12.5 (ATA 24) ELECTRICAL POWER

12.5.1 Introduction

The Electrical Power Generation and Distribution System (EPGDS) is used to supply the electrical energy for all onboard electrical equipment. The EPGDS has DC and AC generating systems. The DC generation system includes a battery system. The EPGDS provides for energy conversion, distribution, storage, control, protection, monitoring, and indication to the flight crew. Provision is made for external connection of DC or AC external power while on the ground.

12.5.2 General

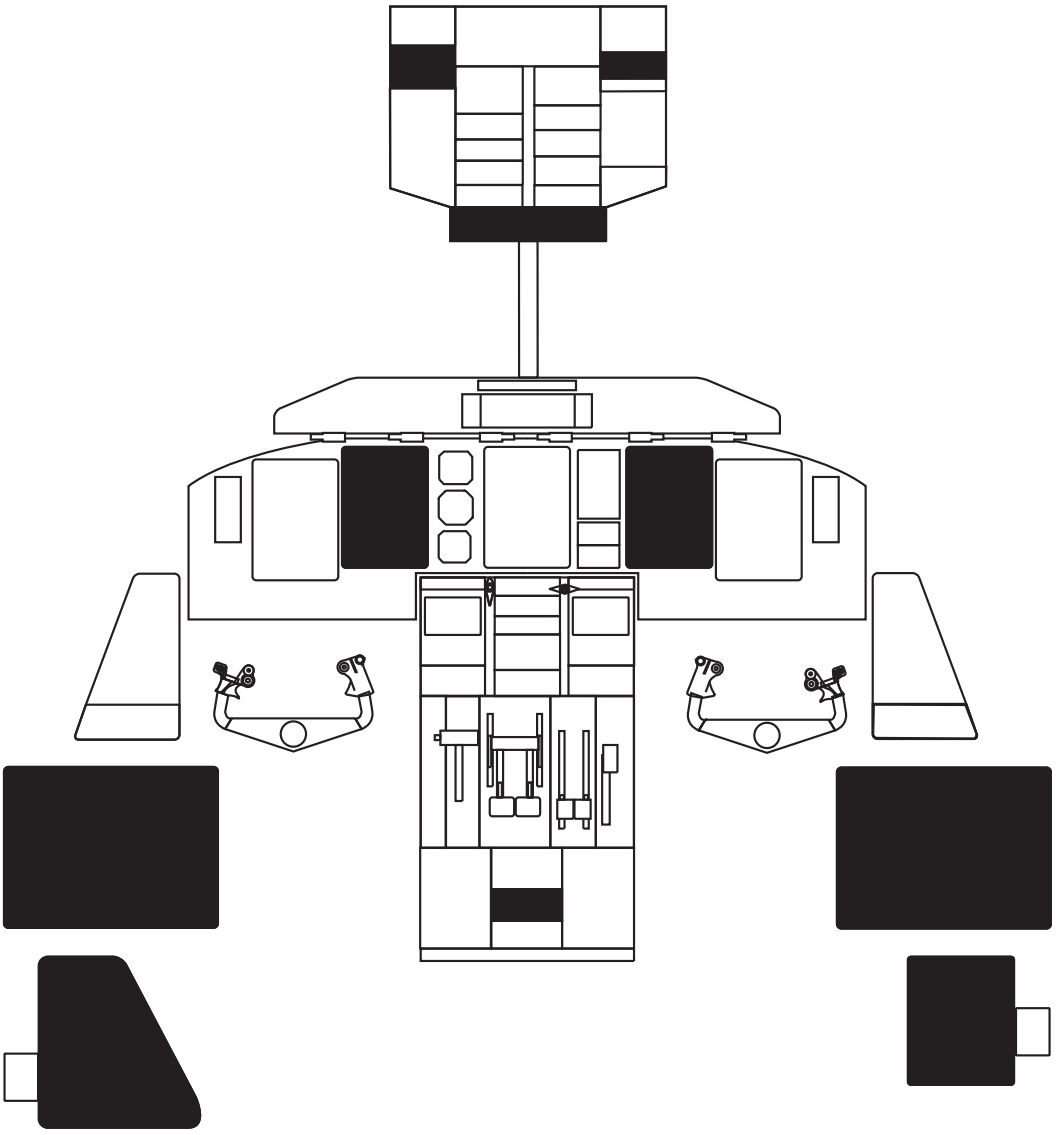
The DC generation system is supplied by three NiCad batteries, two engine driven starter/generators, two Transformer Rectifier Units (TRUs) and an optional Auxiliary Power Unit (APU). The TRUs supply 28VDC and are powered by two engine driven Alternating Current (AC) generators that supply 115Volts Alternating Current (VAC).

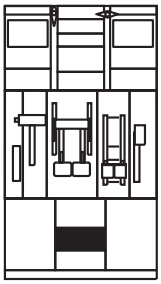
The power is distributed by an electrical bus system. It re configures for individual power source and bus failures, by the automatic closing and opening of bus tie contactors.

There are both DC and AC external power receptacles for Ground Power Unit (GPU) connection.

All AC and DC aeroplane services can be operated from the AC generators or the AC external power alone.

12.5.3 Controls and Indications - Electrical Power





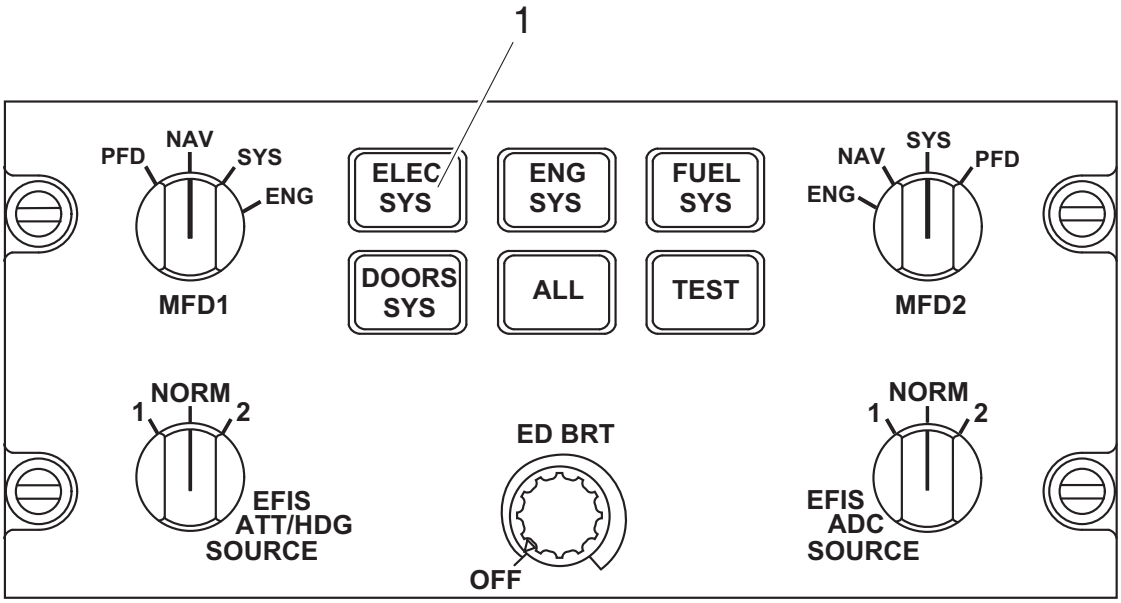


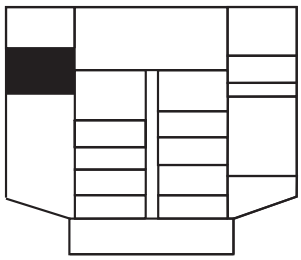
Figure 12.5-1 Engine and System Integrated Displays Control Panel (ESCP)

ESCP CALLOUTS PERTAINING TO ELECTRICAL ITEMS

1. ELEC SYS PUSHBUTTON (momentary action)

PUSH - provides a display of the electrical system page on the MFD (upper area) with MFD 1 or MFD 2 set at SYS

- there is no action with another push



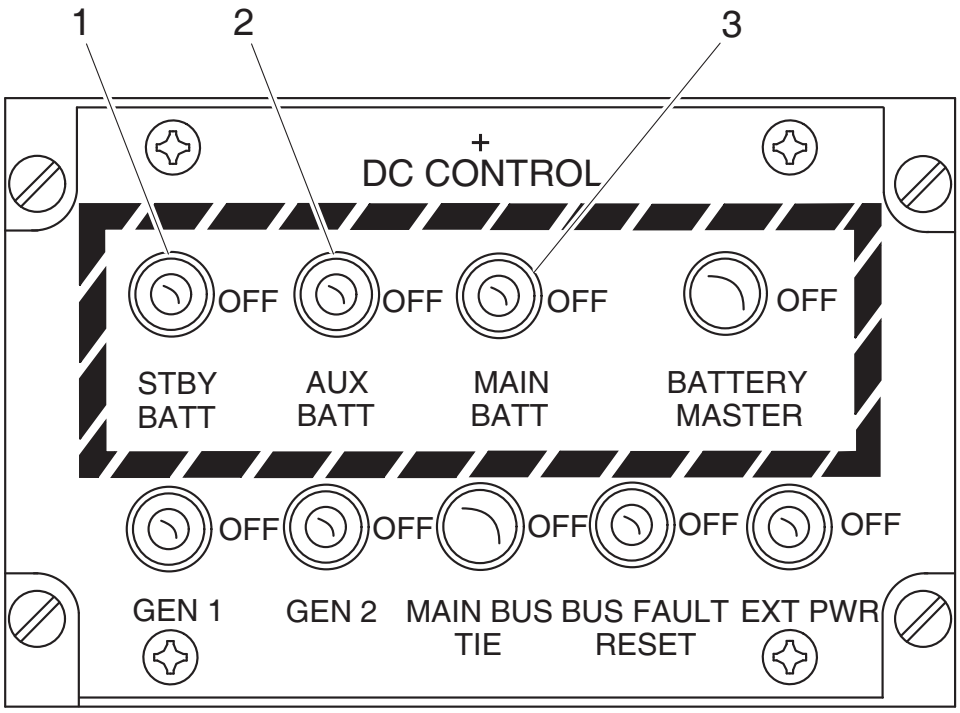


Figure 12.5-2 DC Control Panel (1 of 3)

DC CONTROL PANEL CALLOUTS

1. STBY BATT switch (two position)

STBY BATT - left main feeder bus charging circuit connected to standby battery
- EPCU logic inhibits this connection under the following conditions:
  - with external power (no charge) option
  - when a DC bus fault is present on the left main feeder bus
  - during emergency operations

OFF - disconnects standby battery from left main feeder bus
- STBY BATTERY caution light turns on any time the standby battery is not connected to the left main feeder bus

2. AUX BATT SWITCH (two position)

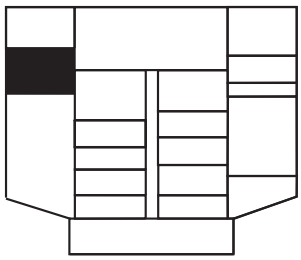
AUX BATT - left main feeder bus charging circuit connected to auxiliary battery
- EPCU logic inhibits this connection under the following conditions:
  - with external power (no charge) option
  - when a DC bus fault is present on the left main feeder bus
  - during emergency operations

OFF - disconnects auxiliary battery from left main feeder bus
- AUX BATTERY caution light turns on any time the auxiliary battery is not connected to the left main feeder bus

3. MAIN BATT SWITCH (two position)

MAIN BATT - right main feeder bus charging circuit connected to main battery
- EPCU logic inhibits this connection under the following conditions:
  - with external power (no charge) option
  - when a DC bus fault is present on the right main feeder bus
  - during emergency operations

OFF - disconnects main battery from right main feeder bus
- MAIN BATTERY caution light turns on any time the main battery is not connected to the right main feeder bus



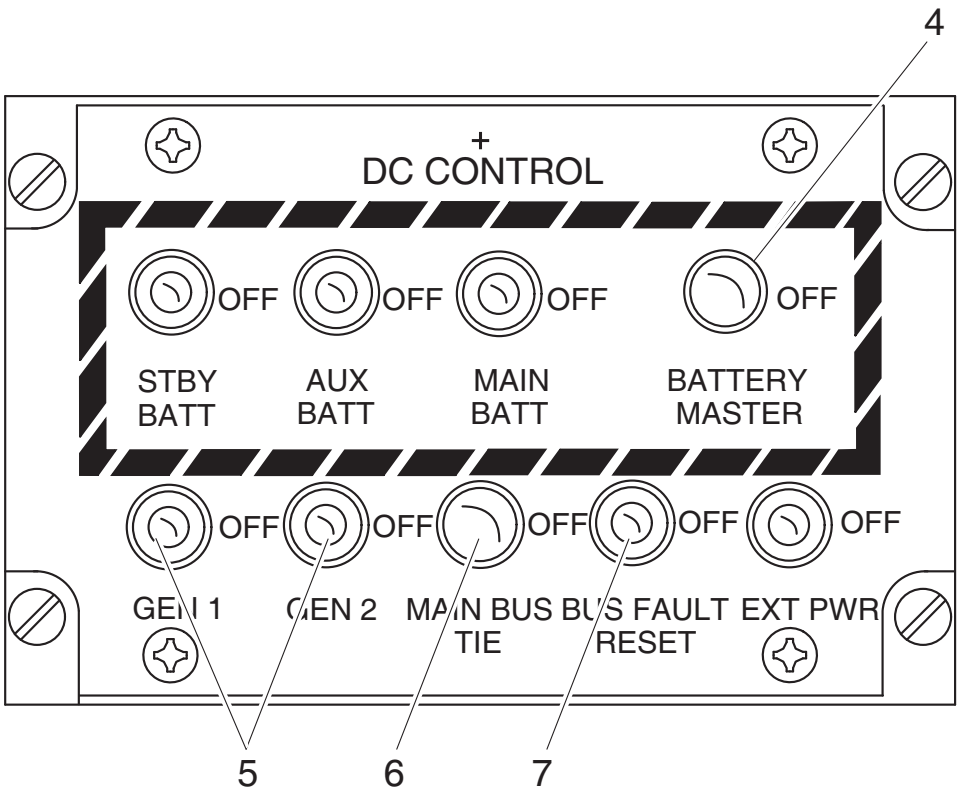


Figure 12.5-3 DC Control Panel (2 of 3)

DC CONTROL PANEL CALLOUTS (cont'd)

4. BATTERY MASTER SWITCH (two position, lever locked at OFF)

BATTERY MASTER
- any battery is capable of powering both essential buses
- switch control is hard wired and independent of EPCU operation

OFF - disconnects the main, auxiliary, and standby batteries from the associated essential buses

NOTE: The battery master switch must be selected to BATTERY MASTER before the main, auxiliary, and standby batteries can power the respective buses.

5. GEN 1 and 2 SWITCHES (two position)

GEN 1 OR 2 - DC GCU permits generator to supply power to the associated feeder bus
- DC generators are inhibited with DC EXT PWR ON

OFF - shuts associated generator off
- resets GCU for subsequent generator and circuit monitoring following shutdown of a generator
- DC GEN 1 or 2 caution light turns on anytime the respective generator is not supplying power to its associated feeder bus

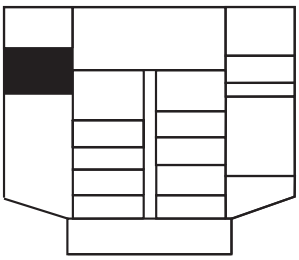
6. MAIN BUS TIE SWITCH (two position, lever locked at OFF)

MAIN BUS TIE - manually ties left and right main feeder buses.
- EPCU inhibits bus tie operation upon detection of a bus fault

OFF - manually opens connection between left and right main feeder buses

7. BUS FAULT RESET SWITCH (momentary selection)

BUS FAULT RESET - re initializes the EPCU after a bus isolation (following a bus fault) to enable subsequent bus fault monitoring



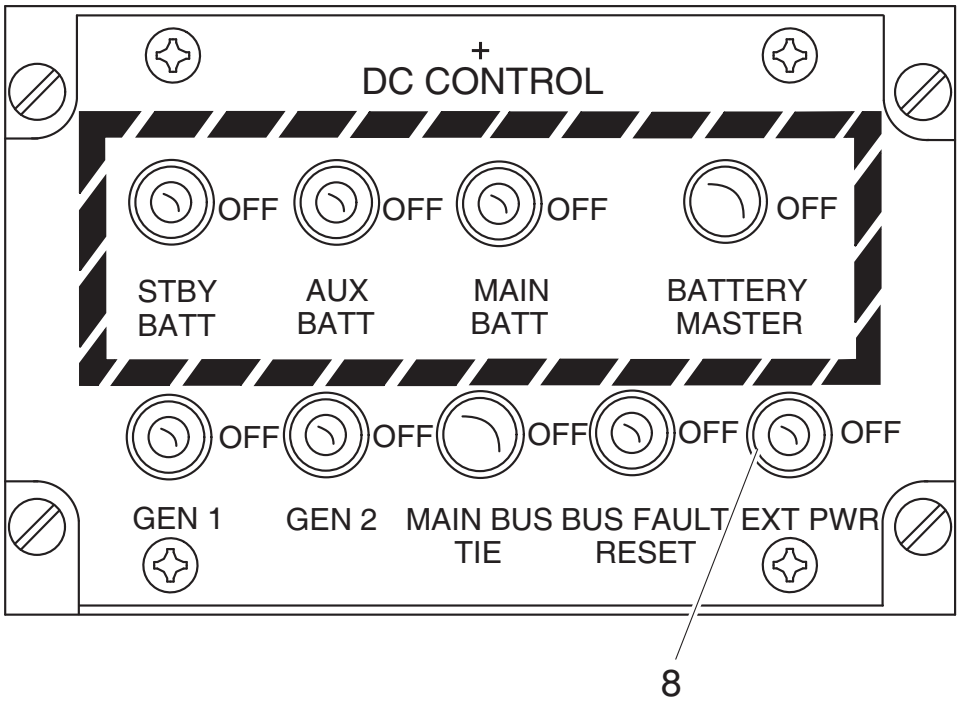


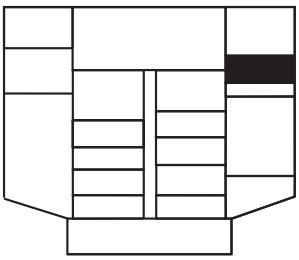
Figure 12.5-4 DC Control Panel (3 of 3)

DC CONTROL PANEL CALLOUTS (cont'd)

8. DC EXT PWR SWITCH

EXT PWR - left and right main feeder buses, essential buses and secondary buses powered from DC external power source

- DC and APU generators are inhibited from connection to feeder buses
- DC EXT PWR ON vindication (green) is displayed on the MFD Electrical page when DC external power is connected to the aeroplane
- the EPCU incorporates External DC Power Protection from too high or too low supply of External DC power voltage
- external DC power is supplied to the aeroplane via the external DC power receptacle. The EPCU will enable the connection of the external DC power to the aeroplane if the applied external voltage is:
  • of correct polarity, and
  • its value is within 22 ± 1VDC to 31 + 0.5; 31- 0.75 VDC
- main, auxiliary, and standby batteries are connected to their feeder buses
- for the duration of engine start, the standby battery is inhibited from the left main feeder bus



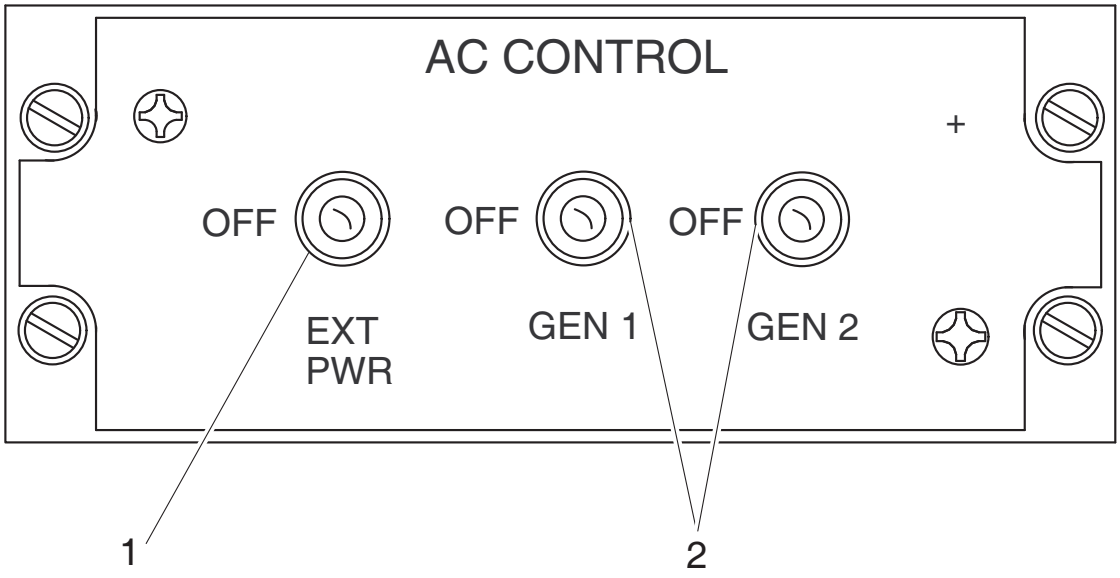


Figure 12.5-5 AC Control Panel

AC CONTROL PANEL

1. EXTERNAL POWER SWITCH (two position)

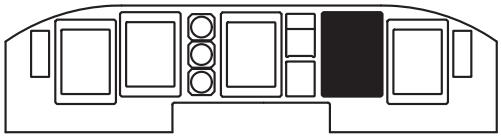
EXT PWR - connects AC external power to variable frequency buses
- is capable of powering all AC and DC buses on the aeroplane
- isolates the AC generators from the buses
- AC EXT PWR ON indication (green) is displayed on the MFD Electrical page when AC external power is connected to the aeroplane
- an External Power Protection Unit (AC PPU) is installed in the right ACCB to ensure only AC Power within specification is allowed on the bus
- the AC PPU checks for the following parameters:
  - voltage level (under voltage trip point 106 VAC ±2%, over voltage trip point 124 VAC ±2%)
  - frequency (underfrequency trip point 370Hz ±2%, overfrequency trip point 450Hz ±2%)
  - phase rotation (A-B-C)

OFF - disconnects AC external power from variable frequency buses

2. AC GEN 1 AND 2 SWITCHES (two position)

GEN 1 OR GEN 2 - arms respective GCU to activate, and connect its generator to the associated variable frequency bus
- AC generators are inhibited with AC EXT PWR ON

OFF - shuts respective generator down
- resets GCU for subsequent generator and circuit monitoring following shutdown of a generator
- AC GEN 1 or 2 caution light turns on anytime the respective generator is not supplying power



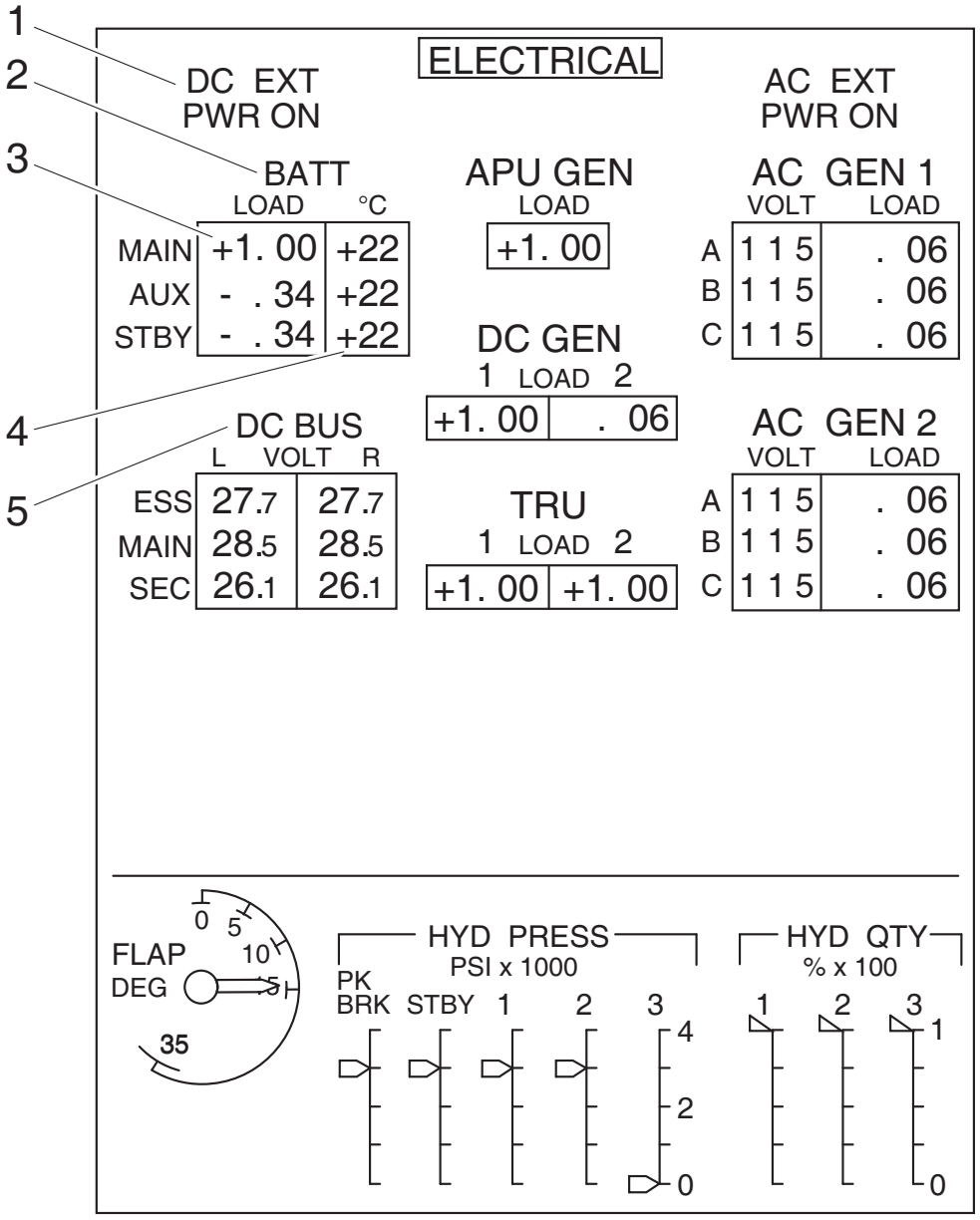


Figure 12.5-6 Copilot's MFD Electrical Page (1 of 3)

MULTI FUNCTION DISPLAY (MFD) ELECTRICAL PAGE CALLOUTS

1. **DC EXT POWER ANNUNCIATOR (green)**
   - displayed when a DC external power source is connected to the aeroplane and supplying DC power within voltage tolerances

2. **BATTERY LOAD AND TEMPERATURE ANNUNCIATION AREA**

   BATT (white)
   LOAD, °C (cyan)
   MAIN, AUX, STBY (white)

3. **DIGITAL DISPLAY OF BATTERY LOAD (white)**
   - displays the load of the battery
   - + or - sign on the left of the lead digit, whether the battery is in overcharge (“+” displayed) or in discharge (“-” displayed)
   - nothing is displayed when the battery is in charge within the expected range
   - leading zero is suppressed in the lead digit position
   - digital number gives the rate of the load, with 1.00 equal to 100% of load
   - examples:

     • “+1.30” indicates that the battery is in overcharge at 30% over the maximum rate of the charge
     • “.60” indicates that the battery is in charge at 60% of its maximum rate of charge
     • “-0.30 “indicates that the battery is discharging at 30% over the maximum rate of discharge

4. **DIGITAL DISPLAY OF BATTERY TEMPERATURE**
   - battery temperature digits are displayed in white with a + or - sign on the left of the lead digit, when the temperature is within normal limits
   - when the temperature is in the range (+50°C to +65°C) the digits turn yellow
   - when the temperature exceeds 65°C the digits are displayed in red

5. **DC BUS VOLTAGE ANNUNCIATION AREA**

   DC BUS (white)
   L, R (white)
   VOLT (cyan)
   ESS, MAIN, SEC (white)

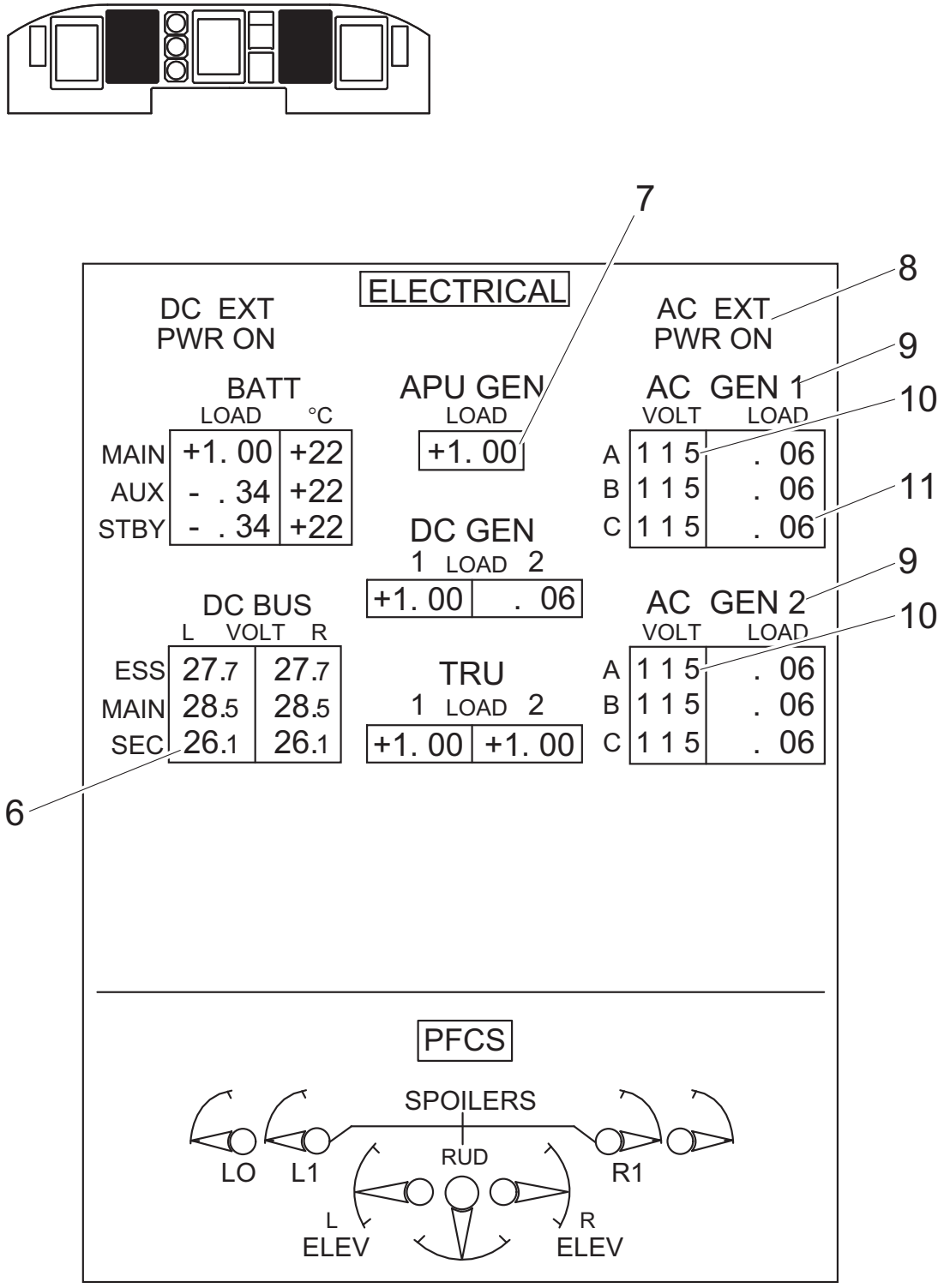


Figure 12.5-7 Pilot's MFD Electrical Page (2 of 3)

MULTI FUNCTION DISPLAY (MFD) ELECTRICAL PAGE CALLOUTS (cont'd)

6. DIGITAL DISPLAY OF DC BUS VOLTAGE (white)

- indicates the voltage on the associated bus

7. DIGITAL DISPLAY OF APU GENERATOR LOAD (white)

APU GEN (white)
LOAD (cyan)

- is activated only if the APU is installed depending on the aeroplane configuration
- the load demand on the APU generator is displayed in the following format:
  - "+" sign is displayed on the left of the lead digit to indicate an overload of the DC power source
  - nothing is displayed when the load is in the expected range
  - leading zero is suppressed in the lead digit position
  - digital number gives the rate of the load, with 1.00 equal to 100% of load examples:
  - ".60" indicates that the DC generator or TRU is loaded at 60% of the maximum output
  - "+1.30" indicates an overload of the DC generator or TRU

8. AC EXTERNAL POWER ANNUNCIATION (green)

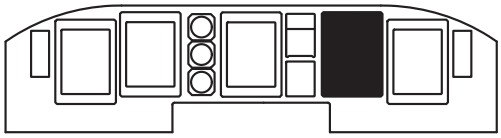
- displayed when an AC external power source is connected to the aeroplane and supplying AC power

9. AC GEN VOLTAGE AND LOAD ANNUNCIATION AREAS

AC GEN 1 and **AC GEN 2** (white)
VOLT, LOAD (cyan)
A, B, C (white)

10. DIGITAL DISPLAY OF AC VOLTAGE (white)

- displays AC bus voltage for each phase



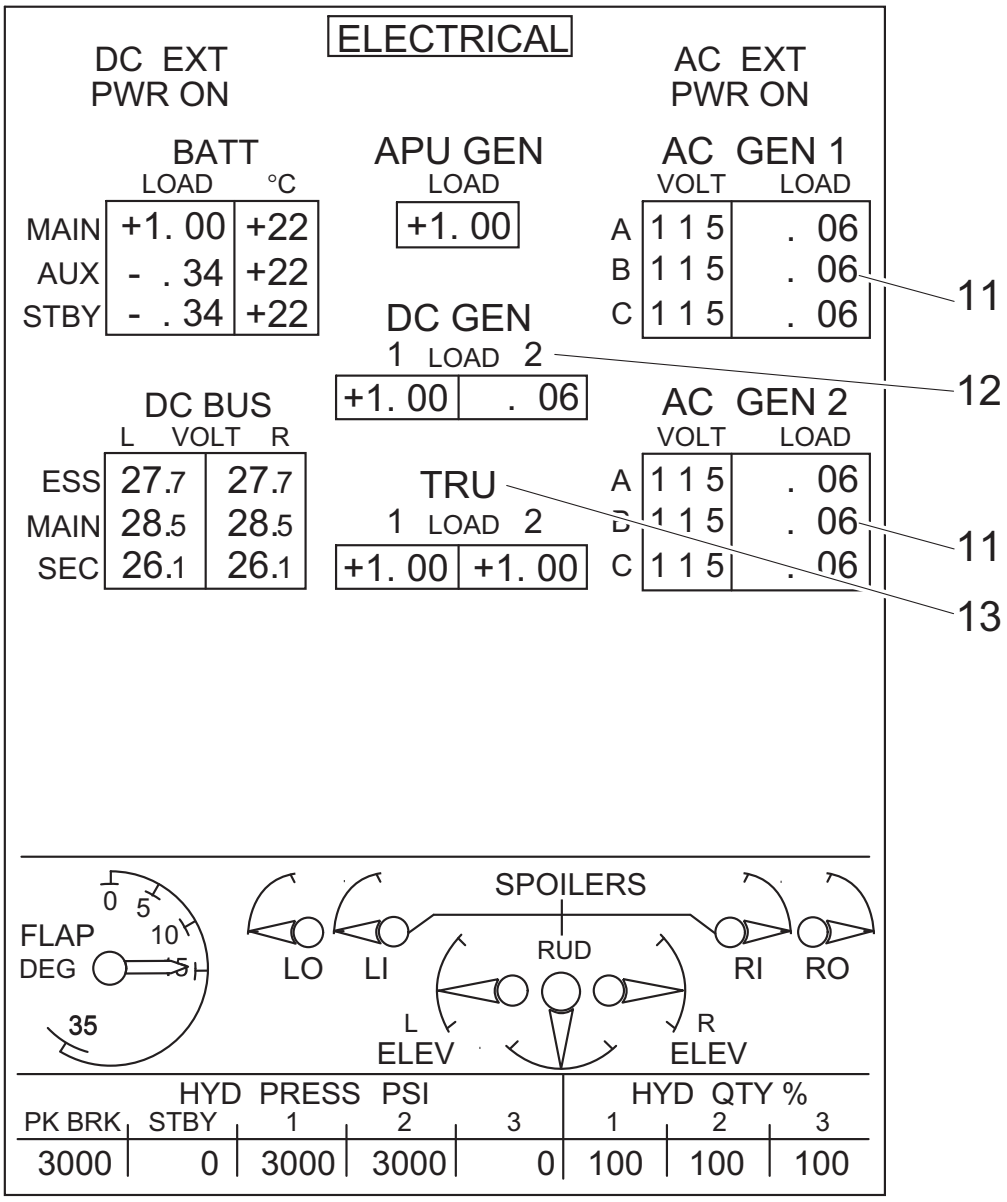


Figure 12.5-8 Composite MFD Electrical Page (3 of 3)

MULTI FUNCTION DISPLAY (MFD) ELECTRICAL PAGE CALLOUTS (cont'd)

11. DIGITAL DISPLAY OF AC GENERATOR LOAD (white)

- the load demand on the AC generator is displayed in the following format:
  - "+" sign is displayed on the left of the lead digit to indicate an overload of the AC power source
  - nothing is displayed when the load is in the expected range
  - leading zero is suppressed in the lead digit position
  - digital number gives the rate of the load, with 1.00 equal to 100% of load
- examples:
  - ".60" indicates that the AC generator is loaded at 60% of the maximum output
  - "+1.30" indicates an overload of the AC generator

12. DIGITAL DISPLAY OF DC GENERATOR LOAD (white)

DC GEN (white)
1,2 (white)
LOAD (cyan)

- DC generator load is displayed in the same manner as the APU generator load

13. DIGITAL DISPLAY OF TRU LOAD (white)

TRU (white)
1,2 (white)
LOAD (cyan)

- TRU load is displayed in the same manner as the APU generator load

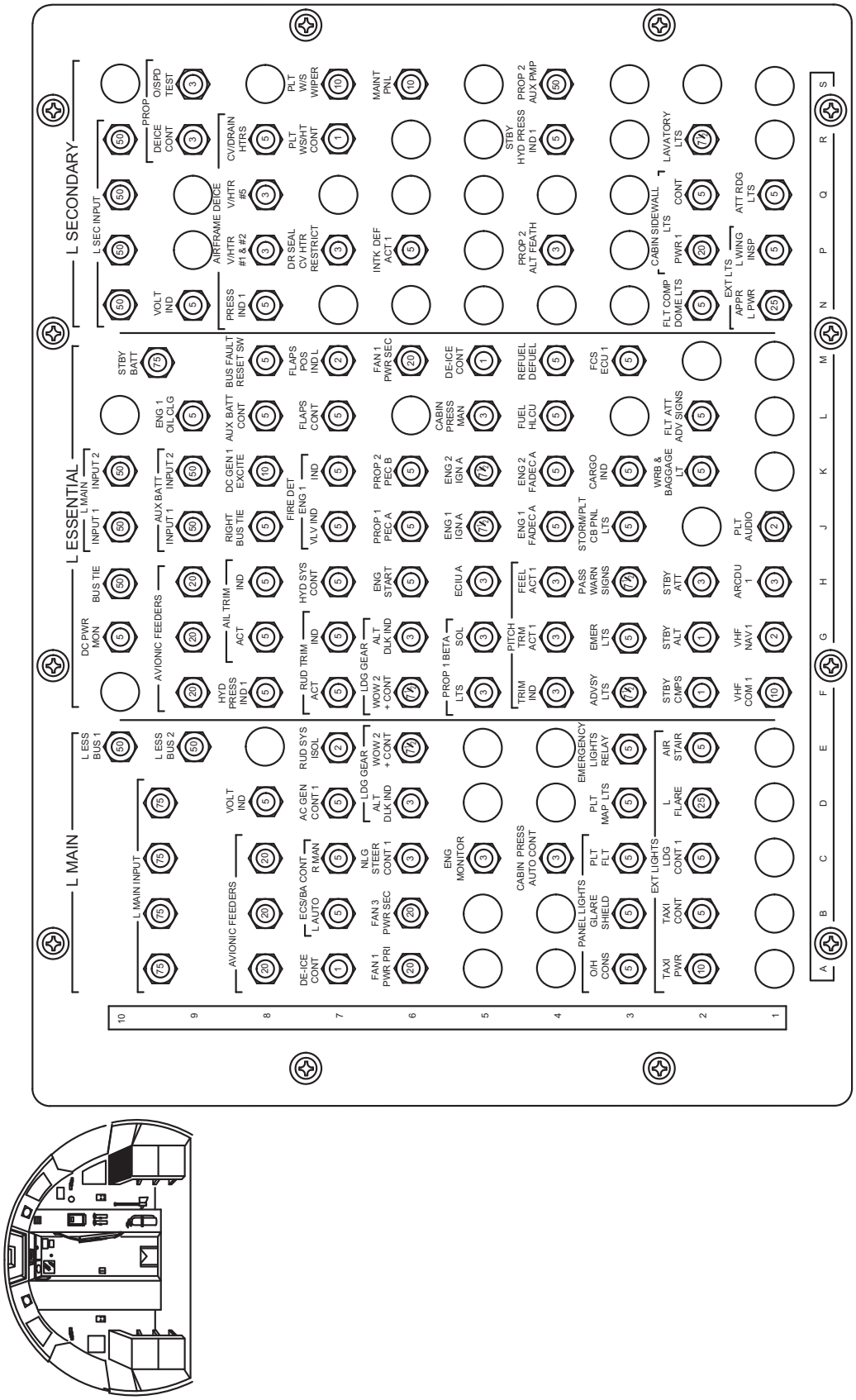
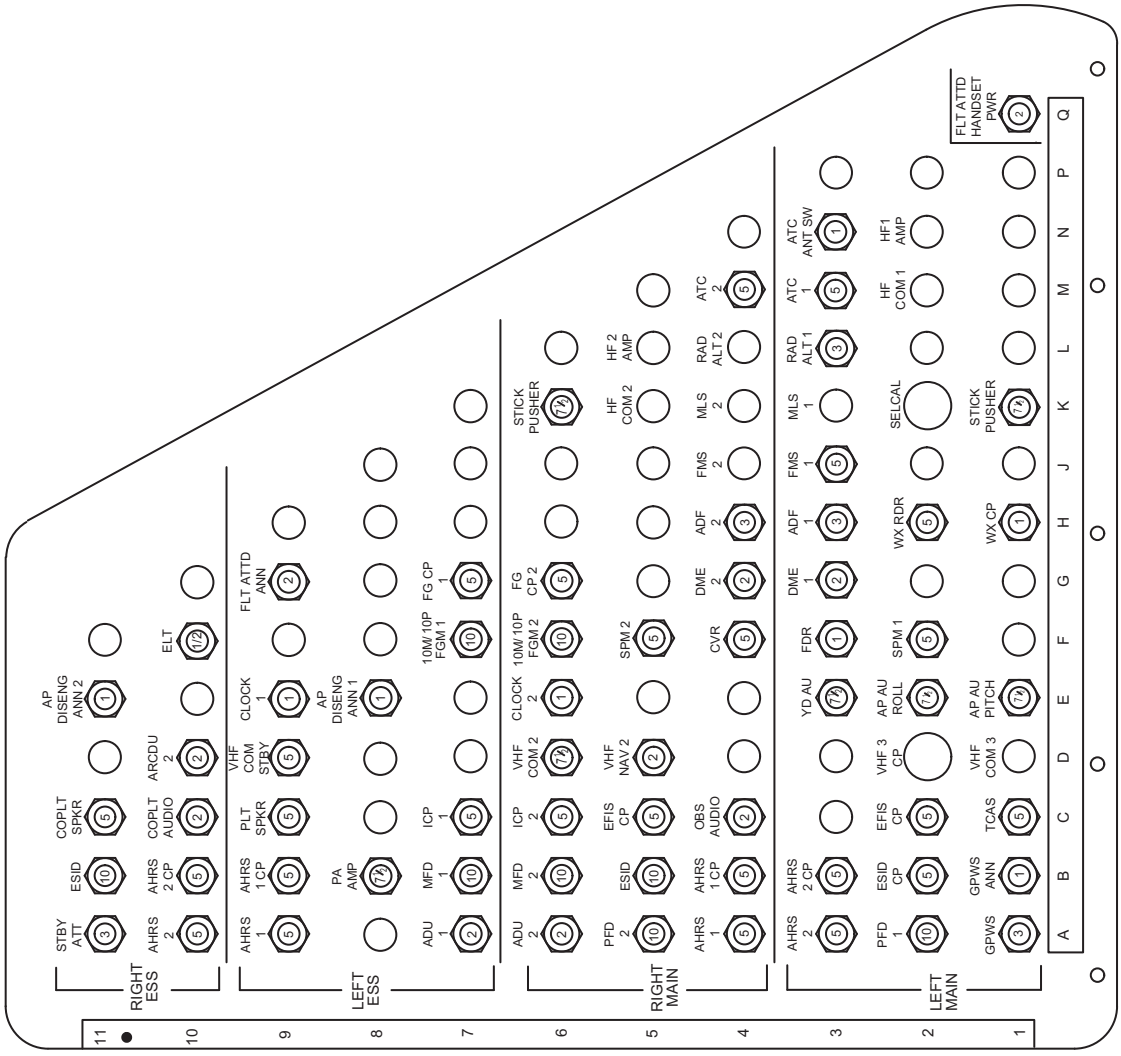


Figure 12.5-9 Pilot’s Lower Circuit Breaker Panel



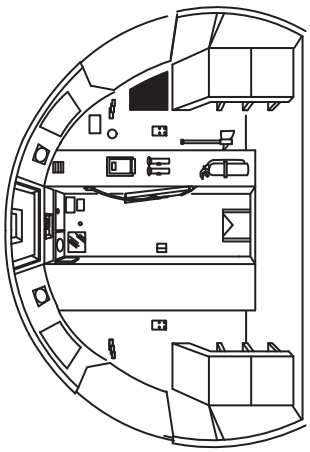
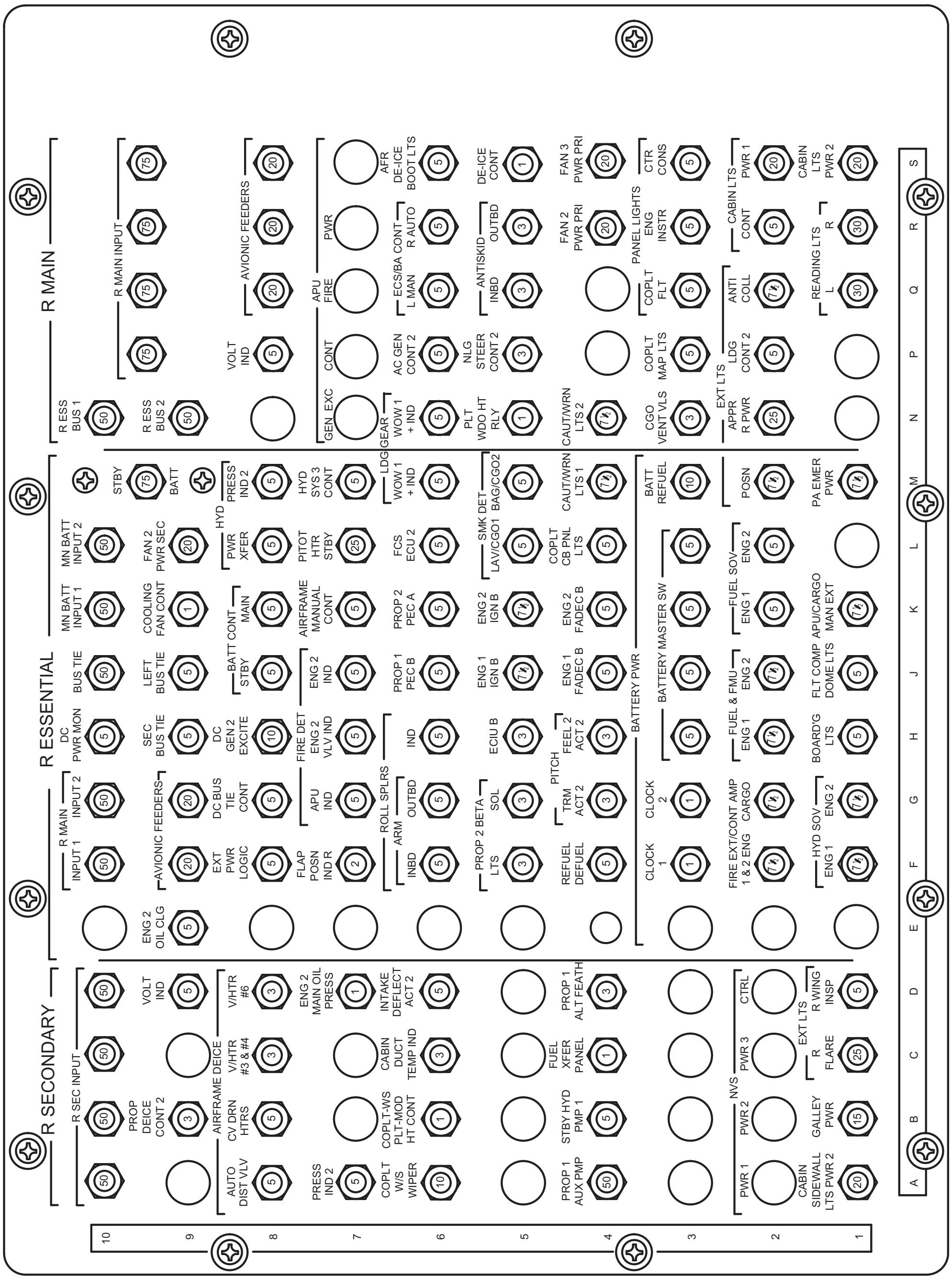


Figure 12.5-10 Pilot’s Upper Circuit Breaker Panel



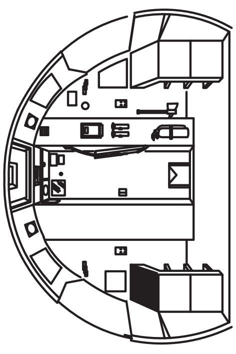
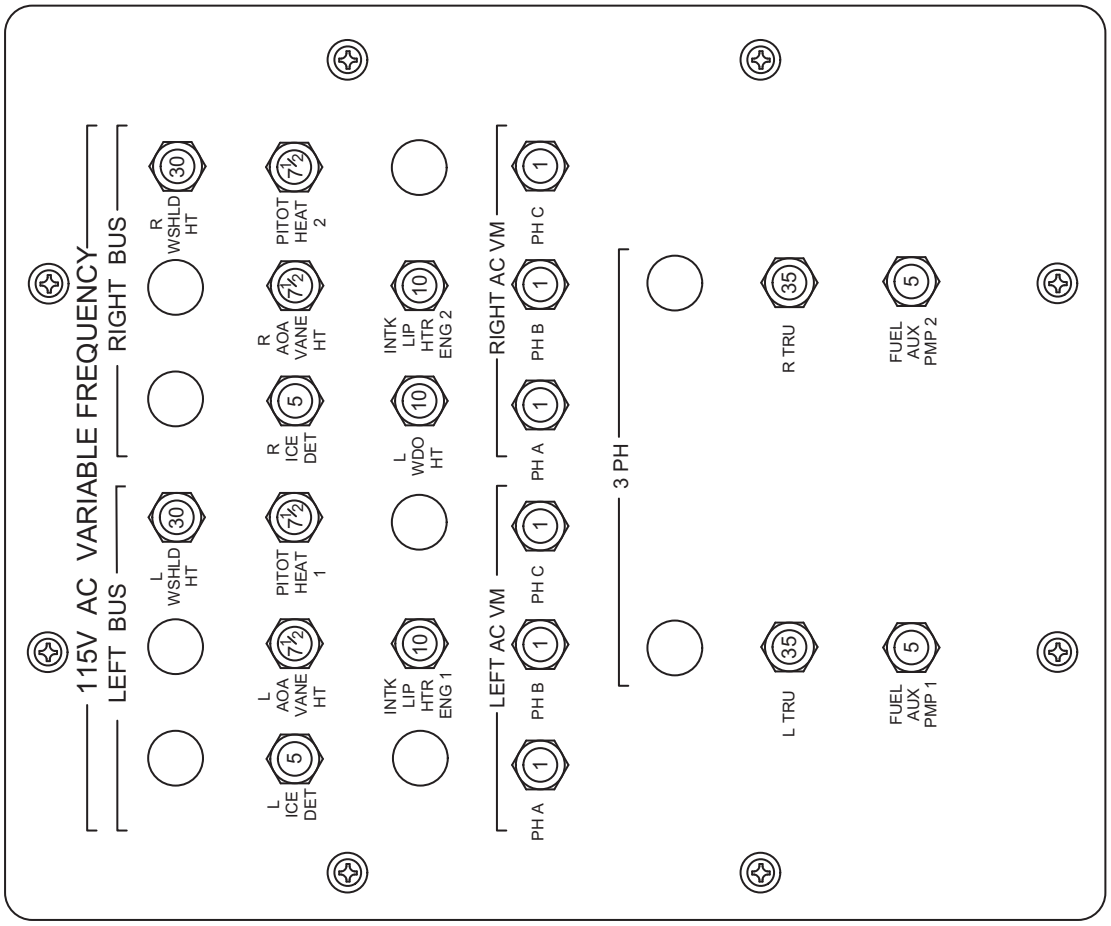


Figure 12.5-11 Copilot’s Lower Circuit Breaker Panel



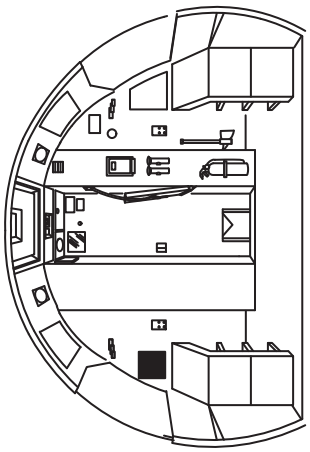


Figure 12.5-12 Copilot’s Upper Circuit Breaker Panel

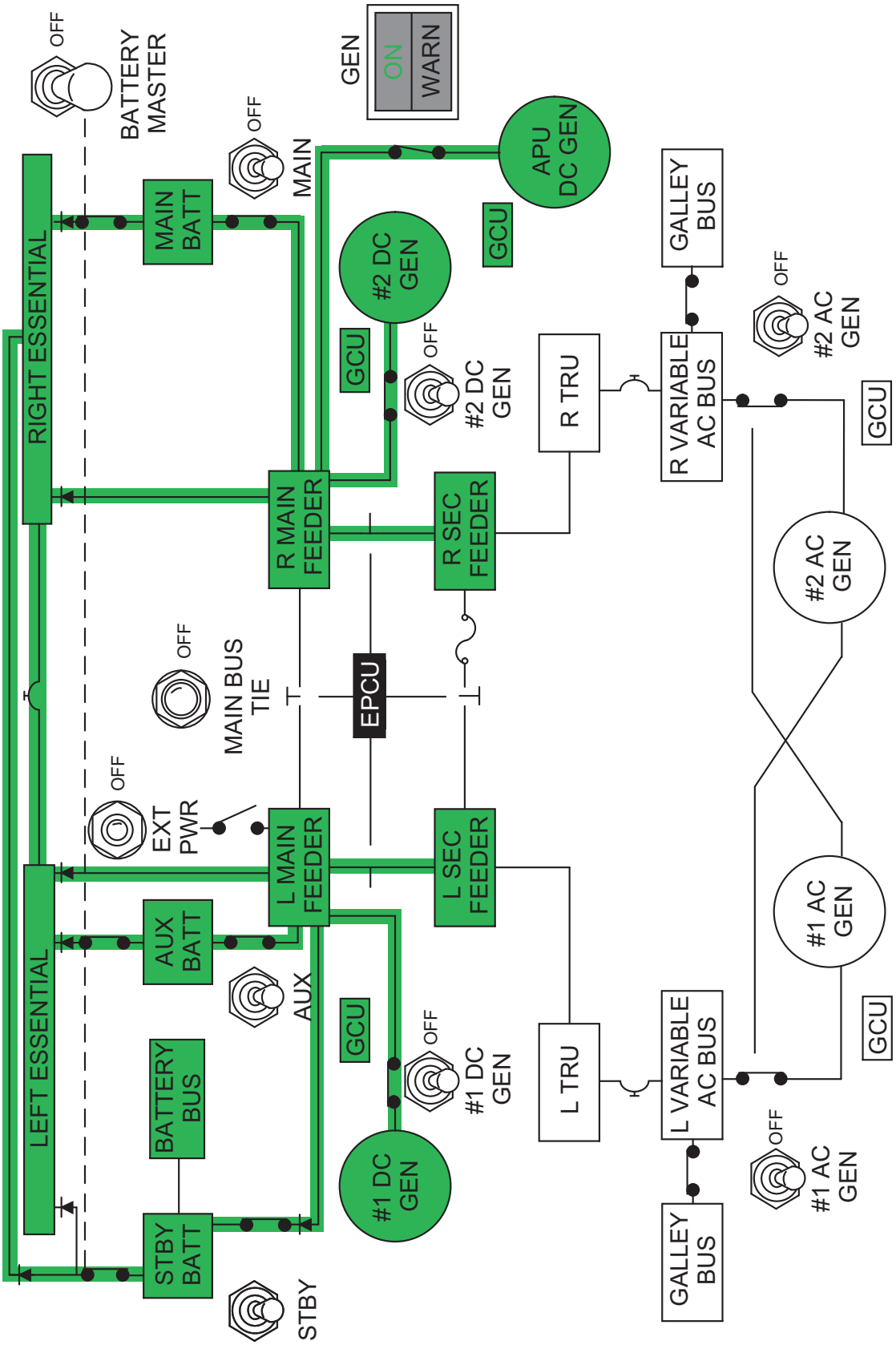
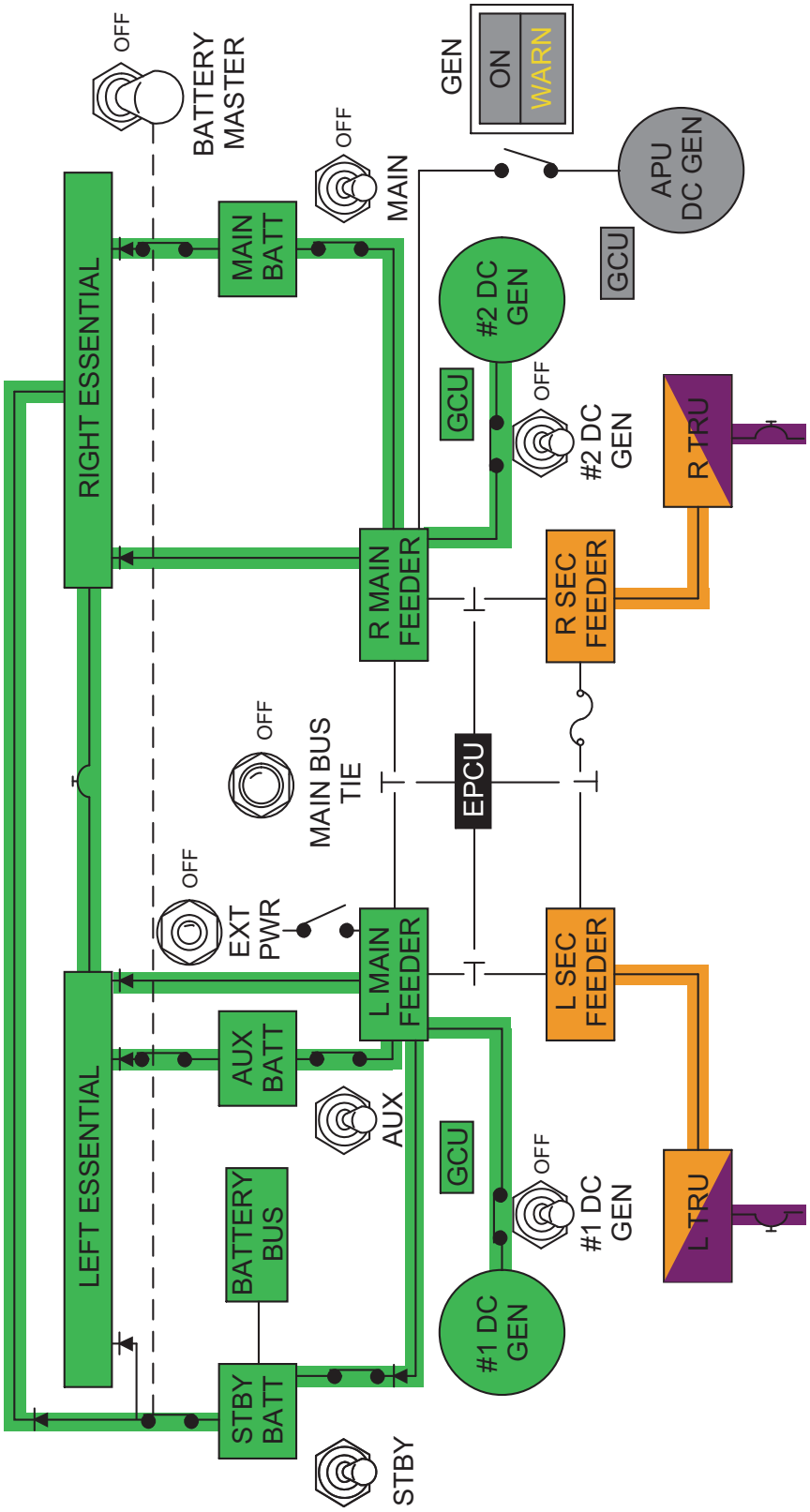


Figure 12.5-13 DC Power Electrical Schematic - Fully Operational


OFF
BATTERY MASTER
OFF
MAIN
GEN
ON
WARN
APU DC GEN
GCU
MAIN BATT
RIGHT ESSENTIAL
#2 DC GEN
GCU
OFF
#2 DC GEN
R TRU
R MAIN FEEDER
R SEC FEEDER
OFF
MAIN BUS TIE
EPCU
OFF
EXT PWR
L MAIN FEEDER
L SEC FEEDER
AUX BATT
AUX
GCU
OFF
#1 DC GEN
L TRU
LEFT ESSENTIAL
BATTERY BUS
STBY BATT
STBY

12.5.4 Detailed Description

The Electrical Power Generation and Distribution System (EPGDS) (Figure 12.5-13) has an Electrical Power Control Unit (EPCU) to control, monitor and distribute DC power to the aeroplane's electrical buses. The EPCU automatically re configures the EPGDS for power source and bus failures, by the closing and opening of bus ties contactors. Contactor control is determined by automatic functions during the operation of the aeroplane. Manual inputs are achieved through the selection of switches in the flight deck that may be vetoed by the EPCU.

12.5.5 AC/DC Power Monitor System

System parameters are monitored in the flight deck on the Electronic System Indicating Displays (ESID). Select the SYS (System) position on the appropriate Multi Function Display (MFD) rotary switch on the ESID control panel to give electrical system indications.

12.5.6 DC System

The DC electrical schematic is shown in Figure 12.5-14.

The DC generation system has the following sources:

- Main, Auxiliary, and Standby Batteries
- Two Starter/Generators
- Two Transformer Rectifiers Units (TRU)
- DC External
- APU Starter/Generator (Optional)

The power sources supply power to the following buses in order of priority:

- Battery
- Left and Right Essential
- Left and Right Main
- Left and Right Secondary

DC Electrical Medical Outlet
A 24 VDC, 35 A electrical outlet for medical purposes is installed on the inboard face of the G1 galley.

12.5.6.1 Batteries

The main and auxiliary 24-volt NiCad batteries are located in the lower left nose compartment. The main and auxiliary batteries have a 40-amp-hour capacity. The standard standby 17-amp-hour battery (optional 40-amp-hour) is located in the tail compartment, when no APU is installed. With an APU installed, the standby battery is located in the nose compartment. The MAIN and AUX batteries are used for engine starting if ground power is not available. All 3 batteries supply backup power to the aeroplane essential services in flight for 45 minutes or more.

The batteries are connected to the left and right essential buses (Figure 12.5-15) by selecting the BATTERY MASTER switch. Selecting the BATTERY MASTER switch to the ON position closes 3 contactors and connects all three batteries to the essential buses. The connection required for the control of the above contactors is directly hard wired and is independent of the EPCU operation. The EPCU itself is energized from the essential buses.

NOTE: Battery power cannot be applied to the secondary buses.

Battery temperatures, as indicated on the ESID Electrical Page, should be equal to or greater than -20°C prior to dispatch.

NOTE: There is no battery temperature limitation for starting Engines or APU.

With the BATTERY MASTER switch on, the batteries are connected to the essential buses at all times. In this way powering of flight safety equipment, which is also connected to the essential buses, is enabled. In case of emergency operation the batteries are the main energy sources for the aeroplane.

In addition to the BATTERY MASTER switch, each of the batteries has a dedicated switch. Selecting the MAIN BATT switch to ON, will directly connect the main battery to the right main bus. Similarly, selecting to ON of the AUX BATT switch will connect the auxiliary battery to the left main bus.

The connections of the main and auxiliary batteries to the main buses are controlled by the EPCU logic. Conditions that require battery disconnection from the bus are the following:

- Emergency operation (defined later)
- Bus fault detected

Manually selecting the STBY BATT switch to ON will connect the standby battery to the left main bus. This connection is achieved electronically by the EPCU if the following conditions are met:

- DC external power (battery charge option) connected
- No emergency operation
- No bus faults detected

MAIN BATTERY, AUX BATTERY and STBY BATTERY caution lights come on whenever the related battery is not connected to its feeder bus. A battery temperature indicator on the MFD Electrical page, continuously shows Main, Aux and Stby battery temperatures when selected on the ESID control panel. High battery temperature will turn on the MAIN BAT HOT, AUX BAT HOT or STBY BAT HOT warning light, and cause associated temperature value on the MFD to turn red. The warning light will go out when the temperature drops below the overheat condition.

17 AMP HR Standby Battery-Forward Fuselage

The 17 AMP HR stanby Battery is re-located in the forward fuselage adjacent to the two 40 AMP

The charge characteristics of the 40 Ahr batteries are as follows:

Discharging Characteristics - The 40 Ahr batteries have a nominal voltage of 24 VDC (20 cells at 1.2 VDC/cell). This is the voltage that would be measured with a fully charged battery under a load equal to its ampere-hour rating, i.e. in this case 40 Ahr. The 'no-load' voltage as measured at the battery terminals approaches 28 VDC. This explains why the batteries will discharge with DC Ground power connected, particularly if the cart voltage is lower than 28 VDC. Battery reserves will be depleted at a higher rate, as the cart voltage is lower.

Charging Characteristics - In order to restore batteries to a full state of charge, charging voltage should be at least 1.4 to 1.6 VDC/cell, or 28 to 32 VDC. This is provided with any DC generator on line. However, if an external ground power cart has an output voltage of less than 28 VDC, the batteries cannot be recharged to full capacity, regardless of the time that voltage is applied.

When the DC External power cart output voltage is low, the discharge current from the batteries is not being supplied to the cart but instead supplied to the aircraft loads. When the batteries are online, the DC External cart and batteries are connected in parallel allowing current to be consumed by either source. If a low voltage output cart is connected with properly charged batteries online, as the case is after flight since the engine generators output 28.5 VDC to charge the batteries, the batteries will provide most of the current to the aircraft loads because charged batteries have a low internal impedance. As the batteries discharge, their internal impedance increases and most of the current to the aircraft loads is provided by the DC External cart. However by this time a significant portion of the batteries' reserve can be consumed. Also, it should be noted that even if the DC External cart and the batteries are at the same potential, there would be a small current flow from the batteries.

Based on the charge/discharge characteristics of NiCad batteries, it is evident that the external DC Power cart must have a voltage of at least 28 VDC or battery reserves will be depleted and cannot be fully restored.

Operators are advised, that if 28 VDC carts are not available or their voltage is lower than 28 vdc, the batteries should be isolated from the aircraft loads by selecting the BATTERY MASTER, MAIN, AUX and STBY battery switches OFF while DC External power is connected.

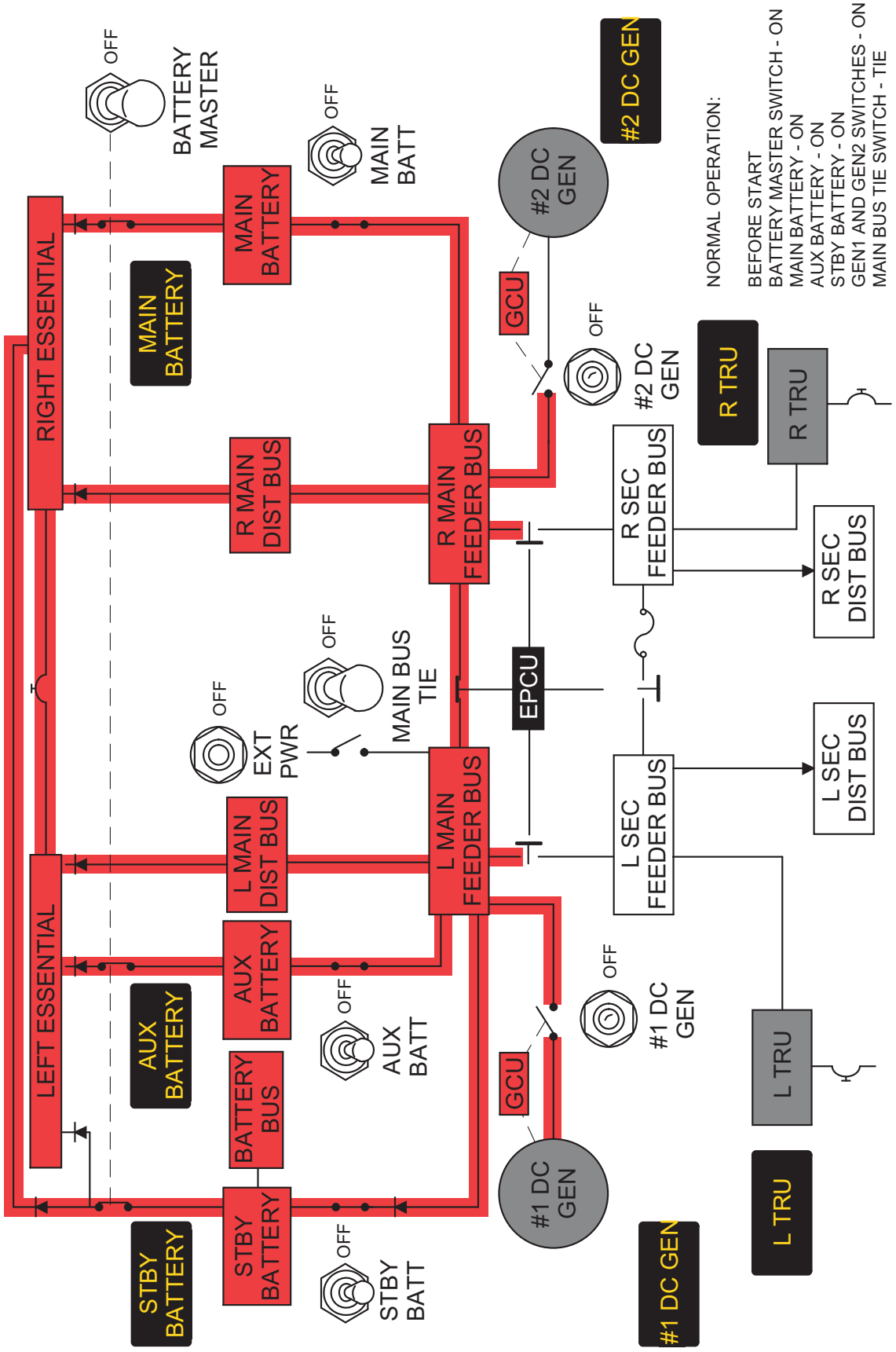


Figure 12.5-15 DC Power System Battery Power Only

12.5.6.2 Starter/Generators

The starter/generators are located on the accessory gearbox of each engine. Each starter/generator serves as a starter motor and will revert to generator operation if the DC GEN switch is in the ON position and the engine speed exceeds 50% NH following successful engine start. Each generator output is monitored and controlled by its Generator Control Unit (GCU). After engine start, the GCU ensures the generator supplies 28.5 VDC (400 Amps max) to its feeder bus regardless of load.

The EPCU will then monitor and control the DC EPGDS. The EPCU will turn on the #1 DC GEN or #2 DC GEN caution lights in the event the DC generator is disconnected from its feeder bus. If a generator overheat condition occurs, the appropriate caution light #1 DC GEN HOT or #2 DC GEN HOT will come on. The light will go out when the temperature drops below the overheat condition.

12.5.6.3 Transformer Rectifier Units

Located in the nose, the two Transformer Rectifier Units (TRU) change three-phase, 115-volt, variable-frequency AC input power into 28 VDC (300 Amps max) nominal output. The TRUs are unregulated but provide DC power in the range of 26 to 29 VDC during operation.

Under normal conditions, each TRU powers its respective secondary bus. The L TRU or R TRU caution light comes on if either TRU is off line or failed. The L TRU HOT or R TRU HOT caution light comes on if the sensor in either detects an overheat condition. The light will go out when the temperature drops below the overheat condition.

The two TRUs alone are capable of powering the entire DC system.

12.5.6.4 Auxiliary Power Unit (APU) Starter/Generator

The APU Starter/generator is located in the tail cone section of the aeroplane. The APU is designed to supply 28VDC to the essential main, and secondary DC buses on the ground.

A Contactor allows the connection of the APU Starter/generator to the right main feeder bus for APU starting and powering of the aeroplane DC buses. Its control is achieved from the APU GCU.

After the APU is started, the starter/generator is available to supply power in parallel with the batteries to start the aeroplane engines.

12.5.6.5 Fault Tolerant Operation

The DC Power subsystem is extremely tolerant to power source failures. It has four separate sources of DC power in flight. They are the two generators and two TRUs. When all DC power sources are operational, each source powers its own dedicated bus. When one or more source failures are detected, the EPCU will automatically reconfigure the power flow.

The EPCU monitors the system for failures. Once a failure is detected, the EPCU will cause the bus system to reconfigure and ensure mission completion with minimal effect for the EPGDS and for the utilization equipment power supply.

Four bus tie contactors are controlled by the EPCU that connect the appropriate feeder buses together when there are one or more inoperative DC power sources. The EPCU ensures operation of all DC buses with loss of up to two power sources. Automatic load shedding will occur only after more than two DC source failures.

The four contactors connect the following feeder buses:

- L Main to R Main
- L Secondary to R Secondary
- L Main to L Secondary
- R Main to R Secondary

For example, if one DC generator fails, the L to R Main bus tie closes and the other generator then powers both main feeder buses. If one TRU fails, the L to R secondary bus tie closes, and the other TRU then powers both secondary buses. If both DC generators fail, the vertical bus tie close, and the TRUs supply DC power to both the secondary and main buses. If both TRUs fail, the vertical bus tie close, and the DC generators supply power to both secondary buses.

The EPCU operates in emergency mode when:

- the aeroplane is in air and
- both DC Generators are not available and
- at least one TRU is not available

When the EPCU operates in emergency mode, it automatically disconnects the batteries from the main buses. The main buses are not powered in this mode. In case of emergency operation the batteries are the main energy sources for the aeroplane. If an engine start attempt is made during an emergency condition, the batteries will automatically be reconnected to the main buses for the duration of the start attempt.

12.5.6.6 Bus Fault Protection

The EPCU and the DC GCUs protection function protects the DC subsystem against short circuits on the main and secondary buses. The selectivity and protection coordination is ensured by the logic, detection and by reaction timing in these units.

12.5.6.7 Main Bus Failures

If a main bus fault occurs, the EPCU prevents the upper horizontal and two vertical bus ties from closing, isolating the bus. The DC BUS caution light comes on to warn of the fault impending condition.

If the fault persists after approximately 5 seconds, the EPCU sends a TRIP signal to the GCU, isolating the affected generator. The EPCU will also open and lock-out the contactors connecting the batteries to the affected main bus. The MAIN BATTERY or AUX and STBY BATTERY caution light(s) and related DC GEN caution light will come on as a result. The EPCU continues to monitor the operating buses. All main DC services on the faulted bus side will not function.

NOTE: Manual operation of the main bus tie through the MAIN BUS TIE switch is not possible once the EPCU has reacted to a fault.

If the fault subsequently clears, power may be restored with the BUS FAULT RESET switch.

12.5.6.8 Secondary Bus Failures

In the case of a secondary bus short, the over current condition will immediately trip the associated TRU primary circuit breaker. Seven seconds later, with the EPCU declaring TRU failed the contactor L to R Secondary bus tie will close, transferring the short circuit to the opposite side TRU. At that moment, the cross tie fuse is blown isolating the fault. This is indicated by a L TRU or R TRU caution light and loss of services on the associated secondary bus.

12.5.6.9 Engine Starting

The starting process is initiated by selecting an engine position using the SELECT switch from the Engine Start control panel. The starting process is initiated by depressing the START button. The power source (which feeds the main buses for the supply of the starter/generator) for the starting process can be different. Therefore, the availability of different power sources results in the following starting modes:

- Starting from batteries
- Generator assisted starting
- Starting from DC external power
- APU assisted starting

In all cases the BATTERY MASTER, MAIN BATT, AUX BATT, STBY BATT and MAIN BUS TIE switches are selected on prior to start.

a) Starting from Batteries

Only the main and auxiliary batteries, in parallel, participate in the starting process. The standby battery is diode isolated from to the left main, to ensure an acceptable level of voltage on the essential buses during engine start.

NOTE: Observe starter cranking limits.

NOTE: After an aeroplane NiCad battery start, the charge rate for fully serviceable batteries will decrease after approximately three minutes.

NOTE: Battery temperatures and charging rates must be continuously monitored on the MFD Electrical page, while charging.

b) Generator Assisted Starting

The generator assisted starting is usually performed, after the start up of an engine is finished (in any mode of starting). After the right DC generator is connected to the right main bus, together, in parallel with the batteries, will perform starting of the other engine.

During the start process and 15 seconds following it, the DC GCUs will be supplied with a ‘CURRENT LIMIT’ signal. This will limit the current the opposite side generator will contribute to the starting and also to limit the current the starter/generator (in generating mode) will supply to the loads.

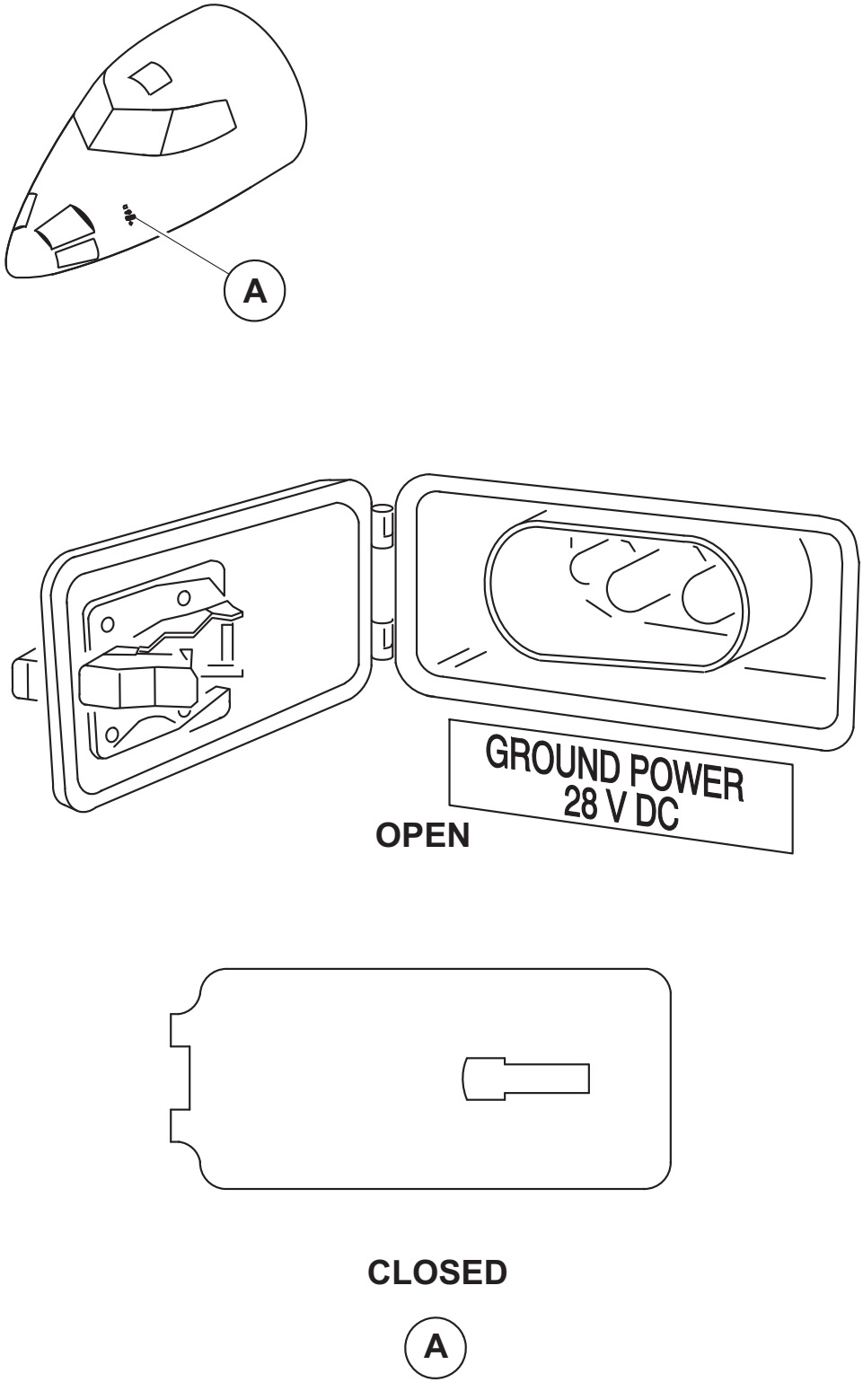


Figure 12.5-16 DC External Power Receptacle

c) Starting from DC External Power

A Ground Power Unit (GPU) can be connected to the DC external power receptacle (Figure 12.5-16) on the left side of the forward fuselage. The GPU can supply DC power for the aeroplane EPGDS and for engine starting (Figure 12.5-17). Contractors connecting the main and aux batteries to the main buses are closed automatically upon selection of engine start, as the main and auxiliary batteries assist in the start. The standby battery is diode isolated from the left main, to ensure an acceptable level of voltage on the ESS Busses during the starting process.

When the starting process is terminated the power source is still the external power. While DC external power is connected to the aeroplane, the generators connections to the main buses is inhibited by the EPCU. The main and auxiliary batteries stay connected to the main buses and the standby battery is reconnected.

Once the DC EXT PWR switch is turned off after engine start, the generators will come on line if the GEN switches are in the ON position. Both vertical bus ties connecting the main to the secondary buses will remain closed until DC power is available from the TRUs.

The EPCU incorporates external DC power protection from too high or too low supply of external DC power voltage. If the external voltage is more than 31+0.5/-0.75 VDC, or less than 22 ± 1 VDC, an over/under voltage condition will cause the external ground power to stop supplying electrical power to the aeroplane. If the external power over/under voltage is rectified, the external power source can be reselected by moving the DC EXT PWR switch to OFF and then to EXT PWR.

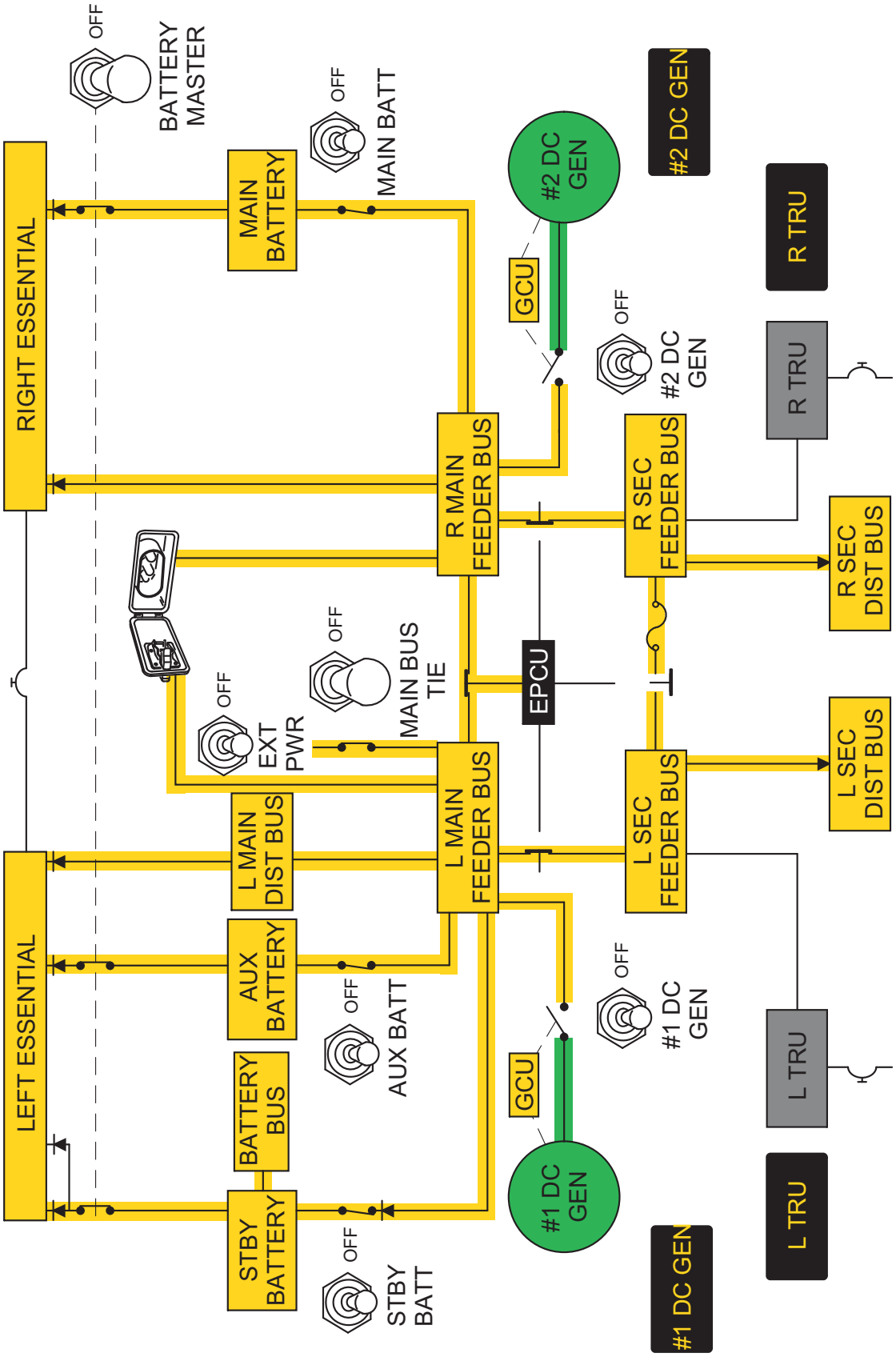


Figure 12.5-17 External DC Power Schematic

12.5.7 AC System

The AC electrical schematic is shown in Figure 12.5-18.

Electrical power sources for the AC portion of the EPGDS include:

- Two alternating current variable frequency generators
- AC External

The power sources supply power to the following buses in order of priority:

- Left or Right AC bus
- Left or Right Galley bus

During normal mode of operation, one AC source supplies its dedicated bus. AC power is required for the following systems:

- De-icing/Anti-icing heaters
- Standby hydraulic pump
- Galley loads
- Transformer Rectifier Units (supplements DC power)
- Auxiliary fuel pumps

AC Electrical Outlet

A 115 V AC, 15A, 400 Hz electrical outlet for vacuum cleaning requirements is installed on the inboard face of the G1 galley.

12.5.7.1 Variable-Frequency AC Power

Two 115 V, 45 KVA AC generators (mounted on the propeller reduction gearbox) supply variable frequency (340 to 560 Hz) AC power. The AC power is supplied to the left and right AC buses. AC power sources are prevented from being operated in parallel.

AC power is available once the condition levers are out of START & FEATHER in the MIN/850 to MAX/1020 range, and the GEN 1 and GEN 2 switches on the AC CONTROL panel are on.

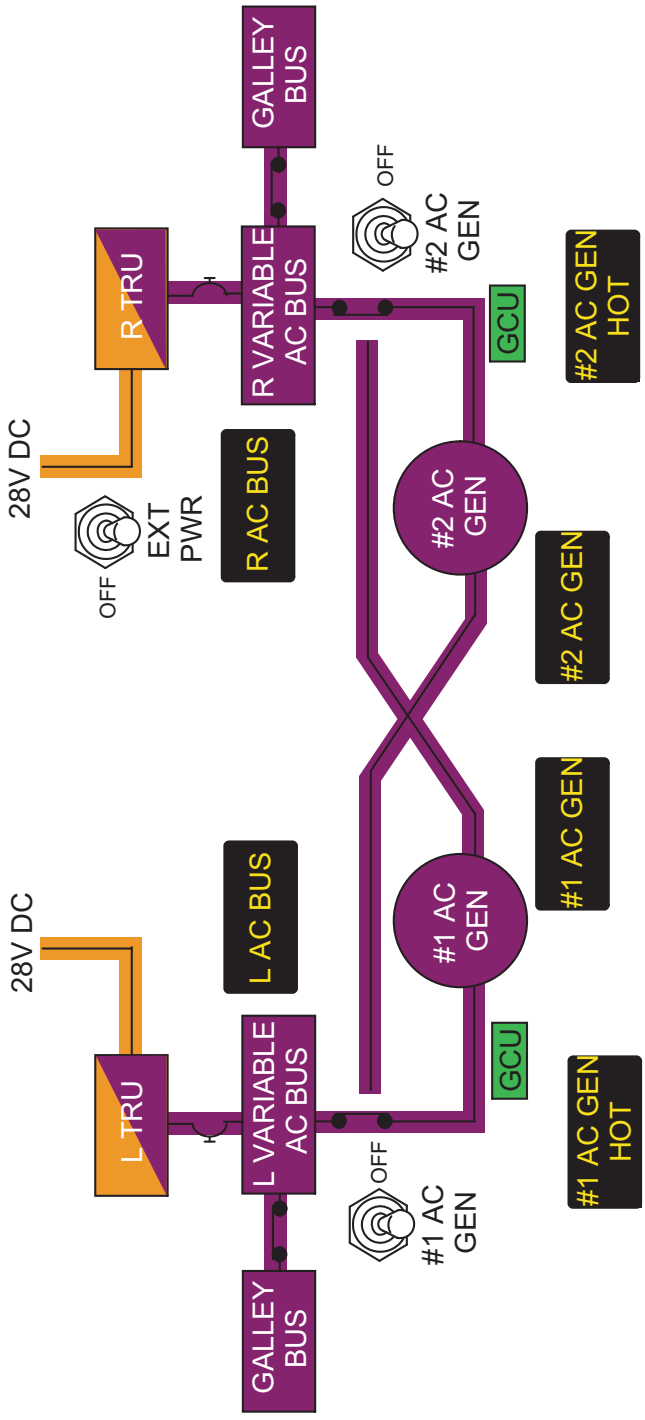
If one AC generator fails, the #1 AC GEN or #2 AC GEN caution light comes and the remaining generator is capable of carrying the aeroplane's AC electrical load except galley power. An automatic cross tie function, controlled by the AC GCU logic circuits, ensures that all variable-frequency buses are powered when only one AC generator is on line. Whenever a fault condition exists, the GCU of the inoperative generator issues a transfer request signal to the operational side AC GCU. The operational side AC GCU will issue a CLOSE command to the failed side line contactor. In this configuration, the remaining generator will power both AC buses. In this situation the load shedding relays will not allow power to the galley buses.

The AC generators are protected from bus faults by the GCUs that detect any excessive load that might result from a short circuit on a bus. Once a heavy load is detected, the GCU isolates the bus, and turns on the appropriate L AC BUS or R AC BUS caution lights.

The # 1 AC GEN HOT or # 2 AC GEN HOT caution lights come on whenever an AC generator overheats. The AC generator must be switched off.

NOTE: All AC and DC aeroplane services can be operated from the AC generators or the AC external power alone.

NOTE
Condition levers above start and feather.
Min/850 to Max/1050 RPM range.
AC GEN1 and AC GEN2 switches on.



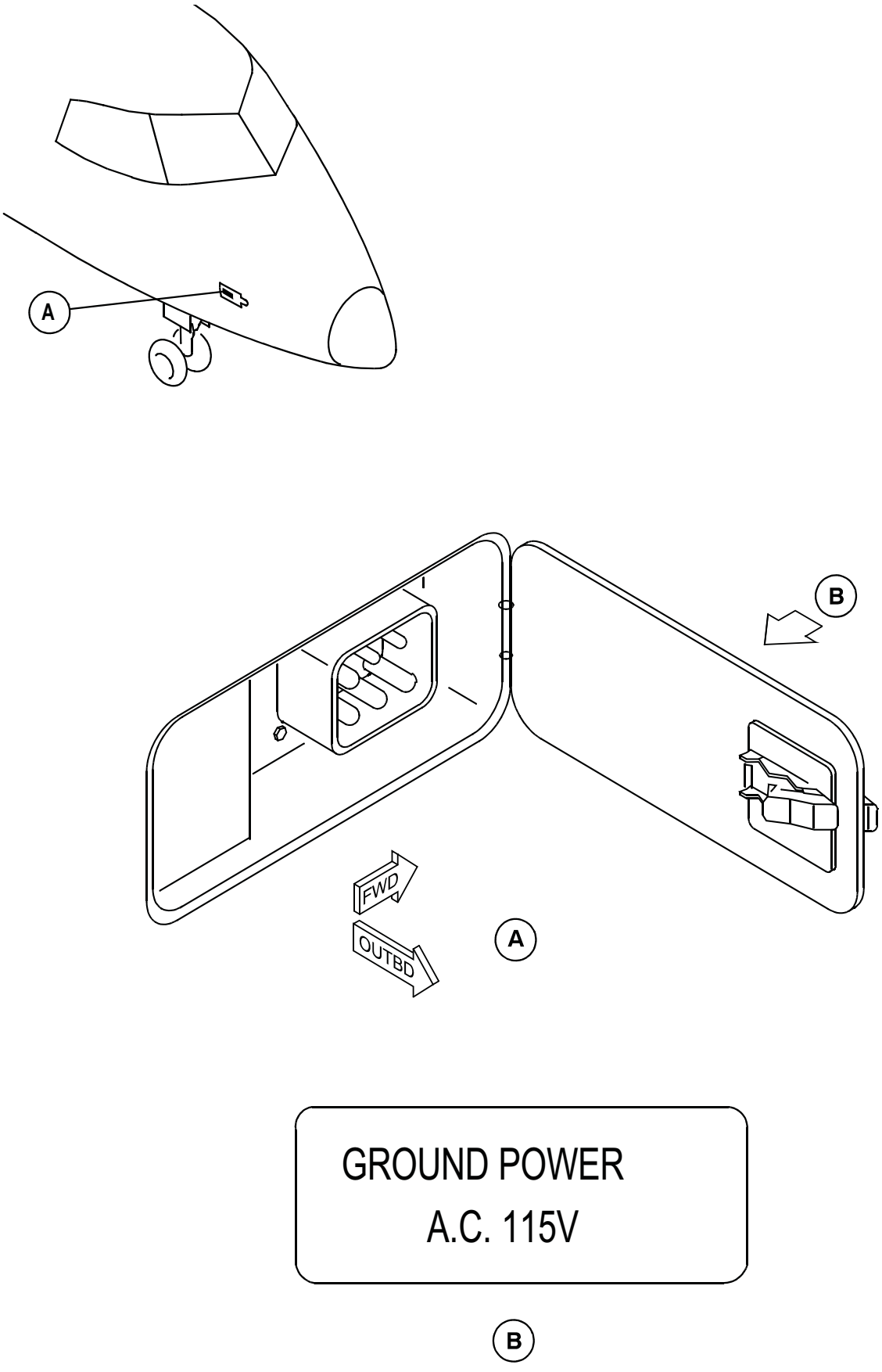


Figure 12.5-19 AC External Power Receptable

12.5.7.2 AC External Power

Location of the AC Ground Power Connection

A GPU can be connected to the AC external power receptacle on the forward right hand fuselage near the nose cone (Figure 12.5-19), to supply AC power to the aeroplane.

An external power switch on the overhead AC CONTROL panel (Figure 12.5-5) connects power directly to the left and right variable-frequency buses, supplying power to all AC and DC buses.

The External Power Protection Unit monitors the qualities of the incoming power. The external power must be within acceptable limits, otherwise the external power is rejected.

12.5.7.3 External Power Protection

An External Power Protection Unit (AC PPU) is installed on the right ACCB to make sure the external ground power is within specified limits before supplying power to the aeroplane busses. The AC PPU monitors the following parameters:

- Undervoltage
- Overvoltage
- Underfrequency
- Overfrequency
- Phase Rotation (A-B-C)

12.5.8 Circuit Breakers

The EPGDS utilizes passive protections in the form of circuit breakers and current limiters. Circuit breakers are protection devices that open the circuit in case of excess current flow. Circuit breakers protect electrical system power sources, component control circuits and bus distribution.

There are circuit breakers on:

- Four flight deck circuit breaker panels
- DC Contactor box in the nose compartment
- AC contactor boxes in the left and right main landing gear wheel wells
  Two wardrobe circuit breaker panels

Each circuit breaker is identified by the:

- Circuit breaker panel
- Electrical bus
- Identification label
- Alphanumeric location.