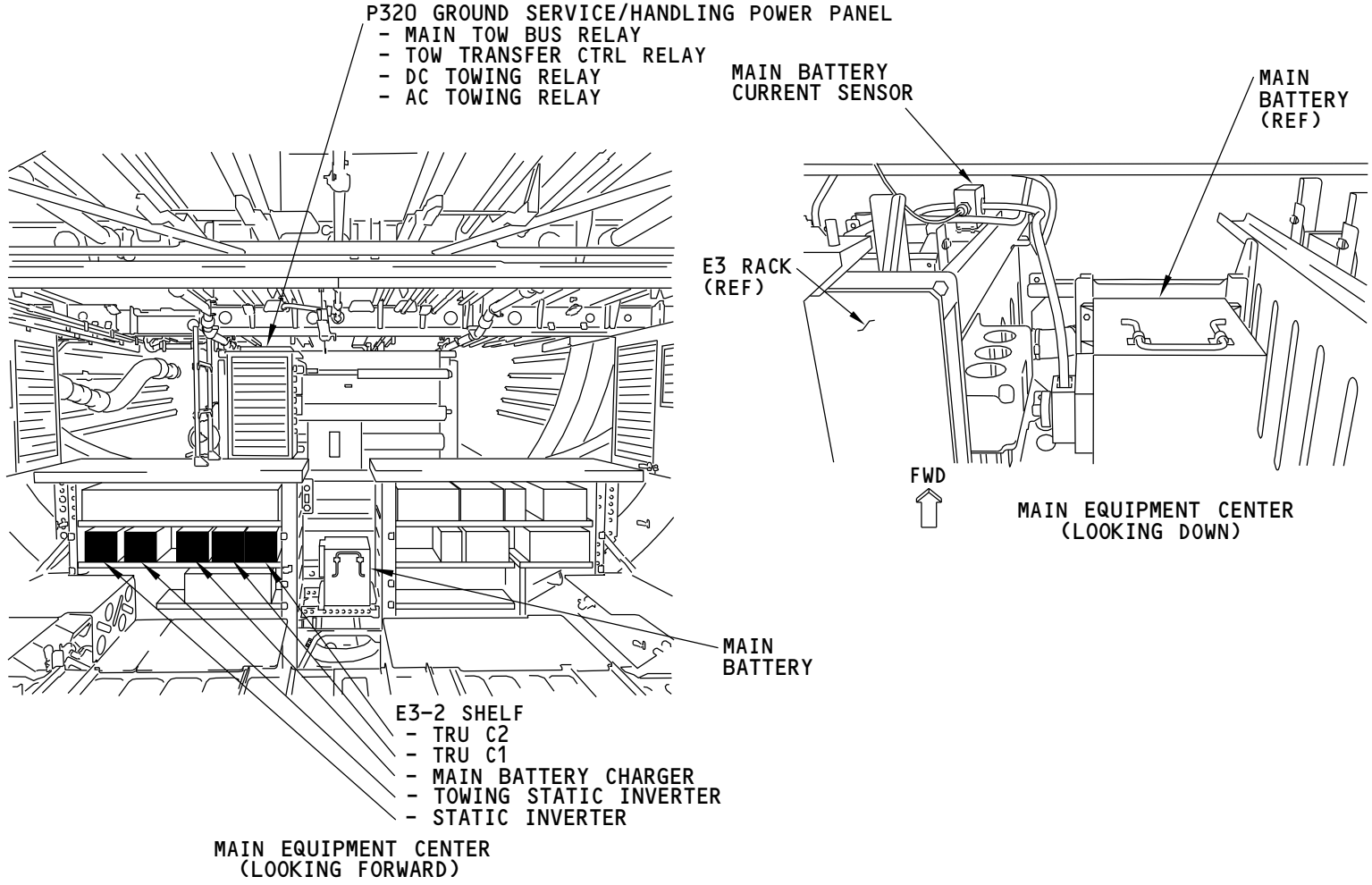
Ground Service/Handling Power Panel

These relays are in the P320 ground service/handling power panel:

- Main tow bus relay
- Tow transfer control relay
- DC towing relay
- AC towing relay.

Main Battery Equipment

The main battery is on the floor between the E3 and the E4 racks. The main battery current sensor is forward of the right side of the E3 rack.



M40286 S000616612_V1

DC GENERATION - COMPONENT LOCATIONS - FORWARD MEC

Right Power Management Panel

The DC tie relay is in the P210 power management panel.

E2 Rack

The right TRU is on the E2-2 shelf. The center FCDC battery is on the E2-5 shelf. The center PSA is on the E2-6 shelf.

E1 Rack

The left TRU is on the E1-1 shelf. The left FCDC battery and the left PSA are on the E1-6 shelf.

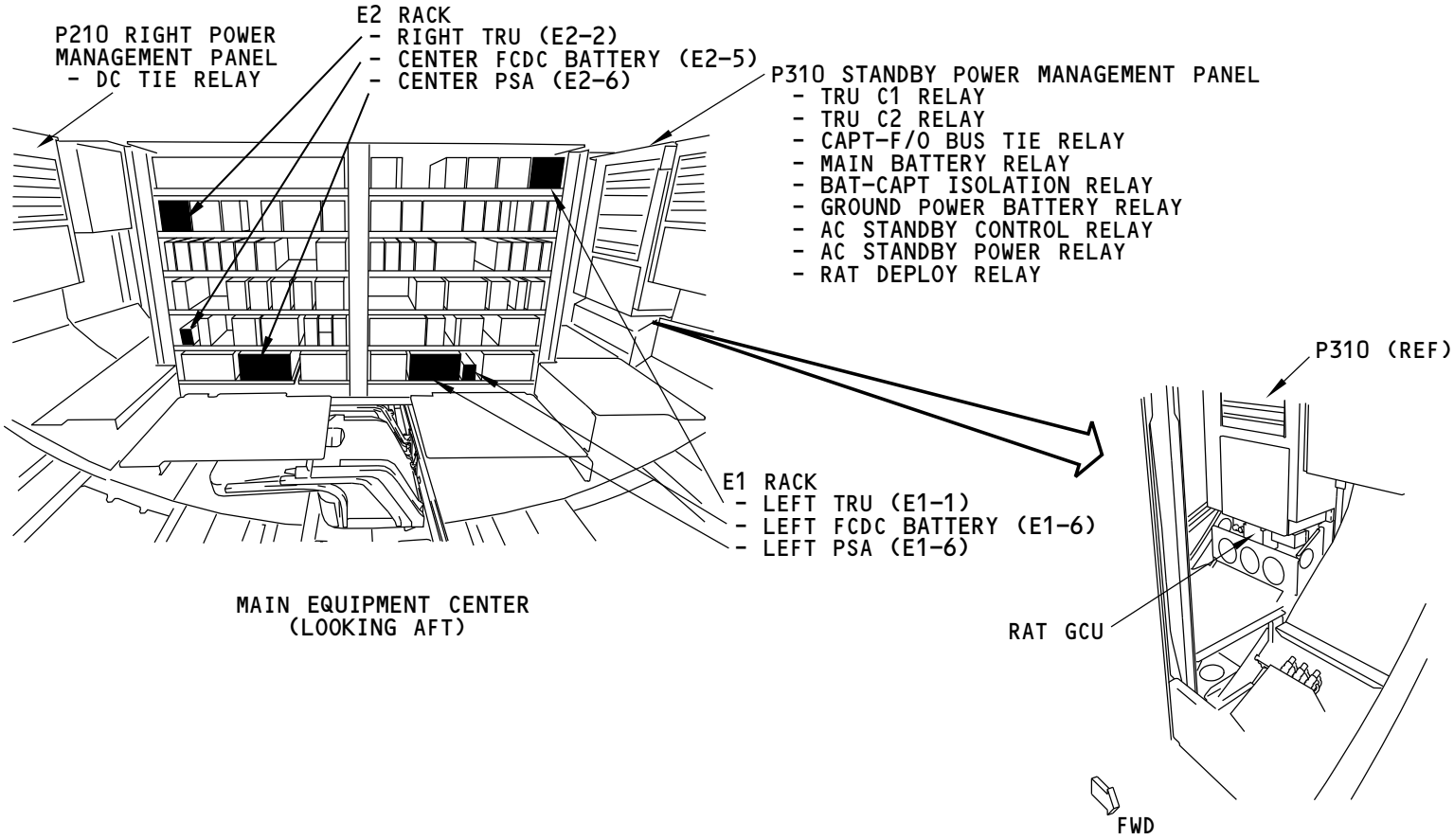
Standby Power Management Panel

These relays are in the P310 standby power management panel:

- TRU C1 relay
- TRU C2 relay
- Capt-F/O bus tie relay
- Main battery relay
- Bat-capt isolation relay
- Ground power relay
- AC standby control relay
- AC standby power relay
- RAT deploy relay.

RAT GCU

The RAT GCU is below the P310 standby power management panel.



M40288 S000616614_V1

DC GENERATION - COMPONENT LOCATIONS - AFT MEC

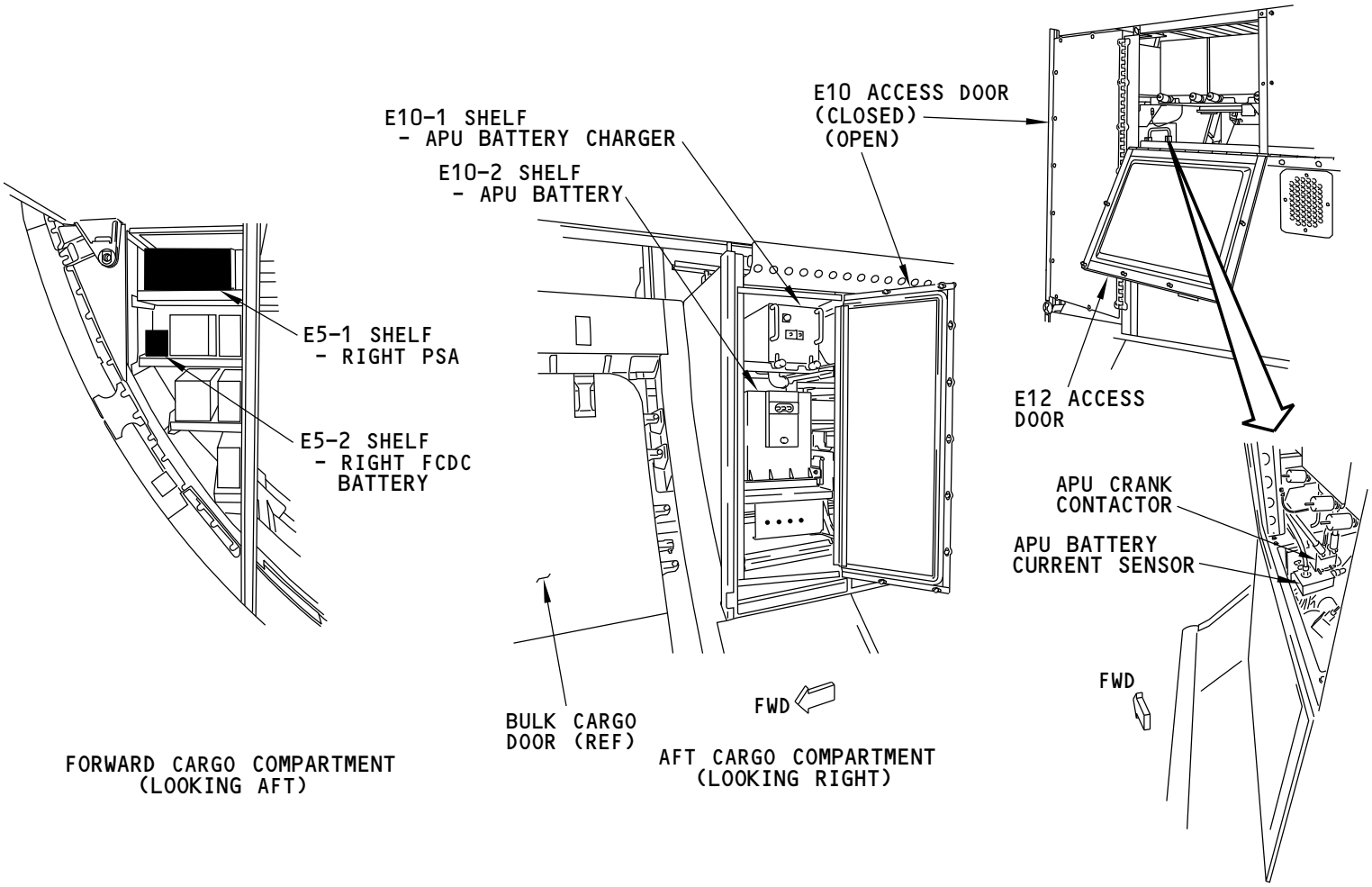
E5 RACK

The right PSA is on the E5-1 shelf. The right FCDC battery is on the E5-2 shelf.

E10 RACK

The APU battery charger is on the E10-1 shelf. The APU battery is on the E10-2 shelf.

The APU crank contactor and the APU battery current sensor attach to the aft side of the E10-2 shelf. But, you gain access to these components through the E12 access door.



M40289 S000616615_V1

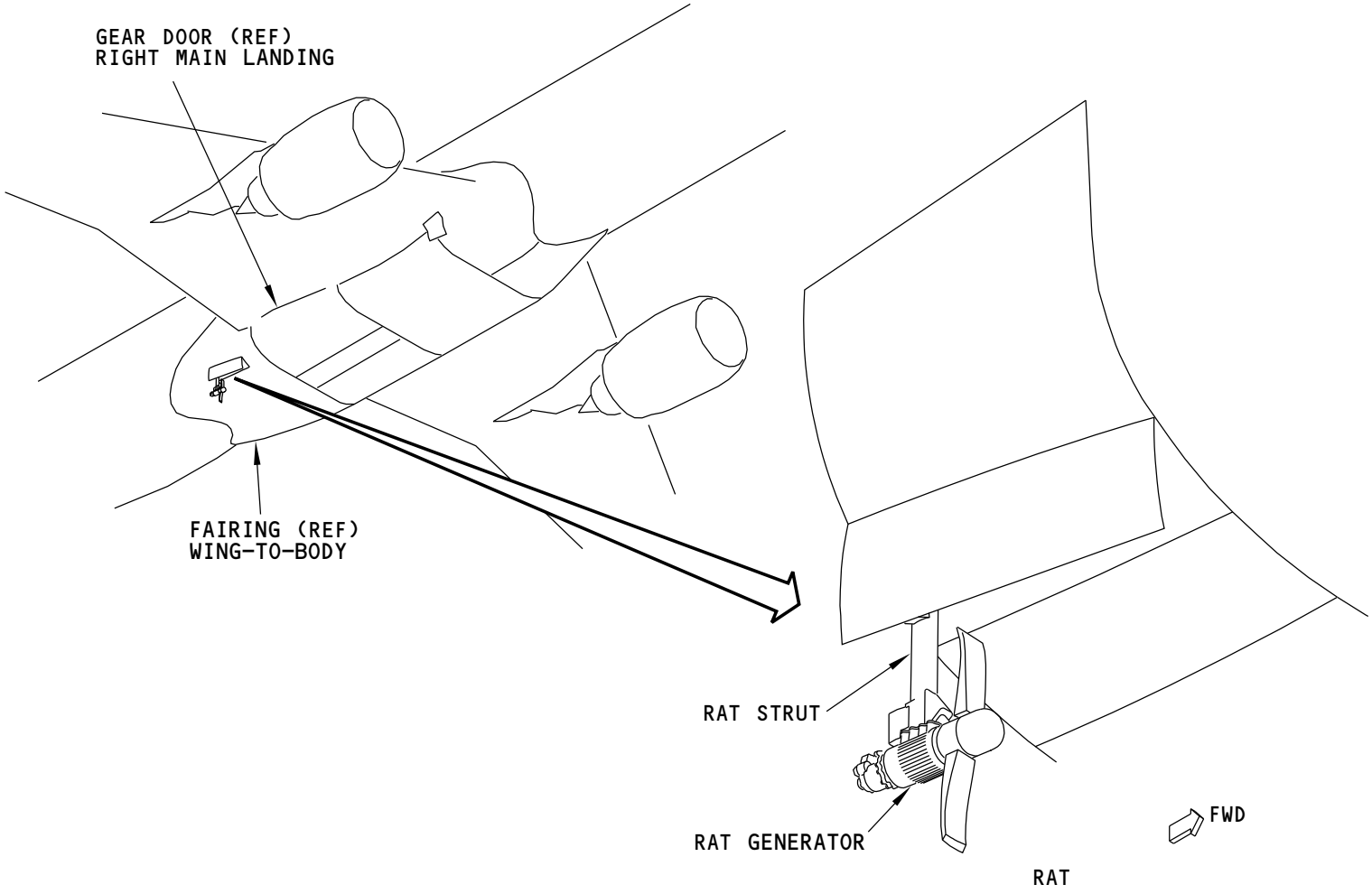
DC GENERATION - COMPONENT LOCATIONS - CARGO COMPARTMENT RACKS

DC GENERATION - COMPONENT LOCATIONS - RAT

Component Locations

The RAT is in the wing-to-body fairing aft of the right main landing gear door. The RAT generator attaches to the RAT strut.

See the ac generation section for more information about the RAT (SECTION 24-20).



M40290 S000616616_V1

DC GENERATION - COMPONENT LOCATIONS - RAT

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DC GENERATION - FUNCTIONAL DESCRIPTION

Normal Power

The dc generation system normally receives power from these ac power sources:

- Left transfer bus
- Right transfer bus
- Ground service bus
- Backup generator PMGs.

Four TRUs change the ac power from the transfer buses to dc power. Most of the dc loads on the airplane use this power.

The standby ac bus uses power directly from the left transfer bus.

Two battery chargers change the ac power from the ground service bus to dc power. This dc power charges the main and APU batteries. It also supplies power to the hot battery bus loads.

Three PSAs change the ac power from the backup generator PMGs to dc power. Flight control components use this dc power.

Standby Power

When all ac power is lost, the main battery supplies power to the standby loads of the dc generation system until the RAT deploys (except those on the first officer's flight instrument bus). The standby loads are on these buses:

- Hot battery
- Battery
- Battery No. 2
- Captain's flight instrument
- First officer's flight instrument
- Standby ac.

After the RAT deploys, its generator supplies all of the power for the standby loads through the two center TRUs.

Control

The ELMS controls all the dc power system relays. (The RAT GCU can also control the TRU C1 relay.) The battery switch and the standby power switch supply manual control inputs to the ELMS.

The ELMS decreases the effect of faults in the dc generation system by normally keeping dc buses isolated. But, if there is a power loss to a dc bus, the ELMS can supply power to that bus from another dc bus. It does this by connecting the two buses. The ELMS uses these relays to connect dc buses:

- DC bus tie
- Main battery
- Battery-captain's isolation
- Captain's-first officer's bus tie
- Ground power battery.

Fault Isolation - DC/Standby Self-Check

The dc subsystem card does a check of the dc system. This is called a dc/standby self-check. It does these tests:

- Makes sure all dc/standby system relays operate correctly
- Makes sure the ac standby bus has power (this does a check of the static inverter).

A dc/standby self-check can start either manually or automatically. You manually start the self-check when you set these conditions:

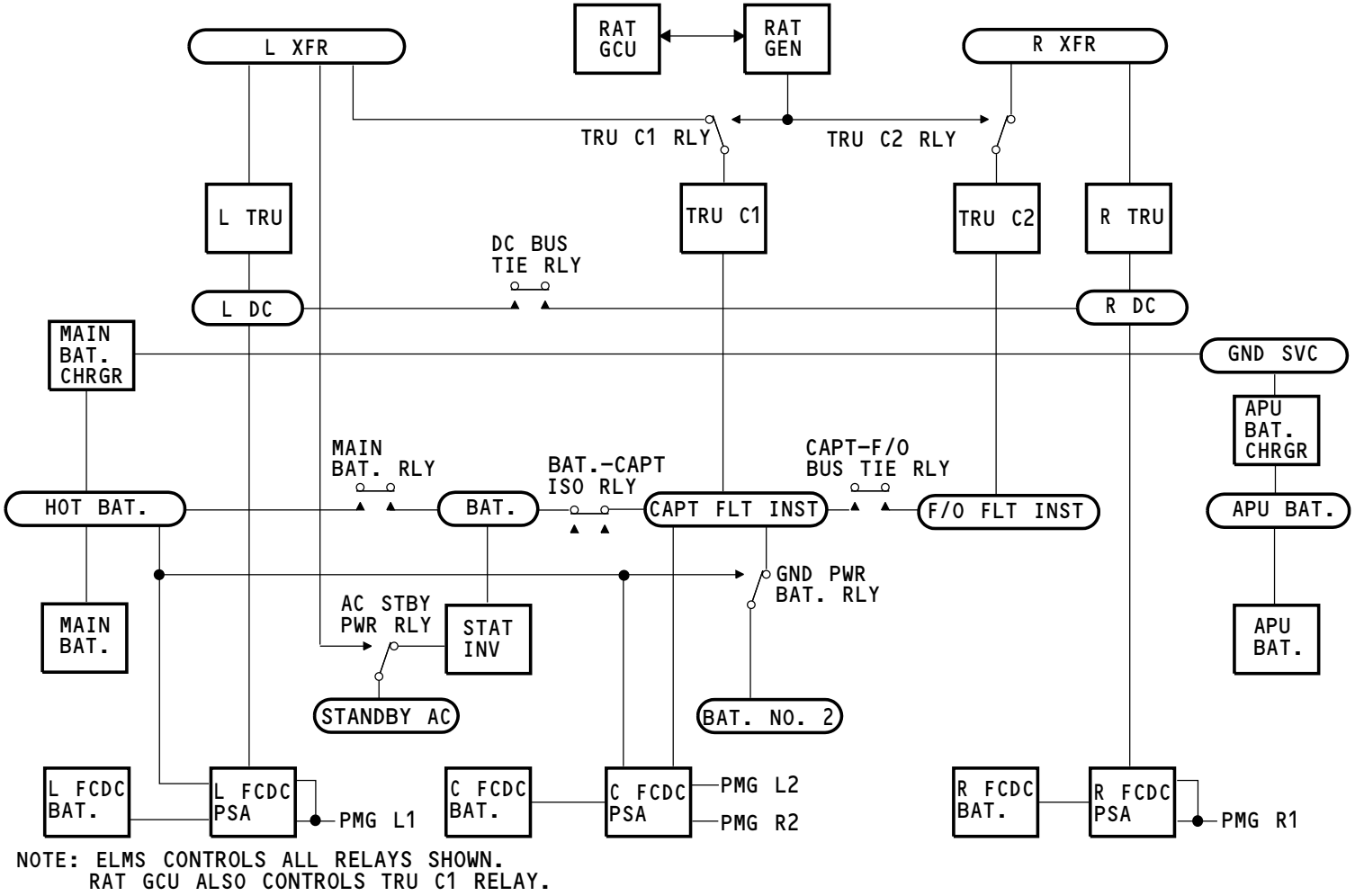
- The airplane is on the ground
- Left and right ac transfer buses have power
- The battery switch is in the ON position
- The standby power switch is in the BAT position (momentary).

The self-check starts automatically when these conditions occur:

- There are more than 72 hours since the last dc system test occurred

- The airplane is on the ground
- Left and right ac transfer buses have power.

The test takes less than ten seconds. If the system passes the test, no message shows on the EICAS display. If the system fails the test, the advisory message ELEC STANDBY SYS shows.



M40291 S000616617_V1

DC GENERATION - FUNCTIONAL DESCRIPTION

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BATTERIES - GENERAL DESCRIPTION

General

There are two equivalent sets of battery equipment for main battery power and APU battery power. Each set has these components:

- Battery
- Battery charger
- Current sensor.

The main battery components supply dc power to important equipment when other power sources are not available.

The APU battery components supply power to start the APU.

The battery switch on the electrical panel supplies a control signal to ELMS. This lets you supply main battery power to the battery bus 2 when the airplane is on the ground and has no ac power.

Batteries

The main battery supplies power to these buses:

- Hot battery bus
- Battery bus
- Captain flight instrument bus
- Battery bus 2.

These relays select the buses to get power from the main battery:

- Main battery relay
- Battery-captain bus isolation relay
- Ground power battery relay.

The APU battery supplies power directly to the APU battery bus. The APU battery bus supplies power to the APU electric starter through the APU crank contactor. The ELMS energizes the APU crank contactor when the APU controller starts the APU.

The APU battery bus is also an alternate power source for the APU controller and the RAT deploy relay.

Battery Chargers

The battery chargers do these functions:

- Change the ac power to dc power for the related dc buses
- Charge the batteries
- Send fault signals to the ELMS.

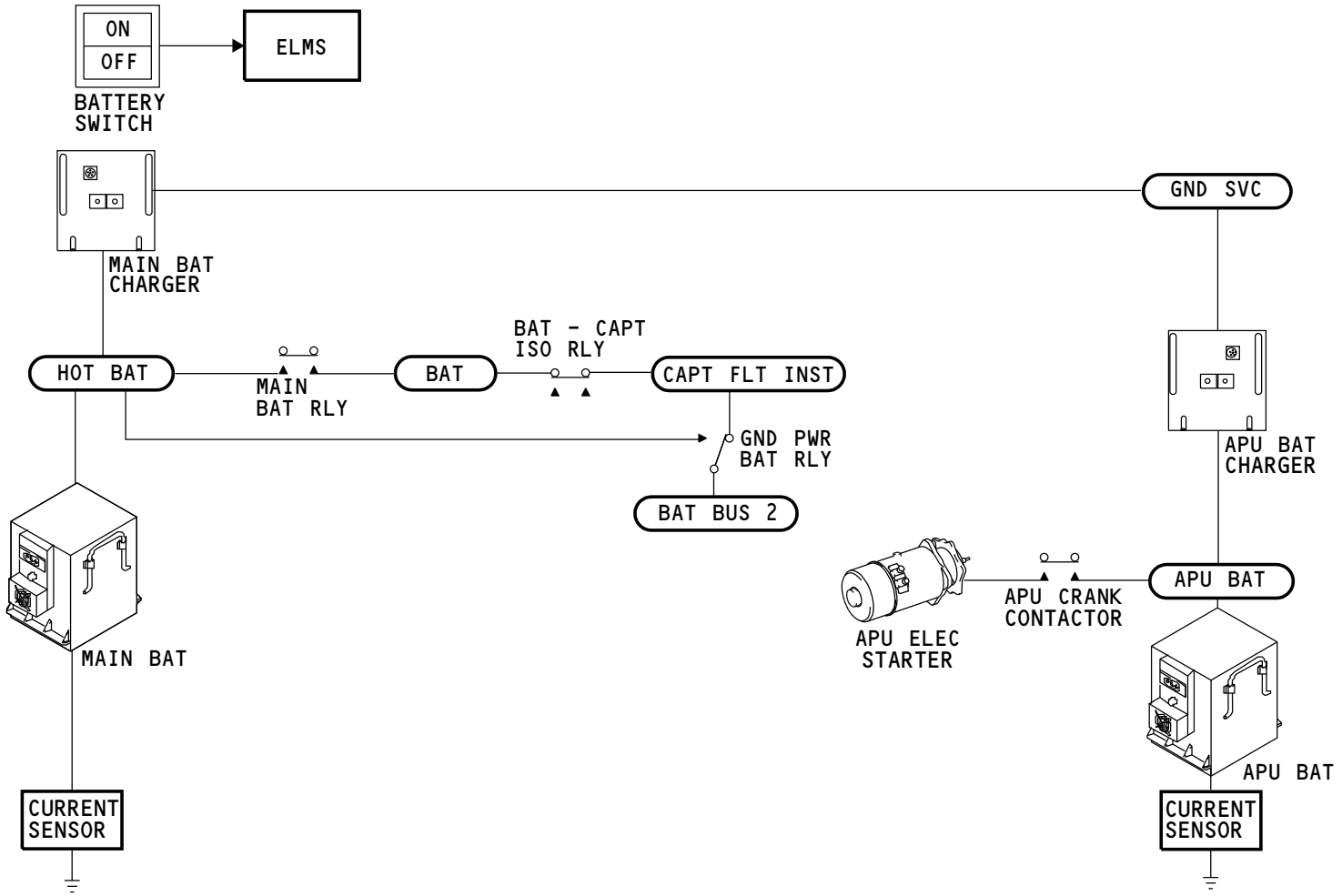
The ground service bus supplies 115v ac power to the main battery charger and the APU battery charger. The main battery charger charges the main battery through the hot battery bus. The APU battery charger charges the APU battery through the APU battery bus.

Current Sensors

Current sensors measure the current through the related battery. The ELMS uses the current sensor output to calculate these data:

- Amount of current
- Direction of current (charge or discharge).

The battery current data shows on page 1 of the MFD electrical maintenance page.



M40293 S000616619_V1

BATTERIES - GENERAL DESCRIPTION

BATTERIES - MAIN AND APU BATTERIES

Purpose

When ac power is not available, the main battery does these functions:

- Supplies power to dc loads that are necessary for ground operation
- Supplies power to all the components that deploy the RAT
- Supplies standby system power until the RAT generator starts to supply power.

The main battery can power the standby system for a minimum of ten minutes.

The APU battery supplies electrical power to start the APU.

Physical Description

The main battery and the APU batteries are rechargeable. They are fiber nickel-cadmium (FNC) batteries. Each battery weighs 106 lb (48 kg).

Each battery has two sets of ten FNC cells. The battery case is green. The case has two mounting flanges and two lifting handles. Bolts attach the mounting flanges to the airplane. The lifting handles help you connect ground support equipment (GSE) to the battery when you move it.

The battery has a terminal block and an electrical connector. The terminal block connects the high power output. The electrical connector connects control and status signals.

The battery has both ambient and battery temperature sensors, and an overheat switch (not shown). The battery cooling fan comes on when the battery gets hot.

Training Information Point

WARNING BE CAREFUL WHEN YOU MOVE THE BATTERY. BECAUSE THE BATTERY WEIGHS 106 POUNDS (48 KG), INJURY TO PERSONS CAN OCCUR.

Use ground support equipment to lift the main battery. You install a rack and pulley between the floor beams above the battery to help you lift it.

The APU battery attaches to a tray that you can pull out to easily remove and install the battery. When you push the tray in, there are two captive screws you must tighten to prevent tray movement.

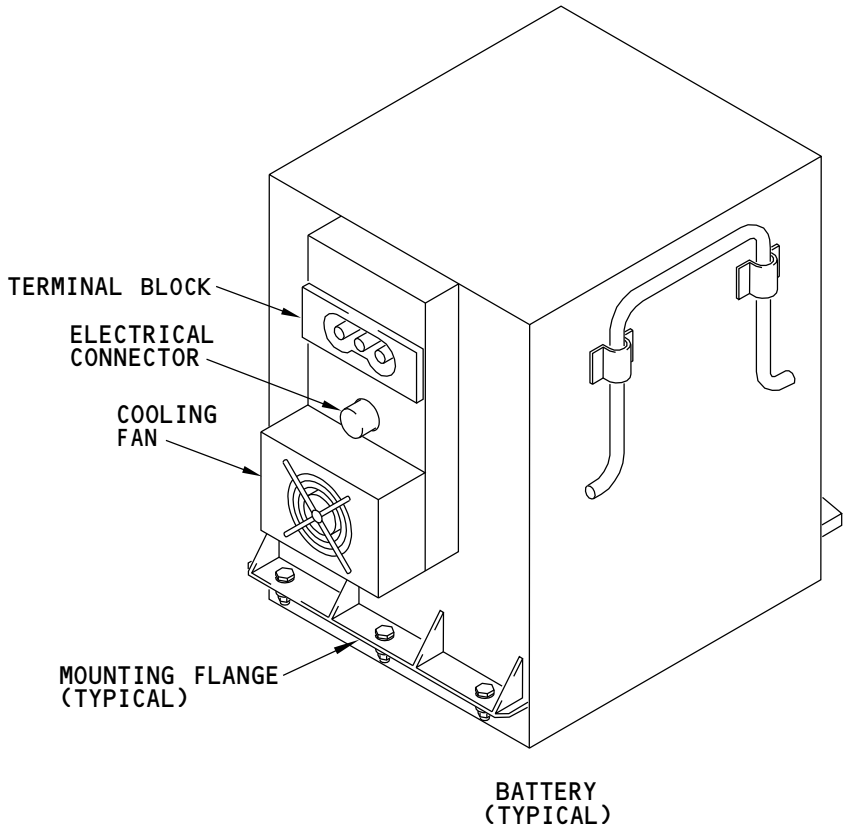
CAUTION DO NOT CHARGE THIS BATTERY WITH BATTERY CHARGERS WHICH ARE NOT APPROVED FOR THIS TYPE OF FNC BATTERY. OVER-CHARGING CAN OCCUR AND SERIOUSLY DAMAGE OR DESTROY BATTERY CELLS.

The capacity of each battery is 47 amp-hours. The main battery can supply the hot battery bus loads for 10 days.

The main battery and the APU battery are interchangeable.

No maintenance is necessary for FNC batteries.

When no other power is on the airplane, the hot battery bus supplies power to the static random access memory (SRAM) of the AIMS. If you disconnect the main battery with no power to the AIMS cabinets, you lose some data. See the AIMS section for more information (SECTION 31-41).



BATTERY (TYPICAL)

M40294 S000616620_V1

BATTERIES - MAIN AND APU BATTERIES

BATTERIES - MAIN AND APU BATTERY CHARGERS

Purpose

The battery chargers change ac power to dc power for the related dc buses. The battery chargers keep the related batteries charged.

Physical Description

The battery chargers are ARINC 600-style LRUs. Each battery charger has these components on the front cover:

- Terminal block
- Electrical connector
- Handles.

The terminal block connects the high power output. The electrical connector connects ac power, control signals, and status signals to the battery charger.

Functional Description

The input power to each battery charger is 3-phase, 115v ac, 400 Hz. power.

The battery charger has four modes of operation. Three of these are charge modes; the other is transformer-rectifier (TR) mode.

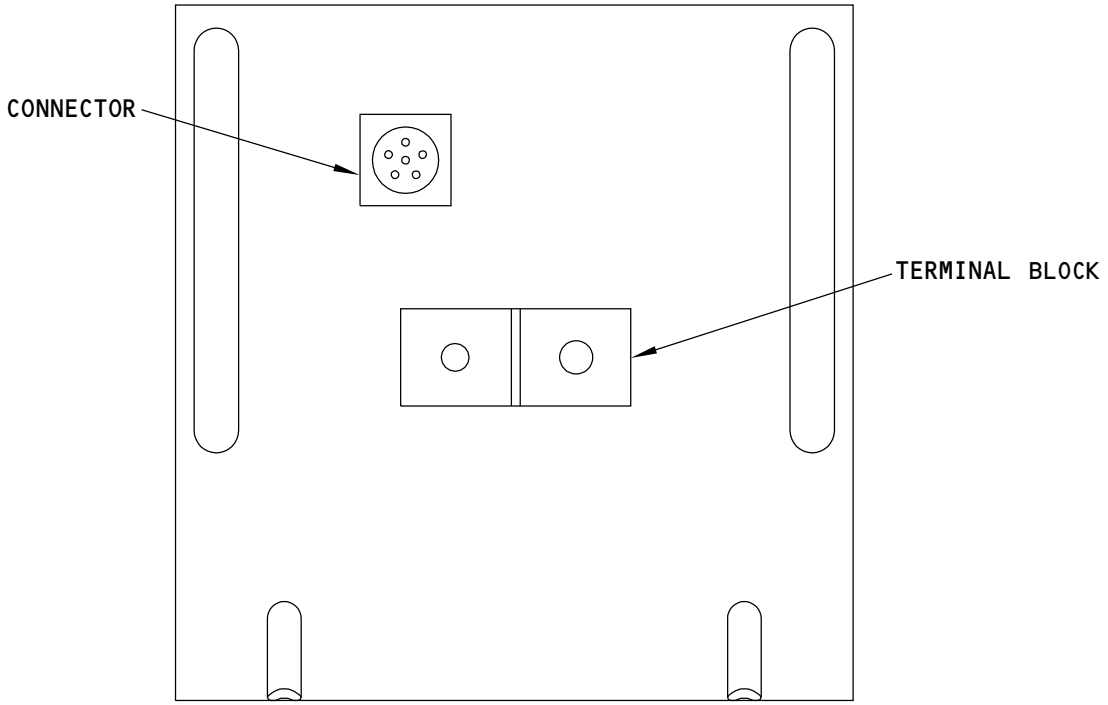
In the TR mode, the battery charger supplies dc power up to 65 amps. The voltage of this power is very tightly regulated.

Training Information Point

The main battery charger and the APU battery charger are interchangeable.

CAUTION

DO NOT TOUCH THE BATTERY CHARGER BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE BATTERY CHARGER.



BATTERY CHARGER

M40296 S000616622_V1

BATTERIES - MAIN AND APU BATTERY CHARGERS

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BATTERIES - FUNCTIONAL DESCRIPTION

General

The battery charger supplies power to dc buses and keeps the battery charged. It operates in these four modes:

- Main
- Topping
- Float
- TR.

Main Mode

The battery charger starts main mode operation when one of these conditions occurs:

- Power turns on the battery charger
- Battery has low voltage during float mode
- Battery charger stops TR mode operation.

The main mode is the fastest charge mode. It has an initial 65 amps maximum output. The battery charger uses the increase in battery temperature to find that the battery is almost fully charged. This can take from a few minutes to an hour depending on battery charge and temperature. The temperature sensor in the battery gives the temperature data to the battery charger. The charger stops the main mode when the battery temperature increases 7F (4C). The maximum voltage in this mode is limited to 31v dc.

Topping Mode

The battery charger automatically starts the topping mode at the end of main mode. The topping mode supplies less current than the main mode. The battery charger uses the topping mode to make sure that the battery is fully charged. The battery charger operates in the topping mode for 11 minutes.

Float Mode

The battery charger automatically starts the float mode at the end of the topping mode. The battery charger stays in the float mode when the battery is fully charged. It can supply 65 amperes to the dc bus while it is in float mode.

TR Mode

In the TR mode, the battery charger operates as a TRU and can supply up to 65 amperes to the dc bus. The output voltage of the TR mode is more closely regulated than the output voltage of the float mode.

For a fully charged battery in the TR mode, the battery current on the Electrical System Maintenance Page or Electrical Synoptic Page could show 0 +/-3 amps (either CHARGE or DISCHARGE).

The battery charger goes into the TR mode when there is a hot battery condition or when it receives a TR mode signal from the ELMS. The TR mode overrides all other modes. The hot battery condition occurs when the battery is 145F (63C) or hotter. The ELMS supplies the TR mode signal when any of these conditions occur:

- Main battery relay energizes
- Ground power battery relay energizes
- Autoland system sends an isolation request.

There is no ELMS TR mode signal for the APU battery charger.

Fault Protection

The battery charger monitors the battery for these conditions:

- Overheat switch closed (160F (70C))
- Colder than -40F (-40C)
- Cell imbalance
- Temperature sensor failure.

The cell imbalance condition occurs when the voltage of the first 10 battery cells is different from one half of the battery voltage. The battery charger monitors the voltage comparator in the battery to find this condition.

If the battery charger finds a fault, it turns off and sends a fault signal to the ELMS.

The battery overheat switch also sends a signal to the ELMS to show an EICAS message.

Current Indication

The current sensor sends current data to the SIU in the P310 panel.

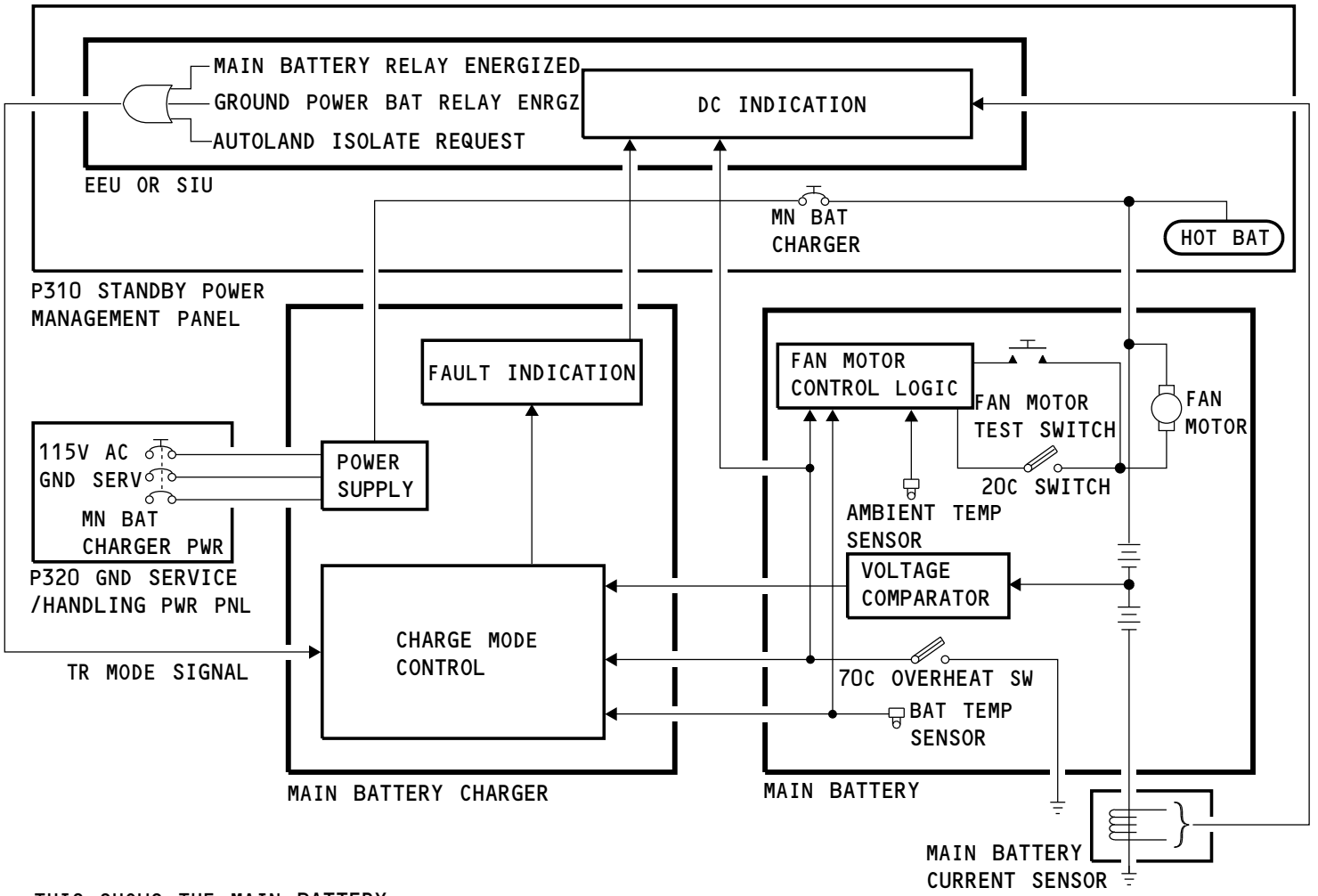
Battery Cooling Fan

The battery cooling fan moves air through the battery case. The cooling fan motor comes on when all these conditions occur:

- Battery temperature at least five degrees higher than the ambient temperature
- Ambient temperature between -40C and 70C
- Battery voltage normal, or battery voltage greater than 12 volts and the overheat switch is closed.
- 20C switch is closed.

The cooling fan case has a press to test switch on it. The fan comes on if you push the switch.

NOTE: Fan operation times of several hours (even with airplane power removed) are possible under certain normal conditions. Extended fan operation does not show a problem with the battery.



NOTE: THIS SHOWS THE MAIN BATTERY THE APU BATTERY IS SIMILAR.

M40298 S000616624_V3

BATTERIES - FUNCTIONAL DESCRIPTION

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TRU - GENERAL DESCRIPTION

General

Four TRUs change 115v ac power into 28v dc power to supply the main dc buses. The TRUs normally get power from the transfer buses. If the transfer buses have no power, the RAT generator supplies power to the two center TRUs.

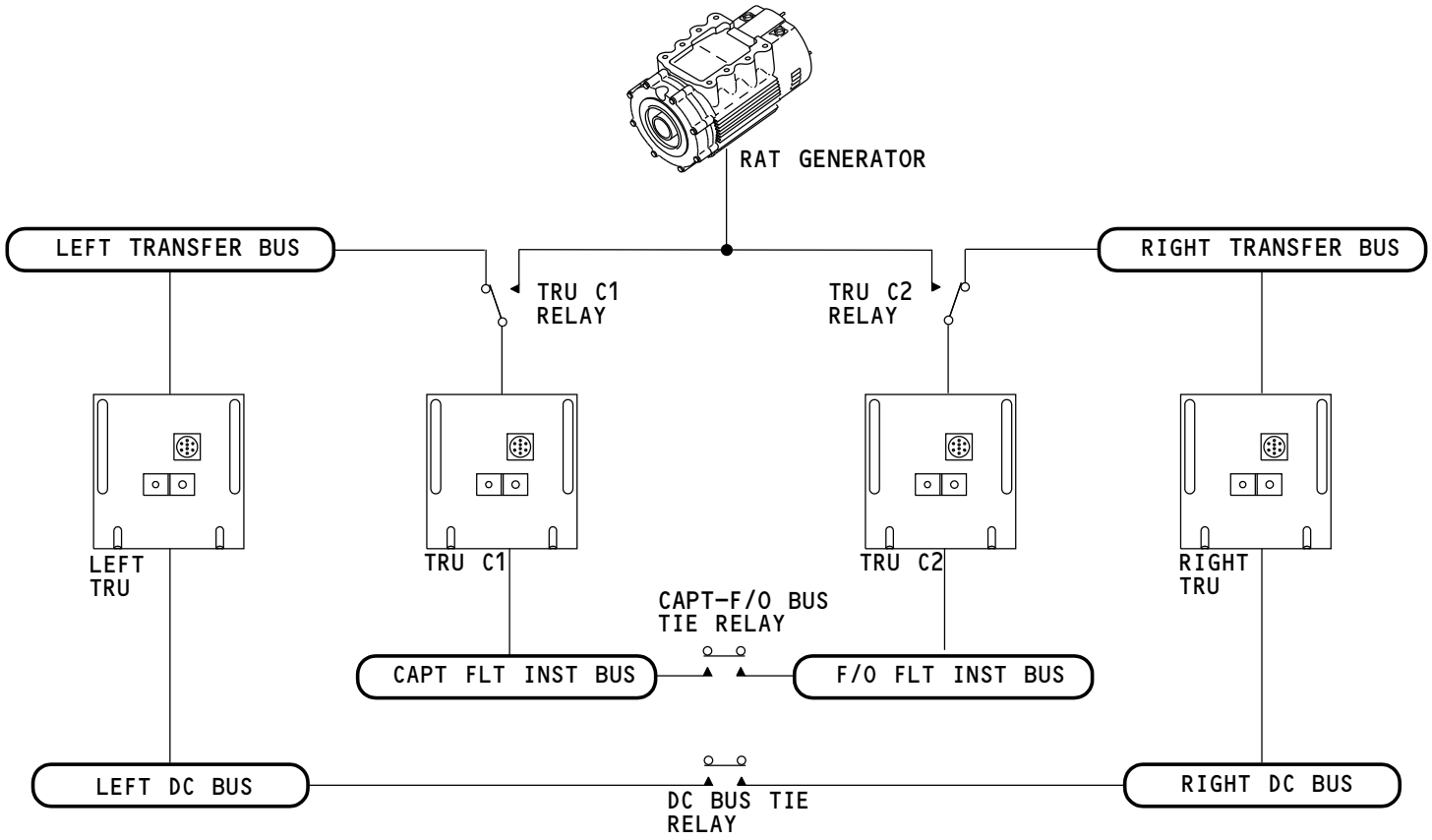
The P310 SIU 1 controls all the relays. This LRM is in the P310 standby power management panel and is on the lower left hand side.

General Description - Left and Right DC Buses

During normal operation, the left TRU supplies power to the left dc bus, and the right TRU supplies power to the right dc bus. If a TRU fails, the dc bus tie relay closes to let the other TRU supply power to the two buses.

General Description - Flight Instrument DC Buses

During normal operation, TRU C1 supplies power to the captain's flight instrument bus, and TRU C2 supplies power to the first officer's flight instrument bus. If a TRU fails, the capt-F/O bus tie relay closes to let the other TRU supply power to the two buses.



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TRU - GENERAL DESCRIPTION

TRU - FUNCTIONAL DESCRIPTION - LEFT AND RIGHT DC BUS

General

Normally the right TRU supplies power to the right dc bus, and the left TRU supplies power to the left dc bus. If one TRU does not operate, the other TRU can supply power to both buses through the dc tie relay.

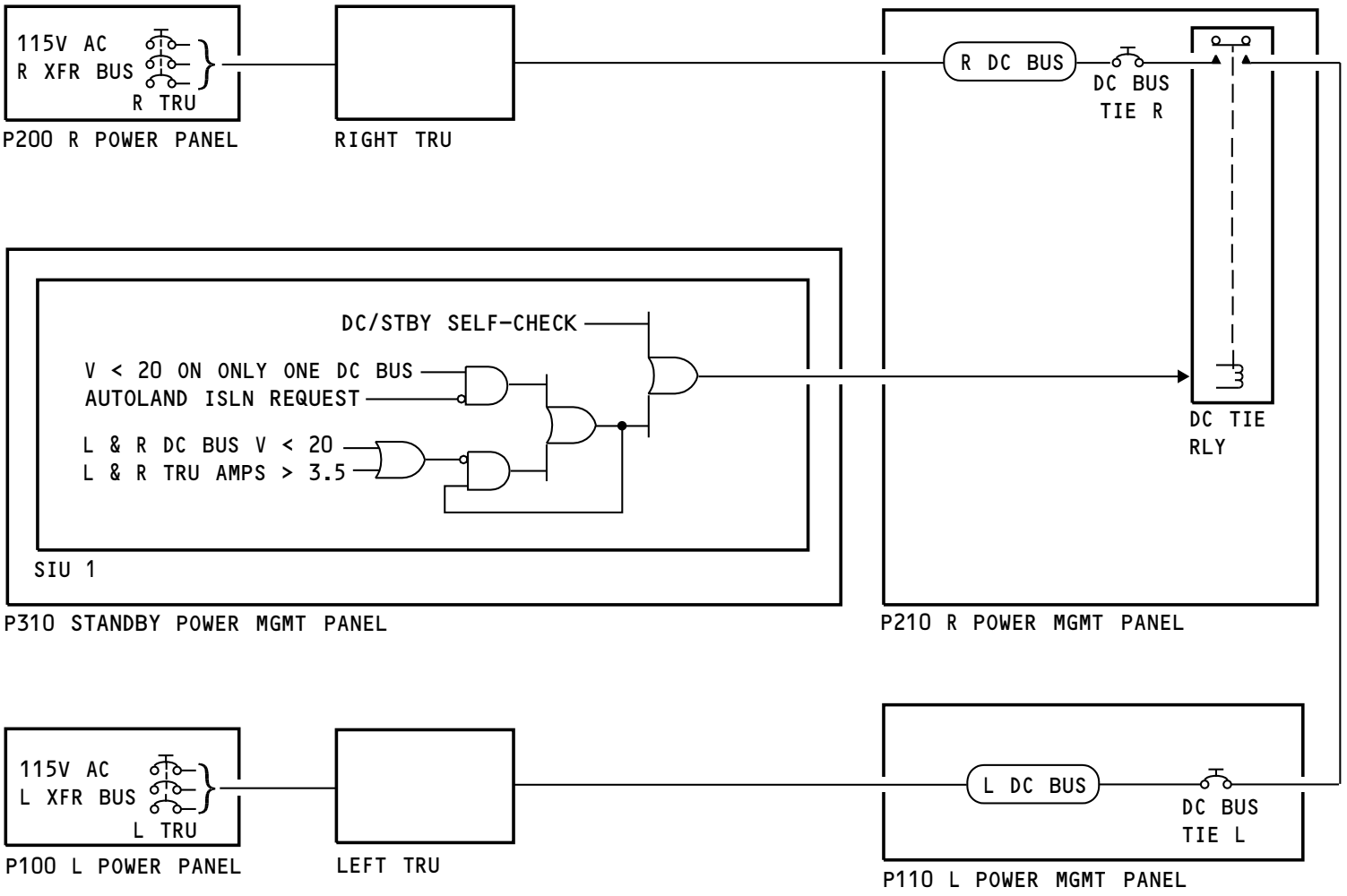
The SIU 1 in the standby power management panel controls the dc tie relay. The card gets voltage inputs from the left and right dc buses. The card also monitors the output current from each TRU.

DC Tie Relay - Normal Control

The dc tie relay is normally open to isolate the left and right dc buses. If one of the two dc buses has low voltage, the dc tie relay closes. This connects the left and right dc buses. The dc tie relay stays closed until there is valid output current from both TRUs. If the tie relay closes and the SIU senses low voltage on the two dc buses, the SIU opens the relay. This is typical of a bus fault.

DC Tie Relay - Autoland Control

When the dc tie relay is open during autoland, the P310 SIU 1 keeps it open. This continues to isolate the left and right dc buses. If the relay is closed before autoland, it stays closed. ELMS rejects the autoland request to isolate the buses.



W69746 S0000128582_V1

TRU - FUNCTIONAL DESCRIPTION - LEFT AND RIGHT DC BUS

TRU - FUNCTIONAL DESCRIPTION - CAPT & F/O FLIGHT INSTRUMENT DC BUSES

General

Normally the TRU C1 supplies power to the captain's flight instrument bus, and the TRU C2 supplies power to the first officer's flight instrument bus. If TRU C1 does not operate, TRU C2 supplies power to the two buses through the captain-F/O bus tie relay. If TRU C2 does not operate, TRU C1 supplies power to the two buses through the captain-F/O bus tie relay.

During standby power operation, the RAT generator supplies power to the two flight instrument buses through the TRU C1 and C2 relays.

The SIU 1 in the standby power management panel controls the captain-F/O bus tie and TRU C2 relays. The SIU and the RAT GCU control the TRU C1 relay.

Standby Power Control

When the RAT deploys, the RAT GCU sends a RAT power ready signal to the P310 SIU 1. The RAT GCU also energizes the TRU C1 relay. This permits the RAT generator to supply power to the captain's flight instrument bus through the TRU C1. The P310 SIU 1 supplies a backup signal to energize the TRU C1 relay.

If the right transfer bus has no power the P310 SIU 1 energizes the TRU C2 relay. This permits the RAT generator to supply power to the F/O flight instrument bus through the TRU C2. Energizing the TRU C2 relay also causes the SIU to energize the captain-F/O bus tie relay.

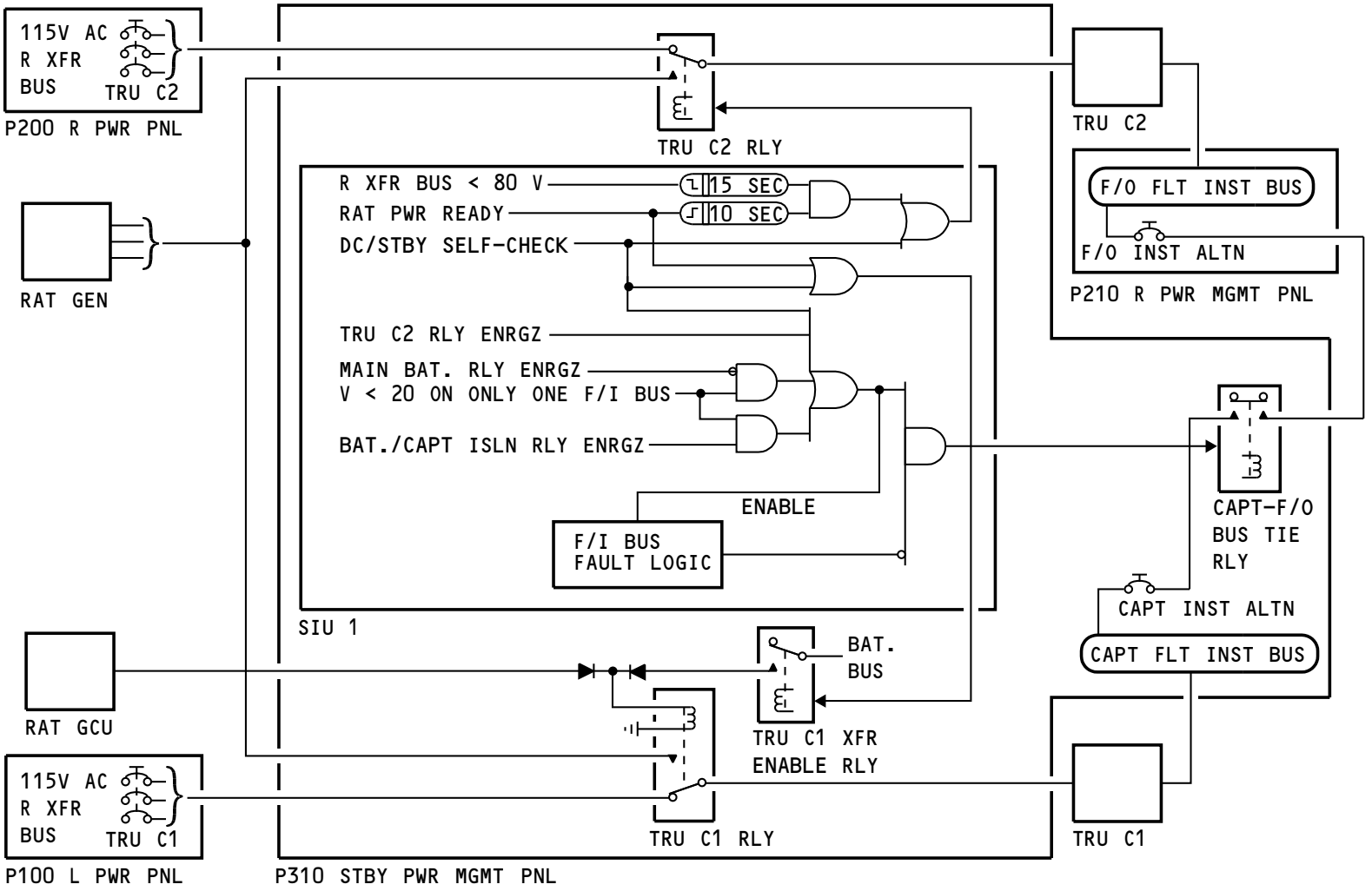
Captain-F/O Bus Tie Relay Control

The captain-F/O bus tie relay is normally open to isolate the captain's and first officer's flight instrument buses. If one of the flight instrument buses has no power and the main battery relay is not energized, the P310 SIU 1 energizes the captain-F/O bus tie relay. If one of the flight instrument buses has no power, the SIU also energizes the relay during autoland when the battery/captain isolation relay energizes. The relay connects the two flight instrument buses.

The control outputs of these two conditions latch to keep the relay energized. The latch releases if any of these occur:

- The left and right transfer buses lose power
- TRU C1 & C2 supply power
- The two flight instrument buses lose power.

All of the conditions that energize the captain-F/O bus tie relay also enable the flight instrument bus fault logic. The P310 SIU 1 monitors TRU current and bus voltage to detect a bus fault. If the SIU detects a fault, the relay is de-energized and the fault logic latches. The logic is reset at system power-up or with the MAT special function test: INITIATE P310 EU SELF TEST.



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TRU - FUNCTIONAL DESCRIPTION - CAPT & F/O FLIGHT INSTRUMENT DC BUSES

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STANDBY POWER - GENERAL DESCRIPTION

General

The standby power system operates when the normal electrical power sources do not supply power to the left and right transfer buses. Standby power goes to these buses:

- Captain's flight instrument bus
- First officer's flight instrument bus
- Battery bus
- Battery bus #2
- Hot battery bus
- AC standby bus.

Standby power comes from either the RAT generator or the main battery. ELMS controls the standby system relays. The battery switch and the standby power switch send control signals to the ELMS.

Rat Generator

The RAT generator supplies 7.5 kva of ac power to the two center TRUs. The RAT GCU monitors and controls the output of the RAT. The TRUs change the ac power into 28v dc power and supply it to the captain's and first officer's flight instrument buses.

The captain's flight instrument bus supplies power to the battery bus and battery bus #2.

The battery bus supplies power to the hot battery bus and the ac standby bus. Power to the ac standby bus goes through the static inverter. The static inverter changes 28v dc power into one phase of 115v, 400 Hz, ac power.

Main Battery

The main battery supplies 28v dc power to the standby system if the RAT generator does not.

To supply power to the standby system, the main battery supplies power to the hot battery bus. The hot battery bus supplies power to the battery bus.

The battery bus supplies power to the captain's flight instrument bus. The captain's flight instrument bus supplies power to battery bus #2.

The battery bus supplies power to the static inverter, so that the ac standby bus has power.

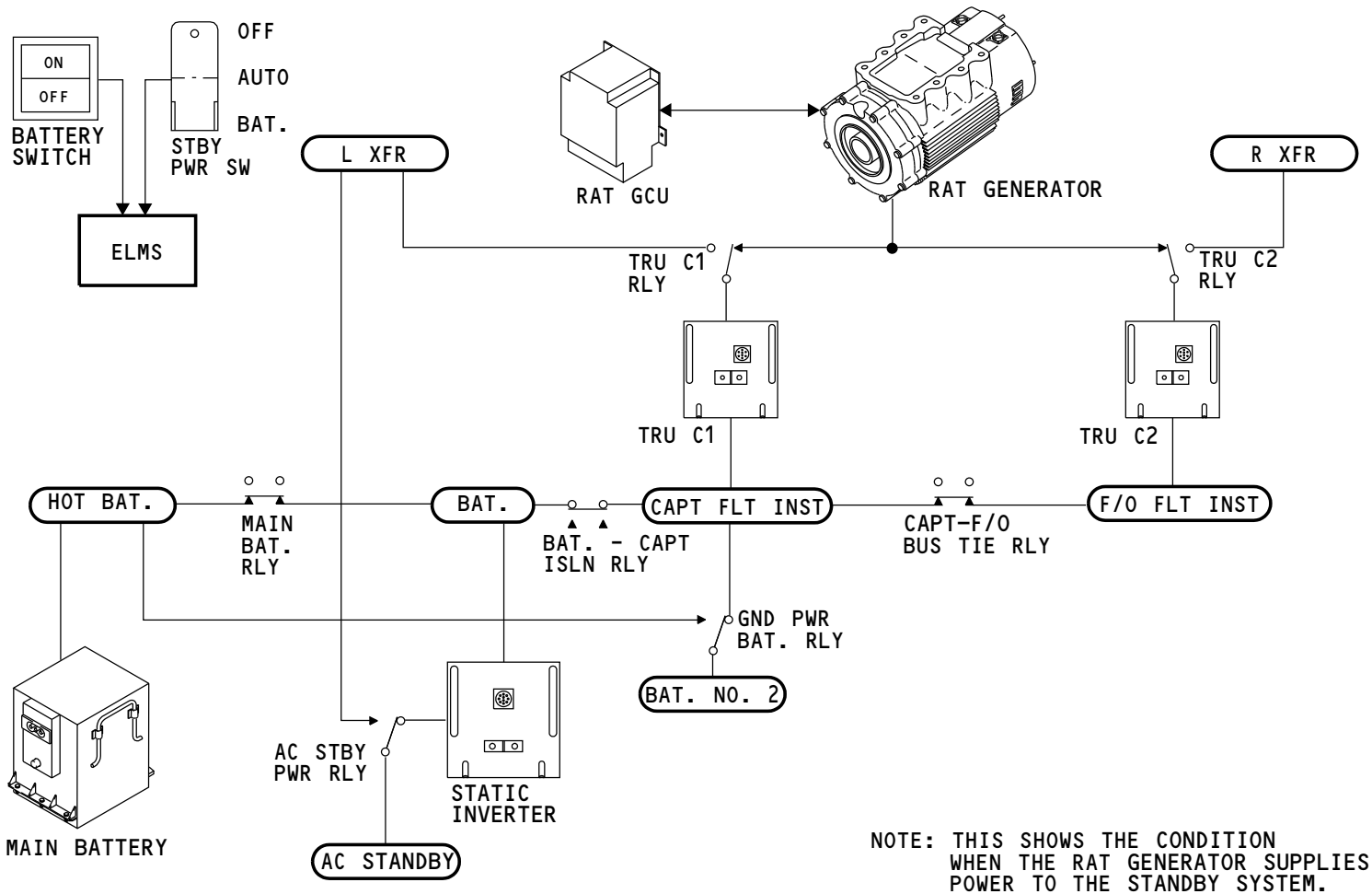
Operation

The standby power switch on the P61 overhead maintenance panel has three positions:

- OFF
- AUTO
- BAT.

The BAT position is a momentary position. The standby power switch permits you to do these functions on the ground only:

- De-energize the ac standby bus (OFF position)
- Arm the standby system for automatic operation (AUTO position)
- Energize the standby buses when ac power is not available (BAT position, when the battery switch is in the ON position)
- Start a self-check of the dc/standby system (BAT position, when ac power is available).



M40302 S000616628_V1

STANDBY POWER - GENERAL DESCRIPTION

STANDBY POWER - RAT GENERATOR

General

The RAT generator supplies ac power when normal power sources are not available. The RAT generator supplies power to TRU C1 and TRU C2 for the standby system buses.

Physical Description

The generator capacity is 7.5 kva. It has two electrical connectors. One connector carries RAT GCU signals and power. The other carries the generator output to TRU C1 and TRU C2.

The generator contains these parts:

- Permanent magnet generator (2)
- Exciter
- Main generator
- Heater (2).

The main generator makes three-phase ac power. The voltage is 115 volts. The frequency is the result of the rotational speed of the of the RAT propeller/governor unit. The frequency range is from 392 Hz to 510 Hz.

There are two heaters in the RAT generator that prevent ice. The hydraulic interface module (HYDIM) cards control the heaters through the ELMS. See the ram air turbine system section for more information on the heaters (SECTION 29-20).

Location

Eight bolts attach the RAT generator to the RAT strut. The RAT propeller/governor unit attaches to the front side of the generator. The hydraulic pump attaches to the aft side of the generator. See the ram air turbine system section for more information on the RAT (SECTION 29-20).

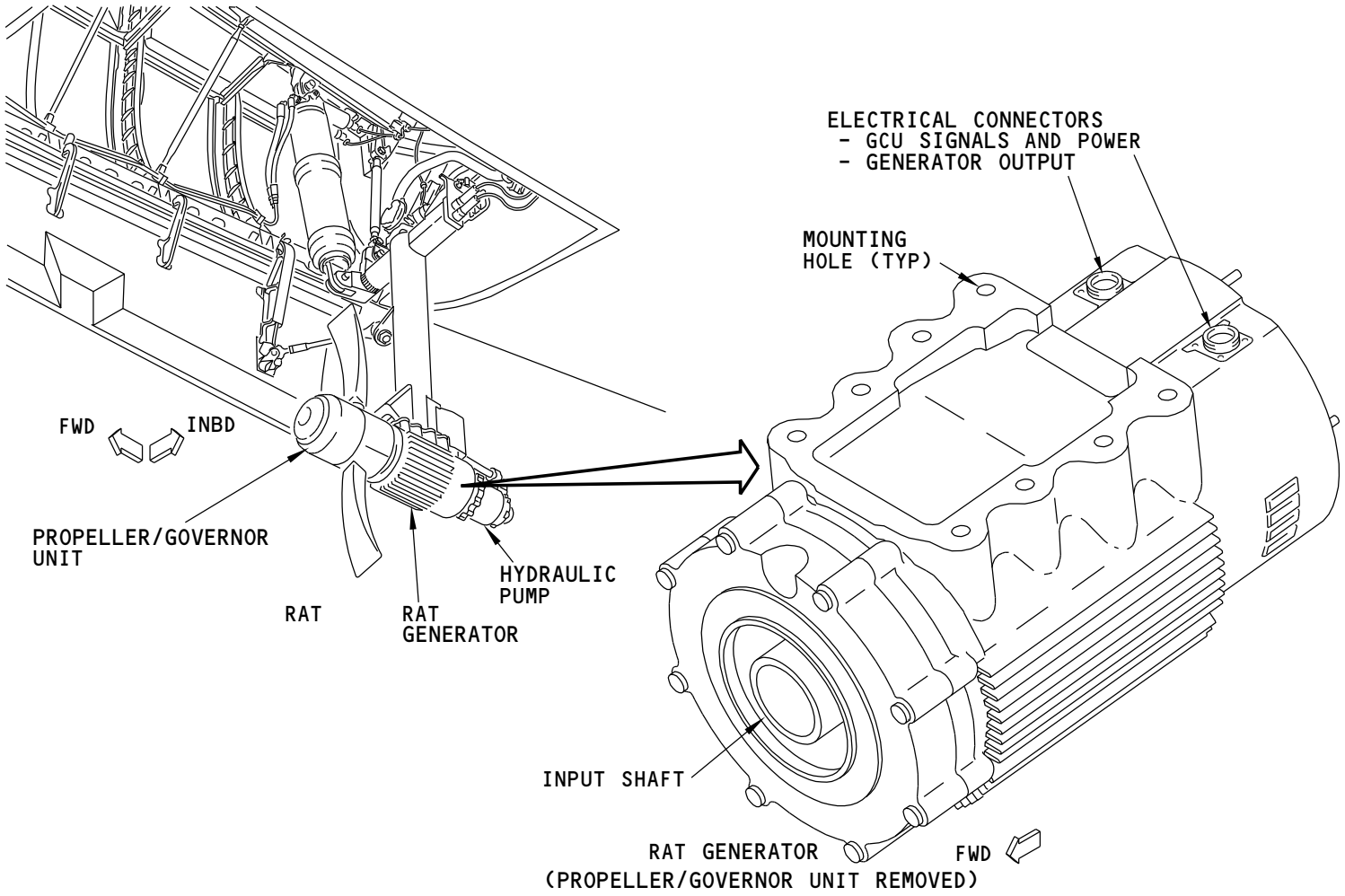
Functional Description

When the RAT deploys, the propeller/governor unit turns the input shaft of the generator and hydraulic pump. The generator changes the energy of the turning shaft into ac power.

Training Information Point

You remove and install the RAT generator and propeller/governor unit as an assembly. More work on the assembly must be done in a shop.

You must do a test of the RAT at specified times. See the ram air turbine system section for more information on the test (SECTION 29-20).



M40303 S000616629_V1

STANDBY POWER - RAT GENERATOR

STANDBY POWER - FUNCTIONAL DESCRIPTION - AC CONTROL

General

The ac standby bus uses single phase, 115v ac power. The left transfer bus is the usual power source for the ac standby bus. The static inverter is an alternative power source for the ac standby bus. These components control power switching to the ac standby bus:

- AC standby power relay
- AC standby control relay
- Static inverter
- P310 SIU 1.

Power to energize the ac standby bus goes through the ac standby power relay. The ac standby control relay controls the ac standby power relay. The P310 SIU 1 controls the ac standby control relay.

Standby Power Control

The left transfer bus normally supplies power to the ac standby bus. The static inverter supplies the power when any of these conditions are true:

- Left transfer bus voltage is below 80 volts
- There is an autoland bus isolation request
- There is a dc/standby self-check in progress.

Static Inverter

The static inverter gets 28v dc power from the battery bus. The static inverter has a converter that increases the dc voltage, and an inverter that changes the dc power into single phase, 115v ac power.

The static inverter turns off for either of these conditions:

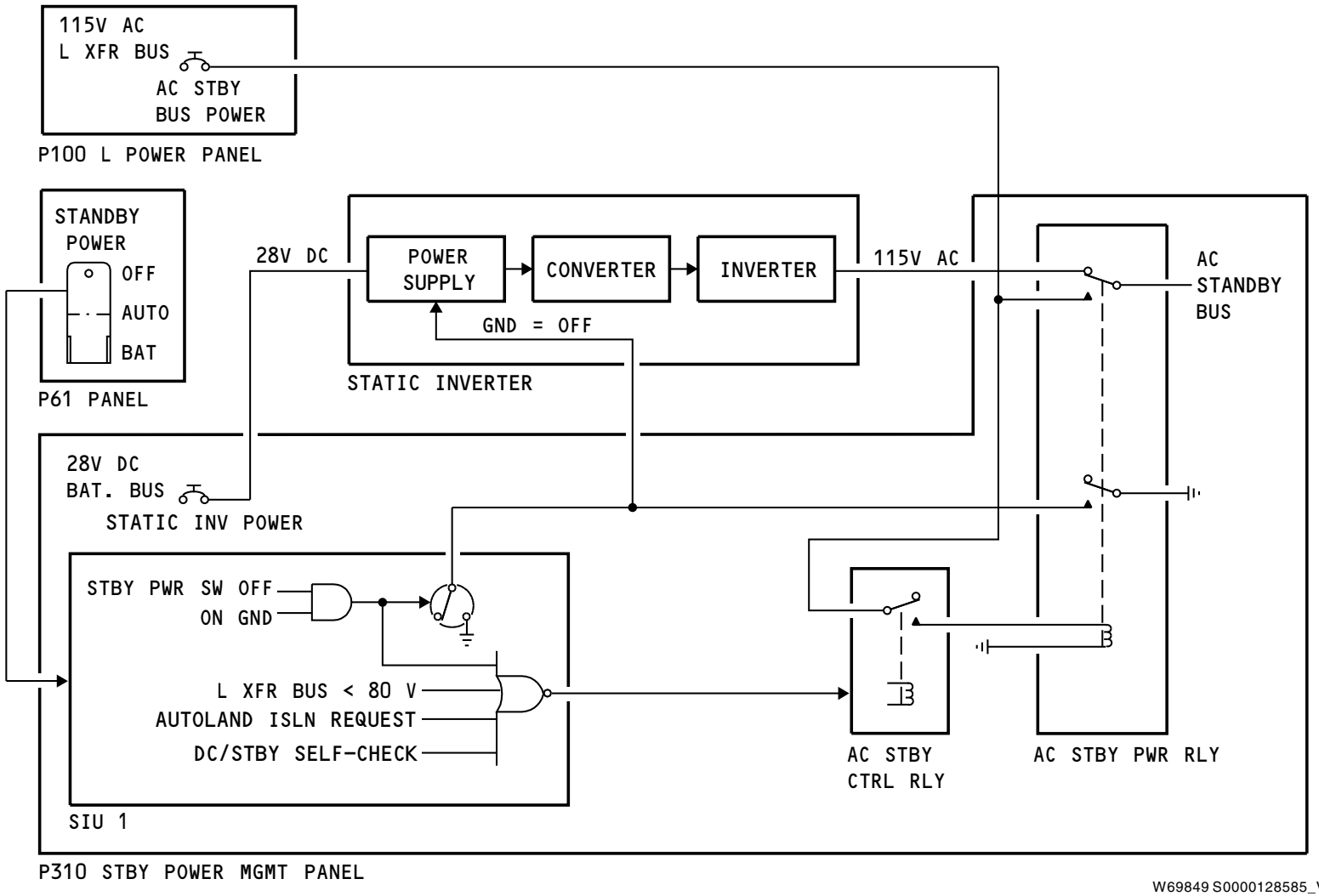
- Standby power switch is in the OFF position and the airplane is on the ground
- AC standby power relay is energized.

DC/Standby Self-Check

The P310 SIU 1 does a test of the dc system with a dc/standby self-check.

The self-check can start either manually or automatically. You manually start the self-check when you set these conditions:

- The airplane is on the ground
- Left and right ac transfer buses have power
- The battery switch is in the ON position
- The standby power switch is in the BAT position (momentary).



W69849 S0000128585_V1

STANDBY POWER - FUNCTIONAL DESCRIPTION - AC CONTROL

STANDBY POWER - FUNCTIONAL DESCRIPTION - RAT GENERATOR CONTROL

General

The RAT deploys manually or automatically. The RAT switch controls manual deployment of the RAT. The ELMS P310 panel and the hydraulic interface modules (HYDIM) (not shown) control the automatic deployment of the RAT. When one or two RAT actuator solenoids energize, the RAT deploys. Then, the RAT GCU controls and monitors the RAT generator power.

RAT Deployment

To deploy the RAT manually, you put the RAT manual switch in the DEPLOY position. This energizes the two RAT actuator solenoids.

The P310 can deploy the RAT automatically. When the airplane is in the air and the two transfer buses do not have power for more than 15 seconds, the P310 energizes the RAT deploy relay for five seconds. The energized RAT deploy relay supplies power to the M29002 RAT actuator solenoid.

See the ram air turbine system section for more information on the hydraulic interface module card control of the M29001 RAT actuator solenoid (SECTION 29-20).

Power

The RAT GCU gets power from a PMG in the RAT generator. The PMG also supplies power to the voltage regulator. The voltage regulator rectifies the power to make dc current for the exciter field.

The generator uses the exciter field current to make ac current. The ac current goes through two relays to the two center TRUs.

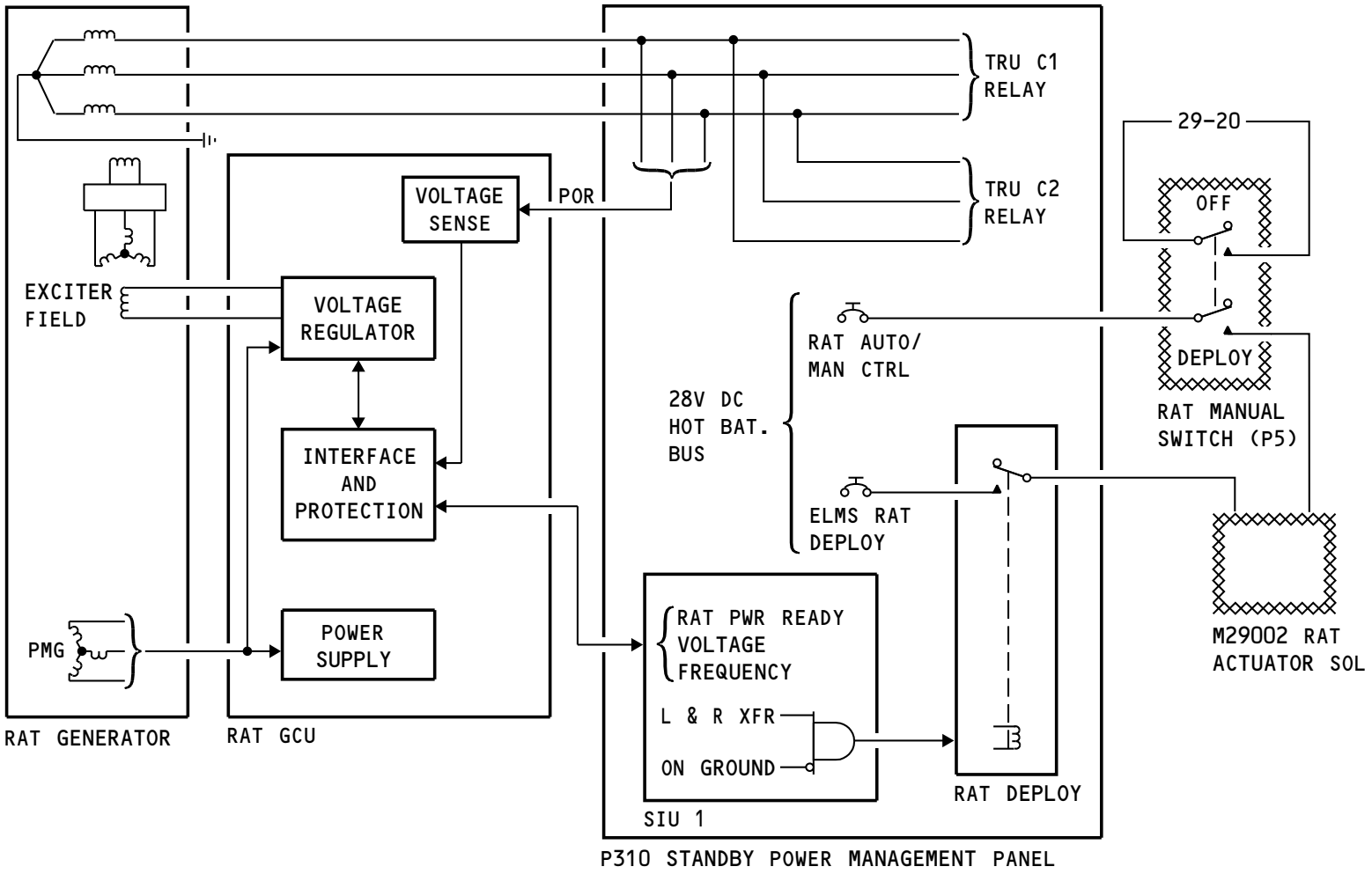
Control

The GCU monitors the voltage at the point of regulation (POR). The POR is between the generator and the TRU relays. The voltage regulator adjusts the dc current to the exciter field to keep the POR voltage at 115 volts.

The GCU sends these signals to the standby power management panel:

- RAT generator power ready signal
- RAT generator voltage
- RAT generator frequency.

The ELMS uses the power ready signal for control logic. The voltage and frequency signals are for indication.



W69824 S0000128594_V1

STANDBY POWER - FUNCTIONAL DESCRIPTION - RAT GENERATOR CONTROL

STANDBY POWER - FUNCTIONAL DESCRIPTION - DC CONTROL

General

The standby power system operates to control power from the hot battery bus to these buses:

- Battery bus
- Captain's flight instrument bus
- Battery bus #2.

The P310 SIU 1 controls these relays to control power from the hot battery bus:

- Main battery relay
- Battery-captain isolation relay
- Ground power battery relay.

Main Battery Relay

When the main battery relay energizes, the hot battery bus can supply power to the battery bus. In general, the main battery relay energizes for these conditions:

- Transfer bus power was available, but was lost (in the air, the P310 keeps the relay energized)
- You manually select standby power on
- The two center TRUs fail
- TRU C1 fails and the captain-F/O bus tie relay energizes to restore power
- Autoland bus isolation request
- DC/standby self-check.

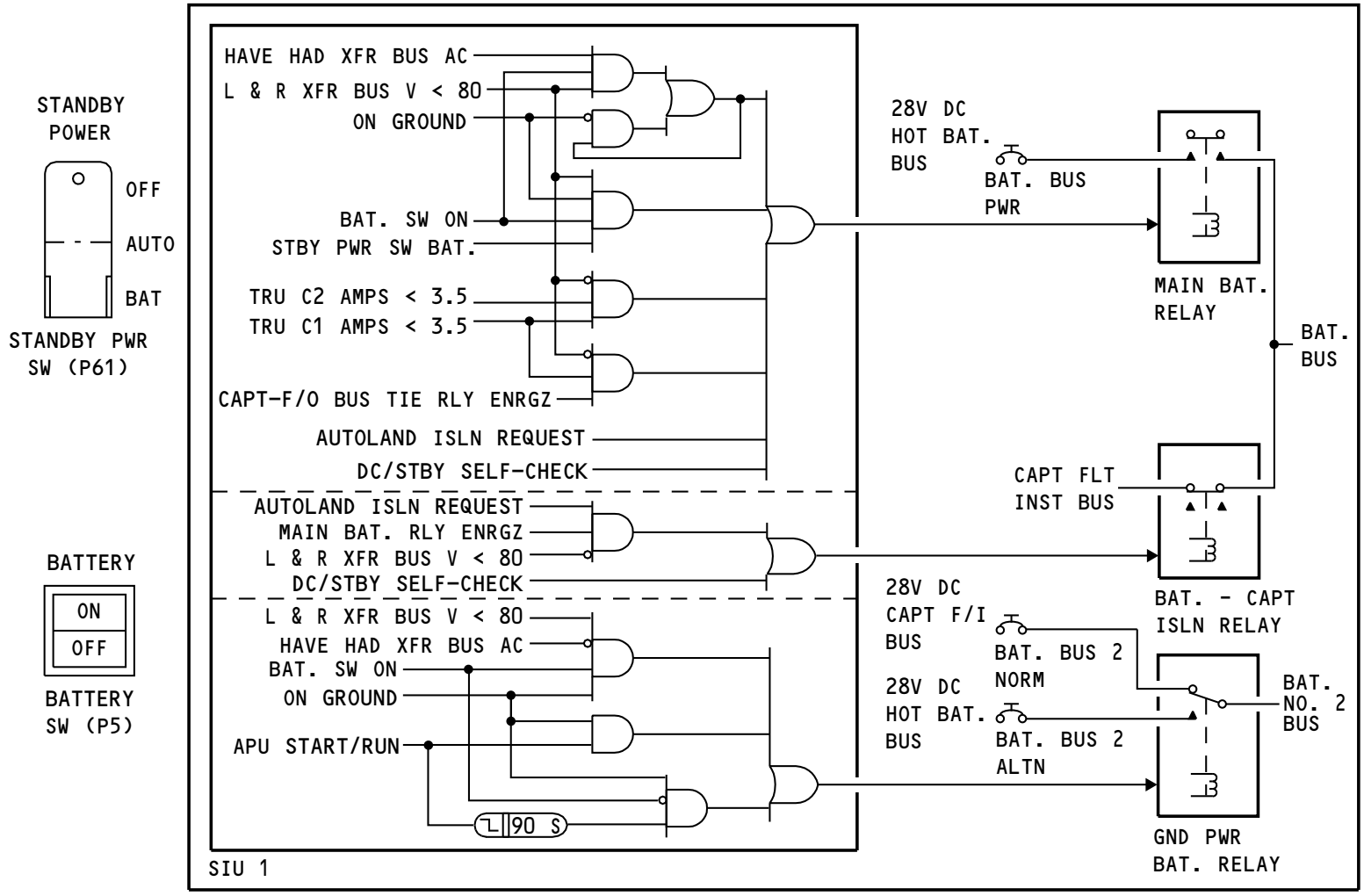
Battery-Captain Isolation Relay

The battery-captain isolation relay energizes to isolate the captain's flight instrument bus from the hot battery bus (through the battery bus). This occurs when there is an autoland bus isolation request or for a dc/standby self-check.

Ground Power Battery Relay

When the ground power battery relay energizes, the hot battery bus can supply power to the battery bus #2. The ground power battery relay energizes for these conditions:

- You push the battery switch on as part of initial power application
- APU starting/running on the ground
- When APU shuts down and the battery switch is off, the relay stays energized for 90 seconds. This makes sure the battery bus #2 has power to close the APU inlet door.



P310 STANDBY POWER MANAGEMENT PANEL

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STANDBY POWER - FUNCTIONAL DESCRIPTION - DC CONTROL

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FLIGHT CONTROLS DC POWER - GENERAL DESCRIPTION

Purpose

The flight controls dc (FCDC) power system supplies power to the flight controls system.

General Description

There are three FCDC power supply assemblies (PSA):

- Left
- Center
- Right.

These PSAs supply power to their related flight control buses.

Power Sources

Each PSA gets power from many different sources. The PSA automatically selects which power source to use. Each PSA has a battery to supply power during power interruptions.

The left PSA gets power from these sources:

- Permanent Magnet Generator (PMG) L1
- Left dc bus
- Hot battery bus.

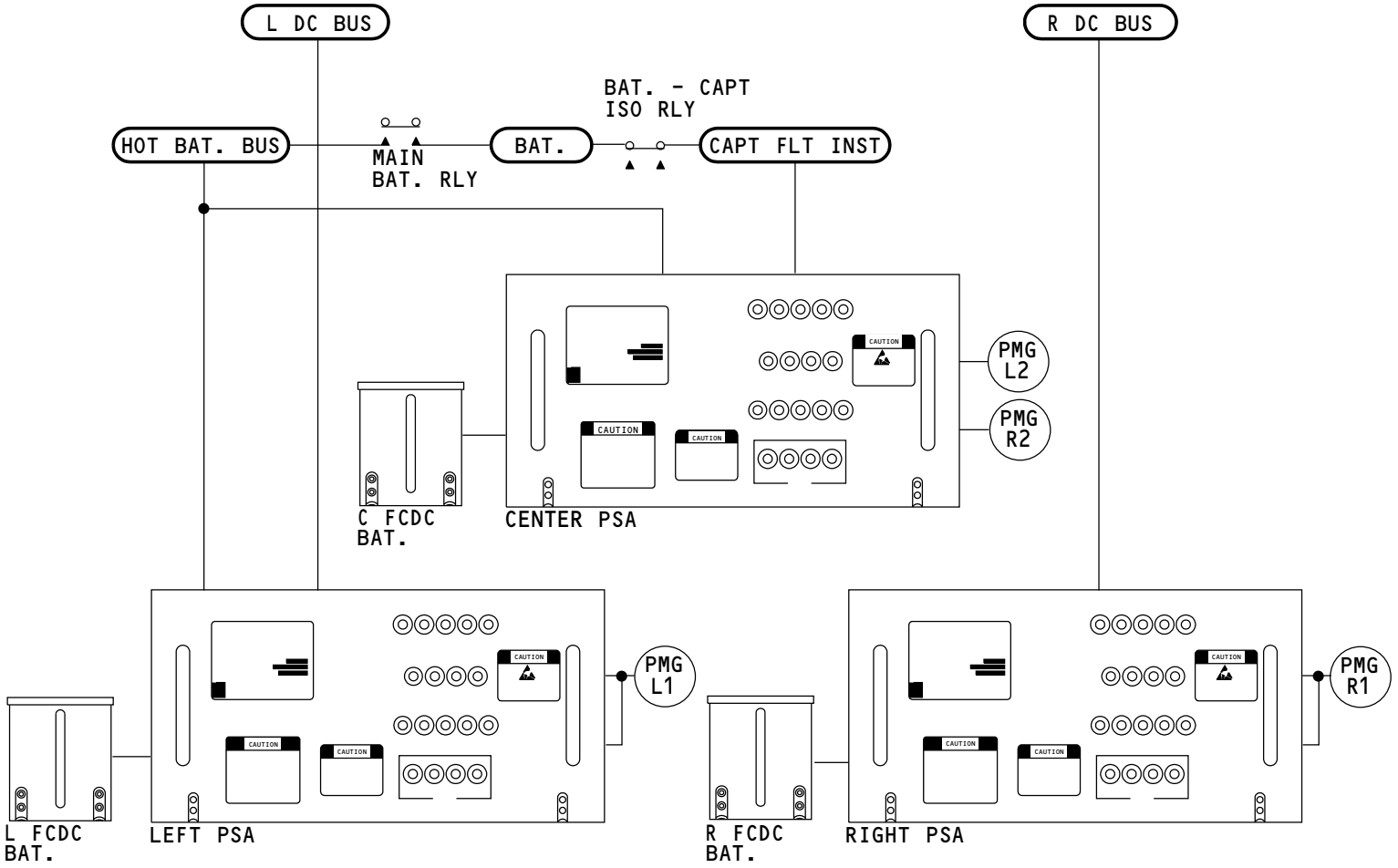
The center PSA gets power from these sources:

- PMG L2
- PMG R2
- Captain's flight instrument bus
- Hot battery bus.

The right PSA gets power from these sources:

- PMG R1
- Right dc bus.

The PMGs are permanent magnet generators in the backup generator housing. Each backup generator has two PMGs that supply power to the PSAs. The PSA changes variable frequency ac power from the PMGs into 28V dc power.



M40307 S000616633_V1

FLIGHT CONTROLS DC POWER - GENERAL DESCRIPTION

FLIGHT CONTROLS DC POWER - POWER SUPPLY ASSEMBLY

General

The PSA supplies power to the flight control systems.

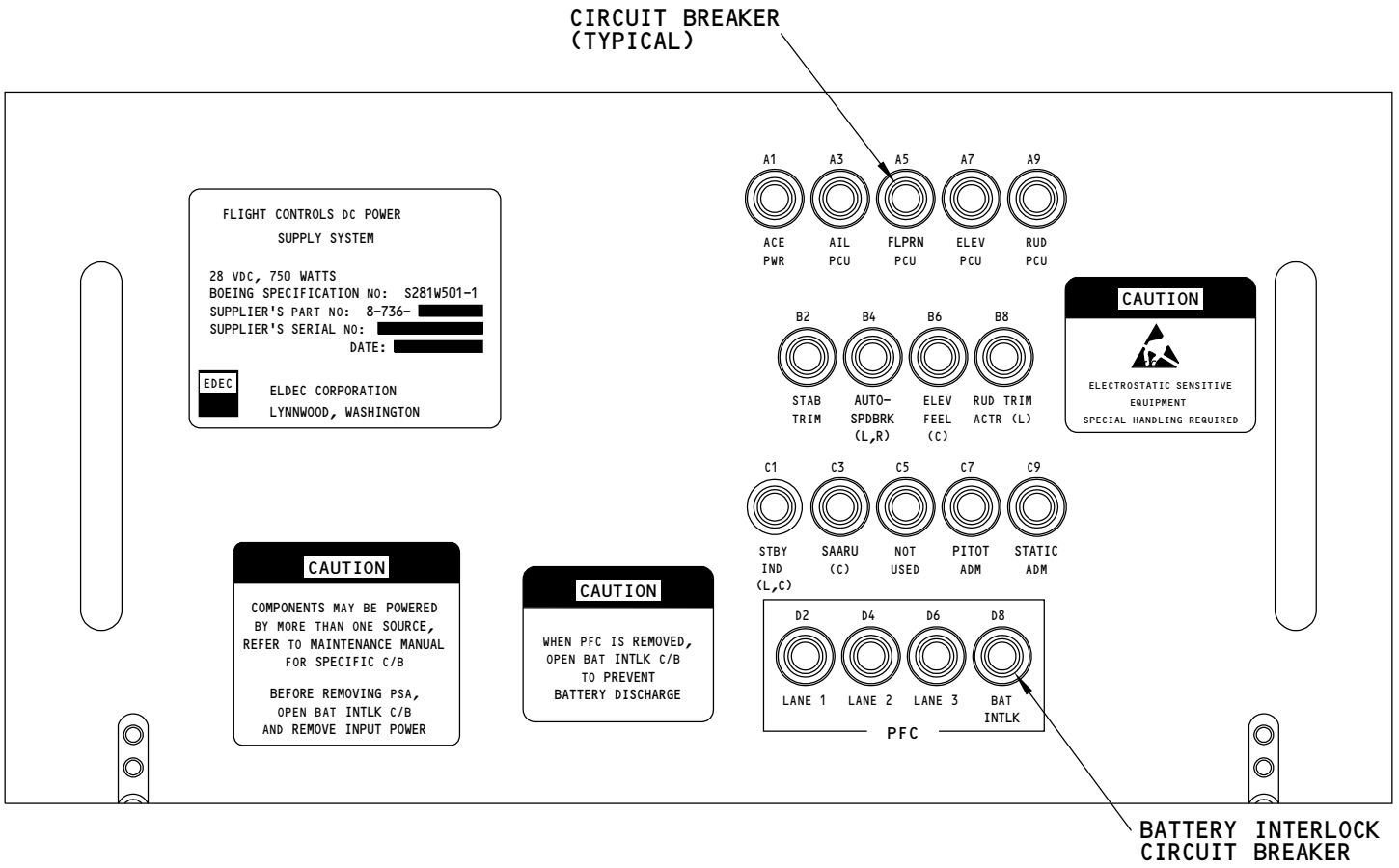
The PSA contains the FCDC bus. The FCDC bus supplies power to flight control LRUs. Power to each LRU goes through circuit breakers on the front of the PSA. You can remove power from an LRU when you open its related circuit breakers.

Training Information Point

Be sure to obey all of the cautions on the front of the PSA.

The left, center, and right PSAs are interchangeable.

The parentheses below a circuit breaker tells the PSA position in which that circuit breaker is active. For example, circuit breaker AUTO-SPDBRK (L,R) is only active when the PSA is in the left or right position.



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FLIGHT CONTROLS DC POWER - POWER SUPPLY ASSEMBLY

FLIGHT CONTROLS DC POWER - FUNCTIONAL DESCRIPTION

General

The center PSA can get power from these sources:

- PMG L2
- PMG R2
- Captain's flight instrument bus
- Hot battery bus.

The PSA has a controller that selects which power source to use. The controller supplies grounds to relays in the PSA to select the different power sources.

PSA Operation Modes

The PSA has three modes of operation:

- Primary
- Secondary
- Backup.

Primary mode is the normal mode when the engines are running. The PSA uses power from one or both PMGs when it is in primary mode. The PMGs send ac power to a power converter. The power converter changes the ac power to 28v dc power.

When there is no power from either PMG, the PSA goes into secondary mode. Secondary mode is the normal mode when the airplane is on the ground and the engines are off. The K2 relay relaxes when the PSA is in secondary mode. This permits the PSA to use power from the captain's flight instrument bus.

When there is no power from either PMG or from the captain's flight instrument bus, the PSA goes into backup mode. The K1 relay energizes when the PSA is in backup mode. This permits the PSA to use power from the hot battery bus.

NOTE: The right PSA does not use backup mode because it does not connect to the hot battery bus.

FCDC Battery

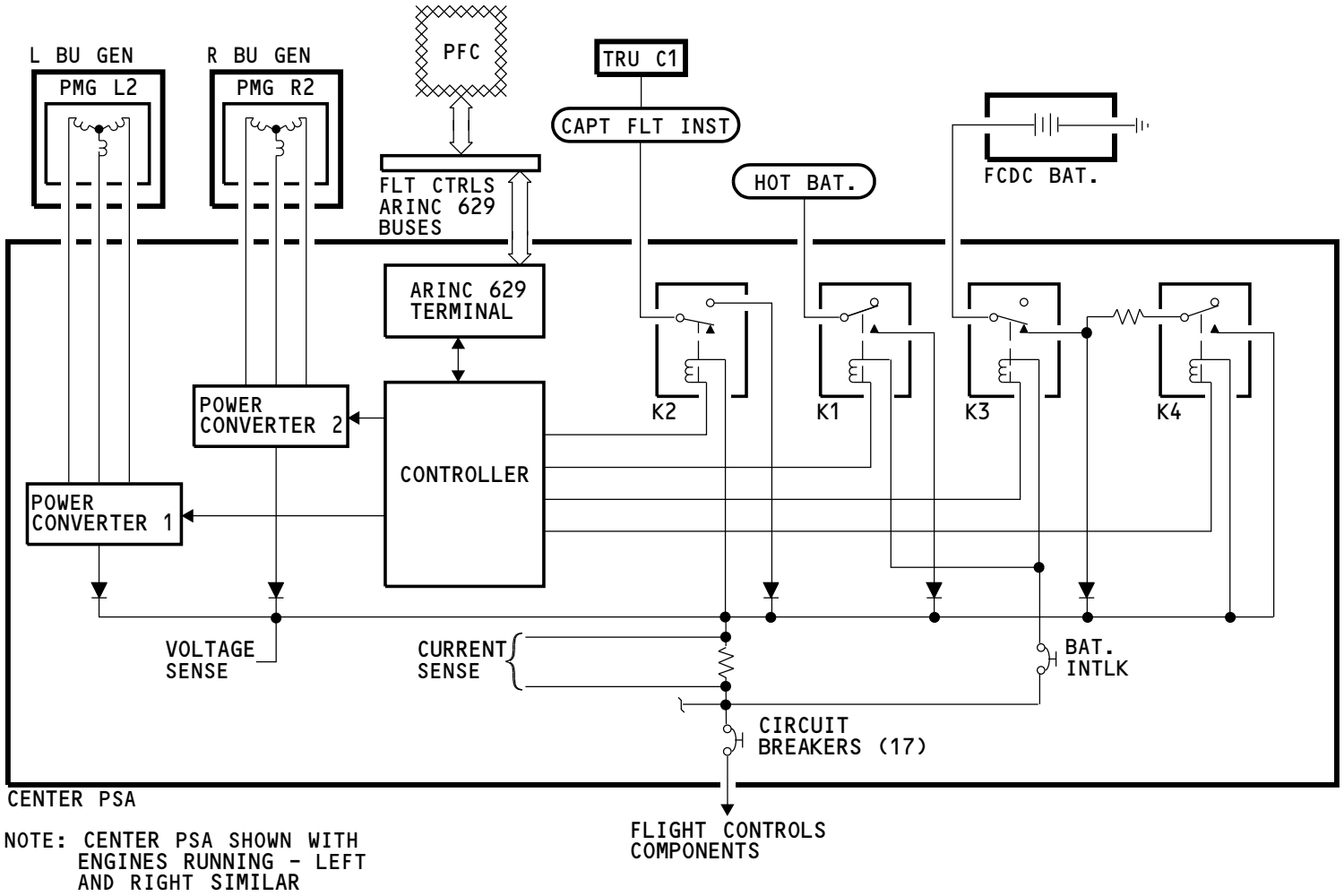
Normally, the controller energizes the K3 relay to connect the FCDC battery to the FCDC bus. A diode prevents uncontrolled charging of the battery from the bus. When the bus loses power, the battery supplies power until the controller connects another power source.

The PSA monitors the voltage of the FCDC battery. When the battery voltage is below 25 volts, the PSA energizes the K4 relay. This permits the FCDC bus to charge the battery. The battery charge cycle lasts for 300 minutes.

The PSA will not charge the battery if the battery voltage is below 21 volts or if the PSA is in backup mode.

Training Information Point

If you replace a primary flight computer (PFC), you must open the battery interlock circuit breaker of the related PSA before you remove power from the airplane. The battery interlock circuit breaker removes power from the K1 and the K3 relays. This prevents the FCDC loads from draining the main battery and the related FCDC battery. But, the PSA does automatically open K1 and K3 if the FCDC bus voltage drops below 17.5.



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FLIGHT CONTROLS DC POWER - FUNCTIONAL DESCRIPTION

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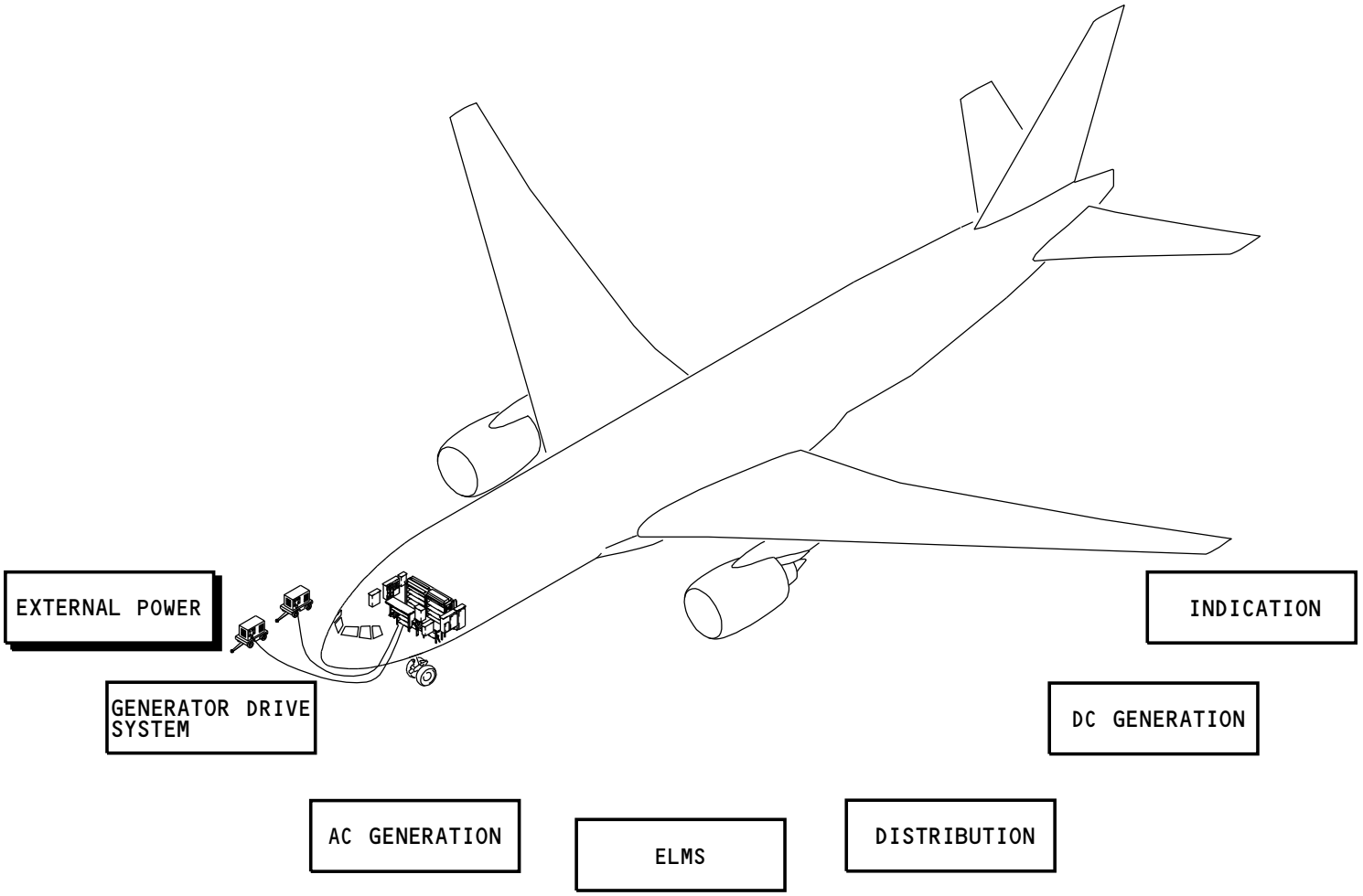
EXTERNAL POWER - INTRODUCTION

General

The external power system controls the electrical power on the airplane from ground power sources. The external power system has these electrical power system functions:

- Bus power control
- Ground handling power
- Ground service power
- Primary external power
- Secondary external power.



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EXTERNAL POWER - INTRODUCTION

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EXTERNAL POWER - GENERAL DESCRIPTION

General

You use external power to supply the airplane with electrical power from a ground power source. You can supply the power directly to these electrical buses:

- Ground Handling
- Ground Service
- Main alternating current (ac).

External Power Panel

The external power panel has two external power receptacles that have a continuous supply capacity of 90 kilovolt-ampere (kVA) each. The forward receptacle is for primary external power. The aft receptacle is for secondary external power.

Control

The Bus Power Control Unit (BPCU) controls these electrical switching devices that connect external power to the airplane:

- Secondary Electrical Power Center (EPC)
- Primary EPC
- Ground handling relay
- Ground service transfer relay
- Ground service select relay.

Each Generator Control Unit (GCU) controls a Bus Tie Breaker (BTB) to connect power between the main AC buses.

Ground Handling Power

When you supply power to the primary external power receptacle, the BPCU energizes the ground handling relay. This connects primary external power to the ground handling ac bus. The ground handling TRU supplies direct current (dc) power to the ground handling dc bus.

The Auxiliary Power Unit (APU) generator can also supply power to the ground handling ac bus, but secondary external power cannot. If both primary external power and the APU generator are available, the BPCU selects primary external power for the ground handling ac bus.

Ground Service Power

The BPCU selects the power source for the ground service bus in this order:

- Right main ac bus
- Primary external
- APU generator.

If the right main ac bus has no power, you can use the ground service switch. When you push the switch, the BPCU connects primary external power or APU generator power directly to the ground service bus.

Primary External Power

When you push the primary external power switch, you connect primary external power to the main ac buses. The BPCU closes the primary EPC and the GCUs close the BTBs to connect the power.

Secondary External Power

When you push the secondary external power switch, you connect secondary external power to the main ac buses. The BPCU closes the secondary EPC and the GCUs close the BTBs to connect the power. If primary external power was on the right main ac bus, the right GCU opens the right BTB first to perform a break-power transfer.

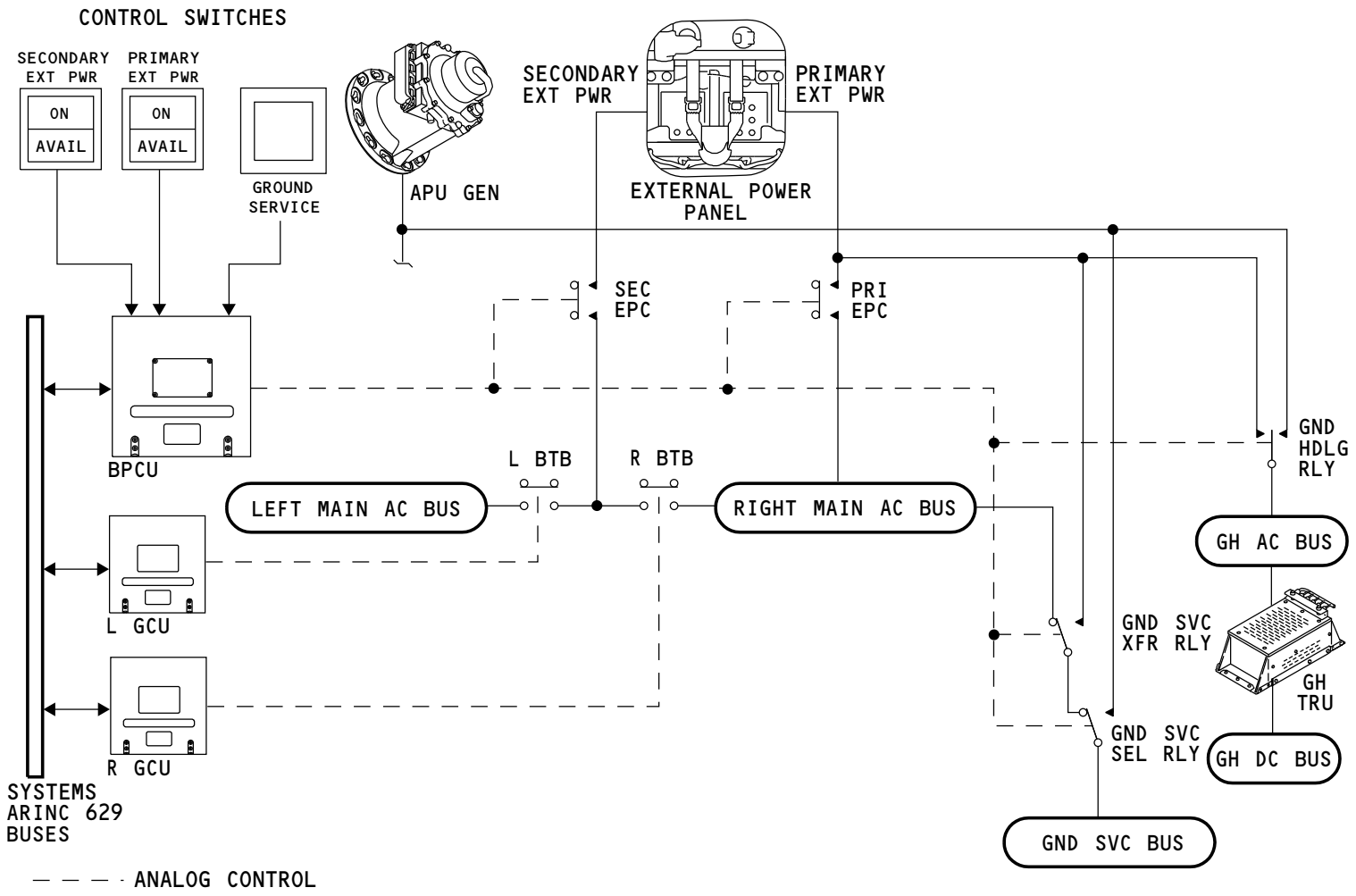
No-Break Power Transfers

The BPCU coordinates power transfers between the external power sources and each integrated drive generator (IDG) or APU generator. The BPCU and GCUs communicate on the systems ARINC 629 buses.

EXTERNAL POWER - GENERAL DESCRIPTION

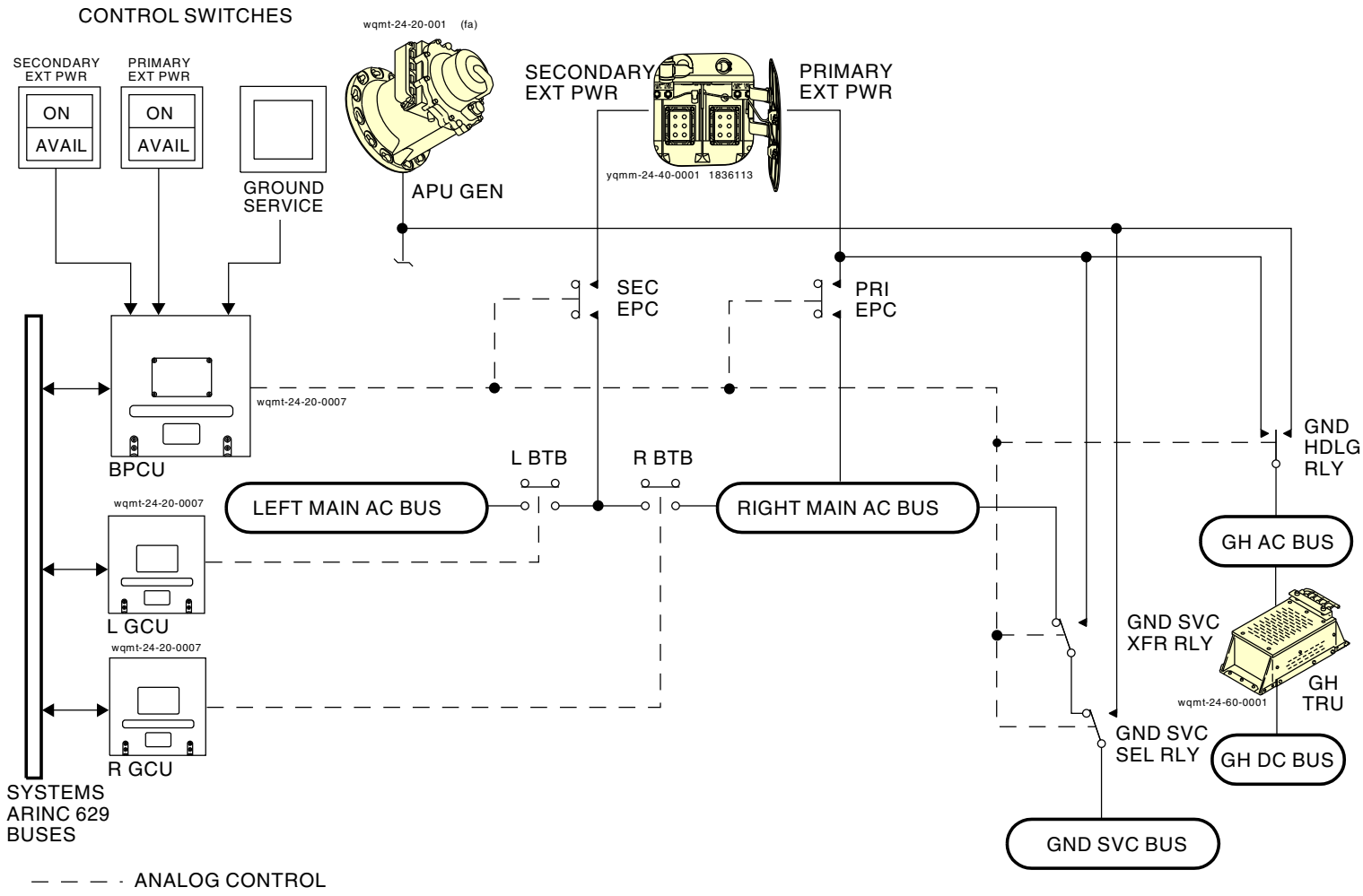
When the ac system changes from an external power source to another power source, it does no-break power transfers. The system momentarily connects the two power sources to one bus so there is no interruption in power. A GCU electronically adjusts an IDG speed to match the power of the external power source to do a no-break power transfer. For transfers between external power and the APU, the APU controller adjusts the APU speed to do the no-break power transfer.

The BPCU always does a break-power transfer between primary external power and secondary external power.



M40311 S000616637_V1

EXTERNAL POWER - GENERAL DESCRIPTION



2837832 S0000661280_V1

EXTERNAL POWER - GENERAL DESCRIPTION

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EXTERNAL POWER - COMPONENT LOCATIONS

General

These are the components of the external power system:

- Primary EPC
- Ground service transfer relay
- Secondary EPC
- Ground service select relay
- Ground handling relay
- BPCU
- Ground handling TRU.

Main Equipment Center

Most of the external power components are in the ELMS panels in the main equipment center. See the electrical load management system section for more information on component locations (SECTION 24-09).

These are the components in the P200 right power panel:

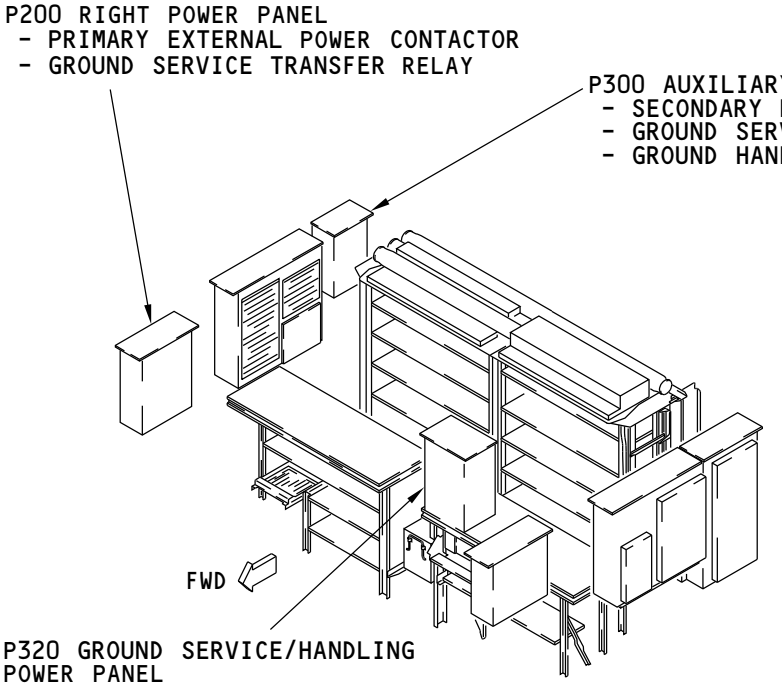
- Primary EPC
- Ground service transfer relay.

These are the components in the P300 auxiliary power panel:

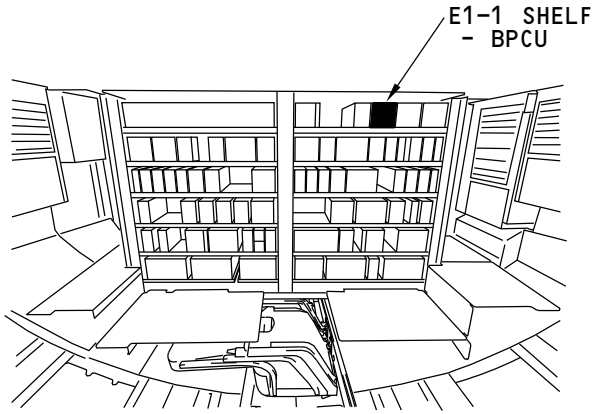
- Secondary EPC
- Ground service select relay
- Ground handling relay.

The ground handling TRU is in the P320 ground service/handling power panel.

The BPCU is on the E1-1 shelf.



MAIN EQUIPMENT CENTER



MAIN EQUIPMENT CENTER
(LOOKING AFT)

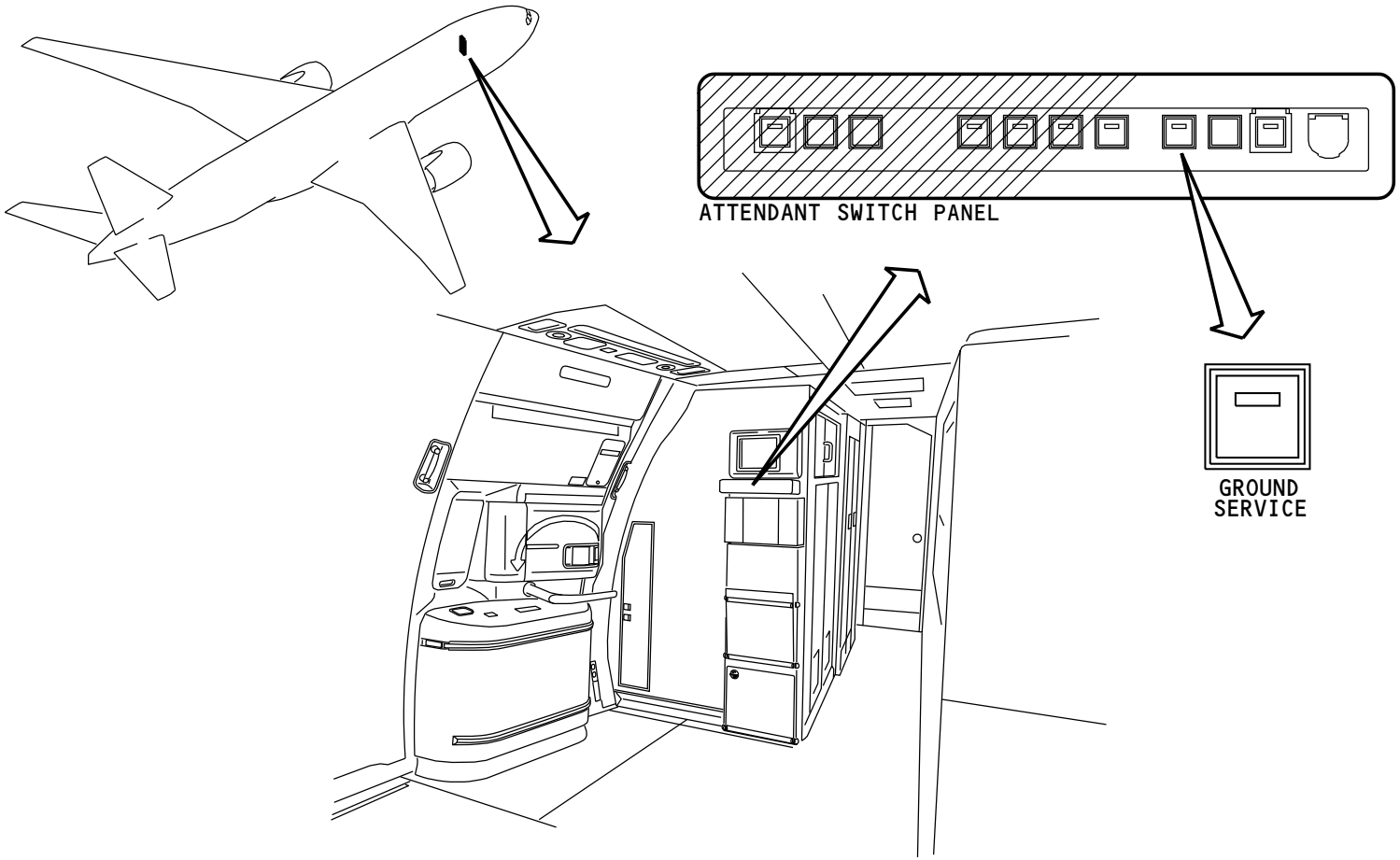
M40313 S000616639_V1

EXTERNAL POWER - COMPONENT LOCATIONS

EXTERNAL POWER - GROUND SERVICE SWITCH

General

The ground service switch arms the BPCU to connect either primary external power or the APU generator directly to the ground service bus. The switch is on the right side of the attendant switch panel at door 1 left.



ATTENDANT SWITCH PANEL - DOOR 1L
(LOOKING FWD)

M40317 S000616643_V1

EXTERNAL POWER - GROUND SERVICE SWITCH

EXTERNAL POWER - EXTERNAL POWER PANEL

General

You use the external power panel to connect ground power sources to the airplane electrical system. The panel is immediately to the right of the main equipment center access door approximately 10 ft (3 m) above the ground.

Physical Description

The panel contains two power receptacles and their related power cord restraining straps. The forward receptacle is for primary power. The aft receptacle is for secondary power.

Each receptacle has four large pins for ac power and two small ones for the interlock. Above each receptacle are two indication lights; CONNECTED and NOT IN USE.

Above the lights are gatelink connectors. You find details on the gatelink connectors in CHAPTER 23.

ARO ALL PRE SB 777-24-0152

The power cord restraining straps are hook-type with adjustable straps. They hold the weight of the power cords to keep the plugs connected to the receptacles. The aft hook, which stows forward, is for the aft receptacle. The forward hook, which stows aft, is for the forward receptacle.

ARO ALL POST SB 777-24-0152

A ring hook is provided to secure the power cord to the receptacle.

ARO ALL

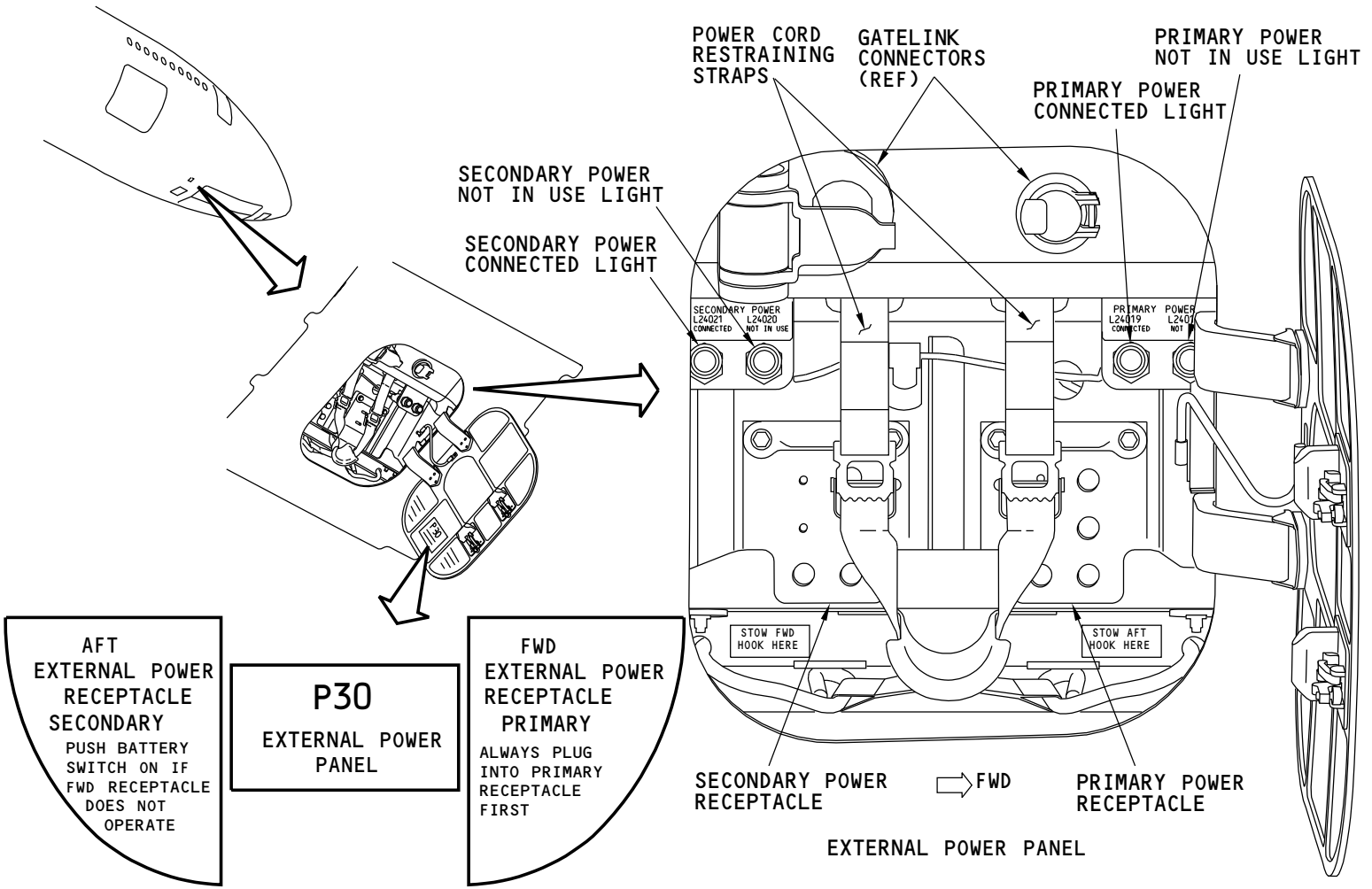
Placards inside the panel access door list specific information about connecting external power.

Training Information Point

ARO ALL PRE SB 777-24-0152

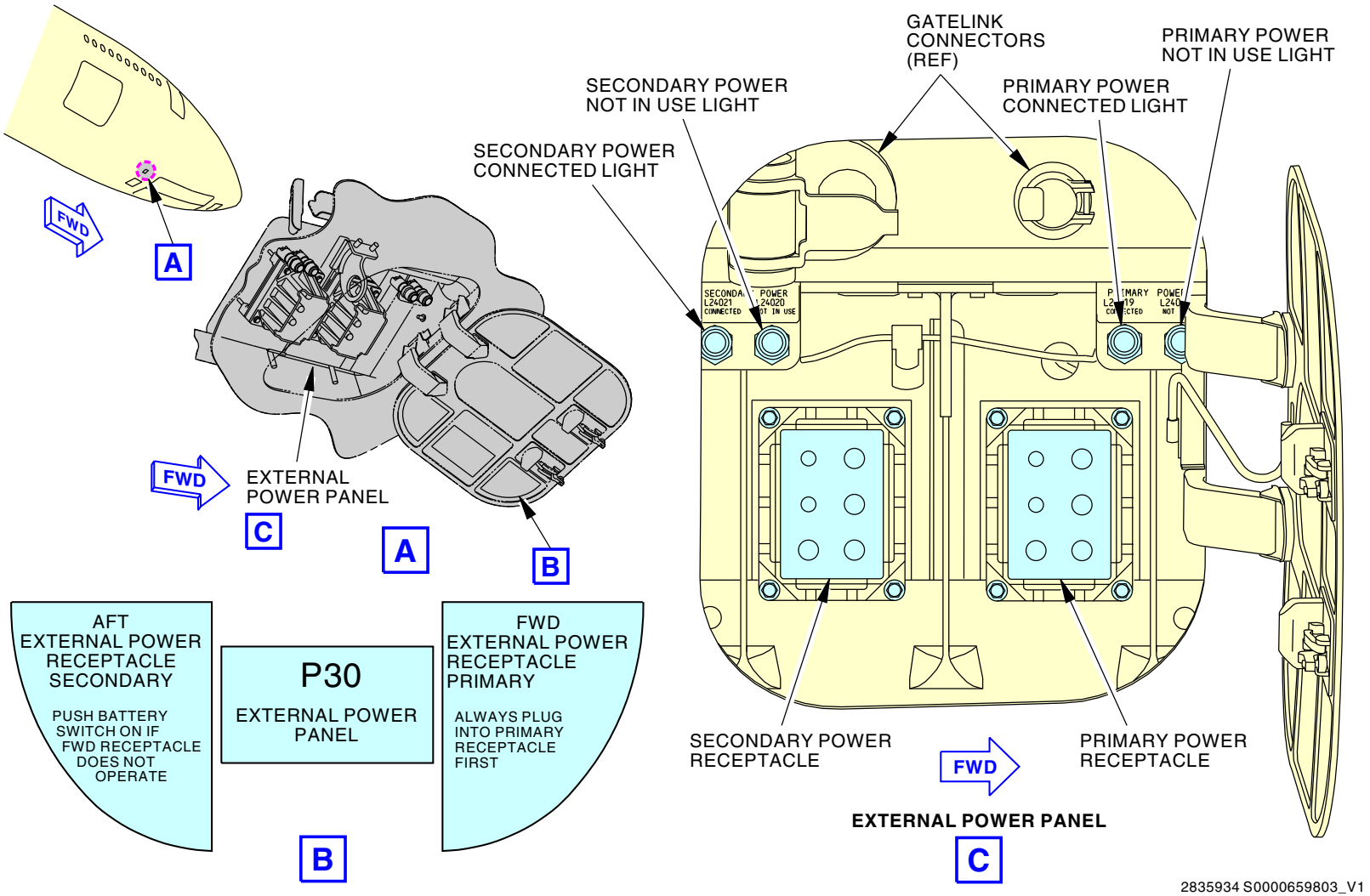
When you stow the hooks, make sure the straps are tight.

ARO ALL



M40318 S000616644_V1

EXTERNAL POWER - EXTERNAL POWER PANEL



2835934 S0000659803_V1

EXTERNAL POWER - EXTERNAL POWER PANEL

EXTERNAL POWER - FUNCTIONAL DESCRIPTION - BPCU

General

The BPCU controls external power on the airplane. It also controls ground handling and ground service power.

The BPCU sends data to the GCUs and the ELMS across the ARINC 629 systems data buses for power management. It also sends data to the AIMS for indications.

Switch Controls

These three switches supply control signals to the BPCU:

- Primary external power
- Secondary external power
- Ground service.

The BPCU supplies power to the switches and controls the lights in the switches.

Contactor and Relay Control

The BPCU controls these five electrical switching devices:

- Primary external power contactor (EPC)
- Secondary EPC
- Ground handling relay
- Ground service transfer relay
- Ground service select relay.

Power Transfer Control

The BPCU controls bus transfers between power sources. A reference frequency circuit in the BPCU permits no-break-power-transfers (NBPT) between external, APU, and IDG power sources on the ground. A NBPT is when two power sources momentarily parallel during a transfer. The power transfer circuit prevents any paralleling in the air and during takeoff and landing.

Protection

The BPCU protects the airplane electrical system from these external power problems:

- Over/under-voltage
- Over/under-frequency
- Over-current
- Unbalanced current
- Open phase
- Sustained parallel source (SPS)
- BPCU processor failure.

BPCU Power

The BPCU has these three power sources:

- Primary external power
- Battery bus #2
- Right dc bus.

A rectifier in the BPCU power supply changes the primary external ac power to dc. Battery bus #2 power connects to the BPCU when you push the battery switch on.

Power Quality

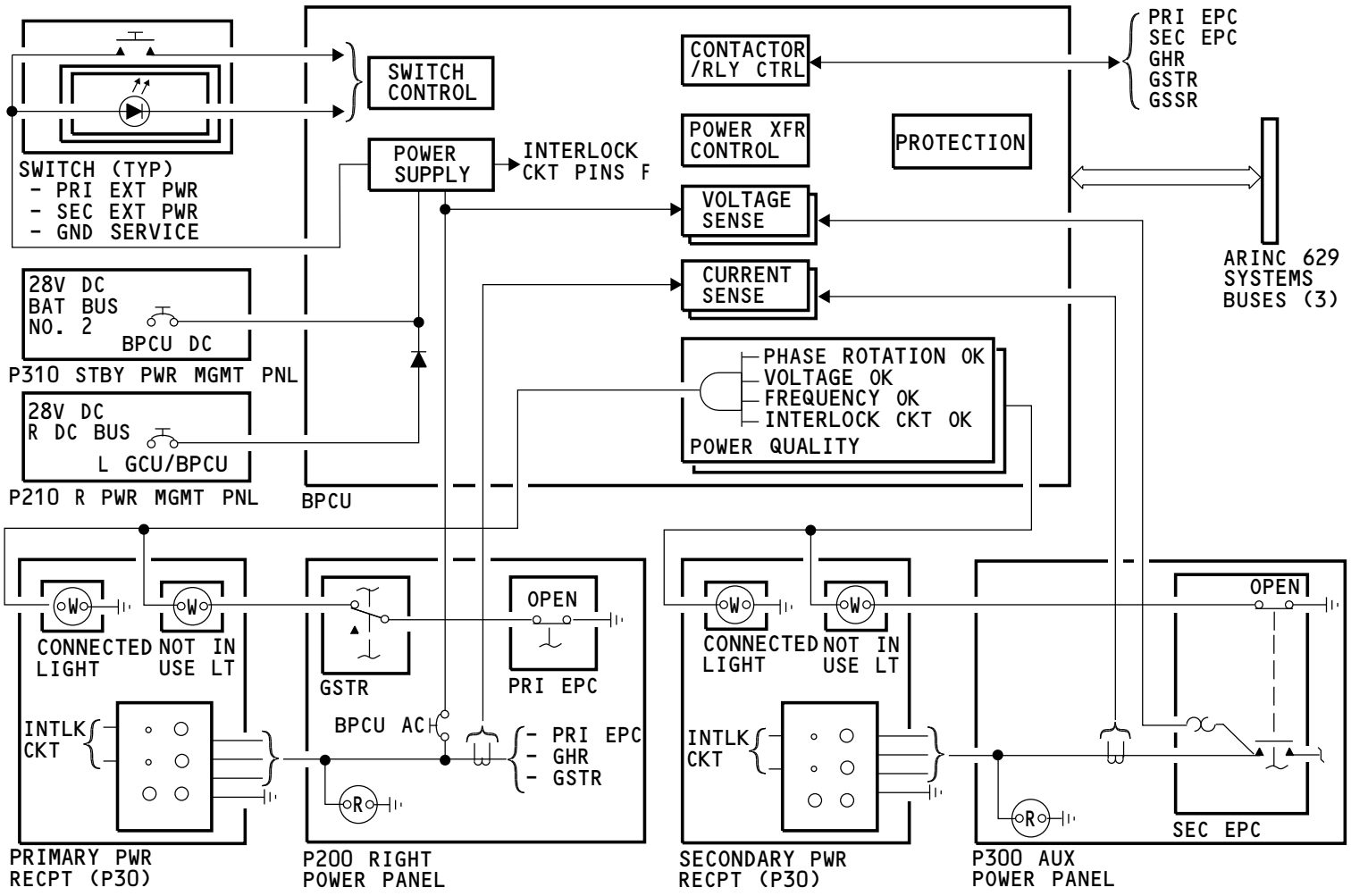
The BPCU checks the quality of the external power sources for:

- Phase rotation
- Voltage
- Frequency
- Interlock circuit.

If the power is good, the BPCU supplies power to turn on the related CONNECTED and NOT IN USE lights. When you select primary external power or ground service power, the primary NOT IN USE light goes off. When you select secondary external power, the secondary NOT IN USE light goes off.

Training Information Point

The secondary external power source does not supply power to the BPCU. To use secondary external power, you must connect the primary external power or push the battery switch on.



M40320 S000616646_V1

EXTERNAL POWER - FUNCTIONAL DESCRIPTION - BPCU

EXTERNAL POWER - GROUND HANDLING/GROUND SERVICE POWER - FUNCTIONAL DESCRIPTION

General

The BPCU controls the power to the ground handling bus and the ground service bus. Ground handling power is available only on the ground. Ground service power is available on the ground and in flight.

Ground Handling Power

When you apply good power to the primary power receptacle, the BPCU energizes one coil of the ground handling relay. This connects the primary external power to the ground handling bus.

If no primary external power is available but the APU generator power quality is good, the BPCU energizes the other coil of the ground handling relay. This connects the APU generator to the ground handling bus.

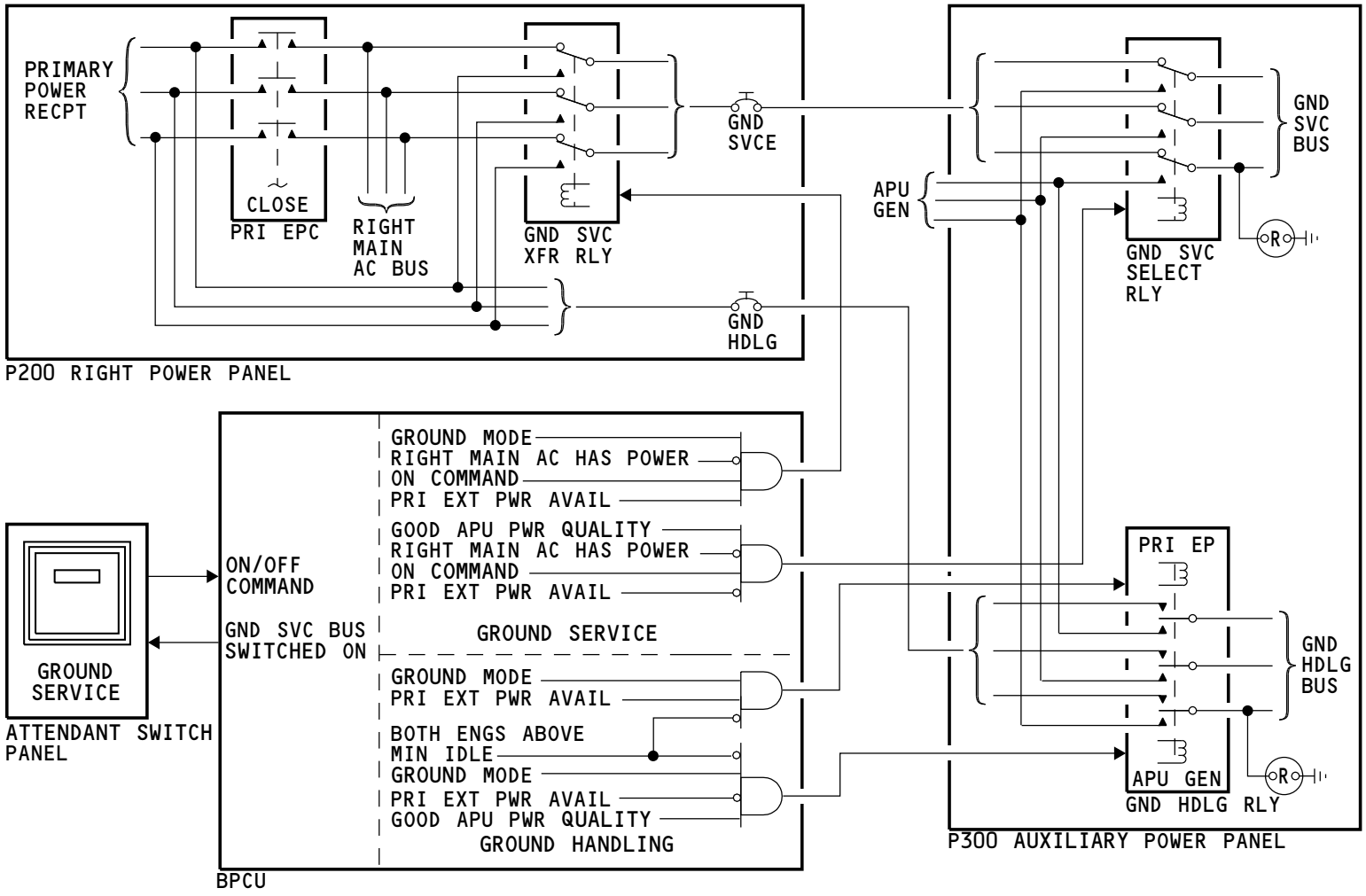
The ground handling bus will not have power if the engines are running or if the airplane is in the air.

Ground Service Power

When you apply good power to the primary power receptacle, power is available at the ground service transfer relay. When you push the ground service switch, the BPCU energizes the ground service transfer relay. This connects primary external power to the ground service bus. With primary external power on the ground service bus, the BPCU turns on the light in the ground service switch.

When you push the ground service switch with no primary external power available, but the APU generator power quality is good, the BPCU energizes the ground service select relay. This connects the APU generator to the ground service bus. With APU power on the ground service bus, the BPCU turns on the light in the ground service switch.

When the right main ac bus has power, it automatically supplies the power to the ground service bus. In this case, the ground service switch has no effect on the ground service bus. The light in the switch does not come on or it goes out if it was on.



M40321 S000616647_V1

EXTERNAL POWER - GROUND HANDLING/GROUND SERVICE POWER - FUNCTIONAL DESCRIPTION

EXTERNAL POWER - FUNCTIONAL DESCRIPTION - PRIMARY/SECONDARY POWER

General

The BPCU controls external power on the airplane. You use the external power switches on the electrical panel to supply command signals to the BPCU.

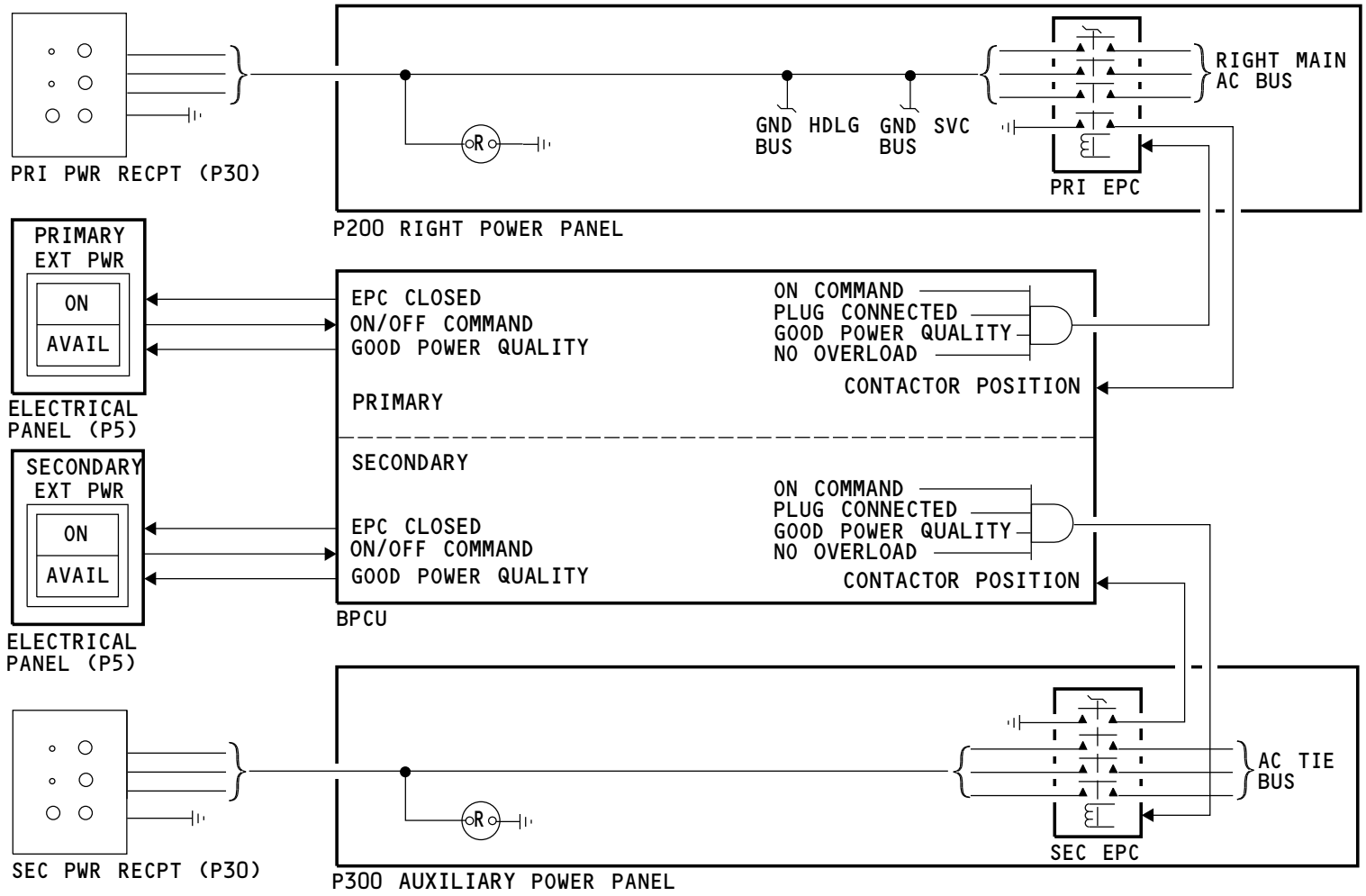
Primary External Power

When you apply power to the primary power receptacle, power is available at the primary EPC. With good power quality, the BPCU turns on the AVAIL light in the primary external power switch. When you push the primary external power switch, the BPCU energizes the primary EPC. This connects primary external power to the right main ac bus. When the EPC closes, the BPCU turns off the AVAIL light and turns on the ON light.

The BPCU must keep control power on the EPC to keep it closed. If you push the primary external power switch again, the on command in the BPCU goes away. This removes power to the EPC and it opens. The ON light goes off and the AVAIL light comes on again.

Secondary External Power

Secondary external power works the same as primary external power except the secondary external power connects to the ac tie bus through the secondary EPC.



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EXTERNAL POWER - FUNCTIONAL DESCRIPTION - PRIMARY/SECONDARY POWER

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EXTERNAL POWER - OPERATION

General

To apply external power to the airplane electrical system, do these steps:

- Connect ground power plugs
- Observe indications
- Operate control switches.

Placards inside the external power panel access door give specific information about connecting external power.

Connect Ground Power Plugs

ARO ALL PRE SB 777-24-0152

To connect to the power receptacles, you must loosen the restraining straps and remove the hooks from their stow points.

ARO ALL

You should always use the primary receptacle. If you need more power, you can use the secondary receptacle.

ARO ALL PRE SB 777-24-0152

Put in the ground power plug. Put the correct hook around the power cord behind the plug and tighten the restraining strap. Turn on power at the power source.

ARO ALL POST SB 777-24-0152

Put in the ground power plug. Put the correct hook around the power cord behind the plug, and secure using the ring hook. Turn on power at the power source.

ARO ALL

Observe Indications

If the quality of the power to the primary receptacle is good, the two lights above the receptacle come on. When the lights above the primary receptacle are on, the ground handling buses have power.

When you supply power to the secondary receptacle, the two lights above the receptacle come on if the power quality is good and one of these conditions are true:

- Primary receptacle has power
- Battery switch is on.

Operate Control Switches

Push the ground service switch to apply power to the ground service bus. The light in the switch comes on when the ground service bus has power. The NOT IN USE light above the primary receptacle goes off when the ground service bus gets power.

The AVAIL light in the primary external power switch comes on if the power quality is good.

The AVAIL light in the secondary external power switch comes on if the power quality is good and one of these conditions are true:

- Primary receptacle has power
- Battery switch is on.

Push the battery switch on. Push the primary external power switch to apply primary ground power to the airplane electrical system. Push the secondary external power switch to apply secondary ground power to the airplane electrical system. When you supply power, the AVAIL lights go off and the ON lights come on.

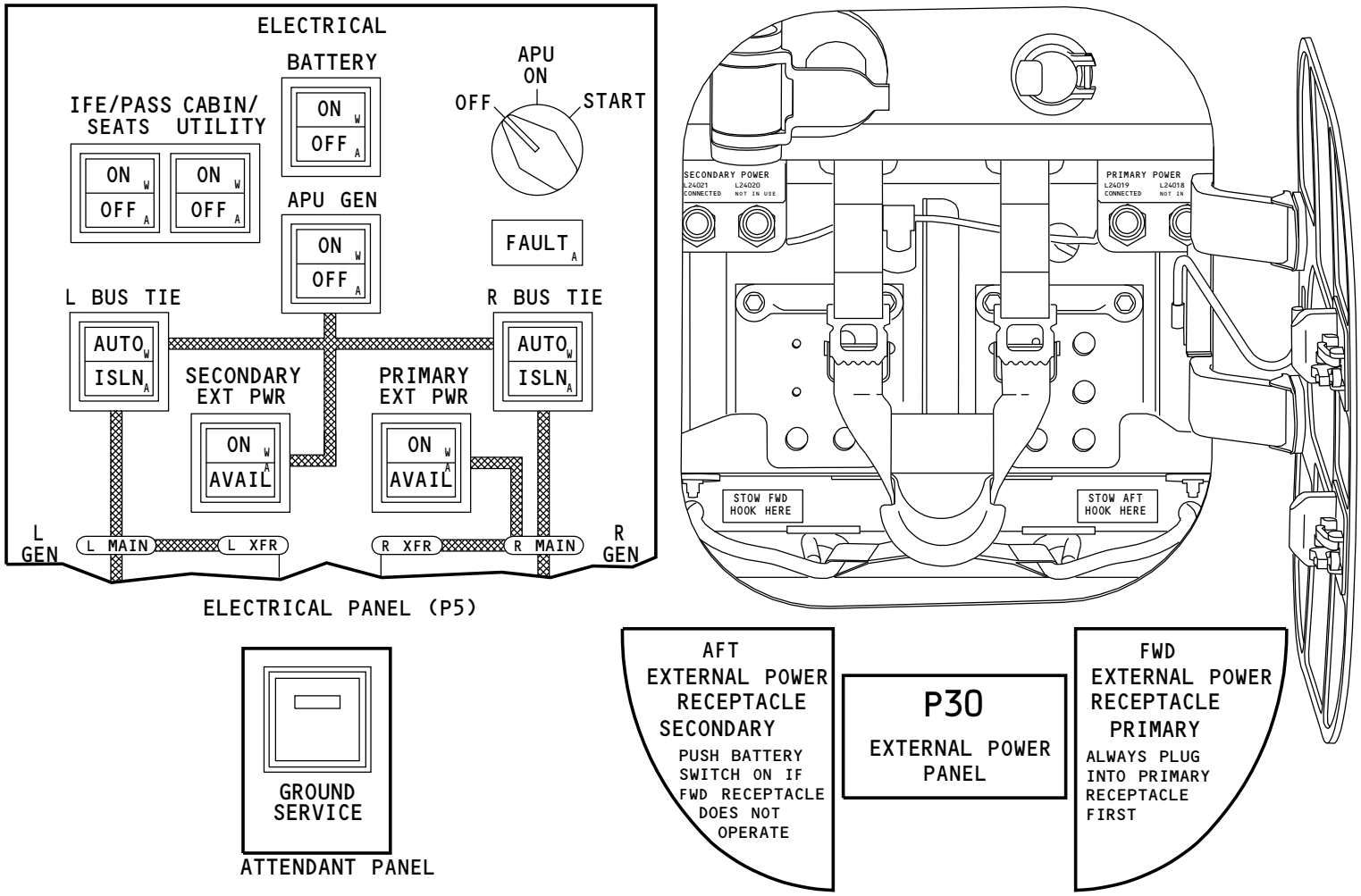
Push the battery switch to off if the airplane is to have power with no personnel on board. This prevents the automatic operation of the standby power system if you lose all ground power.

Training Information Points

Use external power sources that have a power capacity of 90 kilovolt-ampere (kVA) or more for each power receptacle. If you do not, Electrical Load Management System (ELMS) can remove all the loads it controls or the Bus Power Control Unit (BPCU) can open the external power contactor(s). See the Electrical Load Management System section for more information on load shedding (SECTION 24-09).

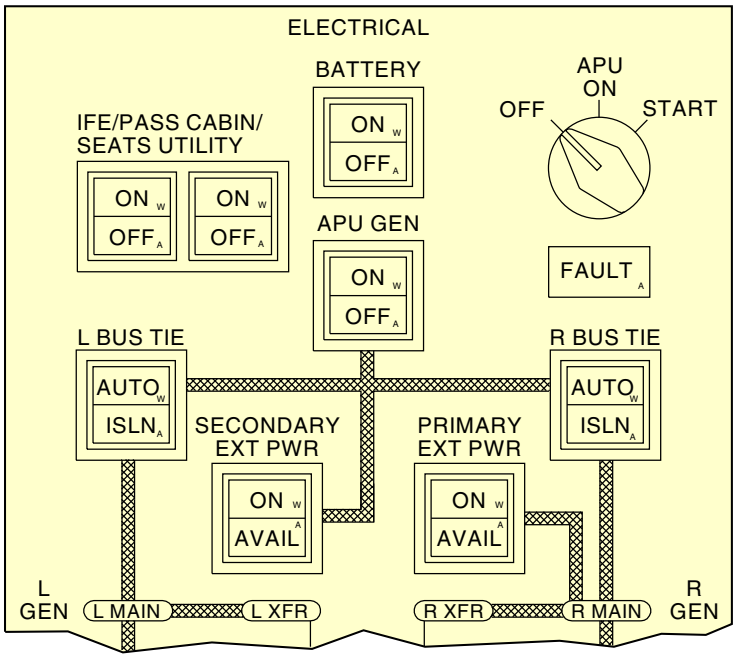
EXTERNAL POWER - OPERATION

If electrical power is supplied to the airplane while it is on jacks, prevent the activation of standby power by opening the Main Battery Relay Control circuit breaker. If this circuit breaker is not open, the main battery can overheat.

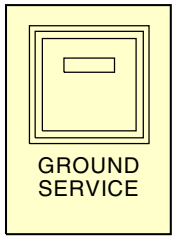


M40362 S000616653_V1

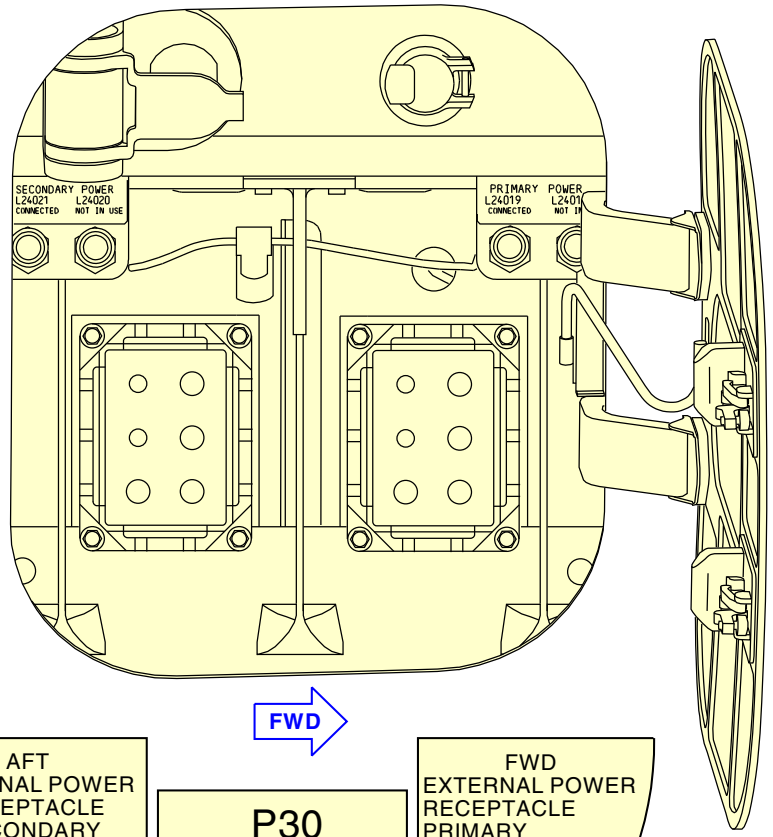
EXTERNAL POWER - OPERATION



ELECTRICAL PANEL (P5)



ATTENDANT PANEL



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EXTERNAL POWER - OPERATION

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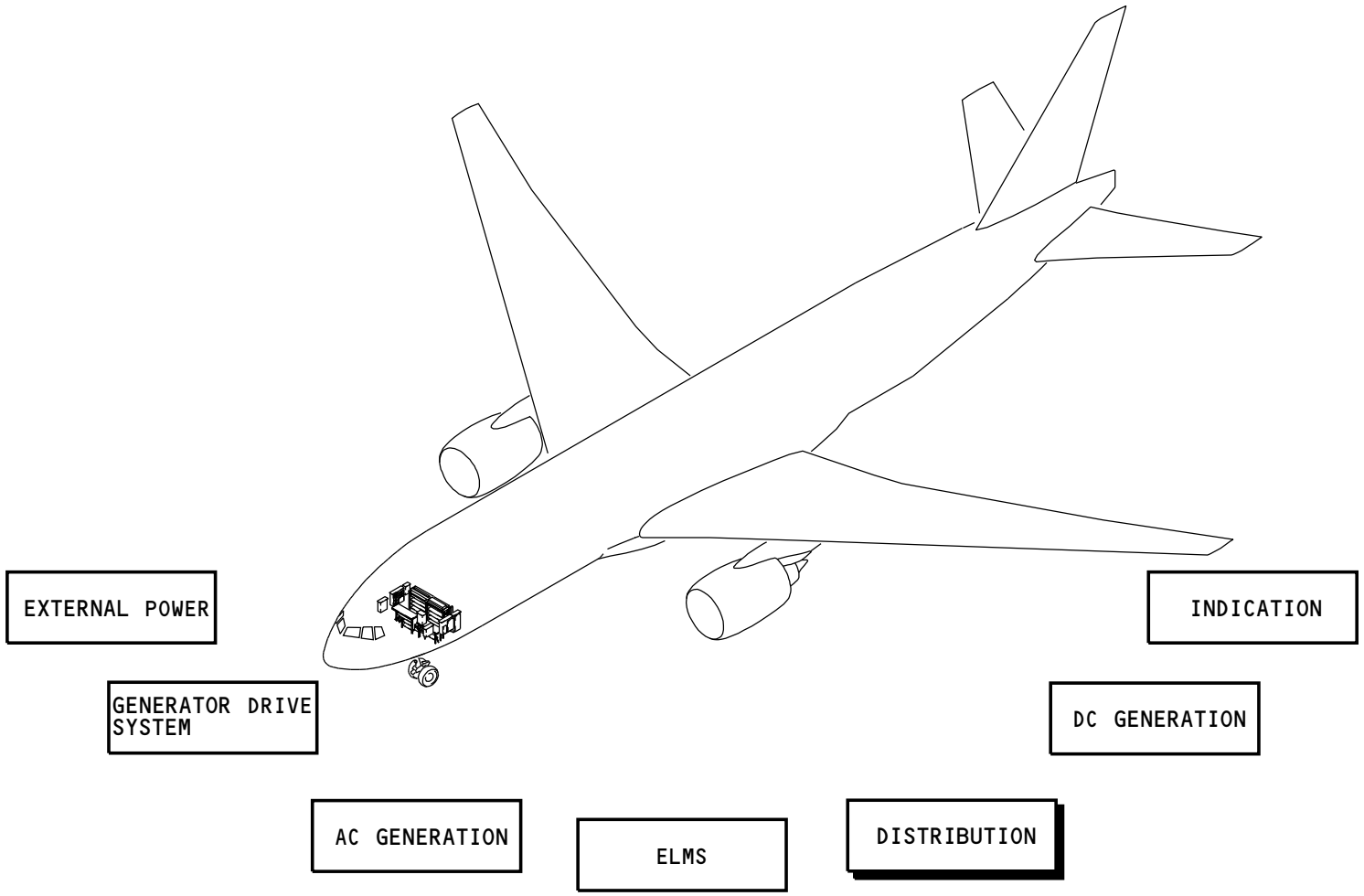
AC DISTRIBUTION - INTRODUCTION

General

The distribution section of electrical power includes both ac and dc power distribution.



M40324 S000616654_V1

AC DISTRIBUTION - INTRODUCTION

AC DISTRIBUTION - GENERAL DESCRIPTION

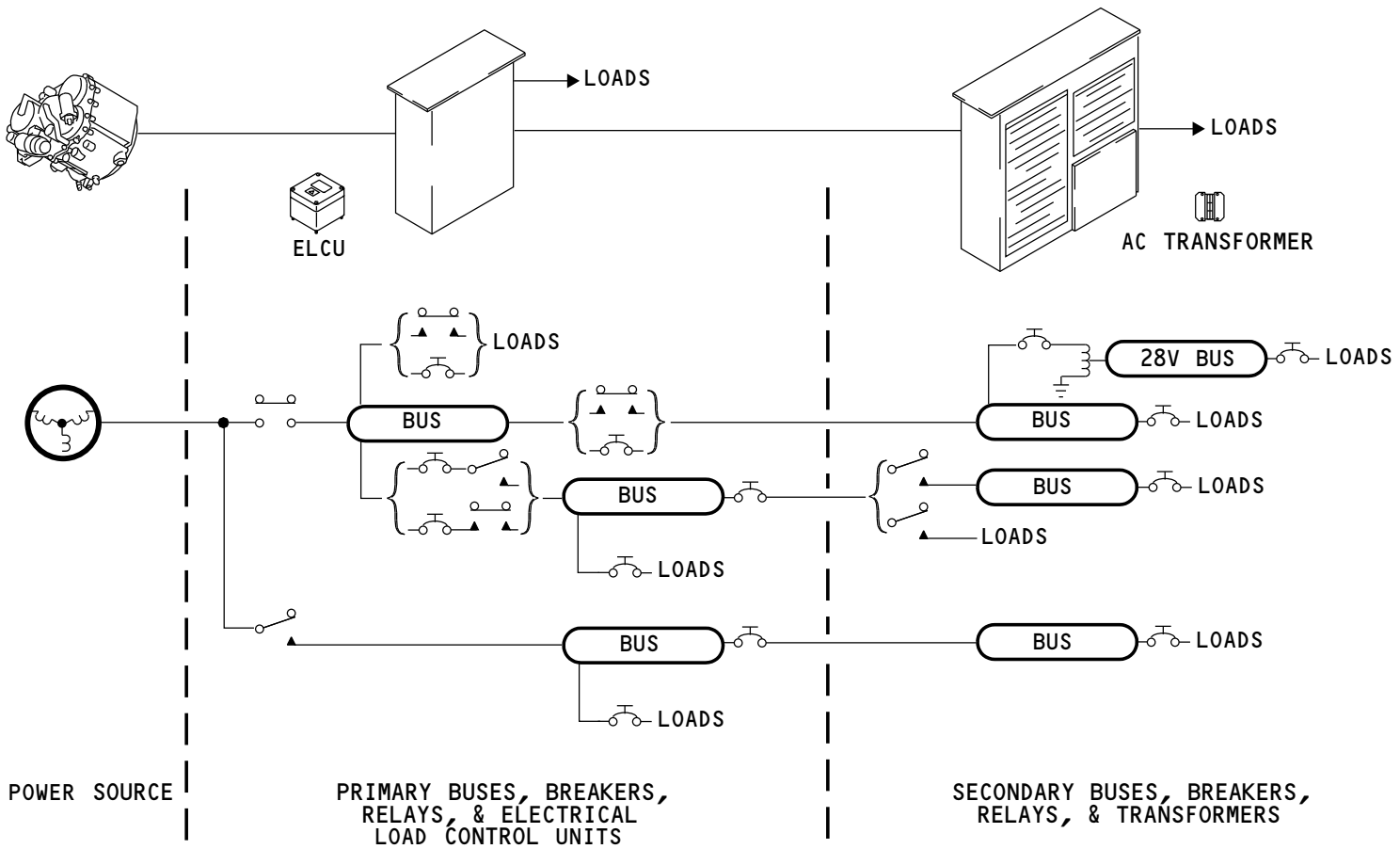
General

The ac distribution system divides the electrical power ac buses into sections. This permits better control over small groups of electrical loads. It also protects against a severe loss of power due to a single electrical power failure.

These are the only components in the ac distribution system:

- Electrical load control units (ELCU)
- 28v ac transformers.

A primary function of the ac distribution system is autoland bus isolation.



M40325 S000616655_V1

AC DISTRIBUTION - GENERAL DESCRIPTION

AC DISTRIBUTION - ELECTRICAL LOAD CONTROL UNIT

General

The ELCUs control and protect the electrical power supplied to large ac loads. There are several ELCUs in the P100 and P200 power panels.

Physical Description

The ELCUs are LRMs of the ELMS power panels. The ELCUs contain these parts:

- Current transformers
- Contactor
- Power supply
- Control logic.

The ELCUs are ESDS components because of the wiring connections to the control logic.

Control

The ELCUs use these things to control their contactors:

- Current transformers
- Rating jumper
- Input command.

The ELCU current transformers supply signals to the control logic for overcurrent and differential fault protection. The load current transformer signal supplies the second current signal necessary for differential fault protection. The control logic does not use the differential fault protection function if there is no load current transformer connected to the ELCU.

A rating jumper (external wiring) across pins of galley ELCU power panel wiring connectors sets the current capacity of the ELCUs.

A control signal to the ELCU causes it to open or close. The control signal comes from the ELMS or other airplane systems.

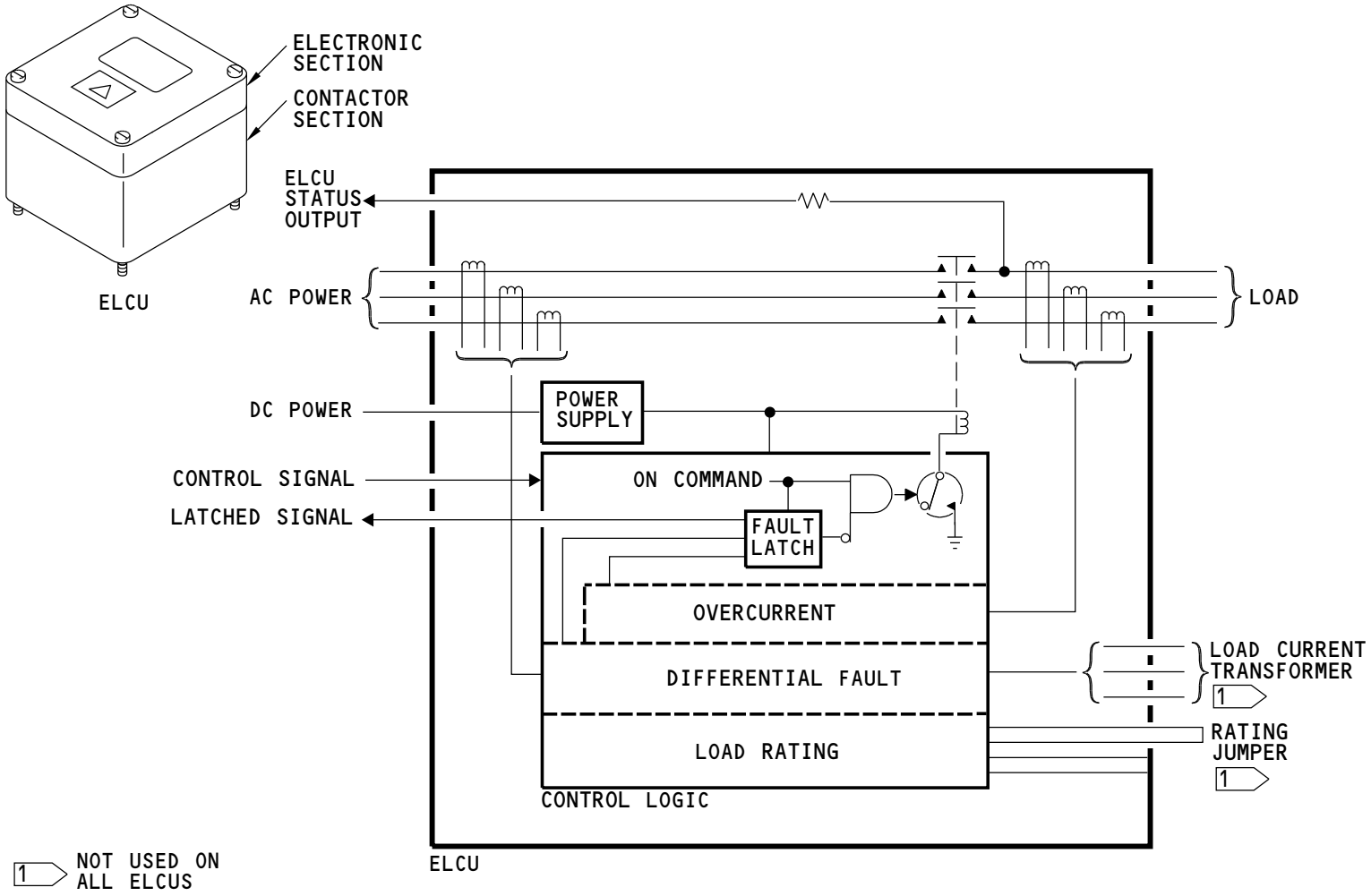
Operation

The ELCU contactor connects ac power to the load when the control inputs satisfy the control logic.

When the ELCU closes, a voltage signal goes to the ELMS for ELCU status monitoring. If the ELCU opens due to a fault, it latches open and sends a latched open signal to the ELMS. The ELCU is reset when the control signal goes off and then back on or when you remove dc power to the ELCU.

Training Information Point

Each ELCU is a two-piece unit. Do not disassemble it. The mounting screws are captive, but can be unscrewed from the ELCU housing. With the screws removed the electronic section can move apart from the contactor section for shop repair.



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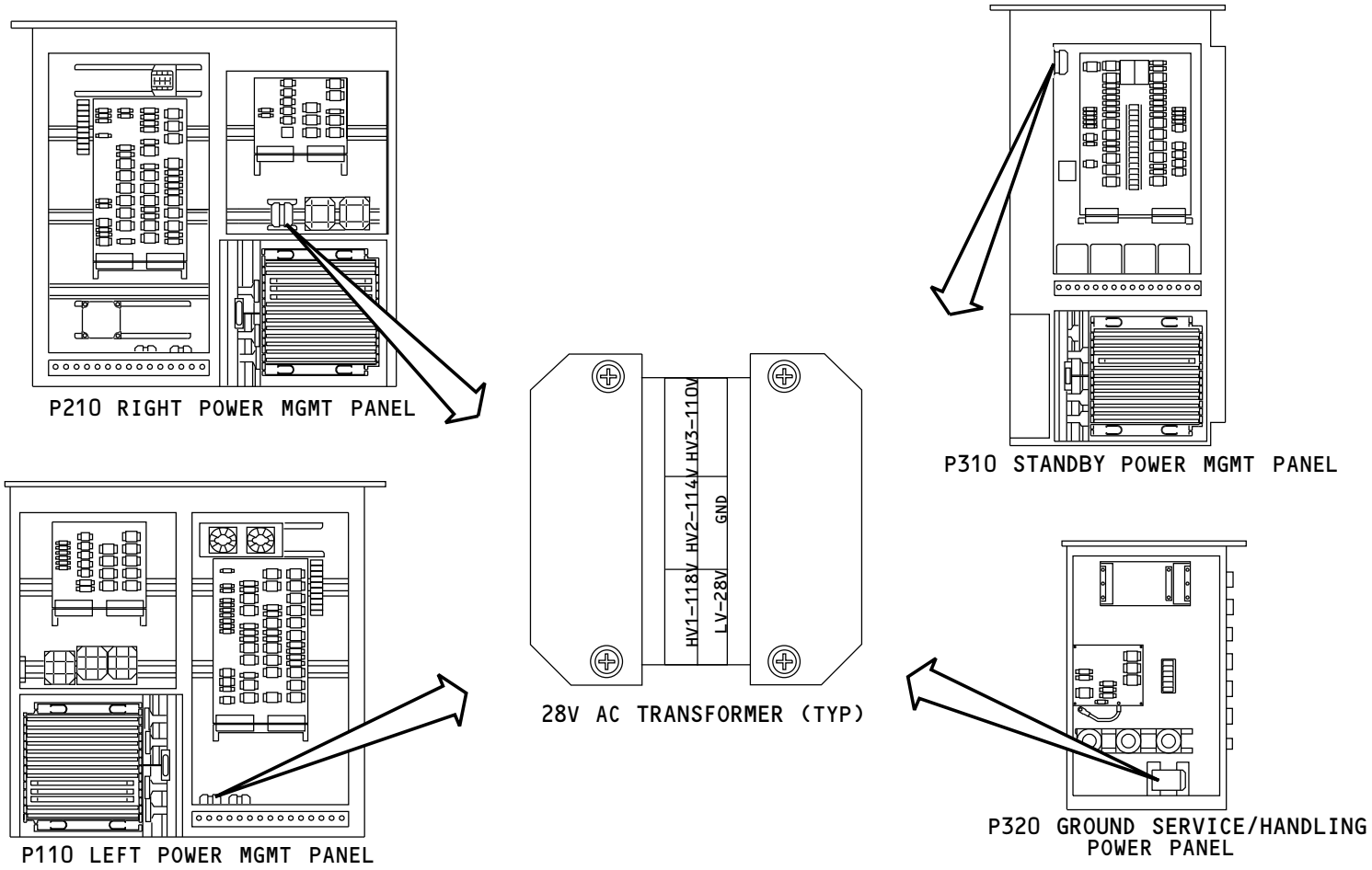
AC DISTRIBUTION - ELECTRICAL LOAD CONTROL UNIT

AC DISTRIBUTION - 28V AC TRANSFORMERS

General

The 28v ac transformers convert 115v ac power into 28v ac power. There are four transformers. They are in the ELMS power management panels and ground service/handling power panel. These are typical loads for the 28v ac power:

- Signal conditioning card power supply
- Resolver excitation
- Sensor excitation
- Service lights.



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AC DISTRIBUTION - 28V AC TRANSFORMERS

AC DISTRIBUTION - FUNCTIONAL DESCRIPTION - POWER DISTRIBUTION

General

The ac distribution divides the electrical power buses into sections. The primary buses are in the ELMS power panels P100, P200, and P300. These are the primary buses of the electrical power ac system:

- Left main ac
- Left transfer
- Right main ac
- Right transfer
- Ground handling ac
- Ground service.

Left Main AC Bus

The left main ac bus divides into these buses:

- Left transfer
- Left utility
- Left section 1
- Left section 2.

The left section 1 bus supplies power to an ac transformer for the left 28v ac bus. The left section 2 bus is a P11 power source.

Left Transfer Bus

The left transfer bus divides into these:

- P11 supply
- Left transfer distribution bus
- Standby ac bus.

The standby ac bus supplies power to an ac transformer for the 28v ac standby bus.

Tow AC Bus

A static inverter supplies power to the tow ac bus.

Right Main AC Bus

The right main ac bus divides into these buses:

- Right transfer
- Right utility
- Right section 1
- Right section 2.

The right section 1 bus supplies power to an ac transformer for the right 28v ac bus. The right section 2 bus is a P11 power source.

Right Transfer Bus

The right transfer bus divides into these:

- P11 supply
- Right transfer distribution bus.

Ground Handling AC Bus

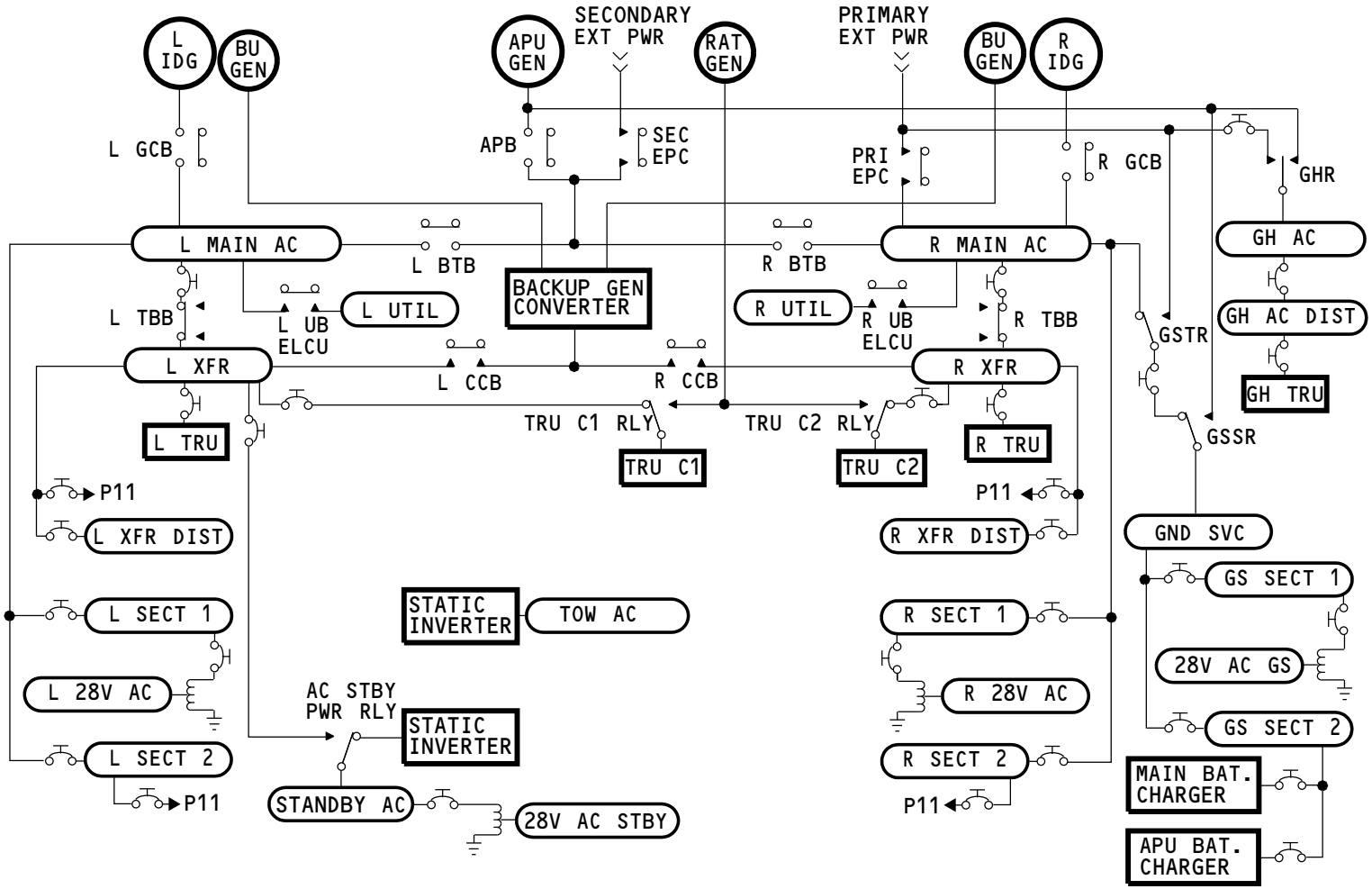
The ground handling ac bus supplies power to the ground handling distribution bus.

Ground Service Bus

The ground service bus divides into these buses:

- Ground service section 1
- Ground service section 2.

The ground service section 1 bus supplies power to an ac transformer for the 28v ac ground service bus.



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AC DISTRIBUTION - FUNCTIONAL DESCRIPTION - POWER DISTRIBUTION

General

Autoland is an automatic flight director system (AFDS) mode. In this mode, the AFDS automatically lands the airplane.

During autoland, the electrical system divides into three different channels (bus isolation). This is to ensure that a single electrical power problem does not endanger the automatic landing.

Bus Isolation Process

The automatic flight director computers (AFDC) get an autoland request from pilot input. They send a bus isolation request signal on the systems ARINC 629 buses to these electrical power system components:

- ELMS
- BU generator converter
- GCUs.

Under normal conditions, the ELMS and the B/U generator converter divide the electrical system. The ELMS operates these components:

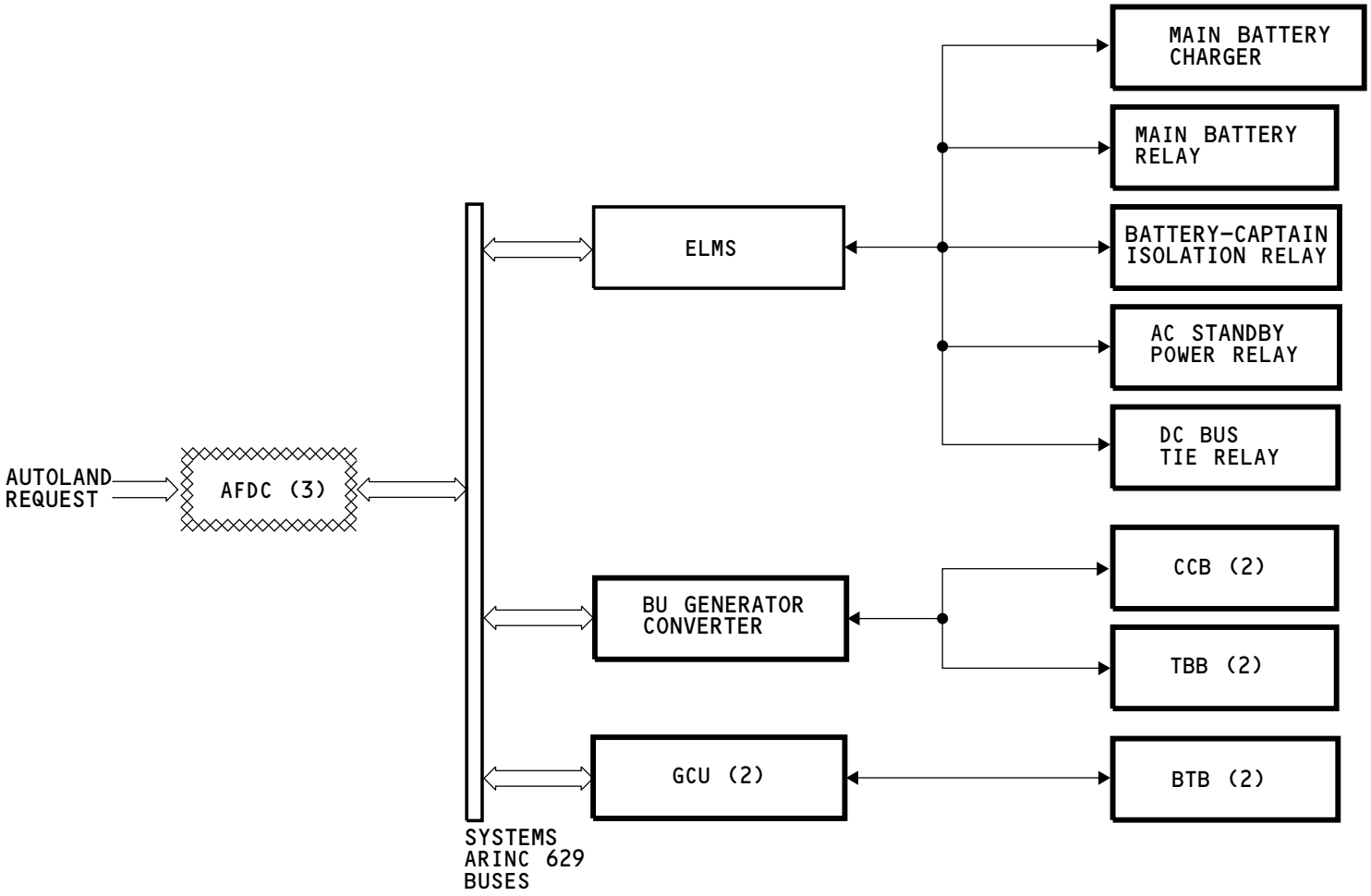
- Main battery charger
- Main battery relay
- Battery-captain isolation relay
- AC standby power relay
- DC bus tie relay.

The B/U generator converter operates the CCBs and TBBs.

When the bus isolation is complete, the B/U converter and the ELMS send autoland confirm signals to the AFDCs.

If the electrical power system is in a non-normal configuration before an autoland, other power configurations support the bus isolation. The GCUs then control part of the bus isolation.

If the electrical system cannot divide to support an autoland, the electrical control components send cannot-support-autoland signals to the AFDCs. The primary display system then shows a NO LAND 3 advisory message.



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AC DISTRIBUTION - FUNCTIONAL DESCRIPTION - AUTOLAND BUS ISOLATION INTERFACES

AC DISTRIBUTION - FUNCTIONAL DESCRIPTION - NORMAL AUTOLAND BUS ISOLATION

General

When the electrical power system receives a bus isolation request signal from the AFDS, it divides into three different channels. This is to supply power to critical autoland components from different power sources. For normal autoland operations, these are the power sources for the three electrical power channels:

- Left IDG
- Right B/U generator
- Right IDG.

B/U Generator Converter Control

The B/U generator converter closes the right CCB to perform a no-break power transfer between the right B/U generator and the right transfer bus. The converter then opens the right TBB. The converter also prevents any operation of the left TBB and left CCB during autoland.

ELMS Control

The ELMS does these operations:

- Sends a signal to put the main battery charger into a TRU mode
- Closes the main battery relay
- Opens the battery-captain isolation relay
- De-energizes the ac standby power relay to connect the standby ac bus to the static inverter
- Prevents operation of the dc bus tie relay.

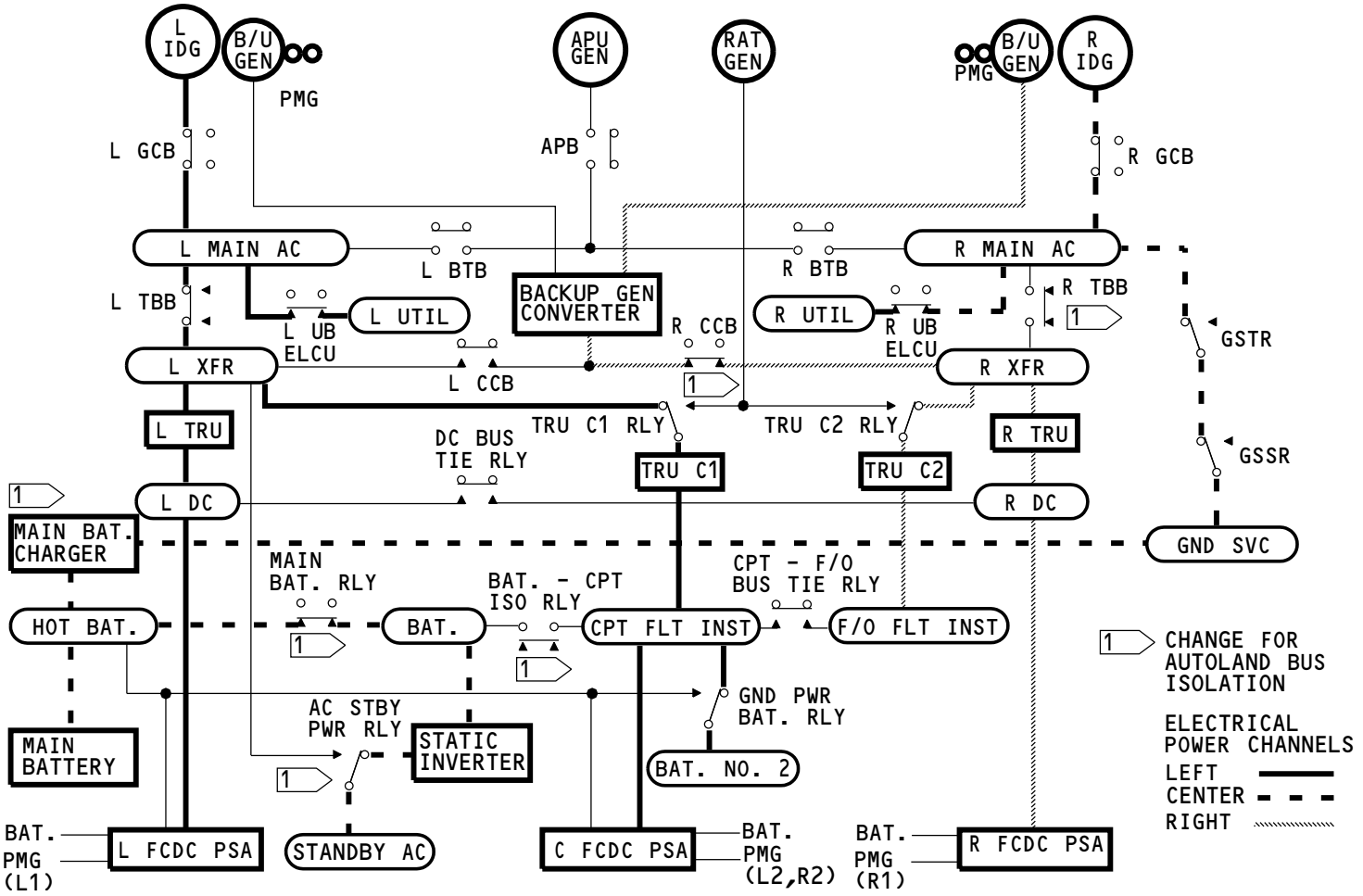
Autoland Components

There are three sets of critical autoland components; left, center, and right. These are the components in each set and their power requirements:

- Instrument landing system (ILS) (115v ac)
- Radio altimeter (115v ac)
- AFDC (28v dc)
- ILS antenna switch (28v dc).

During autoland bus isolation, the left set gets power from the left transfer bus and the left dc bus. The center gets power from the standby ac bus and the battery bus. The right set gets power from the right transfer bus and the right dc bus.

For more details on autoland, go to chapter 22.



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AC DISTRIBUTION - FUNCTIONAL DESCRIPTION - NORMAL AUTOLAND BUS ISOLATION

AC DISTRIBUTION - MEDICAL OUTLET SYSTEM

General

The medical outlet system provides electrical power for medical use by passengers and crew. The interface to the system is through the outlet(s) installed in the passenger compartment. The system can be activated on the ground and in air.

The medical outlet system have these components:

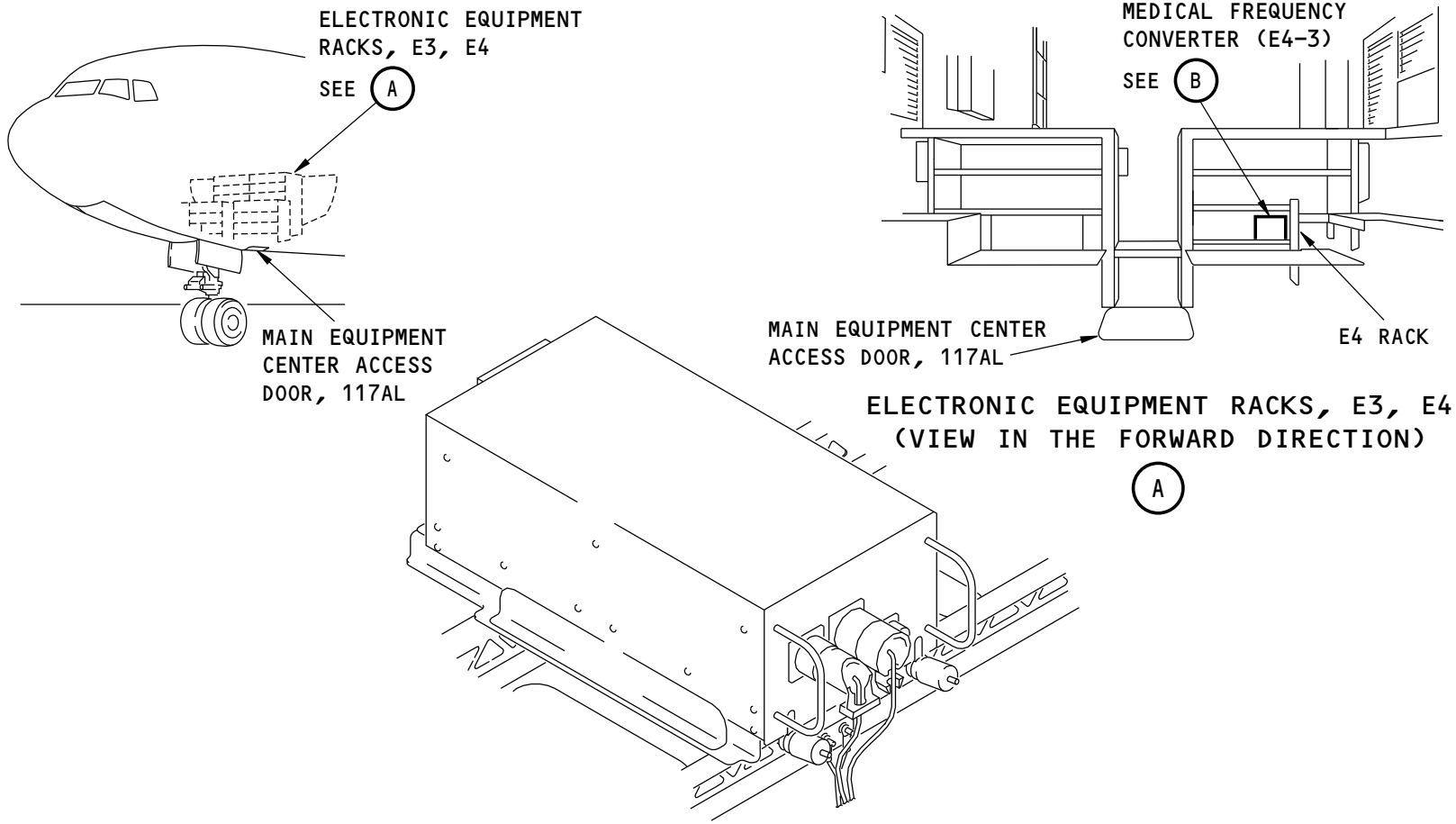
- Medical frequency converter
- Medical outlets
- Medical outlet power switch

Physical Description

The medical frequency converter is located on the E4-3 electrical/electronic equipment rack. It converts the frequency to support the medical equipment.

The medical outlet(s) are located in the passenger compartment. It has window shade type covers that slide away to expose the receptacles for use.

The medical outlet power switch is located on the medical outlets power module on P61, controls the medical frequency converter on-off.



ELECTRONIC EQUIPMENT RACKS, E3, E4
(VIEW IN THE FORWARD DIRECTION)

A

MEDICAL FREQUENCY CONVERTER
(EXAMPLE)

B

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AC DISTRIBUTION - MEDICAL OUTLET SYSTEM

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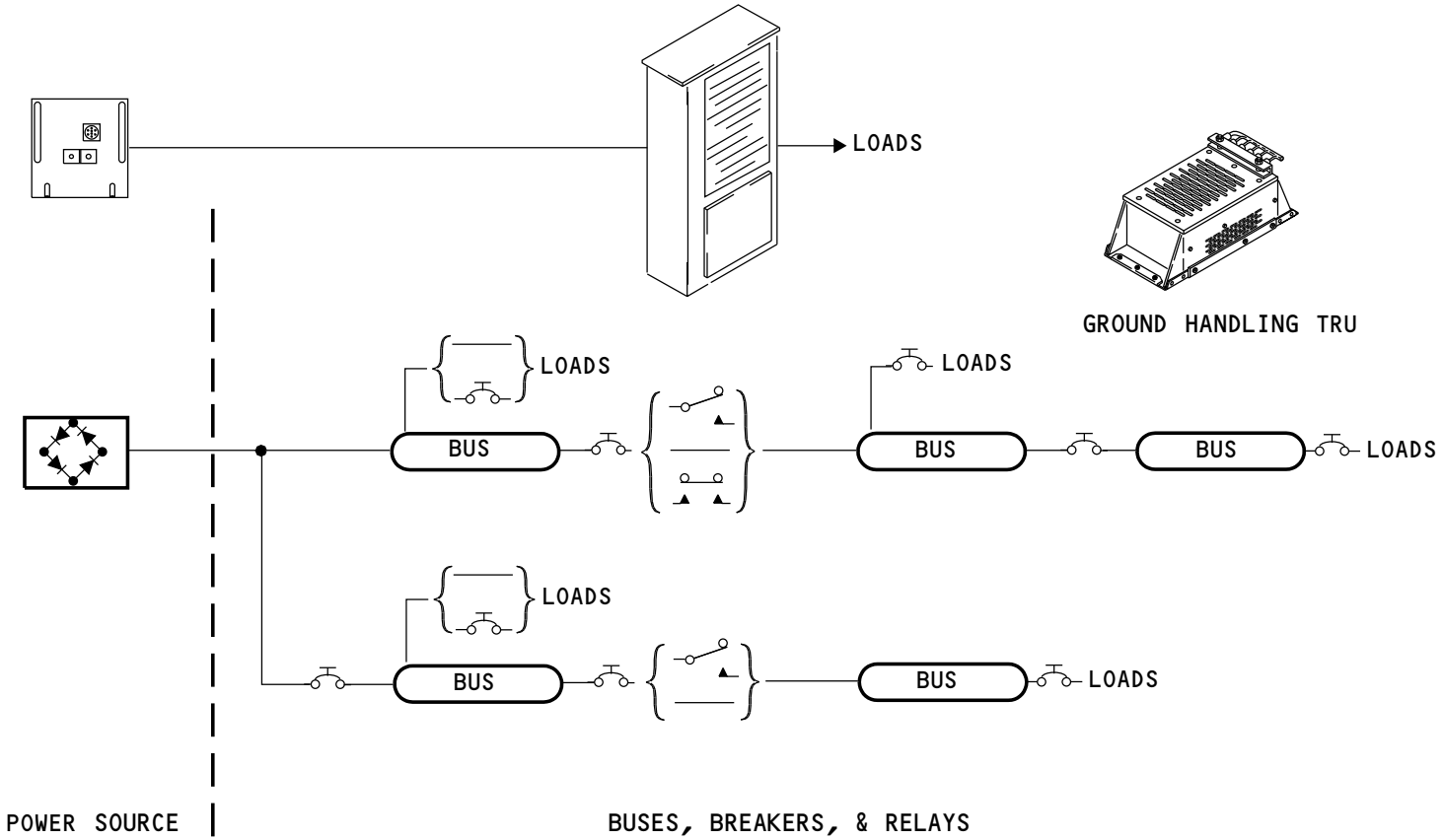
DC DISTRIBUTION - GENERAL DESCRIPTION

General

The dc distribution system divides the electrical power dc buses into sections. This permits better control over small groups of electrical loads. It also protects against a severe loss of power due to a single electrical power failure.

The ground handling TRU is the only component in the dc distribution system.



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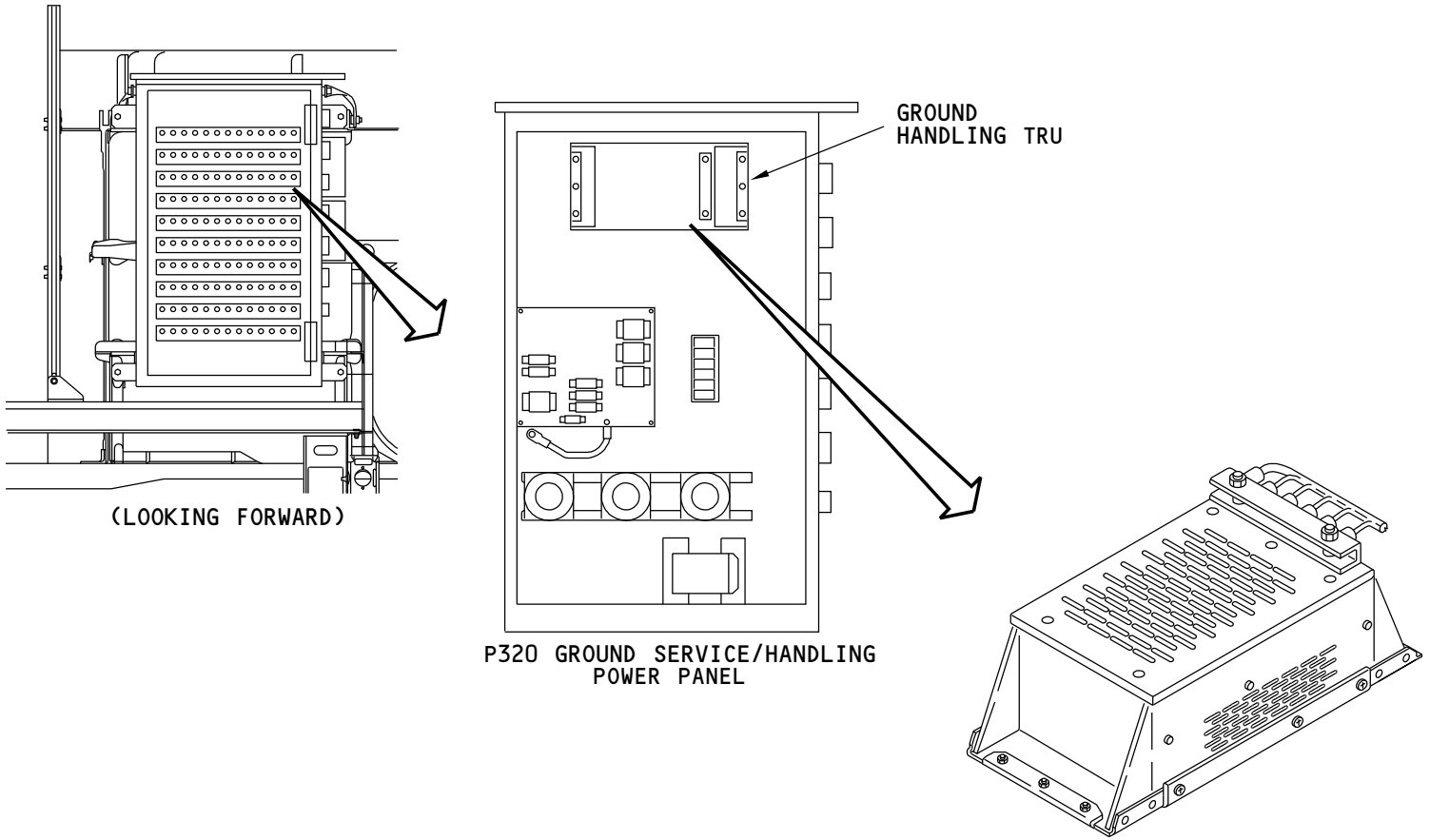
DC DISTRIBUTION - GENERAL DESCRIPTION

DC DISTRIBUTION - GROUND HANDLING TRU

General

The ground handling TRU is in the P320 ground service/handling power panel. It converts ac power into 28v dc power. These are typical loads for the ground handling 28v dc power:

- Cargo handling
- Refuel valves
- Refuel quantity control/indication
- Service interphone
- Powered door opening system (engine cowls).



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DC DISTRIBUTION - GROUND HANDLING TRU

DC DISTRIBUTION - FUNCTIONAL DESCRIPTION - POWER DISTRIBUTION

General

The dc distribution divides the electrical power dc buses into sections. The primary buses are in the ELMS power management panels P110, P210, and P310. These are the primary buses of the electrical power dc system:

- Hot battery
- Left dc
- Right dc
- Captain's flight instrument
- First officer's flight instrument.

The ground handling bus is in the P320 ground service/handling power panel. The APU battery bus is in the P49 APU panel.

Hot Battery Bus

The hot battery bus divides into these:

- Tow dc bus
- P11 supply
- Hot battery distribution bus.

Left and Right DC Buses

The left and right dc buses do not divide. They do supply power to P11.

Captain's Flight Instrument Bus

The captain's flight instrument bus divides into these buses:

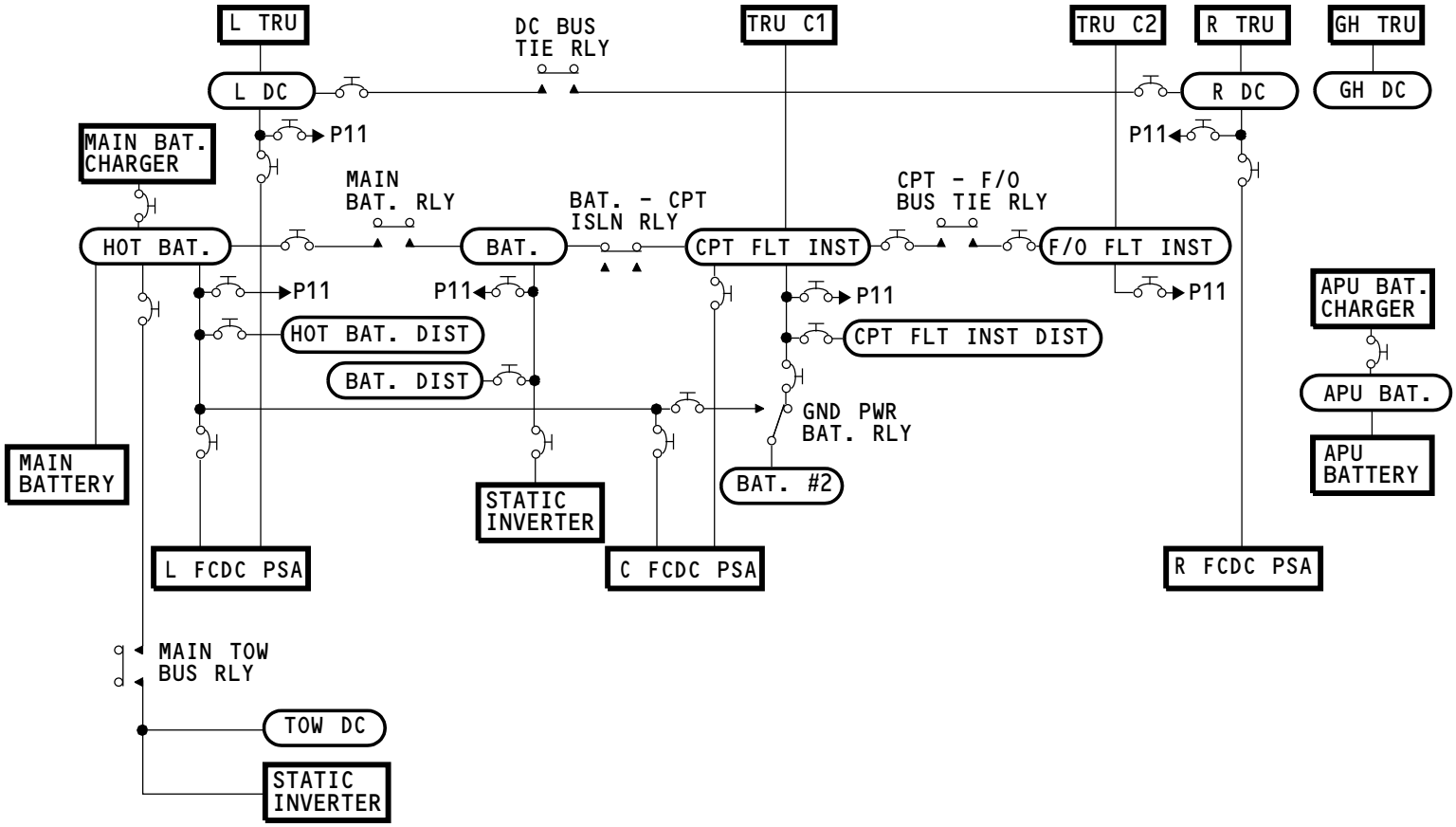
- Battery bus
- P11 supply
- Captain's flight instrument distribution bus
- Battery #2 bus.

The battery bus further divides into these:

- P11 supply
- Battery distribution bus.

First Officer's Flight Instrument Bus

The first officer's flight instrument bus does not divide. It does supply power to the P11.



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DC DISTRIBUTION - FUNCTIONAL DESCRIPTION - POWER DISTRIBUTION