ELECTRICAL POWER SYSTEM

POWER SOURCES

The aircraft DC Electrical Power System (EPS) is an 28Vdc primary power system. No AC inverters are present in the system. Primary power is generated by two 28Vdc, 400A. generators, each driven by engine. The two generators are operating in parallel.

Two main batteries of 24Vdc 43AH each, are connected in parallel with the generators are used for backup power and engines start. A third battery of 24Vdc 27AH used in emergency. It is normally connected in parallel with the other batteries.

A third 28Vdc 400A generator is operated by the APU. It can be operated on ground and in flight as required. The APU generator operates in parallel with the other generators and batteries. The APU is started from the right main battery only.

External power receptacle is provided for external power supply, for engines start and maintenance. The external power circuit includes an overvoltage relay protection.

POWER DISTRIBUTION

Battery Bus

This bus powers engines starting and other essential systems which are heavy load consumers such as fuel pumps, hydraulic auxiliary pump and flaps motors.
These systems are required in emergency/abnormal operations. Normally this bus is fed from the L & R main buses through L & R overload bus tie contactor and from the main batteries which provide the back-up power. The APU generator and external power supply are also connected to the battery bus.
If all generators fail, L & R main buses can be disconnected from the battery bus by pulling L & R MAIN BUS TIE cb's or disconnecting the batteries from the battery bus by placing BATT MASTER switch in OFF position.
MAIN BATT DISCHARGE message comes on when both batteries voltages are less than 25±0.1 Vdc for more than 90 seconds when at least one engine is operating.
With Mod 20134 installed, if BATT MASTER switch is not in OFF position and batteries are not charged by main or APU generator or by external power, the lower anti-collision light is activated to warn of discharging batteries.

Emergency Bus

This bus powers emergency consumers that have to operate during flight without generated power for at least 30 minutes.
Normally this bus is fed from the generators through the battery bus. If all generators fail (and external power is not connected) emergency bus is powered only by the emergency battery if EMERGENCY BATT switch is in ON position. **EMER BATT DISCHARGE** message comes on.
It is possible to connect the main batteries to the emergency bus through the battery bus by placing EMERGENCY BATT switch in OVRRD position.

If the power supply line to the emergency bus fails, it automatically connected to the left main bus. **EMER BUS ALT FEED** message comes on. Battery power for 30 minutes without generated power is not available.
If emergency bus is not powered **EMER BUS FAIL** message comes on. It may be powered from left or right main bus by placing EMERGENCY BUS switch in OVRRD L or OVRRD R position. **EMER BUS ALT FEED** message comes on.
During engine start emergency bus is fed from emergency battery and both are disconnected from the battery bus, to prevent the deep voltage drop on the emergency bus.

Main Buses

Non essential, mostly heavy load consumers are connected to these buses.

Distribution Buses

Non essential, not heavy load consumers are connected to these buses. These consumers are fed from cb's located in the cockpit.
Each distribution bus is connected to its respective main bus through remote cb, controlled from DISTR BUS cb on overhead panel.

Avionics & Accessories Buses

Non essential avionics and accessories which are not heavy load consumers are connected to these buses. Each bus is connected to its respective main bus through remote cb, controlled from AVIONICS BUS cb’s on overhead panel.
These buses are disconnected by the L & R AVIONICS MASTER switches prior to battery engine start.

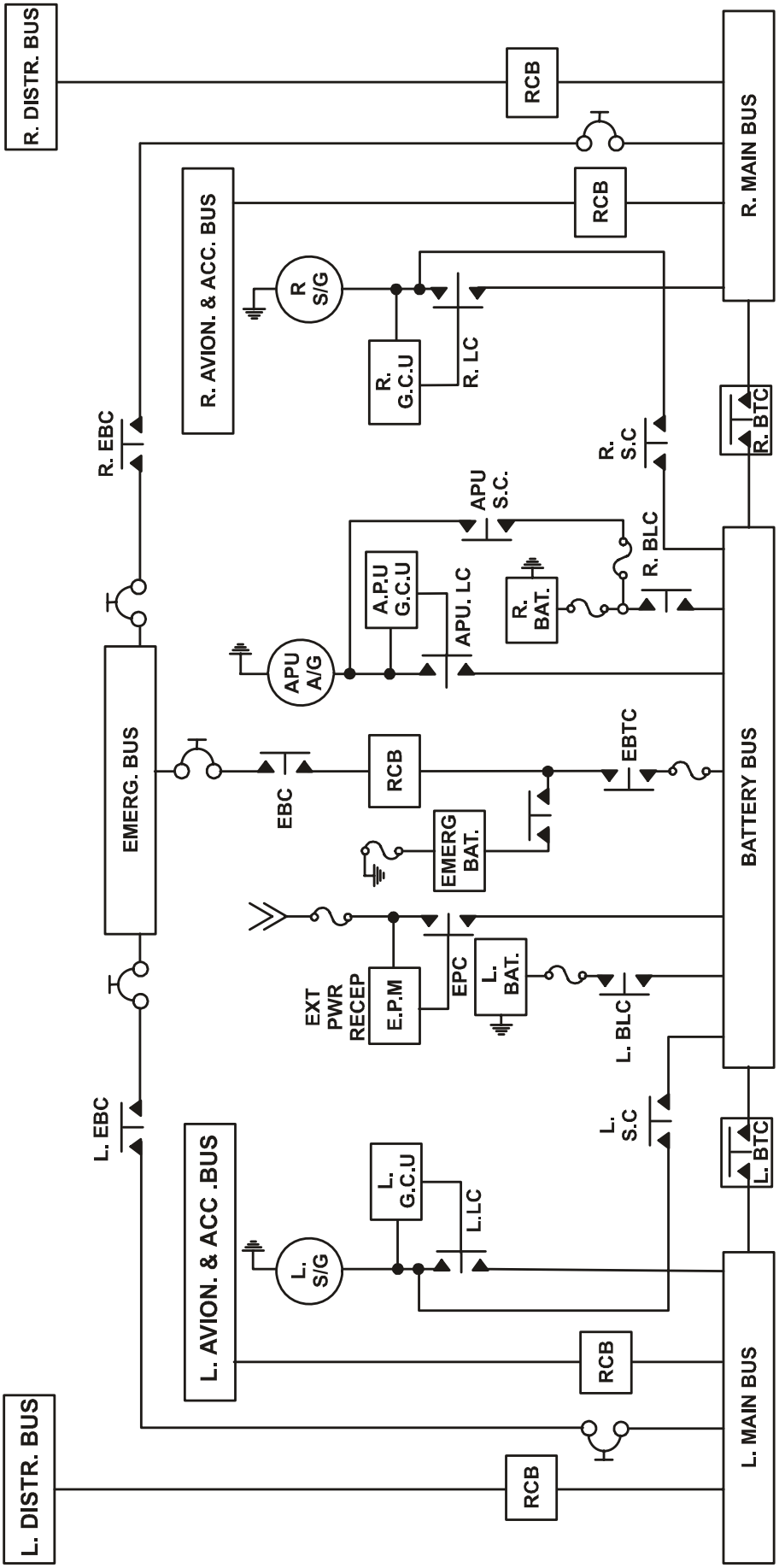

Figure 5-1. Electrical Power System-Schematic

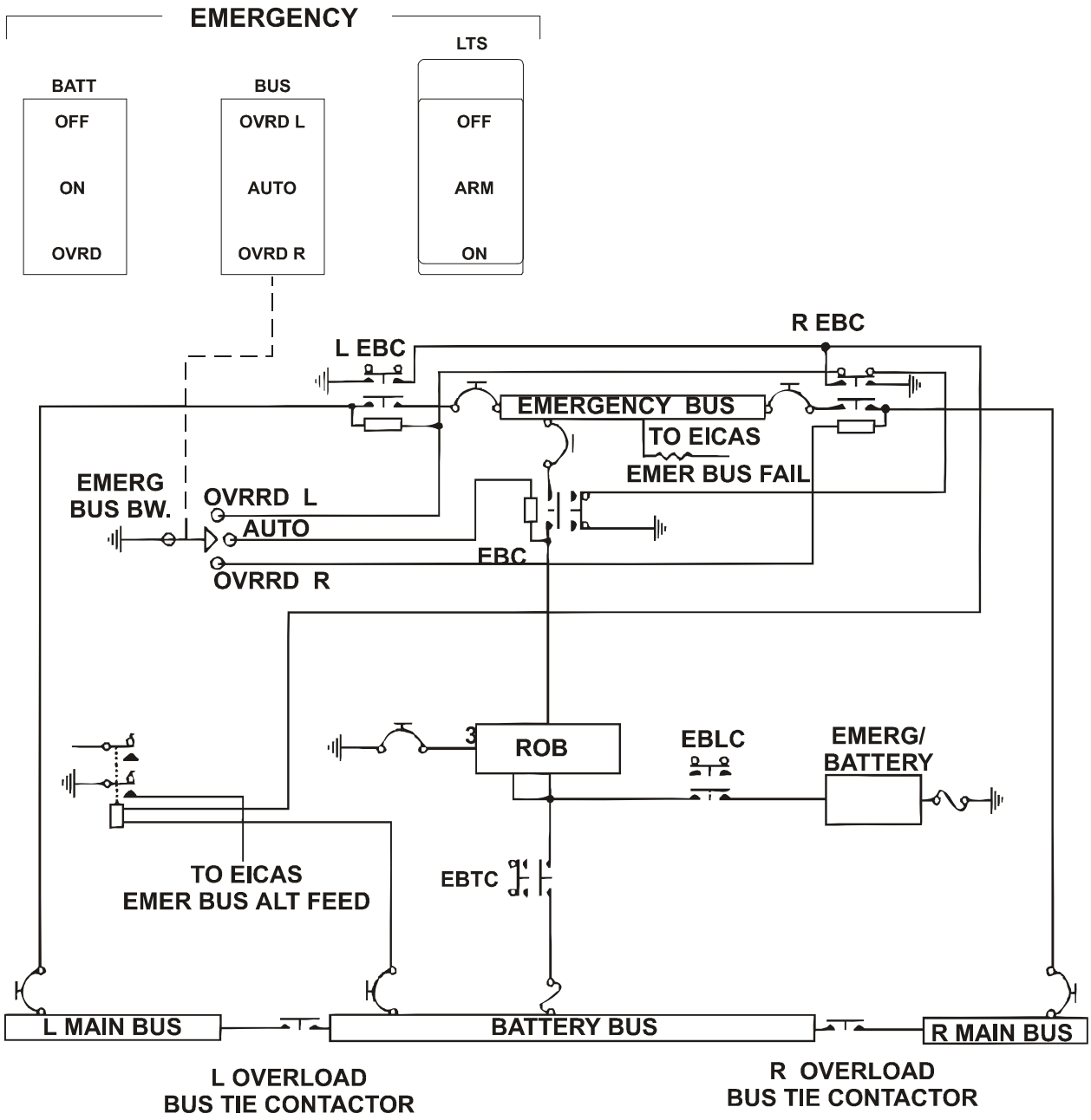

Figure 5-2. Emergency Power System-Schematic

GENERATORS

The starter/generator consists of the following main components: Generator Control Unit (GCU), Two Current Transformers (CT), Line Contactor (LC), Start Contactor (SC), GENERATOR and STARTER switches

Generator functions are:

- Voltage regulation to 28±0.1Vdc
- Current limiting control up to 600A
- Line contactor control
- Paralleling control up to 40A

Generator load: 400A continuous operation, 600A for two minutes, 800A for 5 Seconds

Starter functions are:

- Automatic starter cutout control
- Starter field current control (Field Weakening, Torque Limiting)

Starter/generator protective functions:

- Reverse current protection
- Overvoltage protection
- Overexcitation protection
- Overspeed protection (during starting)
- Reverse polarity protection
- Anti-cycle protection
- Open Shunt protection
- Ground fault protection

FAILURE OF ONE MAIN GENERATOR

If one generator fails, the automatic load reduction relay is de-energized and the following consumers power is removed:

- L & R Windshield anti-ice.
- Baggage compartment heating.
- Galley loads.

Placing BATT MASTER switch in OVRRD LOAD REDUCT position restores power supply to these consumers.

FAILURE OF TWO MAIN GENERATORS (APU OFF)

If both main generators fail, the disconnect relays are de-energized and the surface de-ice and avionics systems emergency bus power are disconnected (when the APU generator is off).
On ground, these relays stay energized and the systems are available even if the main and APU generators are not operative.

Caution Messages

GEN OFF (L/R) - Generator disconnected from main bus or GENERATOR switch is OFF
GEN OVER LOAD (L/R) - Generator load above limits

MAIN ENGINE START

The GCU controls the starting phase. Start power can come from external power with the two main batteries in parallel, from the two main batteries only, by cross start from one main generator with the two batteries in parallel or by the APU generator with the two main batteries in parallel.

Start sequence:

The engine is started by momentarily pressing START switch to START position. Start relays energize or deenergize to prevent two simultaneous engines start.
The emergency battery is connected to the emergency bus to prevent power interruption even if EMERGENCY BATT switch is in OFF position. However, the emergency battery is prevented from taking start loads.
During start **EMER BATT DISCHARGE** message is displayed.

Start cut-out signal to disconnect the power to the starter is provided by the GCU at 40-43% N_2.

During cross-start there is no power interruption on the opposite buses as the operating generator provides power to its bus through its line contactor even if its battery is disconnected.
The operating generator provides time-limited current of 600A.
If engine speed rises above 50% N_2 and **EMER BATT DISCHARGE** message is still displayed, or start has to be aborted, the start is stopped by pressing START switch to STOP position.

During start the GCU provides field excitation control for torque limit at start initiation and for field weakening to maintain 400A current.
The GCU overspeed protection de-energizes start and terminate the cycle before generator overspeeds.

APU START

APU start is available from the right battery only.
The APU is started by momentarily pressing APU STARTER switch to START position.

EXTERNAL POWER SUPPLY AND CONTROL

28Vdc external power is used for main engines starting and ground maintenance. External power is available when EXT PWR switch is placed in ON position and there is no overvoltage.
To enable connection of external power after overvoltage condition has passed, EXT PWR switch is cycled to OFF/RESET position and back to ON position.

BATTERIES

The batteries are nickel-cadmium type of 20 cells 24Vdc nominal voltage. The two main batteries are of 43AH each and the emergency battery is of 27AH. The batteries are charged using constant potential mode from external power or from the generators.

Batteries messages:

BATTERY OVERHT caution is on if battery temperature is above 140°F.

IGNITION SYSTEM

Each engine has two exciters to provide engine ignition. Every exciter is powered by separate circuit breaker through a separate relay which can be energized by two independent relays, controlled by the FADEC (Full Authority Digital Engine Control).
Ignition is provided when IGNITION switch is in AUTO position during normal start; in flight, when auto-relight occurs (N_2 drop of 2.5% or more from flight idle (57% N_2) below 35,000 ft), or manually when IGNITION switch is in ON position.
Each exciter relay, when operated supplys a signal to the EICAS to display the advisory message: **L** or **R IGNITION ON**.

ELECTRICAL POWER SYSTEM CONTROLS AND INDICATORS

BATT MASTER 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 the pilot to override automatic load reduction

EMERGENCY BATT switch - Has three positions:

- OFF - Disconnects the emergency battery, except for engine start
- ON - Connects emergency battery to the emergency bus
- OVRRD - Connects the battery bus to the emergency bus (and battery) as required if all generators fail and emergency battery is depleted

EMERGENCY BUS switch - Has three positions:

- AUTO - Enables connection of emergency bus to battery bus
- OVRRD L - Connects emergency bus to left main bus
- OVRRD R - Connects emergency bus to right main bus

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

- OFF - Disconnects generator output from main bus. **GEN OFF** annunciator comes on (Does not de-energize generator)
- ON - Connects generator output to main bus. Extinguishes **GEN OFF** light, provided generator voltage is sufficient, and external power is disconnected
- RESET - Momentary Position; spring-loaded to OFF position. Renews magnetic field in generator

EXT POWER switch - Has two positions:

- OFF/RESET - 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.

APU GEN switch - has three positions:
ON - pressed to connects APU generator.
OFF - disconnects APU generator
RESET - resets APU generator

AVIONICS MASTER SWITCH (L & R) - Powers up avionics left or right consumers, respectively

BATT DISC cb's (L & R) - pulled to disconnect left or right battery from the battery bus when required

DISTR BUS cb's (L & R) - Connects left and right distribution buses to left and right main buses, respectively

AVIONICS BUS cb's (L & R) - Connects left and right avionics buses to left and right main buses, respectively

EMERG BUS FDRS cb's:
CONTR - Enables automatic connection to left main bus when emergency bus is not powered or its voltage is below 18 Vdc
L/MAIN - Enables connection of emergency bus to left main bus
BATT - Enables connection of emergency bus to battery bus or emergency bus
R/MAIN - Enables connection of emergency bus to right main bus

MAIN BUS TIE cb's (L & R) - pull to disconnect main buses from the battery bus if all generators fail

GEN CONTR cb's (L & R) - disconnects the respective generator

APU GEN CONTR cb - disconnects the APU generator

OVRRD LOAD REDUCT cb - disconnect automatic load reduction

Warning Messages

EMER BUS FAIL - Emergency bus voltage below 18V.

Caution Messages

EMER BATT OFF - Emergency battery disconnected from battery bus

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

GEN OFF (L/R) - Generator disconnected from main bus or GENERATOR switch is OFF

EMER BATT DISCHARGE - Emergency bus is fed by emergency battery

BATT OVER HEAT (L/R) - Main battery temperature exceeds 140°F

EMER BATT OVER HEAT - Emergency battery temperature exceeds 140°F

GEN OVER LOAD (L/R) - Generator load above limits

APU GEN OVER LOAD - APU Generator load above limits

EMER BUS ALT FEED - Emergency bus is not fed from its normal source.

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

Advisory Messages

BATT VOLTAGE (**L** & **R**) - Green readout
EMER BATT VOLTAGE - Green readout
GEN CURRENT - Green readout. Amber if **GEN OVER LOAD** message is on
APU GEN CURRENT - Green readout. Amber if **GEN OVER LOAD** message is on
GEN VOLTAGE (**L** & **R**) - Green readout
APU GEN VOLTAGE - Green readout
BATT TEMP (**L** & **R**) - Green readout if less than 140°F, amber if between 140°F and 160°F and RED if more 160°F
EMER BATT TEMP - Green readout if less than 140°F, amber if between 140°F and 160°F and RED if more 160°F.
Amber dashes (**----**) are on with no valid data

Status Messages

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

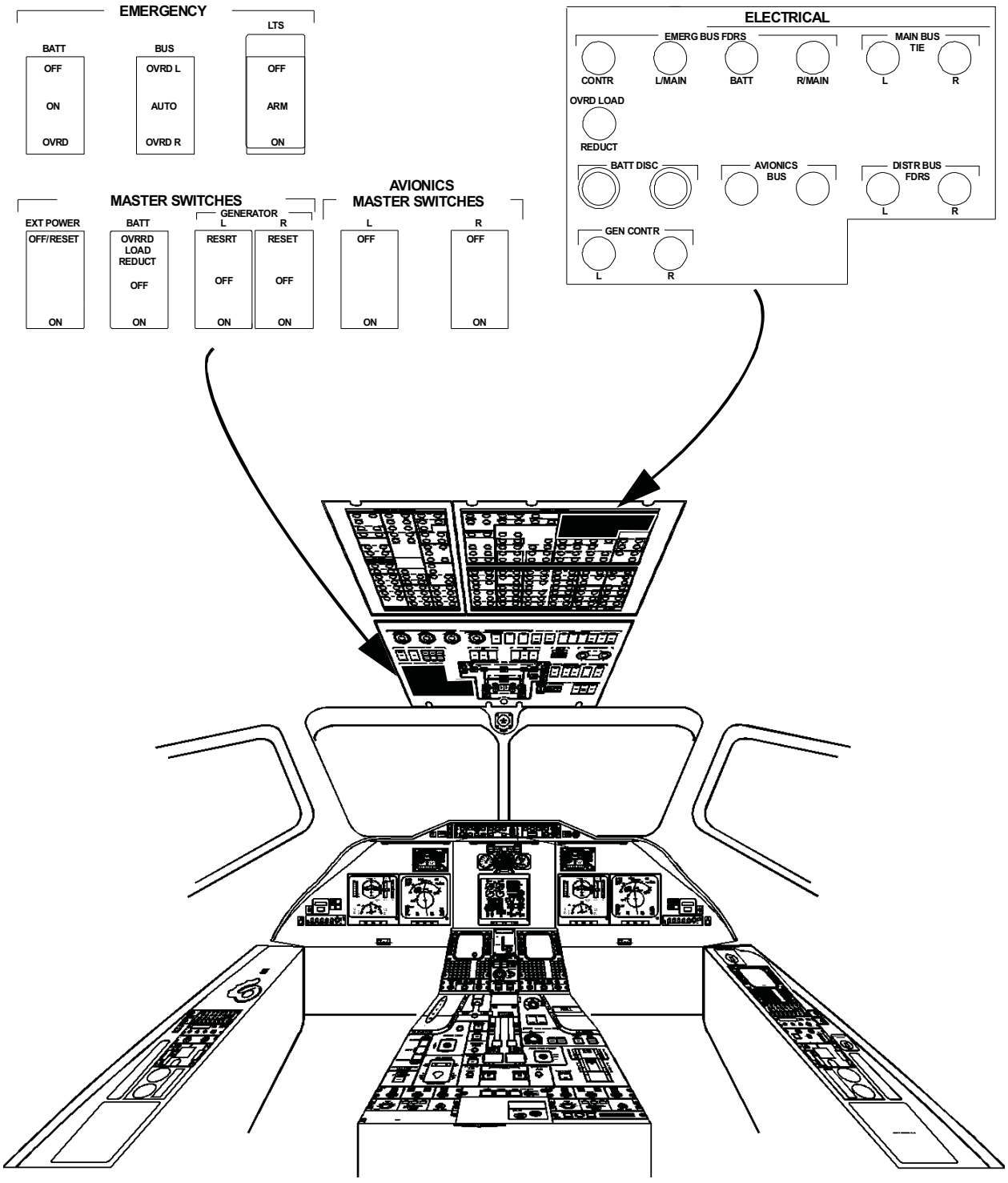

Figure 5-3. Electrical System Controls