ELECTRICAL POWER SYSTEM

DESCRIPTION

The electrical system operates on 28 Vdc power, generated by a starter-generator mounted on each engine. (See LIMITATIONS, SECTION I, DC STARTER - GENERATOR LIMITS, page I-26).

Each engine-driven starter-generator is connected to its respective No. 1 and No. 2 main bus through line contactors. When functioning as a starter, each is energized from the battery bus through its respective contactor. It functions either as starter or generator - never as both, simultaneously,

Two aircraft batteries are installed; they can power the electrical system for limited time, start engines or assist the generator or the external power system during start.

External power system, with overvoltage protection, is available to charge the batteries, start the engines with the batteries and energize the entire electrical system.

The APU starter-generator is able to operate in parallel with the main generators. The APU generator supplies 28 Vdc for ground and flight operations up to 35,000 feet. It is also capable of supporting the batteries for engines starting. The APU generator is rated for a load of 300 A during ground operations and in flight up to an altitude of 25,000 ft, and 250 Amps above 25000 feet.

A network of buses, interconnected by circuit breakers and contactors for safety and flexibility, distributes dc power. All components, controls and wiring are installed in such a manner that failure of one unit will not adversely affect operation of other units essential for safe operation of the aircraft.

AIRCRAFT ELECTRICAL POWER CAPABILITY

Main (Engine Driven) Generators:

Two 28 Vdc generators, one driven by each engine, rated at 300 A each, operating in parallel giving a total power capability of 570 A

APU Generator:

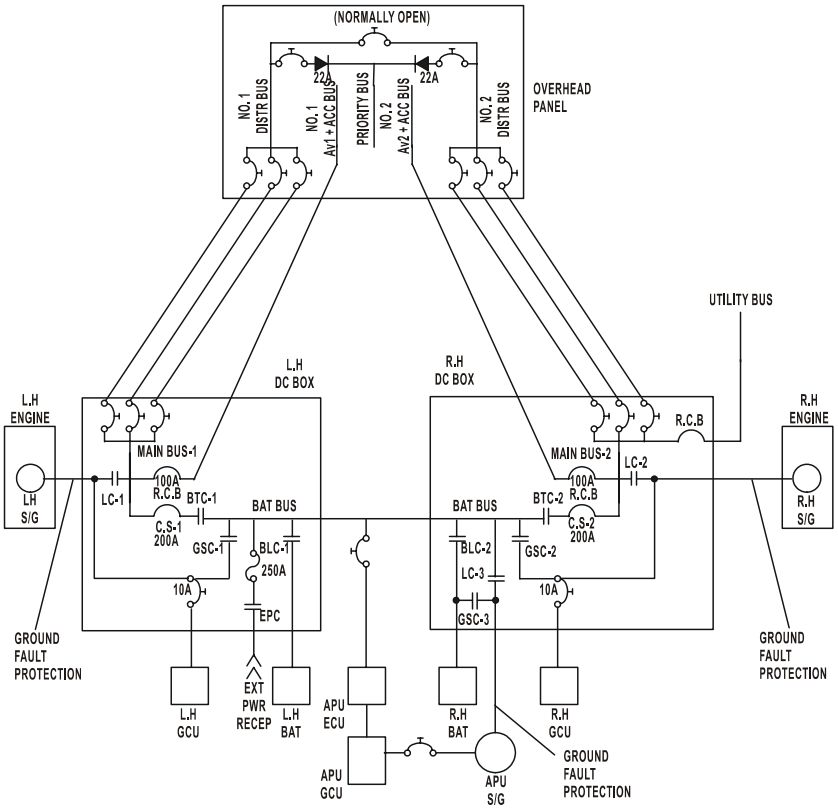
28 Vdc, rated at 300 A

Batteries:

Two 27 AH each

External Power

28 Vdc, 250 A, for continuous operation.



BLC - BATTERY LINE CONTACTOR
GCU - GENERATOR CONTROL UNIT
GSC - GENERATOR START CONTACTOR
OVR - OVERVOLTAGE RELAY
ASR - AUXILIARY START RELAY
EPR - EXTERNAL POWER RELAY
EPR - EXTERNAL POWER CONTACTOR
BTC - BUS TIE CONTACTOR
RCB - REMOTE CIRCUIT BREAKER
LC - LINE CONTACTOR

Figure 7-24-1. Electrical Power Generating System - Schematic

SYSTEM COMPONENTS

Starter-Generator

Each engine has one starter-generator mounted on the accessory gearbox center drive pad. Each starter-generator is cooled by ambient air supplied through a scoop below the engine air inlet. Each generator is rated at 30 volts and 300 amperes, at speeds from 6,700 to 12,000 rpm. Maximum continuous operating limit is 300 amperes on ground and in flight.
Generator output and load paralleling are automatically regulated and each generator is protected against overvoltage and feeder faults by a respective generator control unit (GCU) and associated circuitry. Overvoltage, feeder fault or over excitation will trip the respective GCU, thus deenergizing generator magnetic field and triggering the respective GEN OFF (L/R) message on the EICAS if both GEN OFF (L/R) messages are on, both windshield and side window heat is off.

If a mechanical malfunction (such as bearing failure) causes the generator to overheat, the GEN OVERHEAT (L/R) message comes on.

Automatic protection circuits normally sense any generator malfunction and deenergize the generator magnetic field; therefore, it is rarely necessary to do it manually. If it ever does become necessary, it is accomplished by pulling GEN CONTR cb.

Three generator control units (GCU), one for each generator, are located above the service compartment. The GCU incorporates the following functions:

- Voltage Regulation
  The GCU regulates generator output to 28.5+0.4 - 0.7 volts during all load and environmental conditions for which the generator is designed. Voltage can be adjusted at the GCU from 26 to 30 volts.

(Continued)

- Load Division
  The GCU divides the load, when both generators are functioning, so that the load difference between the two does not exceed 30 A.

- Overvoltage Protection
  An overvoltage sensing circuit in the GCU continually monitors the generator output voltage. When the voltage exceeds a preset level, the generator is deenergized without deenergizing the other generator system.

- Starter Field Current Control Field Weakening
  The starter field current control (field weakening) circuit in the GCU controls the field flux of the starter to achieve maximum output torque at low starter rpm and still permit the starter to reach the relatively high rpm existing at starter cutout.

- Current Limit (Generator) Control
  Each GCU regulates its generator to a load not greater than 300 A (400 A during opposite engine start). This is done by lowering the voltage output of the generator electronically.

- Overspeed (Runaway) Protection
  This protection prevents an unloaded unit from running away (if a shaft breaks) during starting.

- Generator (Line) Contactor Control
  The generator contactor control automatically connects the generator output to the generator bus when GENERATOR switch is ON and the generator output voltage has risen to within 0.3 Vdc of the main bus voltage.

- Reverse Current Protection
  The GCU automatically trips the generator line contactor thus removing the generator from the bus when a voltage greater than +0.22 volts appears across the generator equalizer terminal.

(Continued)

- Feeder (Ground) Fault Protection
  A current flow within the protected zone of an individual generating system to ground removes that system from the generator bus.

- Overexcitation Protection
  The protection de-energize the overexcited generator if the generator bus voltage is 28.5 V or greater and the output current differential between the generators is greater than 15% for more than 5 seconds.

BATTERIES

Two 24 volts, 27 AH 20-cell, nickel-cadmium batteries are installed in the battery compartment. When the BATTERY switch is in ON position, the battery line contactors (BLC) connect the batteries to the battery bus. The batteries, operating in parallel, are used to start a main engine. As soon as the generators start supplying power, the batteries are charged by the generator at a regulated 27 Vdc for two minutes, and then at the normal 28.5 Vdc. The batteries may also be charged by external power.

Each battery is contained in a stainless steel case with removable cover. The batteries are vented overboard through hoses connected to the battery case vent ports. The vent system produces airflow around the batteries.

A thermistor is installed in each battery with output driving battery temperature indication displayed on the EICAS and a BATT OVERHEAT (L/R) message is triggered when battery temperature exceeds 140°F.

OPERATION OF MAIN GENERATORS

During normal operation, the left and right generators supply dc power to No. 1 and No. 2 main buses, respectively. Each main bus then supplies dc power to the respective distribution bus through three feeder cables. Each cable is protected by a circuit breaker at each end: three circuit breakers for each bus, DISTR BUS L FDRS and DISTR BUS R FDRS are on the overhead panel, three circuit breakers for each bus are in the respective dc box and are inaccessible during flight.

A DISTR FEEDER OPEN (L/R) message for each bus comes on only when the respective cb on the dc box trips. A fault in any feeder cable trips its cb in the dc box and respective overhead panel circuit breaker. A fault between the circuit breaker and the dc box, such as at the overhead panel trips only the circuit breaker and the DISTR FEEDER OPEN (L/R) message does not come on. In this case the circuit can be reset. Reset may be attempted only when the message is not on. When the message comes on, with one cb tripped, the unaffected feeder cables will continue to supply the distribution bus and no corrective action is required.

Failure of two feeder cables will probably be followed by failure of the third feeder cable. When all three feeder cables fail (indicated by failure of all consumers of the affected distribution bus) the respective distribution bus is disabled. A disabled bus may be repowered from the remaining operative bus by closing (the normally open) DISTR BUS TIE cb. See DISTRIBUTION BUS FEEDER FAILURE, page III-35

BUSES CONNECTION

Priority Bus

A priority bus in the dc electrical system ensures continuous supply of electrical power to certain critical equipment. Power is supplied to the priority bus by both distribution buses through diodes and circuit breakers.

Main buses

Power to charge the batteries is supplied from no. 1 and no. 2 main buses, through the (normally closed) bus tie contactors and current sensors. Since both generator systems are interconnected through the bus tie contactors and battery bus, they normally operate in parallel and form an integrated electrical system.

Each main bus also supplies power directly, to the avionics and accessories bus and to some circuits that consume heavy power. This prevents overloading of the distribution buses. These circuits are protected by remote controlled circuit breakers (RCCB) activated by circuit breakers on the overhead panel.

Battery Bus

Each battery is connected through a battery line contactor to the respective battery bus. However, the battery buses are connected to each other, thus forming one battery bus. Bus tie contactors connect the battery bus to the main buses, thereby connecting the entire dc system to form an integrated electrical system. The battery bus is also connected to external power and APU. The battery bus assists engine start.

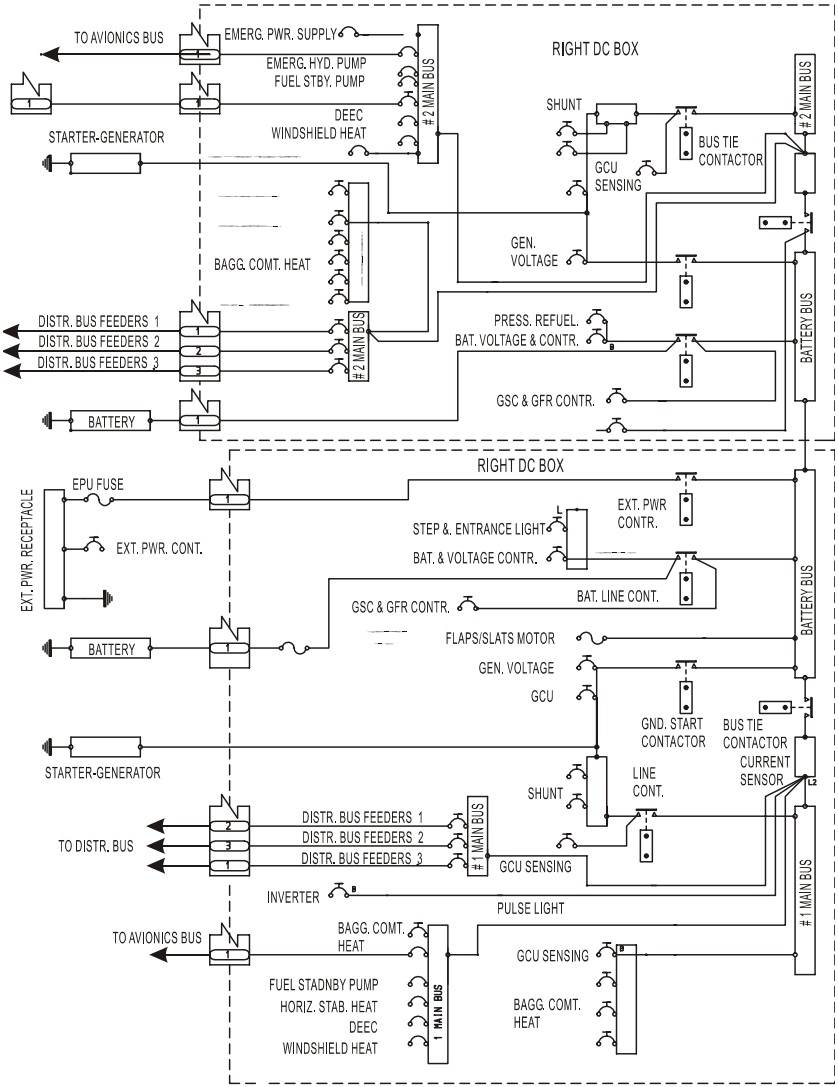


Figure 7-24-2. DC Distribution System - Schematic

APU GENERATOR

During APU Generator operation, the generator supplies dc power to the battery bus through the APU line contactor.
The battery bus supplies dc power to the main buses through the BTC. Each main bus then supplies dc power to the respective distribution bus through three feeder cables. The power from the distribution buses is supplied to the priority bus through diodes and circuit breakers.

EXTERNAL POWER

The external power system consists of a 28 Vdc external power receptacle to connect to the ground power unit (GPU), beneath the left engine, and an external power master switch EXT POWER on the overhead panel.

External power is used to charge the batteries, start an engine together with the batteries or supply power to the aircraft electrical systems. The aircraft is protected against an overvoltage and reverse polarity from the external power source. The GPU should be rated at 28 Vdc and minimum of 1000 A for engine starting.

ELECTRICAL SYSTEMS CONTROLS, INDICATORS AND ANNUNCIATORS

EXT POWER switch - Has two positions:

OFF - Disconnects external power to battery bus through overvoltage relay.

ON - Connects external power to battery bus through overvoltage relay. Prevents generators from coming on the line.

BATT POWER switch - Has three positions:

OFF - Disconnects both batteries from battery bus.

ON - Connects both batteries in parallel to battery bus.

OVRRD LOAD REDUCT - Overrides automatic load reduction resulting from a generator failure. Enables pilot to restore windshield heat, baggage heat and galley power when operating on one generator. Left and right side windows heat, 60 Hz AC inverter and utility bus are not available.

GENERATOR switch (L & R) - Has three positions:

OFF - Momentary position; Disconnects generator output from main bus. GEN OFF (L/R) annunciator comes on. (Does not de-energize generator).

ON - Momentary position; Connects generator output to main bus. Extinguishes GEN OFF (L/R) light, provided generator voltage is sufficient.

RESET - Renews magnetic field in generator.

(Continued)

APU GEN switch – has three positions:

OFF - Momentary position; disconnects generator output from battery bus. APU GEN OFF message comes on. Does not deenergize the generator.

ON - Momentary position; connects generator output to battery bus. Extinguishes APU GEN OFF message, provided generator voltage is sufficient.

RESET - Renews magnetic field in generator

Electrical System Circuit Breakers

GEN CONTR (L/R) - When tripped, field circuit opens, disabling generator. Trips when GCU anti-cycle circuit fails and is used for tripping the generator manually.

APU GEN CONTR - When tripped, field circuit opens, disabling generator. Trips when GCU anti-cycle circuit fails and is used for tripping the generator manually.

MAIN BUS TIE (L/R) - Trips when excessive current flows through bus tie contactor (from main bus to battery bus). Can be used to open bus tie contactors.

DISTR BUS TIE - Normally open. Should be closed only to connect both distribution buses and only after disconnecting all three-feeder cables of disabled distribution bus.

DISTR BUS 1 & 2 FDRS (three each) - One set of three for respective disabled distribution bus, which must be opened before closing DISTR BUS TIE circuit breaker. No indication for tripped overhead panel circuit breaker.

Other circuit breakers pulled to disconnect consumers:

OVRRD LOAD REDUCT, BATT DISCONN 1 & 2, PRIORITY BUS 1 & 2., AVIONICS BUS L & R.

Caution Messages

BATT DISCHARGE - Engine is running and voltage of both batteries less than 25V

BATT OVERHEAT (L/R) - Battery temperature exceeds 140°F

BATT OFF (L/R) - Battery is disconnected from battery bus

DISTR FEEDER OPEN (L/R) - One or more of 3 aft distribution bus feeder cb's are open

GEN OVERHEAT (L/R) - Generator temperature high

GEN OFF (L/R) - Generator failure or generator off line.

GEN OVERLOAD (L/R) - Generator load above limits

APU GEN OVERLOAD - APU generator load above limits

APU GEN OVERHEAT - APU generator temperature high

Status Messages

APU GEN OFF - APU is operating and APU generator is disconnected

GEN LOAD UNBALANCE - Unbalanced electrical load on generators

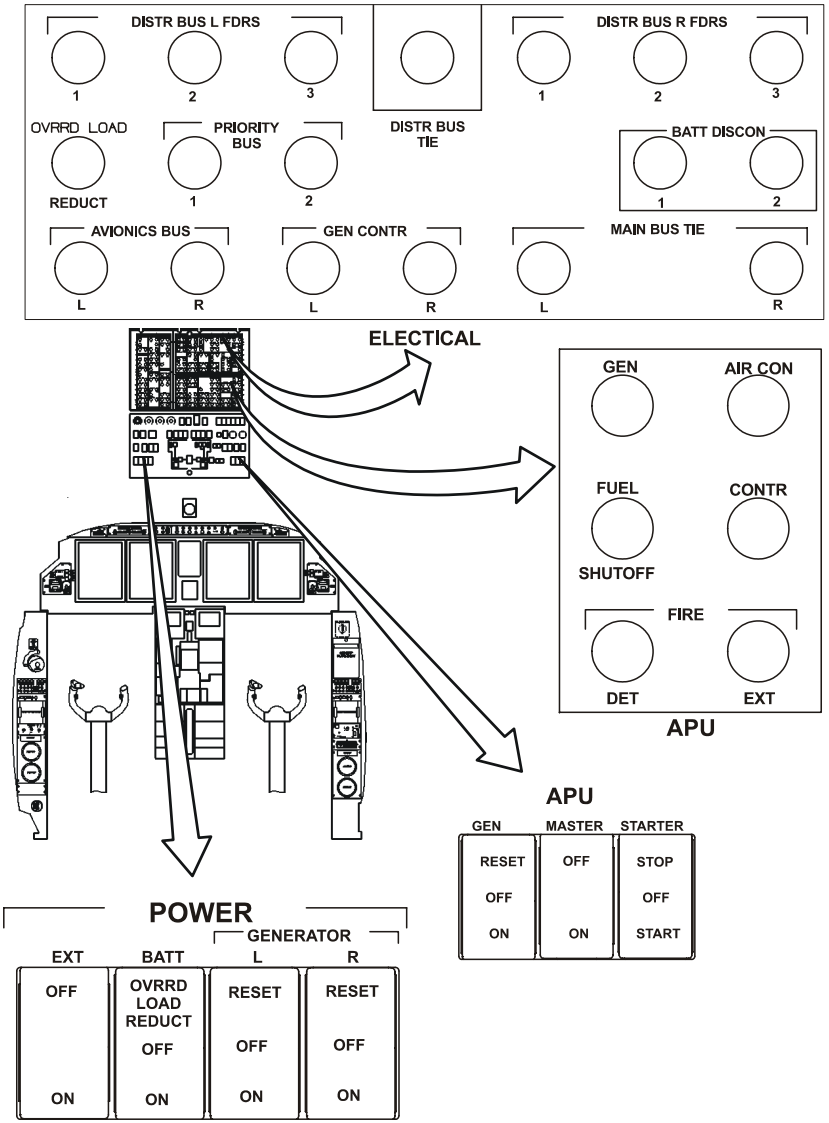


Figure 7-24-3. Electrical System Controls