2.16. ELECTRICAL SYSTEM

2.16.1 ELECTRICAL SYSTEM EQUIPMENT

Electrical power is supplied by a 28 volt, direct current, negative ground electrical system.

Two 28 volt, 400 ampere, D.C. starter/generators in parallel provide torque for engine starting and generate D.C. electrical power.

One 25.2 volt, 38 ampere hour nickel-cadmium battery, located in the front section of the rear baggage compartment, provides power for starting and also serves as reserve source of emergency electrical power in the event of dual generator failure.

One Emergency Power Unit (EPU) with a capacity of 5 ampere hour, installed behind the cockpit instrument panel, provides power to emergency equipment in the event of total aircraft electrical power failure.

The electrical system is automatically protected from overvoltage and reverse current.

An external power receptacle, located on the left side of the fuselage just above the main gear well, allows the use of an external auxiliary power source either to start the engines or to allow an extended ground check of electrical equipment.

CONTROLS

The switches for controlling the electrical system are located in the MASTER SWITCHES panel on the central section of the instrument panel and in the ENGINE/PROPELLER panel on the control pedestal:

– the two three-position switches, placarded GENERATOR L-OFF-RESET (left) and R-OFF-RESET (right), allow controlling the corresponding generator through individual control units;

– the two-position battery switch, placarded BAT-OFF, controls the power delivery from the battery to the bus system through the battery relay;

– the three-position bus switch, placarded EMER-NORM-BUS DISC, provides control of the busses interconnection system;

– the AVIONICS ON-COM1 ONLY-OFF master switch controls the power delivery to the entire avionic equipment or to the primary VHF communication system only;

– the three-position switch, placarded EPU ARM-OFF-TEST, controls the Emergency Power Unit connection and test;

– the L START-OFF and the R START-OFF start switches control the starter operating mode of the generators (ref. Figure 2.13-1).

The electrical system is monitored through the MFD System Page (ref. to Paragraph 2.7-2). When selected, the System Page displays the following electrical system information:

– the output current of each generator (L and R GEN AMPS)

– the system voltage at the essential bus (BUS VOLTS)

– the battery temperature (BAT TEMP)

– the external power connection status (EXT POWER).

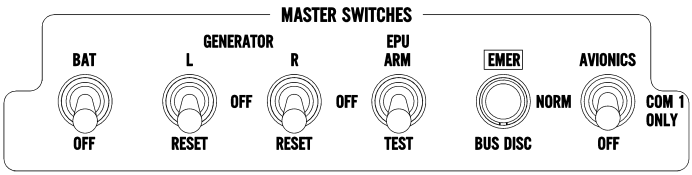


Figure 2.16-1. Electrical System Master Switches

STARTER/GENERATORS

The starting power is delivered to each starter/generator from the battery bus through individual starting relays. Momentary depressing to the START position each springloaded start switch, the corresponding starter/generator control unit initiates the starting cycle converting the generator to the starter mode and actuating the engine ignition unit. As the engine reaches the 40% N_G speed, the start switch automatically resets and the starting power is disconnected: at this point the starter/generator is driven by the engine. After the 54% N_G speed has been reached the generator can be used provided the corresponding switch is moved from the OFF to the L (or R) position.

The cross start system provides generator power to assist the battery in starting the second engine. A generator assisted start is accomplished by engaging the operative engine generator. The inoperative engine will receive power from both the battery and the running generator when the start switch of the engine to be started is moved to the START position.

Resetting a generator after it has been de-energized by its own control unit requires that the corresponding GENERATOR switch is pushed to the momentary RESET position and then raised to the L (or R) position. The resetting circuit of each generator is protected by the corresponding L or R GEN RESET 3-ampere circuit breaker on the pilot circuit breaker panel. The L GEN and R GEN amber caution lights on the annunciator panel come on when the corresponding generator is either disengaged or failed.

The L and R GEN/START INTLK remote control circuit breakers, located on the copilot circuit breaker panel, protect the output line from each generator and the corresponding control unit.

Each starter/generator control unit performs the following operating functions:

– output voltage regulation

– generators paralleling (load division control)

– overvoltage protection

– overexcitation protection

– reverse current protection

– automatic start cycle control.

BATTERY

The battery is permanently connected on the hot battery bus while it can be connected on the bus system only by setting to the BAT position the battery switch. A temperature probe installed on the battery allows monitoring the battery temperature that will be displayed on the MFD System Page. In addition a BAT TEMP amber caution light and BAT OVHT red warning light are provided on the annunciator display to alert the pilot: the BAT TEMP light will come on when the battery temperature reaches 120 °F (battery warm), while the BAT OVHT light will come on when the battery temperature reaches 150 °F (battery overheat).
On the MFD System Page the battery temperature (BAT TEMP) digital readout remains green when temperature is less than 120°F, turns yellow when it is greater than or equal to 120°F, turns red when it is greater than or equal to 150°F.

Engine battery starts must be avoided if the battery is warm (above 120 °F) in order to prevent a possible battery destruction. In this condition secure ground power unit assist.

When a battery start or heavy charging is in progress the battery temperature will increase. The BAT TEMP light may come on, but this is not a warning, just a caution. If the BAT OVHT light (150 °F) comes on isolate the battery as soon as possible and allow to cool, but continue to monitor the temperature.

NOTE

If the battery temperature reaches 150 °F, either during start or in flight, the battery must be turned off and removed for bench test inspection prior to the next flight.

After engines are started and generators are running, note the battery temperature. If the temperature has risen to 140 °F or above do not take off until the temperature has decreased to 120 °F and descending. After the takeoff observe that the temperature continues to drop: the BAT TEMP and the BAT OVHT lights should be off.

Subsequent to the takeoff and the flight if the BAT TEMP comes back on and the temperature is in the caution range, the crew should monitor the trend. If the temperature continues to rise, disconnect the battery at 140 °F and run on the generators.

If the temperature continues to rise after disconnection land the airplane as soon as practical. If running on generators only, when approaching terminal area, if the battery has cooled below 120 °F, place it on the bus to land in order to prevent total power loss during engine idling. If the BAT TEMP light comes back on turn the battery off, exercise caution, and notify tower of the problem before landing.

The battery temperature monitoring system is fed by the essential bus through the 3-ampere BAT TEMP circuit breaker located on the pilot circuit breaker panel.

EMERGENCY POWER UNIT

The Emergency Power Unit (EPU) is connected to the Left Single Feed Bus through the EPU 15-amperes circuit breaker located on the Pilot's CB Panel. During normal operation the EPU switch, on the MASTER SWITCHES control panel, is set to ARM, and the Left Single Feed Bus supplies necessary charging voltage to the EPU battery and the following emergency equipment which are connected to the Emergency Power Bus (EPB):

– Integrated Standby Instrument (ISI)

– Landing gear position lights

– VHF COMM1 (Emergency Mode only)

– emergency lighting of ISI bezel and Magnetic Compass.

In the event of dual generator failure the EPB power supply is automatically provided by the EPU for about 30 minutes.

The EPU DRAIN amber caution light, on the annunciator panel, comes on when:

– after engine starting the EPU switch, on the MASTER SWITCHES control panel, is set to OFF;

– the Left Single Feed Bus power is unavailable and the EPU begins to supply the EPB (EPU switch set to ARM);

– during the EPU test (EPU switch set to TEST), the battery capacity is less than 50%.

EXTERNAL POWER

The external power socket connects on the bus system through a relay that actuates the connection only if the external power source is properly plugged in (correct polarity) and the battery is on (battery switch in BAT position). The specially shaped external power socket prevents the connection with inverted polarity. While the external power source is connected the EXT POWER green annunciation is displayed on the MFD System Page.

NOTE

The external power source used for starting engines should have a peak capacity of at least 1200 Amps at 28 Volts D.C. and a maximum continuous capacity of 400 Amps.

The overvoltage protection, installed on the external power supply line, provides the airplane D.C. system automatic disconnect from the ground power unit should an overvoltage condition occur. The ground power unit operation is automatically recovered as soon as the voltage goes down to the normal range.

2.16.2 POWER DISTRIBUTION

D.C. electrical power supply is divided into separate busses in order to provide for safety and redundancy in the electrical distribution system.

Nine primary feed busses are provided:

– one essential triple feed bus
– two dual feed busses (left and right)
– two single feed busses (left and right)
– two generator busses (left and right)
– one battery bus
– one hot battery bus

The essential bus is fed from the battery and both generators. The left and right feeding line are individually protected by a reverse current diode and a circuit breaker, whilst the center feeding line (from the battery bus) is protected by a reverse current diode and the 35-ampere ESNTL BUS FEEDER circuit breaker located in the main junction box circuit breaker panel. The ESNTL BUS 25 Amp. circuit breakers from the generators are located on the pilot and the copilot circuit breaker panels. The system ensures the essential bus operation also in the event of independent failures on two of the three feeding lines.

The dual feed busses are fed from the battery and from the corresponding side generator. Each feeding line is protected by a reverse current diode and the 35-ampere LH and RH DUAL BUS FEEDER circuit breaker located in the main junction box circuit breaker panel. The L and R DUAL FEED BUS 35 Amp. circuit breakers from the generators are located on the pilot and the copilot circuit breaker panel respectively. The dual feed busses fail to supply the related loads when failures occur on both feeding sources.

The single feed busses are fed from the corresponding side generator through individual 90 Amp. circuit breakers located in the main junction box.

The generator busses, the battery bus and the hot battery bus have no special protection due to the reduced size and the very close position of the feeding source.

To ensure safe flight operations the electrical loads are assigned to the various busses according to their functions.

D.C. electrical power to the avionics equipment is supplied through five auxiliary busses:

– the essential avionics bus, fed from the essential bus
– the left avionics dual bus, fed from the left dual feed bus
– the left supplementary avionics bus, fed from the left dual feed bus
– the right avionics dual bus, fed from the right dual feed bus
– the right avionics single single bus, fed from the right single feed bus, for optional equipment.

Two DC-DC Converters are installed to provide a stable voltage power supply to the pilot's PFD and the MFD, and to the backup inputs of ADC and AHC during undervoltage operations. During engine start procedure or in-flight engine restart, primary attitude, heading and air data information, as well as engine parameters information, are therefore always provided.
The DC-DC Converters are fed one by the essential bus and the other by the essential avionics bus through dedicated circuit breakers on the pilot's circuit breaker panel.

During normal operations all the busses are interconnected acting as a single bus system with power being supplied from the battery and both the generators. When a failure occurs, the affected bus disconnects from the related feeding sources and from the other busses in order to prevent more serious damages.

When either one or both generators are properly operating and the bus switch is in the NORM position all the busses are interconnected. In the event of both generators failure the three bus-interconnecting relays automatically open disconnecting the busses while the BUS DISC amber caution light on the center display panel comes on. The essential bus only remains powered by the battery (as well as the battery bus and the hot battery bus), feeding all the loads essential for the flight in emergency condition. The pilot can re-connect the dual feed busses to the battery, if necessary, by setting the bus switch to the EMER position.

WARNING

In this condition, in order to avoid a too rapid discharge of the battery, disengage all equipment not strictly required by acting on the respective control switch or circuit breaker.

When the bus switch is set to the BUS DISC position the three bus-interconnecting relays open separating the busses and allowing the pilot to investigate for localizing failures.

Two thermal overload sensing controls are provided at the generators busses connections on the battery bus. If an overcurrent occurs, the overload sensing controls actuate the three bus-interconnecting relays that open separating the busses: the BUS DISC caution light comes on and the BUS DISC 3-ampere circuit breaker on the pilot circuit breaker panel trips out.

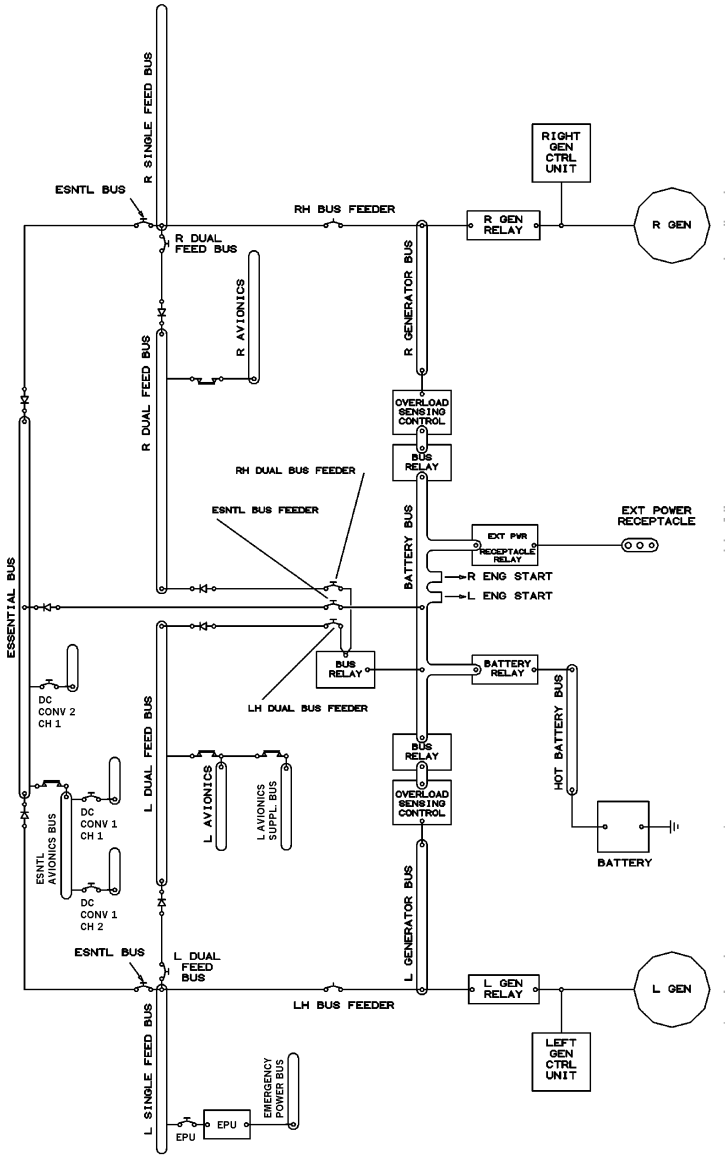


Figure 2.16-2. Power Distribution Diagram

ESSENTIAL BUS	L DUAL FEED BUS	R DUAL FEED BUS	R SINGLE FEED BUS
MASTER AVIONICS	AOA HEATER	R OIL COOLER	LTS DIM 2
COMM 1	TAT HEATER	AVIONICS FAN NOSE	LTS DIM 1
AUDIO 1	L FUEL QTY	BOOTS DE-ICER	DBU
SEC PITCH TR M	L FUEL FIREWALL SOV	R WING HEATER	CKPT BLOWER
AURAL WRN	L ENG ICE VANE	R FUEL FIREWALL SOV	COP LOT PFD HTR
ICE DETECTOR	L BLEED A R	R ENG ICE VANE	READING LTS
RTU	L WING HEATER	R BLEED AIR	COOL PWR
ANN LTS 2	L FUEL FLOW	CABIN PRESS	PASS ADVSY LTS
R ENG START	PRI PITCH TR M	AUTOFEATHER	R PITOT/STATIC HTR
L ENG START	L EDC	TAXI LT	R FWD W NG HEATER
IGNITION SYSTEM	L OIL PRESS XDCR	R EDC	
BUS DISCONNECT	L ENG TORQUE XDCR	R FUEL FLOW	SEC WSHLD CONT
R DC GEN RESET		R FUEL QTY	FIRE DETECTOR TEST
L DC GEN RESET		PROP SYNC	HEATERS
FLOOD LIGHTS		R OIL PRESS XDCR	TR M POS IND
FUEL CROSSFEED		R ENG TORQUE XDCR	ANTI COLN LTS/GND BEACON
W NG OVHT		LTS DOOR ACTR	R LDG LT
ANN LTS 1			CLOCK
OXY VALVE			WING NSP LT
STALL WRN			R MA N FUEL PUMP
LDG GEAR CTRL			REC LT
NOSE STEER NG			L/R OVERSPEED TEST
R DCU			
L DCU			
HYDR WARN NG/PRESS			
L PITOT/STATIC HEAT			
	L AVIONICS DUAL FEED BUS	L AVIONICS SUPPL. BUS	R AVIONICS SINGLE FEED BUS
(DC CONV 2 CH 1)			
MFD	FGC1 SERVO A L/RUD	L IAPS	XPNDR 2 (opt)
CCP	FGC2 SERVO ELEV	CDU	FSU (opt)
		EC	TCAS 1 (opt)
			SATCOM DIALER (opt)
			SATCOM (opt.)
			HF COMM CTRL (opt)

ESNT AVIONICS BUS	L SINGLE FEED BUS	EMERGENCY POWER BUS	R AVIONICS DUAL FEED BUS
CVR (opt.)	PILOT PFD HEATER	STBY INSTR	GPS 1
XPNDR 1	PRI WSHLD CONT	LDG GEAR POS LTS	ELT
ADC 1	L OIL COOLER	EMER LTS	DME 1
AHC 1	L FWD WING HEATER		COMM 2
	L LDG LT		NAV 2
NAV 1	POS LIGHTS		TAWS (opt)
L DCP	YAW TRIM		RADIO ALTM
	ROLL TR M		AUDIO 2
(DC CONV 1 CH 1)	L MAIN FUEL PUMP		
L PFD	MFD HTR		WEATHER RDR
ADC 1 SEC			R-IAPS
			R PFD
(DC CONV 1 CH 2)			AHC 2
AHC 1 SEC			ADC 2
			R DCP

L GENERATOR BUS	R GENERATOR BUS	BATTERY BUS	HOT BATTERY BUS
AUX 1 (opt)	AIR COND PWR	R ENG START	R FUEL FIREWALL SOV
HTR FAN	R GEN CTRL	L ENG START	BATTERY RELAY
PILOT WSHLD ZONE 2 ANTI-ICE	PILOT WSHLD ZONE 6 DEFOG	PRI PITCH TRIM POWER	L FUEL FIREWALL SOV
UTILITY	R FWD WING ANTI-ICE	R STBY FUEL PUMP	GND TEST PNL
L FWD WING ANTI-ICE	HYDR PUMP MOTOR	L STBY FUEL PUMP	REFUEL
P LOT WSHLD ZONE 5 DEFOG	PILOT WSHLD ZONE 1 ANTI-ICE		ENTRY/BAGGAGE LT
FLAPS	HF COMM XCVR (opt)		R FIRE EXT NG (opt)
L GEN CTRL	AUX 2 (opt)		L FIRE EXT NG (opt)

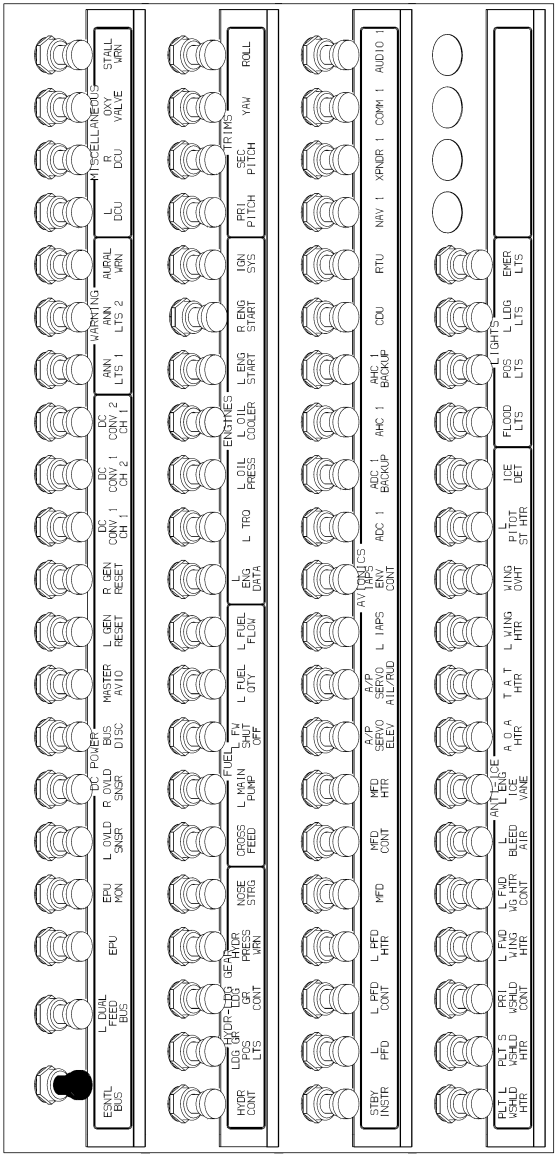


Figure 2.16-3. Left Circuit Breaker Panel (Typ.)

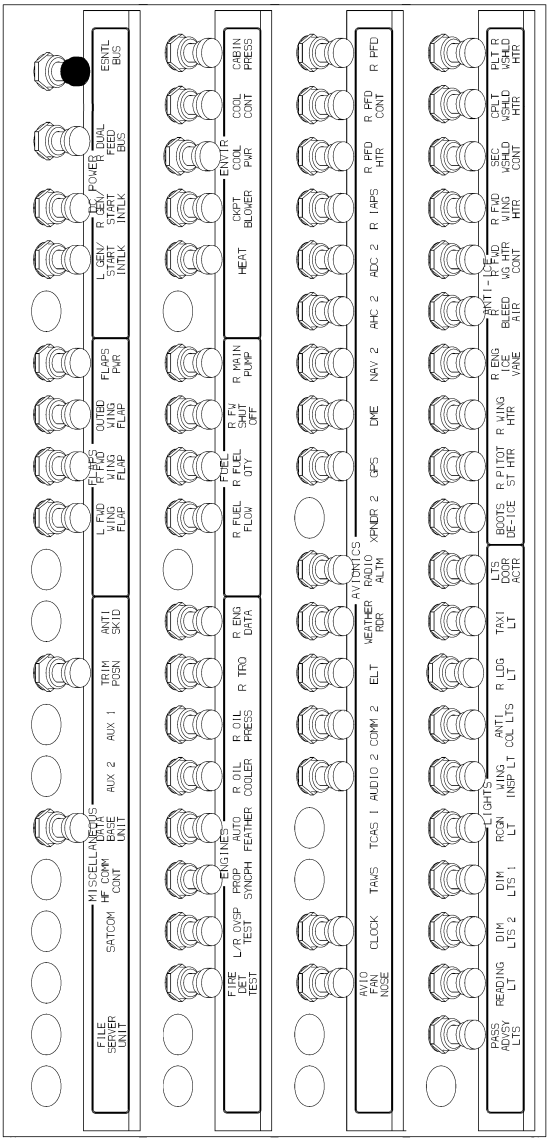
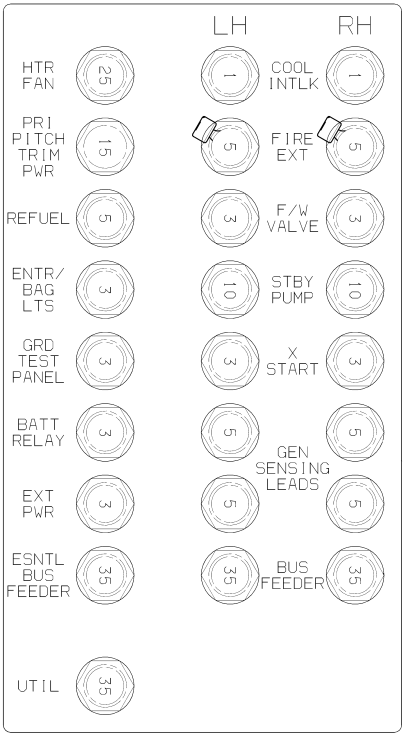


Figure 2.16-4. Right Circuit Breaker Panel (Typ.)



NOTE

This circuit breaker panel is located in the baggage compartment and cannot be reached during flight.

Figure 2.16-5. Main Junction Box Circuit Breaker Panel

2.16.3 AUXILIARY POWER SOCKETS (OPTIONAL)

At customer option, suitable auxiliary D.C. electrical power sockets can be installed flush-mounted on the cabin floor and concealed under protection covers. Such electrical power provisions allow feeding of specific 24 Vdc role equipments to be arranged in the cabin.

The optional cabin auxiliary power sockets connect to the feeding bus through adequate (depending on the equipment loads) remotely controlled circuit breakers installed in the main junction box. The related control circuit breakers, located on the copilot circuit breaker panel, are placarded AUX# in numerical sequence.

NOTE

The use of the auxiliary cabin power sockets is subject to the manufacturer approval with reference to electrical loads, kind of operations, and compatibility of the connected equipment.

Furthermore two optional power sockets, used to feed 12Vdc loads, can be installed, at customer option, on the left and right sidewalls of the cabin. The two sockets are powered by a 14Vdc Auxiliary Power System consisting in a DC/DC Converter, installed inside the cabin baggage compartment, fed by the Left Generator Bus through the 5 ampere AUX PWR circuit breaker installed on the Utility C/B Panel.