CHAPTER

24

Electrical Power

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Electrical Power

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Electrical Power

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ELECTRICAL POWER - INTRODUCTION

Purpose

The electrical power system makes, supplies, and controls electrical power. The system has automatic and manual control features. Built-in test equipment (BITE) and alternate source selection make the system reliable and easy to keep.

Electrical power has these subsystems:

- Generator drive
- AC generation
- DC generation
- External power
- AC electrical load distribution.

Abbreviations and Acronyms

- AGCU - APU generator control unit
- AGB - accessory gearbox
- altn - alternate
- APB - APU breaker
- APS - APU power switch
- APU - auxiliary power unit
- ASG - APU starter-generator
- auto - automatic
- bat - battery
- BPCU - bus power control unit
- BTB - bus tie breaker
- CSD - constant speed drive
- CT - current transformer
- chgr - charger
- disc - disconnect
- DEU - display electronic unit
- DPCT -differential protection current transformer
- EEC - electronic engine control
- EP - external power
- EPC - external power contactor
- flt - flight
- fltr - filter
- F/O - first officer
- GCB - generator control breaker
- GCR - generator control relay
- GCU - generator control unit
- gen - generator
- gnd - ground
- grd - ground
- GSTR - ground service transfer relay
- IDG - integrated drive generator
- j - junction
- LRU - line replaceable unit
- NCT - neutral current transformer
- PDP - power distribution panel
- PMG - permanent magnet generator
- pwr - power
- QAD - quick attach detach
- rly - relay
- RMS - root mean square
- RTL - ready to load
- scav - scavenge
- SCU - start converter unit
- sect - section
- SPCU - standby power control unit
- SPU - start power unit
- srvce - service

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- stdby - standby
- sys - system
- thrm - thermal
- TRU - transformer rectifier unit
- VR - voltage regulator
- xfr - transformer

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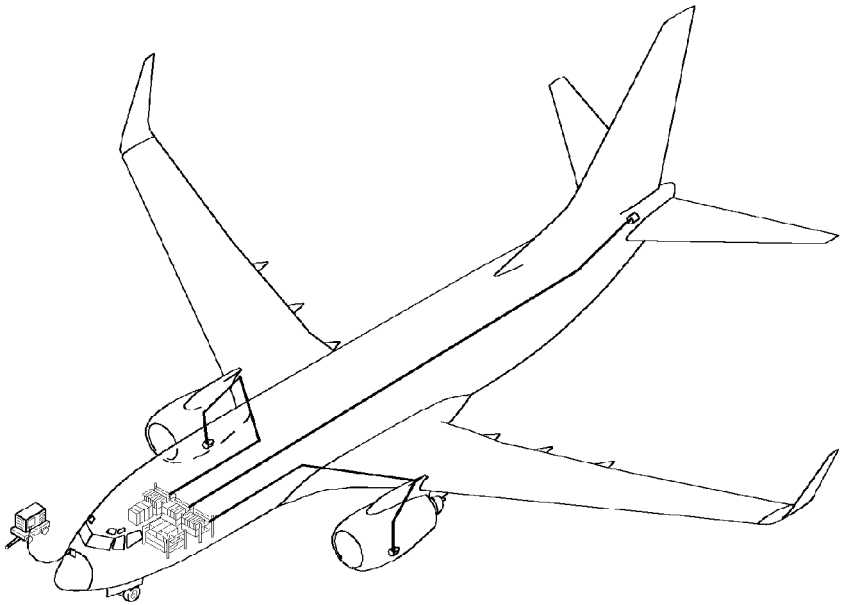

ELECTRICAL POWER - INTRODUCTION

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ELECTRICAL POWER - POWER AND CONTROL - GENERAL DESCRIPTION

Purpose

The electrical power system makes and supplies AC and DC power to airplane. The system has automatic and manual controls and protection. A standby AC and DC system gives normal and emergency power.

AC Power

The electrical power system has four main AC power sources and one standby power source. These are the main AC power sources and their supply capacity:

- Left integrated drive generator (IDG 1) (90 KVA)
- Right integrated drive generator (IDG 2) (90 KVA)
- APU starter-generator (90 KVA below 32,000 feet/9,753 meters, and goes down to 66 KVA at 41,000 feet/12,496 meters)
- External power (90 KVA).

The IDGs and APU starter-generator supply a 3 phase, 115/200 volts (nominal) at 400 Hz. The AC power system design prevents two sources to the same load at the same time.

The static inverter supplies a one phase, 115v ac output to the AC standby bus.

DC Power

Three transformer rectifier units (TRUs) change 115v ac to 28v dc. The airplane also has these DC power sources:

- Main battery
- Main battery charger
- Auxiliary battery
- Auxiliary battery charger.

The batteries are the backup DC source if other sources do not operate. The standby power control unit (SPCU) controls the distribution of dc power.

Standby Power

With the loss of normal power, the standby power system supplies a minimum of 60 minutes of AC and DC power to systems necessary to maintain safe flight. The batteries supply DC power. The static inverter uses battery power to make AC power. The SPCU controls the distribution of AC and DC standby power.

Protection

The electrical power system uses automatic control to protect the system from source failure or load failure. These line replaceable units (LRUs) supply the system with protection and control logic:

- Left generator control unit (GCU 1)
- Right generator control unit (GCU 2)
- APU generator control unit (AGCU)
- Bus power control unit (BPCU)
- Standby power control unit (SPCU)
- Start converter unit (SCU).

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The GCUs monitor the system to control and protect the IDGs. The APU GCU and the starter converter unit (SCU) work together to control and protect the APU starter-generator. The bus power control unit (BPCU) controls and monitors the use of external power. The BPCU protects the airplane from external power whose quality is out of limits.

Control

These modules on the P5 panel give manual control of the electrical power system:

- Electrical meters, battery and galley power module (P5-13)
- Generator drive and standby power module (P5-5)
- AC systems, generator and APU module (P5-4).

The switches on these modules send signals to the LRUs that control portions of the system. The LRUs then energize or de-energize relays or breakers to control electrical power.

Breakers allow power to the buses. A breaker closes to let power through it. The breakers close when you command the GCU to close it. The GCU closes the breaker only when power is good and no other power source is on the bus. The GCU receives breaker position through the BPCU. These are the main breakers:

- External power contactor (EPC)
- APU power breaker (APB)
- Generator control breaker (GCB).

The modules on the P5 also let you monitor the status of the electrical power system. The panels have lights and an alpha-numeric LED display.

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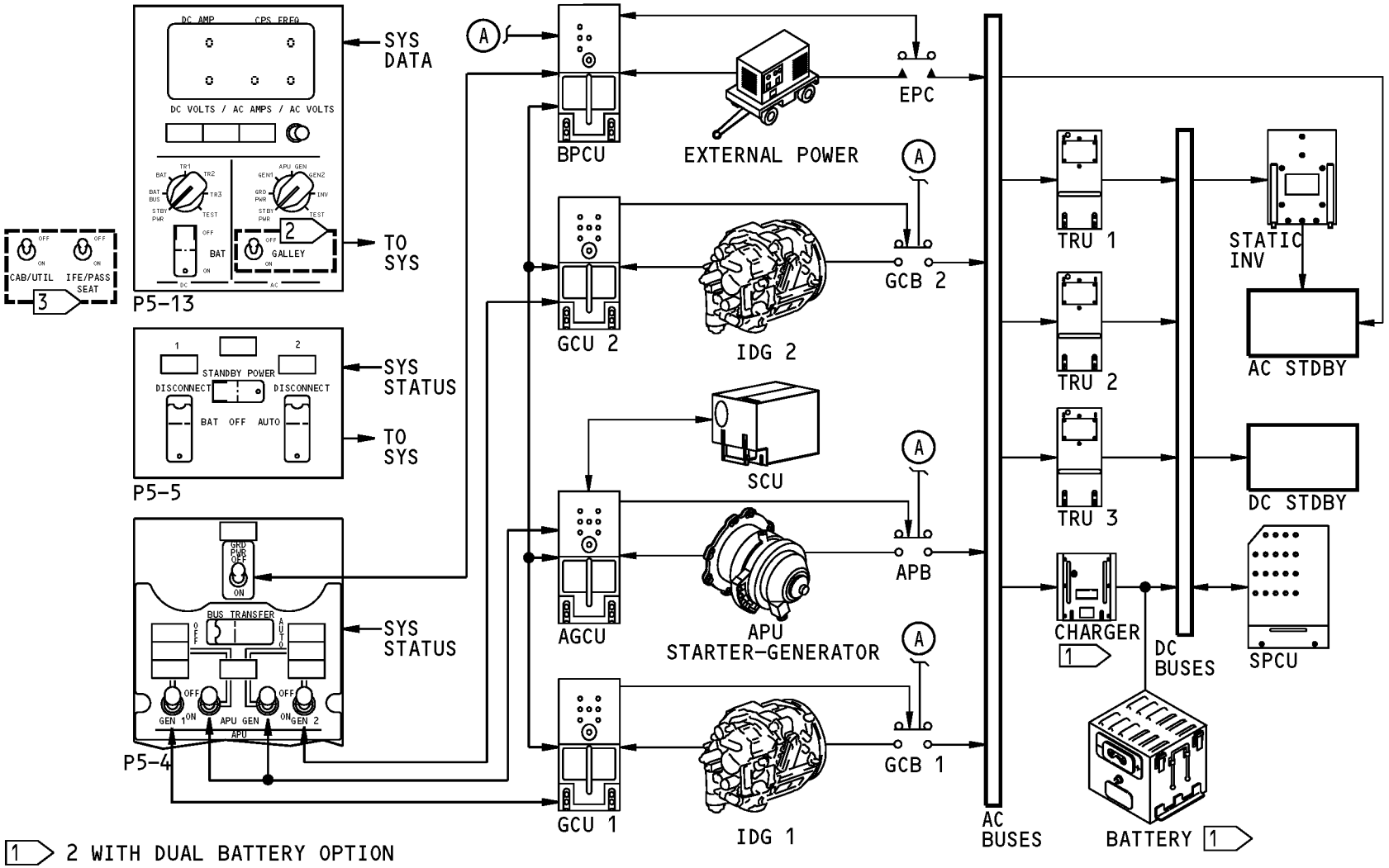

1 > 2 WITH DUAL BATTERY OPTION

2 > AIRPLANES WITH GALLEY SWITCH

3 > AIRPLANES WITH CAB/UTIL AND IFE/PASS SEAT SWITCHES

ELECTRICAL POWER - POWER AND CONTROL - GENERAL DESCRIPTION

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General

These AC buses receive power directly from an AC power source:

- AC transfer bus 1
- AC transfer bus 2
- Ground service bus 1
- Ground service bus 2.

System logic automatically removes loads (load shed) to prevent an overload of an AC power source.

These DC buses receive power directly from the transformer rectifier units (TRUs):

- DC bus 1
- DC bus 2
- Battery bus.

These buses receive power directly from the main battery or the main battery charger:

- Hot battery bus
- Switched hot battery bus.

AC Transfer Buses

These AC sources supply power to the AC transfer buses:

- External power
- APU starter-generator
- Integrated drive generators (IDGs).

The system design makes sure that two AC power sources can not supply power to the same transfer bus at the same time. However, one AC power source can supply power to both transfer buses through the bus tie breakers (BTBs).

Each transfer bus supplies power to these components or buses:

- Galleys (as many as 2)
- Main Bus
- Ground service bus
- Transformer rectifier unit (as many as 2).

Ground Service Buses

Each ground service bus receives power in one of these two ways:

- The AC transfer bus on that side has power
- The ground service switch on the forward attendant panel is in the ON position and external power is connected to the airplane.

The two ground service transfer relays control the selection of the power source.

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Main Buses and Galley Buses

The main buses and the galley buses receive power from their respective AC transfer bus. Load shed relays remove the power to these buses when their loads exceed operating limits. This protects the AC power source from overload. The bus power control unit (BPCU) controls the load shed function.

DC Buses

DC bus 1 usually receives power from TRU 1. However, the bus can receive power from TRU 2 or TRU 3 through the bus tie relay. This relay is usually energized.

DC bus 2 usually receive power from TRU 2. TRU 3 supplies power if TRU 2 fails. DC bus 2 may also receive power from TRU 1 through the bus tie relay.

Standby Buses

The AC standby bus usually receives power from AC transfer bus 1. The static inverter may also supply power to this bus. A remote control circuit breaker (RCCB) controls power to the static inverter.

The DC standby bus usually receives power from DC bus 1. The hot battery bus may also supply power to the DC standby bus.

Battery Buses

The hot battery bus usually receives power from the main battery or main battery charger. The auxiliary battery and auxiliary battery charger connects in parallel with the main battery during non-normal conditions to help supply power. See the DC Generation section for more information. (SECTION 24-30)

The battery bus normally receives power from TRU 3. The battery bus receives power from the battery if TRU 3 has no output.

The switched hot battery bus receives power from the hot battery bus when the battery switch (P5 panel) is in the ON position.

External Power

External power can supply power to these buses:

- AC transfer buses
- Ground service buses.

External power supplies power to each AC transfer bus through the external power contactor (EPC) and the necessary bus tie breaker (BTB).

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APU Power

The APU starter-generator supplies power to each AC transfer bus through the APU breaker (APB) and the necessary BTB. The APU can supply power to both AC transfer buses on the ground or inflight. See the AC Generation section for more information. (SECTION 24-20)

IDG Power

The IDGs are the normal power sources of the AC transfer buses. An IDG supplies power through a generator control breaker (GCB).

Battery Charger

Each battery charger makes sure its battery stays at maximum charge. Each battery charger also operates as a TRU when not in the charge mode.

Remote Control Circuit Breaker (RCCB)

The standby power system uses a RCCB to control power input to the static inverter. This RCCB is normally closed. See the Standby Power section 24-34 for more information. (SECTION 24-34)

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The dual battery RCCB closes to put the auxiliary battery and the auxiliary battery charger output in parallel with the output of the main battery and its charger. This RCCB is normally open. See the DC Generation section for more information. (SECTION 24-30)

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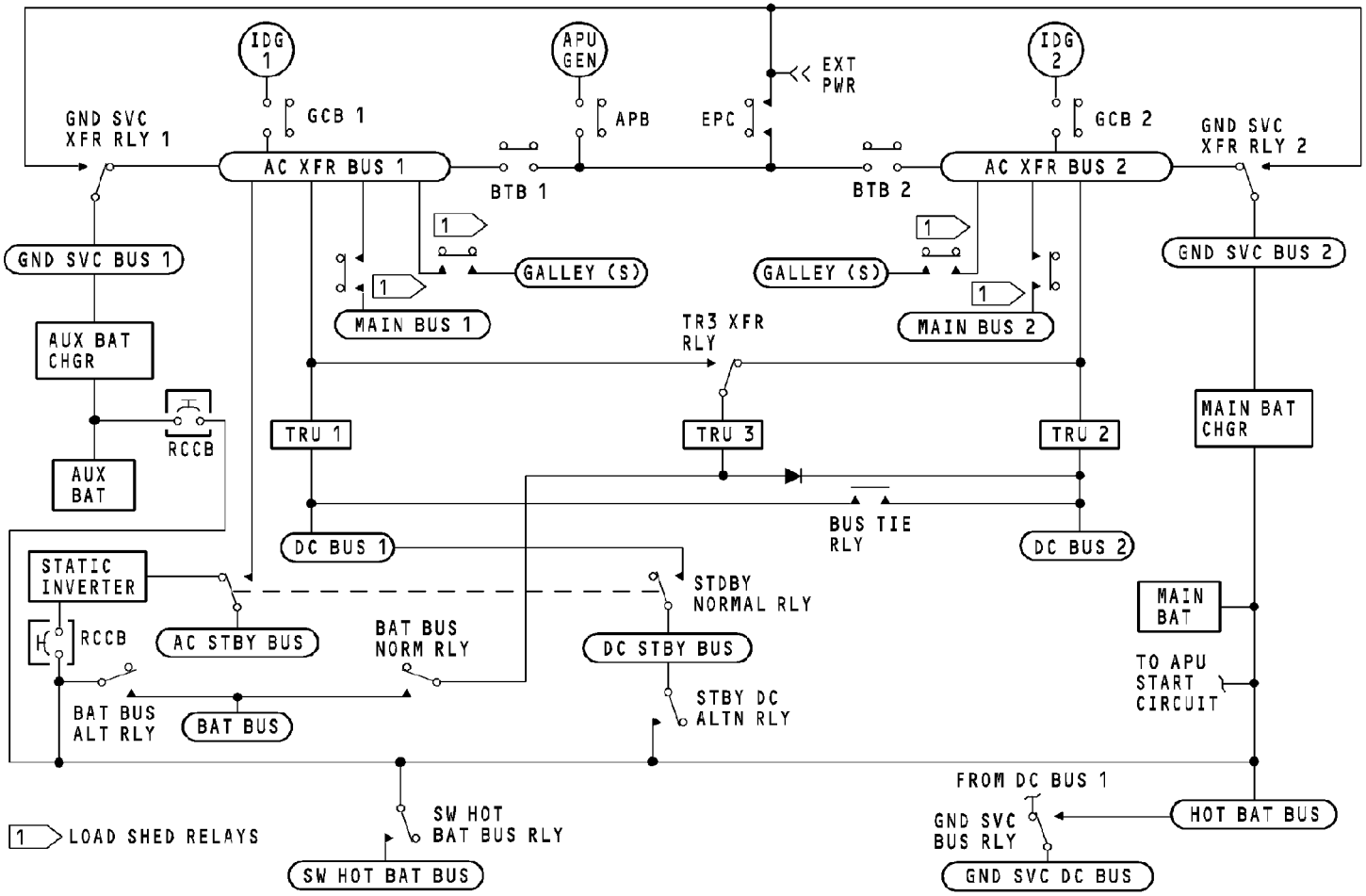

ELECTRICAL POWER - DISTRIBUTION - GENERAL DESCRIPTION

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ELECTRICAL POWER - AIRPLANE - COMPONENT LOCATIONS

General

Electrical power components are in these areas of the airplane:

- Flight compartment
- External power panel
- Forward lower fuselage
- EE compartment
- Engine
- APU compartment.

Flight Compartment

Modules on the P5 overhead panel supply these functions for the electrical power system:

- Manual control
- Indication
- DC and standby power system built-in-test equipment (BITE).

The P6 and P18 panels have many electrical power system circuit breakers and relays.

The standby power control unit (SPCU) is in the P6 panel. The SPCU has relays and circuit breakers for the DC and standby power system.

External Power Panel

The external power panel is on the right side of the fuselage, near the nose. The AC external power receptacle is at this panel.

Forward Lower Fuselage

Relays for the electrical power system and other airplane systems are in junction boxes in this area.

EE Compartment

Many electrical power components are in the EE compartment. These are just a few:

- Main battery
- Main battery charger
- Auxiliary battery
- Auxiliary battery charger
- Generator control units (GCUs)
- Bus power control unit (BPCU)
- Power distribution panels (PDPs)
- Start converter unit (SCU).

The GCUs and BPCU supply BITE for the AC electrical power and external power systems.

Engine

IDGs are on the forward face of the engine accessory gearbox. The air/oil cooler is on the engine fan case.

APU Compartment

The APU starter-generator is on the APU gearbox.

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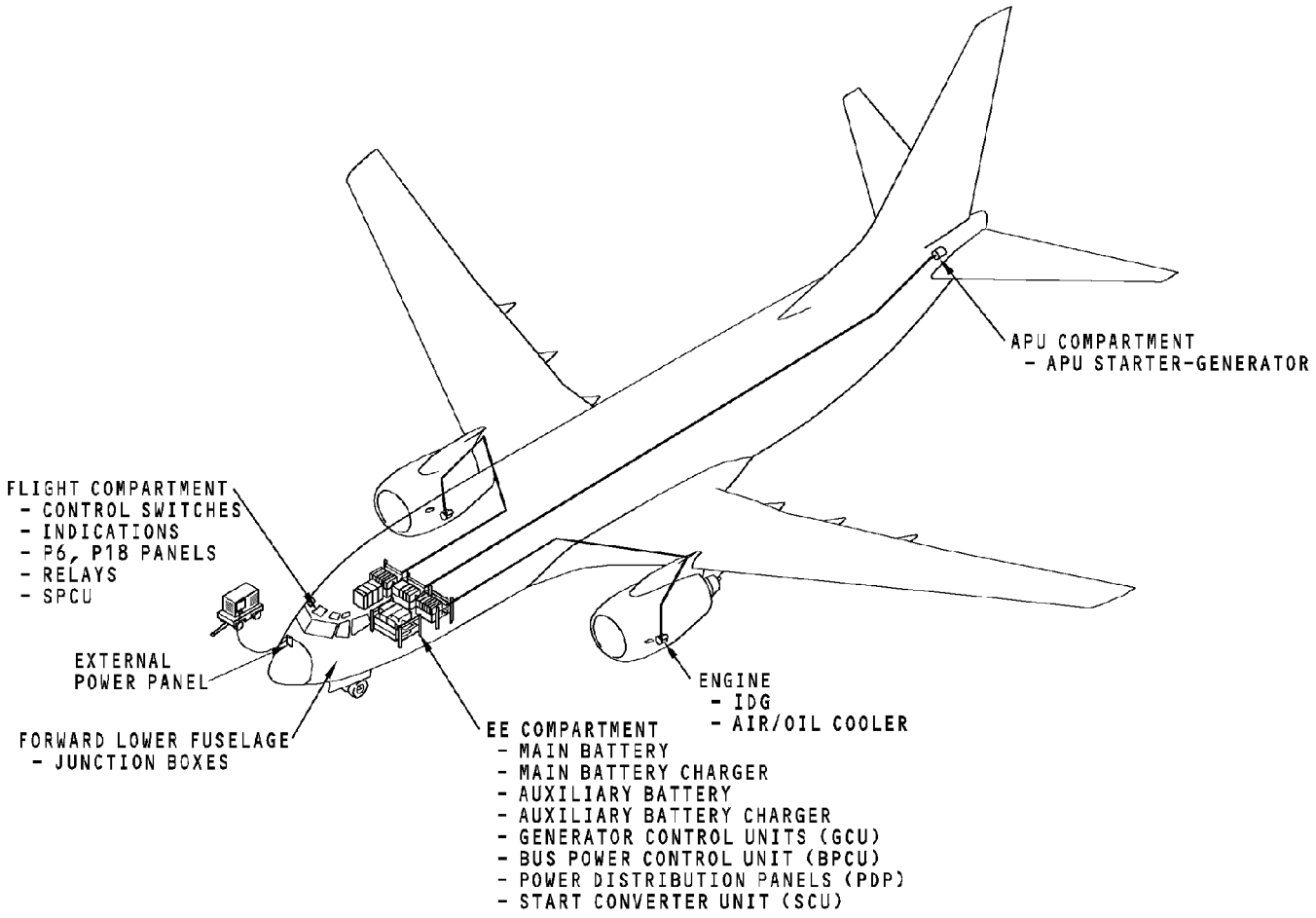

ELECTRICAL POWER - AIRPLANE - COMPONENT LOCATIONS

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General

You use the electrical meters, battery and galley power module (P5-13) for these functions:

- See electrical power parameters for AC and DC components or buses
- Connect battery power to electrical buses with the battery switch

The module also has these BITE functions:

- Supplies DC and standby power system failure indication
- Monitors the dc and standby power and saves fault messages in memory.
- Shows fault messages on the LED alphanumeric display.

Airplanes with the GALLEY Switch

You use the GALLEY switch to supply and remove power to:

- The galleys.

Airplanes with the CAB/UTIL and the IFE/PASS SEATS switches

You use the CAB/UTIL switch to supply and remove power to:

- Left/Right Cabin Recirculation Fan
- Fwd/Aft Door Area Heaters
- Drain Mast Heaters
- Lavatory Water Heaters
- All 115 VAC Galley Buses
- 115 VAC Shaver Outlets
- Logo Lights
- Potable Water Compressor

You use the IFE/PASS SEAT switch to supply and remove power to:

- 115 VAC Audio Entertainment
- 115 VAC Video Entertainment
- 28 VDC Video Entertainment
- Airphone Equipment
- Passenger Seat Electronic Outlets

AC Meter Selector

The AC meter selector is a rotary selector with seven positions. Each position, except the TEST position, is related to an AC power source or AC bus. The alphanumeric display shows these parameters for the three generators:

- Voltage (AC VOLTS)
- Load (AC AMPS)
- Output frequency (CPS FREQ).

The alphanumeric display shows only voltage and frequency when you select one of these:

- STBY PWR
- GRD PWR
- INV.

The selector must be in the TEST position to use the P5-13 BITE.

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DC Meter Selector

The DC meter selector is a rotary selector with seven positions. Each position, except the TEST position, is related to a DC power source or DC bus.

Voltage (DC VOLTS) and load (DC AMPS) show on the alphanumeric display when you put the selector in any of the TR positions or any of the BAT positions.

Only voltage shows when you put the selector to the BAT BUS or STBY PWR positions.

The selector must be in the TEST position to use the P5-13 BITE.

BAT DISCHARGE Light

The amber BAT DISCHARGE light gives indication of main battery discharge or auxiliary battery discharge. The BAT DISCHARGE light temporarily comes on during an APU start with battery power.

See the APU chapter for more information on APU starting. (CHAPTER 49)

TR UNIT Light

The amber TR UNIT light gives indication of transformer rectifier unit (TRU) failure. The TR UNIT light comes on for any one of these reasons:

- Any TRU fails on the ground, or
- TRU 1 fails in flight, or
- TRU 2 and TRU 3 fail in flight.

ELEC Light

The ELEC light gives indication that the DC system or standby power system has a failure. You use BITE to find the failure. The amber ELEC light comes on only when the airplane is on the ground.

MAINT Switch

You use the maintenance switch during BITE. The BITE operates only on the ground. The maintenance switch is a momentary push-button switch.

LED Alphanumeric Display

The LED alphanumeric display shows this type of information:

- DC parameters (amps, volts)
- AC parameters (amps, volts, frequency)
- As many as two lines of maintenance fault messages.

The selectors and the maintenance switch control what shows on the alphanumeric display.

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Battery Switch

The main battery energizes these buses and components when you put the battery switch to the ON position:

- Switched hot battery bus
- Battery bus
- Static inverter
- AC standby bus
- DC standby bus
- P5-13 alphanumeric display.

The battery switch is a two-position switch. The cover, when down, is a guard for the switch in the ON position. You must lift the cover before you move the switch to the OFF position.

Galley Switch

Airplanes with GALLEY switch; the GALLEY switch controls galley electrical power. The switch is a two-position switch.

Cab/Util Switch and IFE/Pass Seat Switches

Airplanes with CAB/UTIL and IFE/PASS SEAT switches; the CAB/UTIL switch controls galley and some utility's electrical power. A second switch, the IFE/PASS SEAT switch, controls electrical power to passenger in-flight entertainment, cabin phones and passenger seat outlets. The two cabin power control switches are two-position switches.

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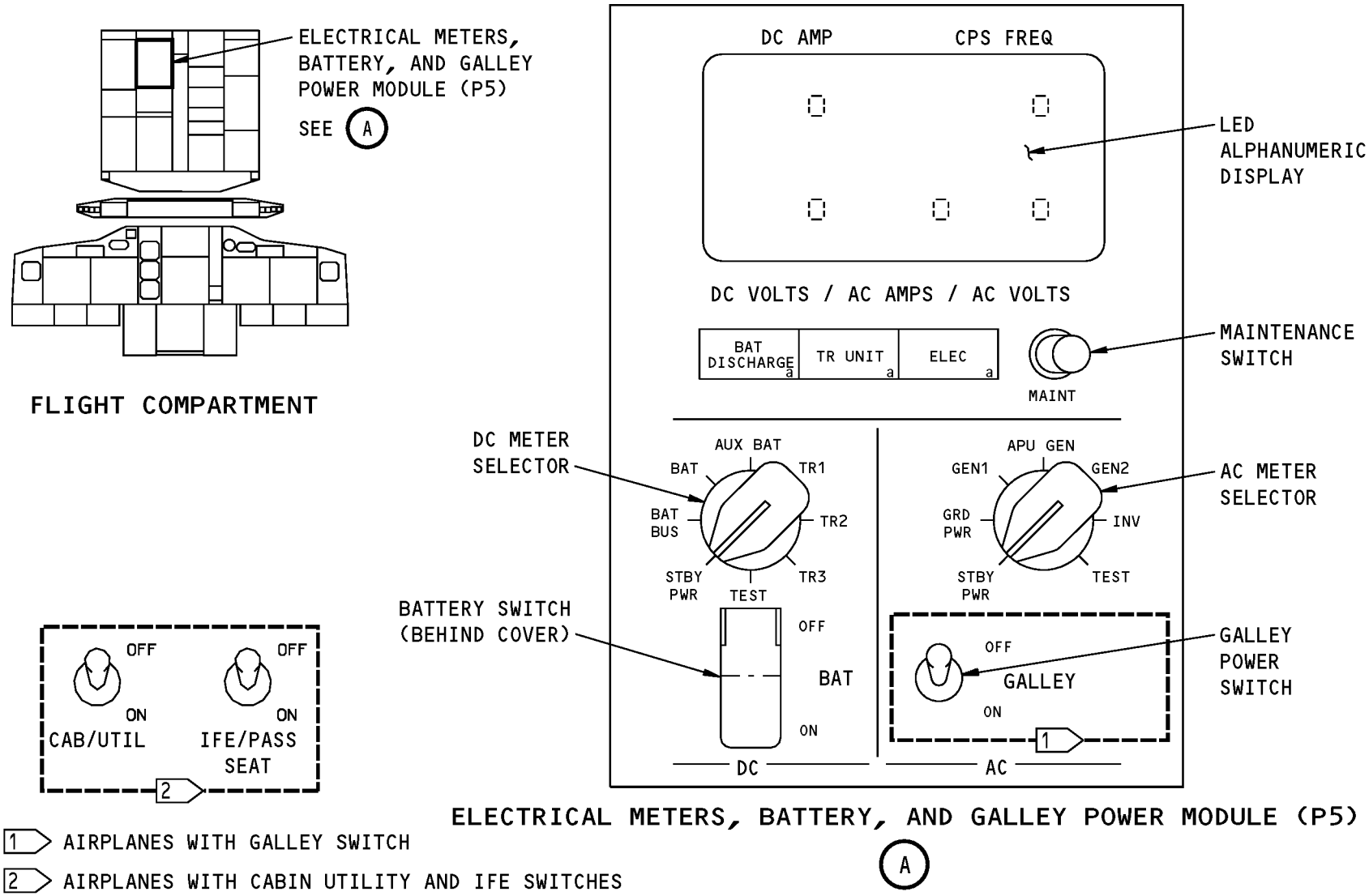

ELECTRICAL METERS, BATTERY, AND GALLEY POWER MODULE (P5)

A

1 AIRPLANES WITH GALLEY SWITCH

2 AIRPLANES WITH CABIN UTILITY AND IFE SWITCHES

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ELECTRICAL POWER - GENERATOR DRIVE AND STANDBY POWER MODULE - GENERAL DESCRIPTION

General

The generator drive and standby power module has these indications and manual controls:

- IDG low oil pressure indication (DRIVE lights)
- Indication that the battery bus or either standby bus do not have power (STANDBY PWR OFF light)
- Generator drive disconnect switches
- Standby power switch.

DRIVE Light

The amber DRIVE light comes on when the IDG oil pressure is less than the operation limit or when there is an underfrequency condition while the engine operates.

Generator Drive Disconnect Switch

The generator drive disconnect switch operates the disconnect mechanism for its (IDG) when the related engine start lever is in the idle position. This removes engine accessory gearbox power from the IDG. There is one switch for each IDG. Each switch is spring-loaded to the NORMAL position. The DISCONNECT position is a momentary position. The guard holds the switch in the NORMAL position. You must lift the guard to move the switch.

STANDBY PWR OFF Light

The amber STANDBY PWR OFF light comes on when any of these buses do not have power:

- AC standby bus
- DC standby bus
- Battery bus.

Standby Power Switch

The standby power switch gives you manual control of the AC and DC standby power bus sources. The switch is a three-position switch. The switch is usually in the AUTO position. The guard holds the switch in the AUTO position.

These buses have power when the standby power switch is in the AUTO position and AC transfer bus 1 has power:

- AC standby bus
- DC standby bus
- Battery bus if the BAT switch is in the ON position.

These buses have power when the standby power switch is in the AUTO position, the BAT switch is in the ON position, and AC transfer bus 1 does not have power:

- AC standby bus
- DC standby bus
- Battery bus.

These are the conditions when the standby power switch is in the OFF position and the BAT switch is in the ON position:

- STANDBY PWR OFF light is on

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- AC standby bus, static inverter, and the DC standby bus do not have power
- Battery bus has power.

These buses have power when the BAT switch is in the ON or the OFF position and the standby power switch is in the BAT position:

- AC standby bus
- DC standby bus
- Battery bus

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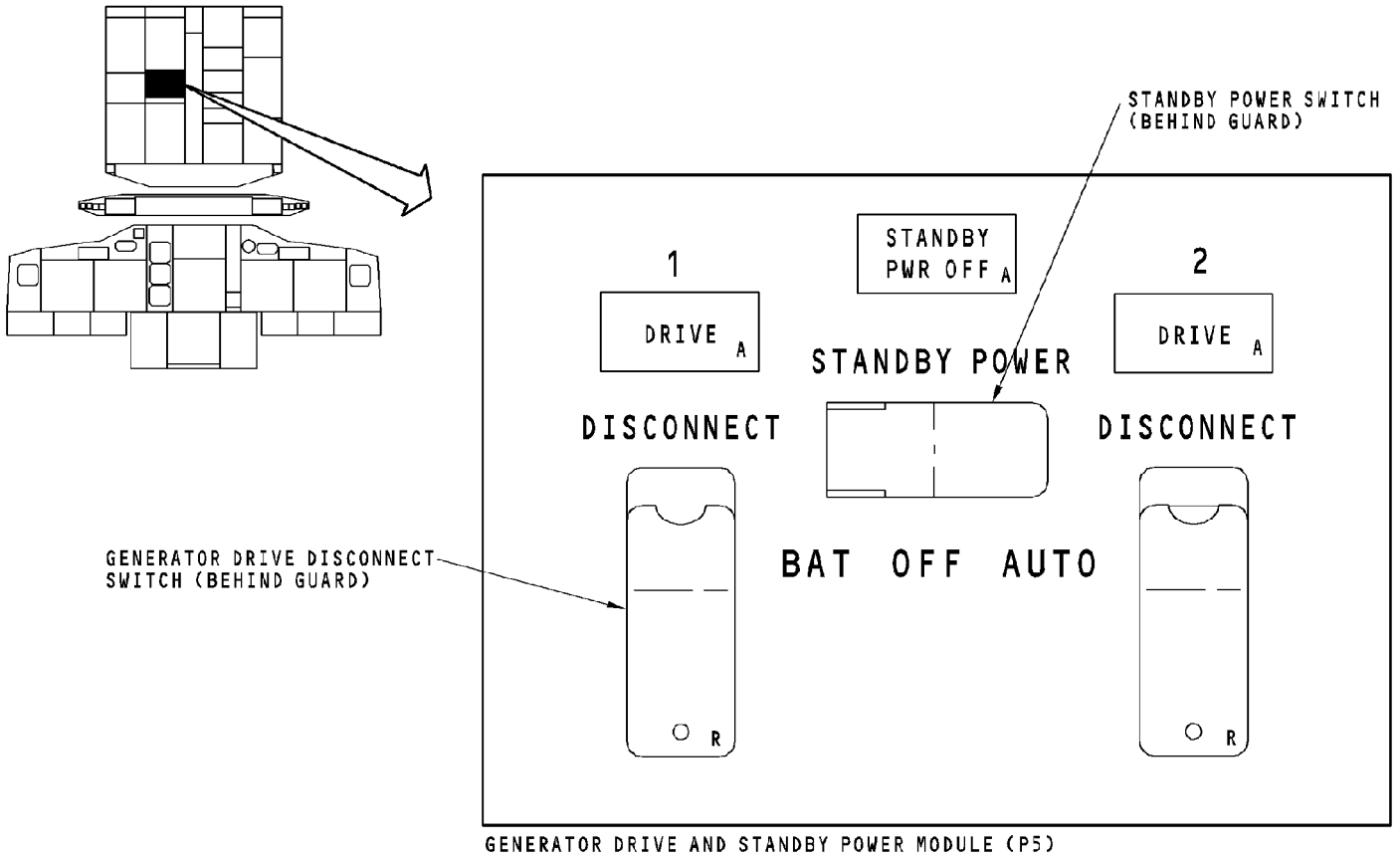

GENERATOR DRIVE AND STANDBY POWER MODULE (P5)

ELECTRICAL POWER - GENERATOR DRIVE AND STANDBY POWER MODULE - GENERAL DESCRIPTION

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General

The upper part of the AC systems, generator, and APU module (P5-4) has these lights:

- GRD POWER AVAILABLE
- TRANSFER BUS OFF
- SOURCE OFF
- GEN OFF BUS
- APU GEN OFF BUS.

The upper part of the module also has these manual controls:

- Ground power switch
- Engine generator switches
- APU generator switches
- Bus transfer switch.

GROUND POWER AVAILABLE Light

The GRD POWER AVAILABLE light is on when external AC power is connected and the quality is good. The light is bright blue when on.

Ground Power Switch

You use the ground power switch to control external power to the AC transfer buses. See electrical power - operation - general description in this section for more information.

TRANSFER BUS OFF Light

The amber TRANSFER BUS OFF light comes on when the AC transfer bus does not have power. There is one light for each AC transfer bus.

SOURCE OFF Light

The amber SOURCE OFF light supplies indication that an AC transfer bus is not energized by the selected source. The left SOURCE OFF light is related to these sources:

- IDG 1 (GEN 1 switch)
- APU (left APU GEN switch)
- External power (ground power switch).

The right SOURCE OFF light is related to these sources:

- IDG 2 (GEN 2 switch)
- APU (right APU GEN switch)
- External power (ground power switch).

The SOURCE OFF light does not indicate that the AC transfer bus is de-energized. In flight, the left SOURCE OFF light comes on when GCB 1 trips. However, the bus transfer function lets IDG 2 power AC transfer bus 1. These are the examples:

- IDG1 fails
- The bus transfer function closes the BTBs
- Both AC transfer buses get power from IDG2.

There is one light for each transfer bus.

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GEN OFF BUS Light

The blue GEN OFF BUS light comes on when the engine generator control breaker (GCB) is open. This shows that the IDG is not a power source in use. The light goes off when the GCB closes.

APU GEN OFF BUS Light

The blue APU GEN OFF BUS light shows that the APU is running, but its generator is not a power source in use. The light is on when the APU is running and the auxiliary power breakers (APBs) is open. The light goes off when the APB closes or you shut down the APU.

Engine Generator Switches

The engine generator switches give manual control for IDG power source selection. Each switch is a three-position switch and is spring-loaded to the center (neutral) position. The ON and OFF positions are momentary positions.

when you put a generator switch momentarily to the ON position, you make that IDG the power source for its AC transfer bus. If IDG power quality is good, the electrical power system first removes the present power source (open its generator breaker). Then, the generator breaker for the IDG closes and the IDG now supplies power. See Electrical Power, Operation, General Description in this section for more information.

APU Generator Switches

The APU engine generator switches give manual control for APU generator power source selection. There are two switches because there are two bus tie breakers (BTBs). The switches operate like the engine generator switches. See Electrical Power, Operation, General Description in this section for more information.

Bus Transfer Switch

The bus transfer switch gives you manual control of the BTBs, the DC BUS TIE RELAY, and the TRU 3 TRANSFER RELAY. The switch has two positions (AUTO and OFF). The switch is usually in the AUTO position. A cover is a guard for the switch in the AUTO position.

In the AUTO position, the BTBs, the DC BUS TIE RELAY, and the TRU 3 TRANSFER RELAY work automatically as necessary. In the OFF position, the DC BUS TIE RELAY and the TRU 3 TRANSFER RELAY cannot energize. The operation of the BTBs when the switch is in the OFF position depends on the electrical power source conditions before you move the switch. See the AC GENERATION-BREAKER CONTROL for more information on the BUS TRANSFER SWITCH and BTB operation.

See the DC GENERATION-DISTRIBUTION AND CONTROL For more information on the operation of the DC BUS TIE RELAY and the TRU 3 TRANSFER RELAY.

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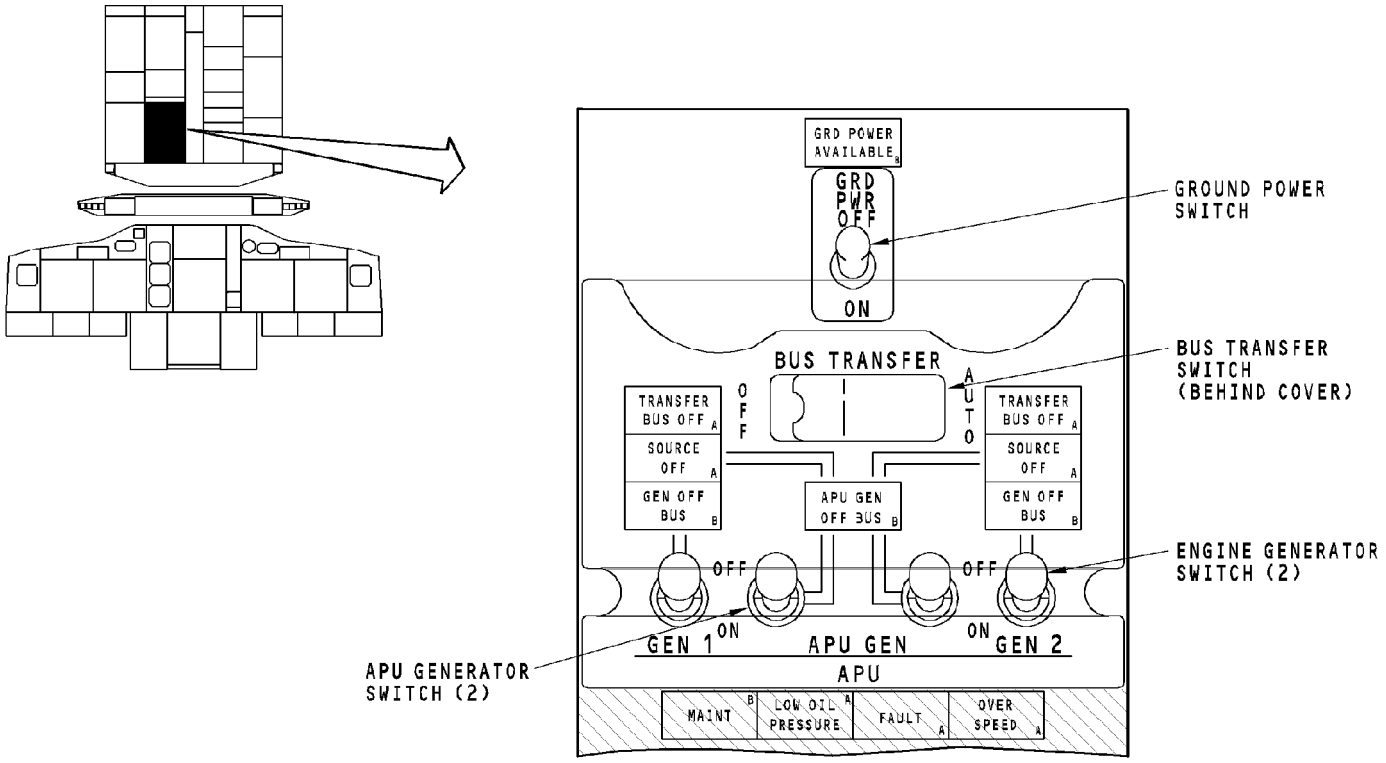

AC SYSTEMS, GENERATOR, AND APU MODULE (P5-4)

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General

You use switches on the forward P5 overhead panel or the forward attendant panel to operate the electrical system. Refer to the distribution general description page in this section for more information about the operation effect on distribution.

Electrical Meters, Battery And Galley Power Module (P5-13)

You put the BAT switch to the ON position to energize these buses and components with battery power:

- Switched hot battery bus
- Battery bus
- Static inverter
- AC standby bus
- DC standby bus
- P5-13 alphanumeric display.

AIRPLANES WITH THE GALLEY SWITCH;

- You use the GALLEY switch to control power to all galleys.

AIRPLANES WITH THE CAB/UTIL AND IFE/PASS SEATS SWITCHES;

- You use the CAB/UTIL switch to control power to all galleys and some utilities.
- You use the IFE/PASS SEATS switch to control power to the passenger entertainment systems.

You use the DC and AC selectors and the alphanumeric display to monitor the electrical power system power sources.

Generator Drive And Standby Power Module (P5-5)

The generator drive disconnect switch operates the disconnect mechanism for its integrated drive generator (IDG). This removes engine accessory gearbox power from the IDG. The engine start lever must be in the idle position for the disconnect function to operate.

The standby power switch gives you manual control of the AC and DC standby power bus sources. In the auto position, the AC standby bus receives power from AC transfer bus 1 and the DC standby bus receives power from DC bus 1 when these sources are available. If the sources are not available, the AC standby bus receives power from the static inverter and the DC bus receives power from the batteries.

These are the effects of the standby power switch in the other two positions:

- De-energize the AC standby bus and the DC standby bus (OFF position),
- Energize the AC standby bus with battery power through the static inverter and energize the DC standby bus with battery power (BAT position).

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AC Systems, Generator And APU Module (P5-4)

You use the ground power switch to control external power to the AC transfer buses. The blue GRD POWER AVAILABLE light above the switch shows if the ground source is connected and quality is good. Both AC transfer buses receive power when you put the ground power switch to the ON position. Any initial power sources are removed before the transfer buses receive external power.

The bus transfer switch gives you manual control of the BTBs and the DC bus tie relay. In the AUTO position, the BTBs and the DC bus tie relay operate automatically as necessary.

In the OFF position, the BTBs open and isolate the AC transfer buses from each other if one IDG is supplying power to both AC transfer busses. The DC bus tie relay will also open. This isolates DC bus 1 and DC bus 2 from each other. The position also resets the BTB trip circuits.

You use the GEN 1 and GEN 2 switches to supply IDG power to an AC transfer bus. The AC transfer bus on that side goes to IDG power when you temporarily put the switch to the ON position. Any initial power sources are removed.

You use the APU GEN switches to supply power to the AC transfer buses. There are two switches because there are two bus tie breakers (BTBs) that supply power to the AC transfer buses. Both AC transfer buses will receive APU power with operation of just one APU GEN switch if both AC transfer buses do not have power initially or if external power is the only source on the AC transfer buses. If the AC transfer buses do have power initially from two power sources, (for example both IDGs) then only the AC transfer bus on the same side as the APU GEN switch you operate will energize with APU power.

The blue APU GEN OFF BUS light comes on when the APU is ready to supply electrical power.

Forward Attendant Panel

You use the ground service switch to supply external power to ground service bus 1 and 2 with external power connected. This makes it possible to supply electrical power for cabin servicing without going into the flight compartment.

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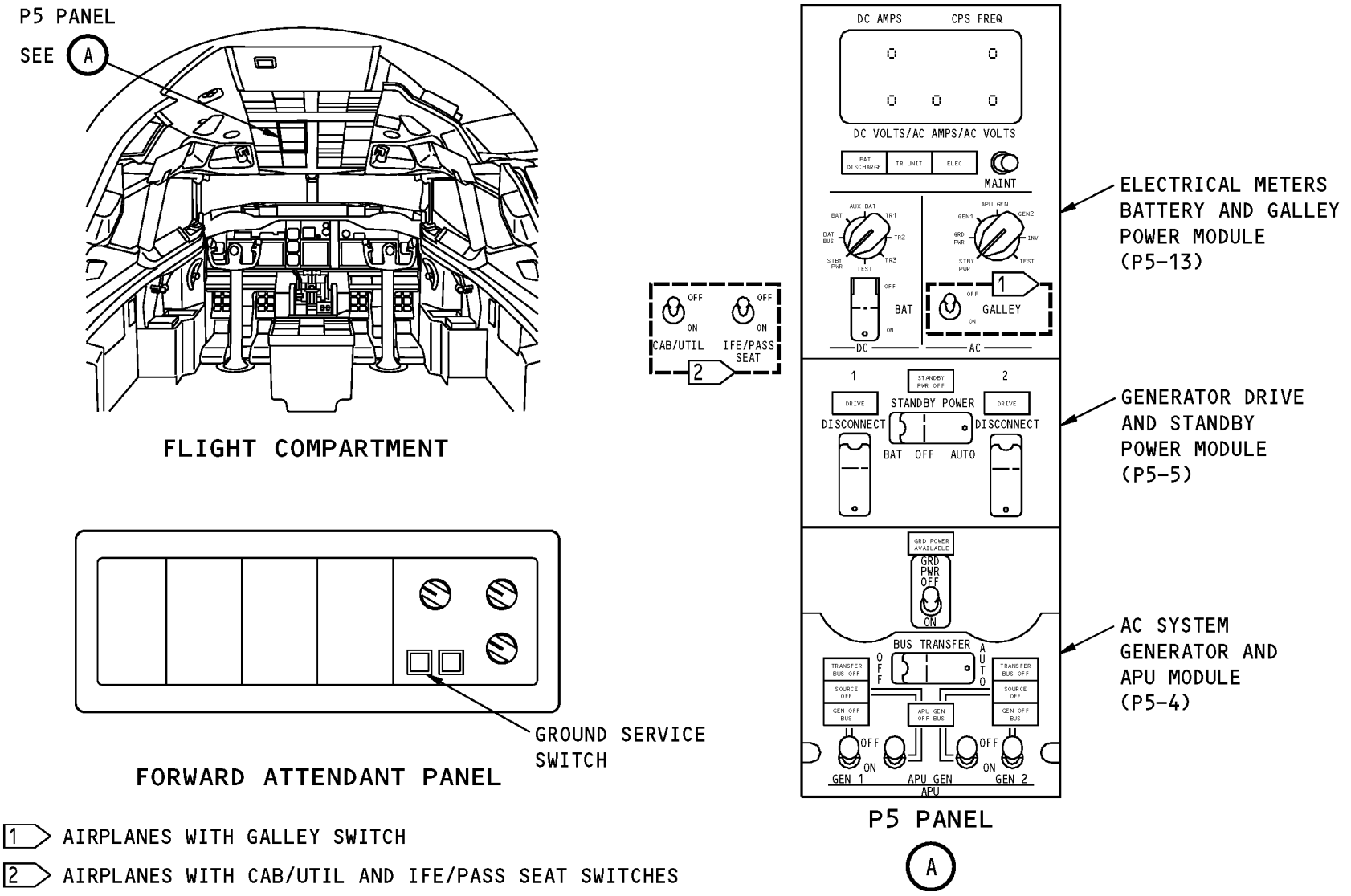

ELECTRICAL POWER - OPERATION - GENERAL DESCRIPTION

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ELECTRICAL POWER - TRAINING INFORMATION POINTS - 1

Built-In Test Equipment (BITE)

These electrical power components have BITE:

- Electrical meters, battery, and galley power module
- Generator control units (GCUs)
- Bus power control unit (BPCU).

Electrical Meters, Battery, and Galley Power Module BITE

The electrical meters, battery, and galley power module has front face BITE for the standby power system and the DC generation system. The module also monitors for internal module faults and wiring interface failures. Fault messages show on the module's LED alphanumeric display. See the TRAINING INFORMATION POINT - 2 page in this section for more information.

See the DC generation section for more information. (SECTION 24-30)

See the standby power system section for more information. (SECTION 24-34)

GCU BITE

Each GCU has front face BITE for the AC generation system. Front panel lights come on to show faults. See section the AC generation system section for more information on GCU BITE. (SECTION 24-20)

BPCU BITE

The BPCU has front face BITE for the external power system. Front panel lights come on to show faults. See the external power section for more information. (SECTION 24-40)

EFFECTIVITY
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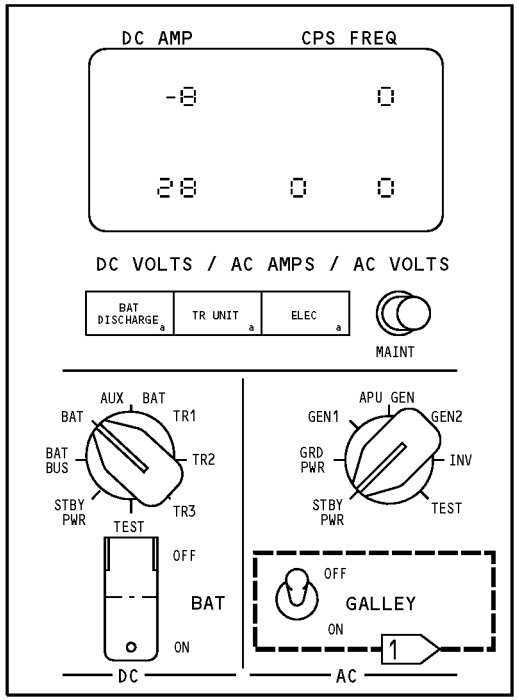
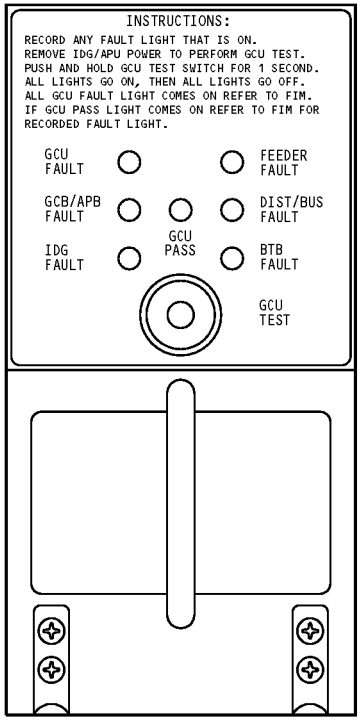
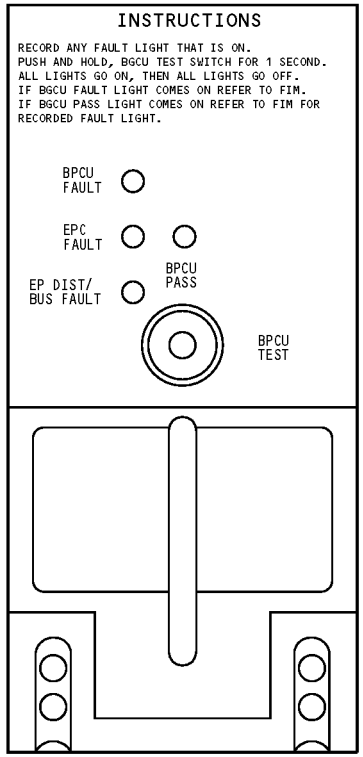


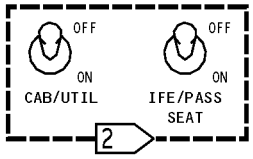
ELECTRICAL METERS, BATTERY, AND GALLEY POWER MODULE (P5)



GCU, AND APU GCU



BPCU



1 AIRPLANES WITH GALLEY SWITCH

2 AIRPLANES WITH CAB/UTIL AND IFE/PASS SEAT SWITCHES

ELECTRICAL POWER - TRAINING INFORMATION POINTS - 1

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Electrical Meters, Battery, and Galley Power Module Built-In Test

The fault information shows on the electrical meters, battery, and galley power module. The amber ELEC light on the module comes on when the module has an electrical system fault message. The light does not come on in flight. Messages show on the LED alphanumeric display when the airplane is on the ground and you push the MAINT switch.

These are the fault messages that can show:

- PANEL FAILURE (soft, display operates)
- INTERFACE FAILURE
- BAT CHGR INOP
- STAT INV INOP
- SPCU INOP.

The letter I may follow the fault message. This means that the fault is intermittent and that the fault is not set at this time.

You do these to see a fault message:

- Put the AC and DC meter selector switches to the TEST position
- Temporarily push the MAINT switch.

All of the segments of the LED alpha numeric display come on (display test) immediately after you release the switch. The time to do the test is approximately 15 seconds. Then, the first message shows on the display. You temporarily push the switch again to see the next message. If there are no messages, NO FAULTS STORED temporarily shows after the display test is complete. The display then goes blank. The display stays blank until you move a selector switch.

You see HOLD BUTTON CLEAR FAULTS on the display when you temporarily push the switch after the last fault message. To erase all of the message from memory, you must push and hold the switch until the FAULTS CLEARED message shows. The HOLD UNTIL FAULTS CLEAR message shows during this time. The fault messages will stay in memory and the display will go blank if you release the switch before the FAULTS CLEARED message shows. The display goes back to normal when you move a selector switch.

Training Information Point

The display test during BITE takes up to 15 seconds. Temporarily push the maintenance switch again (just after the display tests begins) to bypass the display test. The display will go directly to the first message or the NO FAULTS STORED message.

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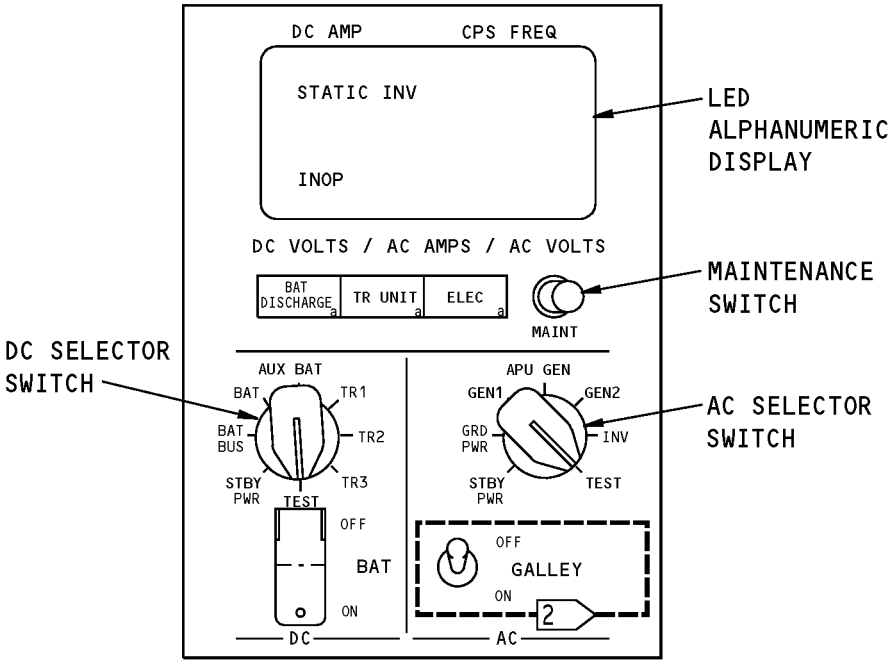
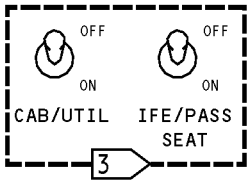
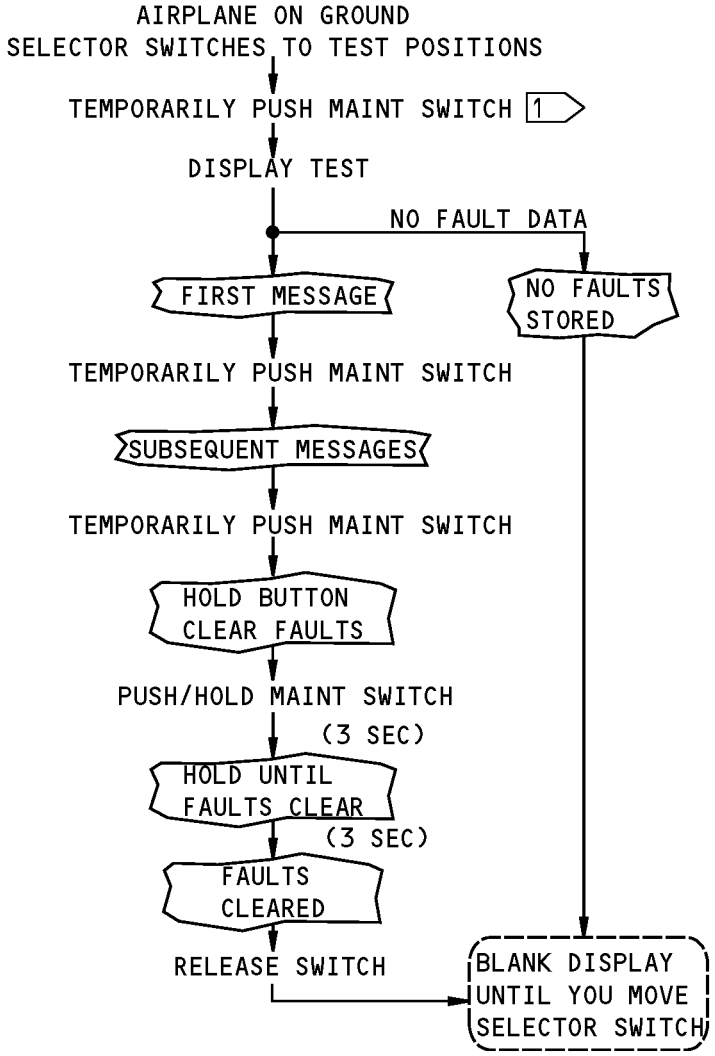


ELECTRICAL METERS, BATTERY, AND GALLEY POWER MODULE (P5)





1 PUSH SWITCH 2 TIMES TO BYPASS DISPLAY TEST

2 AIRPLANES WITH GALLEY SWITCH

3 AIRPLANES WITH CAB/UTIL AND IFE/PASS SEAT SWITCHES

ELECTRICAL POWER - TRAINING INFORMATION POINT - 2

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GENERATOR DRIVE - INTRODUCTION

Purpose

The generator drive makes three-phase, 115/200v ac, 400 Hz power for use by the electrical power system.

General

The generator drive has these components:

- Integrated drive generator (IDG)
- Air/oil cooler
- Quick attach/detach (QAD) adapter.

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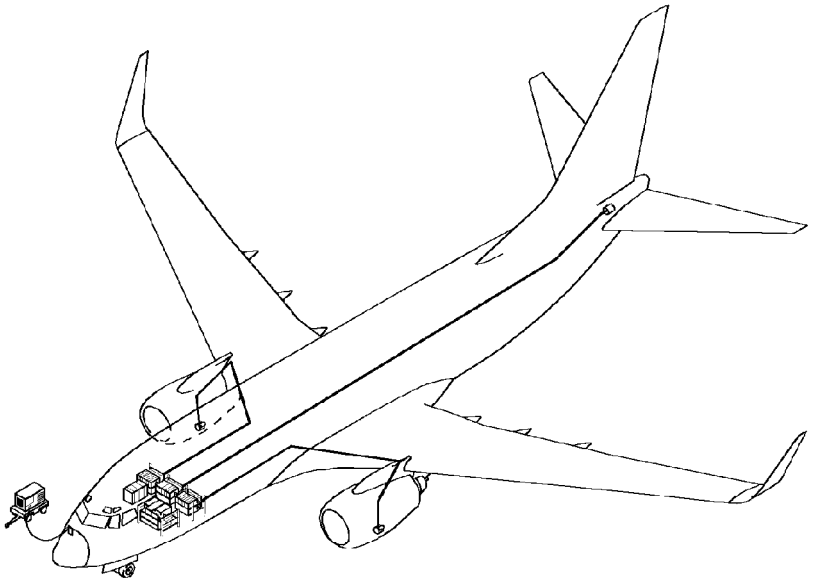

GENERATOR DRIVE - INTRODUCTION

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GENERATOR DRIVE - GENERAL DESCRIPTION

Purpose

The generator drives are the normal source of AC power in flight. There are two IDGs on the airplane. Each supplies 115/200v ac, 400 Hz power. Each IDG can supply up to 90 KVA.

General Description

The engine accessory gearbox turns the IDG. Because engine speed changes, the gearbox speed also changes. The IDG takes the variable input speed and changes it into a constant speed of 24,000 RPM for its internal AC generator. The IDG uses a combination of internal mechanical and hydraulic components to supply the constant speed to the generator.

The IDG uses oil for these purposes:

- Hydromechanical (constant speed drive)
- Lubrication
- Cooling.

The IDG has an oil cooling system. The cooling system has these external cooling components:

- Air/oil cooler
- IDG oil cooler.

The generator drive and standby power module gives indication and control of the AC generator drive system.

You use the generator drive switch to manually operate the disconnect mechanism of the IDG. The IDG stops turning after the disconnect. You can reconnect the IDG on the ground only while the engine is not running. The IDG also has an automatic thermal disconnect which occurs when the oil temperature gets too hot. You must remove the IDG to reset this type of disconnect.

NOTE: The IDG vendor recommends that you do not reconnect an IDG that has been disconnected for any reason other than a functional test or an unintentional disconnect. Operation of IDGs that have had oil pressure problems (causes DRIVE light) may cause further damage to the IDG.

IDG

The IDG is an assembly that has a hydromechanical constant speed drive (CSD) section and an oil-cooled brushless AC generator section. The IDG also includes a permanent magnet generator (PMG) for control and excitation power to the main generator section.

The generator control unit (GCU) rectifies the PMG AC output to DC. See the AC Generation section for more information on the generator.

The GCU monitors IDG output power quality at three places:

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- Neutral current transformer (NCT) in the IDG, between the generator and ground
- Differential protection current transformer (DPCT) between the generator and generator control breaker
- At the feeder wires, just before the GCB (point of regulation).

The GCU uses DC power to excite the generator. The GCU controls the excitation power to control the output power of the IDG main generator. The GCU controls the generator control breaker (GCB) as a function of power quality or manual control input.

IDG Oil System

Pumps inside the IDG move the oil through the IDG and out through two external coolers.

The air/oil cooler first uses engine fan air to decrease the temperature of the IDG oil. The air/oil cooler has an internal bypass which opens if the cooler becomes clogged.

The oil leaves the air/oil cooler and goes to the IDG oil cooler. This cooler uses fuel to decrease the temperature of the IDG oil. See the Fuel Distribution System section for more information on the IDG oil cooler.

The oil returns to the IDG from the IDG oil cooler.

The high pressure bypass valve opens if the IDG oil cooler becomes clogged.

The amber DRIVE light comes on if the IDG oil pressure is less than the minimum operation limit or if there is an underfrequency with the engine running. The GCU gets an input from a low oil pressure switch in the IDG to monitor oil pressure. The GCU monitors the PMG output for frequency and a ready to load signal (RTL) from the DEUs for an engine run signal.

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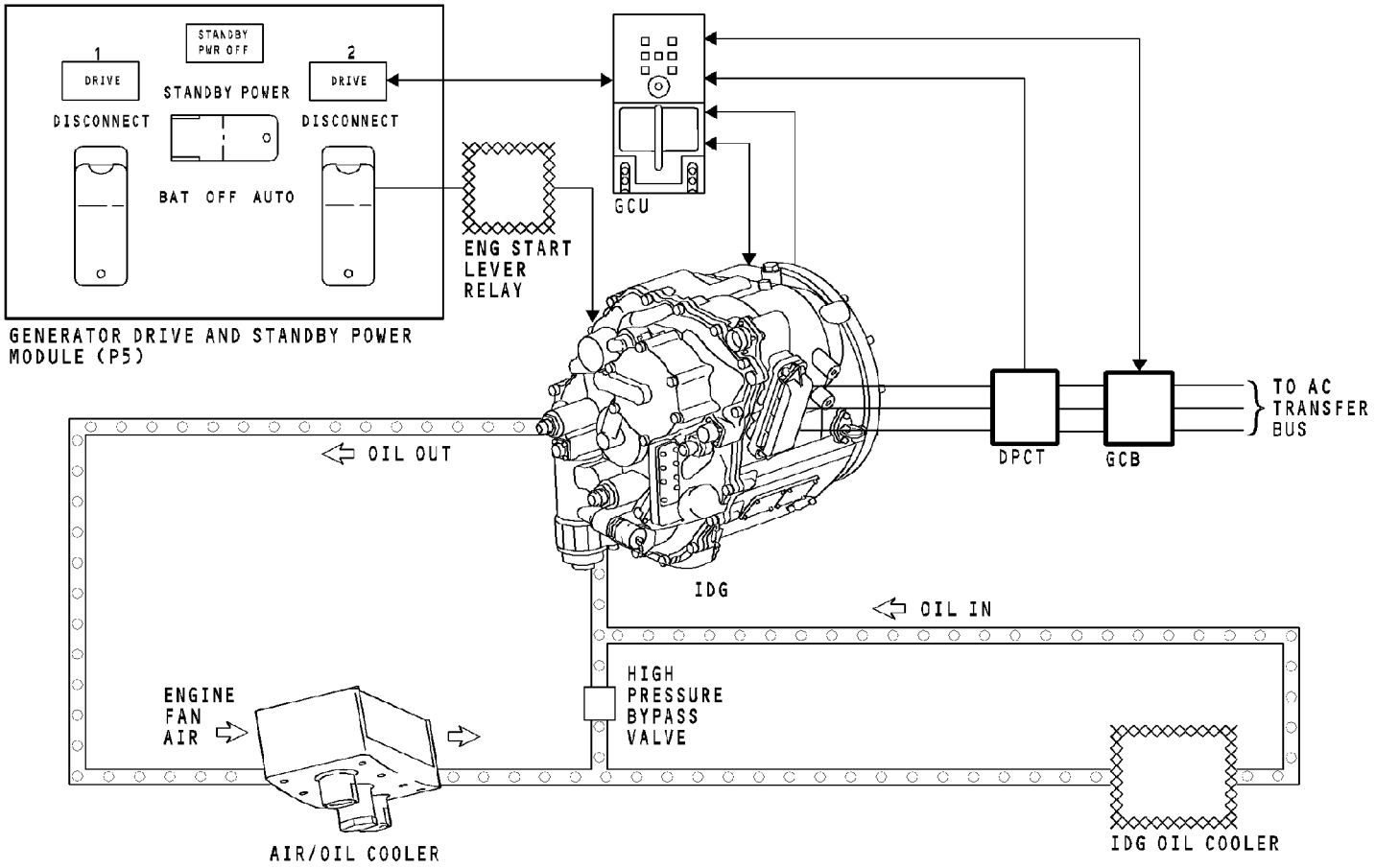

GENERATOR DRIVE - GENERAL DESCRIPTION

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GENERATOR DRIVE - COMPONENT LOCATION

General

The components of the generator drive are on the engine and in the flight compartment.

Integrated Drive Generator (IDG)

The IDG is on the front face of the engine accessory gearbox at the 7:00 position. The IDG is below the engine starter.

You open the left engine fan cowl to get access to the IDG installation.

When servicing, you can get access to the IDG through the IDG servicing door in the left fan cowl.

IDG Air/Oil Cooler

The air/oil cooler is on the inside, aft portion, of the fan case at the 6:30 position. You open the engine left fan cowl and thrust reverser to get access to the air/oil cooler.

Generator Drive And Standby Power Module

The generator drive and standby power module is on the P5 forward overhead panel in the flight compartment.

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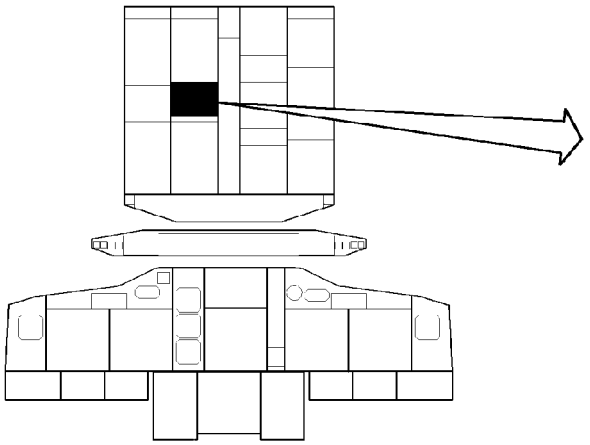
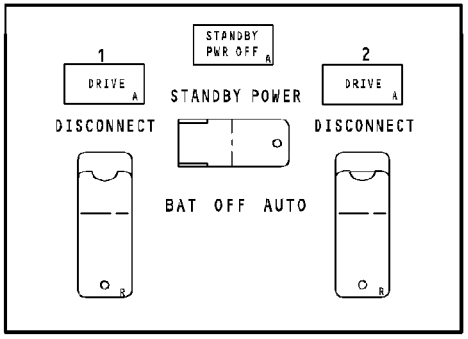
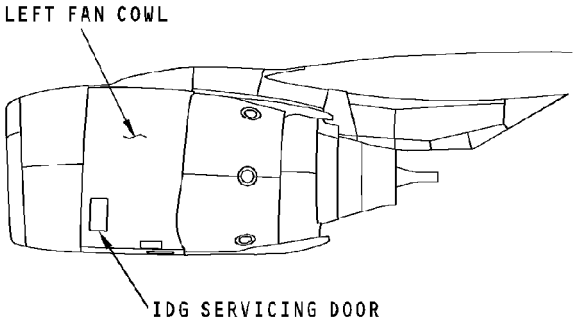
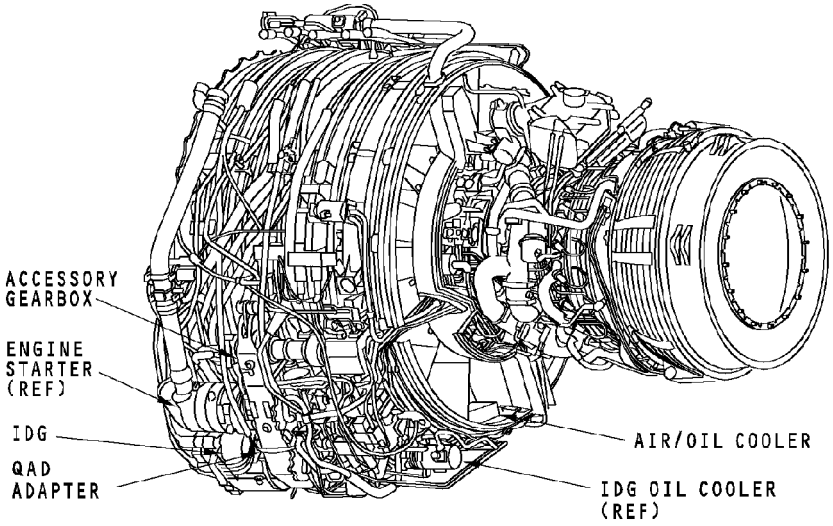


FLIGHT COMPARTMENT



GENERATOR DRIVE AND STANDBY POWER MODULE (P5)





GENERATOR DRIVE - COMPONENT LOCATION

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GENERATOR DRIVE - INTEGRATED DRIVE GENERATOR (IDG)

Purpose

The integrated drive generators (IDG) are the normal source of AC power generation in flight. There are two IDGs on the airplane. Each supplies 115/200v ac, 400 Hz power. The IDG can supply up to 90 KVA.

Physical Description

The IDG has a constant speed drive section and a generator. The IDG weighs 117 pounds (53 kgs).

These are the components on the IDG that you service or inspect:

- Push-to-vent valve
- Case pressure relief valve
- Electrical connectors
- Phase lead terminal
- Disconnect reset ring
- Charge and scavenge oil filters
- Differential pressure indicator (pop-out)
- Oil level sightglass
- Drain plug
- Pressure fill adaptor.

Push-To-Vent Valve

The vent valve is a spring-actuated valve that keeps constant internal pressure in the IDG case. You also push the button to release the air pressure before you service the IDG with oil or drain the oil.

Case Pressure Relief Valve

The case pressure relief valve prevents the IDG case from rupture if the fuel/oil cooler leaks fuel into the oil system. The oil vents into the area between the engine accessory gearbox and the IDG. Fluid in this area drains overboard through the engine drain system.

See the power plant section for more information on the engine drain system.

Electrical Connectors

The IDG has two electrical connectors. Electrical connector A has wire connections of systems with these functions:

- Neutral current transformer information to the GCU
- Disconnect solenoid power from the GEN DRIVE DISCONNECT switch (P5)
- PMG AC power to the GCU.

Electrical connector B has wire connections of systems with these functions:

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- Exciter field DC power input
- Oil pressure signal to the DRIVE light on the P5 panel.

Phase Lead Terminal

The three phase AC feeder wires and ground wire attach at this terminal block.

Disconnect Reset Ring

You use the disconnect reset ring to reconnect the IDG after a manual disconnect. The engine must not be turning when you do a reset of the IDG.

Charge Oil Filter

The charge oil filter is downstream of the IDG charge pump. Oil bypasses this filter if it becomes clogged. There is no visual indication on the IDG that this filter is in the bypass condition. You replace the charge oil filter on regular intervals. See the SERVICING page in this section for more information.

Scavenge Oil Filter

The scavenge oil filter is downstream of the IDG scavenge pump. Oil bypasses this filter if it becomes clogged. You replace the scavenge oil filter on regular intervals. See the SERVICING page in this section for more information.

Differential Pressure Indicator

The differential pressure indicator is in the IDG scavenge oil system and monitors pressure upstream and downstream of the scavenge oil filter. The indicator supplies a visual indication of a clogged scavenge filter. A temperature lockout feature prevents a false differential pressure indication during engine start with cold oil.

Oil Level Sightglass

The oil level sightglass shows the relative amount of oil in the IDG. You use the sightglass to do a check of the oil quantity. See the SERVICING page in this section for more information.

Drain Plug

You remove the drain plug to drain the IDG oil. See the SERVICING page in this section for more information.

Pressure Fill Adaptor

You use the pressure fill adaptor when servicing the IDG oil level. See the SERVICING page in this section for more information.

Safety Lanyards

Three lanyards attach to the IDG and the engine. These lanyards keep the IDG on the engine if there is very high engine vibration. You must disconnect the lanyards from the IDG for IDG removal.

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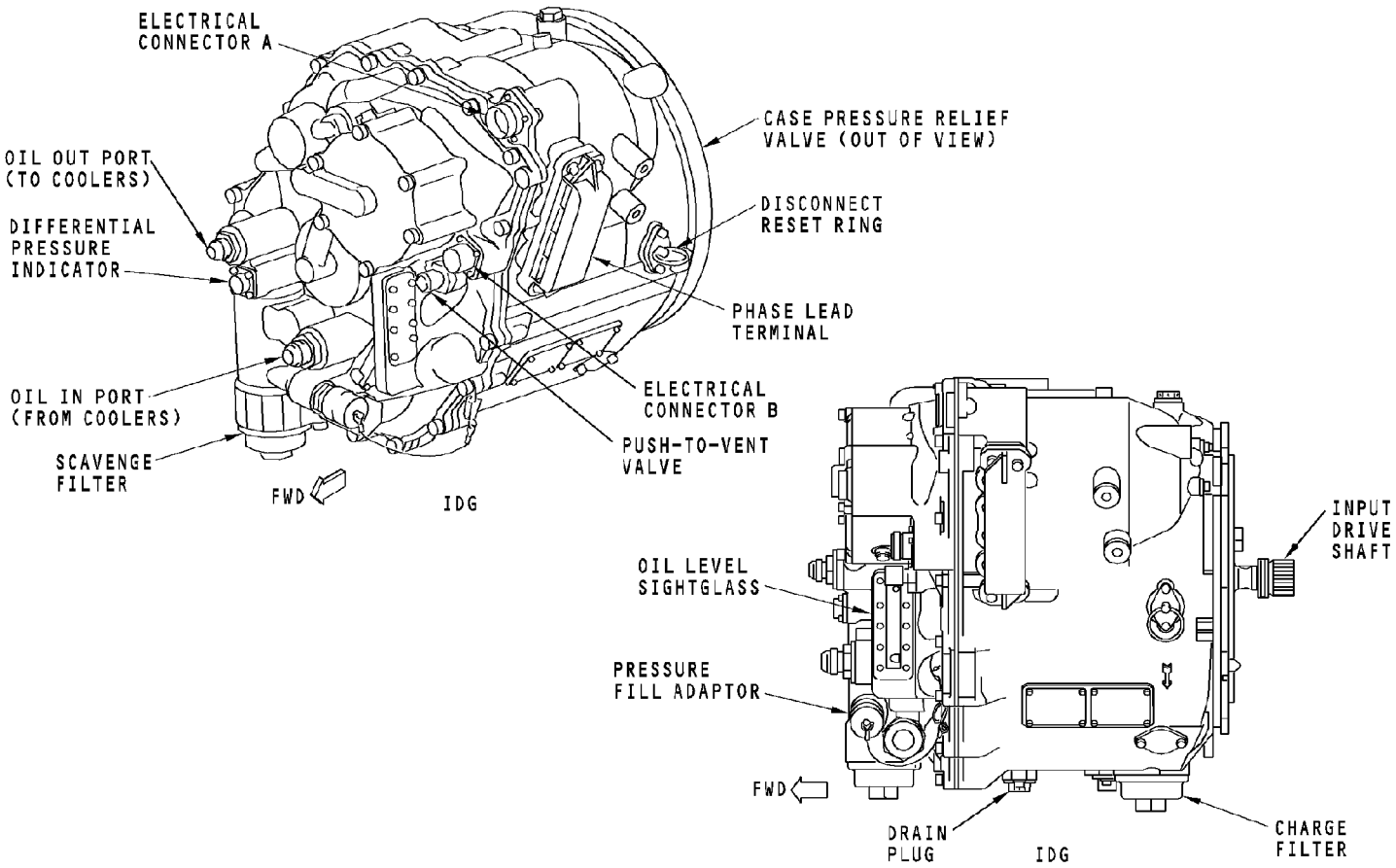

GENERATOR DRIVE - INTEGRATED DRIVE GENERATOR (IDG)

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GENERATOR DRIVE - QUICK ATTACH/DETACH (QAD) ADAPTER

Purpose

The quick attach/detach (QAD) adapter attaches the IDG to the engine accessory gearbox (AGB).

Location

The QAD adapter is on the front face of the AGB.

General

The QAD adapter has these parts:

- Engine adapter plate
- Ring
- Tension bolt.

Screws hold the engine adapter plate to the AGB. The engine adapter plate has an alignment mark near the 4 o'clock position (when looking aft).

The ring is on the engine adapter plate. The ring is free to turn when the tension bolt is not in place. The ring also has an alignment mark which you use during IDG installation.

The tension bolt holds the ring in place on the engine adapter plate. The tension bolt goes through a boss on the ring and fits into a boss on the engine adapter plate.

Functional Description

The QAD ring holds the IDG to the engine adapter plate. The ring has clamp track areas that push against the IDG lugs. The tension bolt keeps the ring in place.

You loosen the tension bolt and turn the ring counter-clockwise (looking aft) to remove the IDG. This aligns the open portions of the ring with the IDG lugs.

Training Information Point

The alignment marks on the ring and the engine adapter plate help you position the ring to the open position for IDG installation.

CAUTION: DO NOT LET THE IDG HANG ON THE INPUT SHAFT DURING INSTALLATION. FAILURE TO SUPPORT THE IDG CORRECTLY OR BUMPING THE SHAFT CAN DAMAGE THE INPUT SEAL.

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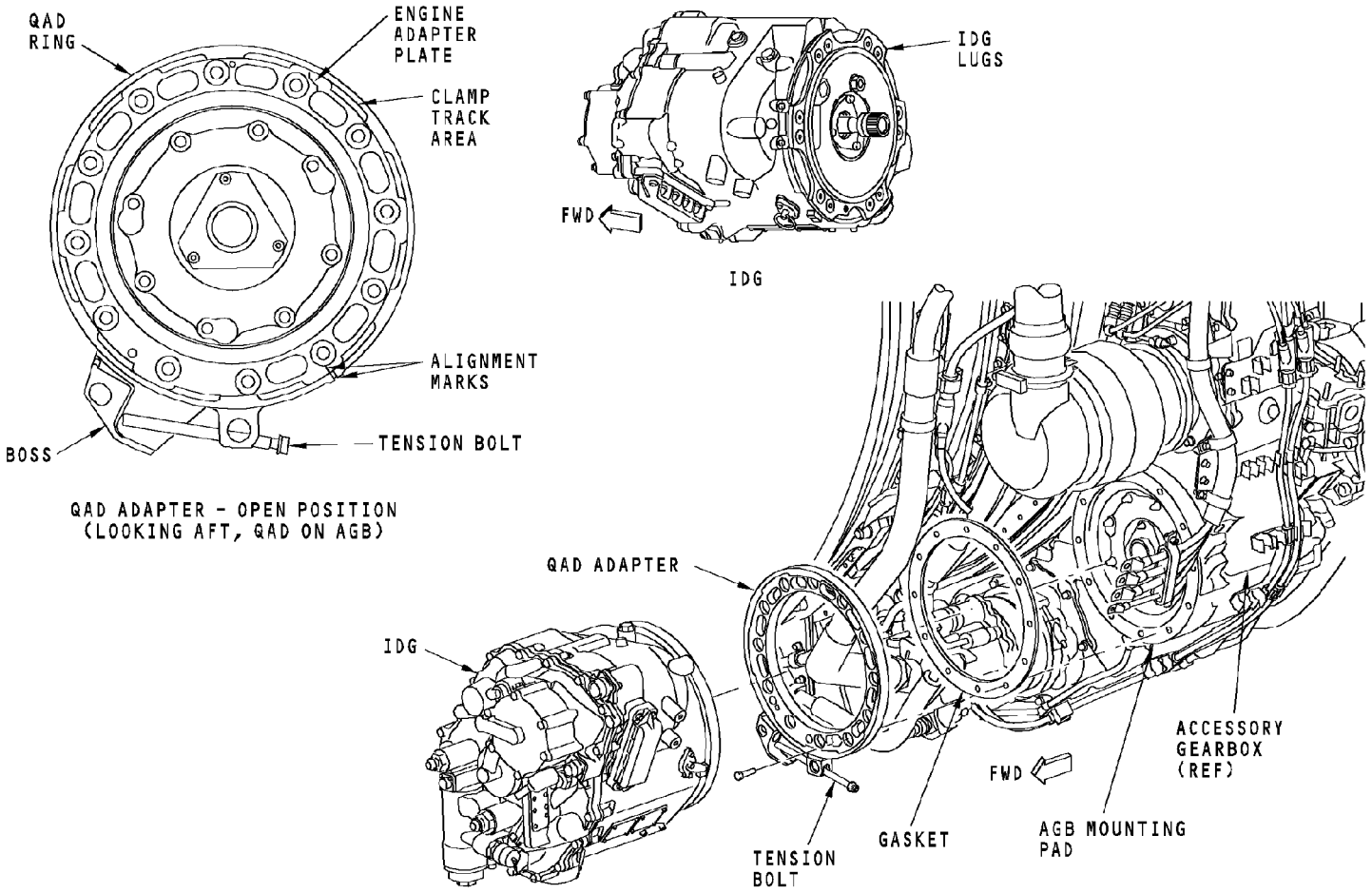

GENERATOR DRIVE - QUICK ATTACH/DETACH (QAD) ADAPTER

EFFECTIVITY

HAP ALL

24-10-00

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Purpose

The IDG air/oil cooler decreases the temperature of the IDG oil. This prevents possible damage to internal components of the IDG.

Location

The air/oil cooler is in the aft lower inside section of the engine fan case at the 6:30 position. You open the left fan cowl and the left thrust reverser half to get access to the air/oil cooler.

General Description

The IDG air/oil cooler uses engine fan air to decrease the temperature of the IDG oil.

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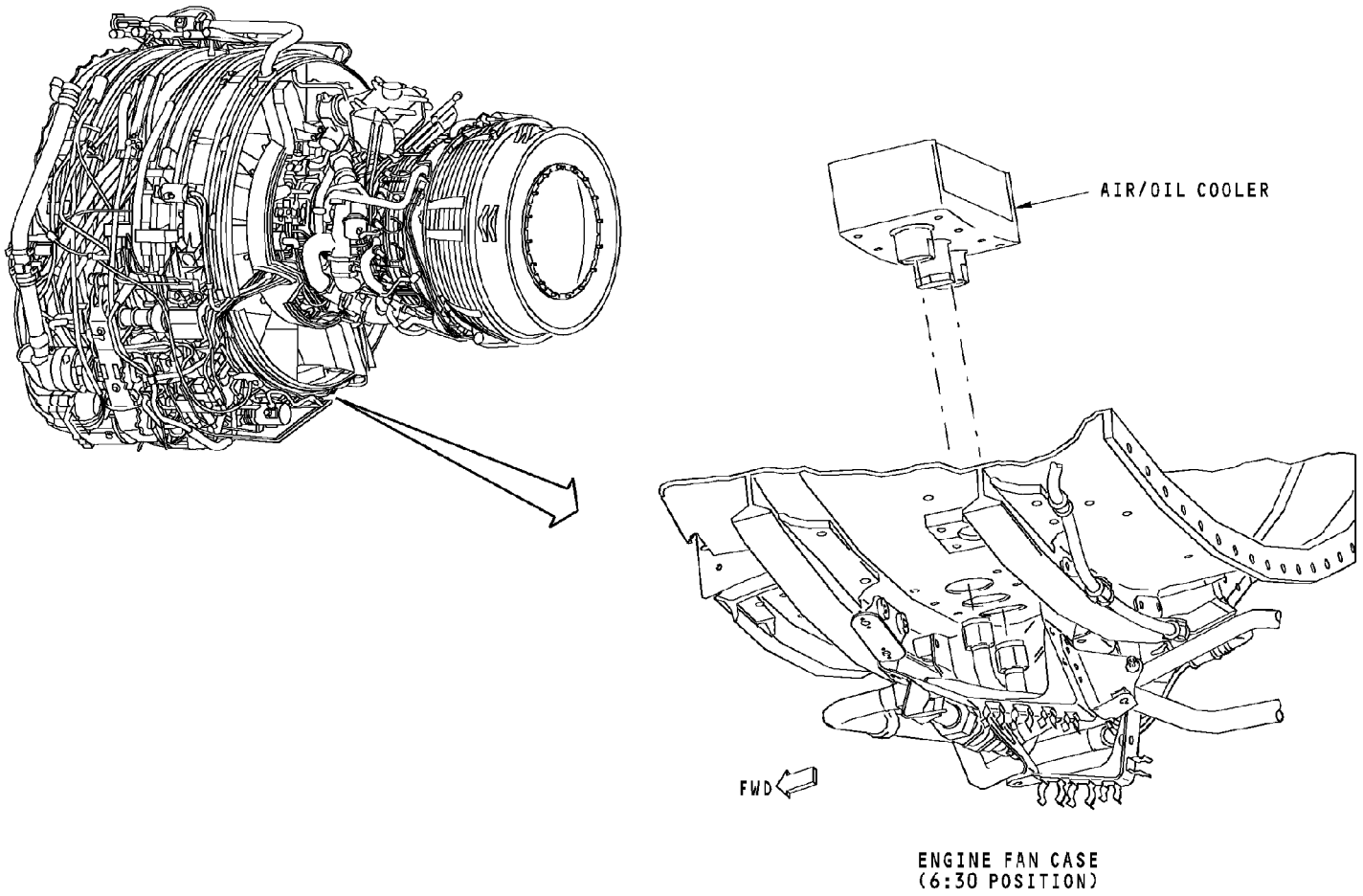

GENERATOR DRIVE - AIR/OIL COOLER

EFFECTIVITY
HAP ALL

24-10-00-030

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IDG Functional Description

The IDG is an assembly that has a hydromechanical constant speed drive (CSD) section and an oil-cooled brushless AC generator. The IDG also includes a permanent magnet generator (PMG) for control and excitation power. Lubrication and cooling of the CSD and generator components are by the same oil circuit. The CSD section turns the generator at a constant speed of 24,000 RPM. The generator supplies 115/200v ac, 400 Hz power and has a rating of 90 KVA.

The AC generator is a three-phase brushless machine. The generator has an AC exciter generator, and a main generator. The permanent magnet generator (PMG) is a permanent magnet rotor and PMG stator. The PMG rotor induces an AC voltage in the PMG stator as the generator turns. The PMG voltage goes to the generator control unit (GCU). The GCU rectifies the PMG AC voltage to DC.

See the AC generation system section for more information on the generator.

IDG Output Power Control

The GCU monitors IDG output power quality at these three places:

- Neutral current transformer (NCT) at the IDG, between the generator and ground
- Differential protection current transformer (DPCT) between the generator and generator control breaker (GCB)
- At the feeder lines, just before the GCB.

The GCU uses the DC voltage to excite the IDG generator through the exciter windings. The GCU controls the excitation power to control the output power of the generator. The GCU controls the generator control breaker (GCB) as a function of power quality.

Manual IDG Disconnect

You use the generator drive disconnect switch to do a manual disconnect of the IDG. When you put the switch to the disconnect position, power goes to a solenoid on the IDG if the engine start lever is in the idle position. The solenoid energizes and disconnects the CSD from the input drive shaft.

You reset the manual disconnect at the IDG. The engine must not be turning when you do the reset.

A manual disconnect is usually done when the DRIVE light comes on. The DRIVE light shows that the IDG oil pressure is less than the minimum operating limit or there is an underfrequency condition. A switch cover and system logic prevent an accidental disconnect.

The IDG input shaft also has a shear section that breaks when torque is too high. This prevents the engine accessory gearbox from being damaged because of an IDG failure.

EFFECTIVITY
HAP ALL

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Thermal IDG Disconnect

The IDG also has a thermal mechanism that automatically disconnects the CSD section of the IDG if the IDG oil temperature gets too hot. Thermal disconnect occurs at 363F (182C). You must remove and disassemble the IDG to reset a thermal disconnect.

IDG Oil System

Inside the IDG are pumps that move the oil through the IDG and out through two external heat exchangers. A charge pump moves the oil to operate the IDG and also lubricate and cool the CSD section of the IDG. The oil also goes to cool the generator. A scavenge pump then moves the hot oil out of the IDG to the two coolers. Oil returns into the IDG through a deaerator. From the deaerator, oil drains into the sump.

The charge pump develops oil pressure for the CSD to operate. The charge pump pressure is regulated between 240 to 290 psi (1655 to 1999 kpa) by the charge relief valve. If the charge filter is clogged, the filter will be bypassed with a differential pressure more than 100 psi (690 kpa) through a charge filter bypass valve.

There is a spring actuated vent valve on the IDG to keep constant internal pressure in the housing. Before you service the IDG, push the vent valve to relieve pressure built up in the case.

The case pressure relief valve prevents IDG case rupture if there is a fuel leak from the IDG OIL COOLER into the IDG oil system. The valve starts to operate at 30 to 40 psi and is fully open at 60 psi. The valve vents into the area between the accessory gearbox and the IDG and overboard through a drain line.

The scavenge pump sends oil into the scavenge oil filter. If the scavenge oil filter becomes clogged, a spring-loaded differential pressure indicator (DPI) goes out. The DPI has a temperature lockout feature. A bimetal element locks out the popout indicator if the oil temperature is less than 125F to 165F (52C to 74C).

A scavenge filter bypass valve in the scavenge circuit limits the discharge pressure of the scavenge pump. If blockage in the circuit causes the oil pressure to increase to 325 psi (2,242 kpa), the bypass valve opens and sends oil to the inlet of the deaerator which bypasses both the scavenge filter and external cooling circuit.

Oil from the IDG goes through the AIR/OIL COOLER first. Air from the engine fan goes through the cooler to decrease the temperature of the IDG oil. The AIR/OIL COOLER has an internal bypass which opens if the cooler becomes clogged.

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GENERATOR DRIVE - FUNCTIONAL DESCRIPTION

The IDG OIL COOLER is in series with the AIR/OIL COOLER. It gets fuel from the low pressure section of the engine fuel pump. The oil temperature decreases and the fuel temperature increases.

The high pressure bypass valve opens if the IDG OIL COOLER becomes clogged. IDG oil then bypasses the IDG OIL COOLER and goes back to the IDG.

The amber DRIVE light comes on if the IDG oil pressure decreases to less than the minimum operating limit of 165 psi (1136 kpa). The DRIVE light also comes on for an underfrequency fault. The GCU controls this light.

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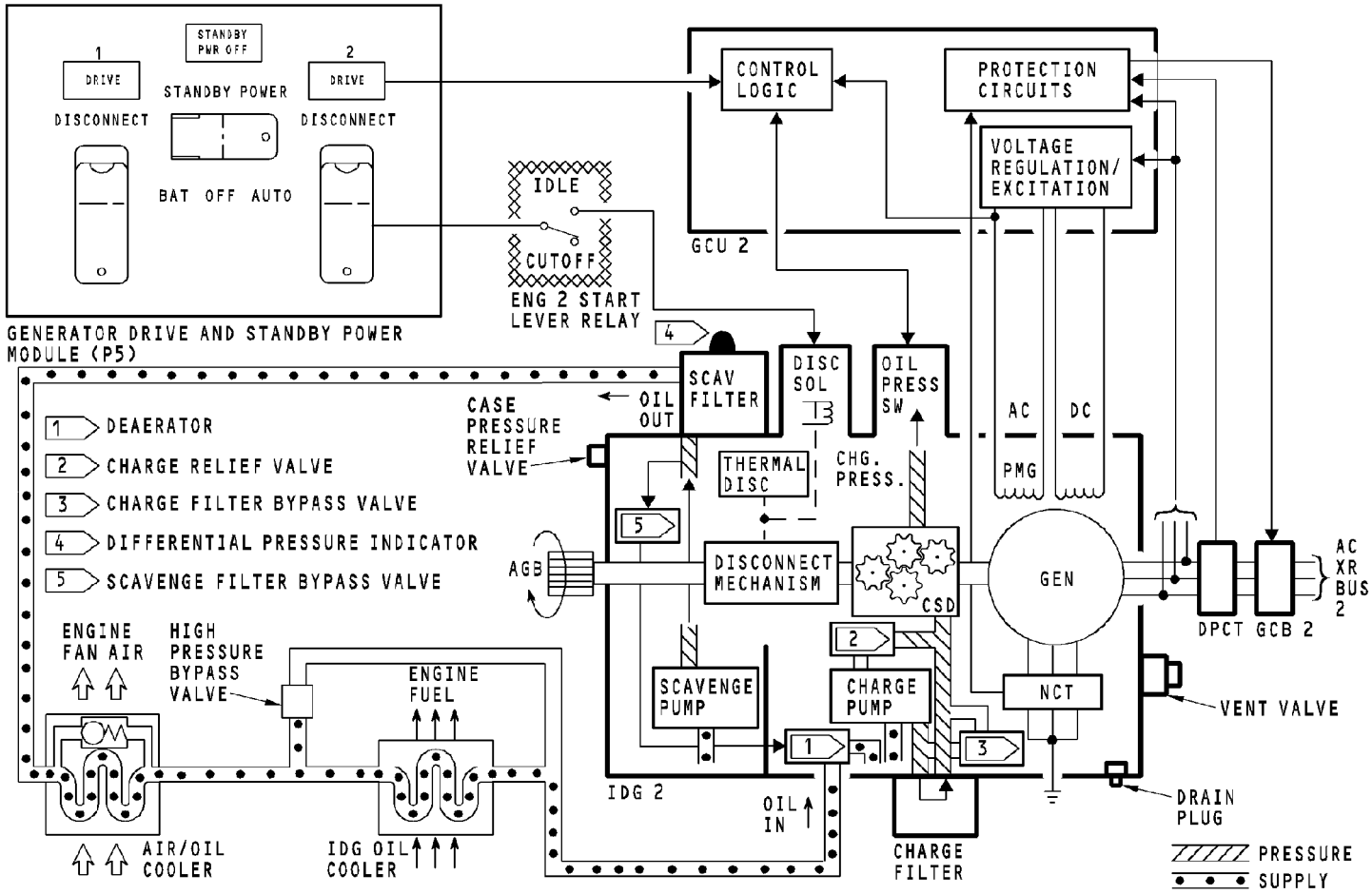

GENERATOR DRIVE - FUNCTIONAL DESCRIPTION

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Charge and Scavenge Oil Filters

There are two remove-and-replace oil filters on the IDG. You check and replace both filters at scheduled intervals. You should always replace old filters with new filters.

The charge oil filter is downstream of the charge pump. If this filter clogs, a differential pressure valve opens and lets oil bypass the filter. There is no indication if this filter clogs.

The scavenge filter is downstream of the scavenge pump. The differential pressure indicator shows if the filter clogs.

Oil Servicing

You do the oil servicing of the IDG at the pressure fill port. You must push the push-to-vent-valve to release IDG case air pressure before you add oil.

The oil that you pump into the IDG flows through the scavenge filter and then through the heat exchangers and into the IDG case. Air in the circuit moves ahead of the oil to the IDG sump.

Because it takes time for the oil to flow through external components, you should add oil slowly. This prevents overservicing. You pump oil into the IDG until the correct oil level shows on the oil sight glass.

CAUTION: DO NOT OPERATE THE IDG IF THE OIL LEVEL IS TOO HIGH OR TOO LOW. THIS CAN CAUSE DAMAGE TO THE IDG.

WARNING: FAILURE TO PUSH THE CAP OF THE VENT VALVE TO RELIEVE THE INTERNAL IDG PRESSURE COULD CAUSE HOT OIL TO SPRAY OUT.

CAUTION: DO NOT MIX DIFFERENT OIL TYPES IN IDG. MIXING DIFFERENT OIL TYPES CAN CAUSE DAMAGE TO IDG.

Oil Quantity Check

The oil level sight glass shows the amount of oil in the IDG. The oil level sight glass cover is black with a silver band. When the oil level is below the silver band, the IDG oil level is low and it is necessary to add oil. When the oil level is in the silver band, the IDG oil level is normal.

When the oil is cold and the level is above the silver band, the IDG oil level is high and you must drain oil.

When the oil is hot and the level is above the silver DRAIN line, the IDG oil level is high and you must drain oil. Hot oil, above the silver band, but below DRAIN, is acceptable.

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Because of wing dihedral, the oil level in the sight glass is different for the left and right engine. You must service to the correct left or right engine marks on the sight glass. You should always vent the IDG before you do an oil quantity check.

CAUTION: DO NOT CHECK THE OIL LEVEL OF A DISCONNECTED IDG. A DISCONNECT CAN CAUSE AN INCORRECT OIL QUANTITY INDICATION IN THE IDG. TOO MUCH OR NOT ENOUGH OIL CAN CAUSE DAMAGE TO THE IDG DURING CONTINUED OPERATION.

NOTE: Make sure that the engine has been shutdown for a minimum of 5 minutes before you do an oil quantity check.

Drain Plug

There is a drain plug at the bottom of the IDG. You use it to drain the oil from the IDG.

Training Information Point

The IDG has two servicing placards.

The small placard below the sightglass reminds you to vent the IDG before you do an oil quantity check. Your check may not be accurate if you do not vent the IDG.

The large placard has a warning and the IDG servicing instructions. You should always vent the IDG before and after you service it.

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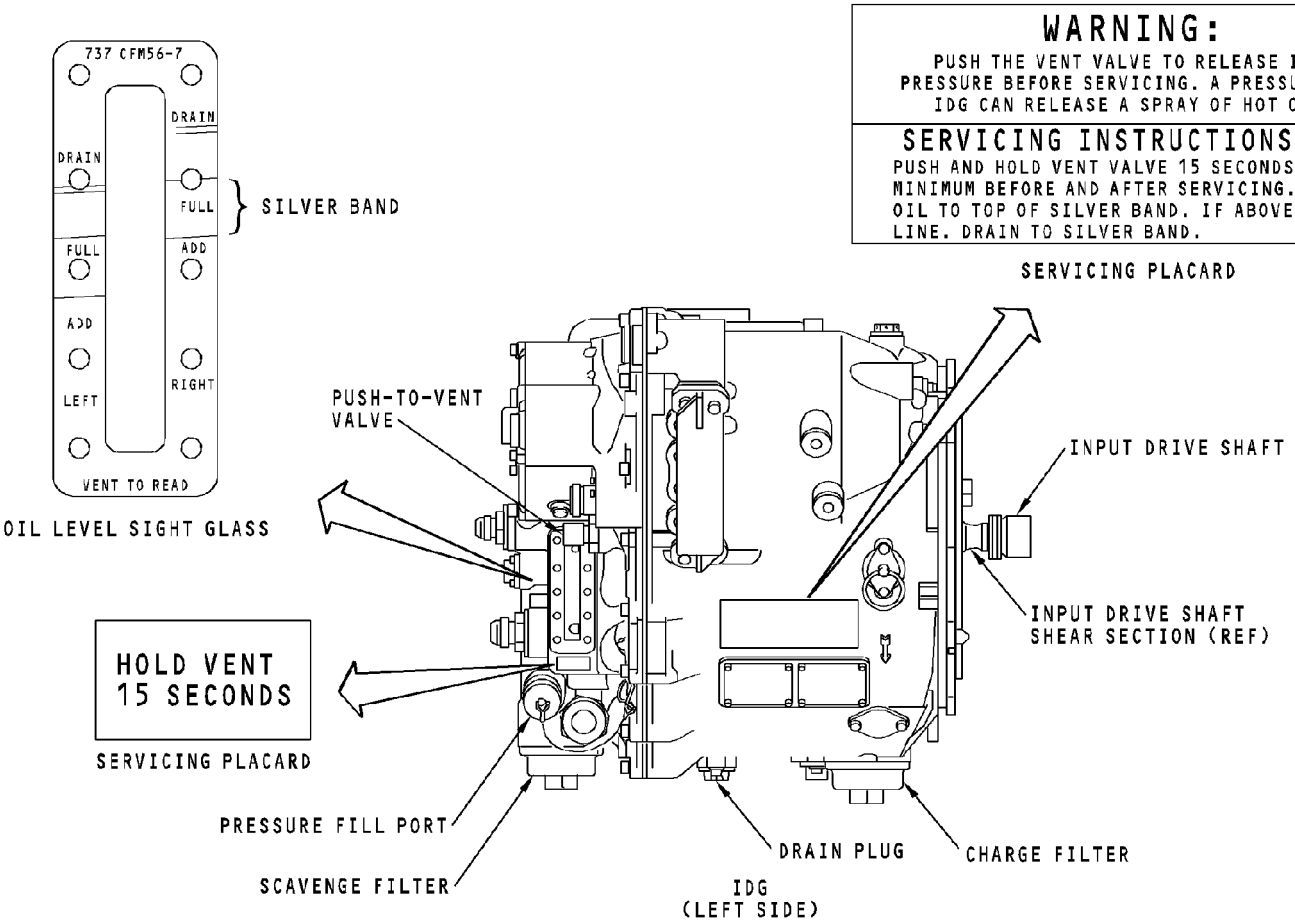

GENERATOR DRIVE - SERVICING

EFFECTIVITY
HAP ALL

24-10-00

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AC GENERATION - INTRODUCTION

Purpose

AC generation makes and controls three-phase, 115/200 v ac, 400 Hz power for use by the electrical power system.

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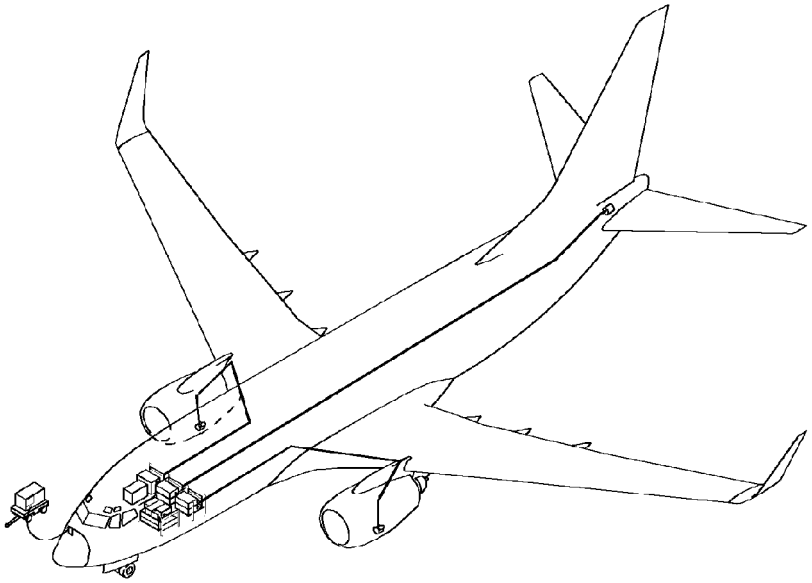

AC GENERATION - INTRODUCTION

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AC GENERATION - DISTRIBUTION AND AUTOMATIC CONTROL - GENERAL DESCRIPTION

General

The AC generation system is a three-phase, four-wire system that operates at a nominal voltage of 115/200 volts, 400 Hz. The AC system has these four power sources:

- Integrated drive generator 1 (IDG 1)
- Integrated drive generator 2 (IDG 2)
- Auxiliary power unit (APU) starter-generator
- External power.

You operate the correct flight compartment switch to use a power source. There is no automatic source selection. Priority goes to the last selection.

Power Distribution

The AC part of the electrical system has separate left and right systems (non-parallel). This means that two power sources never supply power to the same AC transfer bus at the same time. The left and right parts of the AC systems connect if only one power supply is available. The bus power control unit (BPCU) lets the left and right systems connect for any of these conditions:

- Loss of power to the left or right transfer bus
- External power is the only source of electrical power
- APU power is the only source of electrical power.

Each AC transfer bus gets and distributes power to other buses. Each AC transfer bus usually has power unless all AC sources are not operating or you disconnect them.

The ground service buses get power in these two ways:

- You operate a switch in the flight compartment that closes the EPC and BTBs and sends power through the transfer buses
- You operate a switch at the forward attendant panel that sends power to the ground service buses.

The main battery charger gets power from the ground service bus 2. The auxiliary battery charger gets power from ground service bus 1.

The main buses get power from the transfer buses. The BPCU controls power to the main buses. The BPCU opens the main bus relay if power is more than limits.

AC transfer bus 1 normally supplies power to the AC standby bus. The AC standby bus alternatively gets power from the static inverter. The static inverter gets power from the DC system (batteries or battery chargers).

The transfer buses supply power to the galleys. The BPCU opens galley breakers if the galley power is more than limits.

The transformer rectifier units (TRUs) take AC power and change it to DC power for use by the DC system.

EFFECTIVITY
HAP ALL

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TRU 1 gets power from AC transfer bus 1. TRU 2 gets power from AC transfer bus 2. TRU 3 usually gets power from AC transfer bus 2. TRU 3 can get power from AC transfer bus 1 if the TR3 transfer relay (TR 3 XFR RLY) energizes. This relay energizes when AC transfer bus 2 de-energizes.

Each IDG supplies up to 90 KVA continuously. The external power receptacle rating is 90 KVA. The APU starter-generator supplies up to 90 KVA below 32,000 feet (9,753 meters). Above 32,000 feet the APU starter-generator rating decreases linearly to 66 KVA at 41,000 feet (12,496 meters).

The AC power system has these characteristics:

- Normal range of 107.5 - 117v (V) root mean square (RMS) per phase, and 109 - 117 VRMS for three-phase
- Nominal steady-state voltage of 115 VRMS
- Non-normal operation of 97 - 132 VRMS per phase, and 98.5 - 130 VRMS for three-phase
- Steady-state frequency of 400 ± 5 Hertz (Hz), with a nominal value of 400 Hz
- Non-normal frequency of 380 - 420 Hz.

Outside of these values, protection circuits in the generator control units (GCUs), and the BPCU open the related generator breaker to protect the source and the electrical system. Circuit breakers give initial protection for individual buses or loads.

Control

The BPCU and GCUs control and protect the electrical system.

The GCUs control and monitor power quality. With flight compartment switch position input and good power, the GCU supplies a signal to close the breaker.

The GCUs and BPCU communicate with each other. The BPCU monitors breaker positions for the electrical system. The BPCU does not let a GCU send a close signal to a breaker until no other power source is on that side.

The BPCU works with the GCUs to control bus tie-breaker (BTB) position.

The BPCU also controls power to the main buses and galleys. If power requirements are too high, the BPCU opens the galley and main bus load shed relays. The fail-safe design lets the system operate with the failure of the BPCU or a GCU.

The start converter unit (SCU) controls the APU generator voltage. The AGCU operates with the SCU to keep good APU generator power. The AGCU monitors power quality. Poor quality APU electric power causes the AGCU to open the APU power breaker (APB).

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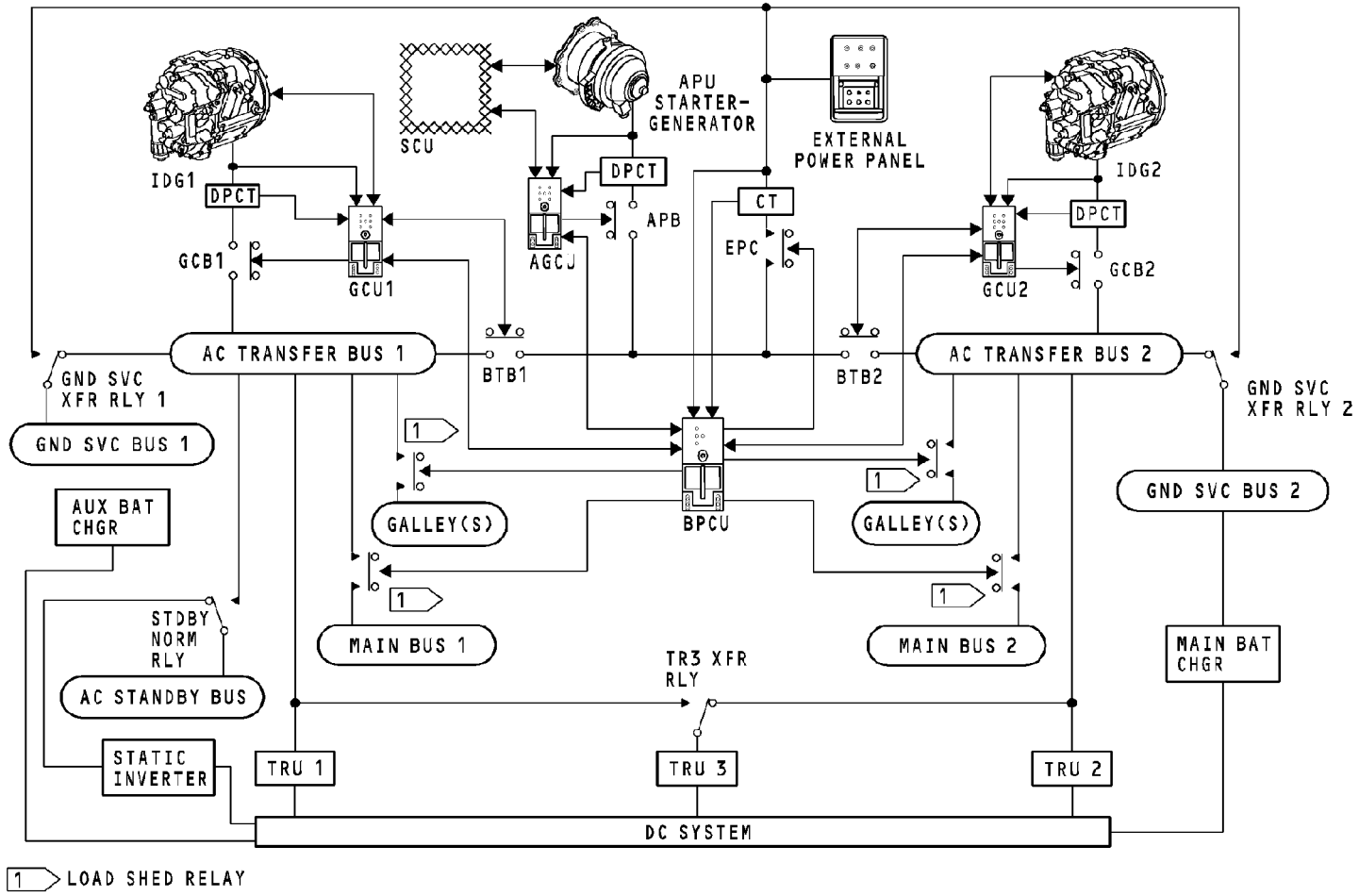

AC GENERATION - DISTRIBUTION AND AUTOMATIC CONTROL - GENERAL DESCRIPTION

EFFECTIVITY
HAP ALL

24-20-00

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Flight Compartment

The P5 forward overhead panel contains these three sub-panels (modules) which have the controls and indications for the electrical power system:

- P5-13 electrical meters, battery and galley power module
- P5-5 generator drive and standby power module
- P5-4 AC system, generator and APU module.

P5-13 Electrical Meters, Battery and Galley Power Module

The battery switch controls relays that supply battery power to the DC buses and the standby buses.

See the DC generation system section for more information. (SECTION 24-31)

The alphanumeric display shows up to two lines of maintenance information.

The AC meter selector is a seven-position rotary switch. The AC meter selector selects the AC channel to show the AC VOLTS, AC AMPS and CPS FREQ sections of the alphanumeric display. Selection of GEN1, APU GEN, or GEN2 tells the display to show voltage, current and frequency. Selection of STBY PWR, GRD PWR, or INV makes the display show voltage and frequency.

You use the TEST position of the AC meter selector when you do P5-13 BITE. See the electrical power section for more information about BITE. (SECTION 24-00)

AIRPLANES WITH THE GALLEY SWITCH;

- The GALLEY switch supplies AC electrical power to galleys when the AC transfer buses have power.

AIRPLANES WITH THE CAB/UTIL AND IFE/PASS SEATS SWITCHES;

- The CAB/UTIL switch supplies electrical power to galleys and numerous utilities.
- The IFE/PASS SEATS switch supplies electrical power to passenger entertainment systems.

P5-5 Generator Drive and Standby Power Module

You use the generator drive disconnect switches to do a manual disconnect of the IDG input shafts from the engine accessory gearboxes (AGB). The engine start lever must also be in the idle position to do a manual disconnect of an IDG.

The generator drive light shows an IDG malfunction. The light comes on when the IDG oil pressure is less than operating limits or for an underfrequency condition.

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The standby power switch gives manual control to disable the standby buses or to override the automatic control of the standby buses from AC transfer bus 1 to battery/inverter power.

The STANDBY PWR OFF light comes on when any of these buses do not have power:

- AC standby bus
- DC standby bus
- Battery bus.

P5-4 AC System, Generator and APU Module

Each IDG has a generator switch. Each switch supplies electrical on/off signals to let the generator control unit (GCU)close the generator control breaker (GCB).

The APU has two generator switches. Each switch supplies electrical on/off signals to let the APU GCU (AGCU)close the APU power breaker (APB).

The bus transfer switch provides on/off control of the automatic bus transfer function. The bus power control unit (BPCU) senses bus transfer switch position. The BPCU controls the bus tie breakers (BTBs).

The TRANSFER BUS OFF lights give indication of power status on each AC transfer bus. A TRANSFER BUS OFF light comes on when no power is on its transfer bus. Thus, the GCB and BTB are open when a TRANSFER BUS OFF light is on.

The SOURCE OFF lights show that a transfer bus is not energized from the selected power source. For example, the left SOURCE OFF light comes on when GCB 1 trips and the AC transfer bus 1 receives power through the bus tie breakers (BTBs) from IDG 2.

The GENERATOR OFF BUS lights provide indication of generator control breaker (GCB) position. A GENERATOR OFF BUS light is off when its GCB is closed. This shows that the AC transfer bus has power from the IDG.

Note: The GENERATOR OFF BUS lights comes on anytime the battery bus has power and the GCB is open. The operation of the GENERATOR OFF BUS lights depends on GCB position only. It is independent of engine operation or IDG output power quality.

The APU GEN OFF BUS annunciator is on when the APU is on and the APB is open. This shows that the APU is ready to load (RTL) and the generator is not on either transfer bus.

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The GRD PWR switch supplies manual control of the external power contactor (EPC). The BPCU receives on/off signals from the ground power switch to control the EPC.

The GRD POWER AVAILABLE light comes on when external power is connected to the airplane and the power quality is good. The light stays on until you remove the external power source at the external power panel.

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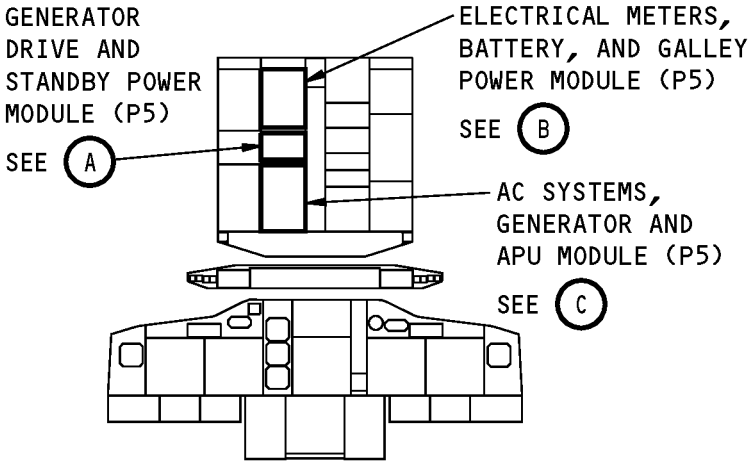
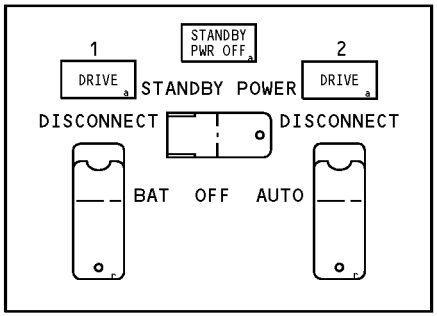


FLIGHT COMPARTMENT



GENERATOR DRIVE AND STANDBY POWER MODULE (P5)

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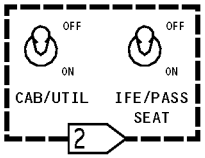

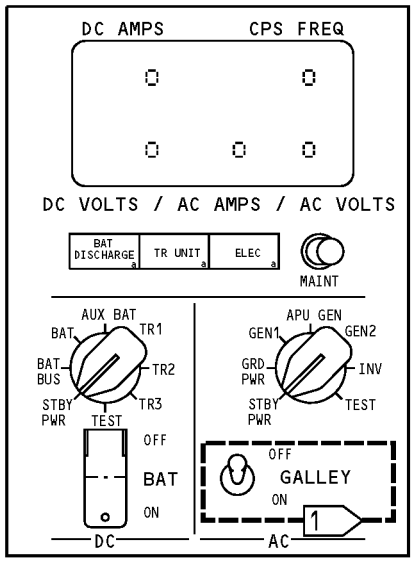

ELECTRICAL METERS, BATTERY AND GALLEY POWER MODULE (P5)

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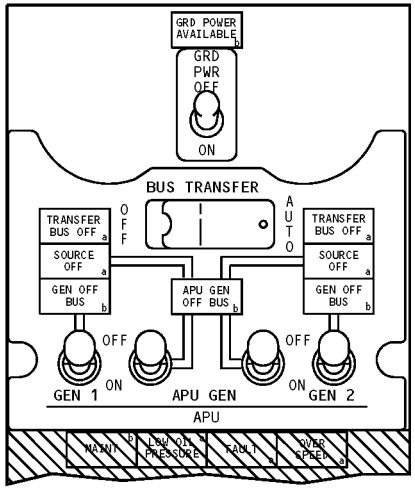

AC SYSTEMS, GENERATOR AND APU MODULE (P5)

C

1 AIRPLANES WITH GALLEY SWITCH

2 AIRPLANES WITH CAB/UTIL AND IFE/PASS SEAT SWITCHES

AC GENERATION - MANUAL CONTROLS AND INDICATION - GENERAL DESCRIPTION

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IDG Wire Routing

The IDG feeder wires go from the IDG to the power distribution panel (PDP) in the EE compartment. The wires have these four connections:

- IDG
- Engine strut firewall
- Strut/wing interface
- Back of the PDPs.

IDG feeder wires go from the strut, along the wing front spar, and into the fuselage. The wires go through the lower part of the fuselage to the back of the PDPs.

APU Wire Routing

The APU feeder wires go from the APU starter-generator to the PDPs. The wires have these two connections:

- APU starter-generator
- PDP 1.

The APU feeder wires route along the top of the fuselage.

External Power

External power feeder wires go from the external power connector, through the lower fuselage to PDP 2. These are the two connections:

- External power connector
- Back of PDP 2.

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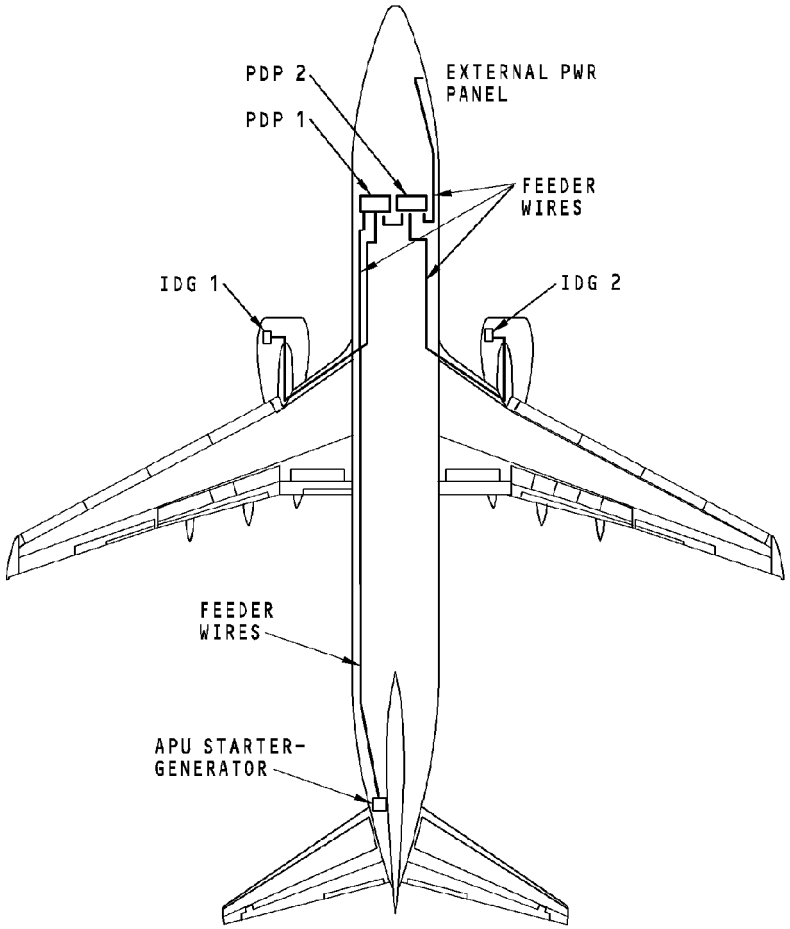

AC GENERATION - AC SOURCE FEEDER WIRE ROUTING - GENERAL DESCRIPTION

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P6 and P18 Panels

The P6 and P18 panels in the flight compartment have most of the airplane system load circuit breakers. These are a few of the panel components:

- Thermal circuit breakers
- Relays
- Diodes
- Wiring.

Each circuit breaker panel contains several sub-panels (doors) that open. Circuit breakers are on the face of the sub-panels. You open the sub-panels to get access to the other components.

The P6 has six sub-panels and the standby power control unit (SPCU). The P18 has three sub-panels.

Electronic Equipment Compartment

The electronic equipment (EE) compartment contains these electrical items:

- Modules (black boxes)
- Power distribution panels (PDPs)
- Aircraft battery
- Relays.

Access to the EE compartment is through a door aft of the nose wheel well at the bottom of the fuselage.

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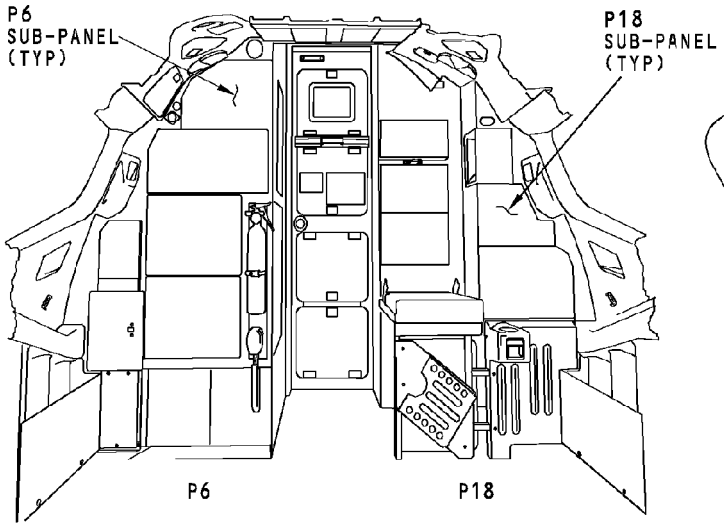

FLIGHT COMPARTMENT
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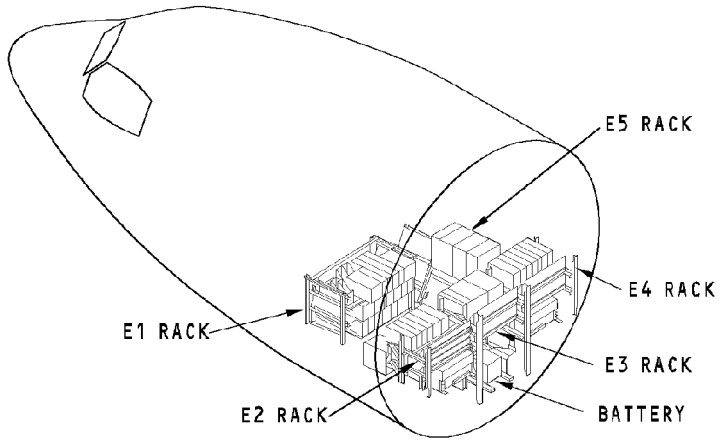

EE COMPARTMENT

AC GENERATION - AIRPLANE - COMPONENT LOCATIONS

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E4 Rack Components

The E4 rack has these components that are in the AC generation system or have interfaces with the system:

- Bus power control unit (BPCU)
- Power distribution panel 2, (PDP 2 or P92)
- Generator control unit 2 (GCU 2).

E2 Rack Components

The E2 rack has these components that are in the AC generation system or have interfaces with the system:

- APU generator control unit (AGCU)
- Generator control unit 1 (GCU 1)
- APU start converter unit (SCU)
- Power distribution panel 1 (PDP 1 or P91).

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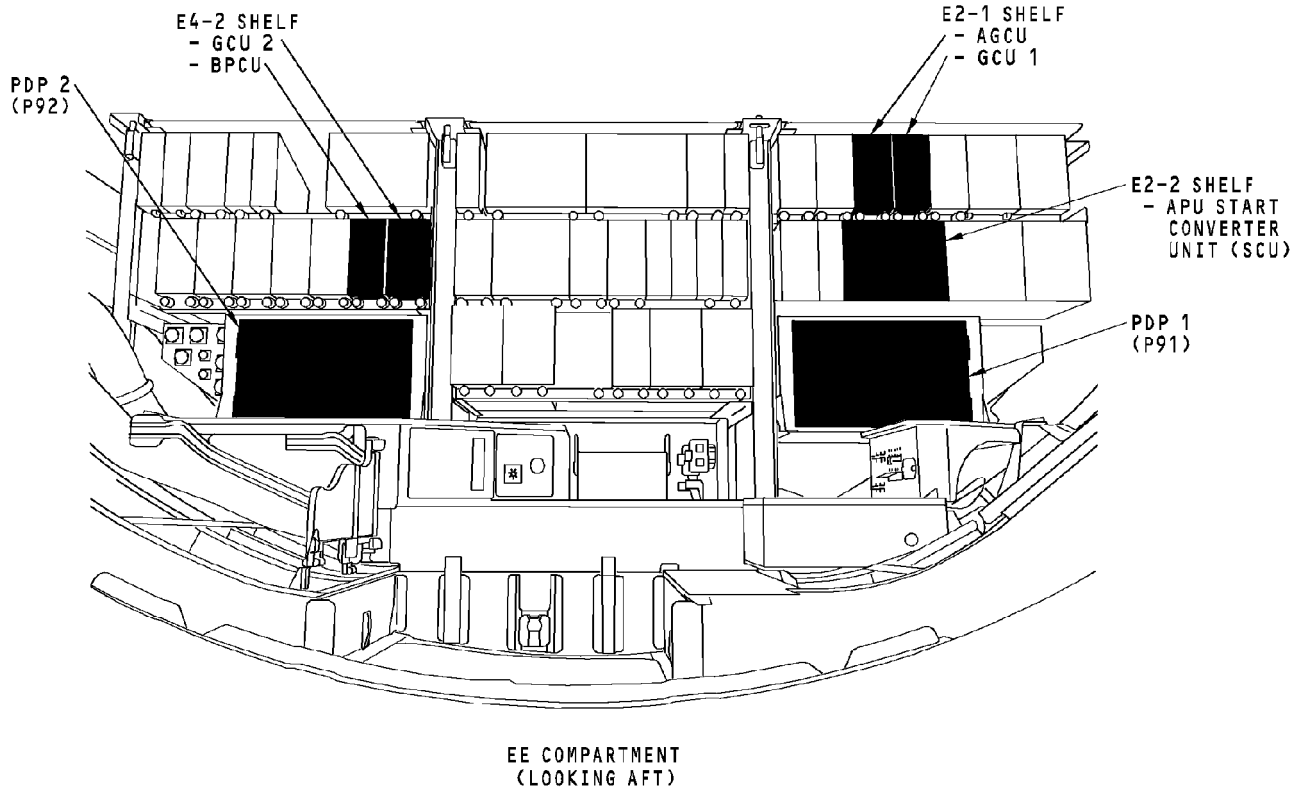

AC GENERATION - EE COMPARTMENT - COMPONENT LOCATION

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General Description

The electrical system has many junction boxes (J). The junction boxes contain many relays for different AC and DC loads on the airplane.

Most of the junction boxes are in the EE compartment or in the forward fuselage, below the flight compartment. These are the major junction boxes on the airplane:

- J4
- J5
- J9
- J20
- J22
- J23
- J24.

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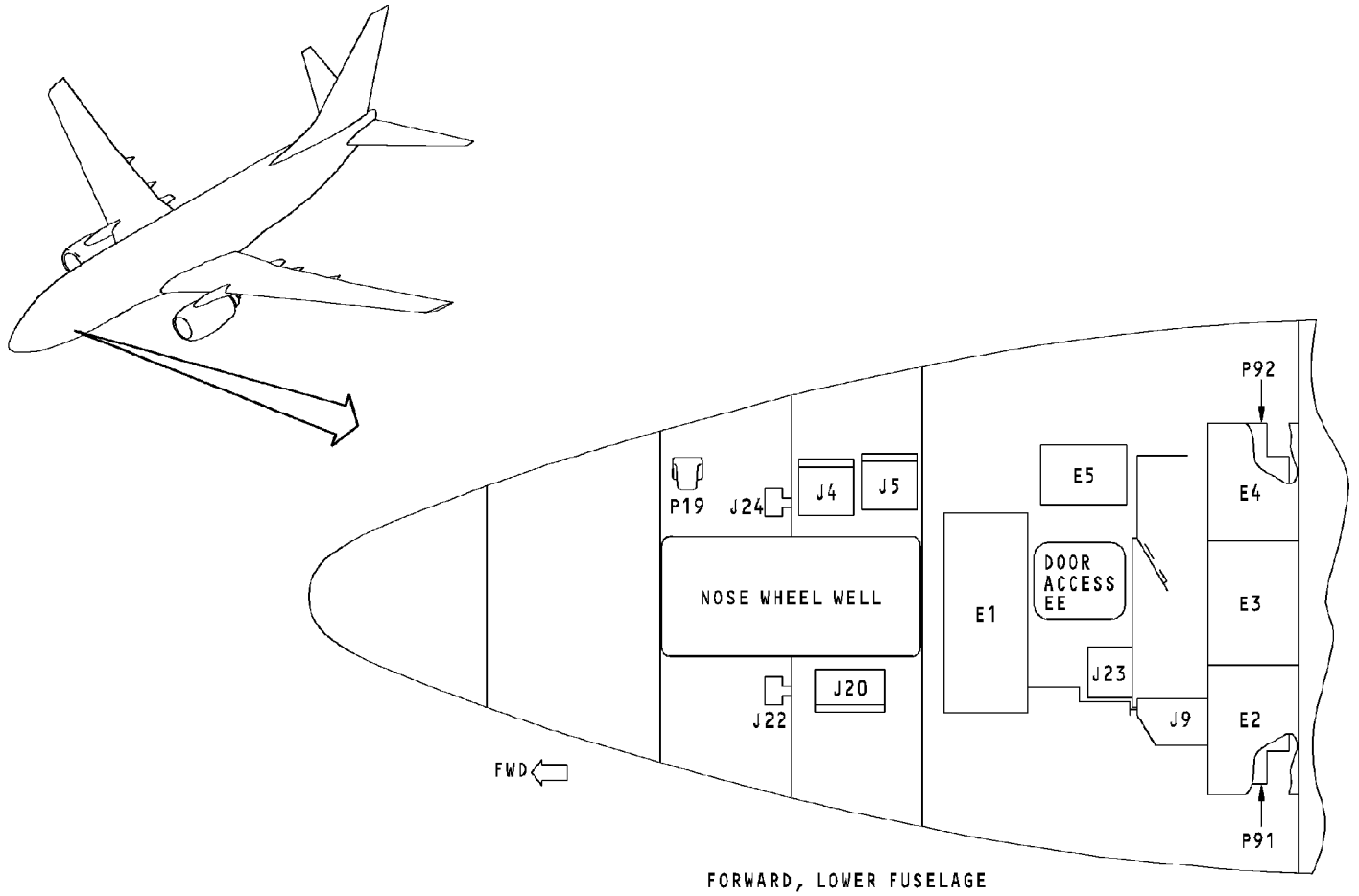

AC GENERATION - JUNCTION BOXES - COMPONENT LOCATIONS

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Purpose

Each generator control unit (GCU) has these functions:

- Control a generator control breaker (GCB) and a bus tie breaker (BTB)
- Supply/control excitation to an IDG generator
- Protect the electrical system and an IDG from electrical parameters not in limits
- Control electrical system indication on the P5-5 and P5-4 modules.
- Give built-in-test for fault isolation.

GCU Inputs

GCU1 and GCU2 receive power from one of these two sources:

- Permanent magnet generator in the IDG (AC power)
- 28v dc power from the BATTERY BUS for GCU 1 and from DC STBY for GCU 2.

Each GCU uses 28v dc to power protection circuits and regulate IDG output voltage. The GCU converts the PMG AC input to DC power.

Each GCU receives three phase sense current inputs from two points:

- The neutral current transformers (NCT) inside each IDG, between the IDG and ground
- The differential protection current transformer (DPCT) on the IDG power feeders, between the IDG and the GCB, in the respective PDP (Power Distribution Panel).

Each GCU also receives three phase sense voltage inputs from splices at the GCB.

GCU1 and GCU2 receive these inputs:

- Generator switch position (momentary)
- Oil pressure input from the IDG
- Position status from the GCB
- Position status from the EPC
- Position status from the APB
- Position status from the BTB
- Signal from the fire switch
- Ready-to-load (RTL) signal from the common display system display electronics units (CDS/DEU)
- Indication if BPCU fail-safe protection is active
- BTB command open/close signal
- Airplane on ground status (AIR/GRD)
- SOURCE OFF light on the P5 (GCU supplies ground)
- TRANSFER BUS OFF light on the P5 (GCU supplies ground).

The GCU monitors IDG oil pressure and frequency to control the DRIVE light on the generator drive and standby power module (P5-4). The light comes on for low oil pressure or underfrequency.

The RTL signal tells the GCU that the engine is operating at a sufficient speed to operate the IDG.

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GCU Outputs

GCU1 and GCU2 have these output signals:

- GCB close
- GCB open
- BTB close
- BTB open.

GCU Fail-Safe

The GCU has fail-safe protection if it loses the protection or control capability for the power channel. These actions occur if the GCU goes to a fail-safe condition:

- GCR opens
- GCB opens
- BTB closes (if open)
- GCU FAULT LIGHT on face of GCU comes on.

BPCU Fail-safe

The GCU receives a 28v dc signal from the BPCU when the BPCU operates properly. If the BPCU goes into a failsafe mode, the 28v dc signal goes away. The GCU responds to the failsafe signal based on GCU position through programming pins. See the External Power-BPCU section for more information on the BPCU failsafe signal. (SECTION 24-40)

Built-In-Test-Equipment (BITE)

Each GCU has front face BITE to help you do troubleshooting of the electrical system. See GCU/AGCU - TRAINING INFORMATION POINT in this section for more information.

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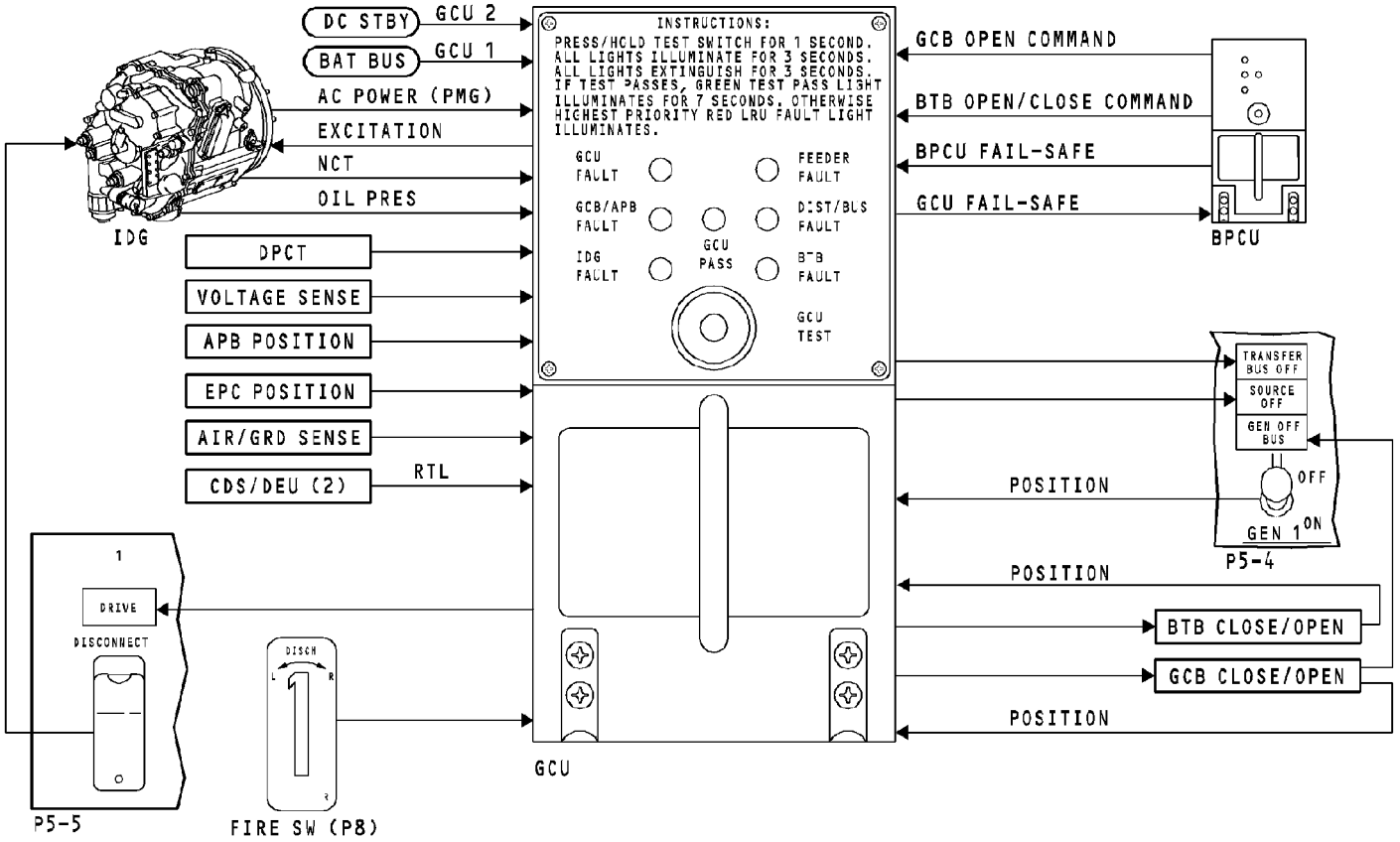

AC GENERATION - GENERATOR CONTROL UNIT (GCU) - GENERAL DESCRIPTION

EFFECTIVITY
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Generator Control Breaker (GCB) - Manual Close

The generator control unit for IDG 1 (GCU 1) sends a close command to generator control breaker 1 (GCB 1) when all of these conditions occur:

- Control switch 1 temporarily goes to the ON position
- Fire switch is in the normal position
- Power quality is OK
- GCU has a ready to load (RTL) signal from the display electronics units (DEUs) or IDG power quality is good for 20 seconds
- Bus tie breaker 1 (BTB 1) is open.

The GCU receives the RTL signal when the engine is at or above idle speed and the engine start lever is in the idle position.

The BTB receives an open (trip) signal from the GCU when the IDG power quality is good (GCR in closed position) and you put the generator control switch to the ON position. The GCU monitors BTB position and closes the GCB only after BTB 1 opens.

GCB - Automatic Close

GCU 1 also sends a close command to the GCB 1 when all of these conditions occur:

- Fire switch is in the normal position
- BTB 1 is open
- Airplane is in the AIR mode
- GCB is open on transition to the AIR mode and the APU is the only source of power on the aircraft (GCB 2 is also open)
- Auxiliary power breaker (APB) opens.

This occurs only once in flight. The circuit gets reset on transition to the GND mode.

GCB - Open

GCU 1 sends an open command to the GCB 1 when any of these conditions occur:

- GCU sees an underspeed condition (engine shut down)
- Engine fire switch is in the FIRE position
- Power quality is out of limits
- Generator control switch 1 goes temporarily to the OFF position
- GCU 1 receives an open (trip) command from the BPCU.

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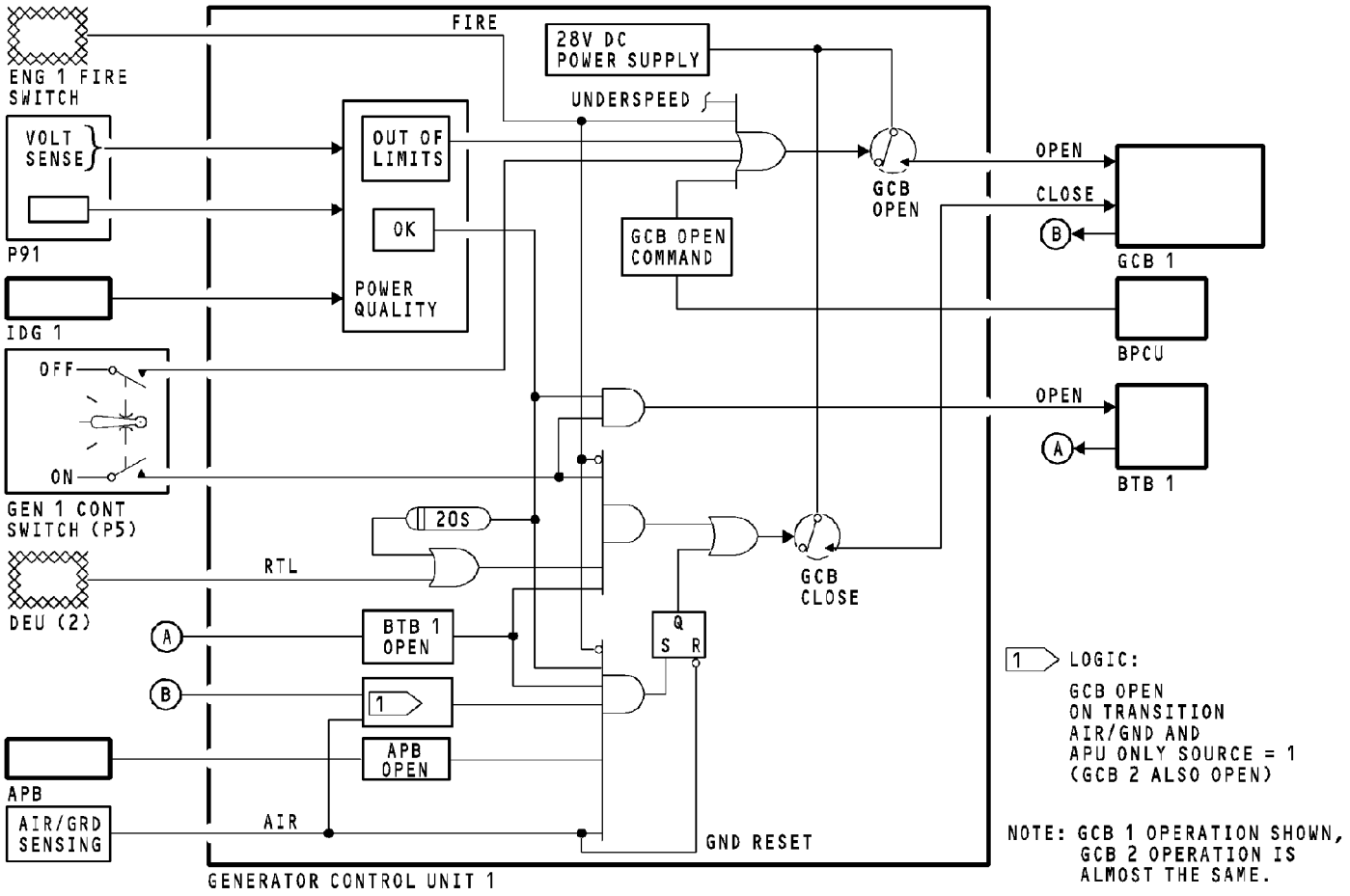

AC GENERATION - GCU - GENERATOR CONTROL BREAKER (GCB) CONTROL

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Generator Excitation

The IDG has a constant speed drive and a brushless AC generator.

The constant speed drive (CSD) is a hydromechanical device that adds or subtracts the variable input speed of the engine accessory gearbox. This operation keeps a constant output shaft speed necessary to turn the AC generator.

The AC generator is a three-phase, brushless generator. The generator has these components:

- Exciter rotor (armature)
- Main generator rotor (field winding)
- Permanent magnet generator (PMG) rotor
- Main generator (exciter) stator
- PMG stator
- Neutral current transformer (NCT).

The CSD turns the PMG rotor. As the PMG rotor turns, it induces an AC voltage in the three-phase windings of the PMG stator. This AC voltage goes to the GCU. A voltage regulator (VR) inside the GCU transforms and rectifies the AC power to DC power. DC power goes to the exciter field windings with the generator control relay (GCR) in the closed position.

The stationary magnetic field caused by the DC voltage in the windings of the exciter field (stator) makes a three-phase AC voltage in the windings of the exciter armature (rotor). A rotating rectifier in the rotor converts the AC to DC voltage. The DC voltage goes to the field windings of the main generator. Current flow in the field windings causes a rotating magnetic field. The rotating magnetic field causes an AC voltage in the windings of the main generator stator.

The GCU monitors the power output of the generator. When the voltage and the frequency are within power quality limits, the GCU can close the GCB. The voltage regulator controls AC power output by control of the excitation power through the GCR.

The TRIP GCR closes, and excitation power goes away if any of these conditions occur:

- Generator switch is OFF
- Engine fire switch is in the FIRE position
- Any GCU protective function occurs
- Generator drive disconnect (underfrequency protection).

The GCB opens when the TRIP GCR closes.

The TRIP GCR does not close when you shut down the engine with the IDG on line. The GCU sees an underspeed condition before the under frequency condition. The GCB opens with an underspeed condition.

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GCU Protection

The GCU monitors voltage, current, and frequency. The GCU opens the GCB and de-excites the generator to protect the electrical channel. The GCU has these protective functions:

- Overvoltage
- Undervoltage
- Overfrequency
- Underfrequency
- Unbalanced phase current
- Generator diode failure
- Phase sequence
- Overcurrent
- Differential fault
- Underspeed protection
- GCU fail-safe.

Overvoltage and Undervoltage Protection

The GCU monitors each of the phase voltages at the point of regulation (POR). A voltage fault commands the generator control relay (GCR) and generator control breaker (GCB) to open.

An overvoltage protection trip happens when a phase voltage goes more than 130 volts.

An undervoltage trip happens when the lowest phase voltage goes below 101 volts for more than 7 seconds. The GCU also sees an open phase (feeder lead not connected) or a short in the IDG exciter circuit as an undervoltage.

Frequency Protection

The GCU monitors frequency at the PMG. Proper generator frequency is 400 Hz. The GCU opens the GCR and GCB if the frequency goes above these values:

- 425 Hz for more than 1.5 seconds
- 435 Hz for 35 milliseconds.

The GCU opens the GCR and GCB if the frequency goes below these values:

- 375 Hz for 1.5 seconds
- 355 Hz for 150 milliseconds.

The GCU sees an underfrequency condition if a manual disconnect or thermal disconnect happens while the IDG is on line. The GCU uses the RTL signal from the DEU to find if the engine is underspeed or the generator is underfrequency.

Unbalanced Phase Protection

The GCU monitors the three phases of the IDG current transformer. Unbalance phase protection occurs if the current unbalance between any two phases is more than 140 amps for 6.3 seconds. The GCU opens the BTB and if the unbalance continues, the GCR and GCB open.

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Generator Diode Failure Protection

The GCU monitors current ripple in the excitation return to find a shorted rotating diode in the IDG. If the current is more than 5 amps, the GCU opens the GCR and GCB.

Phase Sequence Protection

The GCU monitors the phase sequence at the POR. The GCU does not let the GCB close if a phase sequence problem occurs.

Overcurrent Protection

If the current is more than 274 amps for 300 seconds, the GCU commands the BPCU to remove secondary electrical loads (loadshed). The BPCU first removes galley loads and if the overcurrent condition continues, the main buses are shed. If an overcurrent condition still occurs, the GCU opens the GCR and GCB.

If the current is more than 340 amps for five seconds, the GCU commands the BPCU to start loadshed. If the overcurrent continues for another 0.1 seconds, the GCU opens the GCR and GCB.

Differential Fault Protection

The GCU monitors the three phases of the neutral current transformer (NCT) and the differential protection current transformer (DPCT). The GCU compares current flow at the IDG (through NCT) and at the GCB (through DPCT). If the differential current is more than 20 amps for 70 milliseconds, the GCU opens the GCR and GCB.

Underspeed Protection

The GCU monitors the ready-to-load (RTL) signal from the display electronics unit (DEU). The DEU sends the RTL signal when the engine is at or above idle speed and the engine start lever is in the idle position. If the RTL signal is present, an underfrequency or an undervoltage fault will cause the GCB and the GCR to open. The GCB will open if the underfrequency condition is due to an underspeed. The GCR stays closed if the RTL signal is removed.

A normal engine shutdown with the IDG on line is an example of an underspeed condition.

GCU Fail-Safe

The GCU has protection for an internal failure. A fail-safe condition causes these effects:

- GCR and GCB open
- BTB closes, if open

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- GCU fault indication on the front of the GCU and indication on the P5 panel.

GCU Automatic Close

The GCU1 sends a closed command to the GCR when all of these conditions occur:

- Fire switch is in the normal positon
- BTB1 is open
- Airplane is in the air mode
- GCB is open on transition to the air mode and the APU is the only source of power on the aircraft (GCB2 & BTB2 is also open)
- Auxiliary power breaker (APB) opens.

This occurs only once in flight. The circuit resets on transition to the ground mode. The proximity switch electronics unit (PSEU) supplies the air/ground signals.

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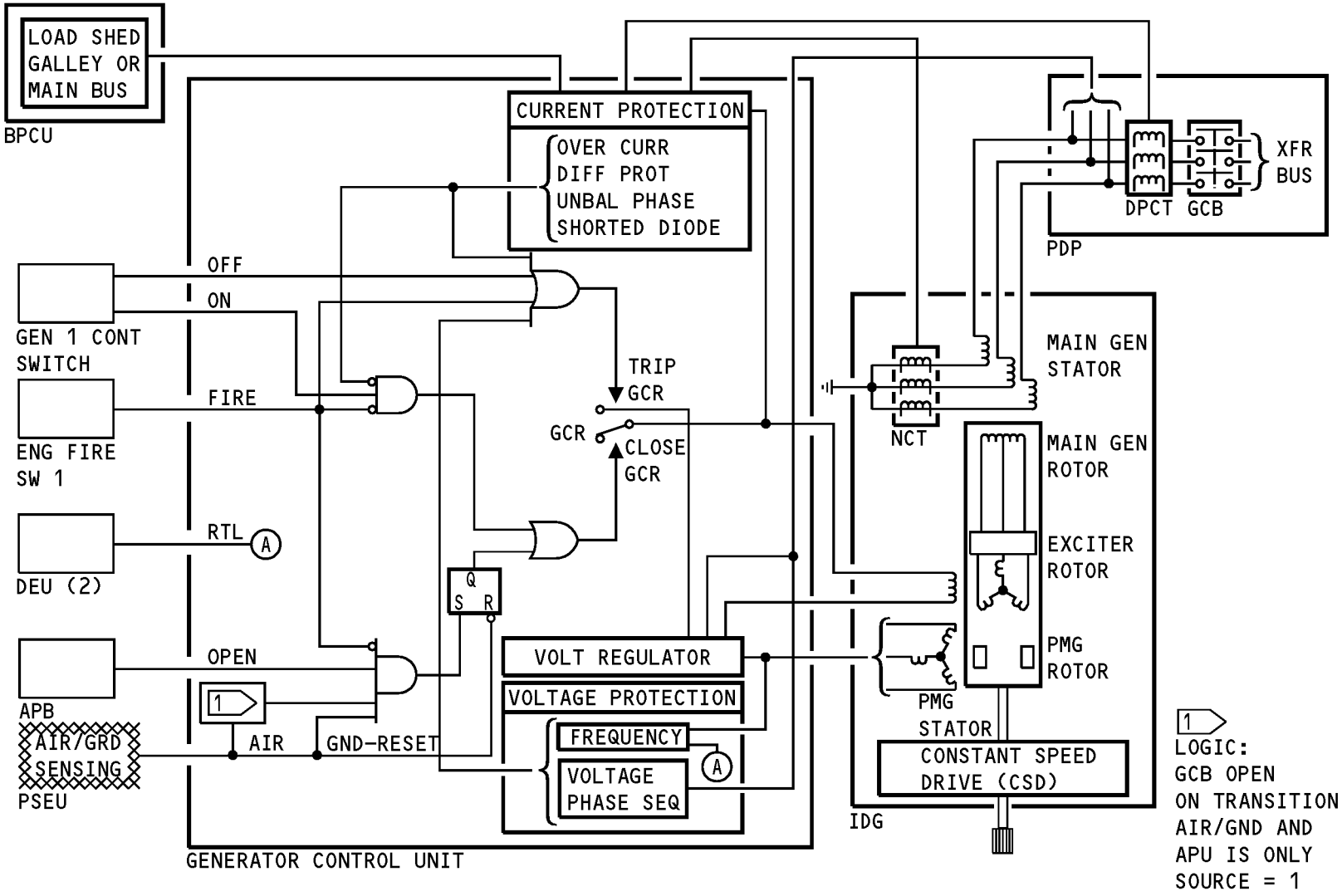

AC GENERATION - GCU - PROTECTION AND EXCITATION

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Built-In Test Equipment

The GCU built-in test equipment (BITE) is circuits and lights to find and isolate faults in each generation channel. BITE operates independently of the normal control and protective circuits. Inputs from other GCUs or the bus power control unit are not necessary. The GCU has these BITE functions:

- Finds and identifies LRU failures in the generation channel
- Saves fault information in the non-volatile memory (NVM)
- Shows fault information with front panel lights
- Self test of GCU circuits during power-up and whenever you push the test switch.

Front Panel

The front panel has one momentary TEST switch and seven lights. You use the TEST switch to turn off lights that come on by faults and to start a GCU self test.

A front panel light comes on when the GCU finds a fault. Only one light comes on at a time. There is a priority if the GCU sees more than one fault at the same time. The highest priority fault light comes on if there is more than one fault. The lights have this priority:

- 1 - GCU FAULT
- 2 - IDG FAULT
- 3 - GCB/APB FAULT
- 4 - BTB FAULT
- 5 - FEEDER FAULT
- 6 - DIST/BUS FAULT
- 7 - GCU PASS.

GCU FAULT Light

The GCU FAULT light comes on when the GCU/AGCU fails a self test or the fail-safe protection starts. An internal failure causes either one of these conditions.

The fail-safe protection starts when the GCU continuous monitor BITE functions finds an internal fault.

The GCU fault light also comes on if an undervoltage or overvoltage trip happens because of a voltage regulator failure.

IDG FAULT Light

For a GCU, the IDG FAULT light comes on when the GCU protection circuits open the generator control breaker (GCB) for any of these IDG output problems:

- Underfrequency
- Overfrequency
- Shorted rotating diodes at power source
- Undervoltage (voltage regulator okay).

The IDG FAULT light does not come on when a GCU is installed in the AGCU position.

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GCB/APB FAULT Light

For a GCU, the GCB/APB FAULT light comes on to show that the GCB did not move to the commanded position. For the AGCU, the GCB/APB FAULT light comes on to show that the APB did not move to the commanded position. The logic has a time delay to let the breakers change position.

BTB FAULT Light

The BTB FAULT light comes and shows that the BTB did not move to the commanded position. This light does not come on for the AGCU.

FEEDER FAULT Light

The FEEDER FAULT light comes on when the GCU opens the breaker for any of these problems:

- Differential current
- Phase sequence
- Undervoltage (IDG only, voltage regulator okay).

DIST/BUS FAULT Light

The DIST/BUS FAULT light comes on when the GCU/AGCU protection circuits open a GCB/APB for any of these power channel problems:

- Overcurrent
- Unbalanced phase current.

GCU PASS Light

The GCU PASS light comes on after the GCU passes a self test that you start. You push the GCU TEST switch for at least one second to start the GCU self test.

GCU Test Switch

You push the GCU test switch to start a self test. The test turns off any fault light that is on before the test. The fault light comes back on when the conditions that made the light come on are true again. The GCU does not respond to the GCU test switch if the applicable AC power source has excitation.

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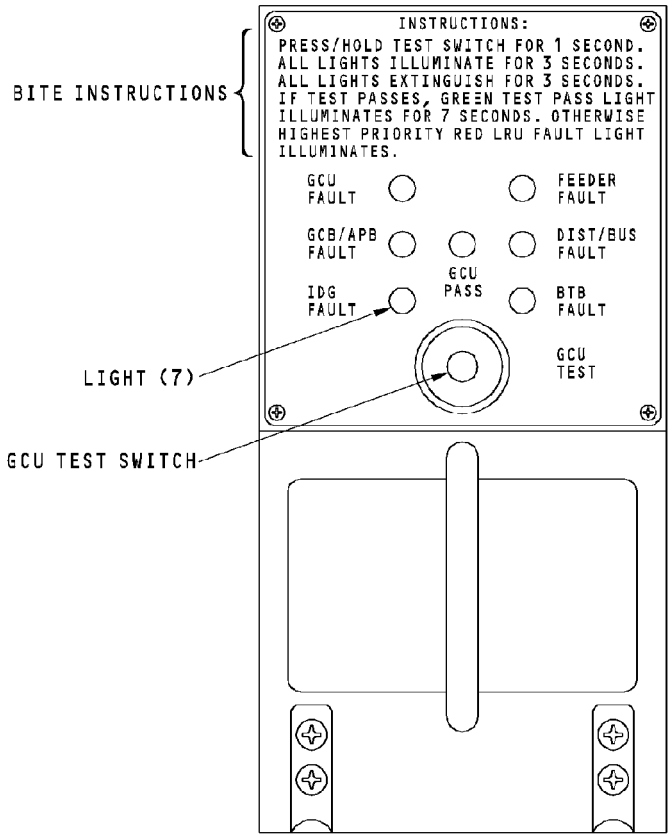

AC GENERATION - GCU/AGCU - TRAINING INFORMATION POINT

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Purpose

The APU starter-generator has two functions.

First, the starter-generator makes AC power for ground operations. The starter-generator can supply electrical power during flight as backup to the IDGs.

The starter-generator also starts the APU. It uses AC power from the start converter unit (SCU) to turn the APU during the start sequence.

Location

The starter-generator is on the right side of the APU gear box. It attaches to the gearbox with 8 nuts. You replace the starter-generator without removal of the APU.

General Description

The APU starter-generator is an oil cooled, three phase, brushless, rotating rectifier machine. It operates at 12,000 rpm. The generator includes these components:

- An exciter
- A main generator
- A permanent magnet generator (PMG).

The PMG supplies power for start-up, and voltage control of the APU channel.

The starter-generator supplies 3 phase, 115/200 volts (nominal) power at 400Hz. The starter-generator supplies up to 90 KVA below 32,000 feet (9753 meters). The starter-generator can supply 66 KVA at 41,000 feet (12,496 meters).

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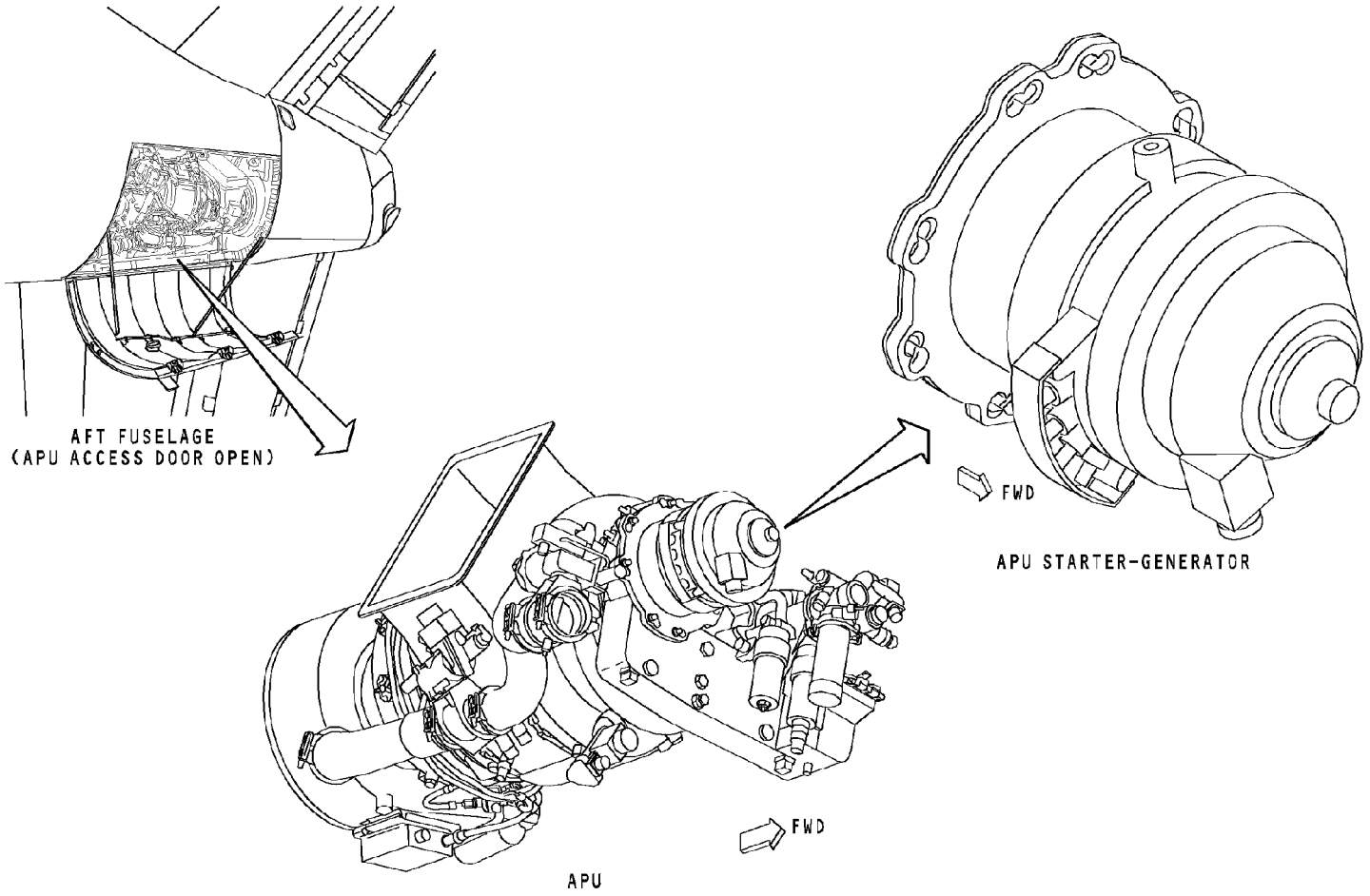

AC GENERATION - APU STARTER GENERATOR

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AC GENERATION - APU GENERATOR CONTROL UNIT (AGCU) - GENERAL DESCRIPTION

General

The APU GCU (AGCU) uses inputs to control auxiliary power breaker (APB) position. The AGCU and the start converter unit (SCU) supply protection for the starter-generator and system loads.

The AGCU is the same part as the GCU. The inputs to the AGCU are different than for GCU 1 and GCU 2. GCU 1 and GCU 2 use an internal voltage regulator to control generator output. The AGCU uses a voltage regulator in the SCU to control starter-generator output.

APU Generator Control Unit (GCU) Inputs

The AGCU receives power from one of these two sources:

- Switched hot battery bus
- DC bus 2.

The AGCU uses 28v dc to power its control and protection circuits.

The AGCU receives three-phase sense current inputs from these two points:

- Neutral current transformer (NCT) inside the APU generator, between the generator and ground
- Differential protection current transformer (DPCT) on the APU power feeders, between the generator and the auxiliary power breaker (APB).

The AGCU receives three-phase sense voltage input from splices into the feeder wires between the starter-generator and the auxiliary power breaker (APB).

The AGCU receives these other inputs:

- APU starter-generator permanent magnet generator (PMG) frequency
- Ready-to-load (RTL) signal from the APU electronic control unit (ECU)
- APU generator switch positions (APS)
- Position status of the external power contactor (EPC)
- APB hold off (prevents APB close)
- Signal from the APU fire switch
- Position status from the APB.

GCU Outputs

The AGCU has these output signals:

- APU generator switch 1 and 2 position to BPCU
- Voltage regulator enable (VR)
- Overvoltage (OV) or undervoltage (UV) protection flag
- APU power available signal to BPCU.

Built-In-Test-Equipment (BITE)

THE AGCU has front face BITE to help you do troubleshooting of the electrical system. See GCU/AGCU - TRAINING INFORMATION POINT in this section for more information.

EFFECTIVITY
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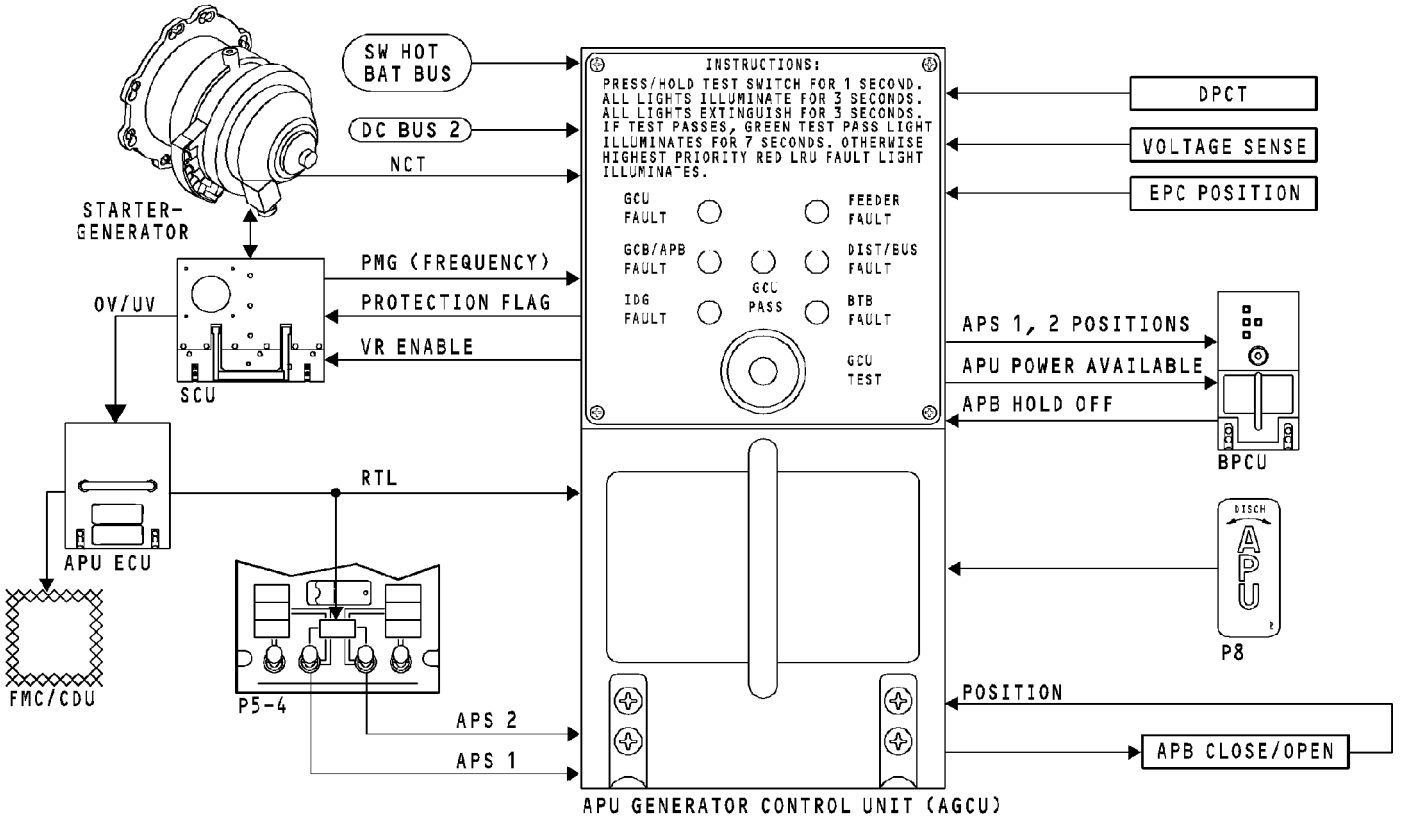

AC GENERATION - APU GENERATOR CONTROL UNIT (AGCU) - GENERAL DESCRIPTION

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General

The AGCU uses inputs and internal logic to control the auxiliary power breaker (APB) position.

The AGCU uses manual input from the APU generator switches to close or open the APB. The BPCU sends a signal to open the APB if an alternate power source selection occurs. The AGCU power quality protective circuits also open the APB if power parameters are not in limits.

APB Close

The AGCU sends a close signal to the APB when all of these conditions occur:

- Either APU generator switch to ON position
- BTB positions and GCB positions are set to prevent two power sources to one AC transfer bus
- Starter-generator power output quality is good
- AGCU has an APU ready-to-load (RTL) signal from the APU electronic control unit (ECU)
- External power contactor (EPC) is open.

When there is a command to close the APB, the BPCU sends a signal to the GCU to open the generator control breakers (GCB). The BPCU also sends an open signal to the external power contactor (EPC).

APB Open

The AGCU sends an open signal to the APB when one or more of these conditions occur:

- You select another power source (BPCU sends open signal to GCU)
- Both APU generator switches to the OFF position
- RTL signal to the AGCU goes away
- APU switch to OFF
- APU fire switch to the fire position
- Power quality goes out of limits.

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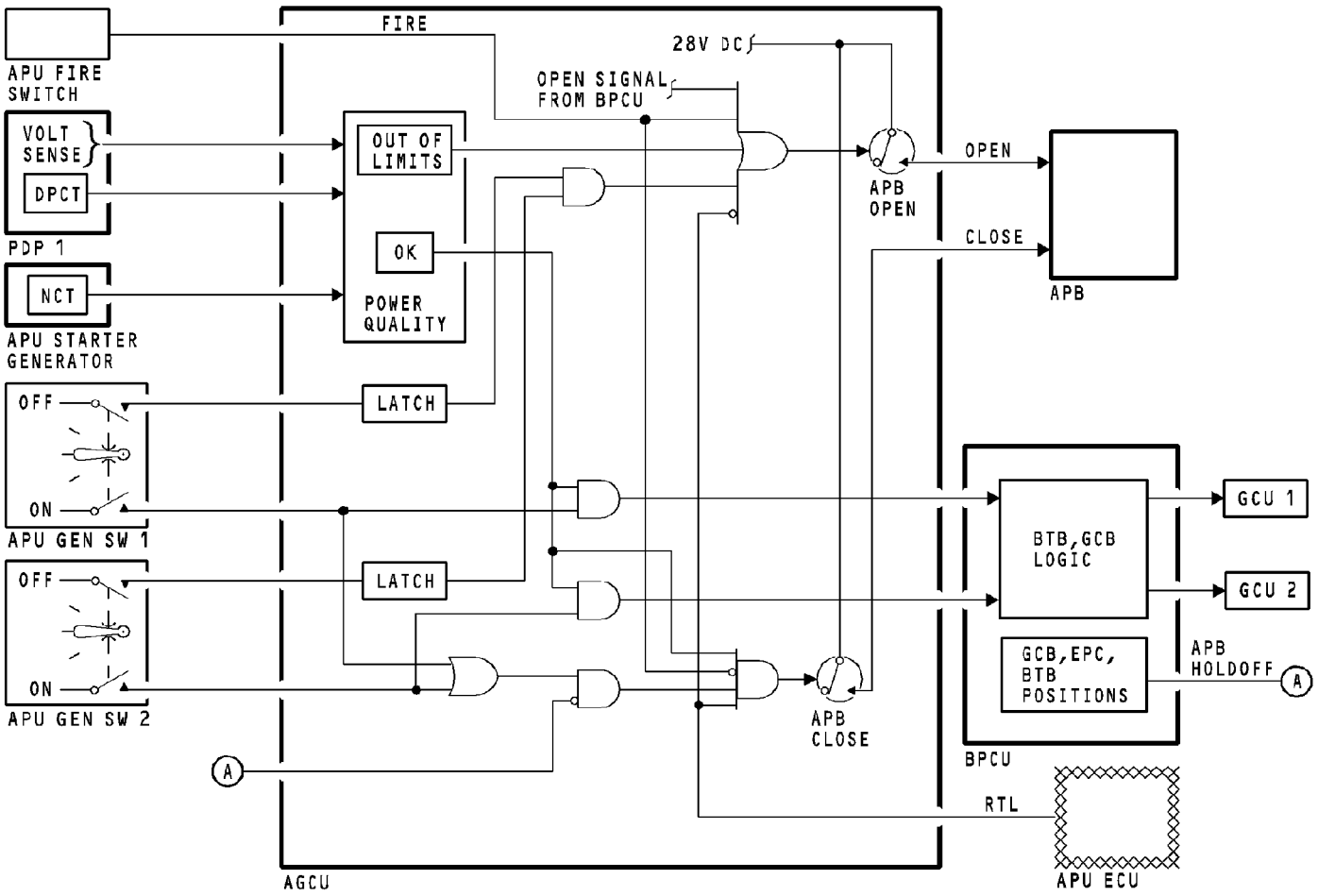

AC GENERATION - AGCU - AUXILIARY POWER BREAKER (APB) CONTROL

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Generator Excitation

The APU starter-generator is a three-phase brushless AC generator. The APU starter-generator contains these three generators and their rotating components:

- Permanent magnet generator (PMG)
- Exciter generator
- Main generator

The APU gearbox turns the PMG rotor. As the PMG rotor turns, it induces an AC voltage in the three-phase windings of the PMG stator. This AC voltage goes to the start converter unit (SCU).

A voltage regulator (VR) in the SCU transforms and rectifies the power to DC. Also in the SCU, is a generator control relay (GCR). With the GCR in the closed position, DC power goes to field windings of the exciter generator. The stationary magnetic field caused by the DC voltage in the windings of the exciter generator stator makes a three-phase AC excitation voltage in the windings of the exciter generator rotor.

This AC voltage rectifies to DC voltage by the rotating rectifier assembly in the exciter generator rotor. The DC voltage goes to the field windings of the main generator. Current flow in the field windings causes a rotating magnetic field. The rotating magnetic field causes an AC voltage in the windings of the main generator stator.

To provide overload protection, the current transformer in the APU starter-generator is used to sense the AC current in each of the three stator windings. The sensed current is used by the GCU to control the power output of the APU starter-generator.

The APU GCU (AGCU) monitors the voltage and current of the APU starter-generator. The start converter unit (SCU) monitors and controls the voltage output from the generator. The auxiliary power breaker (APB) can close when the voltage and frequency are within power quality limits. The voltage regulator (VR) in the SCU controls AC power output by control of excitation power.

The generator control relay (GCR) in the AGCU is not part of the excitation power circuit for the APU starter-generator. The AGCU GCR closes to send the VR enable signal to the SCU. The VR enable signal completes the excitation circuit in the SCU.

APU Starter-Generator Start Mode

The APU starter-generator starter is integral with the generator. The SCU attaches electrically to the starter-generator through connections (splices) to the feeder wires at the back of the power distribution panel (PDP). The SCU voltage regulator uses these connections as a point of regulation (POR). The SCU also uses this connection to supply power to the starter-generator during APU starting. The AGCU protection circuits monitor power quality at connections to the feeder wires inside of the PDP.

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See the APU ignition/starting section for more information. (SECTION 49-40)

AGCU Protection

The AGCU monitors voltage, current, and frequency. The AGCU opens the APB and removes the excitation from the generator to protect the electrical channel. The AGCU removes the VR enable signal to turn off excitation. The AGCU has these protective functions:

- Overvoltage
- Undervoltage
- Overfrequency
- Underfrequency
- Unbalanced phase current
- Phase sequence
- Overcurrent
- Differential fault
- Underspeed protection
- AGCU fail-safe.

Overvoltage and Undervoltage Protection

The AGCU monitors each of the phase voltages. Overvoltage protection starts when the highest phase voltages is more than 130 volts. Undervoltage protection starts when the lowest phase voltage is less than 101 volts for more than 7 seconds. If there is a voltage fault, the AGCU removes the VR enable signal. The SCU removes the excitation from the generator and the AGCU commands the APB to open.

Frequency Protection

The SCU monitors the frequency at the PMG. Proper generator frequency is 400 Hz. The AGCU receives a conditioned PMG signal from the APU SCU. The AGCU removes the VR enable signal to the SCU and opens the APB if the frequency is more than these limits:

- 425 Hz for more than 1.5 seconds
- 435 Hz for 35 milliseconds.

The AGCU removes the VR enable signal and opens the APB if the frequency is less than these limits:

- 375 Hz for 1.5 seconds
- 355 Hz for 150 milliseconds.

Unbalanced Phase Protection

The AGCU monitors the three phases of the APU generator line current transformer. Unbalance phase protection occurs if the current unbalance between any two phases is more than 140 amps. The AGCU commands the BPCU to open BTB 2. If the fault remains, the BPCU opens BTB 1 and re-closes BTB 2. If the fault clears, there is no further action. If the fault remains, the AGCU opens the APB and the VR enable signal. The BPCU prevents the re-closure of BTB 1 and BTB 2.

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Generator Diode Failure Protection

The SCU monitors the current ripple return in the excitation circuit to detect an APU starter-generator shorted rotating diode. The SCU sends a built-in test equipment (BITE) message to the APU electronic control unit (ECU). The ECU gives a maintenance light on P5. The generator operates with a shorted diode. The AGCU may see a low voltage condition if more diodes fail. If this happens, the AGCU removes the VR enable signal and opens the APB.

Phase Sequence Protection

The AGCU monitors phase sequence. The APB cannot close when the AGCU finds a phase sequence problem.

Overcurrent Protection

If current is more than 274 amps for 300 seconds, the AGCU commands the BPCU to shed secondary electrical loads (loadshed). The BPCU first removes galley loads and if the overcurrent condition continues, the main buses are shed. If the overcurrent remains, the AGCU removes the VR enable signal and opens the APB.

If current is more than 340 amps for 5 seconds, the AGCU commands the BPCU to start loadshed. If the overcurrent continues for another.1 seconds, the AGCU removes the VR enable signal and opens the APB.

Differential Fault Protection

The AGCU monitors the three phases of the starter-generator current transformer and the feeder current transformers with the differential protection current transformer (DCPT) in the power distribution panel. The AGCU compares current flow at the generator and at the APB. If differential current is more than 20 amps for 70 milliseconds, the AGCU removes the VR enable signal and opens the APB.

Underspeed Protection

The AGCU monitors the ready-to-load (RTL) signal from the ECU. With no RTL signal, the AGCU removes the VR enable signal which opens the SCU GCR. This removes the excitation from the starter-generator. The AGCU also opens the APB. The sequence above happens when you put the APU switch to the OFF position and the APU is supplying electrical power. The IDG GCU does not open its GCR during engine shutdown. For the APU, the excitation circuit must be open (no VR enable signal) to protect the SCU voltage regulator during an APU start.

AGCU Failsafe

The AGCU contains internal protection against its own failure. A fail-safe condition causes these:

- AGCU removes the VR enable signal which opens the SCU GCR
- AGCU opens the APB
- AGCU tells the BPCU to close the BTB(s), if open

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- GCU fault indication light on AGCU goes on and fault indication shows on the P5.

VR Enable

The starter-generator receives excitation (generator mode) when there is a VR enable signal. The AGCU supplies the VR enable signal when these conditions are true:

- APU RTL signal is available (APU more than 95% rpm and not in cool-down cycle or at start of protective shutdown)
- Starter-generator frequency is in limits
- GCR (in the AGCU) is closed.

Another GCR in the SCU closes when there is a VR enable signal. The voltage regulator in the SCU then controls starter-generator output. There is no VR enable signal during an APU start. During an APU start, the generator excitation circuit is open. This protects the voltage regulator in the SCU from the starter power. If the GCR in the AGCU is closed, the AGCU supplies the VR enable signal when the APU gets to 95% rpm.

The RTL signal goes away during an APU shutdown. This makes the VR enable signal go away and the starter-generator excitation goes away.

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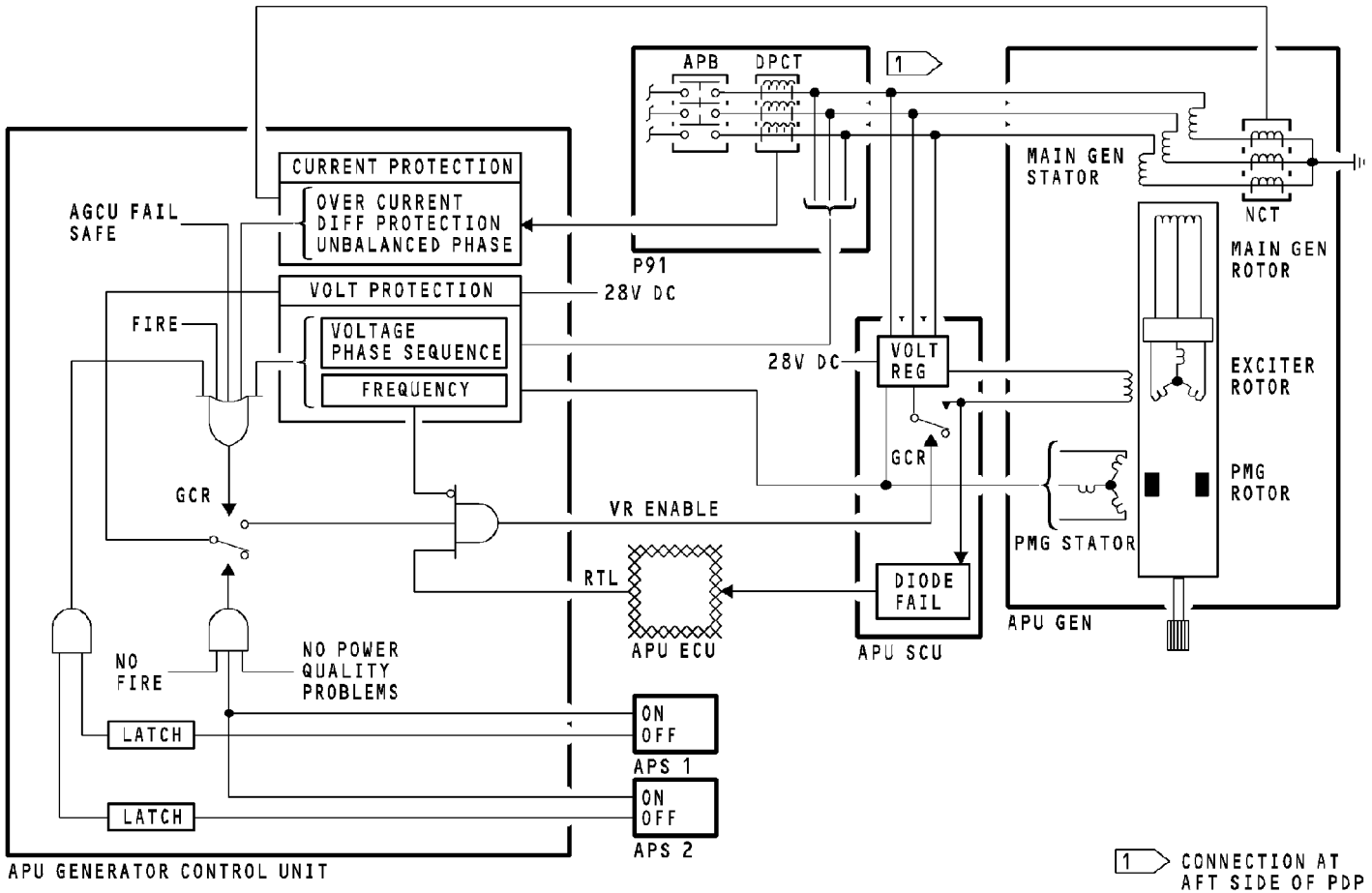

AC GENERATION - AGCU - PROTECTION AND EXCITATION

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AC GENERATION - START CONVERTER UNIT (SCU)

Purpose

The start converter unit (SCU) has two functions:

- Regulate the APU starter-generator electrical power output
- Turn the APU during an APU start.

Location

The SCU is on the E2 rack in the EE compartment.

General

The SCU operates with the APU generator control unit (AGCU) to control and regulate APU starter-generator power. The APU generator control relay (AGCR) and the starter-generator voltage regulator are inside the SCU.

The SCU also makes the starter-generator function like a motor to turn the APU during starting.

See the APU ignition/starting section for more information about APU starting.

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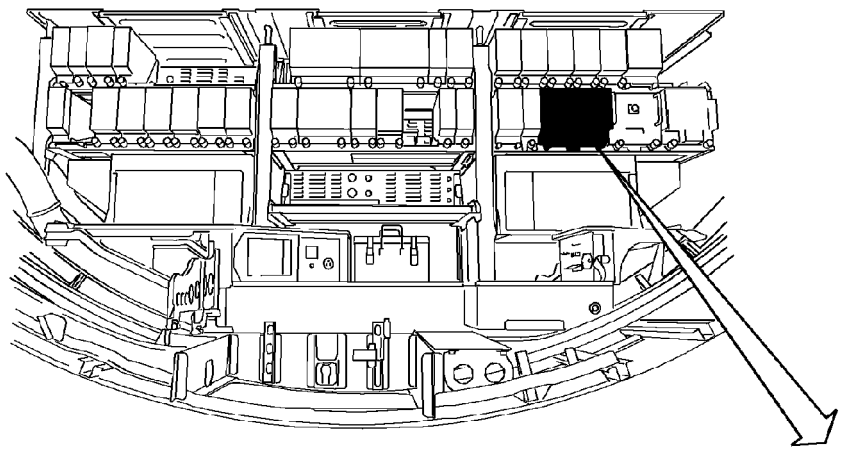
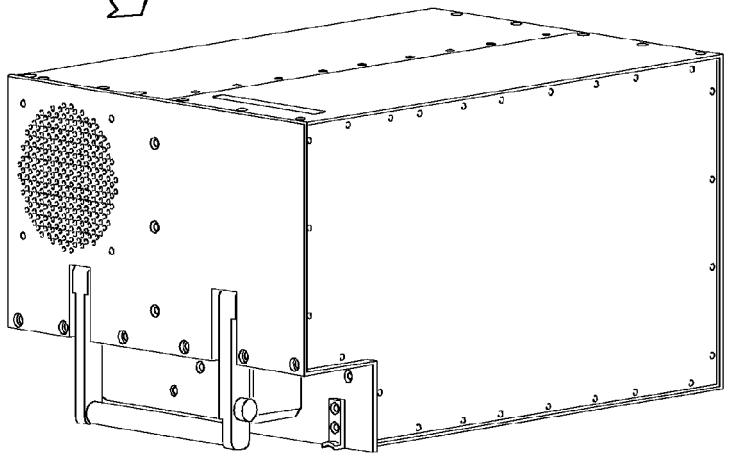


TRANSVERSE RACK, EE COMPARTMENT
(LOOKING AFT)



START CONVERTER UNIT (SCU)

AC GENERATION - START CONVERTER UNIT (SCU)

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General

The start converter unit (SCU) has these functions:

- Controls starter-generator voltage output
- Changes 270v dc from the start power unit (SPU) to AC power to energize the starter-generator during starting (through SCU internal contactor)
- Sends fault data to the APU electronic control unit (ECU).

See the APU chapter for more information about APU starting and the APU ECU.

Power Generation

The voltage regulator and APU generator control relay (AGCR) give excitation to the starter-generator. The voltage regulator controls the amount of excitation and frequency of excitation to control generator output voltage. The AGCR completes or opens the circuit for excitation power.

The APU generator control unit (AGCU) controls the operation (on/off) of the voltage regulator and AGCR position. The AGCU sends a voltage regulator enable signal (turn on signal) to the SCU when you put an APU generator switch to the ON position if the APU is ready to load. The AGCR in the SCU closes, and the starter-generator receives excitation.

The starter-generator permanent magnet generator (PMG) is the power source for the voltage regulator. The AGCU protection circuits use the PMG output to monitor starter-generator frequency output.

The voltage regulator in the SCU and the AGCU monitor the voltage of each phase at a point between the starter-generator and the auxiliary power breaker (APB). The voltage regulator uses this information to control excitation. The AGCU uses this information for system protection.

Protection

The AGCU removes the voltage regulator enable signal and opens the AGCR when the AGCU protection circuits find an electrical parameter not in limits. See the AGCU protection and excitation page in this section for more information.

The AGCU sends a fault signal to the SCU if a starter-generator overvoltage (high voltage) or undervoltage (low voltage) conditions happens. The SCU sends this data to the APU ECU. You can see this data on the control display unit in the flight compartment.

See the APU chapter for more information about APU starting and the APU ECU.

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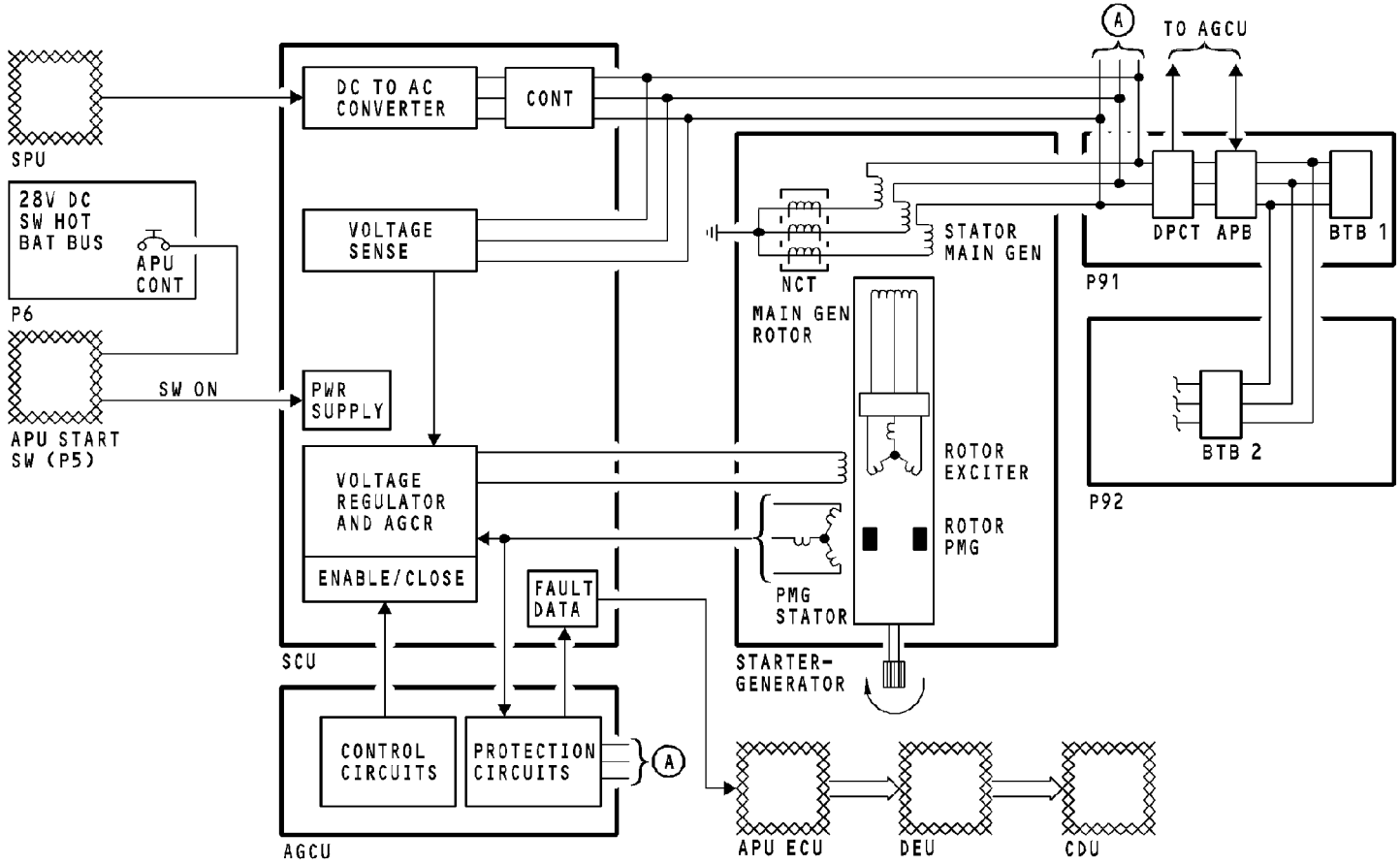

AC GENERATION - SCU - INTERFACE

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Purpose

The breakers supply 115v ac, 400 Hz, 3 phase power to the electrical distribution system from the power sources.

The breakers also complete or open 28v dc electrical power system control and indication circuits.

Location

All breakers are in the power distribution panels. The power distribution panels are in the EE compartment.

These breakers are in power distribution panel 1 (P91):

- Bus tie breaker 1 (BTB 1)
- Auxiliary power breaker (APB)
- Generator control breaker 1 (GCB 1).

These breakers are in power distribution panel 2 (P92):

- Bus tie breaker 2 (BTB 2)
- Generator control breaker 2 (GCB 2).

General Description

Each breaker mechanism has a close and open coil. Both coils operate on a single plunger core. When the breaker gets to the commanded position, the control contacts open and remove command power. A permanent magnet holds the plunger in the actuated position.

The breakers have two types of contacts, primary and auxiliary. The primary contacts carry power flow from the AC source to the transfer buses.

Each breaker gets a signal (command) to open or close. The signals for the GCBs and BTBs come from their respective GCUs. The APB signals come from the AGCU. However, the BPCU also sends breaker open and close signals through the GCUs and the AGCU. The BPCU also monitors the position of each breaker. See the breaker control functional description page in this section for more information.

These are the functions of the auxiliary contacts:

- Control (open/close) of the breaker
- Position status information for the BPCU
- Bus power indication on the P5 panel.

Some auxiliary contacts are closed and some are open when the breaker itself is in the closed position. The auxiliary contacts then change position when the breaker goes to the open position.

All breakers have the same part number.

Training Information Point

Each breaker has a placard that identifies it.

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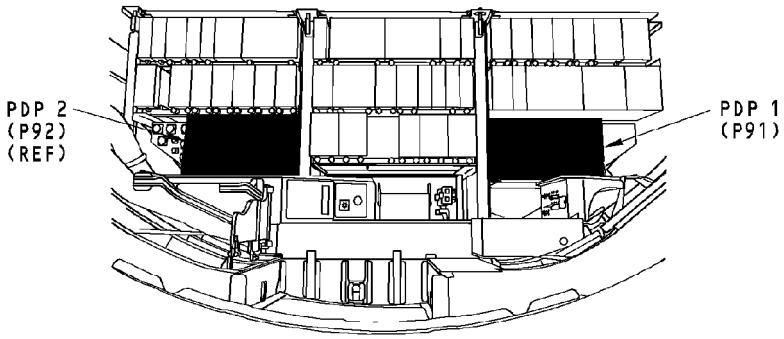
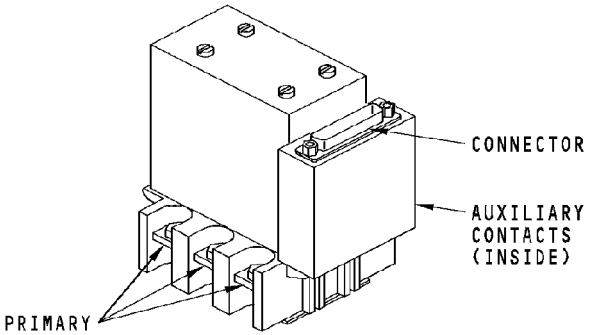
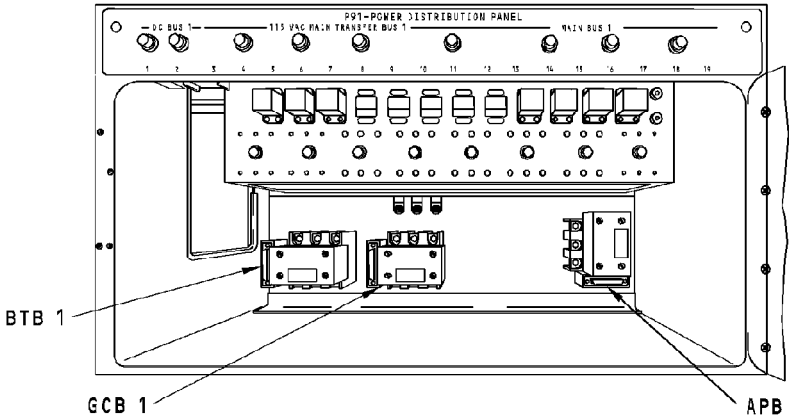


TRANSVERSE RACK, EE COMPARTMENT
(LOOKING AFT)

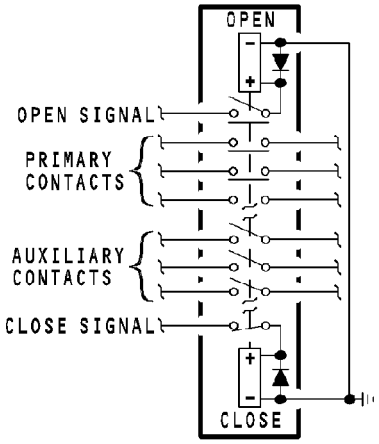


BREAKER
(TYPICAL)



POWER DISTRIBUTION PANEL 1 (P91) 1
(FRONT PANEL OPEN)

1 PDP 2 SIMILAR



BREAKER SCHEMATIC
(TYPICAL)

AC GENERATION - GENERATOR CONTROL BREAKERS, AUXILIARY POWER BREAKER, AND BUS TIE BREAKERS

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AC GENERATION - DIFFERENTIAL PROTECTION CURRENT TRANSFORMER

Purpose

The differential protection current transformers (DPCTs) supply electrical current information from a power source to the correct control unit.

General Description

There are three DPCTs and one CT, one for each AC power source. These are the DPCTs:

- IDG 1 (GEN 1 DPCT)
- IDG 2 (GEN 2 DPCT)
- APU starter-generator (APU GEN DPCT)
- External power (CT).

Power comes from the terminal stud through each DPCT hole to the rigid bus bar assembly. The transformer coils sense current by induction for each phase. This information goes to the control unit for the power source.

The GCU and AGCU use current data for power regulation, protection, and indication. The control unit opens the breaker if current is not in limits. See the protection pages in this section for more information.

The BPCU uses the current data for protection of the electrical system. The BPCU removes electrical loads (load shed) or removes all external power if current is not in limits. See the AC electrical load distribution section for more information about load shed. (SECTION 24-50)

Location

All DPCTs are in a rigid bus assembly at the aft side of each power distribution panel (PDP). You must remove an access panel at the forward end of the forward cargo compartment to get access to the aft side of the PDPs. You must then remove feeder wires and a cover to get access to the rigid bus assembly.

These DPCTs are in the P91 power distribution panel 1:

- Generator 1 DPCT (GEN 1 DPCT)
- APU starter-generator DPCT (APU GEN DPCT).

This DPCT and CT are in the P92 power distribution panel 2:

- Generator 2 DPCT (GEN 2 DPCT)
- External power CT.

Each DPCT or CT is between the source and the source breaker or contactor.

WARNING: REMOVE ELECTRICAL POWER BEFORE REMOVAL OR INSTALLATION OF THE CURRENT TRANSFORMERS IN THE POWER DISTRIBUTION PANELS. HIGH VOLTAGES PRESENT CAN CAUSE INJURY TO PERSONS.

EFFECTIVITY

HAP ALL

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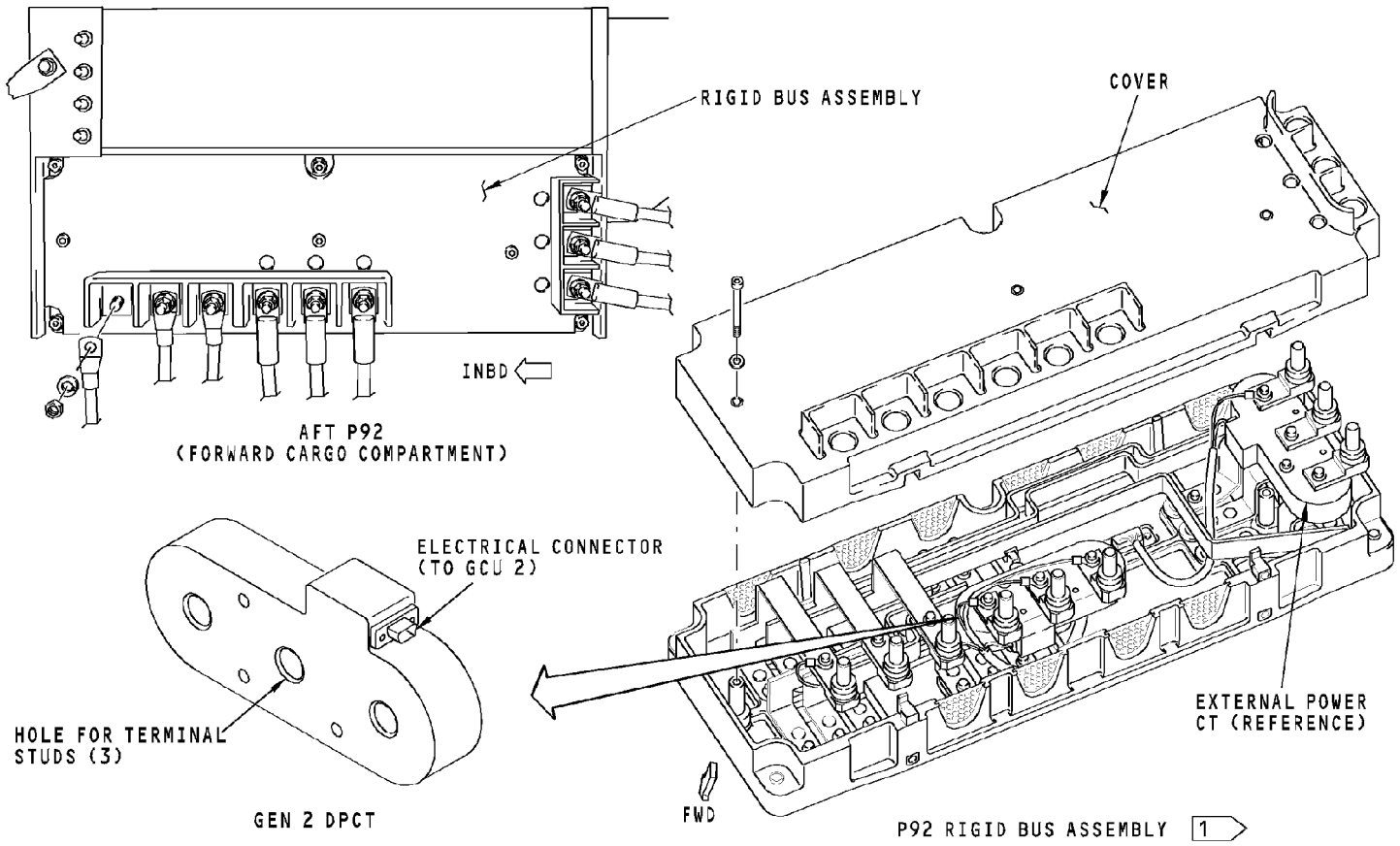

AC GENERATION - DIFFERENTIAL PROTECTION CURRENT TRANSFORMER

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General

The power distribution panels (PDPs) have the breakers and many of the electrical buses.

Each PDP has a door on the front of it that is usually closed. The front of each door has circuit breakers.

Location

PDP 1 (P91) is on the left side of the EE compartment. PDP 2 (P92) is on the right side of the EE compartment.

Power Distribution Panel 1

The power distribution panel 1 (PDP 1 or P91), has these components:

- AC transfer bus 1
- Ground service bus 1
- DC bus 1
- Generator control breaker 1 (GCB 1)
- Auxiliary power breaker (APB)
- Bus tie breaker 1 (BTB 1).

There are four red lights on the forward and aft face of the panel. These lights come on to warn you that electrical power is active inside the panel. You can see the lights on the aft face when you are in the forward cargo compartment. The lights have these names and come on with these conditions:

- GEN 1 (on when IDG 1 supplies power)
- TIE BUS (on where there is power at the bus tie breakers)
- APU PWR (on when the starter-generator supplies power)
- EXT PWR (on when external power supplies power).

Power Distribution Panel 2

The power distribution panel 2 (PDP 2 or P92), has these components:

- AC transfer bus 2
- Ground service bus 2
- DC bus 2
- Generator control breaker 2 (GCB 2)
- External power contactor (EPC)
- Bus tie breaker 2 (BTB 2).

There are four red lights on the forward and aft face of the panel. You can see the lights on the aft face when you are in the forward cargo compartment. These lights come on to warn you that electrical power is active inside the panel. The lights have these names and come on with these conditions:

- GEN 2 (on when IDG 2 supplies power)
- TIE BUS (on where there is power at the bus tie breakers)
- XFR BUS 1 (on when AC transfer bus 1 has power)
- EXT PWR (on when external power supplies power).

EFFECTIVITY
HAP ALL

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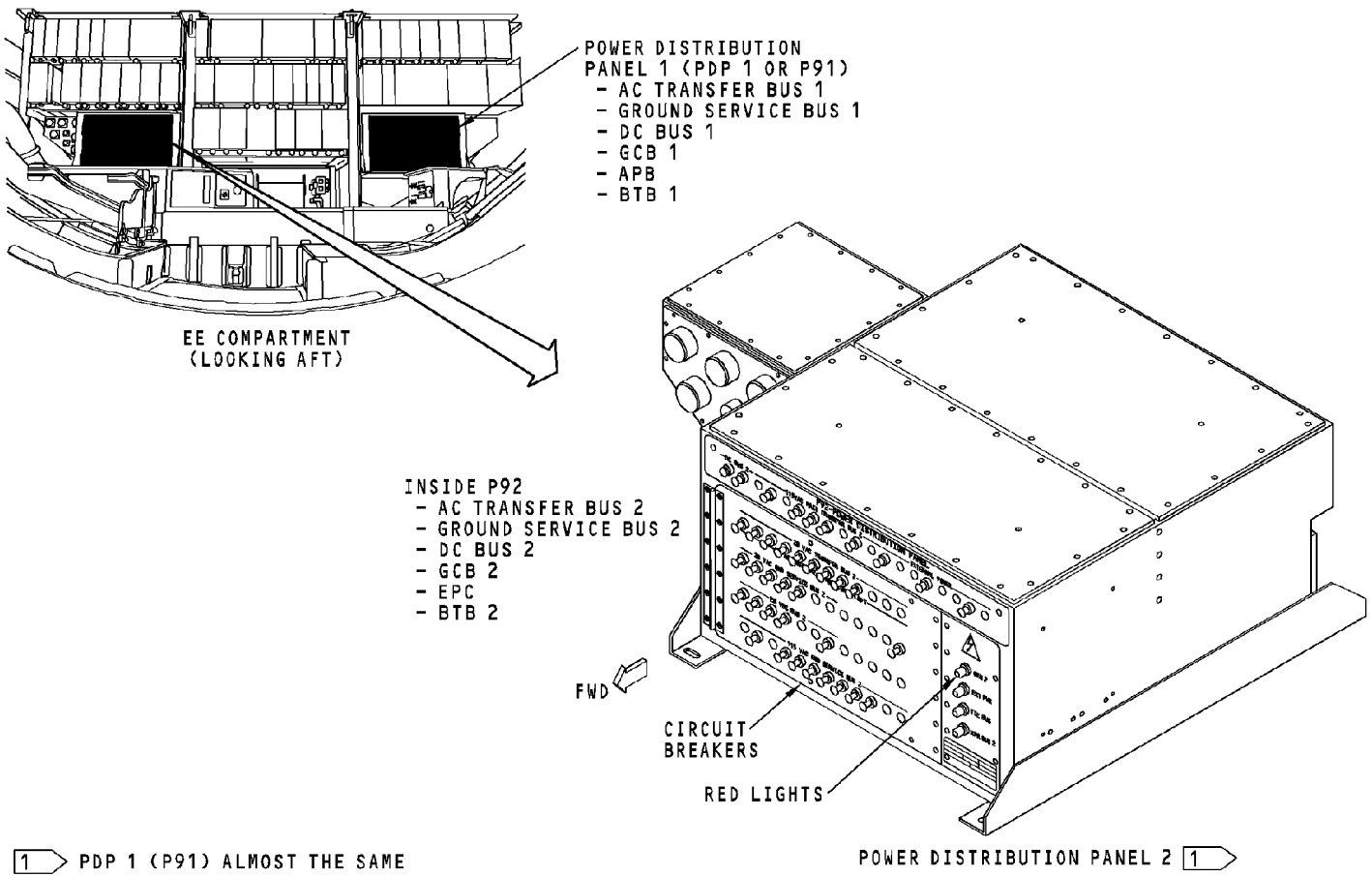

AC GENERATION - POWER DISTRIBUTION PANELS

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AC GENERATION - BREAKER CONTROL - FUNCTIONAL DESCRIPTION

General

The generator control units (GCUs) and the bus power control unit (BPCU) operate together to control AC power. With source selection from the P5-4 AC systems, generator, and APU module, the GCUs and BPCU control the bus tie breakers (BTBs) and generator control breakers (GCBs) to keep one electrical source on a transfer bus. A sequence of command signals and breaker position signals must happen before an electrical power source can supply power to a transfer bus.

External Power

The BPCU controls the use of external power. The BPCU monitors the external power contactor (EPC), GCB, and BTB positions by auxiliary contacts on each breaker. The BPCU also monitors the quality of the external power. The BPCU gets current (power) information from a current transformer (CT). The BPCU monitors line voltage properties at the feeder lines inside the power distribution panels.

The BPCU must find that all GCBs are open and external power quality is good before it closes the EPC. The BPCU tells the GCUs to send open commands to the GCBs and auxiliary power breaker (APB) when you select external power on the AC systems, generator, and APU module.

After the EPC closes, the BPCU commands the GCUs to close the BTBs. The BTBs close and transfer bus 1 and transfer bus 2 receive external power.

When external power is on both transfer buses, selection of another power source causes this sequence:

- GCU monitors for good power from the source
- GCU for the related source sends an open command to the related BTB (the AGCU opens both BTBs)
- BTB open signal (position status message) goes to the BPCU
- GCU sends a close command to the related GCB.

With external power on only one transfer bus, selection of another power source for that transfer bus causes this sequence:

- GCU monitors for good power from the selected source
- GCU for the related source sends an open command to the related BTB (and the EPC if the new source selection is the APU)
- BTB open signal (and EPC open signal for APU selection) goes to the BPCU
- GCU sends a close command to the related GCB after the BPCU sees all applicable breakers open.

APU Power

These components control APU power:

- APU GCU (AGCU)
- BPCU
- Engine GCUs.

EFFECTIVITY
HAP ALL

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The AGCU monitors the power quality at the starter-generator and power feeder lines in power distribution panel 1. The AGCU uses a neutral current transformer (NCT) and differential protection current transformer (DPCT) to monitor current related properties.

The AGCU signals the BPCU to remove any other power source off the related transfer bus before the APU power comes on to a transfer bus.

Selection of APU generator switch 1 temporarily to the ON position causes this sequence:

- AGCU monitors power quality of the APU starter- generator (the sequence only continues if APU power is good)
- AGCU signals the BPCU of APU power selection
- BPCU signals GCU1 to open GCB1 if closed
- BPCU signals the EPC to open if closed
- AGCU signals the APB to close
- BPCU signals GCU1 to close BTB1
- If no power is on transfer bus 2, the BPCU signals GCU2 to close BTB2.

You must put APU generator switch 2 temporarily to the ON position if transfer bus 2 has power from another source.

Engine Generator Power

The GCU monitors the power quality at the IDG and at the feeder lines in the power distribution panels. The GCU uses differential protection current transformers (DPCT) to monitor current related properties.

The GCB connects the IDG (generator) to the transfer bus. Before an engine generator comes on to the transfer bus, the GCU signals the BPCU to remove any other power source off the related transfer bus.

Selection of engine generator switch 1 causes this sequence:

- GCU commands BTB1 open if other power sources are on
- BTB1 status goes to the BPCU
- BPCU sends an open command to the APB if it only powers the related transfer bus
- BPCU sends an open command to the EPC if it only powers the related transfer bus
- If the power is good, the GCU sends a close command to the GCB
- BTB1 and BTB2 close if no other power source is on the airplane.

A similar sequence occurs for the engine generator switch 2. If you close both generator switches, both BTBs open.

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Automatic Function

Usually, you must select the electrical power source to use it. However, both GCBs automatically close and the IDGs supply power if these conditions happen:

- APU supplies power to both transfer buses
- Airplane leaves the ground
- APB opens
- IDG power quality is good.

In this type of situation, these are the reasons why the APB may open (trip):

- Crew shuts down APU
- APU starter-generator current overload
- APU starter generator power quality problem.

Bus Transfer Switch

The BPCU monitors bus transfer switch position for BTB control. The BTB operation is automatic when the bus transfer switch is in the AUTO position. The AUTO position is the normal position of the switch.

You control the BTBs when you put the switch to the OFF position. The BTB control you have depends on the electrical power source conditions and air ground logic before you move the switch to the OFF position. Here are the examples of what happens when you put the bus transfer switch to the OFF position:

- Lock both BTBs open (can not close) if each AC transfer bus has power from its respective IDG
- Open the respective BTB of an IDG that supplies power to both AC transfer buses (stops bus transfer to opposite AC transfer bus)
- If one AC transfer bus has power from its IDG, and the opposite AC transfer bus has power from the APU or external power, the BTB related to the IDG opens and locks open
- On ground, no change of BTB position happens if both AC transfer buses have power from the APU starter-generator
- On ground, no change of BTB position happens if both AC transfer buses have power from the external power source.

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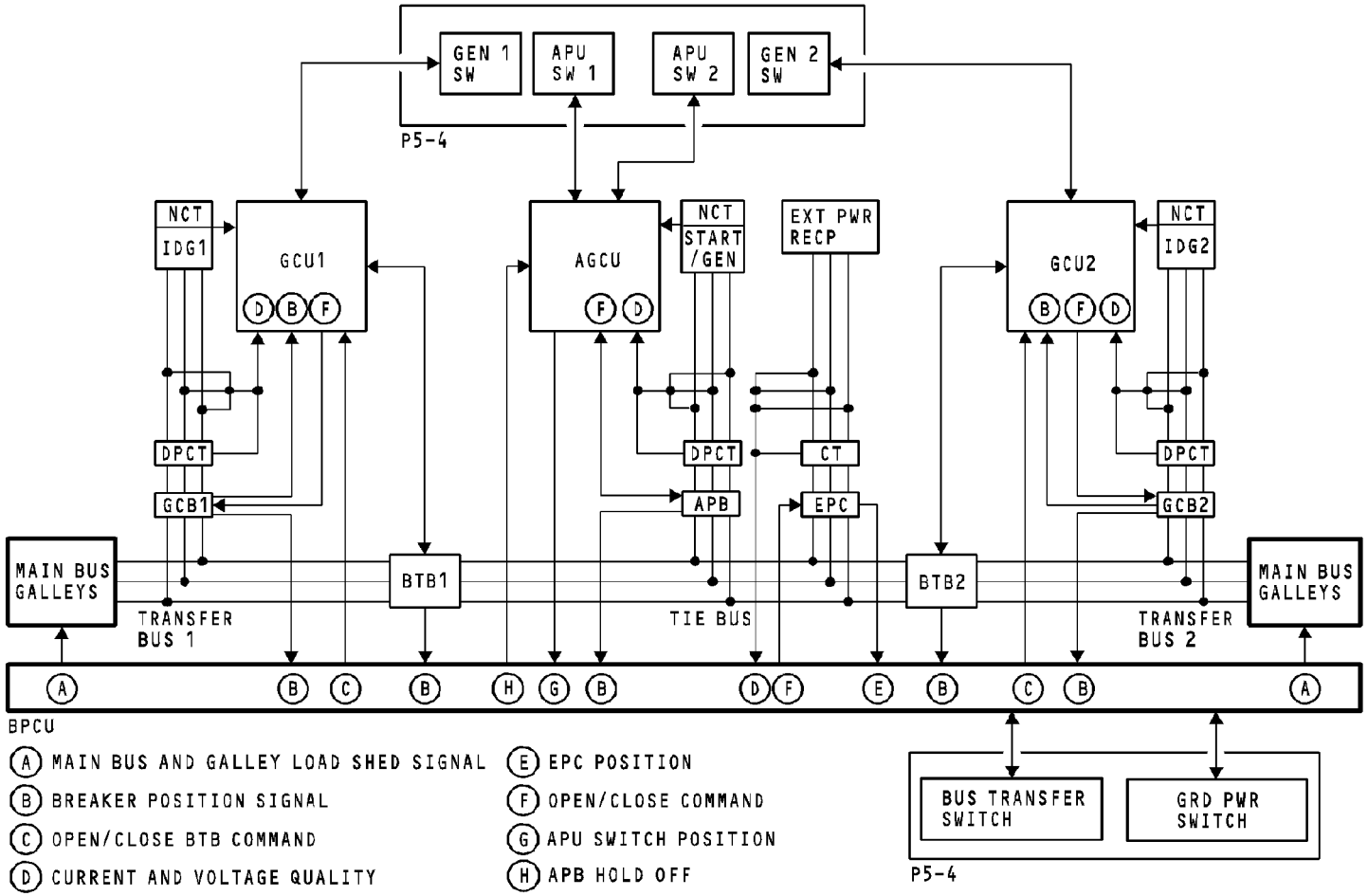

AC GENERATION - BREAKER CONTROL - FUNCTIONAL DESCRIPTION

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General

The AC systems, generator, and APU panel on the P5 overhead panel has these lights:

- GRD POWER AVAILABLE
- TRANSFER BUS OFF (1 and 2)
- SOURCE OFF (1 and 2)
- GEN OFF BUS (1 and 2)
- APU GEN OFF BUS.

All lights are push-to-test. All lights also come on when you put the master dim test switch to the test position.

GRD POWER AVAILABLE Light

The blue GRD POWER AVAILABLE light comes on when external AC power is connected and the quality is good. The bus power control unit (BPCU) does a check of power quality and supplies the ground for the light to come on. The light can get power from any of these three sources:

- Switched hot battery bus
- DC bus 1
- BPCU internal power transformer, which gets power from ground power source.

The light is bright blue when it is on. The light does not go dim with the master dim test switch in the dim position.

For more information about external power, see the external power section.

TRANSFER BUS OFF Light

The amber TRANSFER BUS OFF light comes on when the AC transfer bus does not have power. There is one light for each AC transfer bus. The generator control unit (GCU) monitors the transfer bus-phase C power to control the ground for the light. GCU 1 monitors transfer bus 1, GCU 2 monitors transfer bus 2. The power for TRANSFER BUS OFF light 1 comes from DC bus 1 and the battery bus. The TRANSFER BUS OFF light 2 power comes from DC bus 2 and the battery bus.

The master caution light also comes on when either TRANSFER BUS OFF light comes on. ELEC comes on the annunciator panel.

SOURCE OFF Light

The amber SOURCE OFF light supplies indication that an AC transfer bus is not energized by the source you last selected. The left SOURCE OFF light is related to these sources:

- IDG 1 (GEN 1 switch)
- APU (left APU GEN switch)
- External power (ground power switch).

The right SOURCE OFF light is related to these sources:

- IDG 2 (GEN 2 switch)

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- APU (right APU GEN switch)
- External power (ground power switch).

The BPCU monitors the auxiliary power breaker (APB) position and the APU generator switch position to supply a source-off logic input to the GCU. Logic in the GCU then supplies the ground for the SOURCE OFF light. Master caution also comes on with either SOURCE OFF light. ELEC comes on on the annunciators panel. See the BUS TIE BREAKER CONTROL - FUNCTIONAL DESCRIPTION page in this section for more information about the BPCU SOURCE OFF logic.

GEN OFF BUS Light

The blue GEN OFF BUS light comes on when the engine generator control breaker (GCB) is open. The power for the GEN OFF BUS light 2 comes from DC bus 2. The GEN OFF BUS light 1 get power from DC bus 1. Power also comes from the battery bus when the master dim test switch is in the BRT position. The light gets a ground through the auxiliary contacts of its generator control breaker. The light goes off when the GCB closes.

APU GEN OFF BUS Light

The APU electronic control unit (ECU) and the auxiliary power breaker (APB) control the blue APU GEN OFF BUS light. The APU supplies a ready to load (RTL) signal when the ECU senses the APU above 95 percent and not in a cool down cycle. The APB auxiliary contacts complete the circuit to ground when the APB is in the open position.

The light goes off when the APB closes (you select APU generator power) or when you shut down the APU (RTL signal goes away).

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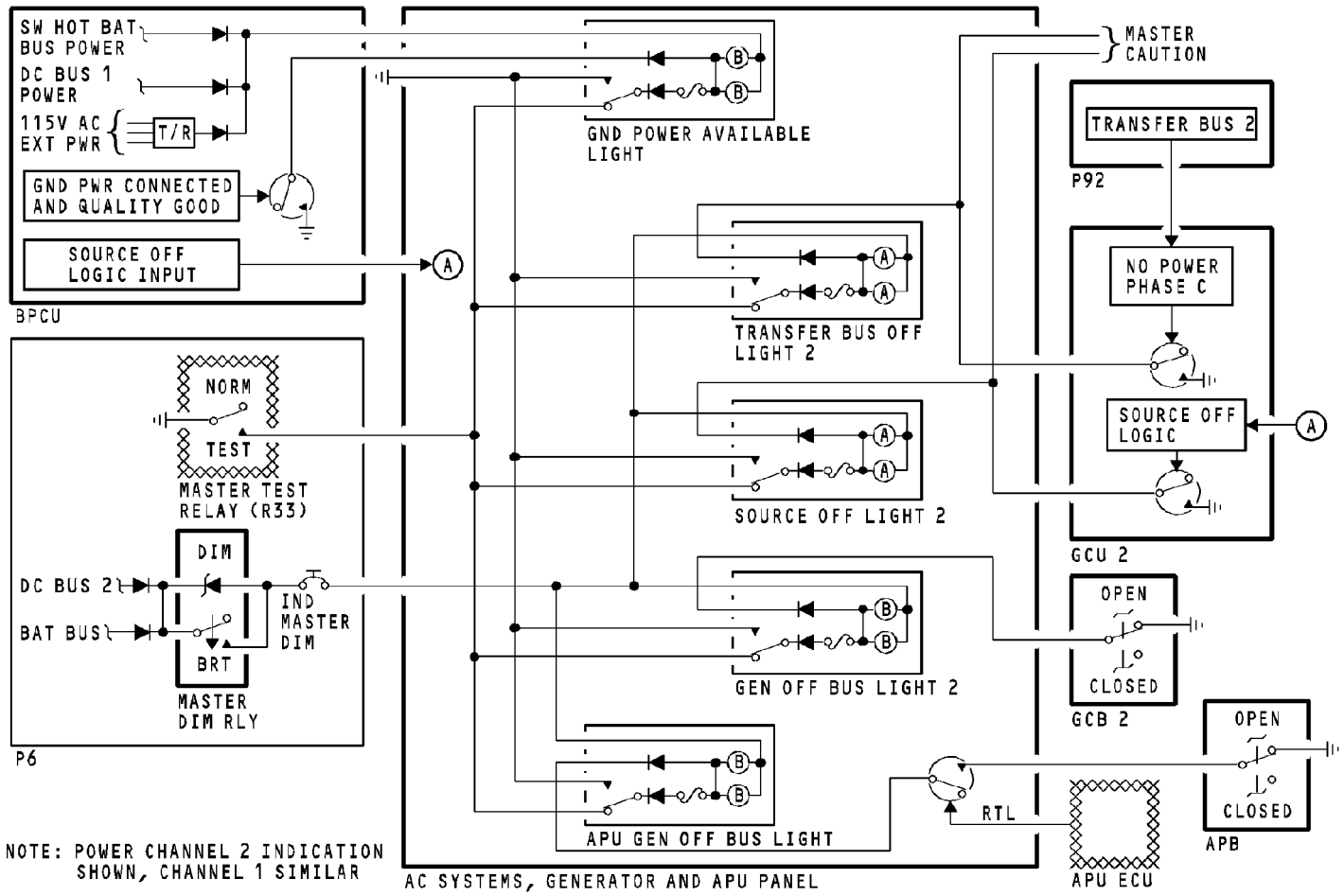

AC GENERATION - AC SYSTEMS, GENERATOR, AND APU PANEL - INDICATION

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DC GENERATION - INTRODUCTION

Purpose

DC generation makes and controls 28v dc power for use by airplane systems.

General

DC generation has these sub-systems:

- DC generation system
- Standby power system.

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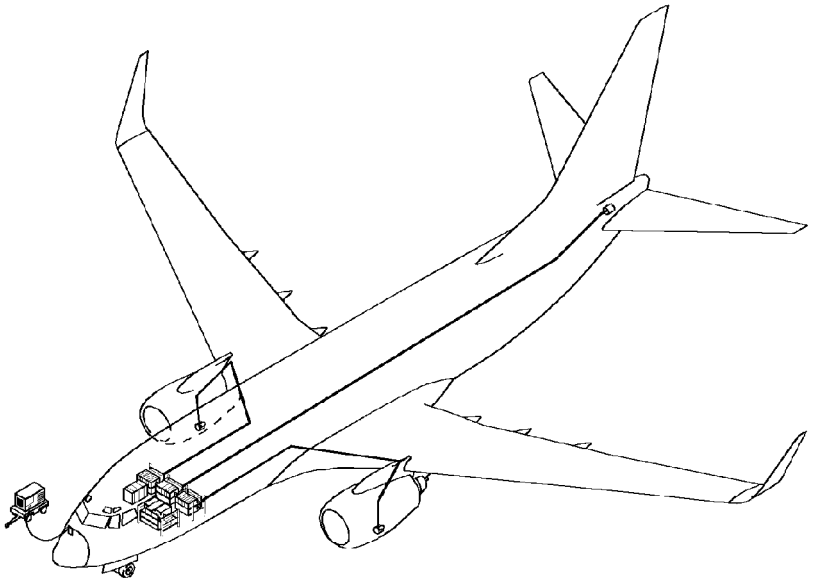

DC GENERATION - INTRODUCTION

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General

The DC power system is a two-wire system that operates at 28 volts (nominal). The DC system has these power sources:

- Three transformer rectifiers units (TRUs)
- Battery charger
- Battery.

The TRUs are the normal power source for the DC power system. The TRUs change 115v ac, 3-phase power to unregulated 28v dc. Each TRU can supply up to 75 amps when airplane cooling air is available. The TRUs are connected in parallel to give back-up to each other.

TRU 1 gets power from the AC transfer bus 1. TRU 1 output connects directly to DC bus 1.

TRU 2 gets power from the AC transfer bus 2. TRU 2 output connects directly to DC bus 2.

TRU 3 usually gets power from AC transfer bus 2. AC transfer bus 1 supplies back up power through R622 if normal power is lost. The primary use of TRU 3 is as a power source for the battery bus.

Control

These switches and components control the relays in the DC distribution:

- Standby power control unit (SPCU)
- Bus power control unit (BPCU)
- Battery switch
- Standby power switch.

Standby Power Control Unit (SPCU)

The SPCU gives manual and automatic control of most relays in DC distribution.

The SPCU uses the battery and standby power switch positions to control relays. The SPCU also monitors AC and DC bus power to control relays for primary and secondary power source selection.

These relays are inside the SPCU:

- Battery bus normal relay (K2)
- Battery bus alternate relay (K1)
- Standby normal relay (K5)
- Standby DC alternate relay (K3)
- Switched hot battery bus relay (K8).

Bus Power Control Unit (BPCU)

The BPCU controls the ground service relay. See the external power section for more information.

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Battery Bus Normal Relay (K2)

The battery bus normal relay (K2) energizes to let the battery bus get power from TRU 3.

Battery Bus Alternate Relay (K1)

The battery bus alternate relay (K1) energizes to let the battery bus get power from the battery or the battery charger. The relay energizes when these conditions are true:

- Battery switch is in the ON position
- TRU 3 has no power.

K1 also energizes when the standby power switch is put to the BAT position.

Standby Normal Relay (K5)

The standby normal relay (K5) energizes to let the DC standby bus get power from DC bus 1. The AC standby bus also gets power for AC transfer bus 1 when the relay energizes. The K5 relay energizes when these conditions are true:

- Standby power switch is in the AUTO position
- Both DC bus 1 and AC transfer bus 1 have power.

The AC standby bus gets power from the static inverter when K5 is open.

Standby DC Alternate Relay (K3)

The standby DC alternate relay (K3) energizes to let the DC standby bus get power from the battery. The relay energizes when these conditions are true:

- Standby power switch is in the AUTO position
- Either or both DC bus 1 and AC transfer bus 1 have no power.

The K3 also energizes if the standby power switch is put in the BAT position.

K3 is open if DC bus 1 and AC transfer bus 1 have power or the standby power switch is put in the OFF position.

Switched Hot Battery Bus Relay (K8)

The switched hot battery bus relay (K8) energizes to let the switched hot battery bus get power from the battery or the battery charger.

K8 energizes when the battery switch is in the ON position.

K8 also energizes when the airstairs handle is in the STANDBY position.

Other Relays

These relays control DC power distribution and are outside of the standby power control unit:

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- TRU 3 transfer relay (R622)
- DC bus tie relay (R9)
- DC ground service relay (R634).

The SPCU controls all of the relays except the DC ground service relay. The BPCU controls the ground service relay.

TRU 3 Transfer Relay (R622)

The TRU 3 transfer relay (R622) controls the power source of TRU 3. The relay energizes to let TRU 3 get power from AC transfer bus 1 when AC transfer bus 2 loses power. R622 energizes when all of these conditions are true:

- Bus transfer switch is in the AUTO position
- AC transfer bus 1 has power
- AC transfer bus 2 does not have power.

DC Bus Tie Relay (R9)

The DC bus tie relay energizes to connect DC bus 1 and DC bus 2 in parallel. The relay energizes when all these conditions are true:

- Bus transfer switch is in the AUTO position
- AC transfer bus 1 or AC transfer bus 2 has power
- Autopilot system is not in the approach mode with glideslope capture.

The relay opens when any of the conditions are not true.

Ground Service Bus Relay (R634)

The ground service bus relay (R634) controls the power source selection of the ground service DC bus. The BPCU lets R634 energize when you push the ground service switch on the forward attendant panel. The relay de-energizes to let this bus get power from the DC bus 1.

Static Inverter RCCB

The static inverter gets input power through the static inverter RCCB when it closes. This RCCB is normally closed. See the standby power system section for more information.

Dual Battery RCCB

HAP 001-005 PRE SB 737-24-1120

The auxiliary battery and auxiliary battery charger are in parallel with the main battery and main battery charger when the dual battery RCCB closes. This RCCB is normally open. The RCCB closes when any of these conditions are true:

- Battery switch is in the ON position and the AC transfer bus 1 and DC bus 1 have no power
- TRU 3 fails (Relay K2 opens and K1 closes.)
- Standby power switch is in the BAT position.

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HAP 001-005 PRE SB 737-24-1120 (Continued)

HAP 006-013, 015-026, 028-054, 101-999; HAP 001-005 POST SB 737-24-1120

The auxiliary battery and auxiliary battery charger are in parallel with the main battery and main battery charger when the dual battery RCCB closes. This RCCB is normally open. See the DC Generation system section 24-31 for more information about the operation of this RCCB.

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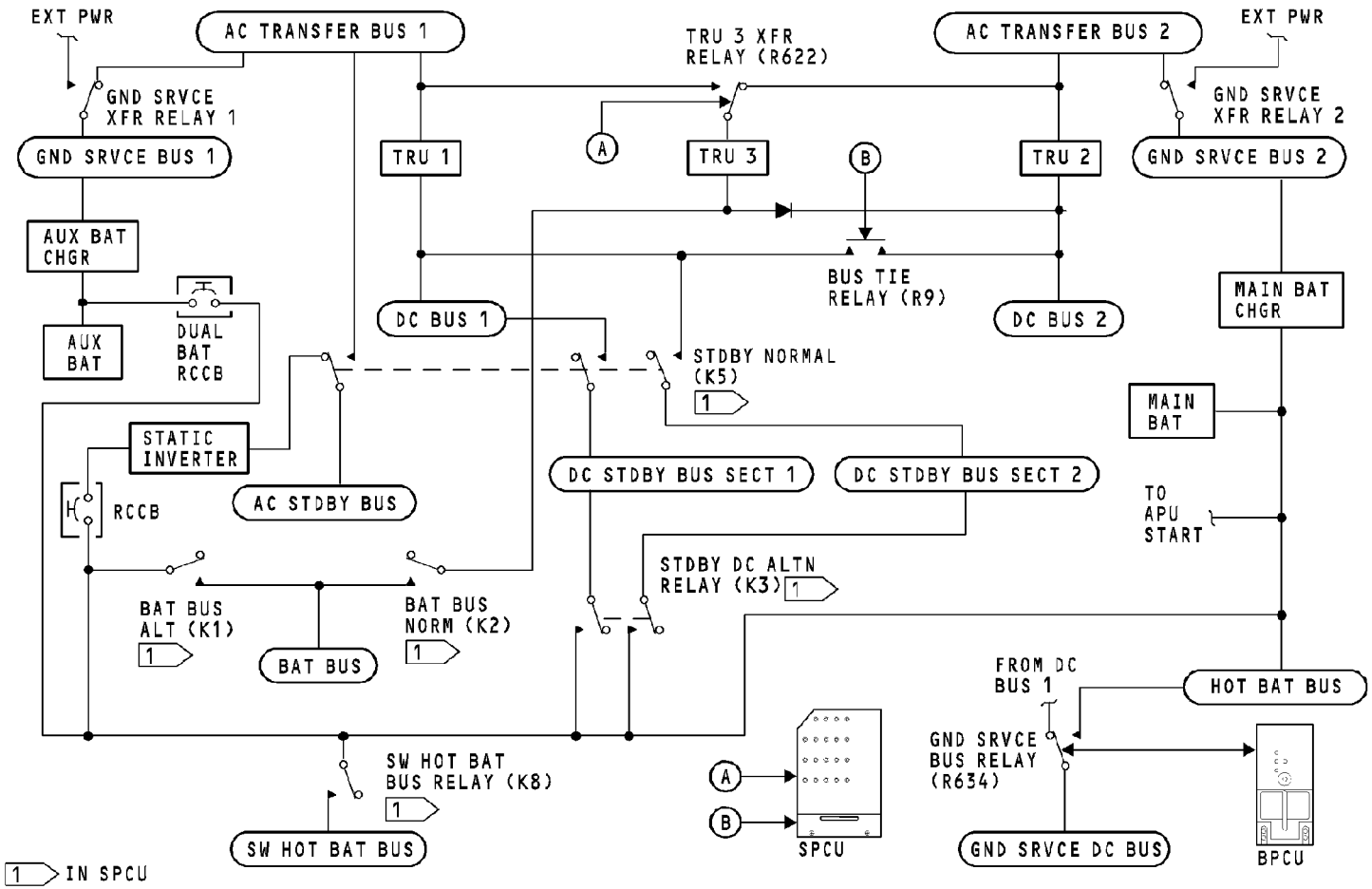

DC GENERATION - DISTRIBUTION AND CONTROL - GENERAL DESCRIPTION

EFFECTIVITY

HAP ALL

24-30-00

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General

The manual controls of DC generation are in the flight compartment on the P5 overhead panel and at the forward attendant station.

DC generation indication is on the P5 overhead panel.

Electrical Meters, Battery, and Galley Power Module (P5-13)

These indications are on the P5-13 module:

- BAT DISCHARGE light
- TR UNIT light
- ELEC light
- LED alphanumeric display.

The lights come on to show a failure in the DC generation system. You use the DC meter selector and the alphanumeric display to see DC system data.

The battery energizes buses and components of the electrical system when you put the battery switch on.

See the DC generating system section for more information about the P5-13 module interfaces. (SECTION 24-31)

See the electrical power section for more information about the P5-13 module. (SECTION 24-00)

Generator Drive And Standby Power Module (P5-5)

The P5-5 module gives you manual control and indication of the standby power system.

The standby power switch gives you manual control of the AC and DC standby bus power sources. The STANDBY PWR OFF light comes on when a standby bus or the battery bus de-energizes with the battery switch on.

See the standby power system section for more information about how the P5-5 module interfaces with the standby power system.

See the electrical power section for more information about the P5-5 module.

Forward Attendant Panel

The ground service switch is on the forward attendant panel. You use this switch to energize AC and DC ground service buses with external power. See the external power section for more information about external power.

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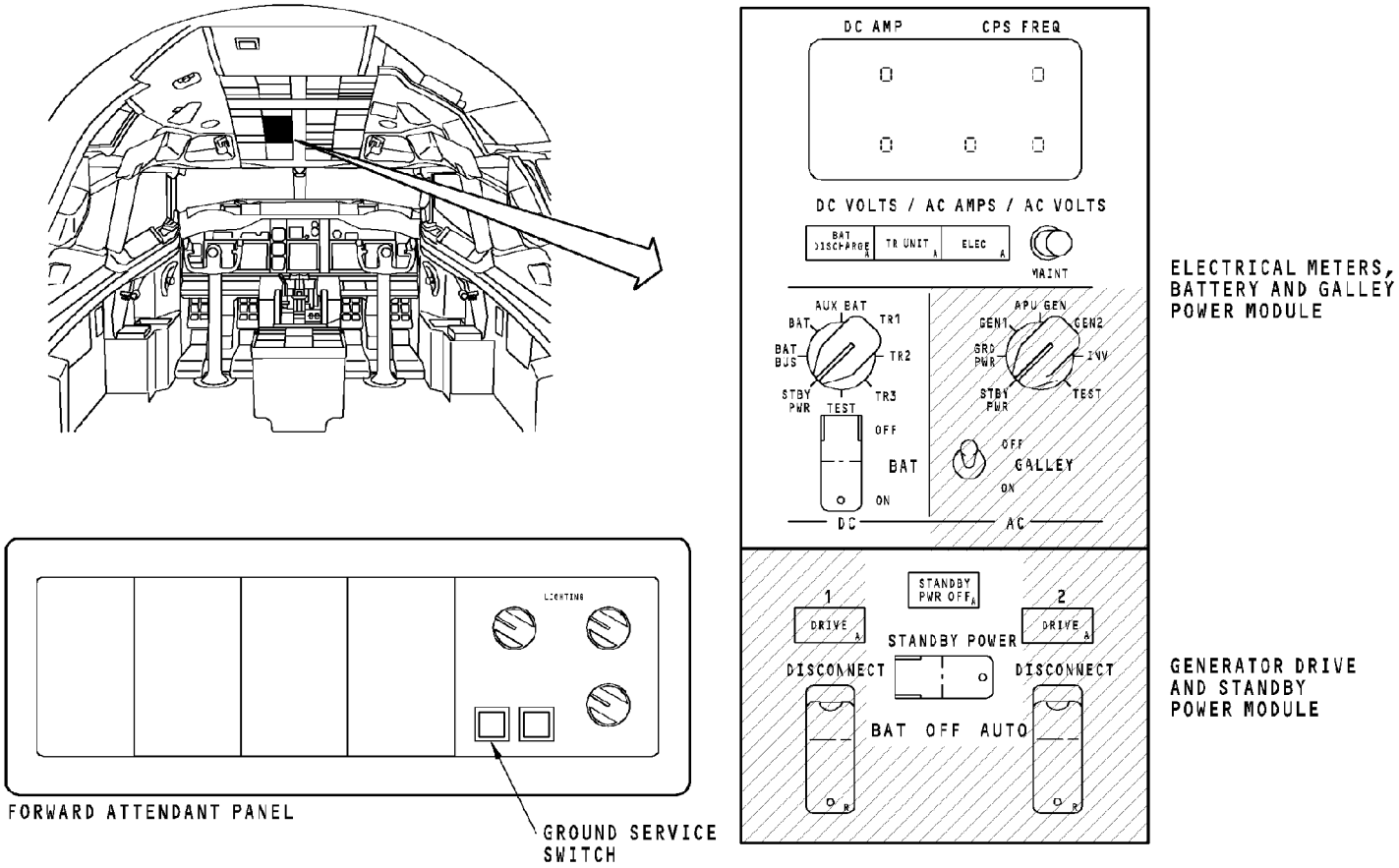

DC GENERATION - MANUAL CONTROLS AND INDICATION - GENERAL DESCRIPTION

EFFECTIVITY
HAP ALL

24-30-00

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DC GENERATION - COMPONENT LOCATION

General

DC generation components are in the flight compartment and the EE compartment.

Flight Compartment

The P6 and P18 panels have these DC generation components:

- Circuit breakers for DC bus sections and other components
- Relays, including the R634 ground service relay
- The standby power control unit (SPCU).

The P5 overhead panel has these modules that interface with DC generation:

- P5-13 electrical meters, battery, and galley power module
- P5-5 generator drive and standby power module.

Electronic Equipment Compartment

DC generation components are in these areas of the EE compartment:

- E2 rack
- E3 rack
- E4 rack
- Left power distribution panel (PDP 1)
- Right power distribution panel (PDP 2).

The batteries are below the bottom shelf of the E3 rack

E2 rack

These DC generation components are on the E2 rack:

- Transformer rectifier unit 1 (TRU 1)
- Main Battery Charger
- Static inverter.

E4 rack

These DC generation components are on the E4 rack:

- Transformer rectifier unit 2 (TRU 2)
- Transformer rectifier unit 3 (TRU 3).

Power Distribution Panels (PDP)

See the AC generation section for more information about the PDPs. (SECTION 24-20)

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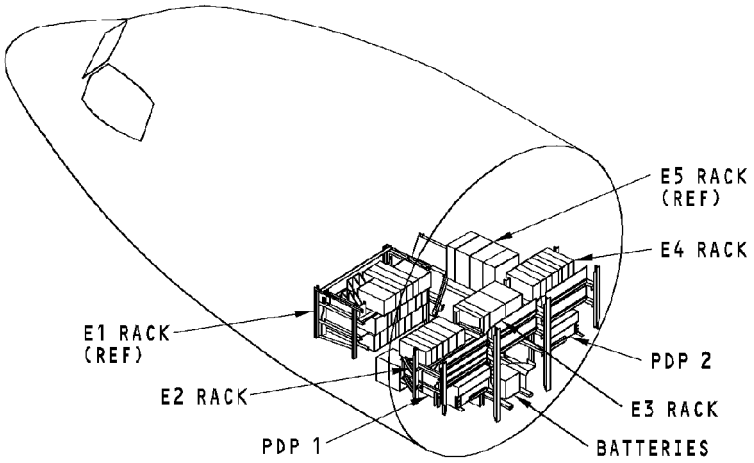
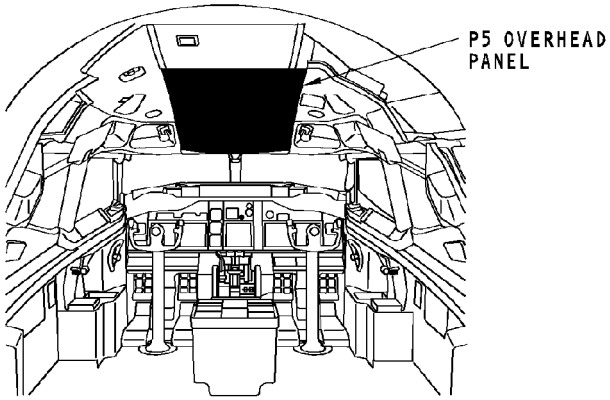
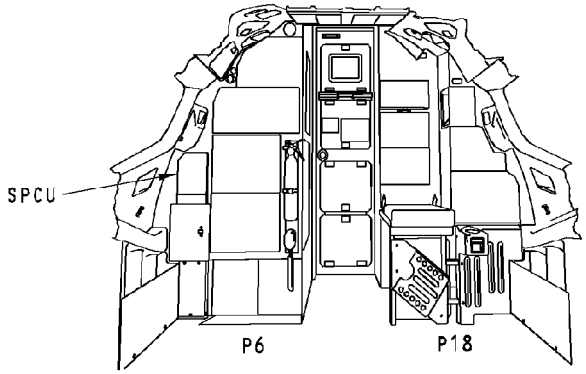


EE COMPARTMENT





FLIGHT COMPARTMENT
(LOOKING AFT)

DC GENERATION - COMPONENT LOCATION

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DC GENERATION SYSTEM - INTRODUCTION

Purpose

The DC generation system makes a nominal 28v dc for airplane systems.

General

The DC generation system has these components:

- Battery
- Battery charger
- Transformer rectifier units (3).

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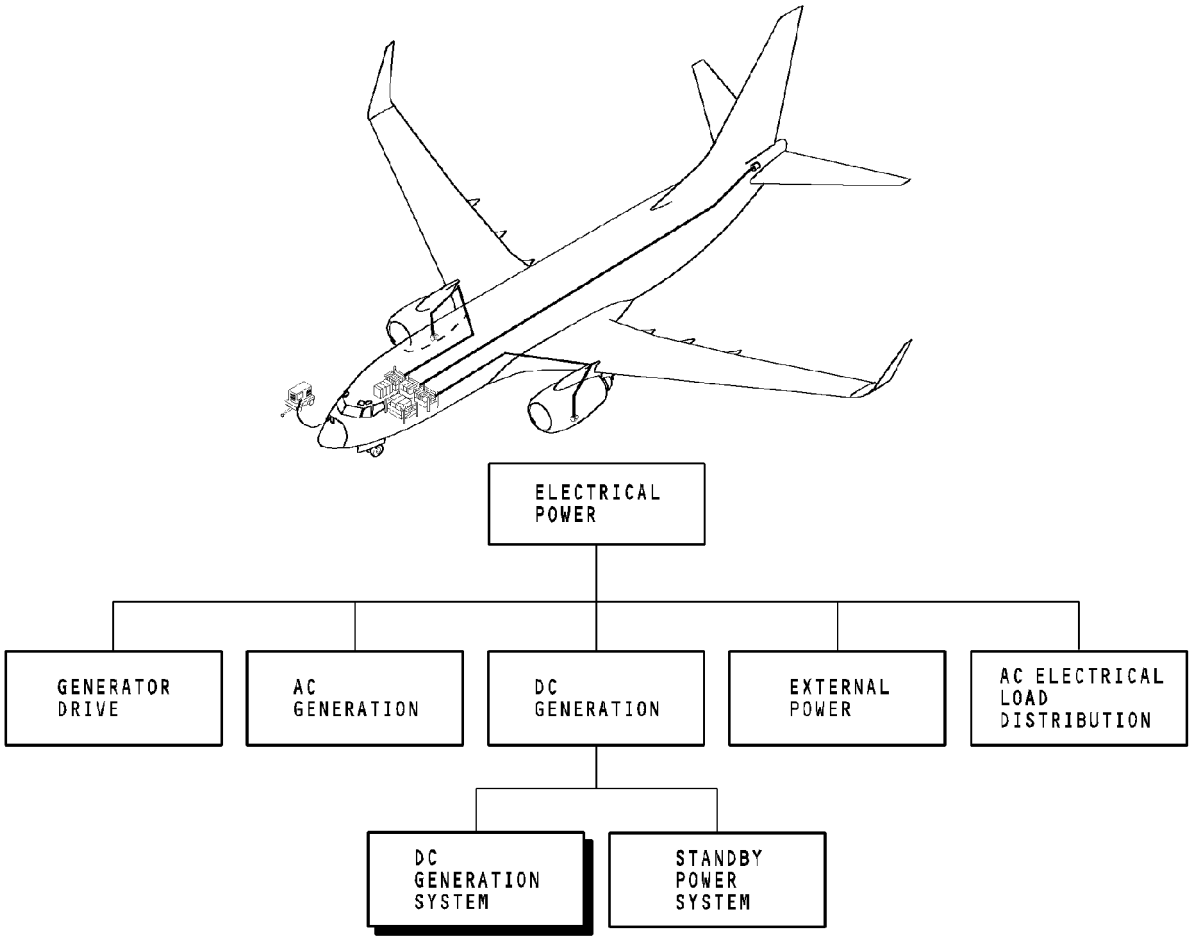

DC GENERATION SYSTEM - INTRODUCTION

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General Description

The DC generation system supplies a nominal 28v dc to different loads. The power source for the DC system is usually the AC system. The battery supplies power if the AC system is not available.

Transformer Rectifier Units

To create DC power from the normal AC source, the DC system uses transformer-rectifier units (TRUs). The three TRUs take 115v ac, decrease the voltage (transforms), and rectify it to a nominal 28v dc.

Batteries

Each battery is a 48 ampere-hour, nominal 24v dc power source. The main battery supplies power for APU starting and is a standby power source if all other power supplies do not operate. The auxiliary battery helps the main battery supply standby power only.

Control and Protection

The standby power control unit (SPCU), the battery switch, and the standby power switch give primary control of the DC system.

The battery switch and the standby power switch give manual control of power to some DC buses.

The SPCU gives automatic control and protection of DC buses. It uses inputs from the flight compartment and system monitoring to control DC power sources and distribution.

Power Distribution

The DC power distribution system is in the power distribution panels (PDPs) and in the SPCU.

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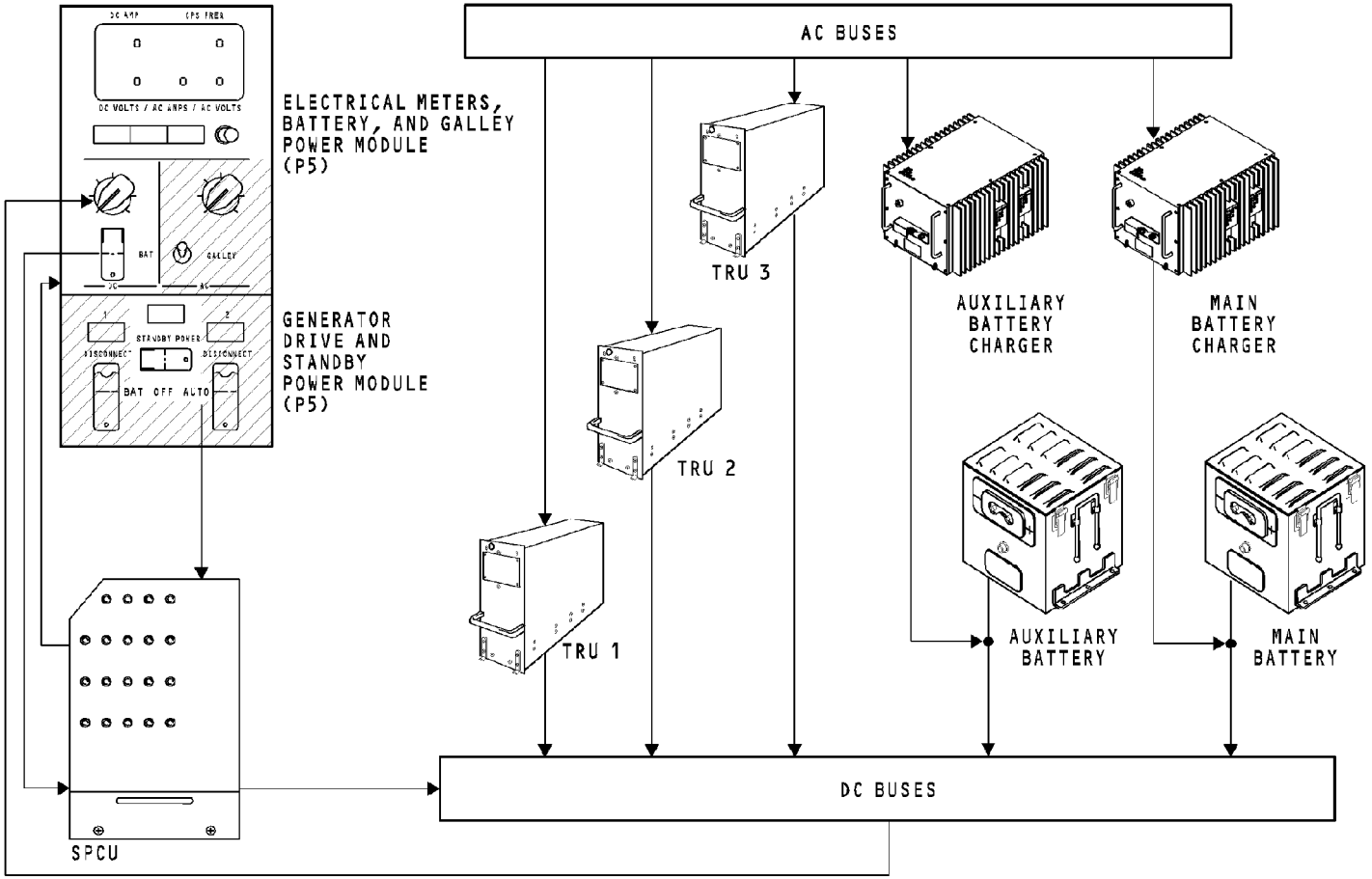

DC GENERATION SYSTEM - GENERAL DESCRIPTION

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DC GENERATION SYSTEM - MAIN BATTERY CHARGER AND AUXILIARY BATTERY CHARGER

Purpose

The main battery charger has these two functions:

- Keeps main battery at maximum charge
- Supplies DC power to the battery buses.

The auxiliary battery charger keeps the auxiliary battery at maximum charge.

General Description

Both battery chargers have the same part number. Each battery charger has these two basic modes of operation:

- Battery charge mode (constant current, then constant voltage)
- Transformer rectifier mode (constant voltage).

Each battery charger supplies constant current, variable voltage power in the basecharge mode. After a transition voltage is reached, the battery charger overcharges the battery at a constant voltage, variable current. The battery charger logic calculates the amount of overcharge. The total charge time is less than 180 minutes.

In the transformer rectifier (TR) mode, the main battery charger supplies constant voltage DC power to the hot battery bus and the switched hot battery bus. The main battery also receives a small trickle charge to help keep it at maximum charge. The auxiliary battery charger does not supply power to the DC buses in either mode. However, the auxiliary battery receives a small trickle charge when the auxiliary battery charger is in the TR mode.

The front face of each battery charger has two green status lights (LED). One light is for the battery charger and the other is for the battery. These lights are on when the battery and battery charger are in operation.

Location

The main battery charger is on the E2 rack. The auxiliary battery charger is on the E3 rack.

Functional Description

Each battery charger takes three-phase, 115v ac power and changes it to DC power. Usually, each battery charger is in the transformer rectifier mode. The battery chargers supply a constant voltage output in this mode. Each charger can supply up to 65 amps in this mode.

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A battery charger goes to the charge mode when its battery voltage is less than 23v dc. In this mode, the charger supplies constant current power. The output voltage is variable. During the charge, the battery voltage rises until the voltage gets to the transition voltage. The charger logic uses the battery temperature at the start of charging to calculate the transition voltage. The charger logic then calculates the length of the overcharge period.

After the overcharge period, the charger goes into a transformer rectifier mode with a constant 27.5v dc output. The battery gets a trickle charge in this mode.

The battery charger goes into the charge mode again if any of these occur:

- Battery charger input power is off for more than 1 second.
- Battery voltage is less than 23 volts.

You use the electrical meters, battery, and galley power module to monitor the operation of each battery charger. The main battery charger is in the charge mode when you see a positive DC AMPS indication while the DC meter selector in the BAT position. Use the AUX BAT position to monitor the auxiliary battery charger.

The main battery charger cannot go into the charge mode during any of these conditions:

- Fueling station door open
- APU start
- Standby power switch (P5-5) in the BAT position
- Standby power switch (P5-5) in the AUTO position, battery switch ON, and DC BUS 1 and AC TRANSFER BUS 1 do not have power
- Main battery overheat.

The auxiliary battery charger cannot go into the charge mode during any of these conditions:

- Standby power switch (P5-5) in the BAT position
- Standby power switch (P5-5) in the AUTO position, battery switch ON and DC BUS 1 and AC TRANSFER BUS 1 do not have power.
- Auxiliary battery overheat.

Status Lights

Both status lights are usually on when the battery charger has input power. A malfunction with any of these components makes one or both status lights go off:

- Battery charger
- Battery
- Connection wiring.

Both status lights are off if any of these conditions are true:

- Input power to the battery charger goes away
- Input voltage to the battery charger is less than 94v ac for more than 0.5 seconds.

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The battery charger status light is on and the battery status light is off if any of these conditions are true:

- Battery charger senses a loss of connection to the battery
- Battery overheat
- Battery temperature sensor open or shorted
- Battery not charged in time limits
- Battery voltage less than lower limits.

The battery charger status light is off and the battery status light is on when there is an internal battery charger failure. The battery charger fail maintenance message also shows on P5-13 BITE.

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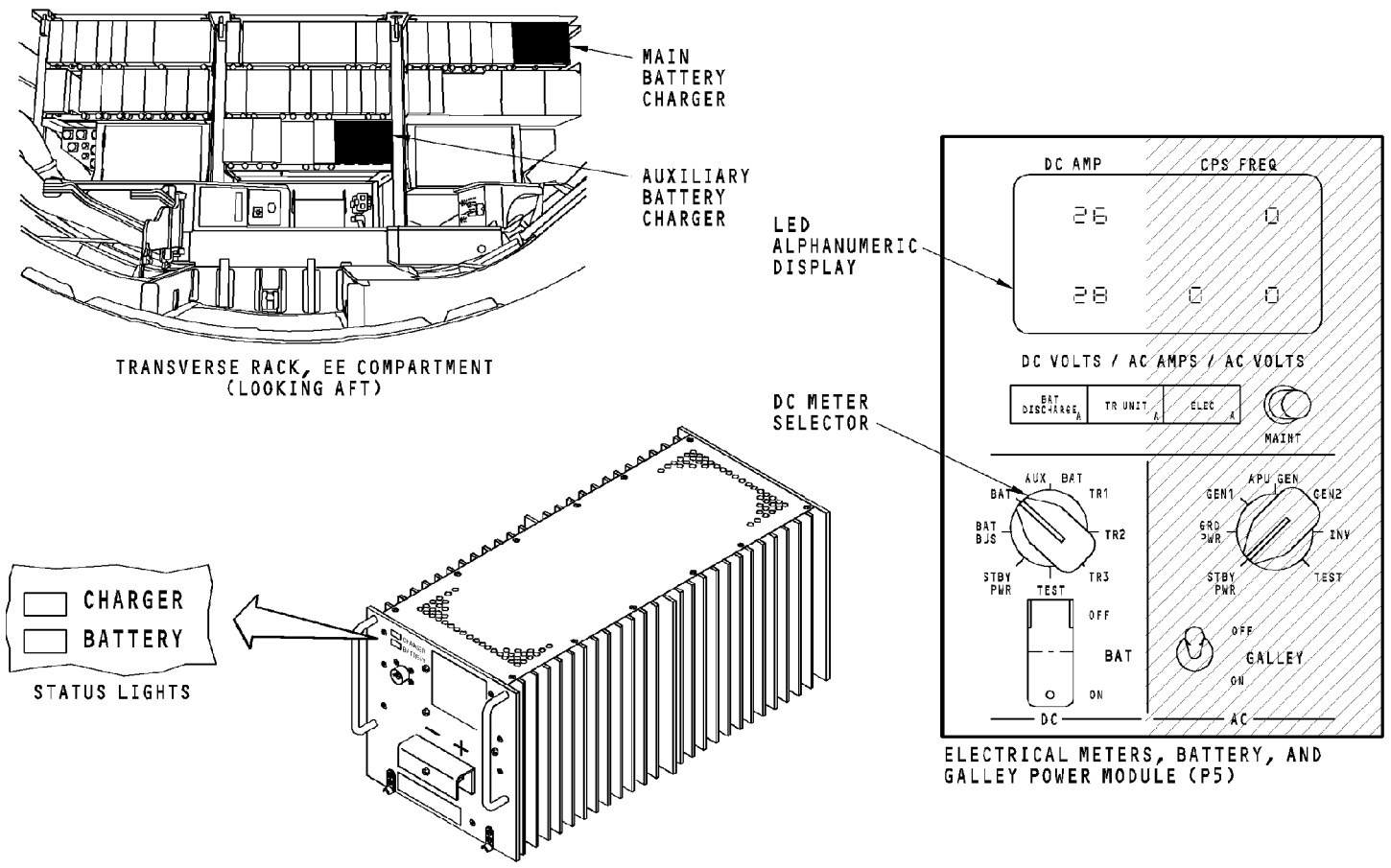

DC GENERATION SYSTEM - MAIN BATTERY CHARGER AND AUXILIARY BATTERY CHARGER

EFFECTIVITY

HAP ALL

24-31-00

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Functional Description

The battery charger takes 3-phase, 115v ac power and changes it to dc power. Usually, the battery charger is in the transformer rectifier mode. The battery charger supplies a constant voltage output in this mode. The charger can supply up to 65 amps in this mode.

The battery charger goes to the charge mode when the battery voltage goes below 23v dc. In this mode, the charger supplies constant current power. The output voltage is variable, the current output is 50 amps. During the charge, the battery voltage increases until the voltage gets to the inflection point. The charger logic uses the battery temperature at the start of charge to calculate the inflection point. The charger logic then calculates the length of the overcharge period.

After the overcharge period, the charger goes into a transformer rectifier mode with a constant 27.5v dc output. The battery gets a trickle charge in this mode.

The battery charger goes into the charge mode again if any of these occur:

- Battery charger input power is off for more than 1 second
- Battery voltage goes below 23 volts.

You use the electrical meters, battery and galley power module to monitor the operation of the battery charger.

The battery charger is in the charge mode when you see a positive DC AMPS indication when the DC meter selector in the BAT position.

The battery charger cannot go into the charge mode during any of these conditions:

- Fueling station door open
- APU start
- Standby power switch (P5-5) to the BAT position
- Standby power switch (P5-5) to the AUTO position, battery switch ON, and DC BUS 1 and AC TRANSFER BUS 1 do not have power
- Battery overheat.

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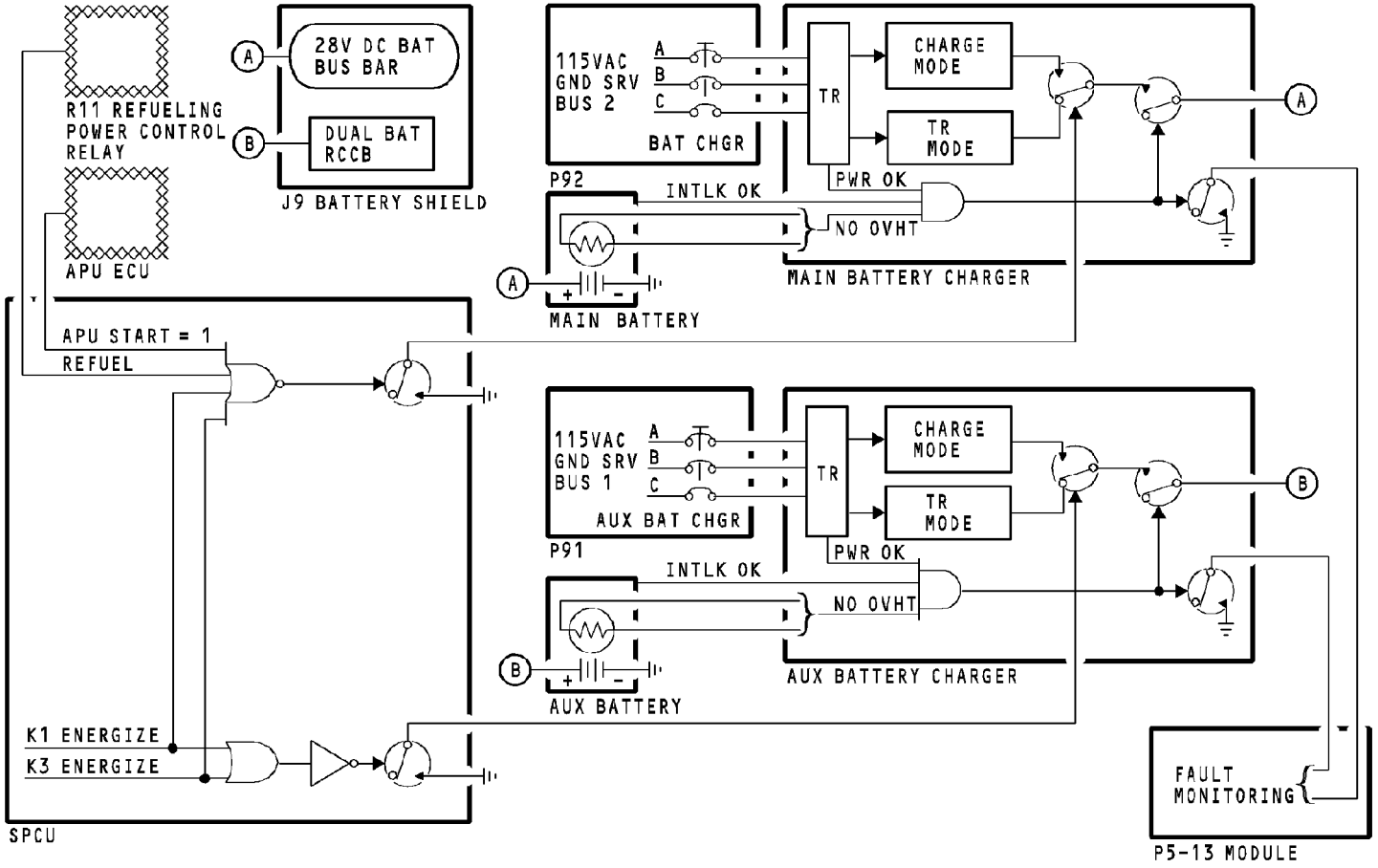

DC GENERATION SYSTEM - BATTERY CHARGER - FUNCTIONAL DESCRIPTION

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Purpose

The main battery has these functions:

- Supply power to critical airplane systems (AC and DC standby buses) if the normal power sources are not available
- Backup power supply for the AC system control and protection
- Power supply for APU start.

The auxiliary battery helps the main battery supply power to the critical airplane systems (AC and DC standby buses).

Location

The batteries are in the EE compartment, under the E3 rack. The auxiliary battery is forward of the main battery. You remove an access panel in the forward cargo compartment to get access to the batteries. You must remove the main battery before you can remove the auxiliary battery.

General Description

Each battery is a 20 cell nickel-cadmium battery with a 48 amp-hour capacity. With full charge, the batteries supply a minimum of 60 minutes of standby AC and DC power.

Each battery has an internal thermal sensor. The battery's charger uses this sensor to measure internal battery temperature. See the MAIN BATTERY CHARGER AND AUXILIARY BATTERY CHARGER page in this section for more information.

Indication

You can see the output of each battery on the electrical meters, battery and galley power module on the P5 forward overhead panel. You see the voltage and current output of a battery with the DC meter selector in the BAT position or AUX BAT position. If the battery's charger has power, you see the output voltage of the battery or its battery charger, whichever is more.

The amber BAT DISCHARGE light comes on when any one of these output conditions are true for either battery:

- Current draw is more than 5 amps for 95 seconds
- Current draw is more than 15 amps for 25 seconds
- Current draw is more than 100 amps for 1.2 seconds.

Master caution and the ELEC annunciator usually come on with the BAT DISCHARGE light. The light goes out when the output current goes below the limit for more than 1 second. Master caution and the ELEC annunciator do not come on during a DC power APU start.

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Training Information Point

You remove a battery from the airplane before you do a battery inspection or servicing.

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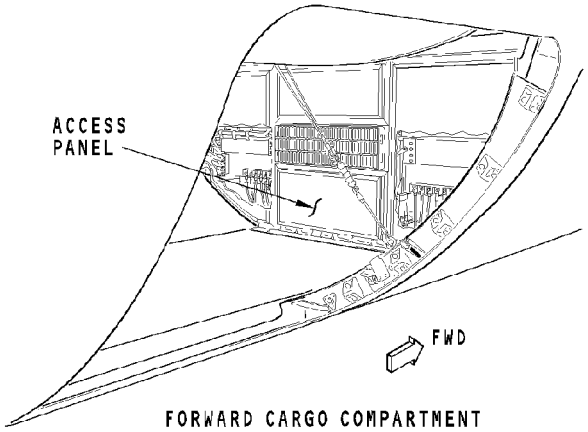
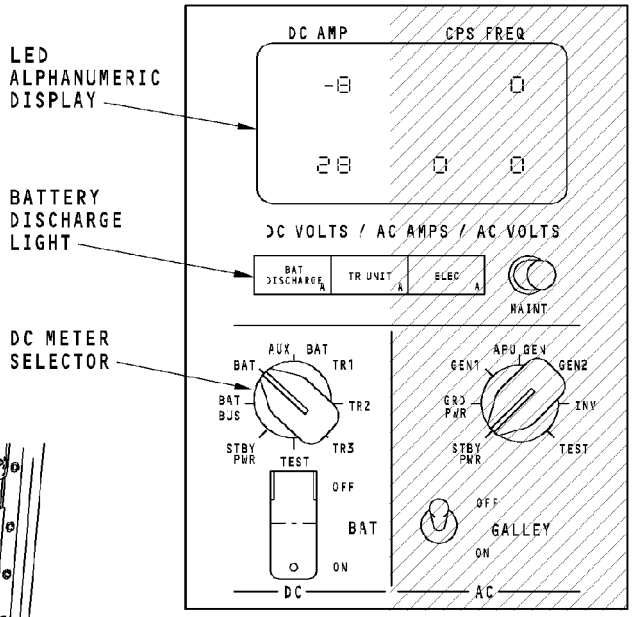
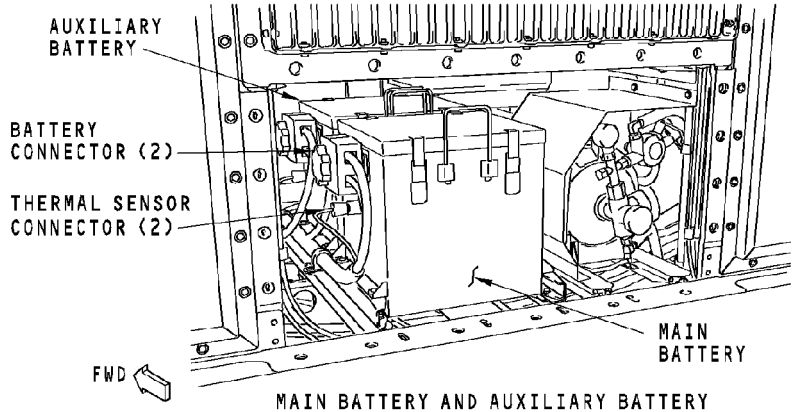


FORWARD CARGO COMPARTMENT



ELECTRICAL METERS, BATTERY, AND GALLEY POWER MODULE (P5)



MAIN BATTERY AND AUXILIARY BATTERY

DC GENERATION SYSTEM - MAIN BATTERY AND AUXILIARY BATTERY

EFFECTIVITY

HAP ALL

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DC GENERATION SYSTEM - DUAL BATTERY REMOTE CONTROL CIRCUIT BREAKER

Purpose

The dual battery remote control circuit breaker (RCCB) puts the output of these in parallel:

- Auxiliary battery
- Auxiliary battery charger
- Main battery
- Main battery charger.

Location

The RCCB is inside the J9 junction box. J9 is in the EE compartment, in front of the E2 rack.

General Description

The RCCB is normally open and closes when the SPCU signals it to close. This lets the 28v dc battery bus bar receive power from the main and auxiliary batteries at the same time.

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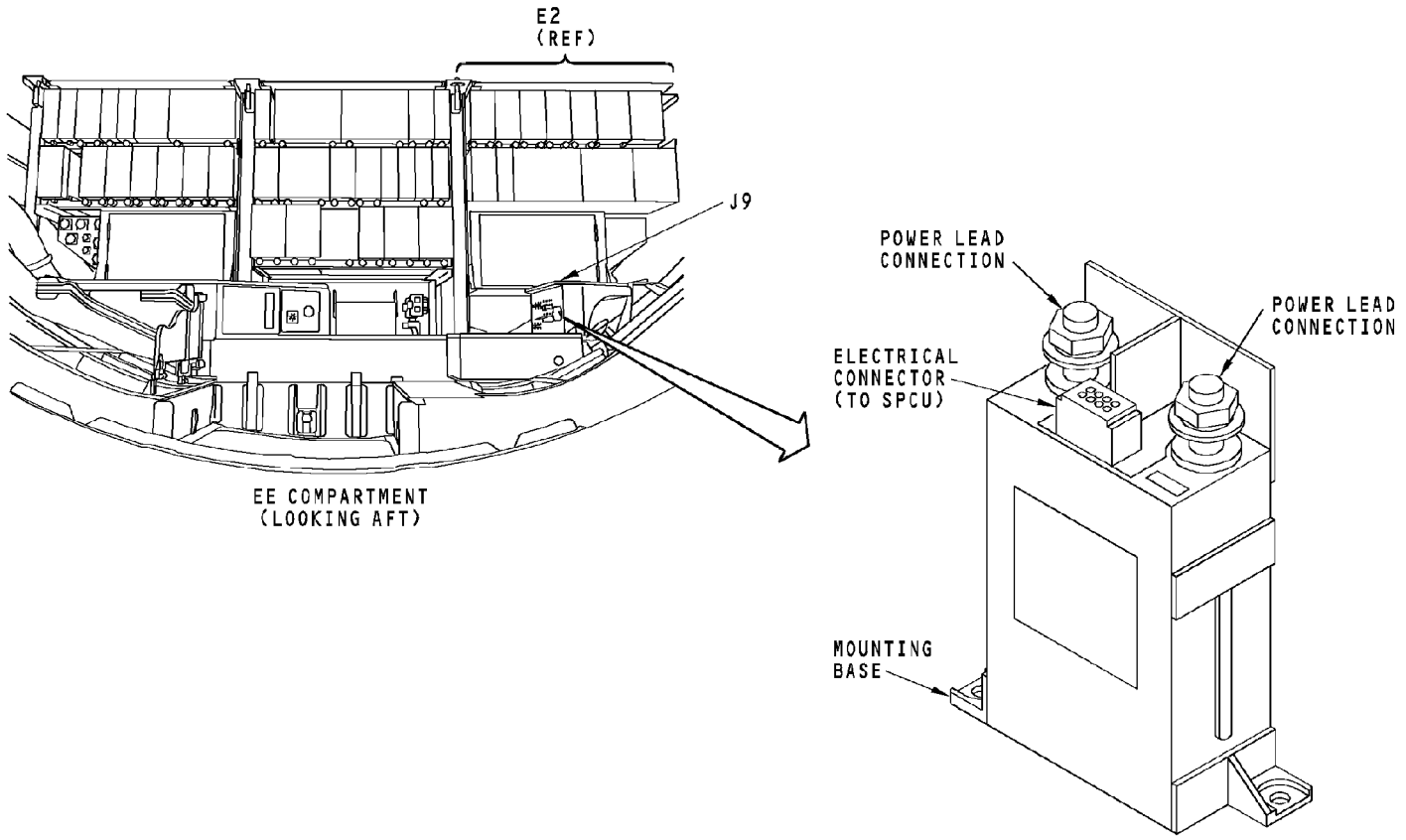

DC GENERATION SYSTEM - DUAL BATTERY REMOTE CONTROL CIRCUIT BREAKER

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Purpose

The transformer rectifier units (TRU) change three-phase nominal 115v ac, 400 hz input power into 28v dc to supply the main DC system loads.

General Description

The DC generation system has three TRUs. Each TRU can supply a continuous output load of 75 amps with forced air cooling. The TRUs can supply 50 amps with convection cooling.

There are no external controls to the TRUs. The TRUs are the same part number.

Location

The TRUs are in the EE compartment. TRU 1 is on the E2 rack. TRU 2 and TRU 3 are on the E4 rack.

Indication

You may monitor output power for each TRU from the P5-13. You can use the DC meter selector to select the TRU. TRU output voltage and amperes show in the alphanumeric display.

The amber TR UNIT light comes to show a TRU failure. The light comes on for any of these conditions:

- Any TRU fails on the ground
- TRU 1 fails in flight
- TRU 2 and TRU 3 fail in flight.

EFFECTIVITY
HAP ALL

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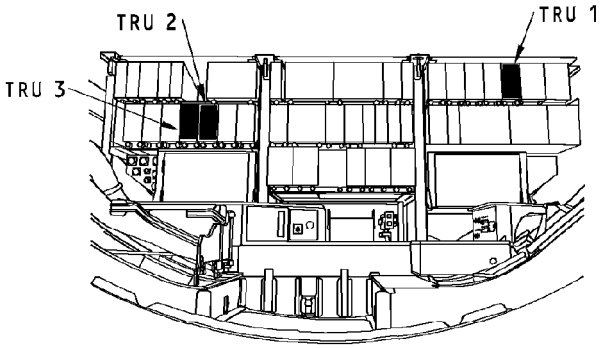
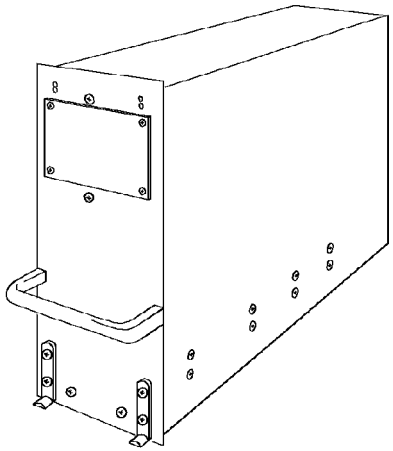
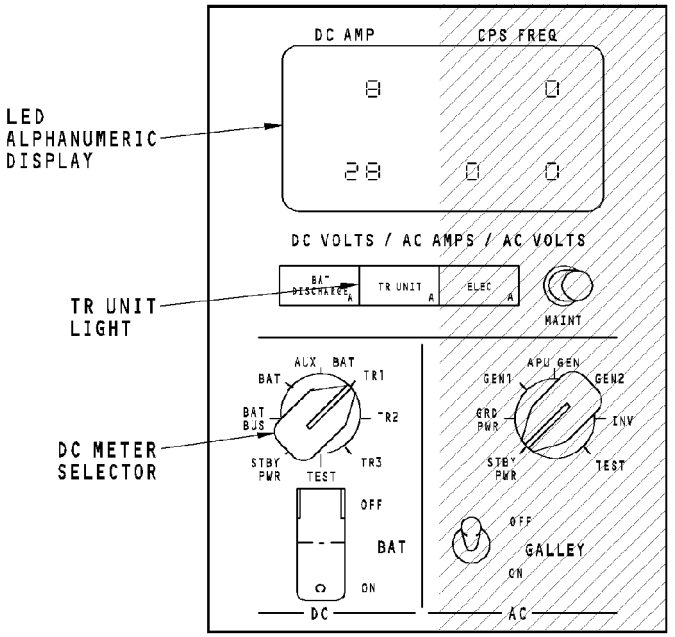


TRANSVERSE RACK, EE COMPARTMENT
(LOOKING AFT)



TRU



ELECTRICAL METERS, BATTERY, AND
GALLEY POWER MODULE (P5-13)

DC GENERATION SYSTEM - TRANSFORMER RECTIFIER UNIT (TRU)

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DC GENERATION SYSTEM - DUAL BATTERY REMOTE CONTROL CIRCUIT BREAKER - FUNCTIONAL DESCRIPTION

General

The DUAL BATTERY RCCB is normally open. When it is closed, it lets the main battery and auxilary battery supply power to the standby system in parallel.

Functional Description

The DUAL BATTERY RCCB receives control logic from the SPCU. The DUAL BATTERY RCCB closes when these conditions occur:

- APU switch is not in the start position and
- Relay K1 or K3 is energized.

When it is closed, the DUAL BATTERY RCCB receives power from the auxiliary battery or auxiliary battery charger and sends it to the 28v dc battery bus bar.

During an APU start the electronic control unit (ECU) sends a signal to the SPCU. This causes the logic in the SPCU to open the DUAL BATTERY RCCB.

Relay K1 will close if TRU3 fails and the standby power switch is in the AUTO position. Relay K3 closes when AC transfer bus 1 or DC bus 1 does not have power. Both relays close when the standby power switch is in the BAT position.

Training Information Point

The SPCU logic isolates the output of the batteries during a DC APU start. The SPCU logic will not let a DC APU start open the RCCB REMOTE circuit breaker. The RCCB REMOTE circuit breaker is on the front of the SPCU and must be closed manually if it is open.

When the RCCB REMOTE circuit breaker is open, the DUAL BATTERY RCCB will not close and let the batteries operate in parallel. In this condition, 60 minutes of standby power is not available.

EFFECTIVITY

HAP 006-013, 015-026, 028-054, 101-999; HAP 001-005 POST SB 737-24-1120

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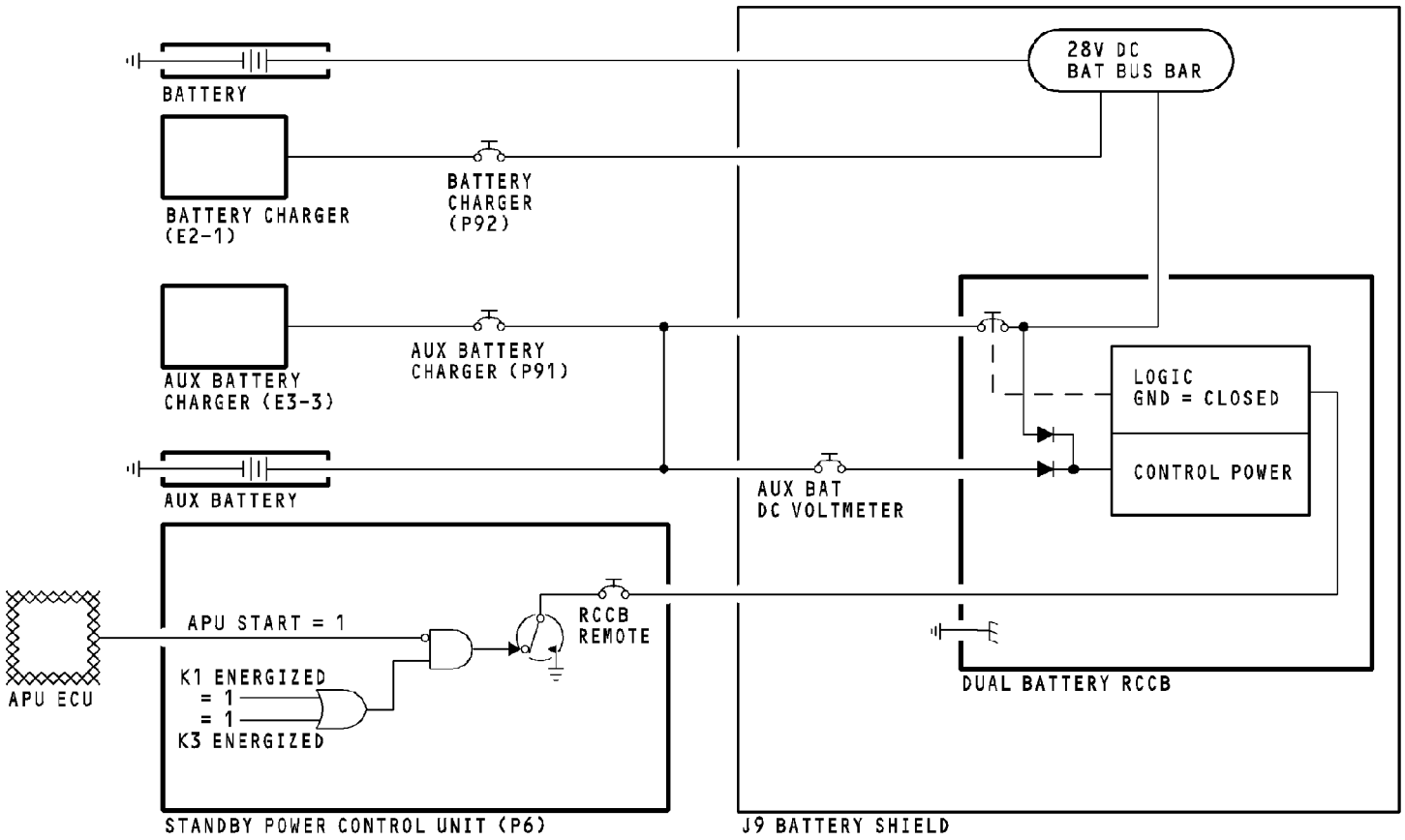

DC GENERATION SYSTEM - DUAL BATTERY REMOTE CONTROL CIRCUIT BREAKER - FUNCTIONAL DESCRIPTION

EFFECTIVITY

HAP 006-013, 015-026, 028-054, 101-999; HAP 001-005 POST SB 737-24-1120

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Hot Battery Bus Power

The hot battery bus receives DC power from the battery through a 28VDC bat bus bar in the J9 battery shield. There is a circuit breaker on the SPCU that permits power to the bus.

The 28v dc battery bus bar receives DC power from the main battery or the main battery charger under normal power conditions. On standby power the 28v dc battery bus bar receives power from the main battery and the auxiliary battery.

Switched Hot Battery Bus Power

The switched hot battery bus receives DC power from the 28v dc battery bus bar through a circuit breaker on the SPCU and relay K8 in the SPCU.

To get power to the switched hot battery bus, the battery switch must be ON. When the battery switch is ON, K8 SW HOT BAT BUS RLY closes and gives dc power to the bus.

With the forward airstair option, the K8 relay closes when the airstair handle is put in the standby position.

The K8 relay gives DC power from the 28v dc battery bus bar to the SPCU power supply.

Battery Bus Power

The battery bus receives power from the 28v dc battery bus bar or TRU 3.

The BAT BUS NORM RLY (K2) is closed and gives DC power from TRU3 to the battery bus when all of these conditions are true:

- BATTERY SW ON
- STANDBY POWER SW not in BAT position
- TRU 3 gets more than 18v dc for more than 0.15 seconds.
- When the K2 relay is closed, the BAT BUS ALT RLY (K1) must be opened.

The K1 BAT BUS ALT RLY is closed and gives power to the BATTERY BUS during these conditions:

- Battery switch is ON and TRU 3 does not have power (less than 18v dc) for more than 0.1 seconds or
- STANDBY POWER SWITCH is in the BAT position.

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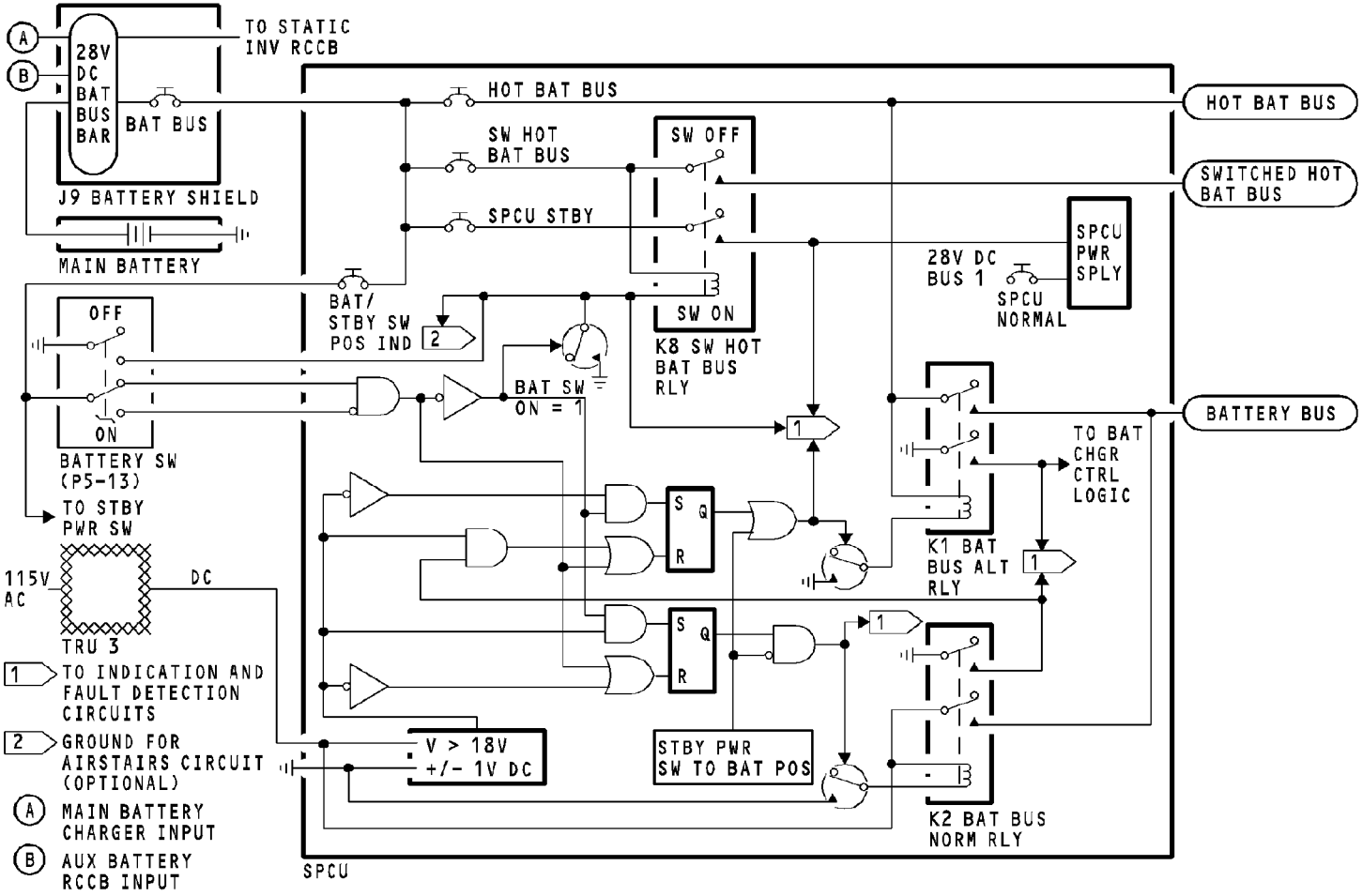

DC GENERATION SYSTEM - BATTERY BUSES - FUNCTIONAL DESCRIPTION

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STANDBY POWER SYSTEM - INTRODUCTION

Purpose

The standby power system supplies a nominal 28v dc and single phase 115v ac to electrical buses which must have power to maintain safe flight.

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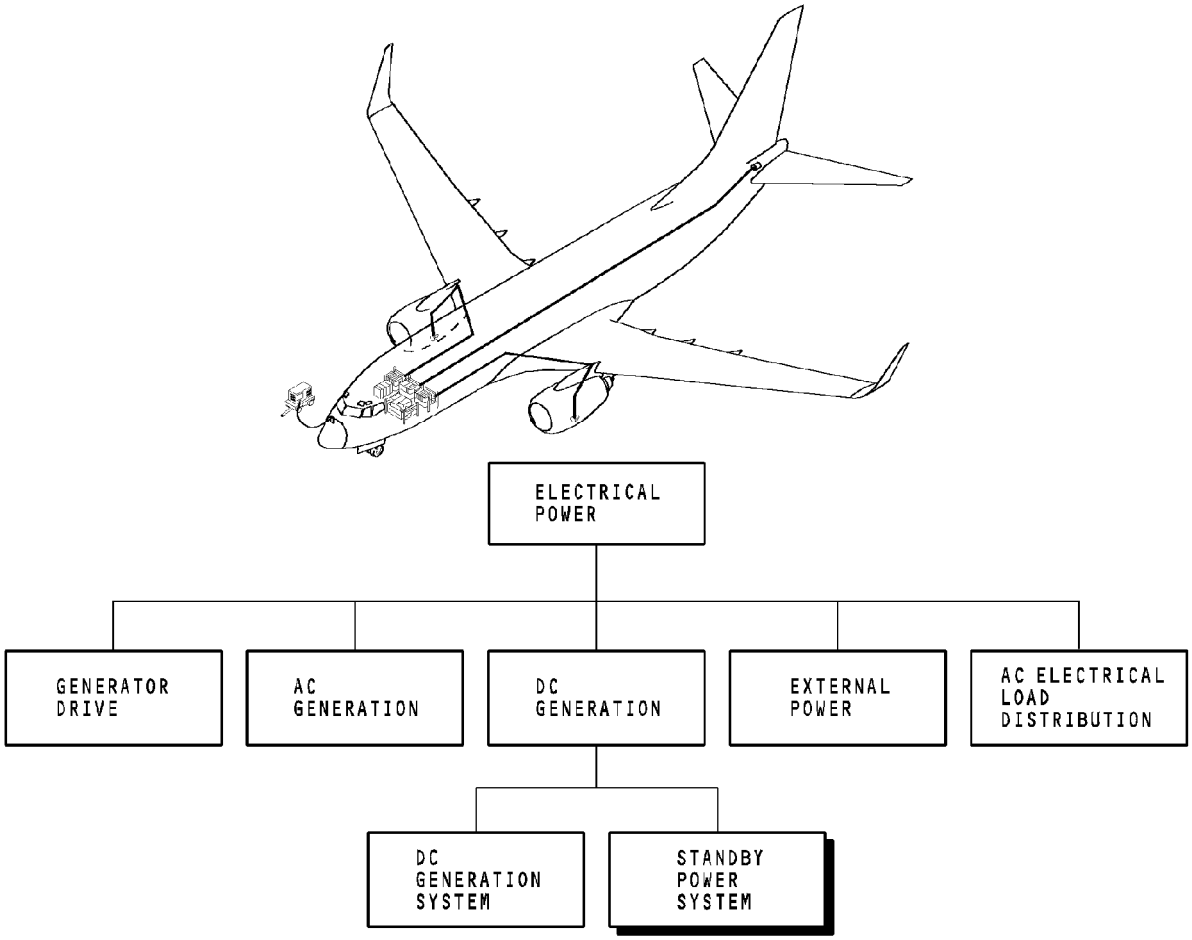

STANDBY POWER SYSTEM - INTRODUCTION

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STANDBY POWER SYSTEM - GENERAL DESCRIPTION

Purpose

During normal conditions, the standby power system supplies a nominal 28v dc power to these buses:

- Battery
- DC standby
- Switched hot battery.

The standby power system supplies single phase 115v ac, 400 Hz power to the AC standby bus during non-normal conditions.

The battery and standby buses give power to systems that are necessary to keep a safe flight. The standby system also gives power for ground operations when there is no AC power.

General Description

The standby power control unit (SPCU) gives automatic and manual control of the battery and standby buses. The SPCU controls power distribution by these internal relays:

- Battery bus alternate relay (K1)
- Battery bus normal relay (K2)
- Standby DC alternate relay (K3)
- Standby normal relay (K5)
- Switched hot battery bus relay (K8).

The SPCU monitors the standby power system for faults. The SPCU sends the fault data to these components where the ELEC light comes on:

- Electrical meters
- Battery
- Galley power module (P5-13).

You use the P5-13 built-in test equipment (BITE) to see the fault message data.

The amber STANDBY PWR OFF light on the P5-5 generator drive and standby power module comes on if any one of these buses loses power:

- AC standby bus
- DC standby bus
- Battery bus (when the battery switch is ON).

The main battery and the auxiliary battery supply at least 60 minutes of AC and DC power when normal sources are not available. The batteries supply DC power to the DC standby bus and the battery buses. The batteries use the static inverter to supply power for the AC standby bus. The inverter receives DC power from the batteries through the static inverter remote control circuit breaker (RCCB) in the J9. This RCCB is normally closed so the static inverter normally has power. This lets you monitor the static inverter output on the P5-13.

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STANDBY POWER SYSTEM - GENERAL DESCRIPTION

The dual battery remote control circuit breaker (RCCB) closes to put the two batteries in parallel. This RCCB, which is also in the J9, is normally open and only closes when the batteries supply standby power. See the DC generation system section for more information about the operation of this RCCB.

CAUTION: WHEN YOU CLOSE THE BATTERY SWITCH, THE BATTERY AND STANDBY BUSES HAVE POWER. YOU WILL DISCHARGE THE BATTERY TO ZERO VOLTS VERY FAST. YOU SHOULD GET AN AC POWER SOURCE ON THE ELECTRICAL SYSTEM QUICKLY.

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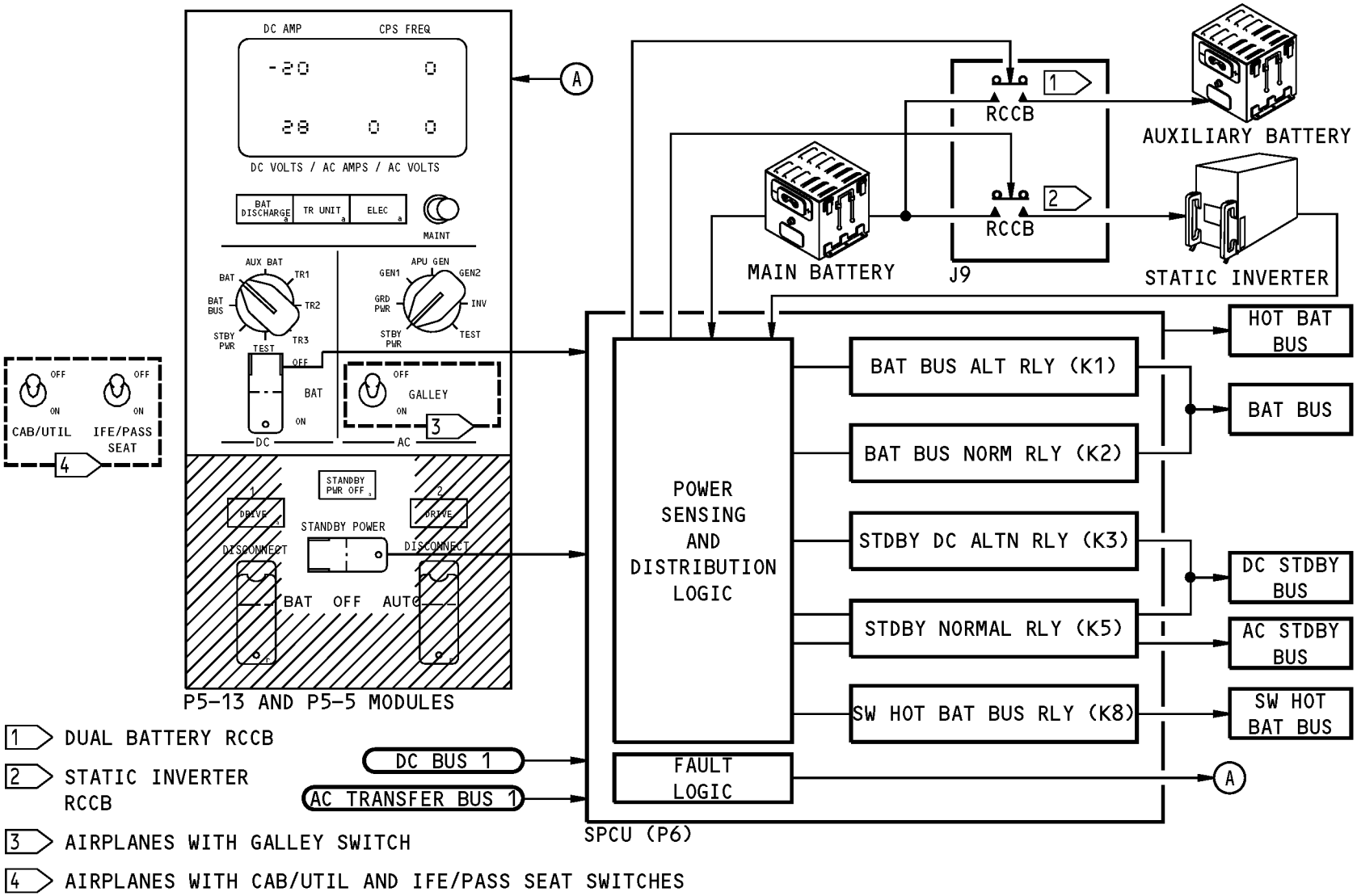

STANDBY POWER SYSTEM - GENERAL DESCRIPTION

EFFECTIVITY

HAP ALL

24-34-00-005

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STANDBY POWER SYSTEM - STANDBY POWER CONTROL UNIT (SPCU)

Purpose

The standby power control unit (SPCU) gives manual and automatic power source selection control of the battery and standby buses.

The SPCU supplies DC system failure data to the P5-13 electrical meters, battery, and galley power module.

The SPCU also controls some power distribution relays in the electrical system.

Location

The SPCU is in the P6 panel. The P6 panel is in the flight compartment, behind the first officer seat.

General Description

The SPCU monitors the position of the battery and standby power switches. It also monitors AC, DC, and battery buses to control the connection of these items to the correct power source:

- Battery bus
- Switched hot battery bus
- AC standby buses
- DC standby buses.

The SPCU controls electrical power distribution by these internal relays:

- Battery bus normal relay (K2)
- Battery bus alternate relay (K1)
- Standby normal relay (K5)
- Standby DC alternate relay (K3)
- Switched hot battery bus relay (K8).

The SPCU monitors and sends standby power system controls and relay failure data to the P5-13 module. These are the failures:

- SPCU fail (power supply or relay not in correct position)
- Battery charger does not operate.

See the electrical power section for more information about how to use P5-13 built-in test equipment (BITE).

The SPCU controls power distribution with these relays:

- TRU 3 transfer relay (R622)
- Bus tie relay (R9).

The SPCU has circuit breakers on its front panel. These circuits breakers are for electrical bus sections and for indication circuits.

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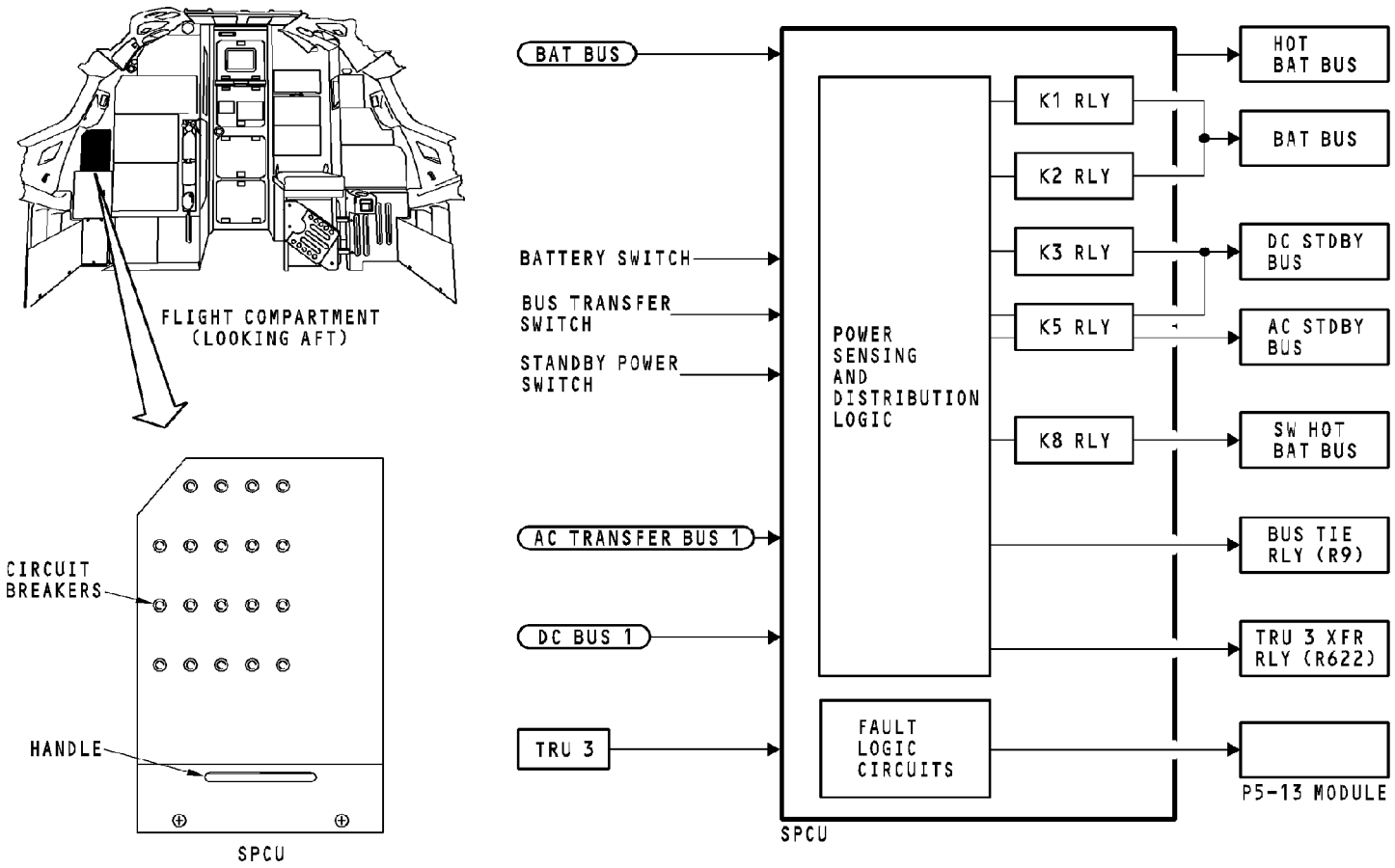

STANDBY POWER SYSTEM - STANDBY POWER CONTROL UNIT (SPCU)

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Purpose

The static inverter is the backup power source for the AC standby bus. The AC transfer bus 1 is the normal power source.

General Description

The static inverter uses DC power to give 115 volts, 400 Hz, single phase AC power to standby loads.

The static inverter has input power whenever the BAT switch is in the ON position or the standby power switch is in the BAT position.

The AC standby bus usually gets power from the AC transfer bus 1. The SPCU sends a command to the static inverter to supply power if transfer bus 1 has no power or when you put the standby power switch to the BAT position. The static inverter power goes through the SPCU to the AC standby bus.

Location

The static inverter is on the E2 rack in the EE compartment.

Indication

You may monitor the static inverter on the electrical meters, battery, and galley power module. You see these static inverter output parameters when you put the AC meter selector to the INV position:

- Frequency (CPS FREQ)
- Voltage (AC VOLTS).

A static inverter failure causes the amber ELEC light to come on. This light means that the electrical meters, battery, and galley power module has found a fault in the system and you must do a BITE test.

Other electricaL system failures will also cause the ELEC light to come on. See the electrical power - general section for more information about the light and BITE functions of the electrical meters, battery, and galley power module. (SECTION 24-00)

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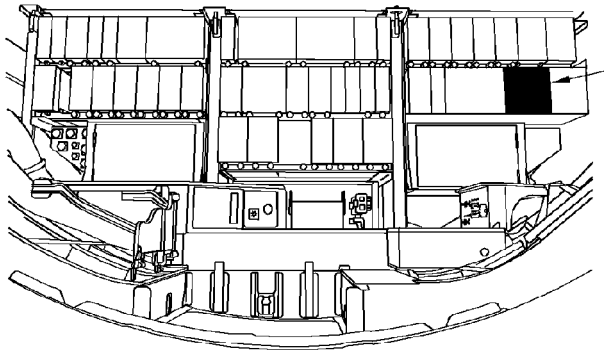
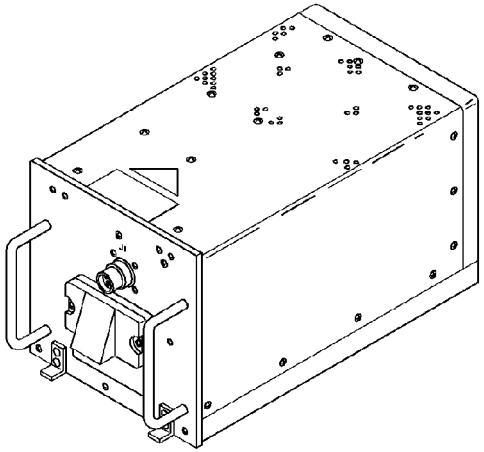
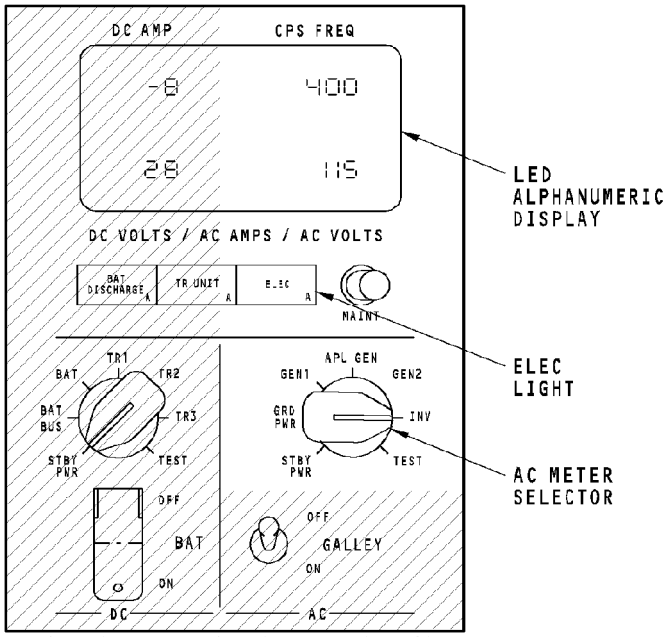


TRANSVERSE RACK, EE COMPARTMENT
(FORWARD LOOKING AFT)



STATIC INVERTER



ELECTRICAL METERS, BATTERY, AND GALLEY
POWER MODULE (P5)

STANDBY POWER SYSTEM - STATIC INVERTER

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STANDBY POWER SYSTEM - STATIC INVERTER REMOTE CONTROL CIRCUIT BREAKER

Purpose

The static inverter remote control circuit breaker (RCCB) connects battery power to the static inverter.

Location

The RCCB is inside the J9 junction box. The J9 is in the EE compartment, in front of the E2 rack.

General Description

The RCCB closes when the SPCU signals it to close. This lets the static inverter receive power from the battery. The SPCU closes the RCCB when either of these conditions occur:

- The BAT switch to the ON position
- The standby power switch to BAT.

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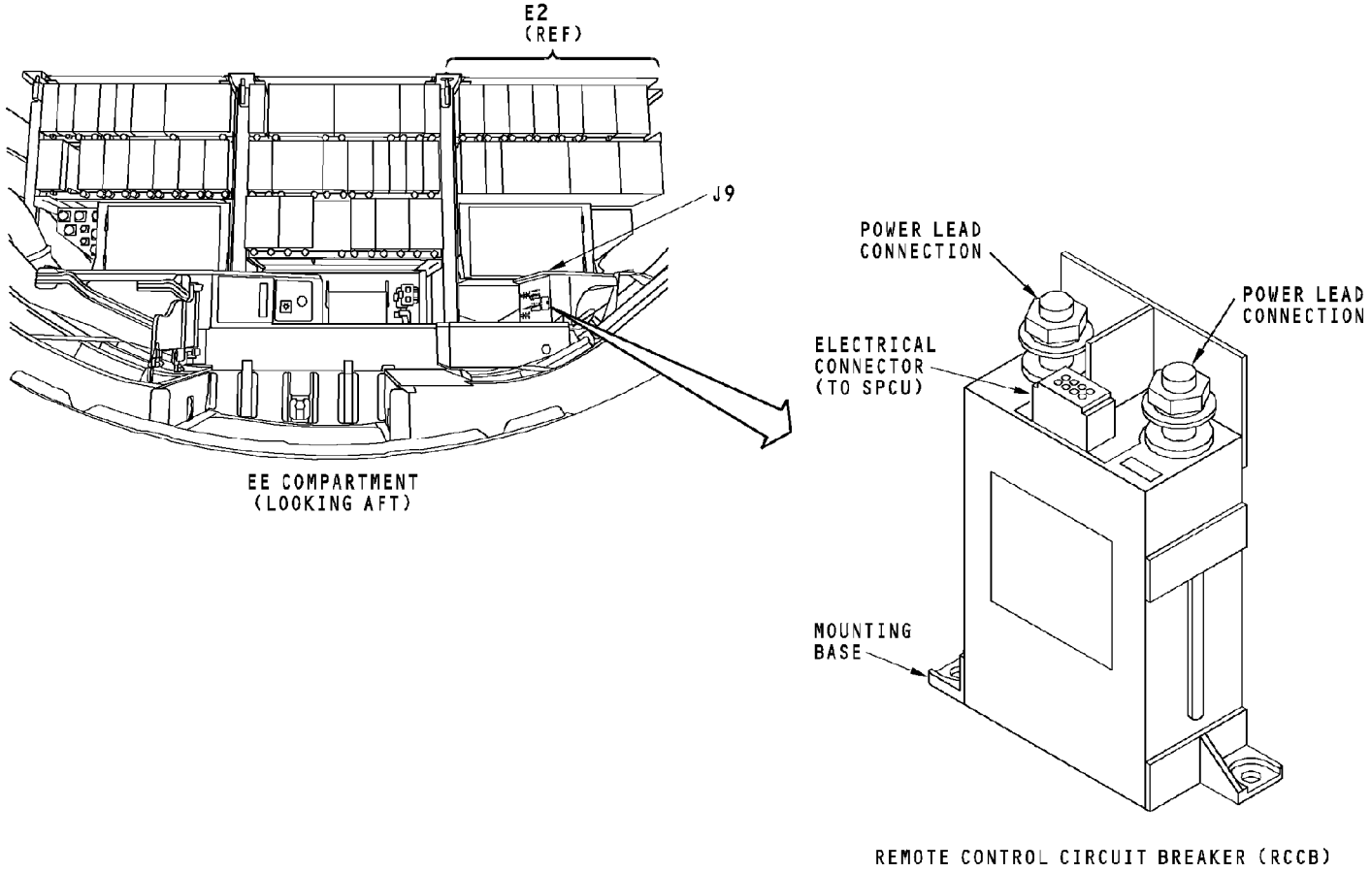

STANDBY POWER SYSTEM - STATIC INVERTER REMOTE CONTROL CIRCUIT BREAKER

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STANDBY POWER SYSTEM - CONTROL - FUNCTIONAL DESCRIPTION

Standby Power

The AC standby bus always has power when the battery switch is in the ON position and the standby power switch is in the AUTO or BAT position. The normal power source of the AC standby bus is the AC transfer bus number 1. The alternate source of power is the hot battery bus and the static inverter. The static inverter uses 24v dc nominal power from the battery and changes it into 115v ac, 400 Hz, single phase power.

The DC standby bus always has power when the battery switch is in the ON position and the standby power switch is in the AUTO or BAT position. The normal source of power for the DC standby bus is DC bus 1. The alternate source of power is the hot battery bus through relay K3.

The standby power system uses these controls:

- Battery switch
- Standby power switch
- Standby power control unit (SPCU).

The standby power system uses these components and relays to give power to the AC and DC standby buses at all times:

- Static inverter
- Remote control circuit breaker (RCCB)
- K5 standby normal relay
- K3 standby alternate relay.

Standby Power Logic

When you close the battery switch, and the standby power switch is in AUTO, the AC and DC standby buses have power. The battery switch signals the SPCU to close the RCCB to give power to the static inverter. The inverter then powers the AC standby bus.

SPCU logic gives power to the AC and DC standby buses. K5 energizes when transfer bus 1 and DC bus 1 both have power to give standby bus power. If either transfer bus 1 or DC bus 1 has no power, K5 opens. In this condition, the static inverter powers the AC standby bus.

The DC standby bus gets power from the hot battery bus when K3 energizes. K3 energizes when all of these are true:

- Battery switch to ON position
- Standby power switch to AUTO
- AC transfer bus 1 and/or DC bus 1 does not have power.

K3 also energizes when the standby power switch is in the BAT position. This occurs with the battery switch in either position.

The standby power switch in the OFF position keeps power off of the AC and DC standby buses. The RCCB, K3, and K5 get no signals and no power goes to the standby buses.

The SPCU has these other relays that control DC power:

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- Battery bus normal relay (K2)
- Battery bus alternate relay (K1)
- Switched hot battery bus relay (K8).

See the DC generation section for more information about these relays. (SECTION 24-30)

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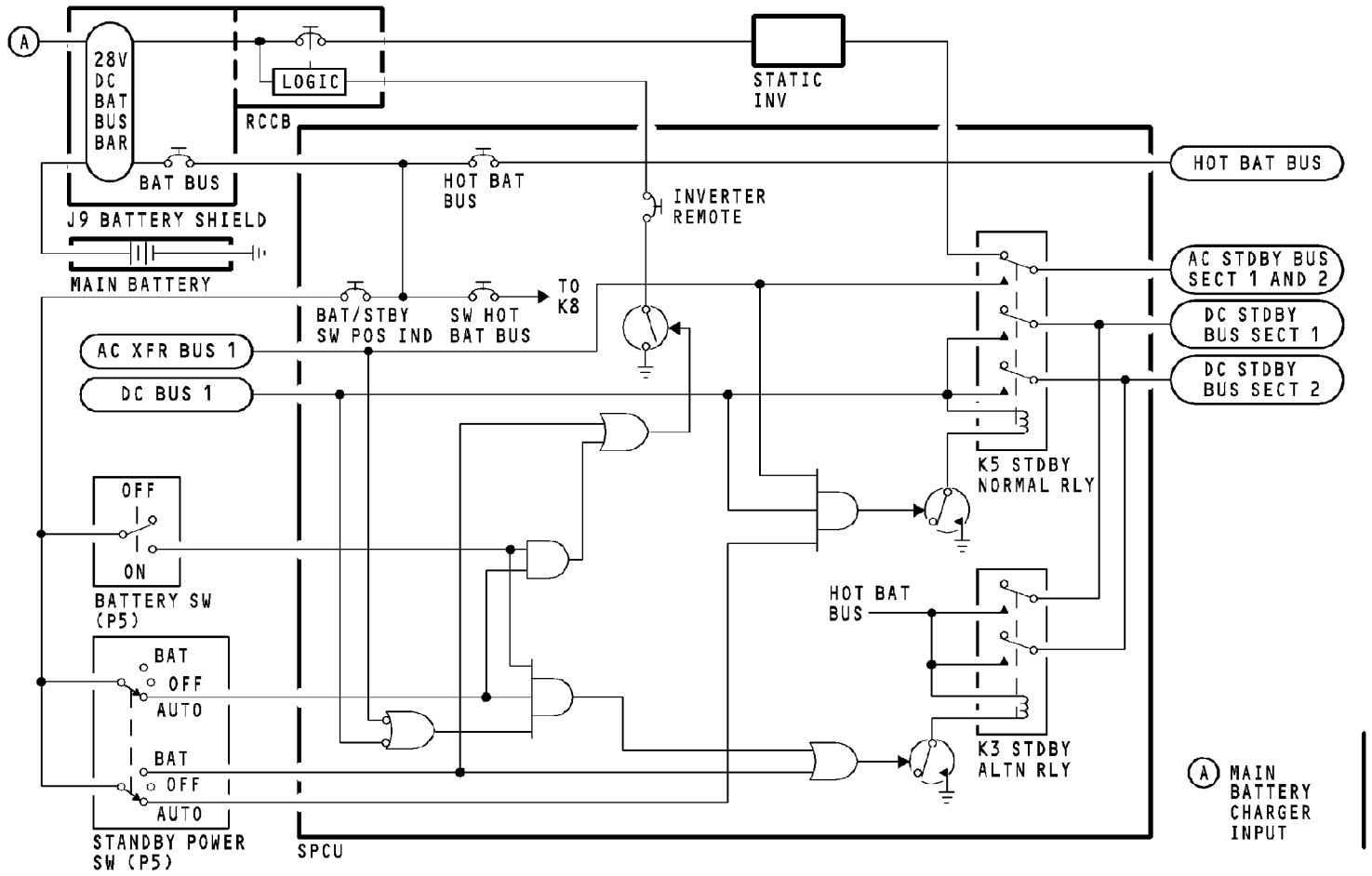

STANDBY POWER SYSTEM - CONTROL - FUNCTIONAL DESCRIPTION

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STANDBY POWER SYSTEM - INDICATION - FUNCTIONAL DESCRIPTION

General

The STANDBY PWR OFF light shows that the standby power system buses have no power. The ELEC light comes on to show that the standby power system has a failure.

STANDBY PWR OFF Light

The STANDBY PWR OFF light is on the generator drive and standby power module (P5-5). This amber light comes on when one of these buses have a low voltage condition:

- AC standby bus
- DC standby bus
- Battery bus.

The electrical meters, APU and galley power module (P5-13) has circuits which monitor the voltage at these buses for low voltage conditions.

An AC low voltage condition happens when the voltage at the AC standby bus goes below 100 v AC for more than two seconds.

A DC low voltage condition happens when the bus voltage goes below 17.5v dc for more than two seconds.

The P5-13 supplies the electrical ground for the STANDBY PWR OFF light. The master caution and the ELEC annunciator on the P7 panel also come on.

ELEC Light

The ELEC light is on the P5-13 module. This amber light comes on when the module finds a failure in the electrical system or an internal failure. The master caution and the ELEC annunciator also come on.

The SPCU monitors components of the standby power system. The SPCU causes the ELEC light to come on if any of these conditions are true:

- Internal SPCU relay fails
- SPCU power supply fails
- SPCU internal circuit card fails
- Static inverter voltage output is below 100 v AC for more than two seconds, and there is a static inverter on command from the SPCU control logic.

The SPCU internal relays are important components of the electrical system distribution. These are the internal relays that the SPCU monitors:

- Battery bus alternate (K1)
- Battery bus normal (K2)
- Switched hot battery bus (K8)
- Standby DC alternate (K3)
- Standby normal (K5).

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You use the MAINT switch to show messages for the fault that causes the ELEC light. The messages show on the module LED alphanumeric display. See section 24-00 for more information about the P5-13 Built-in-test equipment (BITE). (SECTION 24-00)

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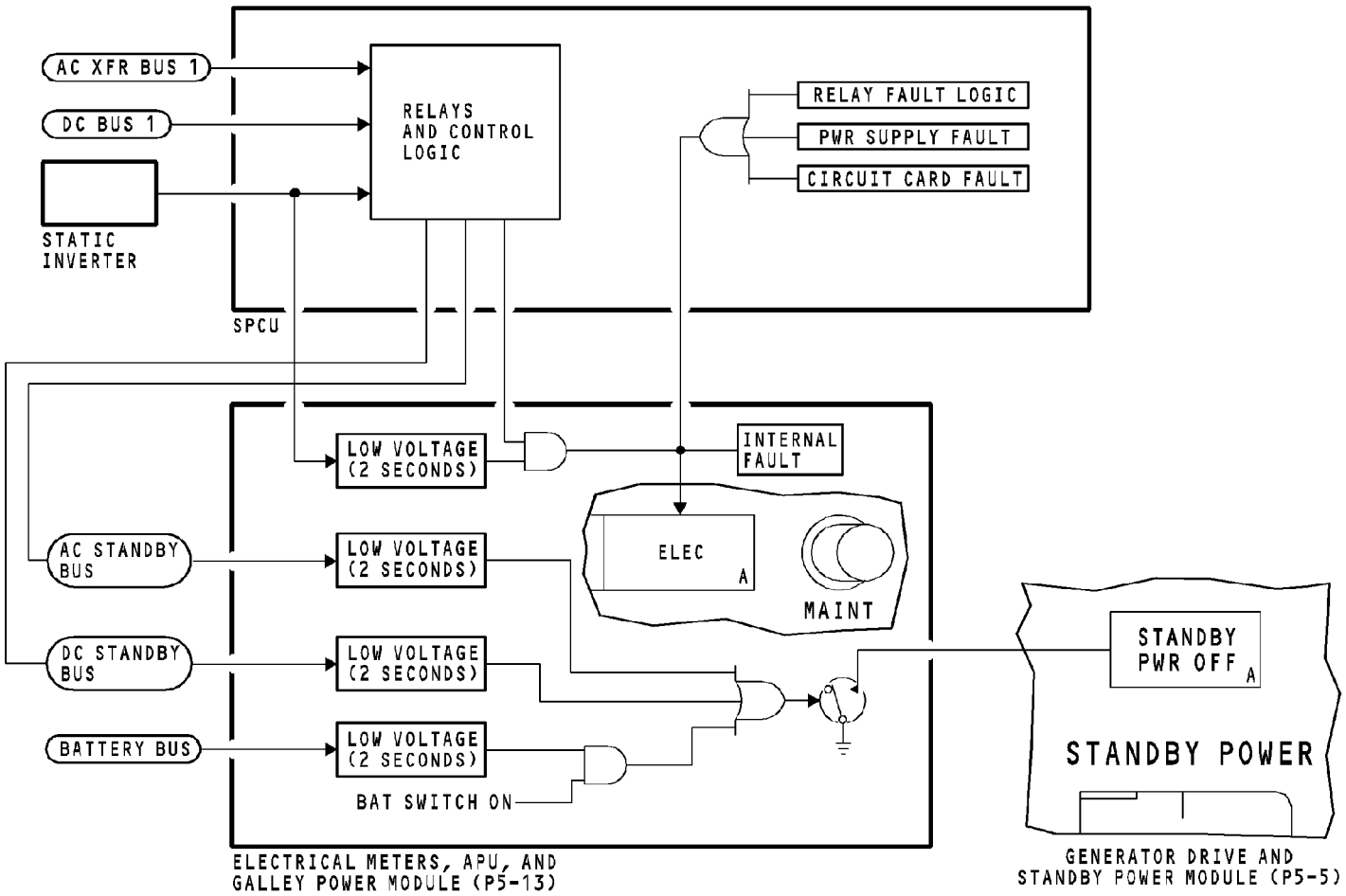

STANDBY POWER SYSTEM - INDICATION - FUNCTIONAL DESCRIPTION

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EXTERNAL POWER - INTRODUCTION

Purpose

External power is the usual source of AC power for the airplane electrical system when the airplane is on the ground.

General

The external power source supplies AC power to the airplane. The airplane electrical components change the AC power to DC power.

External power has these components:

- External power receptacle
- External power contactor (EPC)
- Bus power control unit (BPCU).

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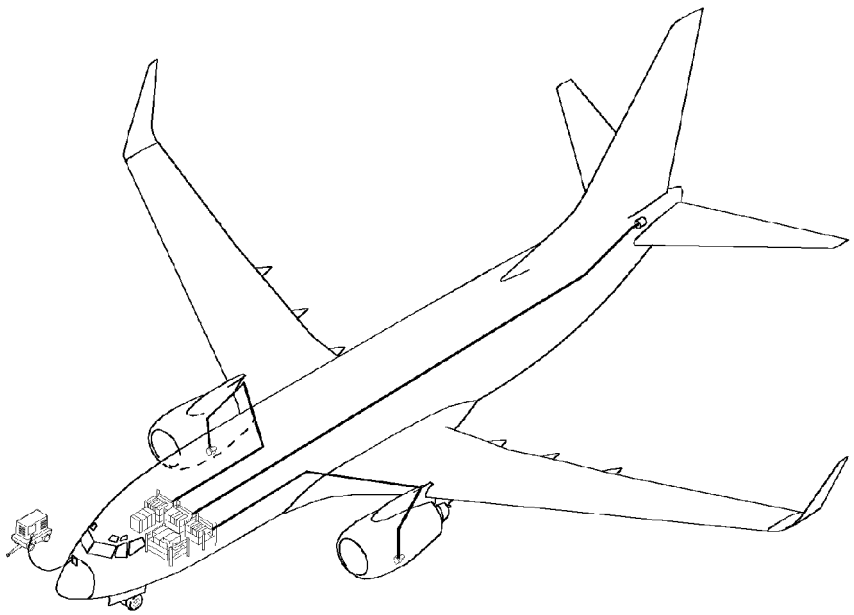

EXTERNAL POWER - INTRODUCTION

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Purpose

External power is the normal source of AC power for the airplane electrical system when the airplane is on the ground. It lets you have the engines and APU power sources off. It also gives power to the battery charger to charge the battery.

General Description

The bus power control unit (BPCU) uses inputs and internal logic to control distribution of external power on the airplane. The BPCU has built-in test equipment (BITE) to help you do troubleshooting of the external power system.

Switches on the AC system, generator, and APU module and the forward attendant panel give you manual control of external power.

The external power panel and the AC system, generator, and APU module have external power indication.

The external power panel has a receptacle for AC external power connection.

Bus Power Control Unit (BPCU)

The BPCU uses these inputs to control the use of external power:

- External power contactor (EPC) position
- Bus tie breaker (BTB) positions through the generator control units (GCUs)
- Ground service transfer relays (power to AC ground service buses)
- Ground service bus relay (power to ground service DC bus)
- Indication on the AC system, generator, and APU module and the external power panel.

The BPCU also interfaces with other systems. See the BPCU pages in this section for more information.

Manual Control

The ground power switch is on the AC system, generator, and APU module (P5-4).

You use this switch to control external power to the AC transfer buses through the EPC and the BTBs. The BPCU closes the EPC directly. Each BTB closes after it receives a signal from the BPCU through a GCU.

A switch on the forward attendant panel lets you supply power to the AC and DC ground service buses from the external power source. The AC power goes through the two ground service transfer relays. The DC power goes through the ground service bus relay. The BPCU uses input from the forward attendant panel to control the relays.

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Automatic Control (System Protection)

The BPCU uses inputs from the external power current transformer (CT) and feeder lines to monitor external power quality. The BPCU controls the EPC position to protect airplane systems.

The BPCU also removes power to some buses (load shed) to protect the system.

Indication

The BPCU controls external power indication at the AC systems, generator, and APU module and at the external power panel.

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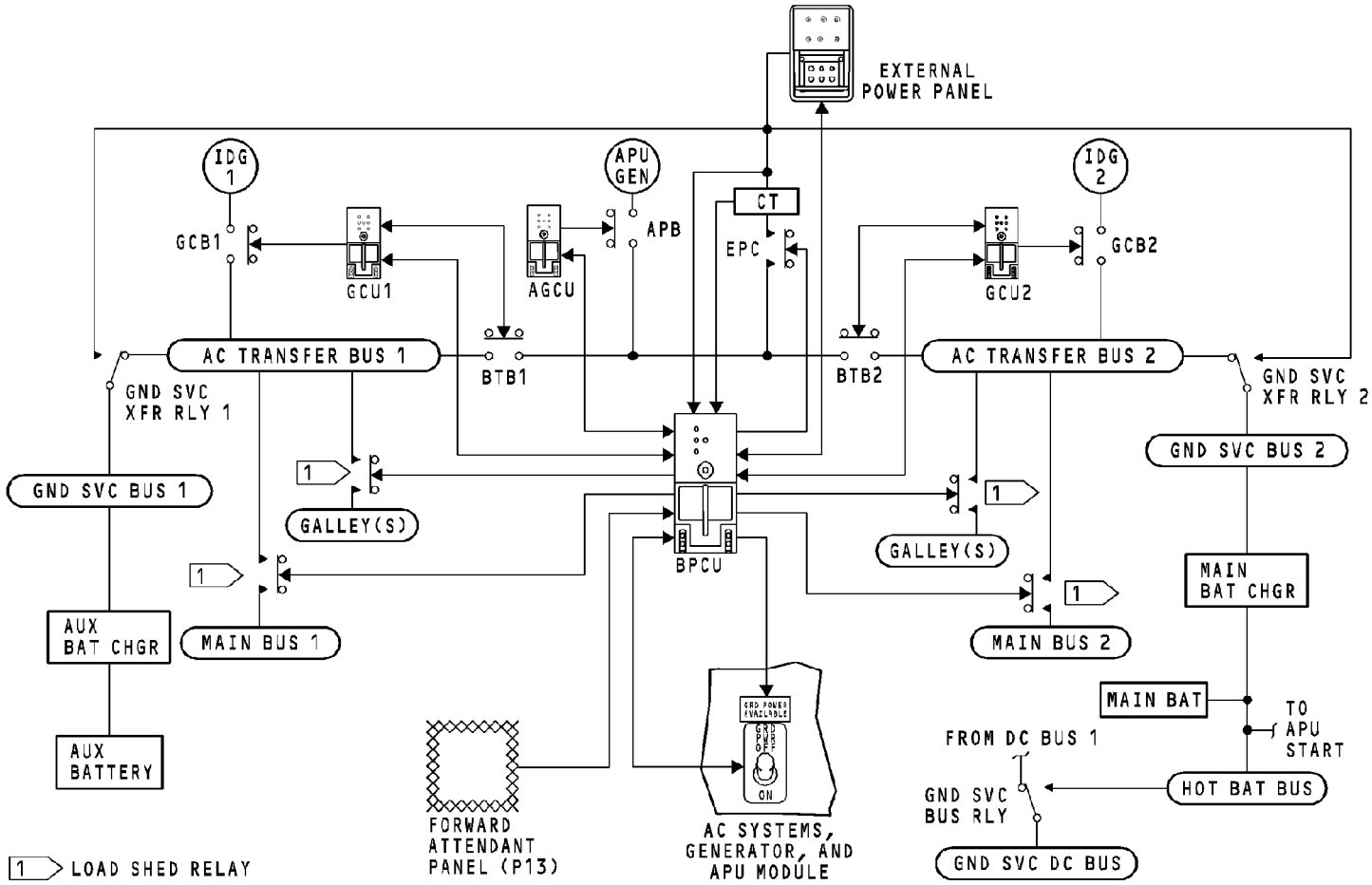

EXTERNAL POWER - GENERAL DESCRIPTION

EFFECTIVITY
HAP ALL

24-40-00

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EXTERNAL POWER - AIRPLANE - COMPONENT LOCATIONS

General

External power components are in the EE compartment and on the right side of the forward fuselage. External power controls are in the flight compartment and at the forward attendant panel.

EE Compartment

The bus power control unit (BPCU) in on the E4 rack. The external power contactor (EPC) is in the power distribution panel 2 (PDP 2).

Flight Compartment

The P5-4 AC systems, generator, and APU module is on the P5 overhead panel. This module gives you manual control and indication of external power.

Forward Attendant Panel

The ground service switch is on the forward attendant panel.

Forward Fuselage

The external power panel and receptacle is on the right side of the fuselage, near the nose of the airplane. The external power source connects to the airplane external power receptacle.

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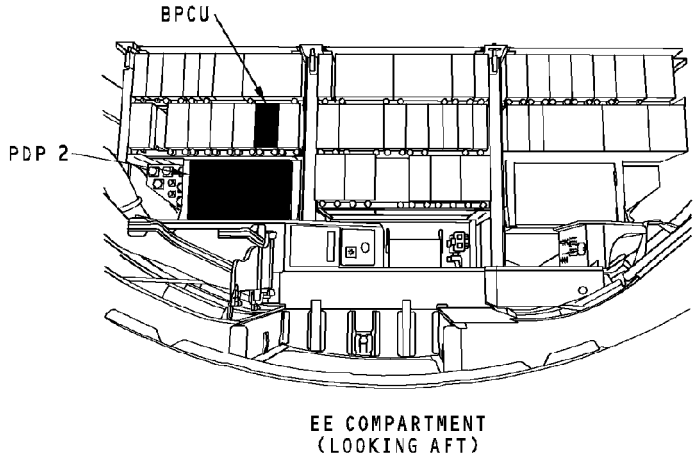

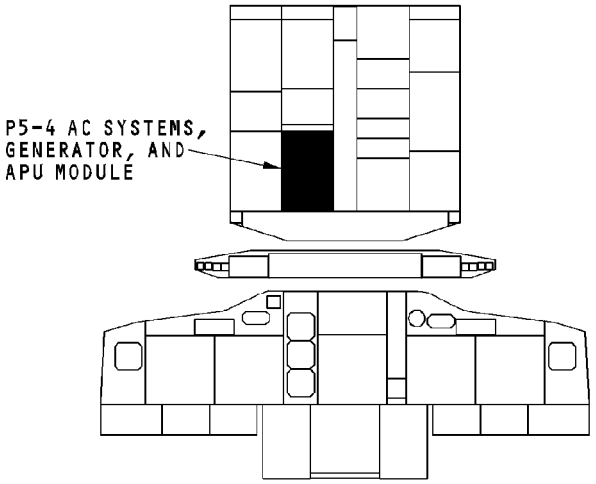

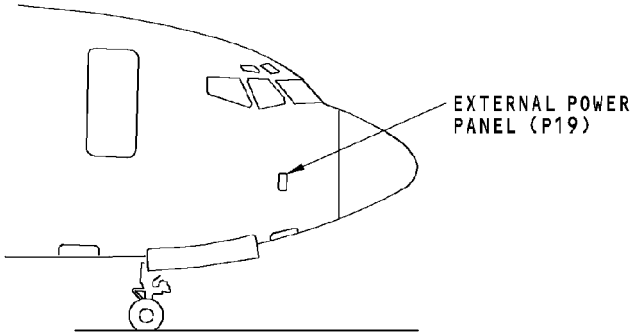

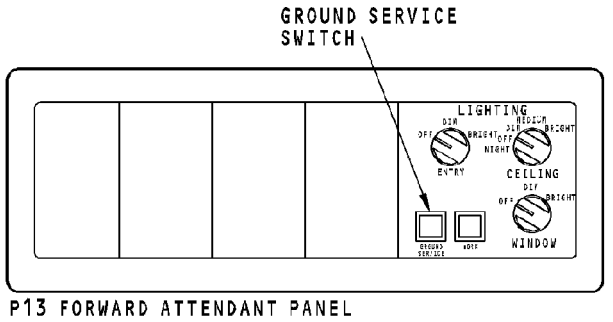

EXTERNAL POWER - AIRPLANE - COMPONENT LOCATIONS

EFFECTIVITY
HAP ALL

24-40-00

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EXTERNAL POWER - EXTERNAL POWER RECEPTACLE

Purpose

The external power panel is the location for external AC power connection and power use indication.

Location

The external power panel is in the right lower portion of the forward fuselage.

General Description

You open the external power panel access door to get access to the panel and the connection. The panel has an external power receptacle and a control and display section.

The control and display section has these components:

- EXTERNAL POWER CONN indicator
- External power NOT IN USE indicator
- FLIGHT INTERPHONE jack
- SERVICE INTERPHONE jack
- PILOT CALL switch
- NOSE WHEEL WELL light control switch.

EXTERNAL POWER CONN Indicator

The amber EXTERNAL POWER CONN indicator comes on when the ground power plug is connected and the ground source is operating.

NOT IN USE Indicator

The white NOT IN USE indicator comes on when these conditions are true:

- External power is available
- The EPC is open
- Both ground service transfer relays are de-energized.

FLIGHT INTERPHONE Jack

You use the flight interphone jack to talk with only the flight compartment. You use this jack when it is important that no other person talks over your communication.

See the flight interphone section for more information. (SECTION 23-51)

SERVICE INTERPHONE Jack

You use the service interphone jack to talk with other areas inside and outside the airplane. Many people can use this at the same time.

See the service interphone section for more information. (SECTION 23-41)

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PILOT CALL Switch

You use the PILOT CALL switch to operate a bell in the flight compartment. This alerts a person in the flight compartment to talk with you.

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

NOSE WHEEL WELL Light Control Switch

You use this switch to turn on the lights in the wheel well.

See the lighting chapter for more information. (CHAPTER 33)

External Power Receptacle

The external power receptacle has these six pins:

- Three pins for each AC power phase (pins A, B, C)
- One pin for ground (pin N)
- Two short pins for BPCU interlock logic (pins E, F).

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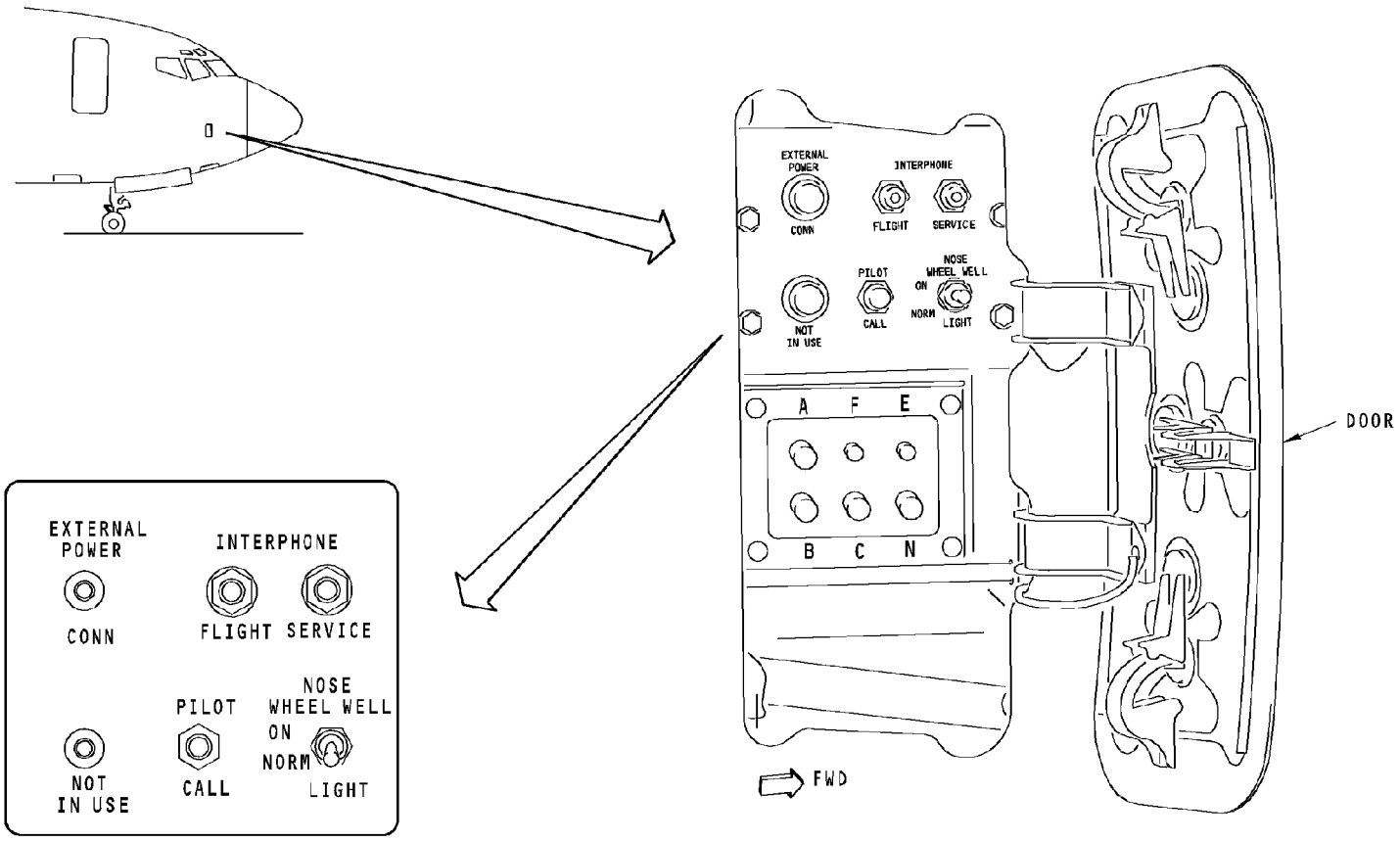

P19 EXTERNAL POWER PANEL

EXTERNAL POWER - EXTERNAL POWER RECEPTACLE

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EXTERNAL POWER - EXTERNAL POWER CONTACTOR

Purpose

The external power contactor (EPC) connects 115v ac, 400 Hz, 3 phase external power to the tie bus.

Location

The EPC is in power distribution panel 2 (PDP 2).

General Description

The contactor mechanism has a close coil and a hold coil. After the EPC closes, switches inside the contactor change position and remove power to the close coil. The hold coil keeps the contactor in the closed position.

The contactor has two types of contacts: primary and auxiliary. The primary contacts allow power from the external power source to the bus tie breakers (BTBs). The auxiliary contacts have these functions:

- EPC position control
- EPC position feedback to BPCU
- Bus power indication on the P5 panel.

Electrical power keeps the EPC in the closed position. The EPC opens when this power goes away.

Training Information Point

The EPC looks like the generator breakers and bus tie breakers. However, the EPC has a different part number and operates differently. The EPC and the breakers have a placard which identifies it.

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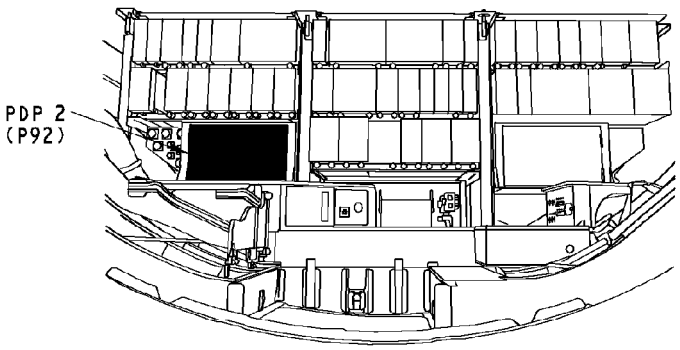
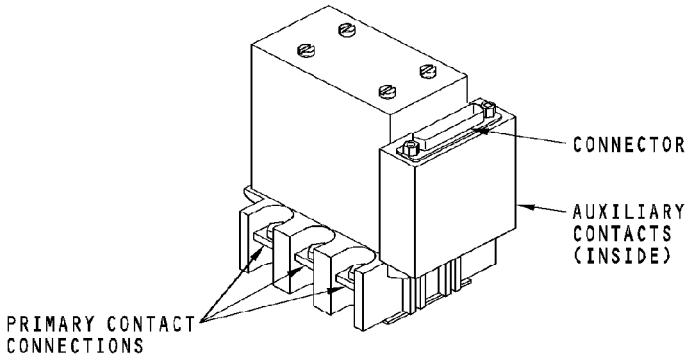
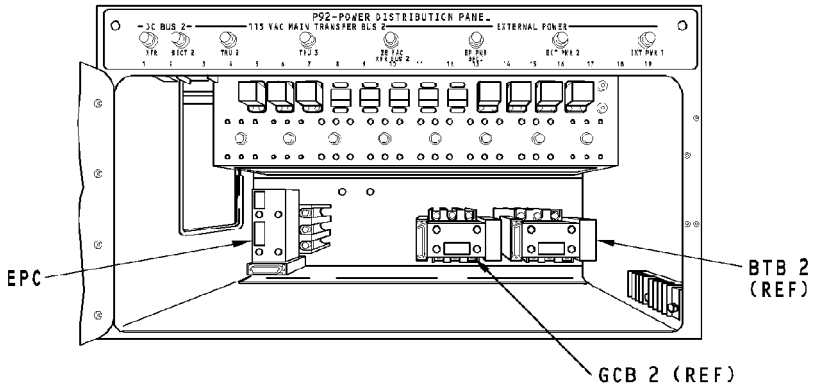


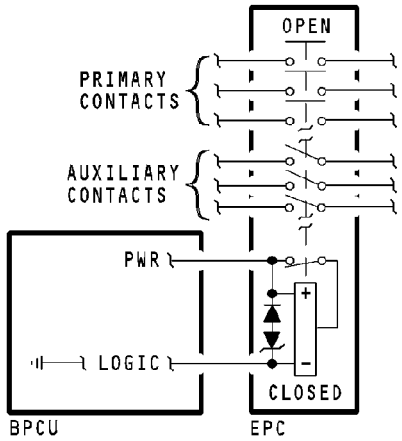
TRANSVERSE RACK, EE COMPARTMENT
(LOOKING AFT)



EXTERNAL POWER CONTACTOR



POWER DISTRIBUTION PANEL 2 (P92)
(FRONT PANEL OPEN)



SIMPLE SCHEMATIC
(TYPICAL)

EXTERNAL POWER - EXTERNAL POWER CONTACTOR

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EXTERNAL POWER - BUS POWER CONTROL UNIT (BPCU) - GENERAL DESCRIPTION

Bus Power Control Unit

The bus power control unit (BPCU) supplies these functions:

- External power contactor (EPC) control
- AC distribution bus protection
- External power monitoring and protection
- Flight compartment indication
- Bus and galley load shed
- Ground service power source control
- Refueling station power
- Built-in test equipment for fault isolation.

The BPCU coordinates the operation of the full AC power system in normal and abnormal conditions. To do this, the BPCU uses its inputs from components and other control units. Fail-safe functions are in the system to allow power distribution if the BPCU fails.

BPCU Power Supplies

The BPCU gets power from these three sources:

- External three-phase AC power
- 28v dc from the battery
- 28v dc from DC bus 1.

BPCU Inputs

The BPCU receives these inputs:

- Ground power switch position
- Bus transfer switch position
- Line voltage at a point between the external power panel and the EPC
- Signal from the current transformer (CT) that is proportional to the current flow through the feeder wires
- Continuity circuit through pins E and F at the external power panel (interlock)
- Bus tie breaker 1 (BTB 1) and BTB 2 positions
- Generator control breaker 1 (GCB 1) and GCB 2 positions
- Auxiliary power breaker (APB) position
- Air/ground
- Ground service relays position
- Ground service switch position
- EPC position
- APU generator switch positions (from AGCU)
- Source off signals from GCUs
- Autoland signal from flight control computers (FCCs).

AIRPLANES WITH GALLEY SWITCH;

- Galley switch position

AIRPLANES WITH CAB/UTIL AND IFE/PASS SEATS SWITCHES;

- Cab/Util switch position
- IFE/Pass Seats switch position

BPCU Outputs

The BPCU supplies these outputs:

- GRD PWR AVAILABLE indication on the P5-4 module
- Indication at external power panel (P19)

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- Close command to EPC
- Power to refueling relay
- BTB close command (through GCUs)
- Breaker open command (through GCUs)
- APB hold off command
- BPCU fail-safe command to GCUs
- APU configuration load shed information to APU electronic control unit (ECU)
- Load shed (to galley and main bus load shed relays)
- Ground service relays.

Protection

The BPCU uses inputs to monitor the electrical system. If necessary, the BPCU removes loads from some buses (load shed) to protect the system. The BPCU opens the EPC if the problem continues. See the EPC control and protection page in this section for more information.

BPCU Fail-Safe

The BPCU has protection to fail-safe the power channel if the BPCU loses control or protection capability. A signal goes to the GCU of the power channel. A fail-safe condition will do these functions:

- Open the EPC
- Make the NOT IN USE light on the external power panel go off
- Make the GRD PWR AVAILABLE light on the P5 panel go off
- Remove power to the galleys and main buses
- The BPCU sends a fail-safe signal to GCU 2. GCU 1 signal has 200 millisecond time-delay
- GCU 2 closes BTB 2 if the BUS TIE is de-energized
- GCU 1 closes BTB 1 if transfer bus 1 needs power
- Apply APU power manually if the tie bus is de-energized
- Make the BPCU FAULT light on the face of the BPCU come on
- Prevent the operation of the fueling power control relay (R11).

Built-In Test Equipment (BITE)

The BPCU has BITE to help you do troubleshooting of the external power system. See the TRAINING INFORMATION POINT page in this section for more information.

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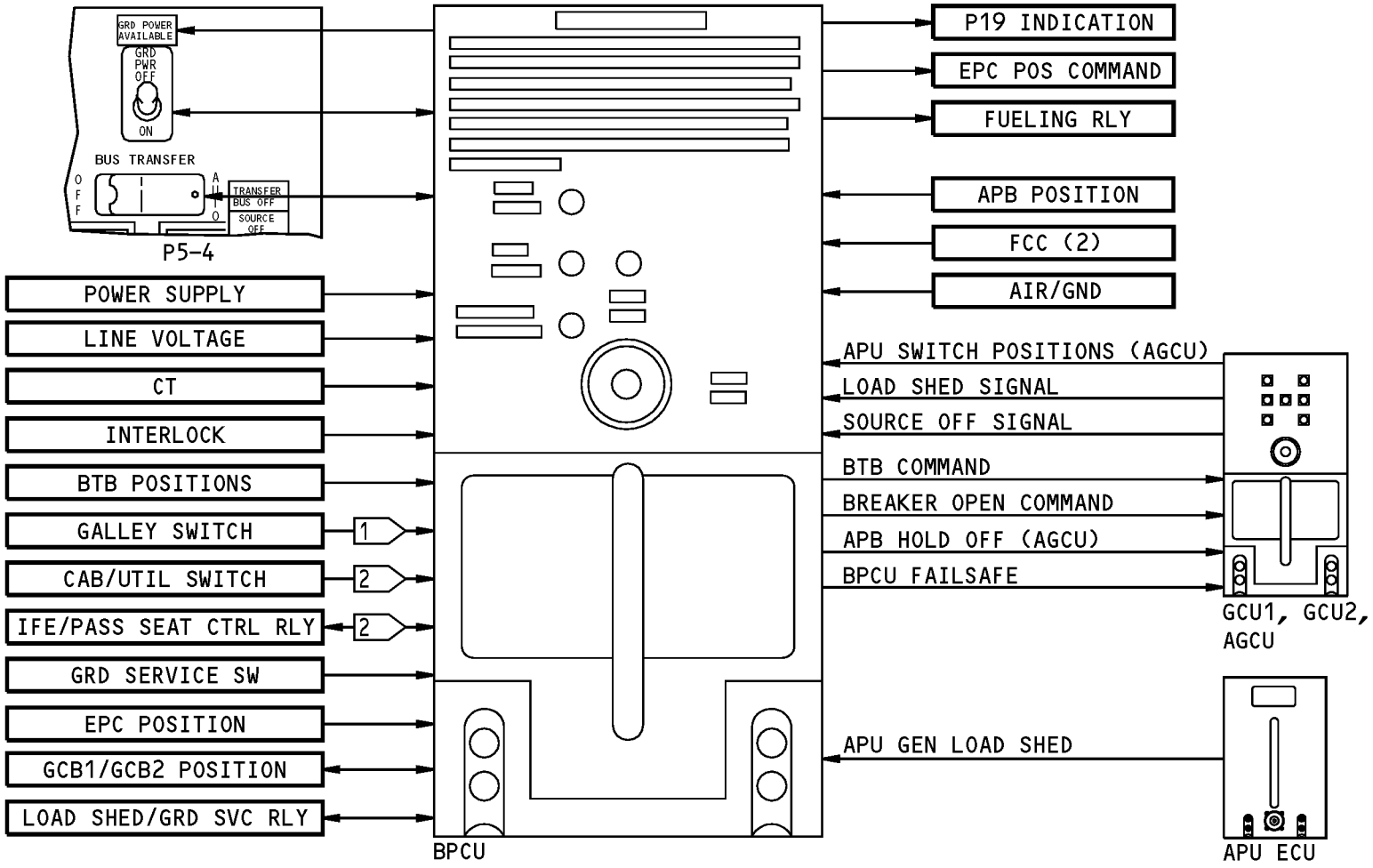

1 AIRPLANES WITH GALLEY SWITCH

2 AIRPLANES WITH CAB/UTIL AND IFE/PASS SWITCHES

EXTERNAL POWER - BUS POWER CONTROL UNIT (BPCU) - GENERAL DESCRIPTION

EFFECTIVITY

HAP ALL

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Control

The BPCU closes the EPC when all of these occur:

- Ground power switch on P5 is in the ON position
- External power quality has correct voltage and frequency
- The interlock pins (EF) have continuity
- No protective functions occur
- There is no power between the BTBs.

The EPC opens if any one of these occur:

- Quality of external power is bad
- Ground power switch is put to OFF position
- A protective function occurs
- You remove the external power plug
- The interlock pins do not have continuity
- Another power source selection trips (opens) the EPC.

Protection

The BPCU protects the external power channel and isolates the channel if a failure occurs. The BPCU monitors these parameters of external power:

- Current
- Voltage
- Frequency.

Current Protection

The BPCU has protection logic for these types of current faults:

- Overcurrent
- Unbalanced phase current
- Phase sequence.

The BPCU opens bus tie breaker 2 (BTB 2) if there is an overcurrent condition. The BPCU then opens BTB 1 if the condition continues. Finally, the BPCU opens the EPC if there is still an overcurrent condition.

The EPC opens if the BPCU finds an unbalanced phase current condition. The BPCU will not close the EPC if a phase sequence fault is true.

The BPCU also uses current information to remove power (load shed) to the galley and main buses. See the AC Electrical Load Distribution section for more information. (SECTION 24-50)

Voltage Protection

The BPCU has protection logic for these types of voltage faults:

- Overvoltage (high voltage)
- Undervoltage (low voltage)
- External power plug fault.

The BPCU opens the EPC if an overvoltage or undervoltage condition happens. The BPCU will not let the EPC close if there is an overvoltage or undervoltage condition.

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The BPCU monitors the voltage and polarity at pins E and F of the external power panel. The BPCU opens the EPC or prevents the EPC from closing if there is a fault condition.

Frequency Protection

The BPCU opens the EPC or prevents the EPC from closing if there is an under frequency (low frequency) condition.

The BPCU opens the EPC or prevents the EPC from closing if an there is an over frequency (high frequency) condition.

Indication

The blue GRD POWER AVAILABLE light comes on to show the external power is connected and power quality is in limits. The BPCU supplies power for the light. The light comes on for these conditions:

- There is continuity through pins E and F at the external power connection
- Connected external power quality is in limits.

The amber CONN light comes on to show that external power is connected. The light is not an indication that power quality is good. The light is neon and receives AC power directly from the external power feeder lines in P92 PDP 2.

The white NOT IN USE light comes on to show that the ground service buses and transfer buses do not receive power from the external power source. The light comes on when these conditions are true:

- Continuity through pins E and F (external power plug connected)
- Ground service relays are de-energized, and
- EPC is open.

Interfaces

The R47 external power sensing relay energizes to supply entry way lighting to the passenger entry door areas. This relay receives power from the BPCU.

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

The refueling power control relay (R11) energizes to supply power to the fueling station. This relay receives power from the BPCU.

See the Pressure Refueling section for more information about the pressure refueling system. (SECTION 28-21)

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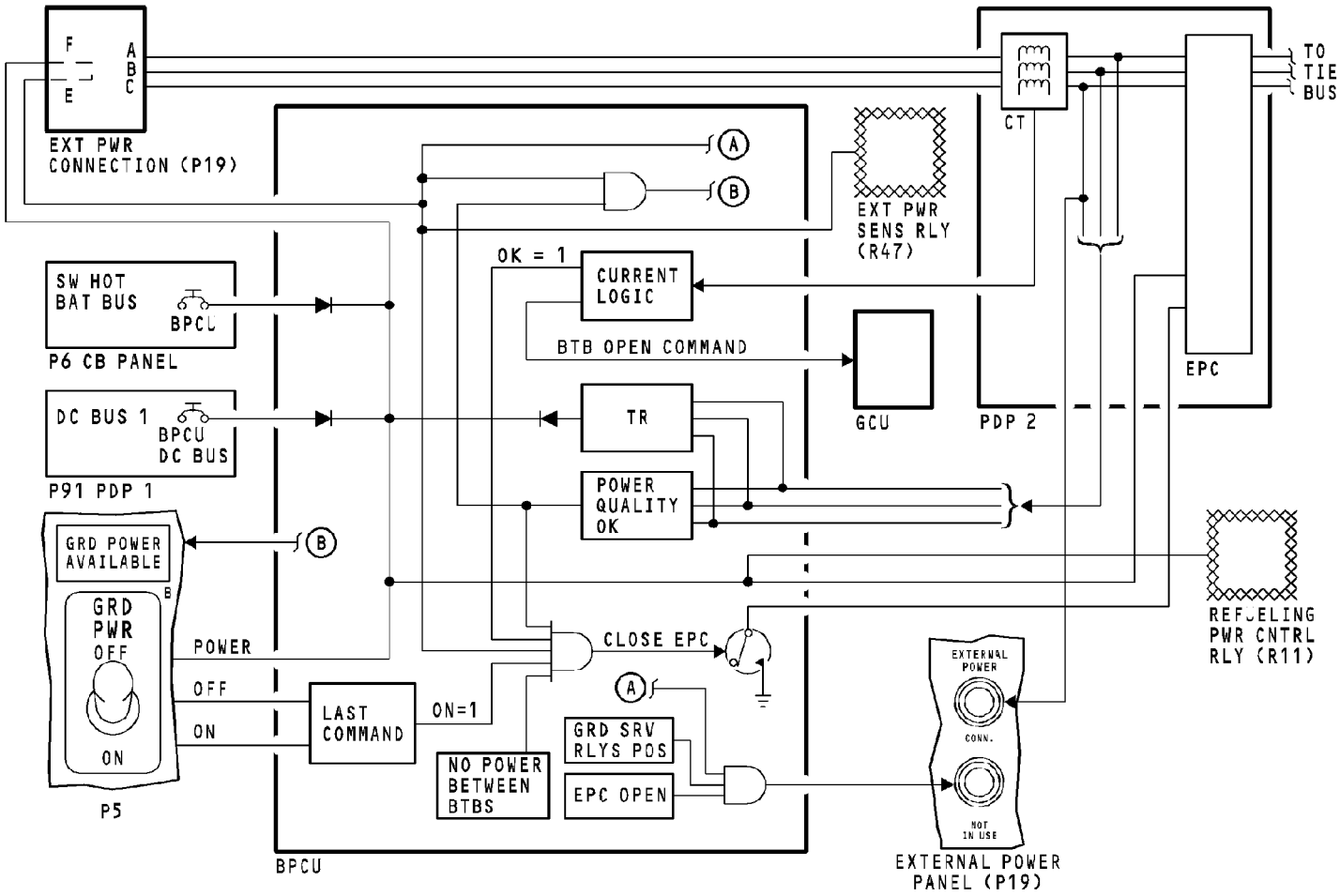

EXTERNAL POWER - BPCU - EXTERNAL POWER CONTROL, PROTECTION, AND INDICATION

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Built-In Test Equipment

The BPCU BITE helps you isolate faults with the external power circuit. The BPCU BITE operates independently of the normal control and protective circuits. The BPCU has these BITE functions:

- Detects and identifies failures in the external power channel
- Saves fault information in its non-volatile memory
- Shows fault information on the front of the BPCU (indicator lights)
- Does a self test of the BPCU circuits at power-up and when you push the TEST switch on the front of the BPCU.

The BPCU BITE has these three operating modes:

- Continuous monitoring
- Protective faults
- Self-test.

BITE Front Panel Display

The BITE front panel display has a TEST switch and four lights. You use the test switch to turn off any fault lights and to do a test of the BPCU. The BPCU FAULT and BPCU PASS lights are the only lights that come on at the end of the self test.

During continuous monitoring and protective fault modes, only one fault light comes on at a time. There is a priority if the BPCU see two faults at the same time. This is the priority for the lights:

- BPCU FAULT
- EP DIST/BUS FAULT
- EPC FAULT
- BPCU PASS (green).

Monitor FAULT

Monitor BITE compares cause and effect relationships to find out if there is a fault condition. After a protective action occurs, the monitor BITE isolates the fault. The monitor BITE is continuous when the BPCU has power. Monitor BITE isolates faults to one of these:

- BPCU FAULT
- EP DIST/BUS FAULT
- EPC FAULT.

Protective Fault BITE

Protective fault BITE occurs when a fault condition makes the ground service relays or the EPC open.

Protective fault BITE isolates faults to these:

- External power
- The tie bus
- The transfer buses.

You must do a self-test BITE after fault isolation to make sure the fault is gone. The BPCU shows the fault by an EP DIST/BUS FAULT (red) light.

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Self-Test BITE

Self-test BITE looks for BPCU passive circuit malfunctions. Self-test BITE isolates faults to the BPCU and shows this by a BPCU FAULT (red) light.

You push the BPCU TEST switch to do a manual self test. When the test occurs, all lights come on for 3 seconds. Then all the lights go off. If there are no BPCU faults, the green BPCU PASS light comes on for 7 seconds. The red BPCU FAULT light comes on if it finds and internal fault. Any previous fault lights that were on go off at the start of this test and do not come on until the BPCU finds the fault again.

Self-test BITE is automatic when the BPCU receives power and the airplane is on the ground. No lights come on if the test passes. If the BPCU finds faults, the red BPCU FAULT light comes on, and previously latched faults are reset.

EPC FAULT

The BPCU EPC fault (red) light monitors the voltage of the EPC close signal and the position status of the EPC. The EPC fault light comes on if the position does not match the commanded position.

BPCU DIST/BUS FAULT

The BPCU monitors internal protective functions. The EP DIST/ BUS FAULT light comes on when the BPCU opens the EPC, BTB1, BTB2 for any of these faults:

- Overcurrent
- Unbalanced phase current.

BPCU FAULT

The BPCU FAULT light comes on if the BPCU fails a self test BITE or the BPCU goes into fail-safe protection.

BPCU PASS

The BPCU PASS light (green) comes on when you push the TEST switch and the BPCU is good.

BPCU Test Switch

You push the BPCU test switch to make the BPCU do a self test. The test turns off any fault light that is on before the test. The fault light will come back on when the conditions that made the light come on are true again. Not like the GCU, the BPCU responds to the test switch if it's associated AC power source (external power) is on the airplane.

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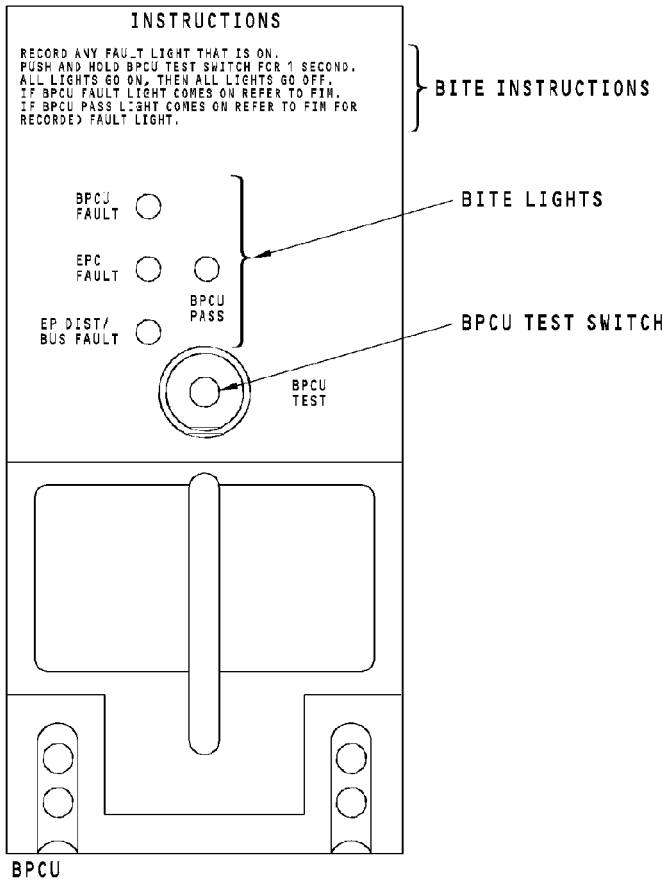

EXTERNAL POWER - BPCU - TRAINING INFORMATION POINT

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AC ELECTRICAL LOAD DISTRIBUTION - INTRODUCTION

General

The distribution section of electrical power includes AC and DC power distribution.

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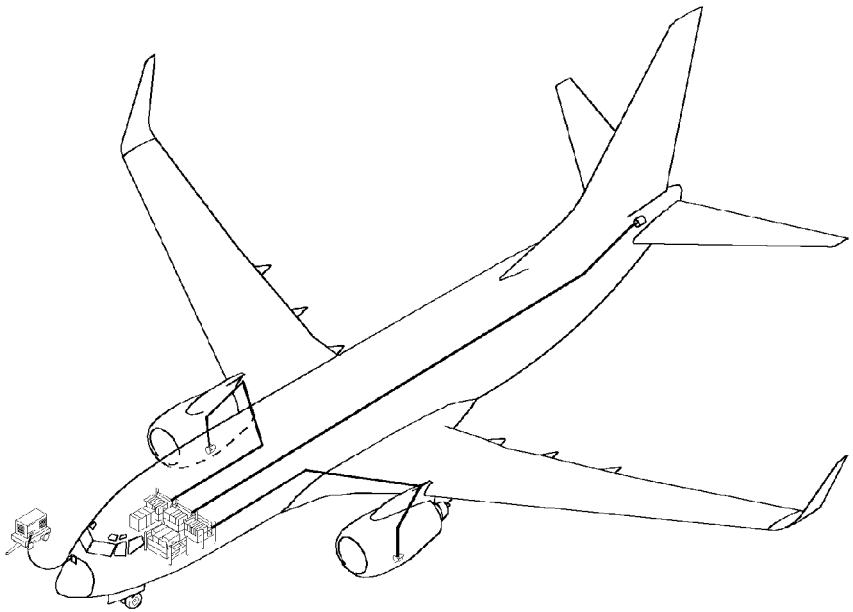

AC ELECTRICAL LOAD DISTRIBUTION - INTRODUCTION

EFFECTIVITY
HAP ALL

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AC ELECTRICAL LOAD DISTRIBUTION - GENERAL DESCRIPTION

General

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

These are the AC power sources:

- Integrated drive generator 1 (IDG 1)
- IDG 2
- APU starter-generator
- AC external power
- Static inverter.

These are the control units that control electrical power distribution:

- Generator control unit 1 (GCU 1)
- GCU 2
- APU generator control unit (AGCU)
- Bus power control unit (BPCU)
- Standby power control unit (SPCU).

See the AC generation section for more information about the GCUs. (SECTION 24-20)

See the external power section for more information about the BPCU. (SECTION 24-40)

See the DC generation section for more information about the SPCU. (SECTION 24-30)

The relays, breakers, and buses that distribute electrical power are in these panels:

- Power distribution panels (PDPs)
- P6 panel
- P18 panel.

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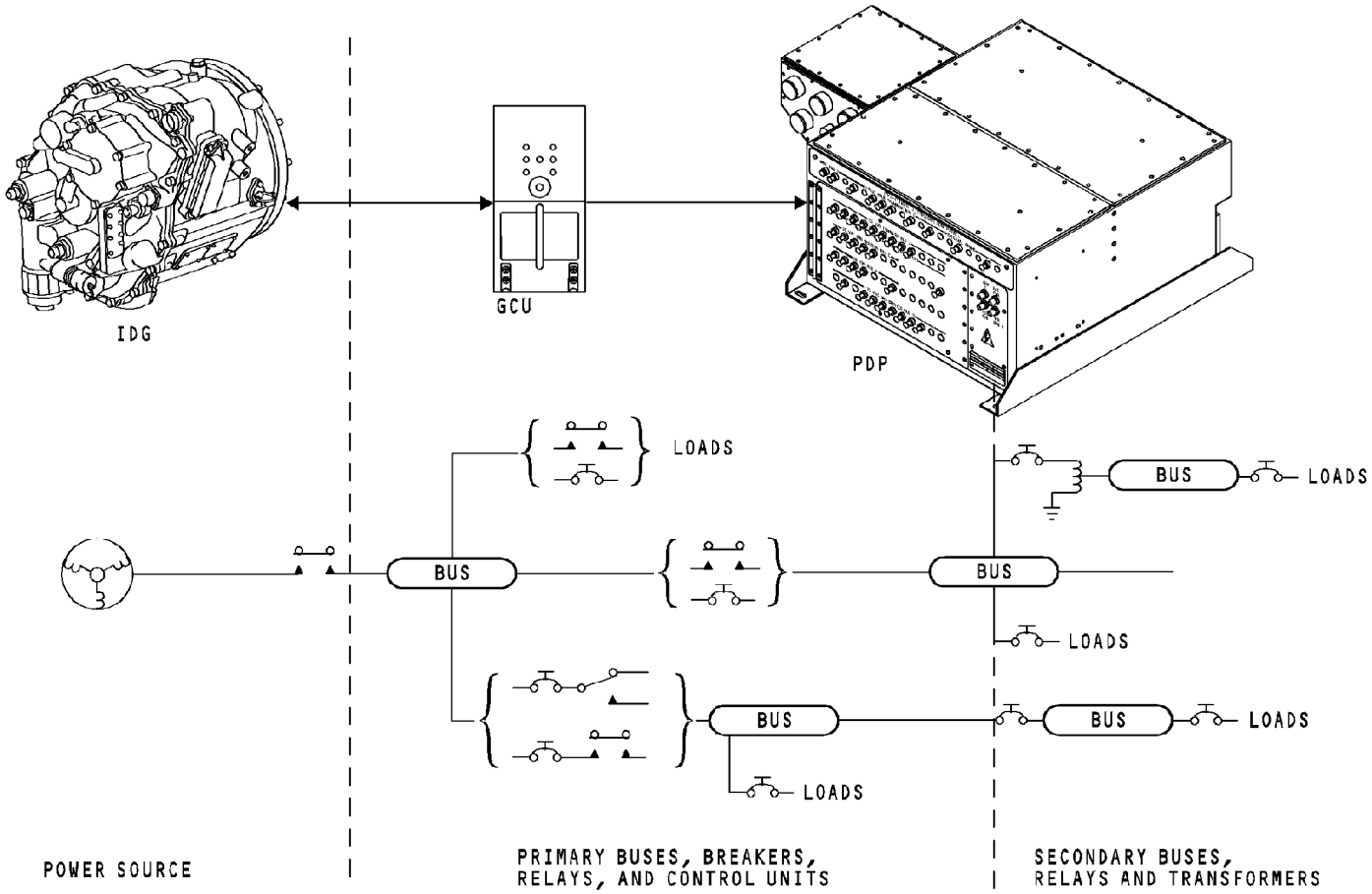

AC ELECTRICAL LOAD DISTRIBUTION - GENERAL DESCRIPTION

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AC ELECTRICAL LOAD DISTRIBUTION - LOAD SHED RELAY

Purpose

The load shed relays control power to the main buses and the galley buses to protect the power source from overload.

Location

The load shed relays are in the aft part of each power distribution panel (PDP). You remove panels in the forward cargo compartment to get access to the aft face of the PDPs. You then remove panels on the PDPs to get access to the load shed relays.

General Description

The bus power control unit (BPCU) controls the load shed relays. The load shed relays open when the BPCU de-energizes them.

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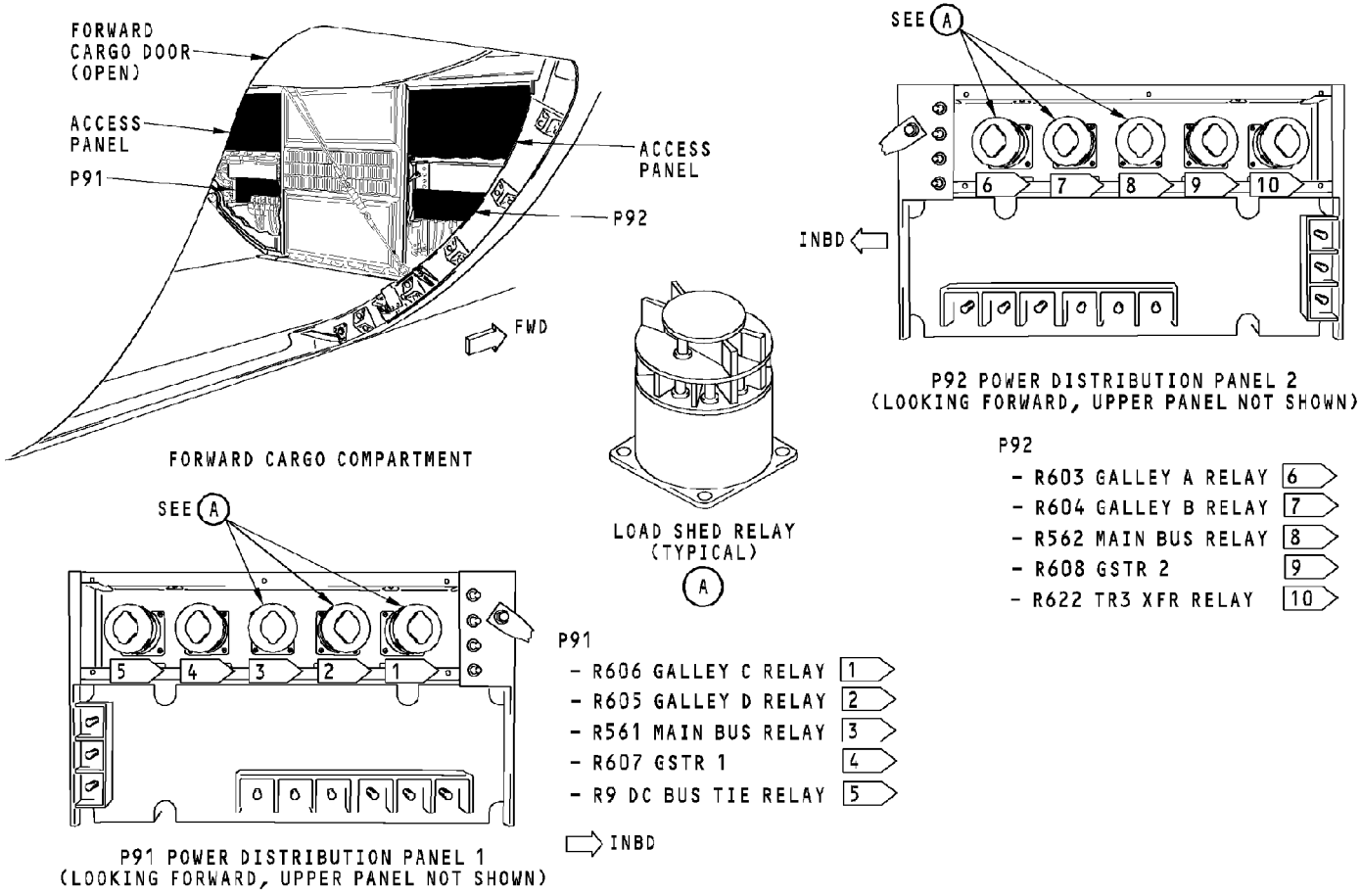

AC ELECTRICAL LOAD DISTRIBUTION - LOAD SHED RELAY

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General

The BPCU automatically removes power (load shed) to the galley buses and sometimes the main buses to protect the power source from overload. There are three types of load shed:

- Configuration
- Command
- Overcurrent.

Configuration Load Shed

Configuration load shed occurs when the APU is the only source of AC power in flight. The BPCU opens (de-energizes) all galley load shed relays. Air/ground inputs come from the proximity switch electronics unit (PSEU). AC power is provided by the BPCU to the PSEU for the air or ground modes.

Command Load Shed

This type of load shed occurs for the APU starter-generator only. The command load shed occurs when the APU electronic control unit (ECU) senses APU high EGT. The APU ECU monitors APU performance parameters to determine a possible overload condition.

The ECU sends an APU load shed signal to the BPCU. The galley load shed relays open first. The main bus relays will open if the overload condition continues.

Overcurrent Load Shed

Overcurrent load shed occurs when a generator control unit (GCU or AGCU) sees an overcurrent condition of a generator or the BPCU sees an overcurrent conditions of external power. These are the overcurrent limits for a generator or external power source to cause load shed:

- 274 amps (nominal) for 300 seconds
- 340 amps (nominal) for 5 seconds.

The number of galleys and main buses which lose power and the order in which they lose power depends on the configuration of the electrical power system.

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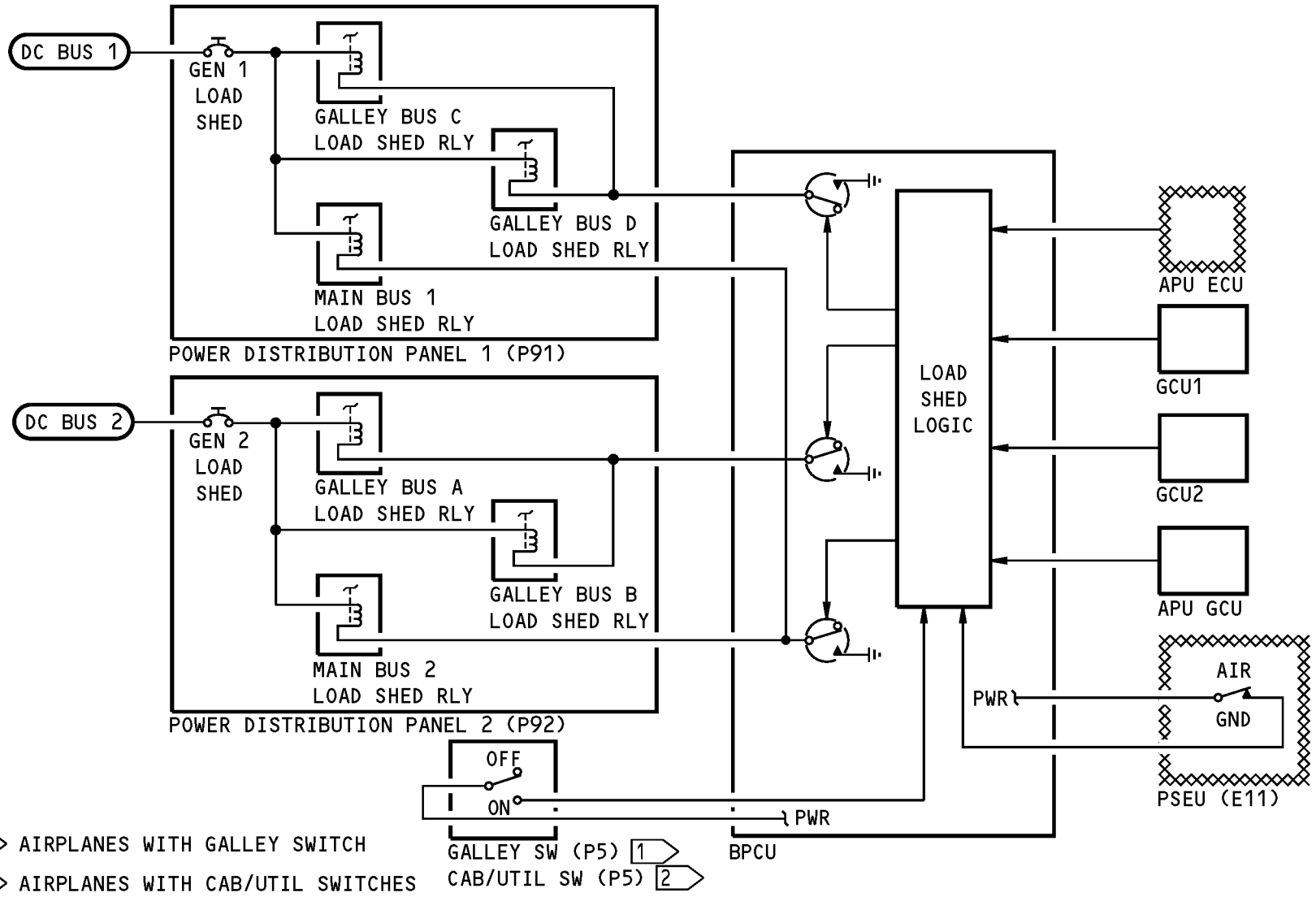

AC ELECTRICAL LOAD DISTRIBUTION - LOAD SHED - FUNCTIONAL DESCRIPTION

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AC ELECTRICAL LOAD DISTRIBUTION - LOAD SHED - OPERATION

General

The BPCU removes power (load shed) to the galley buses and sometimes the main buses to protect the power source from overload. There are three types of load shed:

- Configuration
- Command
- Overcurrent.

Configuration Load Shed

Configuration load shed occurs when the APU is the only source of AC power in flight. The BPCU opens (de-energizes) all galley load shed relays within 100 milliseconds. The galley relays close (energize) if a second source of AC power is established.

AIRPLANES WITH GALLEY SWITCH;

After landing, move the galley switch to OFF and back to the ON position to reset the galley relays.

AIRPLANES WITH CAB/UTIL SWITCH;

After landing, move the cabin utility switch to OFF and back to the ON position to reset the galley relays.

Command Load Shed

This type of load shed occurs when the APU electronic control unit (ECU) senses high exhaust gas temperature (EGT). The APU ECU monitors APU performance parameters to determine a possible overload condition.

The ECU sends an APU load shed signal to the BPCU. In flight if the APU is the only source of power, both main bus relays open (de-energize).

NOTE: Galley relays are already opened due to configuration load shed.

The main bus relays close when another AC power source is selected.

If the APU is the only source of power on the ground, all galley relays will open. The galley relays close when the APU operates within normal EGT limits, provided the galley switch stays in the ON position.

If the APU generator supplies power to an AC transfer bus and an IDG supplies power to the opposite AC transfer bus, the galley relays that get power from the APU open. The galley relays close when the APU operates within normal EGT limits if the galley switch stays in the ON position.

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AC ELECTRICAL LOAD DISTRIBUTION - LOAD SHED - OPERATION

Overcurrent Load Shed

Overcurrent load shed occurs when a generator control unit (GCU or AGCU) senses an overcurrent condition of a generator or the BPCU senses an overcurrent condition of external power. These are the overcurrent limits for a generator or external power source to cause load shed:

- 274 amps (nominal) for 300 seconds
- 340 amps (nominal) for 5 seconds.

Overcurrent Load Shed, Two Generator Operation

Galley relays that get power from the affected generator open.

AIRPLANES WITH GALLEY SWITCH;

After landing, move the galley switch to OFF and back to the ON position to reset the galley relays.

AIRPLANES WITH CAB/UTIL SWITCH;

After landing, move the cabin utility switch to OFF and back to the ON position to reset the galley relays.

If the overcurrent condition continues, the generator control breaker (GCB) on the effected generator opens and the associated bus tie breaker (BTB) will be locked in the open position. This will result in an unpowered AC transfer bus.

Move the generator switch to OFF and back to ON to re-excite the generator and close the GCB. The BTB stays locked open until the GCU or BPCU that shows the DIST/BUS FAULT has had power off and on.

Overcurrent Load Shed, Single IDG Operation

The bus power control unit (BPCU) opens the galley relays that get power from AC transfer bus 2. If the overcurrent condition continues, the BPCU opens the galley relays that get power from AC transfer bus 1.

AIRPLANES WITH GALLEY SWITCH;

After landing, move the galley switch to OFF and back to the ON position to reset the galley relays.

AIRPLANES WITH CAB/UTIL SWITCH;

After landing, move the cabin utility switch to OFF and back to the ON position to reset the galley relays.

If the overcurrent condition continues, the BPCU opens both main bus relays. The main bus relays are closed by selection of a second source of AC power or by removal and reapplication of power to the BPCU.

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If the overcurrent condition continues, the GCU opens and locks open the associated BTB. The BTB will stay locked open until the GCU that shows the DIST/BUS FAULT has had power off and on.

If the overcurrent condition continues, the GCU opens the associated GCB. This results in unpowered AC transfer buses. Move the generator switch to the ON position to re-excite the generator and close the GCB.

Overcurrent Load Shed, APU/External Power Operation

The BPCU opens the galley relays powered by AC Transfer Bus 2. If the overcurrent condition continues the BPCU will open the galley relays that get power from AC transfer bus 1. The BPCU closes the galley relays if another source of AC power is selected.

If the overcurrent condition continues, the BPCU opens both main bus relays. The main bus relays closes by selection of another source of AC power or by removal and reapplication of power to the BPCU.

If the overcurrent condition continues, the BPCU commands BTB 2 to open and lock open. If the overcurrent condition continues, the BPCU commands BTB 1 to open and lock open. If this corrects the overcurrent condition, the BPCU commands BTB 2 to re-close.

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*LOAD SHED	CONFIG-URATION	COMMAND		OVER-CURRENT	OVER-CURRENT	OVER-CURRENT
*POWER SOURCE	APU	APU	APU AND GEN	TWO GENERATORS	ONE GENERATOR	APU/EPC
GALLEY LOAD RELAYS	AIR ONLY	GND OR AIR	APU POWERED BUS	AFFECTED GENERATOR ONLY	XFR BUS 2 [1] XFR BUS 1	XFR BUS 2 [1] XFR BUS 1
MAIN BUS RELAYS		AIR ONLY			[1]	[1]
BTB				AFFECTED GENERATOR ONLY [1]	[1]	[1] NUMBER 2 [1] NUMBER 1
GCB				AFFECTED GENERATOR ONLY	[1]	
APB/EPC						APPLIED SOURCE [1]

SEQUENCE

[1] = IF THE OVERCURRENT CONDITION CONTINUES, THEN OPEN RELAY/BREAKER

AC ELECTRICAL LOAD DISTRIBUTION - LOAD SHED - OPERATION

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