SECTION 2-05

ELECTRICAL

TABLE OF CONTENTS

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GENERAL

The electrical power system supplies AC and DC voltage for all loads during normal or emergency operation.
Two different types of sources provide electrical power supply:
- DC Power
- AC Power

The DC power system supplies 28 V DC for all aircraft electrical loads and recharges the batteries. It is the primary electrical power supply system. The DC power system is comprised of:
- Four independent generators (28 V DC/400 A/engine driven).
- One APU starter-generator (28 V DC/400 A).
- Two Nickel-Cadmium batteries (24 V DC/44 Ah/1 hour rate).
- One lead-acid backup battery (24 V DC/5 Ah/10 hour rate).
- External power source.

AC power is supplied by one 250 VA/400 Hz single-phase static inverter, which converts 28 V DC into 115 V AC.

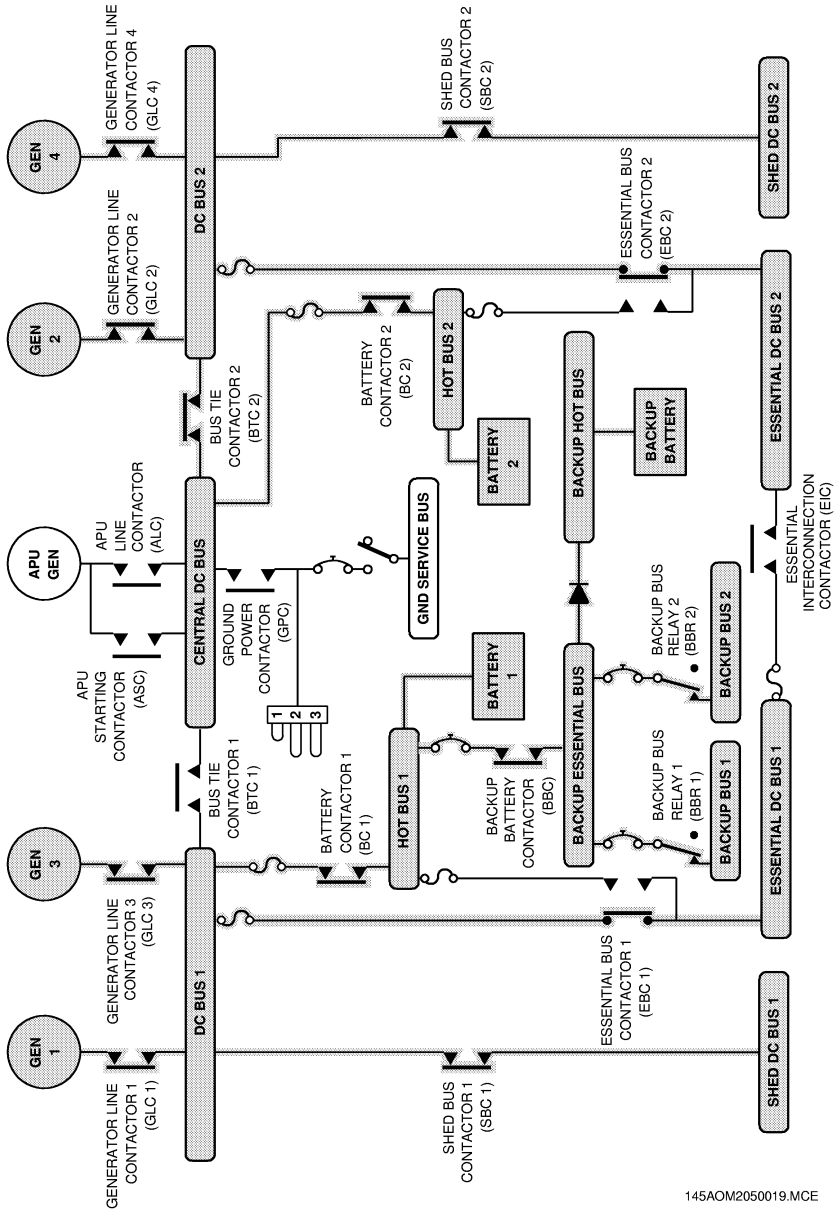
A dedicated page on the MFD (electrical page) provides, on request, information regarding system configuration, load and voltage conditions as well as battery temperatures. Furthermore, warning and caution messages are presented on the EICAS to indicate an electrical system failure.

DC SYSTEM

The 28 V DC electrical power system automatically controls power contactors, fault protection, load shedding and emergency system operation. This reduces pilot workload during normal operation, external power supply or system failures. The Electrical Distribution Logic (EDL) and Generator Control Units (GCU) perform system management. Detected system failures are automatically isolated, causing some bus(es) to be deenergized.

Under normal operation, the electrical DC system is divided into isolated left and right electrical networks. The left network includes generators 1 and 3, driven by engine 1. Operated in parallel, generators 1 and 3 are connected to DC BUS 1 to supply ESSENTIAL DC BUS 1, SHED DC BUS 1 and HOT BUS 1. Battery 1 is charged by the generators connected to DC BUS 1. Similarly, generators 2 and 4 power the right network and are driven by engine 2.

Both networks are interconnected through Bus Tie Contactors (BTC) in case of operation with less than four generators. APU generator may replace any inoperative generator, or may be used before engine starting when the APU generator or Ground Power Unit (GPU) may supply the electrical system.



DC ELECTRICAL DISTRIBUTION SYSTEM SCHEMATIC

DC SYSTEM PROTECTION

The system monitors generators current and voltage to the electrically supplied equipment to protect it from a control unit failure, such as an overvoltage or a bus failure. If an overvoltage is detected, the associated GCU deenergizes the generator, disconnecting it from the bus.

A bus failure produces an overcurrent condition to one or more generators. Upon sensing this overcurrent, the GCU isolates the system networks, opening the BTCs. If any generator remains overloaded due to the failure, it is then deenergized and disconnected from the bus.

As long as the generator current exceeds 400 A, a caution message is presented on the EICAS, indicating that manual load shedding is required. If no action is taken, the system will be isolated and some buses may be deenergized.

System protections are designed so that normal transients will not cause generators to be disconnected from the bus inadvertently.

Resetting of the generator after a failure is accomplished by releasing the associated Generator Button and then pressing it again.

EXTERNAL POWER SOURCE

The Ground Power Unit (GPU) is connected to the aircraft through an external receptacle. The GPU supplies 28 V DC to the load buses for ground operation and APU starting, independently of the internal batteries.

The GPU has priority over any battery and generator when energizing the airplane. Thus, the generators and the batteries cannot operate in parallel with the GPU.

The GPU Button, located on the overhead panel, controls the External power supply. As soon as the Ground Power Unit is energized, properly connected to the airplane receptacle, ready to supply power but not connected to the buses, the GPU AVAIL inscription illuminates on the GPU Button. A identical inscription above the GPU receptacle simultaneously illuminates.

When GPU AVAIL is illuminated and the batteries are not connected to the buses, only the GROUND SERVICE BUS is supplied through the external power supply. When the GPU Button is pressed, the Ground Power Contactor (GPC) will close, allowing the external power to feed the load buses. When the external power comes on line, the GPU AVAIL inscription on the GPU Button extinguishes itself and the white stripe on the button lower half illuminates.

An overvoltage circuit isolates the GPU from the aircraft's electrical buses if the GPU voltage is incorrect. External power inverse polarity protection is also provided. To reset the system, release the GPU button and then press it again. If the GPU overvoltage persists, GPC will be kept open.

The external power voltage can be monitored through the electrical page, on the MFD. The electrical system page shows the GPU box and its voltage. The GPU voltage indication is removed in flight.

BATTERIES

Two 24 V DC, 44 Ampere-hour, nickel-cadmium batteries supply essential loads in case of an in-flight failure of all generators or if both engines are shut down simultaneously and the APU is not available. Both batteries can supply at least 40 minutes of power for essential loads in an all-generator-failure condition.

During normal operation, Battery 1 is connected in parallel with generators 1 and 3 (network 1). Battery 2 is connected in parallel with generators 2 and 4 (network 2). Battery 2 also supplies power for APU starting.

During APU starting, battery 1 is isolated from the load buses. While battery 2 provides power for APU start, battery 1 provides stable electrical power to the equipment that can be adversely affected by voltage transients.

A selector switch on the overhead panel controls each battery. When set to the AUTO position, battery contactors (BC 1 or BC 2) actuation is controlled according to the Electrical Distribution Logic (EDL). When the GPU is connected, the battery contactors open so that only the GPU can supply the load buses. When on the ground, with the batteries as the only electrical power source, EDL deenergizes the shed buses for battery conservation. When the battery selector knob is switched to the OFF position, the battery contactor opens, isolating the battery from the system.

The batteries are installed in the battery compartment, on the left side of the aircraft nose section. They are ventilated in flight by forced airflow to prevent overheating. Temperature sensors installed in each battery provide temperature indication to the MFD. If battery internal temperature rises above 70°C, a warning message is presented on the EICAS. If a battery is isolated from the load buses, a caution message is displayed on the EICAS.

BACKUP BATTERY

A 24 V DC, 5 Ampere-hour sealed lead-acid battery provides stabilized power for operation of the GCUs protective function, even in case of short-circuit, when system voltage may drop near zero volts.

The Backup Battery Button, on the overhead panel controls the backup battery. Pressing the button when the Battery 1 or 2 Selector Knob is set to the AUTO position connects the backup battery to the electrical system for charging. If the Backup Battery Button is released, a caution message is displayed on the EICAS.

GENERATORS

The primary source of electrical power are the four 28 V DC, 400 Amperes, independent engine-driven brushless generators, two installed on each engine accessory gearbox.

Each generator is automatically controlled and protected by a dedicated Generator Control Unit (GCU), provided the Generator Control Button on the overhead panel is pressed.

The generators will come on line when engine speed stabilizes above 56.4% N2. If a failure occurs and the Generator Line Contactor (GLC) opens, a reset may be attempted once by releasing the associated Generator Control Button and then pressing it again.

Anytime the Generator Line Contactor is inadvertently opened or generator current is above 400 A, a caution message is displayed on the EICAS. The generator voltage and current can be monitored through the electrical page, on the MFD.

APU STARTER-GENERATOR

A 28 V DC, 400 Amperes, APU-driven starter-generator supplies electrical power during ground operation or in flight, as an alternative source of electrical power. The APU starter generator is controlled and protected by its dedicated GCU.

The APU Generator Button, on the Electrical System Panel, must be pressed for normal operation. The APU line contactor is actuated on and off by APU speed. If a failure occurs on the APU generator, a reset may be attempted releasing the APU Generator Button and pressing it again. Only one reset may be attempted.

The APU generator, when operating, is connected in parallel with the generators supplying DC Bus 2. If needed, the APU generator can replace an inoperative left network generator. After starting, and with an engine driven generator inoperative, the APU generator automatically replaces the inoperative generator.

Three electrical sources may be used to power an APU start: ground power unit, battery 2 or battery 2 assisted by the main generators. Battery 1 cannot be used for APU starting. Instead, it is isolated from the load buses to provide stable electrical power to supply equipment that may be affected by voltage fluctuation.

During starting, the APU Starting Contactor (ASC) is closed, allowing the APU starter-generator to operate as a starter, energized through the Central DC Bus. When the APU starting cycle is completed, the ASC opens. A caution message is displayed on the EICAS if the ASC does not open.

At 95% RPM plus seven seconds, the APU starter generator is available to supply electrical power to the system. In this condition, the APU Line Contactor (ALC) is closed, connecting the APU starter generator to the load buses. If the ALC does not close due to contactor failure or button not pressed, a caution message is displayed on the EICAS.

The APU starter generator voltage and current may be monitored on the MFD.

ELECTRICAL DISTRIBUTION LOGIC

Many different configurations are available in the Electrical Distribution Logic (EDL) to suit any particular situation. The EDL's architecture is symmetrical and the operational logic sequence for EDL 1 is the same as for EDL 2. EDL 1 is composed of DC Bus 1, Shed DC Bus 1, Essential DC Bus 1 and Hot Bus 1. The EDL 2 is composed of DC Bus 2, Shed DC Bus 2, Essential DC Bus 2 and Hot Bus 2.

The Central DC Bus primary function is to connect the APU generator or GPU to the load buses through the Bus Tie Contactors (BTC). The Central DC Bus also provides bus interconnections in case of asymmetrical configuration, such as generators failure or engine shutdown.

The Electrical Distribution Logic (EDL) differs depending on whether the airplane is on the ground or in flight. In flight, some buses are deenergized, depending on the power source available.

On the ground, all the DC buses are energized if at least one of the following conditions occurs:
– At least three generators are on.
– The GPU is on and connected to the airplane.
– At least one generator is on, and the Shed Buses Selector Knob is set to OVRD position.

The DC distribution table below shows the Electrical Distribution Logic configuration according to the conditions of the generators.

DC DISTRIBUTION TABLE

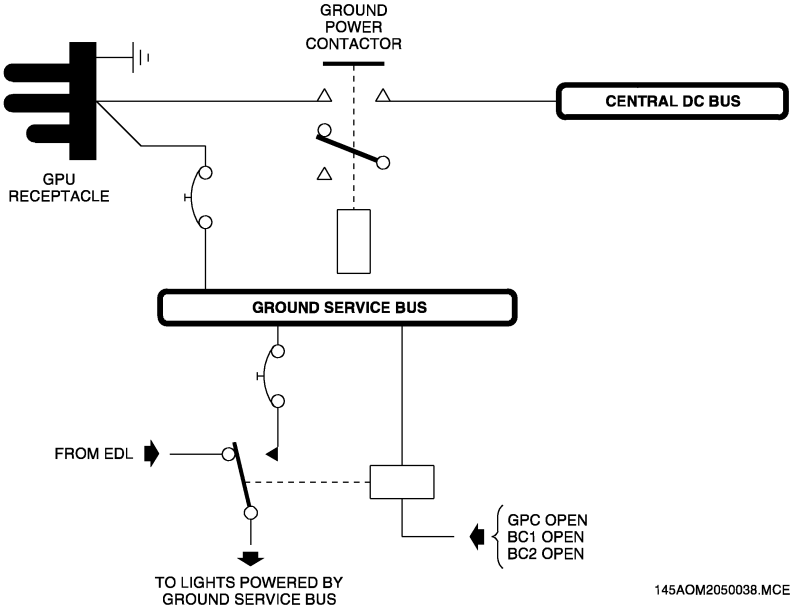
CONDITION	RESULTS
4 or 5 Generators On	Two isolated left and right electrical networks with all buses energized.
3 Generators On	Both electrical networks interconnected through Bus Tie Contactors with all buses energized.
1 or 2 Generators On	Both electrical networks interconnected through Bus Tie Contactors with shed buses deenergized.
Loss of all Generators	Batteries to supply the Essential Buses (in-flight condition only).

GROUND SERVICE BUS

The Ground Service Bus is energized by connecting the GPU connector to the airplane receptacle, provided the batteries and generators are not connected to the buses (GPC, BC 1 and BC 2 are open).

The Ground Service Bus supplies electrical power for airplane servicing and maintenance while on the ground. It functions independently of the Electrical Distribution Logic and does not energize all electrical distribution buses.

The following lights will be powered by the Ground Service Bus:
– Passenger cabin lights;
– Lavatory lights;
– Galley lights;
– Courtesy/stairs lights;
– Cockpit dome lights;
– Baggage/service compartment lights.

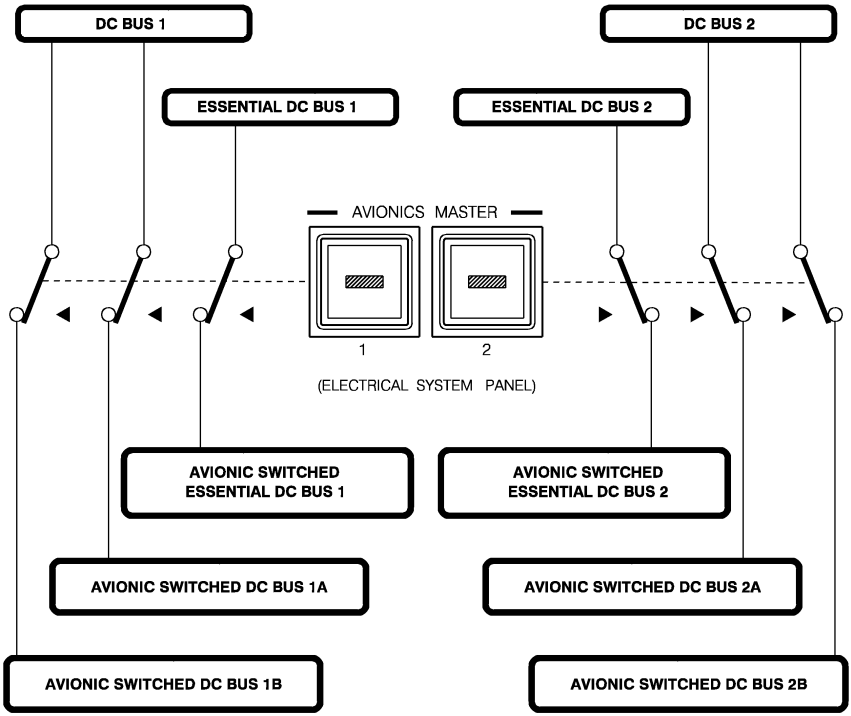


GROUND SERVICE SCHEMATIC

AVIONICS MASTER

The avionics master system allows manual disconnection of some navigation and communication equipment from the load buses. This prevents undesirable voltage transients during APU starting on the ground.

The avionics master system consists of six buses: Avionics Switched DC Buses 1A, 1B, 2A, 2B and Avionics Switched Essential DC Buses 1 and 2. These buses are supplied by their associated DC buses. Two Avionics Master Buttons, located on the overhead panel, control switching the buses.



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AVIONICS MASTER SCHEMATIC

AC SYSTEM

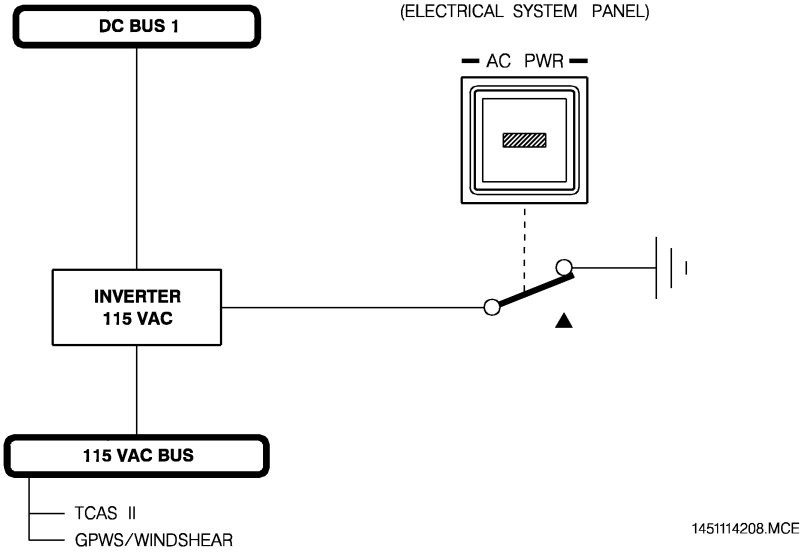
One 250 VA/400 Hz single phase static inverter converts 28 V DC electrical power into 115 V AC for airplane systems requiring AC power. The avionics system is the primary user of AC power.

The inverter is power supplied by the DC Bus 1 and controlled by the AC Power Button, on the overhead panel. If DC Bus 1 is energized and the AC Power Button is pressed, the 115 V AC BUS is automatically energized. If the DC Bus 1 is deenergized, the inverter becomes inoperative.

To reduce pilot workload, the AC Power Button should remain pressed, even after engine shutdown. If the AC Power Button is released, a striped bar illuminates to indicate that the button is out of normal operating condition.

During normal airplane operation, if 115 V AC BUS is deenergized, a caution message is displayed on the EICAS. An inverter reset may be attempted through the AC Power Button, by releasing and then pressing it again.

Under electrical emergency conditions the inverter stops the operation.



AC GENERATION AND DISTRIBUTION SCHEMATICS

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ELECTRICAL DISTRIBUTION LOGIC (EDL) CONFIGURATIONS AND DIAGRAMS

ABNORMAL OPERATION CONFIGURATIONS

For the Electrical Distribution Logic configurations presented here, the initial control positions on the Electrical System Panel are the following:

– Generator Buttons pressed;
– GPU Button released;
– Battery Selector Knobs set to AUTO position;
– Essential Power Button released;
– Bus Tie Selector Knob set to AUTO position;
– Shed Buses Selector Knob set to AUTO position;
– Backup Battery Button pressed;
– Avionics Master Buttons pressed.

NOTE: - All abnormal conditions considered below are in-flight conditions.
- In the schematic configurations, the continuous boxes indicate energized buses while dashed boxes indicate deenergized buses.

CONFIGURATION 1

Loss of one left side generator (network 1):

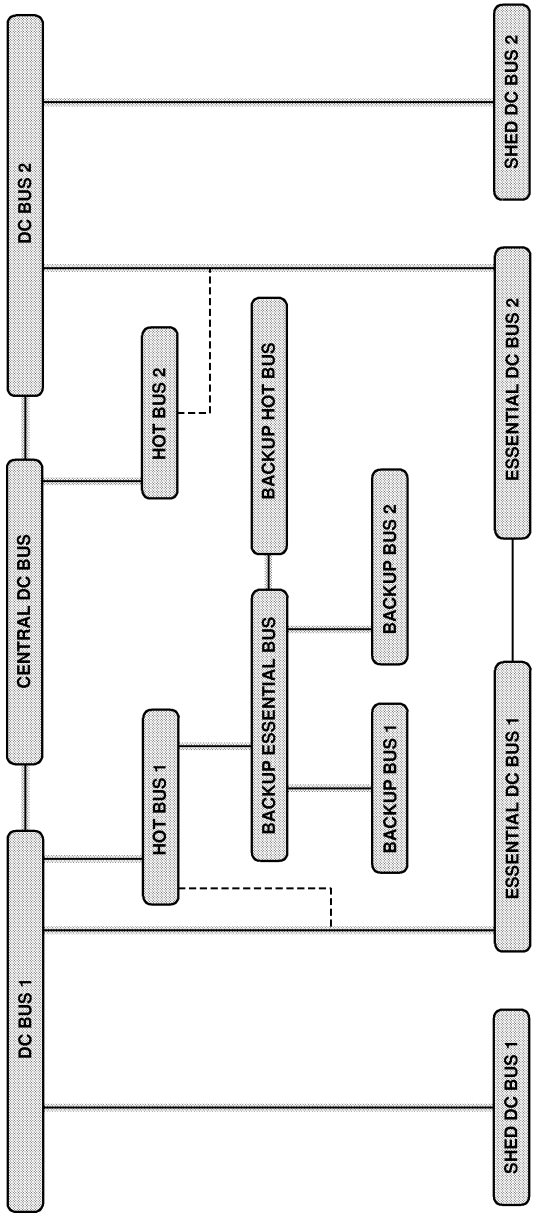
- **Without APU generator available:**
  - GLC 1 or 3 is open.
  - ALC is open.
  - BTC 1 is closed.
- **With APU generator available:**
  - GLC 1 or 3 is open.
  - ALC is closed.
  - BTC 1 is closed and BTC 2 is open.

Loss of one right side generator (network 2):

- **Without APU generator available:**
  - GLC 2 or 4 is open.
  - ALC is open.
  - BTC 2 is closed.
- **With APU generator available:**
  - GLC 2 or 4 is open.
  - ALC is closed.
  - BTC 2 is closed and BTC 1 is open.

Loss of two generators with APU generator available:

- GLCs from affected generators are open.
- ALC is closed.
- BTC 1 and BTC 2 are closed.



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CONFIGURATION 1

CONFIGURATION 2

Loss of two generators without APU generator available:

- GLCs from affected generators are open.
- ALC is open.
- BTC 1 and BTC 2 are closed.
- SBC 1 and SBC 2 are open.

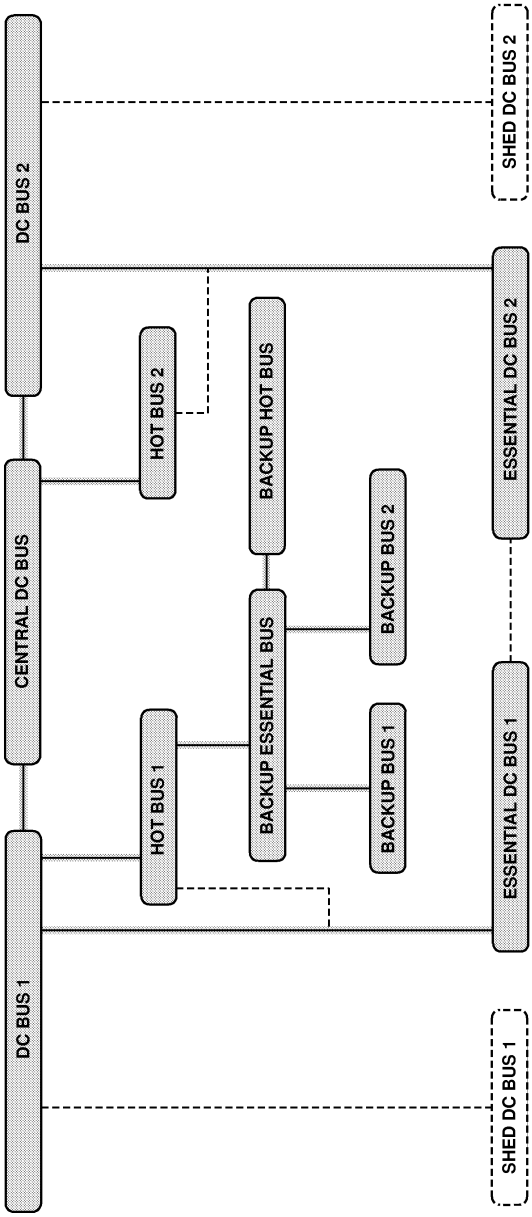
Loss of three generators without APU generator available:

- GLCs from affected generators are open.
- ALC is open.
- BTC 1 and BTC 2 are closed.
- SBC 1 and SBC 2 are open.

NOTE: Depending on the amount of load on the remaining buses, an overload condition may occur. In this case, the pilot are required to perform an additional load shedding.

Loss of three generators with APU generator available:

- GLCs from affected generators are open
- ALC is closed.
- BTC 1 and BTC 2 are closed.
- SBC 1 and SBC 2 are open.



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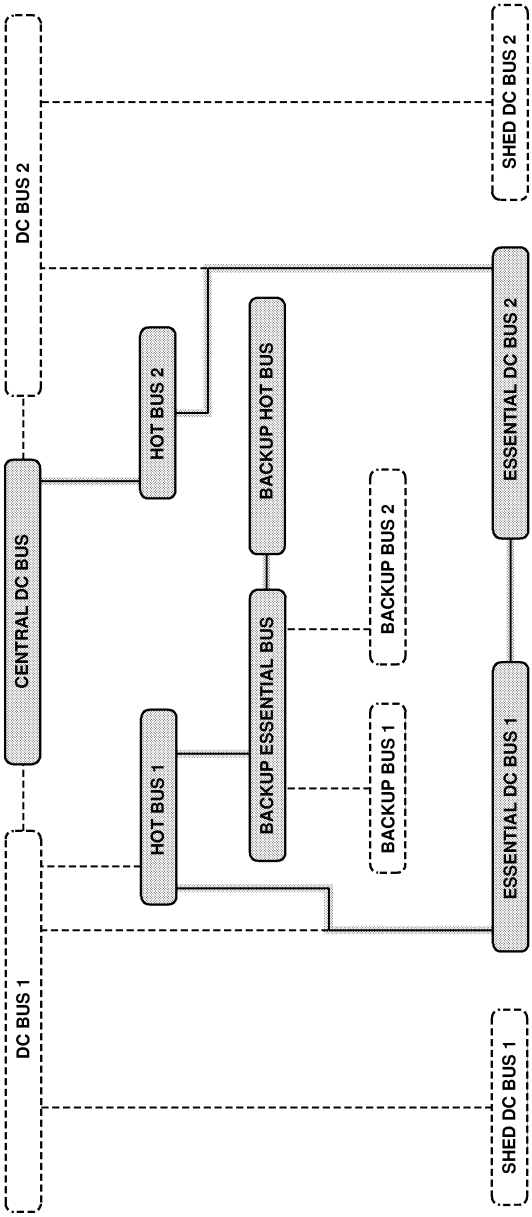
CONFIGURATION 2

CONFIGURATION 3

Loss of all generators:

- When the last generator fails, the operational logic configures the system to dedicate the batteries to supply the Essential Buses only (electrical emergency condition). In this configuration, the Central DC Bus is also powered to allow the APU to be started.
- BTC 1, BTC 2, BC 1, SBC 1, SBC 2, BBR 1 and BBR 2 are open.
- EIC, EBC 1, EBC 2 and BC 2 are closed.

NOTE:- This operational mode is activated for in-flight condition only.
- A 1-second time delay is provided to avoid inadvertent switching to emergency configuration due to electrical transients.
- If the automatic transfer fails, perform this function manually by pressing the Essential Power Button.
- While In-flight, the electrical system is automatically reset if at least one generator is reset and supplying its associated bus.
- On the ground, the system can be reset by switching both Battery Selector Knobs from AUTO to OFF and then back to AUTO.



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CONFIGURATION 3
(Electrical Emergency Condition)

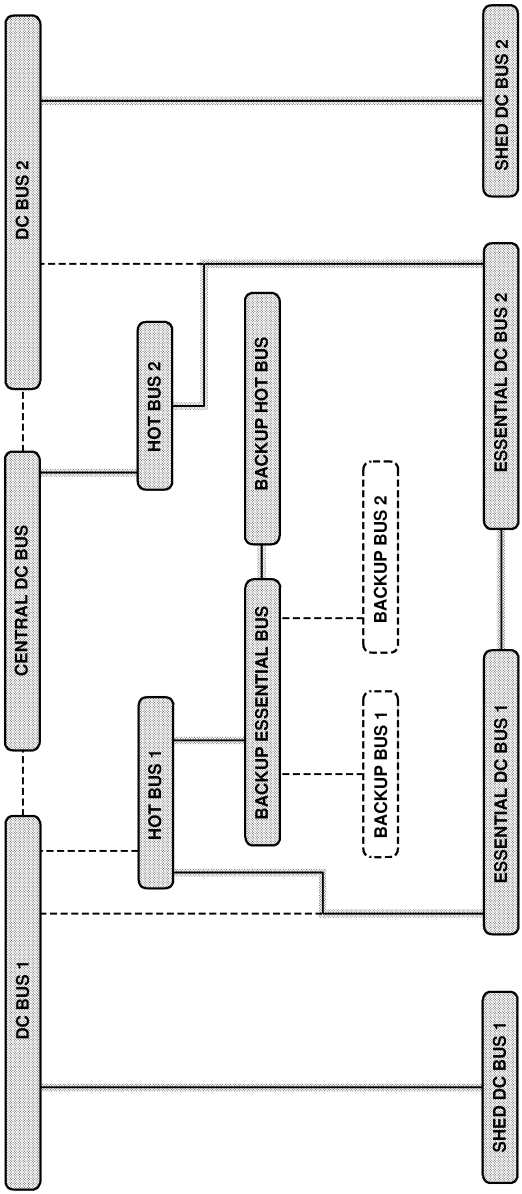
ABNORMAL OPERATION - CONFIGURATION 3A

Improper transfer to electrical emergency condition:

If during normal operation an improper transfer to electrical emergency condition occurs, the following modification will take place:

- ELEC EMERG ABNORM caution message on the EICAS.
- EBC 1, EBC 2, EIC and BC 2 are closed.
- BTC 1, BTC 2 and BC 1 are open.
- GLCs from operating generators are closed.
- SBC 1 and SBC 2 are closed if at least three generators are on.

NOTE:
- BC 2 remains closed to keep the CENTRAL DC BUS energized and making it possible to perform an APU start.
- In case APU generator is not available, the batteries will feed the essential buses for at least 40 minutes.
- DC BUS 1 and DC BUS 2 remain energized by the respective engine generators, but isolated from the CENTRAL DC BUS.



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CONFIGURATION 3A

ABNORMAL OPERATION - CONFIGURATION 3B

Electrical essential transfer failure:

An electrical essential transfer failure will occur when all GLCs and ALC are open (loss of all generators) and DC BUS 1 and/or DC BUS 2 remain energized.

The DC BUS 1 may remain energized because:

- BTC 1 fails to open.
- BC 1 fails to open or;
- EBC 1 fails to close.

The DC BUS 2 may remain energized because:

- BTC 2 fails to open or;
- EBC 2 fails to close.

Case 1 - Loss of all generators and BTC 1 is closed (DC BUS 1 is energized):

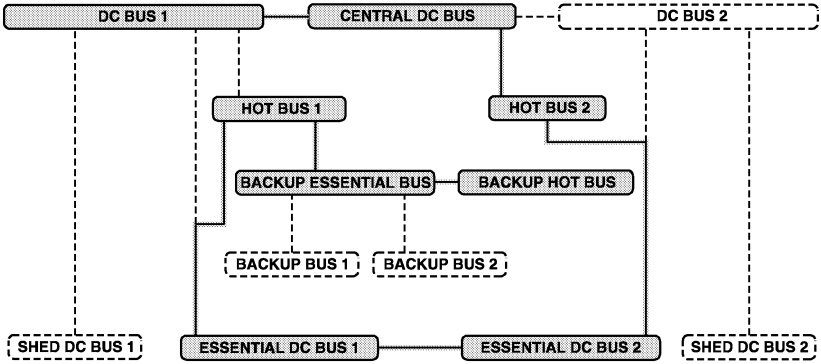
- ELEC ESS XFR FAIL warning message on the EICAS.
- All GLCs and ALC are open.
- BTC 2, BC 1, SBC 1 and SBC 2 are open.
- EBC 1, EBC 2, BTC 1, BC 2, BBC and EIC are closed.

NOTE: BC 2 remains closed to keep the CENTRAL DC BUS energized and making it possible to perform an APU start.

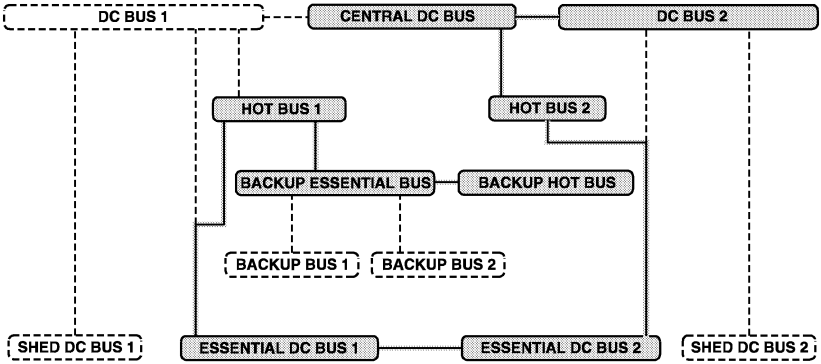
Case 2 - Loss of all generators and BTC 2 is closed (DC BUS 2 is energized):

- ELEC ESS XFR FAIL warning message on the EICAS.
- All GLCs and ALC are open.
- BTC 1, BC 1, SBC 1 and SBC 2 are open.
- EBC 1, EBC 2, BTC 2, EIC and BC 2 are closed.

NOTE: BC 2 remains closed to keep the CENTRAL DC BUS energized and making it possible to perform an APU start.



CASE 1



CASE 2

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CONFIGURATION 3B

CONFIGURATION 4

Short circuit at one DC Bus with all generators on:

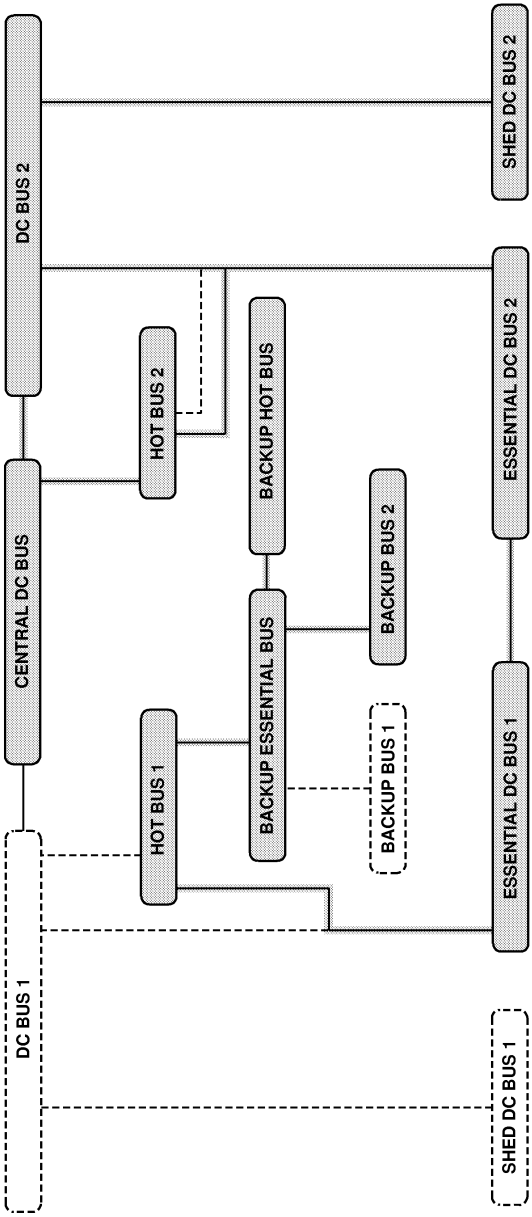
- Associated battery is removed from affected DC bus through a fuse.
- BTC 1 and BTC 2 are open.
- Both GLCs of the affected DC Bus are open, isolating the bus.
- Cross-side BTC and EIC are closed and affected side EBC is energized to maintain both Essential DC Buses energized and batteries charged.

Short circuit at one DC Bus with loss of one associated generator and with APU generator:

- Associated battery is removed from the affected DC bus through a fuse.
- BTC 1 and BTC 2 are open.
- Remaining GLC of the affected DC Bus opens, isolating the bus.
- Cross-side BTC and EIC are closed, and affected side EBC is energized to maintain both Essential DC Buses energized and batteries charged.

Short circuit at one DC Bus with loss of associated generators and with APU generator:

- Both batteries are removed from the affected DC bus through the fuses.
- BTC 1 and BTC 2 are open.
- EIC closes and EBC of affected side is energized to maintain the associated Essential DC Bus energized and associated battery charged.



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CONFIGURATION 4
(Only EDL 1 Failure Shown)

CONFIGURATION 5

Short circuit at one DC Bus with loss of one associated generator and without APU generator:

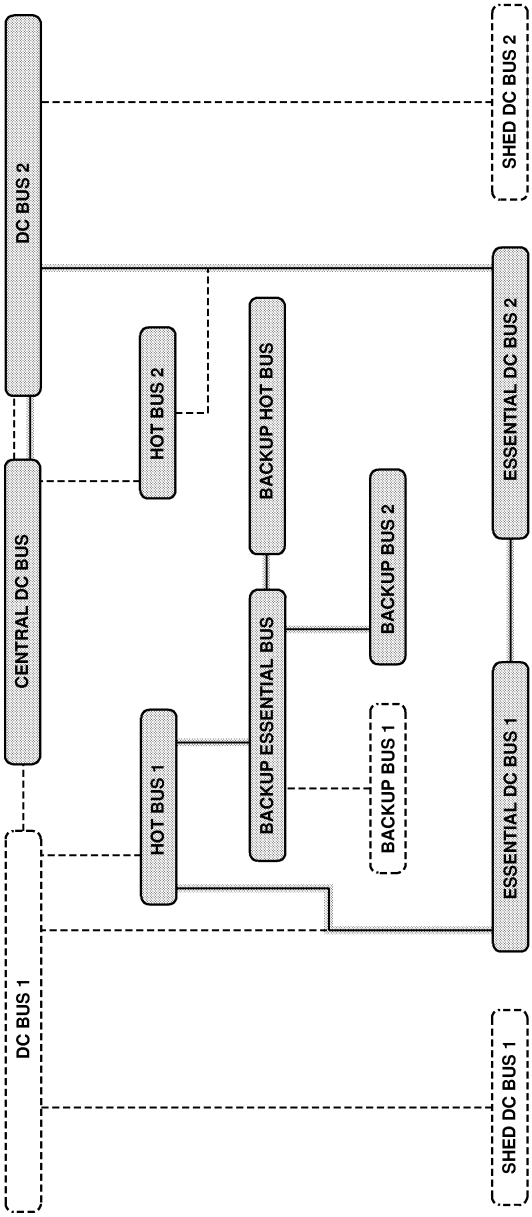
- Both batteries are removed from the affected DC bus through the fuses.
- BTC 1 and BTC 2 are open.
- Remaining GLC of the affected DC Bus opens, isolating the bus.
- Cross-side BTC and EIC close, and EBC of the affected side is energized to maintain both Essential DC Buses energized and associated battery charged.
- Both SBCs are open.

Short circuit at one DC Bus with loss of associated generators and without APU generator:

- Both batteries are removed from the affected DC bus through the fuses.
- BTC 1 and BTC 2 are open.
- EIC closes and EBC of the affected side is energized to maintain the associated Essential DC Bus energized and associated battery charged.
- Both SBCs are open.

Short circuit at one DC Bus with loss of associated generators plus one generator of the other side, with or without APU generator:

- The EDL operational sequence is the same as in the previous condition.



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CONFIGURATION 5
(Only EDL 1 Failure Shown)

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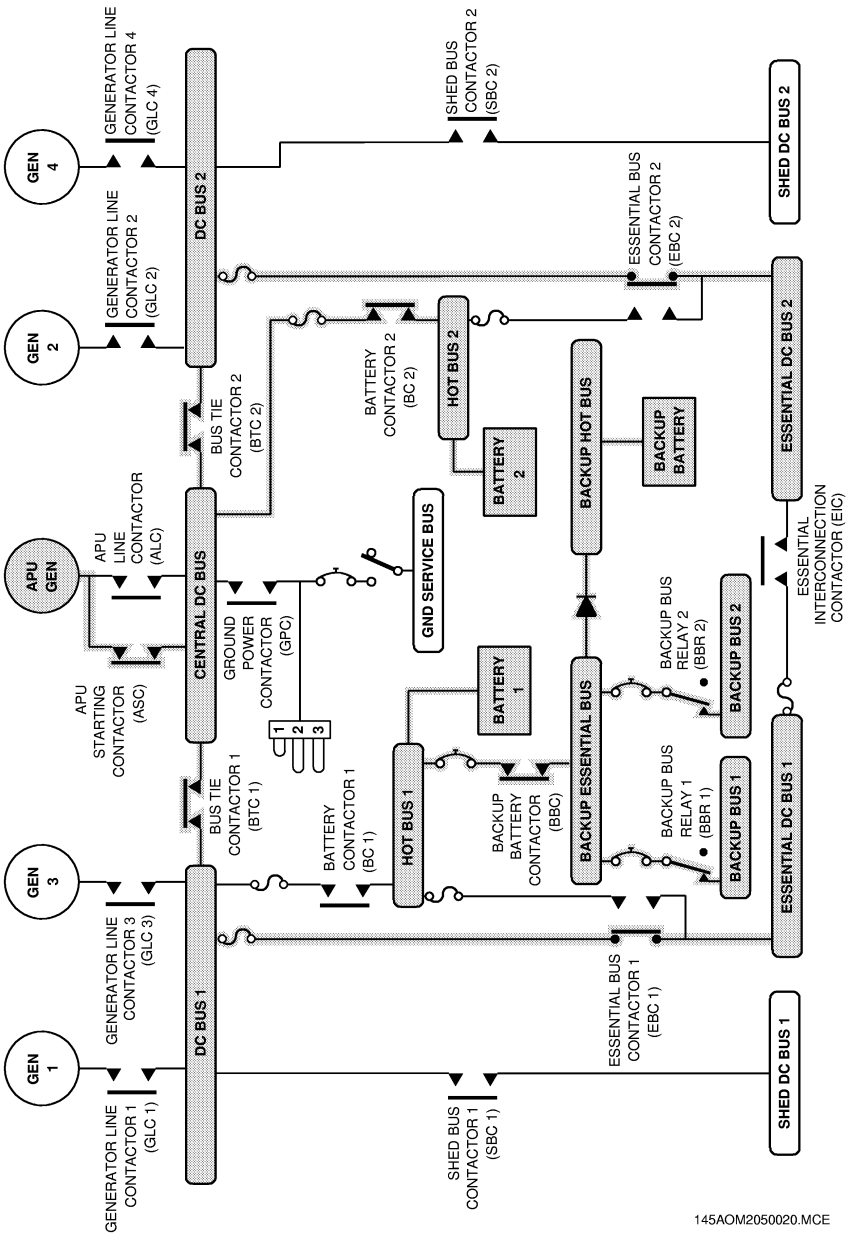
NORMAL, ABNORMAL AND EMERGENCY OPERATION DIAGRAMS

The following diagrams present the Electrical System layout when operating in normal, abnormal and emergency condition.



EDL STATUS DURING APU STARTING WITH BATTERIES

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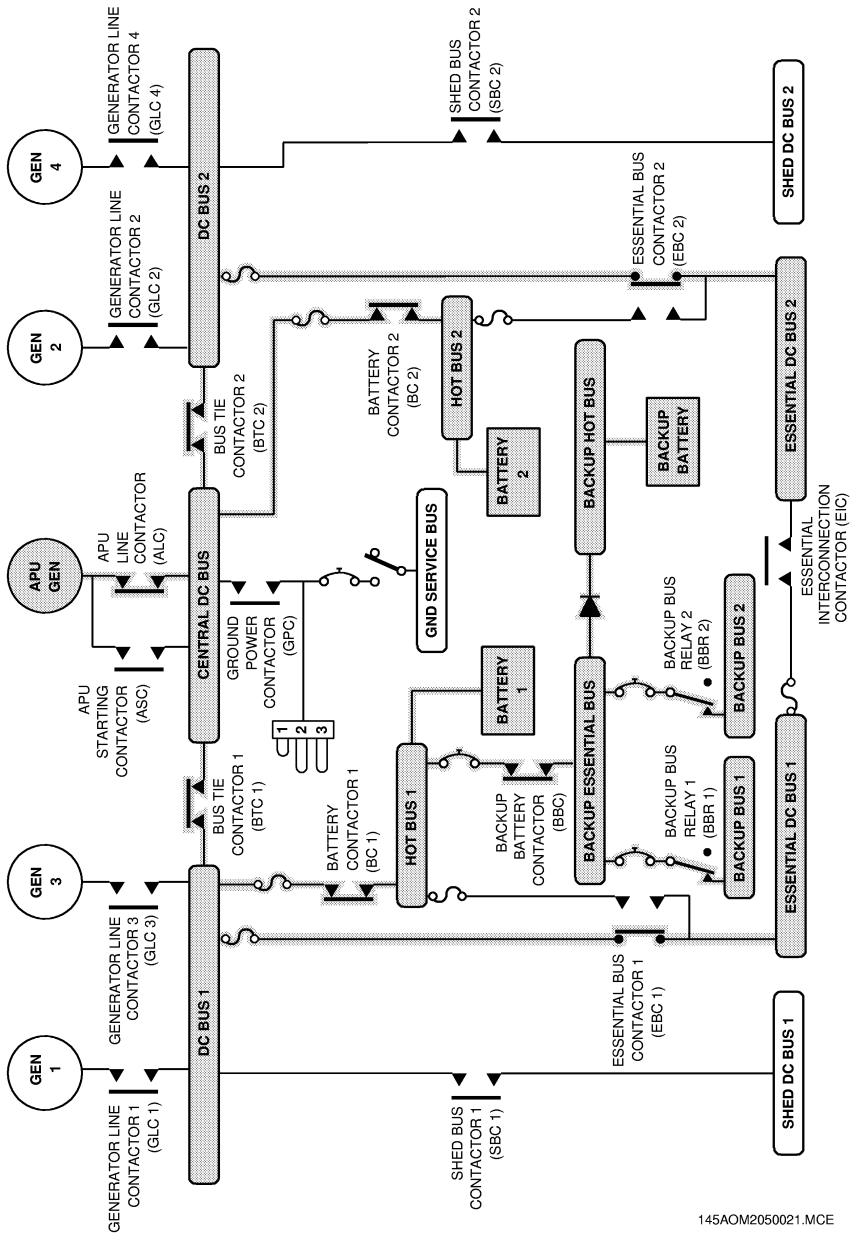
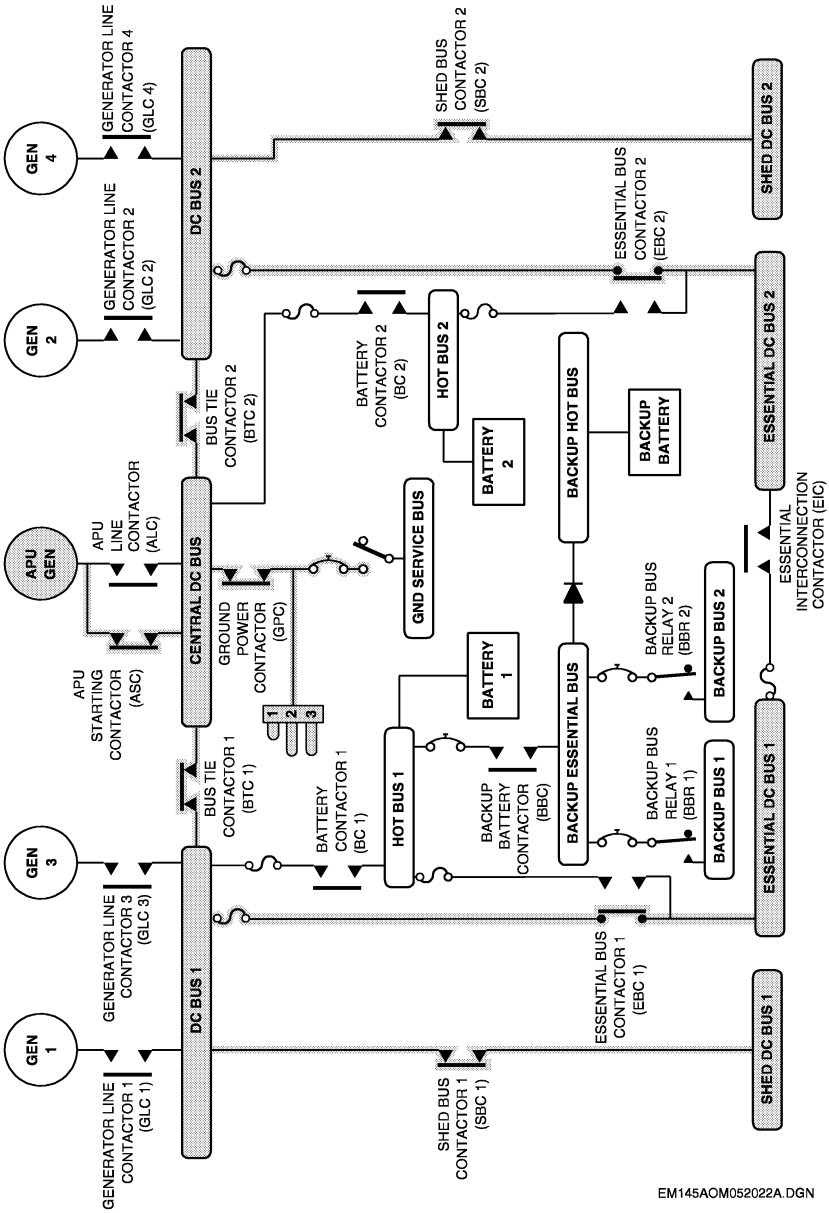
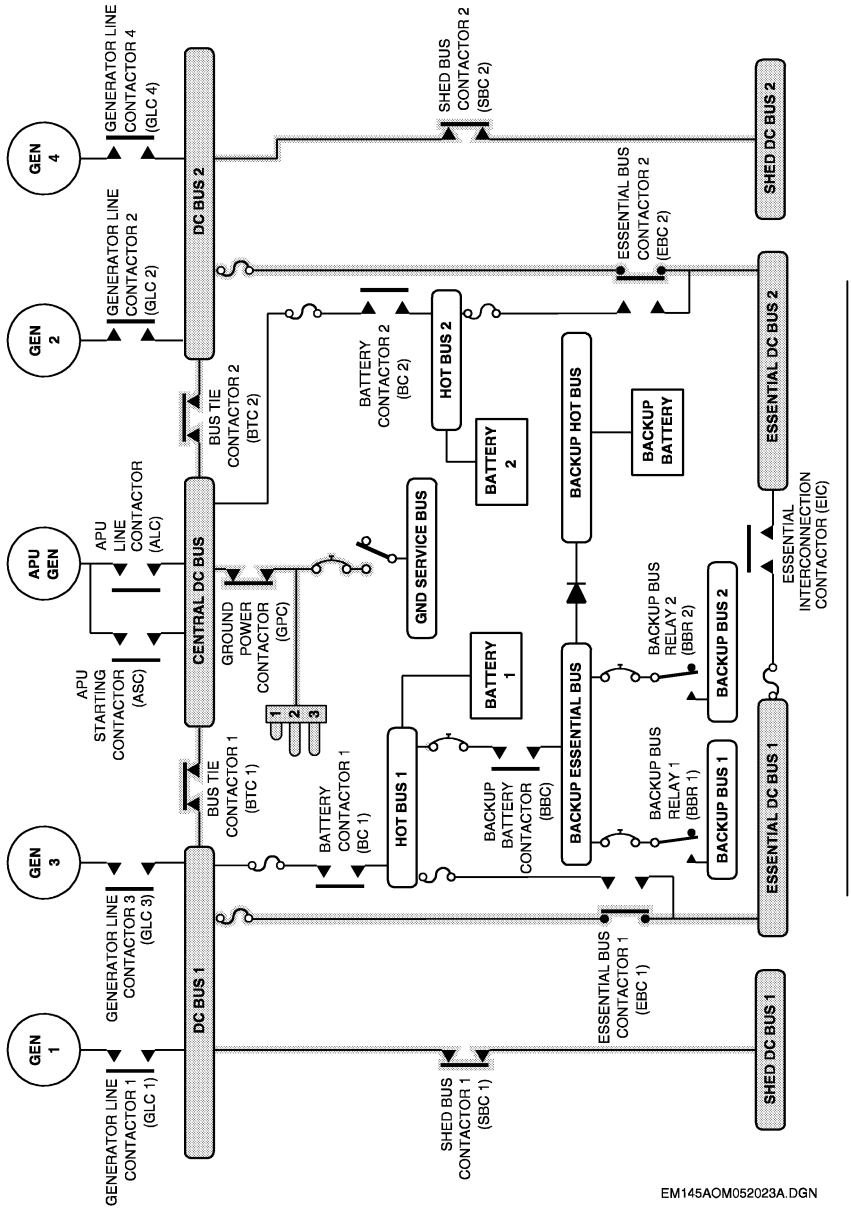


EDL STATUS AFTER APU STARTING WITH BATTERIES



EDL STATUS DURING APU STARTING WITH GPU



EDL STATUS AFTER APU STARTING WITH GPU

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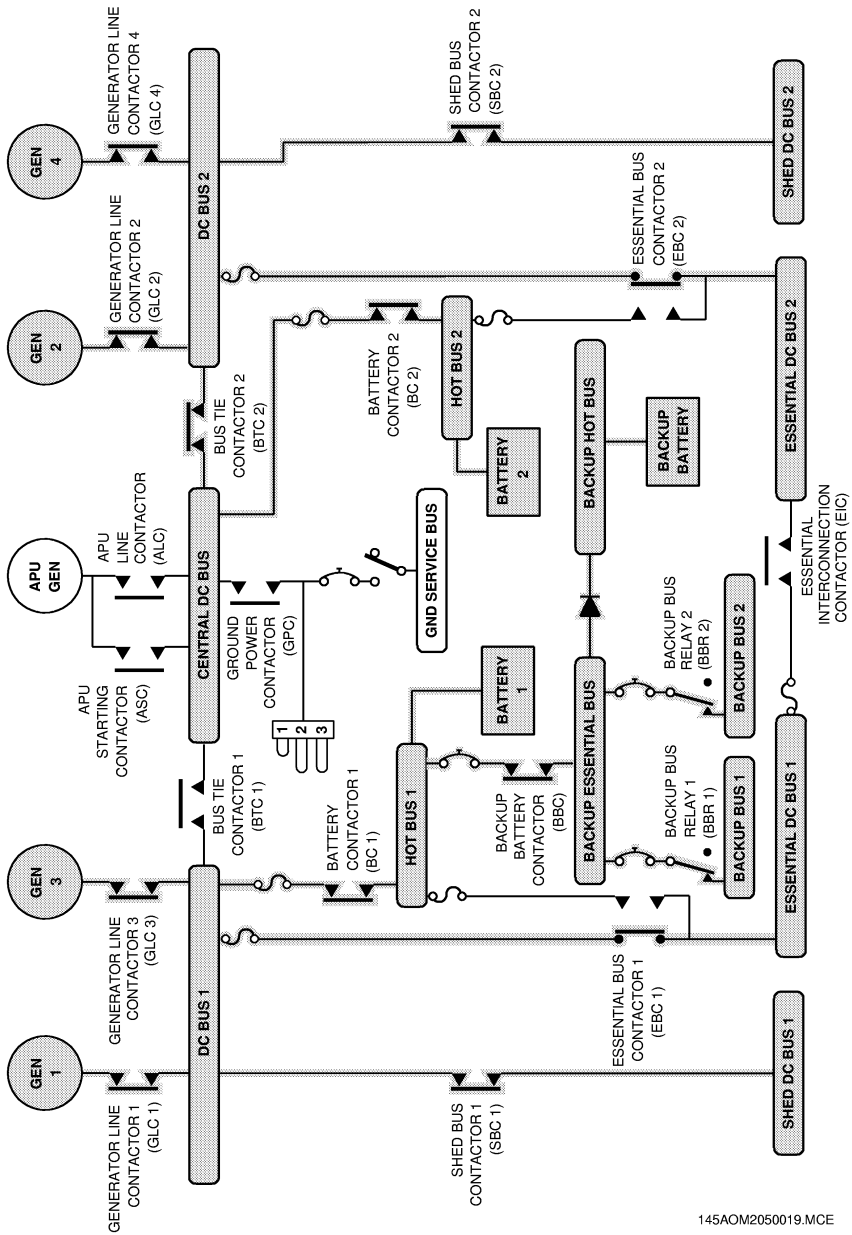
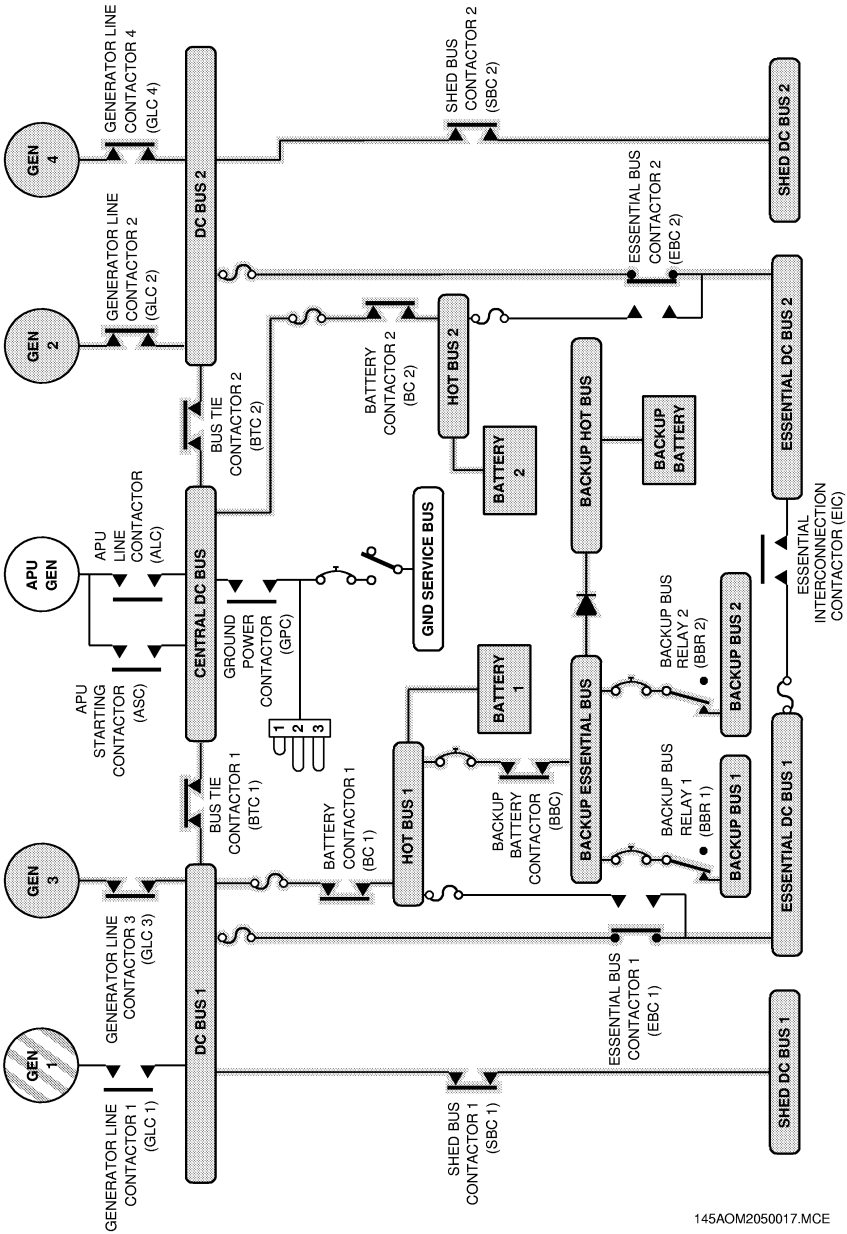
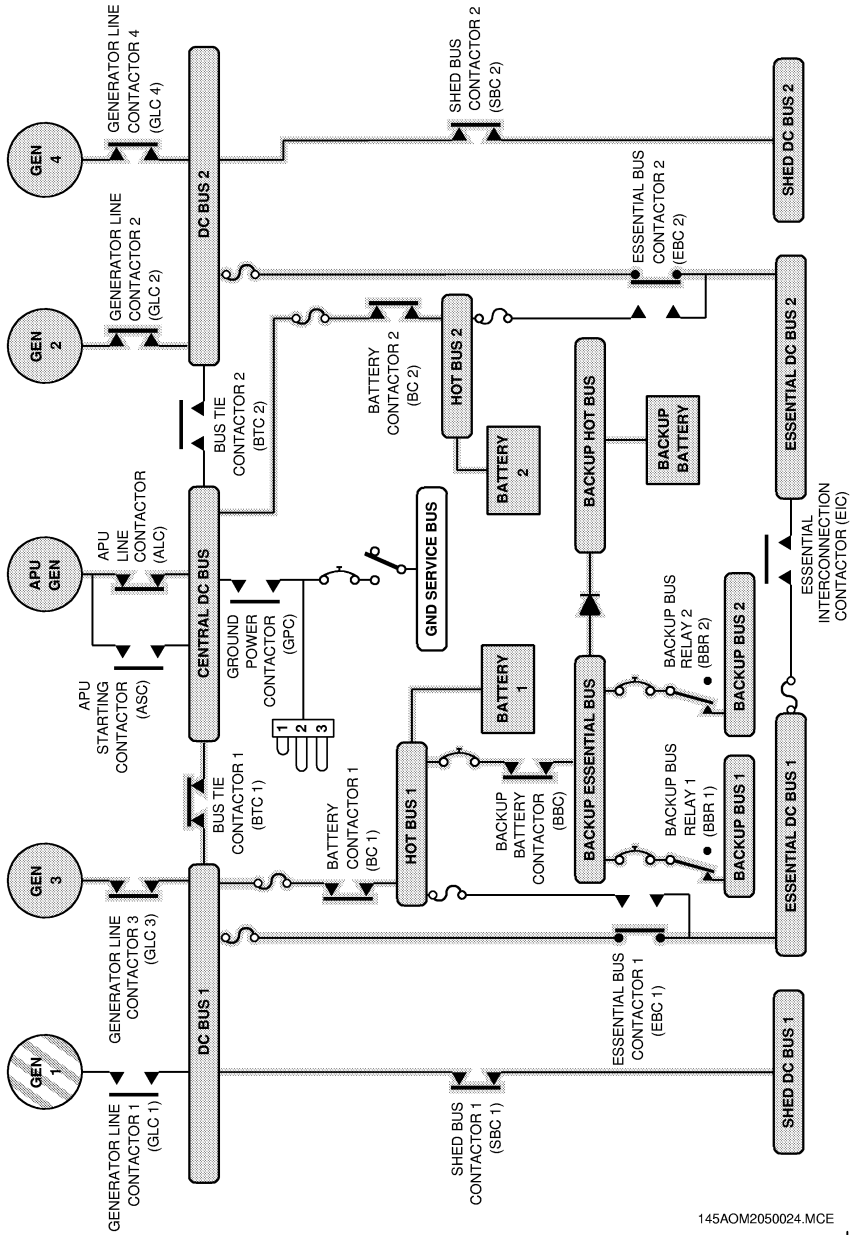


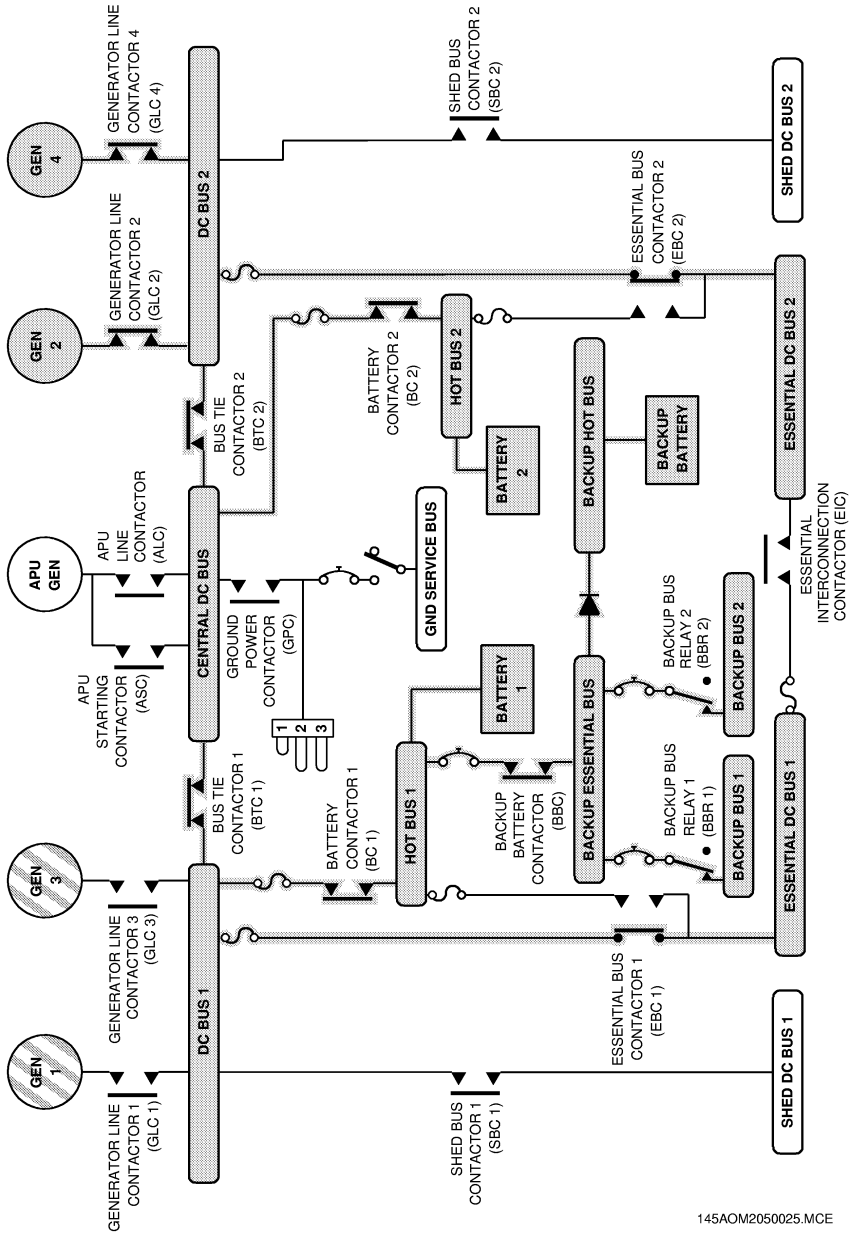
EDL STATUS DURING NORMAL OPERATION



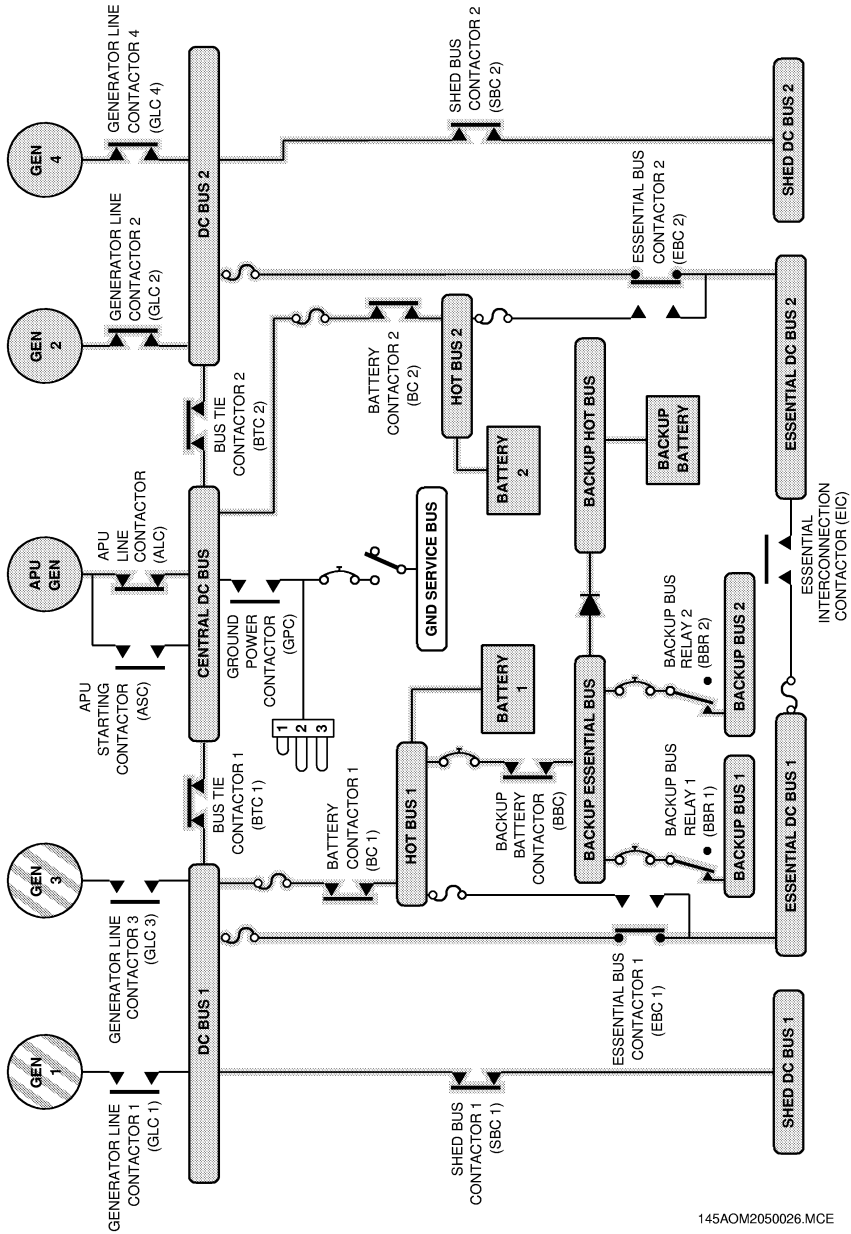
EDL STATUS AFTER LOSS OF GENERATOR 1 WITHOUT APU GENERATOR



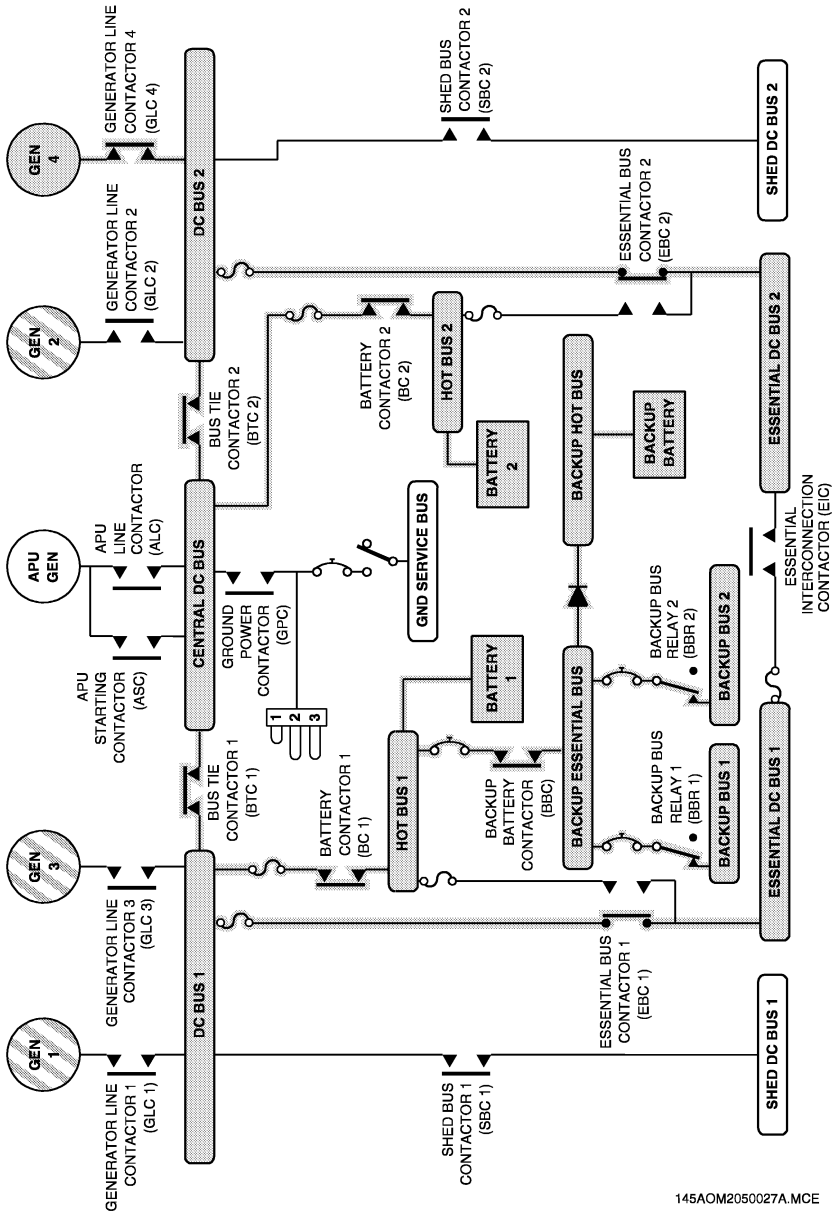
EDL STATUS AFTER LOSS OF GENERATOR 1 WITH APU GENERATOR



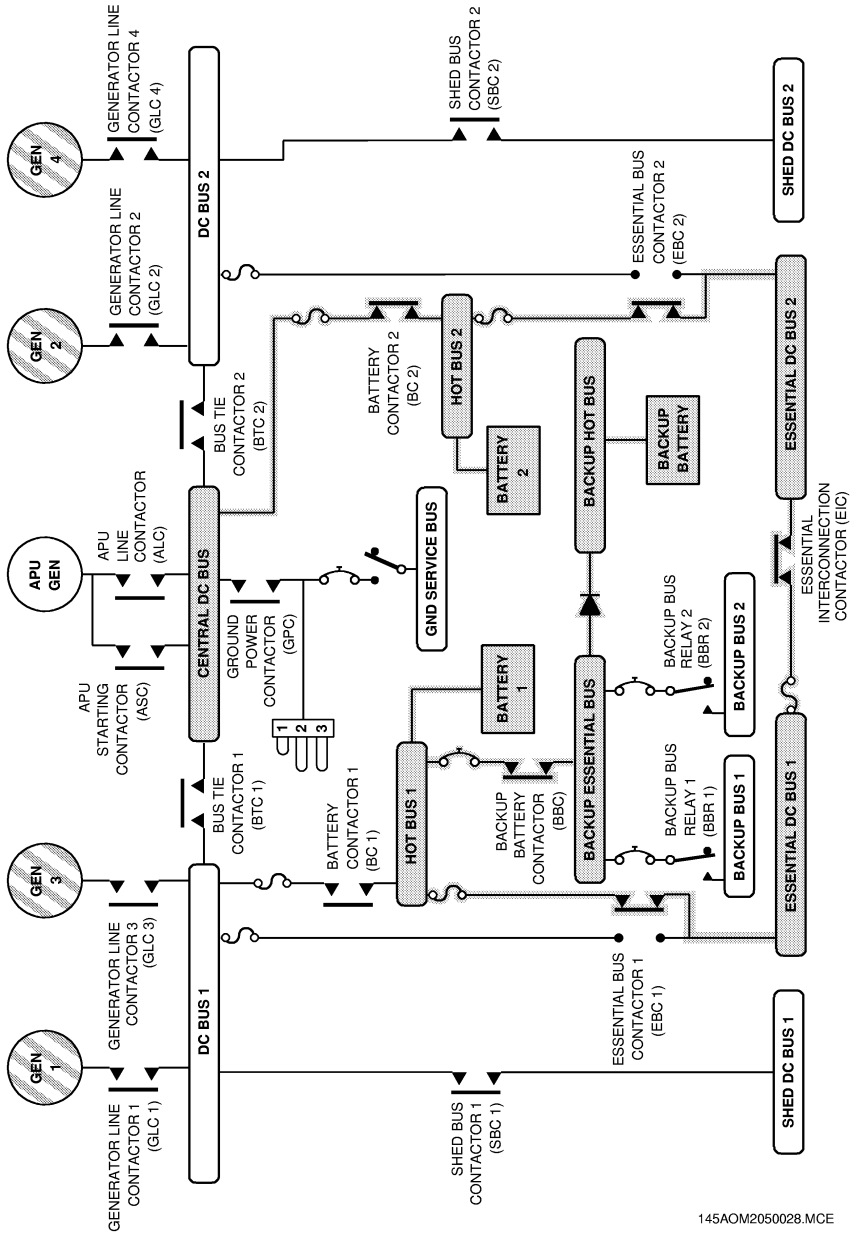
EDL STATUS AFTER LOSS OF GENERATORS 1 AND 3 WITHOUT APU GENERATOR



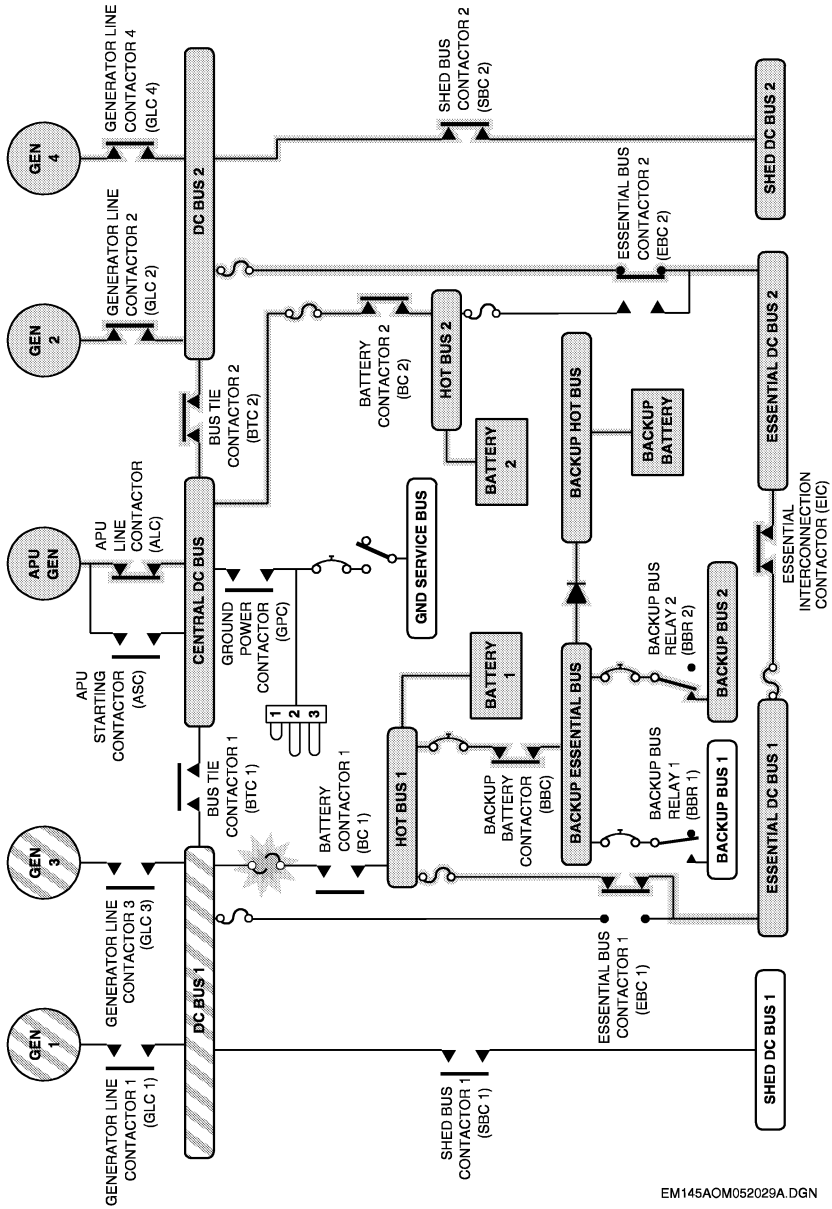
EDL STATUS AFTER LOSS OF GENERATORS 1 AND 3 WITH APU GENERATOR



EDL STATUS DURING LOSS OF THREE ENGINE GENERATORS WITHOUT APU GENERATOR



EDL STATUS AFTER LOSS OF ALL THE GENERATORS (ELECTRICAL EMERGENCY CONDITION)



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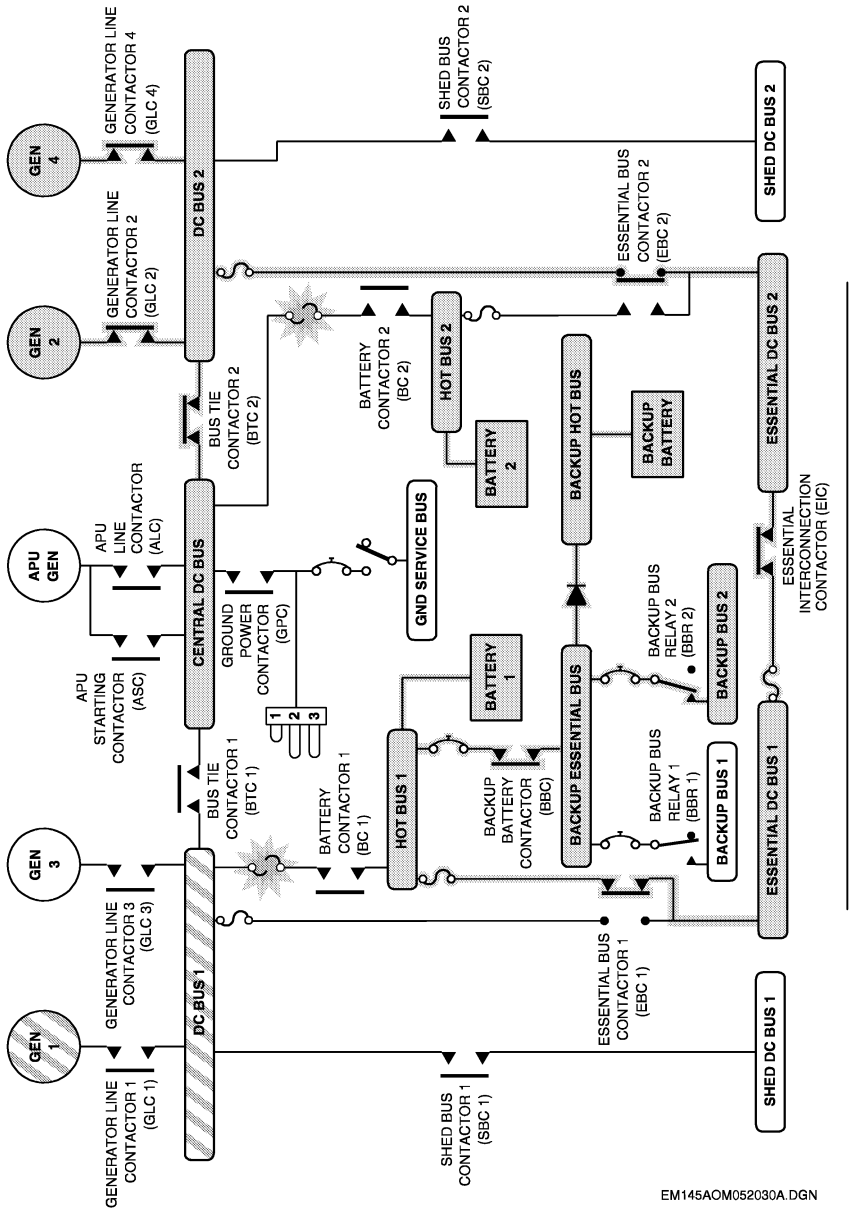
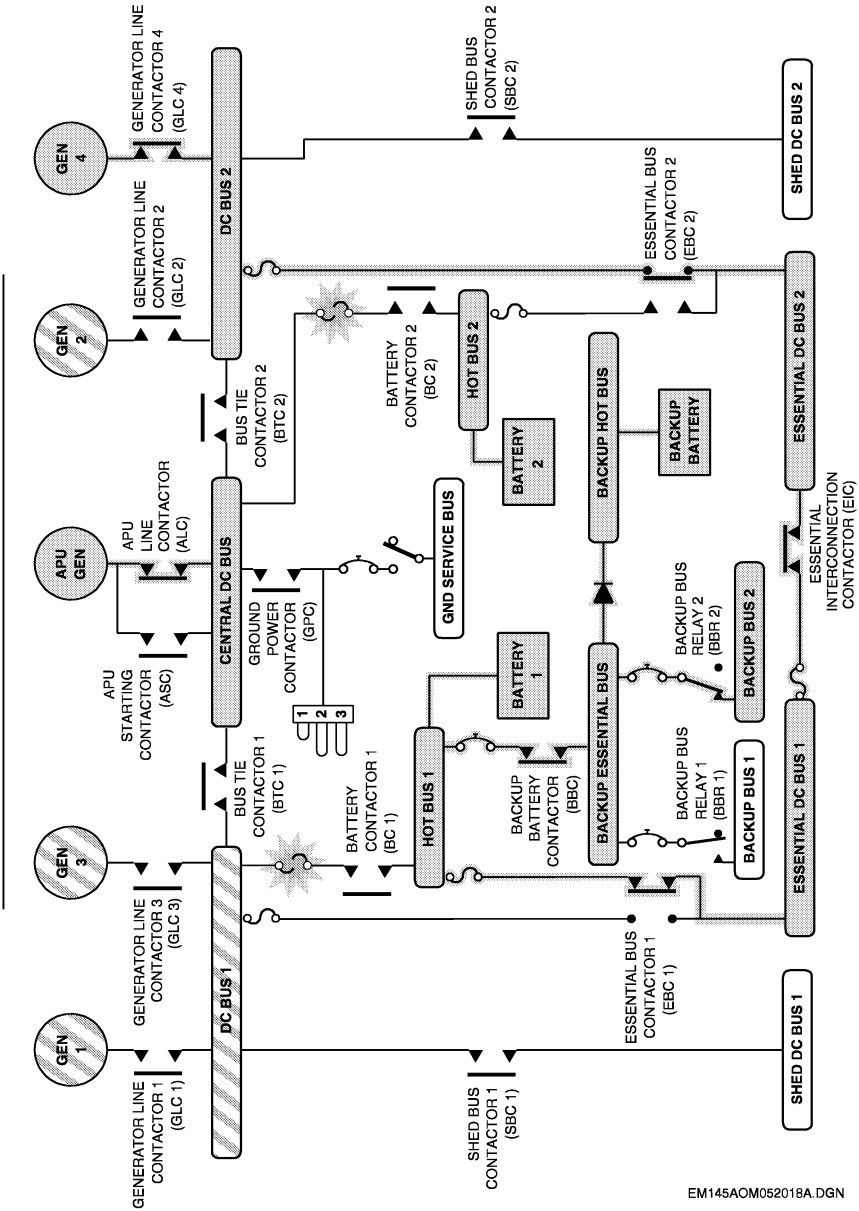
EDL STATUS AFTER A SHORT CIRCUIT AT DC BUS 1 WITH ALL GENERATORS ON



EDL STATUS AFTER A SHORT CIRCUIT AT DC BUS 1 WITH LOSS OF GENERATOR 1 AND WITHOUT APU GENERATOR



EDL STATUS AFTER A SHORT CIRCUIT AT DC BUS 1 WITH LOSS OF GENERATORS 1, 2 AND 3 WITH APU GENERATOR ON

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	BATT 1 (2) OVTEMP	Associated battery temperature is above 70°C.
	ELEC ESS XFR FAIL	Automatic transfer to electrical emergency condition has failed.
CAUTION	GEN 1 (2, 3, 4) OVLD	Associated generator current is above 400 A.
	GEN 1 (2, 3, 4) OFF BUS	Associated generator is disconnected from the electrical network after engine stabilization due to generator channel failure or button released.
	APU GEN OVLD	APU generator current is above 400 A.
	APU GEN OFF BUS	APU generator is disconnected from electrical network, due to open ALC, with APU RPM above 95% plus seven seconds. This is caused by generator channel failure or button released.
	APU CNTOR CLSD	APU Starting Contactor (ASC) or Line Contactor (ALC) is inadvertently closed.
	DC BUS 1 (2) OFF	Associated DC Bus is de-energized. If DC Bus 1 is deenergized the inverter becomes inoperative.
	ESS BUS 1 (2) OFF	Associated Essential Bus is deenergized.
	SHED BUS 1 (2) OFF	Associated Shed Bus is deenergized.
	BATT 1 (2) OFF BUS	Associated battery is discon-nected from the electrical network.
	BKUP BATT OFF BUS	Backup battery is discon-nected from the electrical network.

EICAS MESSAGES (continued)

TYPE	MESSAGE	MEANING
CAUTION	ELEC EMERG ABNORM	Improper transfer to electrical emergency condition has occurred.
	115 VAC BUS OFF	115 VAC bus is deenergized.
ADVISORY	GEN 1 (2, 3, 4) BRG FAIL	Associated generator bearing has failed.

CONTROLS AND INDICATORS

ELECTRICAL SYSTEM PANEL

1 - GENERATOR BUTTON

- Connects (pressed) or disconnects (released) the associated generator to/from the respective DC Bus.
- Pressing and depressing the Generator Button causes all GCU latches protection circuits to be reset if the associated generator is running.
- A striped bar illuminates inside the button when it is released.

2 - GROUND POWER UNIT BUTTON

- Connects (pressed) or disconnects (released) the GPU to/from the electrical system.
- A GPU AVAIL inscription illuminates, in the upper half of the button, when the GPU is properly connected to the airplane receptacle and ready to supply power. The GPU AVAIL inscription extinguishes when the button is pressed and the external power is connected to the electrical network.
- A striped bar illuminates inside the button when it is pressed.

3 - APU STARTER GENERATOR BUTTON

- Connects (pressed) or disconnects (released) the APU starter generator, when APU RPM is above 95%, plus 7 seconds.
- A striped bar illuminates inside the button when it is released.

4 - BATTERY SELECTOR KNOB

OFF - Respective battery contactor is kept open, disconnecting the associated battery from the electrical system.

AUTO - The actuation of the respective battery contactor is controlled according to the Electrical Distribution Logic.

5 - ESSENTIAL POWER BUTTON (guarded)

- When pressed the system overrides the automatic transfer to the electrical emergency circuitry, connecting the batteries directly to essential buses, regardless of any other command from the Electrical Distribution Logic.
- When released, the power contactors operate automatically according to the Electrical Distribution Logic.
- A striped bar illuminates inside the button when it is pressed.

6 - SHED BUSES SELECTOR KNOB

OVRD - Closes the Shed Buses Contactors, provided the airplane is on ground and at least one generator is operative.

AUTO - Controls the operation of Shed Buses Contactors according to the Electrical Distribution Logic.

OFF - Deenergizes the Shed Buses manually regardless of any other command from the Electrical Distribution Logic.

7 - AVIONICS MASTER BUTTONS

- Connect (pressed) or disconnect (released) the navigation and communication equipment supplied by the avionics switched buses.
- A striped bar illuminates inside the button when it is released.

8 - BACKUP BATTERY BUTTON

- Connects (pressed) or disconnects (released) the backup battery to/from the electrical system.
- A striped bar illuminates inside the button when it is released.

9 - AC POWER BUTTON

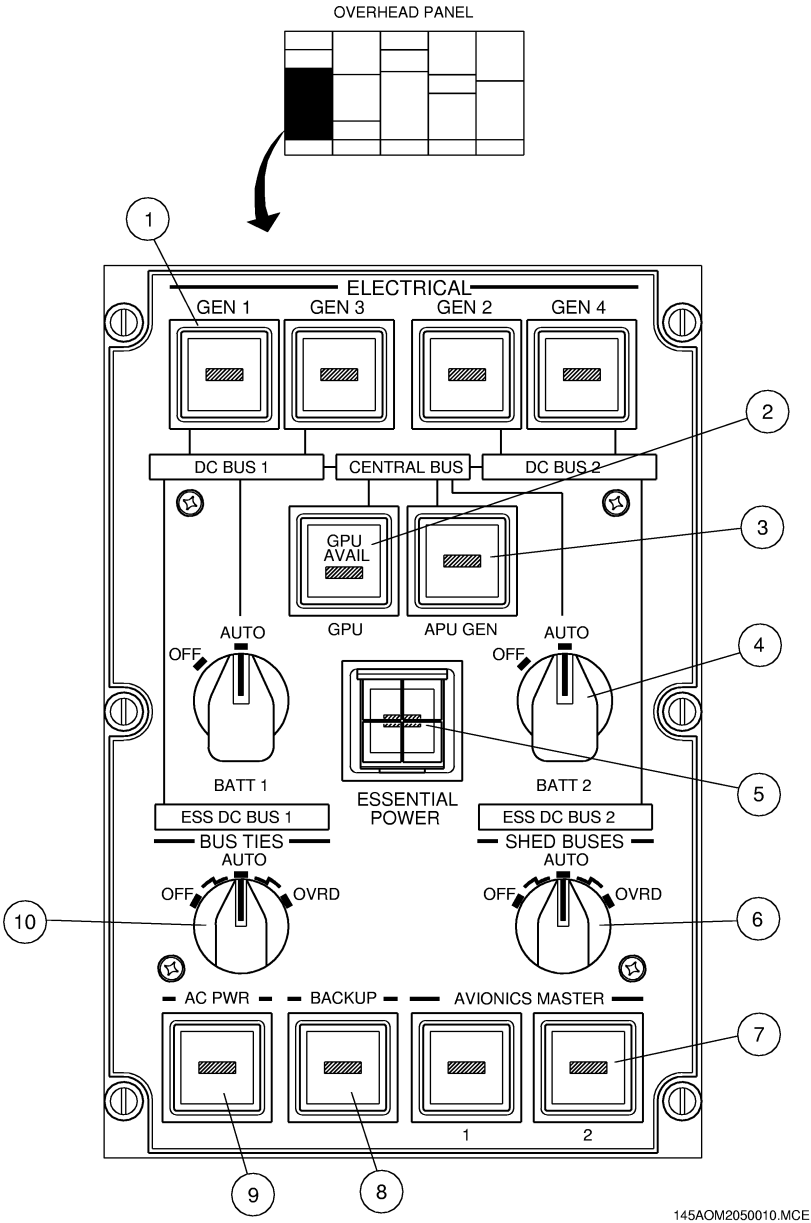
- Connects (pressed) or disconnects (released) the inverter to/from the system.
- A striped bar illuminates inside the button when it is released.

10- BUS TIES SELECTOR KNOB

OVRD - Bus Tie Contactors (BTCs) are kept closed regardless of Electrical Distribution Logic, provided that no overcurrent is detected by one of the five GCUs.

AUTO - Controls the operation of the BTCs according to the Electrical Distribution Logic.

OFF - Opens the BTCs and EIC regardless of any other command from the Electrical Distribution Logic.



ELECTRICAL SYSTEM PANEL

MFD ELECTRICAL PAGE

1 - LABELS AND UNITS

– Labels and units are always white.

2 - GENERATOR VOLTAGE AND CURRENT INDICATION

VOLTAGE:

– Digits are green and boxes are white during normal operation.
– Digits and boxes are amber when the generator is inadvertently off bus.
– Ranges from 0 to 40.0 V, with a resolution of 0.1 V.

CURRENT:

– Digits are green and boxes are white during normal operation.
– Digits and boxes are amber when the generator is inadvertently off bus or when the current is higher than 400 A.
– Ranges from 0 to 600 A, with a resolution of 5 A.

NOTE: The APU indication is removed when the APU is not available and/or the APU Master Selector is set to the OFF position with APU RPM below 10%.

3 - DC BUS INDICATION

– Green when bus is energized.
– Amber when bus is off.

4 - GPU VOLTAGE INDICATION

– Digits are always green.
– Box is always white.
– Ranges from 0 to 40.0 V, with resolution of 0.1 V.

NOTE: GPU voltage indication is removed in flight.

5 - BUS LINES INDICATION

– Bus lines are always white.

6 - BATTERY VOLTAGE AND TEMPERATURE INDICATION

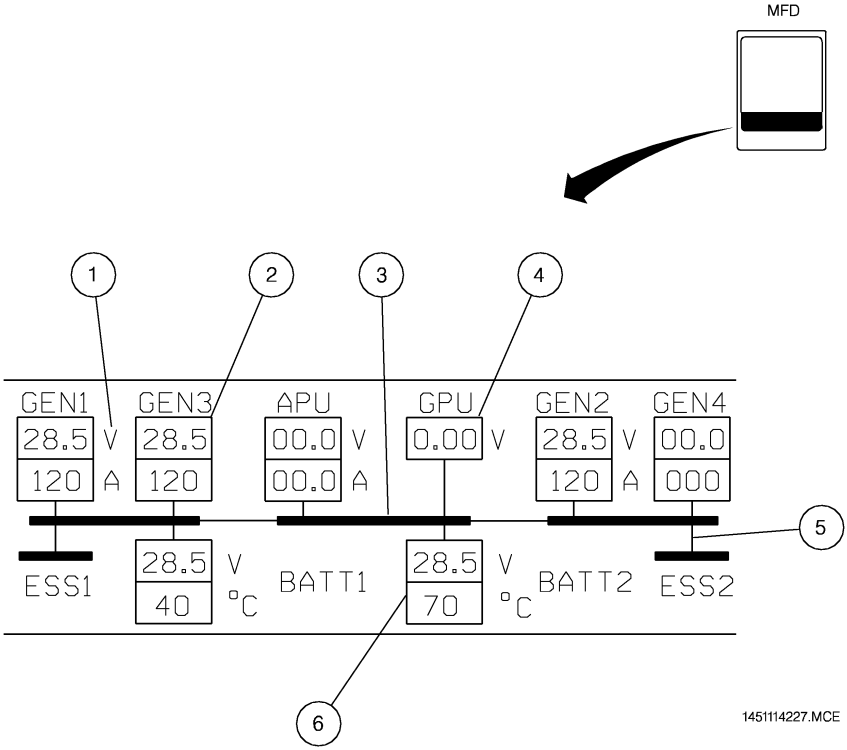
VOLTAGE:

- Digits are green and boxes are white during normal battery operation.
- Digits and boxes are amber when the battery is inadvertently off bus.
- Ranges from 0 to 40.0 V, with a resolution of 0.1 V.

TEMPERATURE:

- Boxes are white during battery normal operation.
- Boxes are amber when the battery is off bus.
- Digits are green when the temperature is below 70°C.
- Ranges from –40°C to 150°C, with a resolution of 1°C.
- Digits and boxes are red when the temperature is greater than 70°C.

NOTE: The red alerts supersede any other condition.



ELECTRICAL PAGE ON MFD

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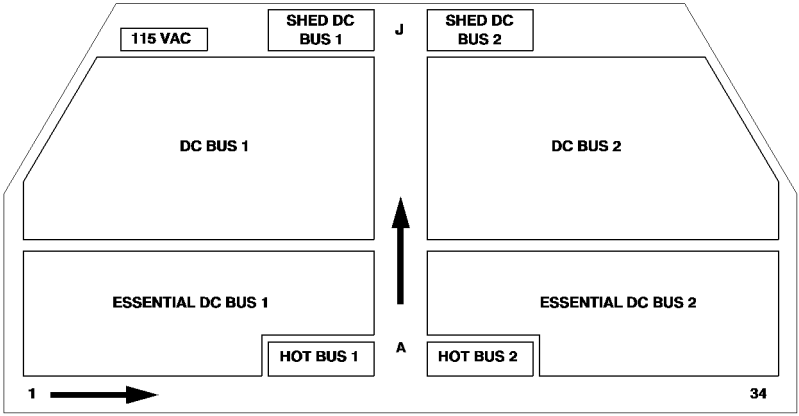
CIRCUIT BREAKER PANEL AND LOAD DISTRIBUTION

CIRCUIT BREAKER PANEL

The Circuit Breaker Panel is divided in areas associated to electrical system buses.

Columns and lines on the circuit breaker panel are identified through an alphabetic (for the lines) and numeric (for the columns) code.



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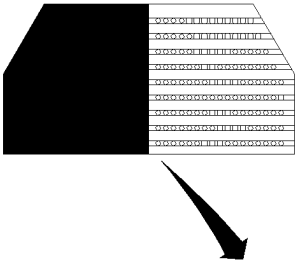
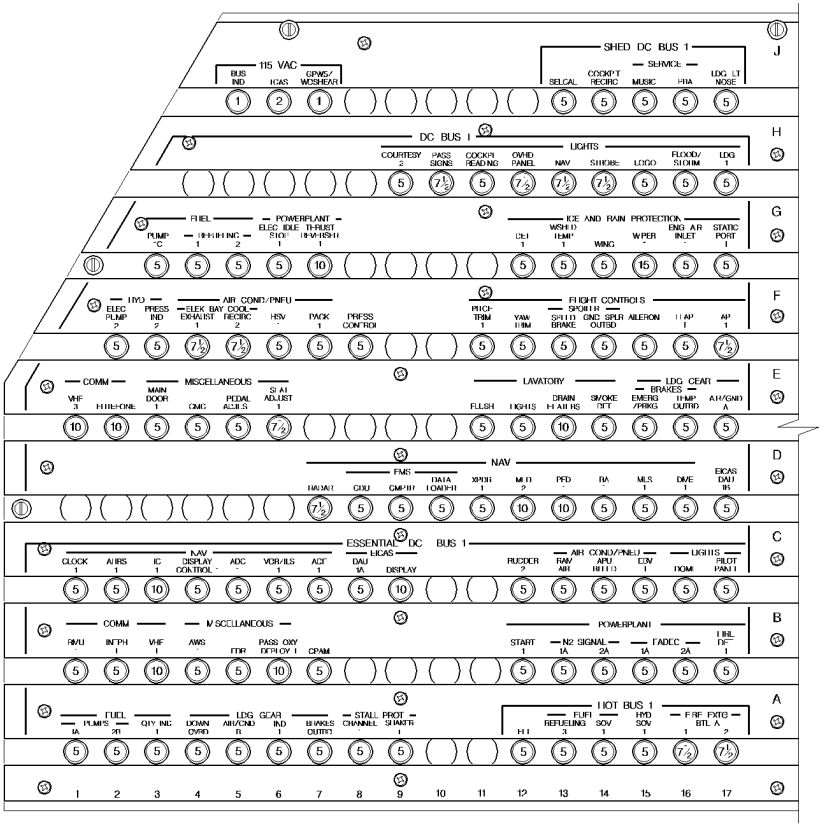
CIRCUIT BREAKER PANEL MAP

CIRCUIT BREAKER PANEL



NOTE: THE CIRCUIT BREAKER PANEL CONFIGURATION PRESENTED HEREIN IS TYPICAL, THE SPECIFIC CONFIGURATIONS CAN BE FOUND IN THE FAULT ISOLATION MANUAL (FIM).



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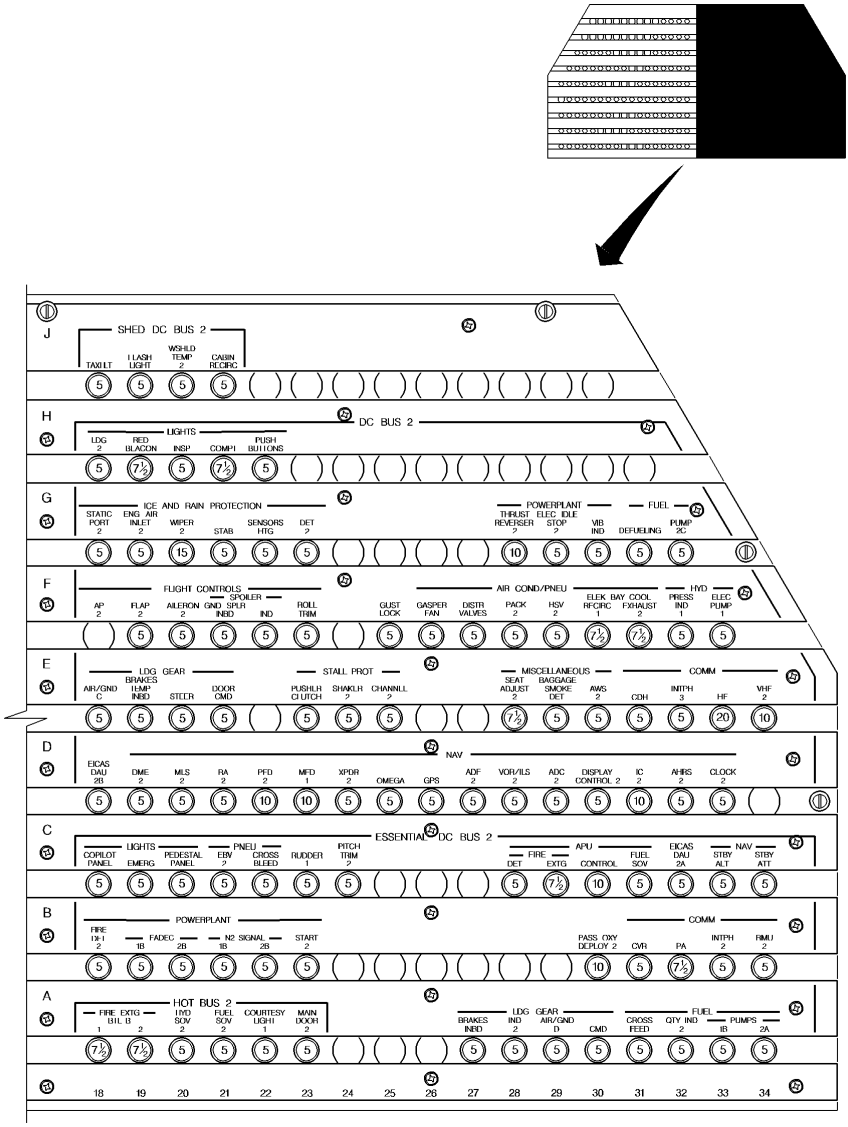
CIRCUIT BREAKER PANEL (TYPICAL)

CIRCUIT BREAKER PANEL



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CIRCUIT BREAKER PANEL (TYPICAL)

DC BUS LOAD DISTRIBUTION (TYPICAL)

The following list identifies the DC buses and the equipment powered by them. Optional equipment are preceded by an asterisk (*).

DC BUS 1

AILERON CONTROL SYSTEM 1
AIR/GND POSITION SYSTEM A
AOA 1 SENSOR HEATING
BRAKES TEMPERATURE INDICATION OUTBD
CABIN LIGHTING 1
CENTRAL MAINTENANCE COMPUTER
CLEAR ICE DETECTION SYSTEM - CHANNEL 1
COCKPIT READING LIGHT
COURTESY/STAIR LIGHTS 2
CREW PEDAL ADJUSTMENT
CREW SEAT ADJUSTMENT 1
EICAS POWER (DAU 1B)
* ELECTRICAL FLIGHT IDLE STOP 1
ELECTRONIC BAY COOLING (EXHAUST 1)
ELECTRONIC BAY COOLING (RECIRC 2)
EMER/PARKING BRAKE
ENG 1 FUEL PUMPS 1C
* ENG 1 THRUST REVERSER COMMAND
ENGINE 1 LIP ANTI-ICE
FLAP POWER/COMMAND 1
FLOOD/STORM LIGHTS
FUEL PRESSURE REFUELING 1/2
GROUND SPOILER OUTBD
* HEAD-UP GUIDANCE SYSTEM
HYDRAULIC ELECTRIC PUMP 2
HYDRAULIC GEN SYS 2 INDICATION
ICE DETECTOR 1
INVERTER
LANDING LIGHTS 1
LAVATORY FLUSH
LAVATORY LIGHTS
LAVATORY SMOKE DETECTOR
LAVATORY WATER DRAIN HEATER
LOGOTYPE LIGHTS
MAIN DOOR CONTROL 1
NAVIGATION LIGHTS
OVERHEAD PANEL LIGHTING
PACK VALVE 1

PASSENGER SIGNS
PITCH TRIM 1
PITOT 1 HEATING
PNEUMATIC HSV 1
PRESSURIZATION CONTROL
SPEED BRAKE
STATIC PORT HEATING 1
STROBE LIGHTS
TAT 1 SENSOR HEATING
* TCAS 2000
VENTRAL FUEL TRANSFER PUMP A (EMB-145 XR)
WINDSHIELD HEATING 1
WINDSHIELD WIPER SYSTEM 1
WING ANTI-ICE SYSTEM
YAW TRIM SYSTEM

DC BUS 2

ADC 2 POWER/CONTROL
AHRS 2 POWER
AILERON CONTROL SYSTEM 2
AIR/GND POSITION SYSTEM C
AOA 2 SENSOR HEATING
AURAL WARNING SYSTEM 2
BAGGAGE SMOKE DETECTOR
BRAKES TEMP INDICATION INBD
CABIN RECIRCULATION
CLEAR ICE DETECTION SYSTEM - CHANNEL 2
COMPARTMENT LIGHTS
COPILOT'S CLOCK
CREW SEAT ADJUSTMENT 2
DEFUELING
DISPLAY PRCS/CONTROL POWER 2 (IC2)
EICAS POWER (DAU 2B)
ELECTRICAL FLIGHT IDLE STOP 2
ELECTRONIC BAY COOLING (RECIRC 1)
ELECTRONIC BAY COOLING (EXHAUST 2)
ENG 2 FUEL PUMPS 2C
* ENG 2 THRUST REVERSER COMMAND
ENGINE 2 LIP ANTI-ICE
ENGINE VIBRATION SENSORS
FLAP POWER/COMMAND 2
GASPER FAN
GROUND SPOILER INBD
* GUST LOCK (ELECTROMECHANICAL)
HYDR ELECTRIC PUMP 1
HYDR GEN SYS 1 INDICATION
ICE DETECTOR 2
INSPECTION LIGHTS
* IRS POWER 2
LANDING GEAR DOOR COMMAND
LANDING LIGHTS
OBSERVER AUDIO (INTPH 3)
OVERHEAD PANEL LIGHTING
PACK VALVE 2
PASSENGER CABIN LIGHTS 1/2/3
PITOT 2 HEATING
PNEUMATIC HSV 2
RED BEACON LIGHTS
ROLL TRIM SYSTEM
SENSORS HEATING CONTROL
SPOILER INDICATION
SPS (SHAKER 2/CHANNEL 2)
SPS PUSHER
STABILIZER ANTI-ICE SYSTEM
STATIC PORT HEATING 2
STEERING SYSTEM
TAT 2 SENSOR HEATING
VENTRAL FUEL TRANSFER PUMP B (EMB-145 XR)
WINDSHIELD WIPER SYSTEM 2

AVIONIC SWITCHED DC BUS 1A

AUTOPILOT 1
DME 1
MFD 2 POWER
* MLS 1 POWER/CONTROL
PFD 1 POWER
RADIO ALTIMETER 1

AVIONIC SWITCHED DC BUS 2A

AUTOPILOT 2
DME 2
* FMS SYSTEM 2 DATA LOADER (#)
* FMS SYSTEM 2 COMPUTER (#)
* FMS SYSTEM 2 CDU (#)
MFD 1 POWER
* MLS 2 POWER/CONTROL
PFD 2 POWER
* RADIO ALTIMETER 2
TUNING BACKUP CONTROL HEAD
VHF SYSTEM 2

AVIONIC SWITCHED DC BUS 1B

* CMU MARK III
* FLITEFONE
* FMS SYSTEM 1 DATA LOADER
* FMS SYSTEM 1 COMPUTER
* FMS SYSTEM 1 CDU
RADAR SYSTEM
* TDR 1 POWER/CONTROL
* VHF SYSTEM 3

AVIONIC SWITCHED DC BUS 2B

* ADF 2
* GPS
* HF POWER/CONTROL
* OMEGA
TDR 2 POWER/CONTROL
VOR/ILS/MB 2

SHED DC BUS 1

COCKPIT RECIRCULATION
* GALLEY OVEN POWER
NOSE LANDING LIGHTS
* MUSIC
* PRE RECORD ANNOUNCEMENTS (PRA)
READING LIGHTS/ATTENDANT CALL 1
* SELCAL SYSTEM

SHED DC BUS 2

CABIN RECIRCULATION
FLASHLIGHT
* GALLEY
* GALLEY COFFEE MAKER POWER
READING LIGHTS/ATTENDANT CALL 2/3
TAXI LIGHTS
WINDSHIELD HEATING 2

HOT BUS 1

EMERGENCY LOCATOR TRANSMITER (ELT)
ENG 1 FIRE EXTINGUISHING (BTL A1)
ENG 2 FIRE EXTINGUISHING (BTL A2)
FUEL PRESSURE REFUELING 3
FUEL SHUTOFF VALVES 1
HYDRAULIC SHUTOFF VALVE 1

HOT BUS 2

COURTESY/STAIR LIGHTS 1
ENG 1 FIRE EXTINGUISHING (BTL B 1)
ENG 2 FIRE EXTINGUISHING (BTL B 2)
FUEL SHUTOFF VALVES 2
HYDRAULIC SHUTOFF VALVE 2
MAIN DOOR CONTROL 2

BACKUP ESSENTIAL BUS

AHRS POWER 1
DATA ACQUISITION UNIT ½
DISPLAY PRCS/CONTROL POWER 1
EICAS POWER
* IRS POWER 1

BACKUP HOT BUS

APU GENERATION
DC DISTRIBUTION
DC GENERATION 1
DC GENERATION 2
DC GENERATION 3
DC GENERATION 4
ISIS (EMB-145 XR)

BACKUP BUS 1

NONE

BACKUP BUS 2

AHRS POWER 2
* IRS POWER 2

(#) Applicable only if DUAL FMS is installed

ESSENTIAL DC BUS 1

ADC 1 POWER/CONTROL
AHRS 1 POWER
AIR/GND POSITION SYSTEM B
APU BLEED
AURAL WARNING SYSTEM 1
BRAKE CONTROL UNIT (OUTBOARD SYSTEM)
COCKPIT DOME LIGHTS
DISPLAY PRCS/CONTROL POWER 1 (IC 1)
EICAS DISPLAY POWER
EICAS POWER (DAU 1A)
ENG 1 FIRE DETECTION 1
ENG 1 FUEL PUMPS 1A
ENG 2 FUEL PUMPS 2B
ENGINE 1 FADEC A POWER
ENGINE 2 FADEC A POWER
ENGINE 1 STARTING
ENGINES N2 SIGNALS 1A
ENGINES N2 SIGNALS 2A
FDR MANAGEMENT
FUEL QUANTITY INDICATION 1
LANDING GEAR CONTROL (DOWN OVRD)
LANDING GEAR NOSE INDICATION 1
* IRS POWER 1
PASSENGER OXYGEN SYSTEM 1
PILOT/COPILOT AUDIO SYSTEM (INTPH 1)
PILOT'S CLOCK
PILOT'S PANEL LIGHTING
PNEUMATIC 1 (EBV 1)
RAM AIR DISTRIBUTION
RMU 1 POWER/CONTROL
RUDDER CONTROL SYSTEM 2
SPS (SHAKER 1/CHANNEL 1)
VHF SYSTEM 1

ESSENTIAL DC BUS 2

AIR/GND POSITION SYSTEM D
APU CONTROL
APU FIRE DETECTION
APU FIRE EXTINGUISHING
APU FUEL FEED
BRAKE CONTROL UNIT (INBOARD SYSTEM)
COPILOT'S PANEL LIGHTING
CROSS BLEED
EICAS POWER (DAU 2A)
EMERGENCY LIGHTING CONTROL
ENG 2 FIRE DETECTION 2
ENG 1 FUEL PUMPS 1B
ENG 2 FUEL PUMPS 2A
ENGINE 1 FADEC B POWER
ENGINE 2 FADEC B POWER
ENGINE 2 STARTING
ENGINES N2 SIGNALS 1B
ENGINES N2 SIGNALS 2B
FUEL CROSS FEED
FUEL QUANTITY INDICATION 2
ISIS (ALL MODELS EXCEPT EMB-145 XR)
LANDING GEAR CONTROL
LANDING GEAR NOSE INDICATION 2
PASSENGER OXYGEN SYSTEM 2
PEDESTAL PANEL LIGHTING
PILOT/COPILOT AUDIO SYSTEM (INTPH 2)
PITCH TRIM 2
PITOT HEATING 3
PNEUMATIC 2 (EBV 2)
PUBLIC ADRESS
RMU 2 POWER/CONTROL
RUDDER CONTROL SYSTEM 1
STANDBY ALTIMETER
STANDBY ATTITUDE INDICATOR
VOICE RECORDER

AVIONIC SWITCHED ESSENTIAL DC BUS 1

ADF 1
VOR/ILS/MB 1

AVIONIC SWITCHED ESSENTIAL DC BUS 2

NONE