**ON A/C ALL

24–00–00–001

ELECTRICAL POWER, GENERAL

Introduction

The flight crew can manually set available power sources from the flight deck overhead control panel. System parameters are monitored and electrical signals are transmitted to the cockpit electronic Engine and System Integrated Display (ESID) panels. Failure indications are made available to the flight crew by caution, warning, and advisory panels, and ESID system pages.

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 and an optional Auxiliary Power Unit (APU). External DC or AC power connections are available while the airplane is on the ground. The EPGDS gives the functions that follow to the flight crew:

- Energy conversion
- Energy storage
- Control
- Protection
- Monitoring
- Distribution
- Indication.

General Description

Refer to Figures 1 , 2 and 3.

The AC Generation System contains two ac variable frequency generators, #1 AC GEN and #2 AC GEN. These generators supply 115 Vac three phase electrical power to ac systems that are not frequency sensitive. These systems include deicing heaters, fuel auxiliary pumps, the Standby Power Unit (SPU) hydraulic pump and the galleys. It also supplies power to the Transformer Rectifier Units (TRU), which are part of the DC Generation System.

The DC Generation System is supplied by three NiCad batteries, two engine driven starter/generators, two TRUs and an optional APU. The TRUs supply 28 Vdc and are powered by the two engine driven Alternating Current (ac) generators that supply 115 Volts Alternating Current (Vac).

An electrical bus system is used to supply ac and dc power to all aircraft electrical equipment. The supply of electrical power from individual sources is controlled by the operation of the bus tie contactors.

There are dc and ac external power receptacles for connecting Ground Power Units (GPU) while the aircraft is on the ground.

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

The EPGDS has the systems and the subsystems that follow:

- AC Generation System (24–20–00)
- Alternating current variable frequency (24–21–00)
- DC Generation System (24–30–00)
- Main 28 Vdc generation Subsystem (24–31–00)

- Battery Subsystem (24–32–00)
- APU 28 Vdc Generation Subsystem (24–33–00)
- External Power System (24–40–00)
- External ac ground power (24–41–00)
- External dc ground power (24–42–00)
- ac electrical load distribution (24–50–00)
- dc electrical load distribution (24–60–00).

Detailed Description — AC Generation System (24–20–00)

Refer to Figures 4 , 5 and 6.

Two ac generators, one on each engine, supply power independently to the left and right ac bus systems. An ac external power receptacle and control circuitry let the system be powered from an external power source while the aircraft is on the ground. When one generator malfunctions, the ac variable frequency system automatically connects the two ac buses to the serviceable generator and disconnects the two galley buses.

Toggle switches located on the AC CONTROL panel in the flight compartment give manual control of the alternating current variable frequency system. The ESID system shows ac variable frequency system electrical indications.

The ac variable frequency system has current sensors in the left and right ac contactor boxes. The current sensors measure A, B, and C phase currents and supply the data to the Generator Control Units (GCU) and the Electrical Power Control Unit (EPCU) for monitoring. The EPCU also measures A, B, and C phase voltage from the ac generators and buses.

DC Generation System (24–30–00)

The DC Generation System has the subsystems that follow:

- Main 28 Vdc Generation Subsystem (24–31–00)
- Battery Subsystem (24–32–00)
- APU 28 Vdc Generation Subsystem (24–33–00)

The main and the auxiliary batteries are connected to the main feeder buses that supply electrical power to start the engines. During an engine start, the standby battery is disconnected from the main feeder bus but stays connected to the essential buses. This maintains a minimum voltage level on the essential buses. The main, auxiliary, and standby batteries are connected to the main feeder buses to receive a charging current.

Main 28 Vdc Generation System (24–31–00)

Refer to Figures 7 , 8 and 9.

The main 28 Vdc generation system has two dc starter/generators, one on each engine, and two Transformer Rectifier Units (TRUs) to supply electrical power independently to the left and right dc bus systems.

Two dc starter/generators energize their related main feeder and essential distribution busses. The left and right main feeder busses are isolated and are connected to each other automatically or manually through a bus tie contactor. The left and right essential busses are connected together through circuit breakers.

Two TRUs energize their related secondary busses.

NOTE

Two engine driven ac generators supply 115Vac variable frequency ac electrical power to the TRUs. The TRUs change the 115Vac variable frequency ac electrical power to 28 Vdc power.

When a dc starter/generator or TRU malfunctions, the main 28 Vdc generation system automatically connects its bus to another serviceable electrical source for continuous operation.

A dc external power receptacle and control circuitry allows the system to be powered from an external power source while the aircraft is on the ground.

Toggle switches located on the dc control panel in the flight compartment give manual control of the main 28 Vdc generation system. The ESID system shows main 28 Vdc generation system electrical indications.

Main 28 Vdc Generation System: The main 28 Vdc generation system has five internal power sources and one external power source that follows:

- Left TRU
- Right TRU
- #1 DC starter/generator
- #2 DC starter/generator
- Batteries, main, auxiliary and standby
- DC external power

Battery System (24–32–00)

Refer to Figures 10 , 11 and 12.

The batteries are used for engine starting if ground power is not available, and to supply backup power to the aircraft essential services in flight for 30 minutes or more (60 minutes with 40–amp–hour standby battery).

The BATTERY MASTER switch is located on the DC CONTROL panel in the flight compartment overhead console. When the BATTERY MASTER switch is set to the on position, all three batteries are connected to the left and right essential buses.

NOTE

Battery power cannot be applied to the secondary buses.

The connections of the main and auxiliary batteries to the main buses are controlled by the Electrical Power Control Unit (EPCU) logic. Necessary conditions for disconnecting the batteries from the buses are:

- Battery switches set to the OFF position
- Emergency operation
- Bus fault detected
- With DC external power.

Auxiliary Power Unit (APU) 28 Vdc (24–33–00)

Refer to Figures 13 and 14.

The APU Starter/generator is located in the tail cone section of the aircraft. The APU is designed to supply 28Vdc to the essential and main DC buses with the aircraft on the ground.

When the APU CONTROL GEN ON/WARN switch on the APU CONTROL panel is pushed to the ON position, 28 Vdc is applied to contactor K26. This starts the APU and applies 28 Vdc to the right main feeder bus and the other aircraft buses. The APU dc generator is controlled by the APU DC GCU.

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

External ac Ground Power (24–41–00)

Refer to Figures 15 , 16 and 17.

An ac Generator Control Unit (GCU) can be connected to the ac external power receptacle in the right engine nacelle to supply ac power to the aircraft.

The EXT PWR switch on the overhead AC CONTROL panel connects power directly to the left and right variable frequency buses, supplying power to all ac and dc buses.

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

External ac power is monitored for the conditions that follow:

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

External DC Ground Power (24–42–00)

Refer to Figures 18 , 19 and 20.

A dc GPU can be connected to the dc external power receptacle which is installed on the left side of the forward fuselage section.

When the dc external source is supplying electrical power to the aircraft and the external power toggle switch on the overhead DC CONTROL panel is set to the EXT PWR position, the EPCU will let the external power source connect to the left main feeder bus.

NOTE

When dc external power is connected, the battery master toggle switch located on the dc control panel is set to the BATTERY MASTER position to energize the EPCU before the dc external power toggle switch is set to EXT PWR for dc external power operation.

The dc external power system uses circuit breakers and fuses for passive protection so that a malfunction condition will not cause damage to the aircraft wiring.

The dc external power system uses the EPCU to automatically control the external power contactor for active protection so that a fault condition will not cause damage to the aircraft wiring. The automatic functions do not require a manual input from the flight deck.

External dc power is monitored for the following conditions:

- Correct polarity
- Over voltage, 31 Vdc
- Under voltage, 22 Vdc

AC Electrical Load Distribution (24–51–00)

Refer to Figures 21 and 22.

The 115 Vac variable frequency is supplied through the 115 Vac variable frequency circuit breaker panel in the flight compartment. The 115 Vac variable frequency three–phase busses and their related circuit breakers are identified on the panel.

The variable frequency ac generation system has two internal and one external power source that follows:

- #1 AC generator
- #2 AC generator
- AC external power.

AC power is supplied to aircraft equipment loads through the circuit breaker panels that follow:

- 115 Vac variable frequency

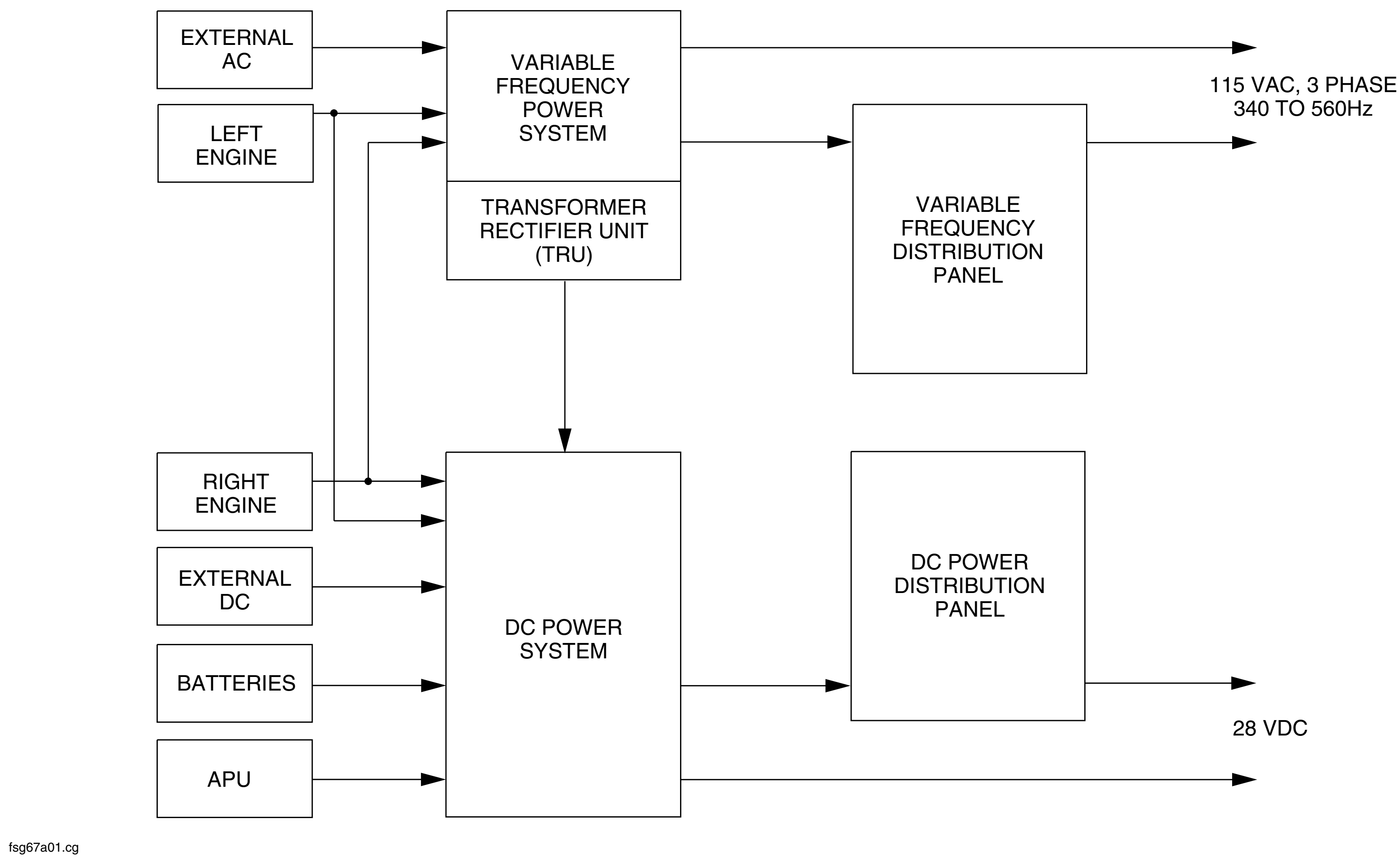
DC Electrical Load Distribution (24–61–00).

Refer to Figures 23 , 24 and 25.

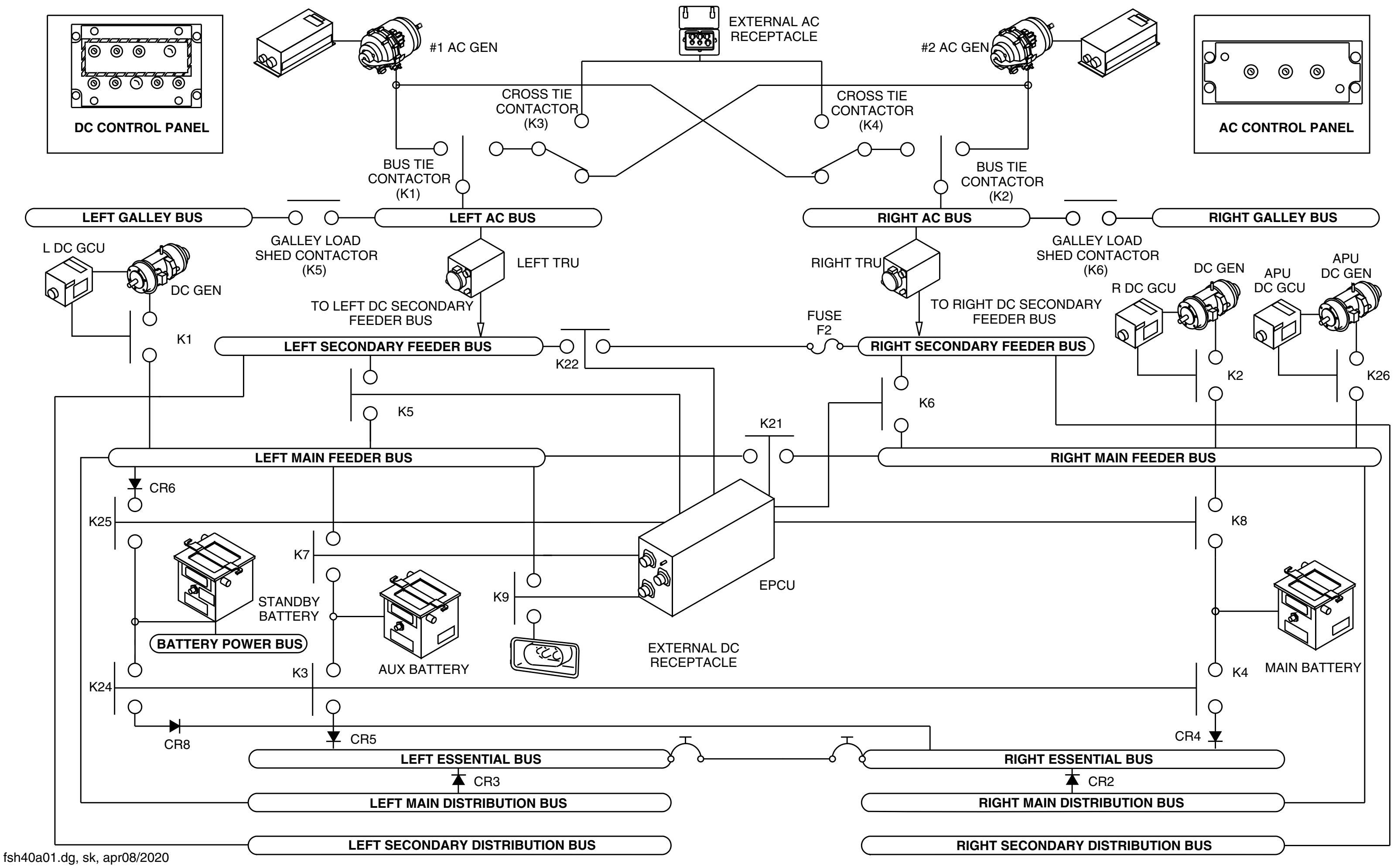
The main 28 Vdc is distributed through circuit breaker panels in the flight compartment to the electrical loads.

DC electrical load from the dc power sources is supplied to the aircraft equipment through the circuit breaker panels that follow:

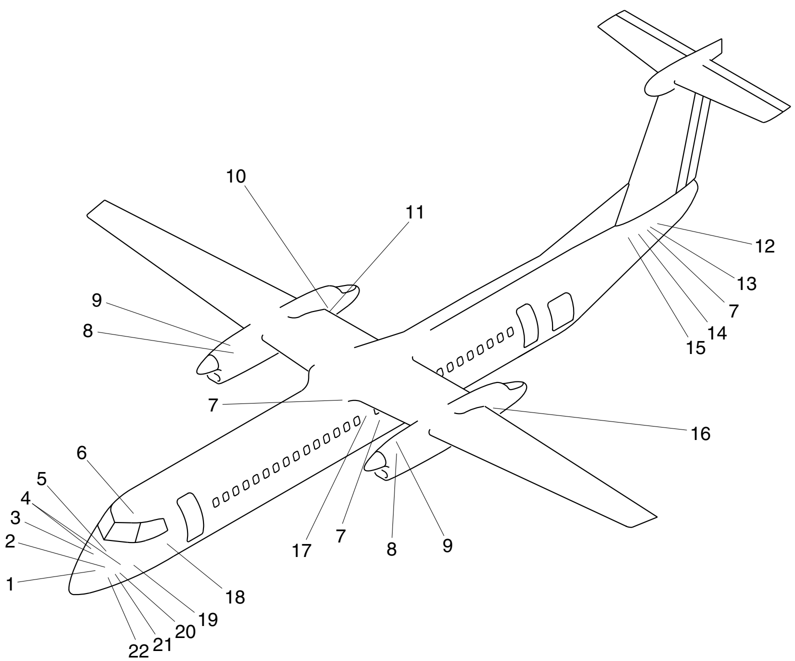
- Left dc circuit breaker panel
- Right dc circuit breaker panel
- Avionics circuit breaker panel



EPGDS SIMPLIFIED BLOCK DIAGRAM
Figure 1



EPGDS Block Diagram
Figure 2



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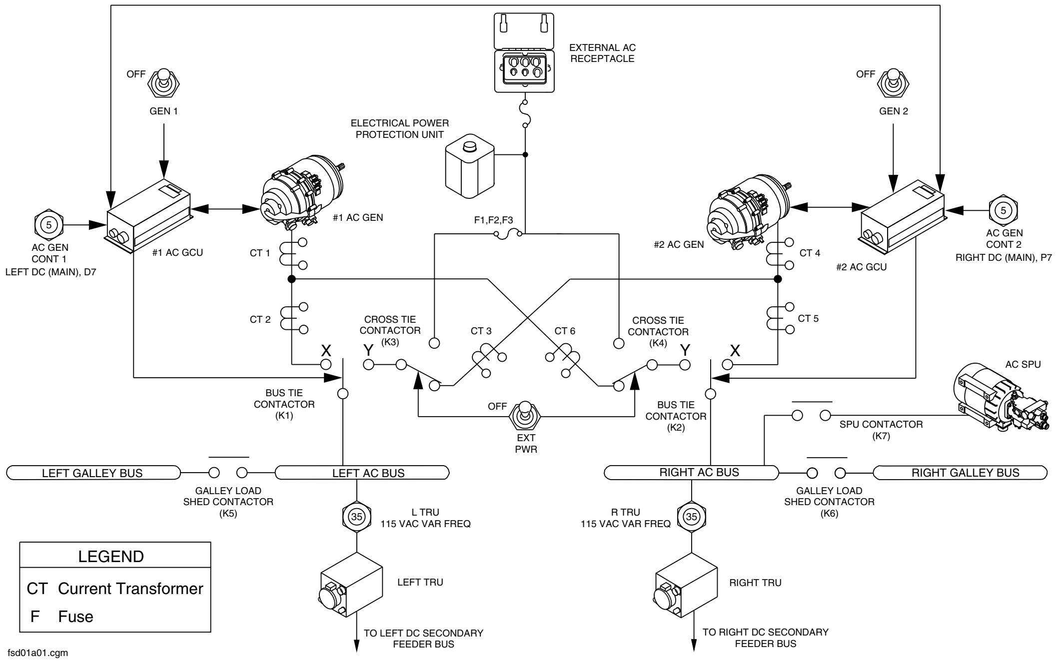
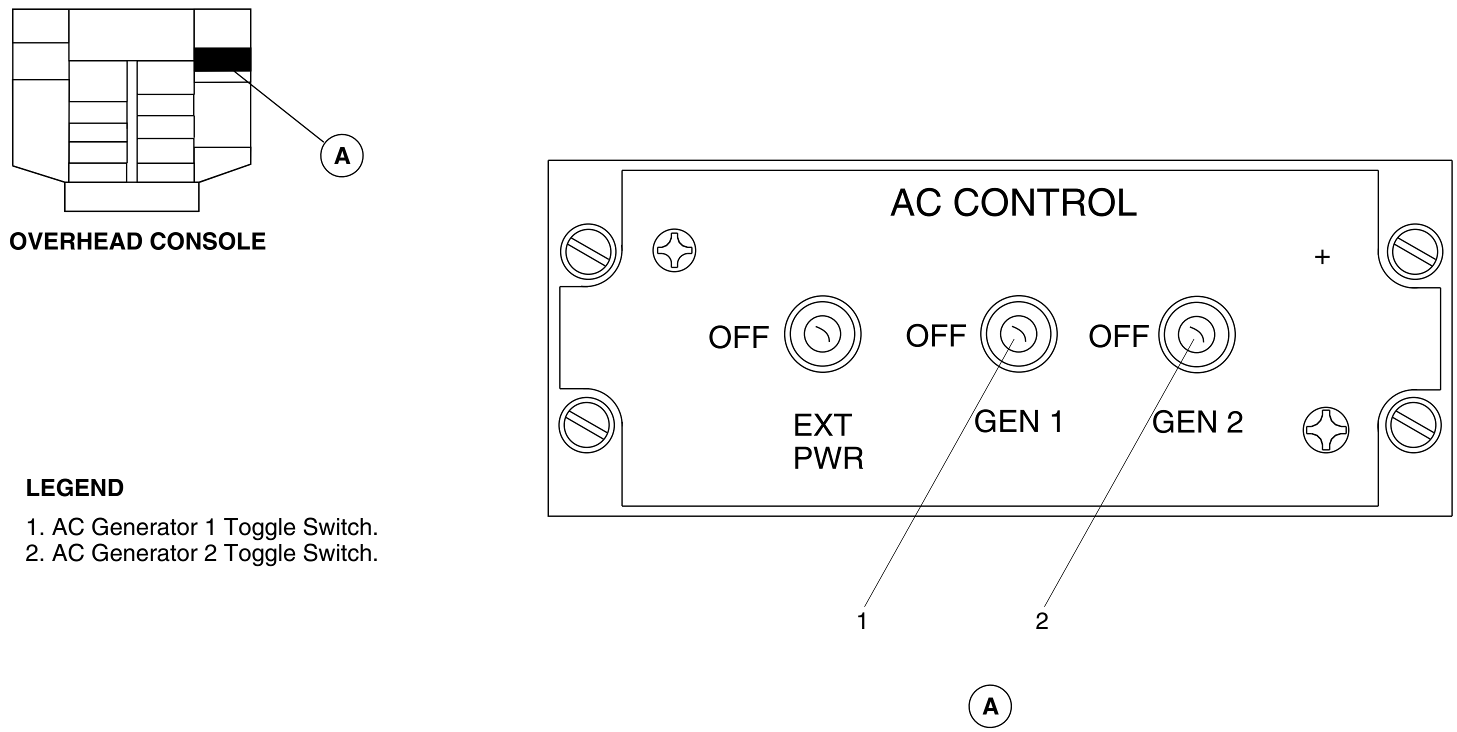
LEGEND

1. FWD Standby DC Contactor Box.
2. FWD Standby Battery.
3. Left and Right TRUs.
4. DC Current Shunts.
5. DC Contactor Box.
6. DC GCUs.
7. DC Current Shunt and, Transformer.
8. AC Generator.
9. DC Starter Generator.
10. Right AC Contactor Box and
    External Power Protection Unit.
11. AC External Power Recepticle.
12. APU DC Generator.
13. APU DC GCU.
14. AFT Standby Contactor Box.
15. Aft Standby Battery.
16. Left AC Contactor Box.
17. AC GCUs.
18. EPCU.
19. DC Ground Power Receptacle.
20. DC Current Shunts.
21. Auxiliary Battery.
22. Main Battery.

ELECTRICAL SYSTEM COMPONENT LOCATOR
Figure 3



AC VARIABLE FREQUENCY SYSTEM BLOCK DIAGRAM
Figure 4



LEGEND

1. AC Generator 1 Toggle Switch.
2. AC Generator 2 Toggle Switch.

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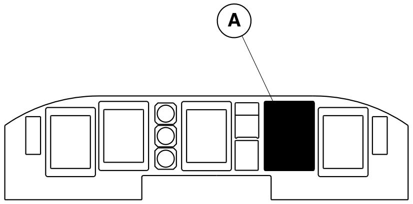
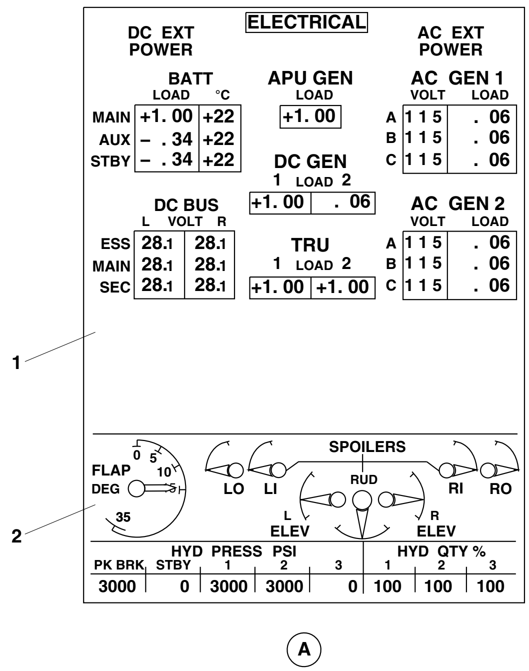
AC VARIABLE FREQUENCY SYSTEM, AC CONTROL PANEL
Figure 5



MAIN INSTRUMENT PANEL



LEGEND

1. Electrical System Page.
2. Permanent System Data Area.

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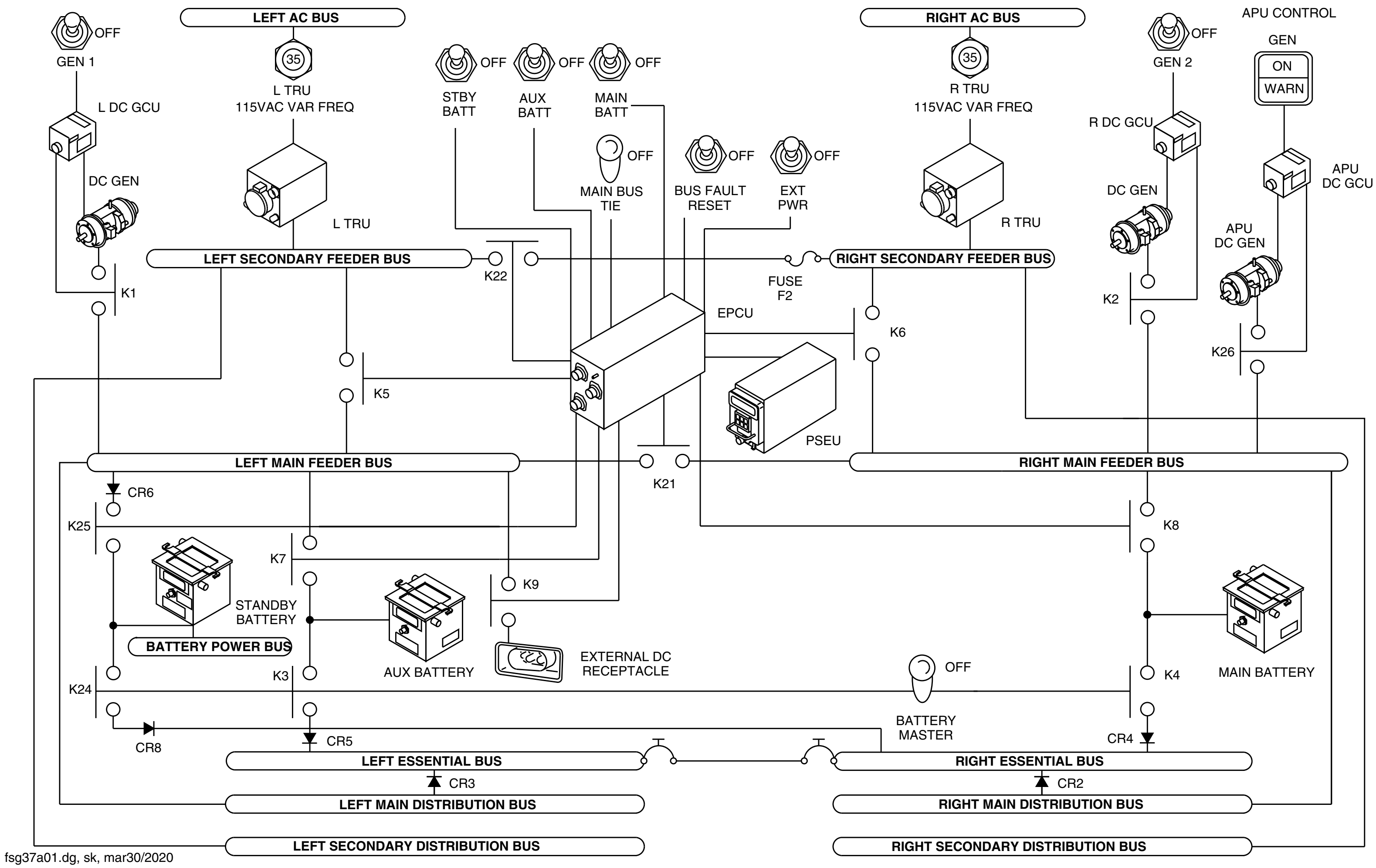
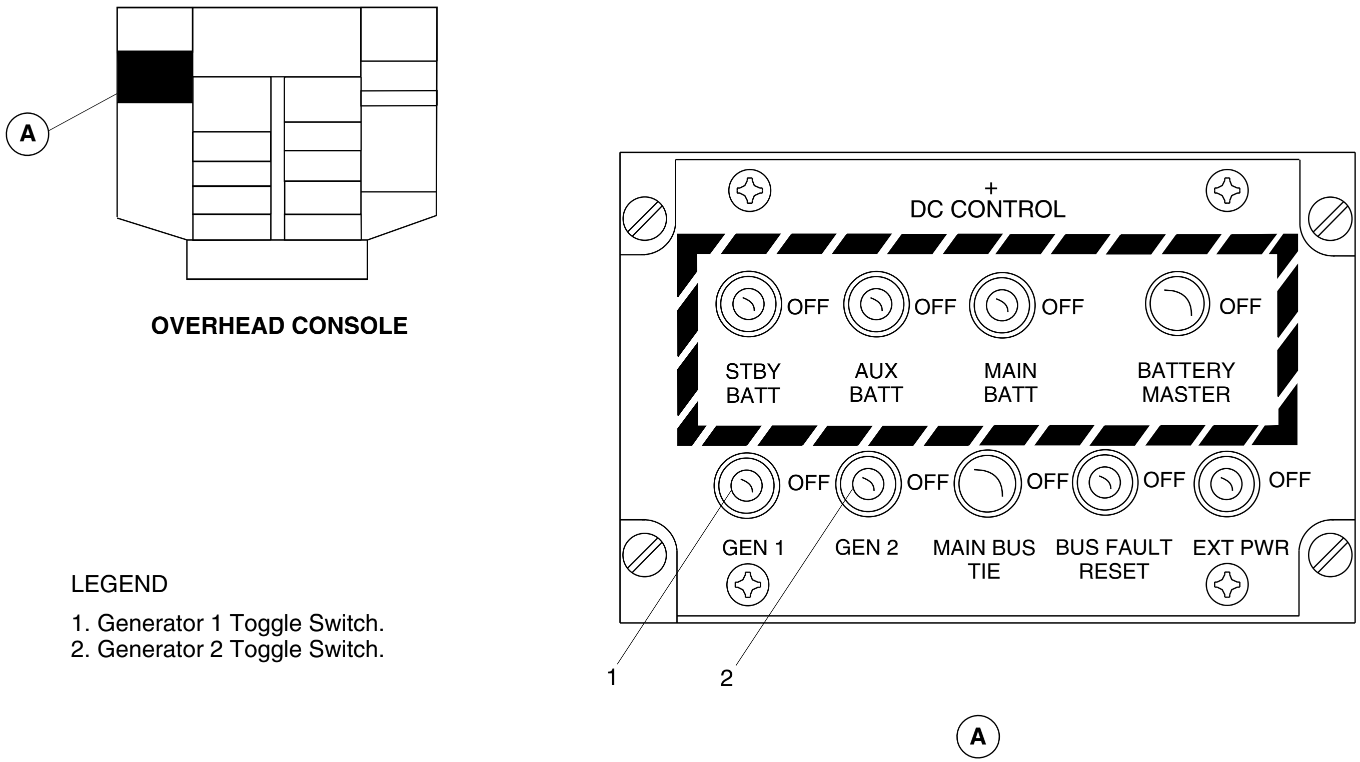
AC VARIABLE FREQUENCY SYSTEM INDICATIONS
Figure 6



Main 28 VDC Generation System Block Diagram
Figure 7



LEGEND

1. Generator 1 Toggle Switch.
2. Generator 2 Toggle Switch.

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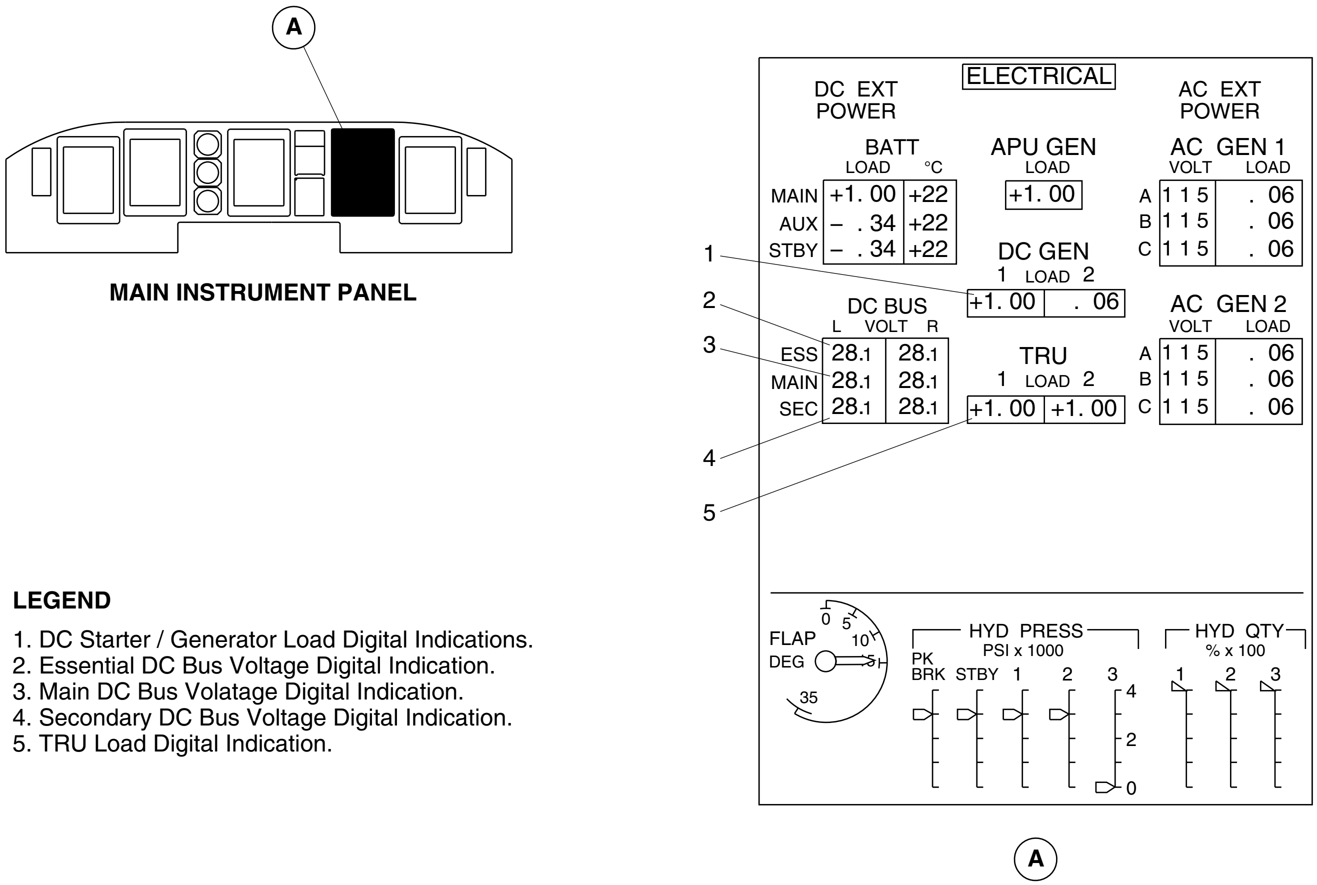
MAIN 28 VDC GENERATION SYSTEM, DC CONTROL PANEL
Figure 8



LEGEND

1. DC Starter / Generator Load Digital Indications.
2. Essential DC Bus Voltage Digital Indication.
3. Main DC Bus Volatage Digital Indication.
4. Secondary DC Bus Voltage Digital Indication.
5. TRU Load Digital Indication.

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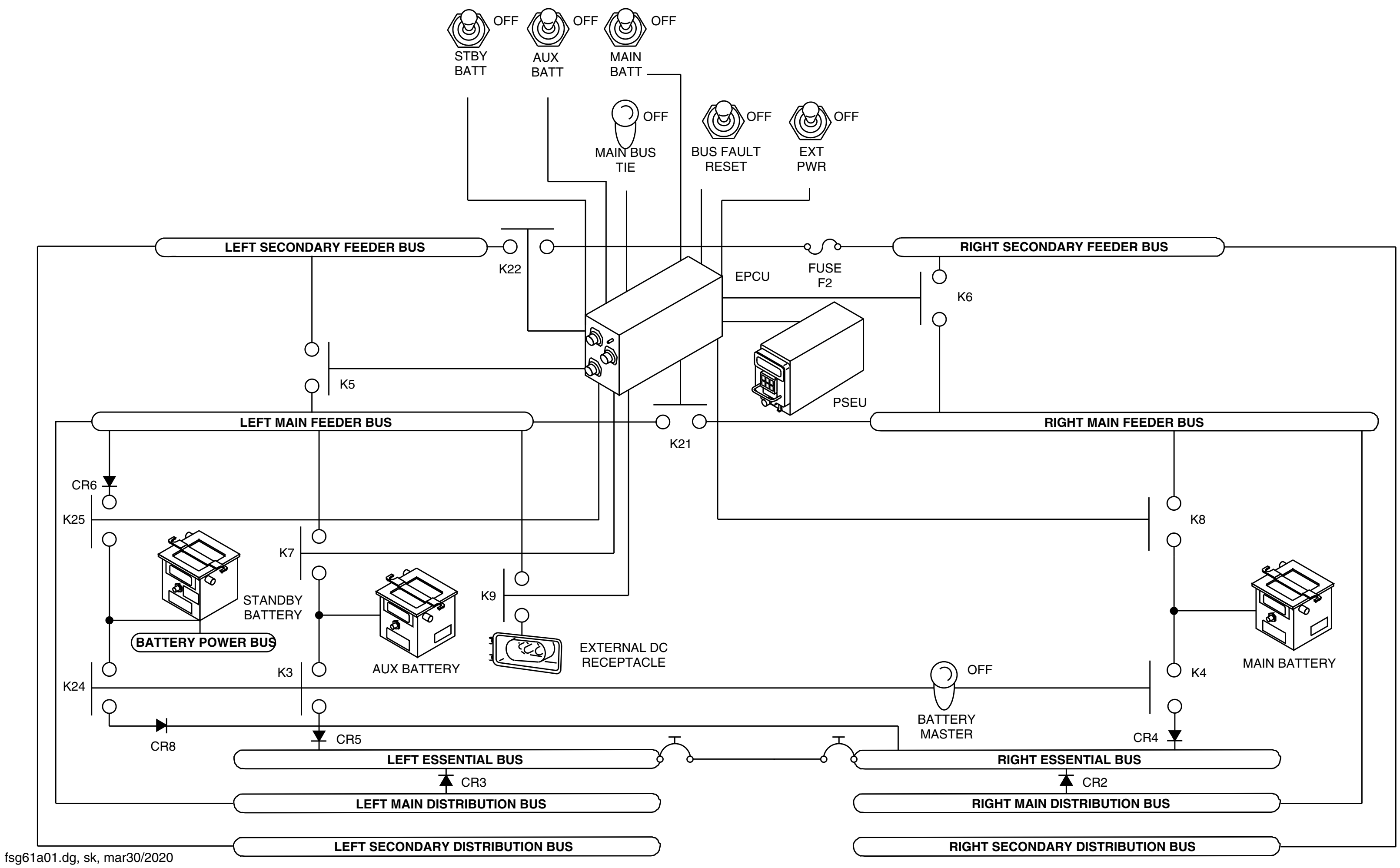
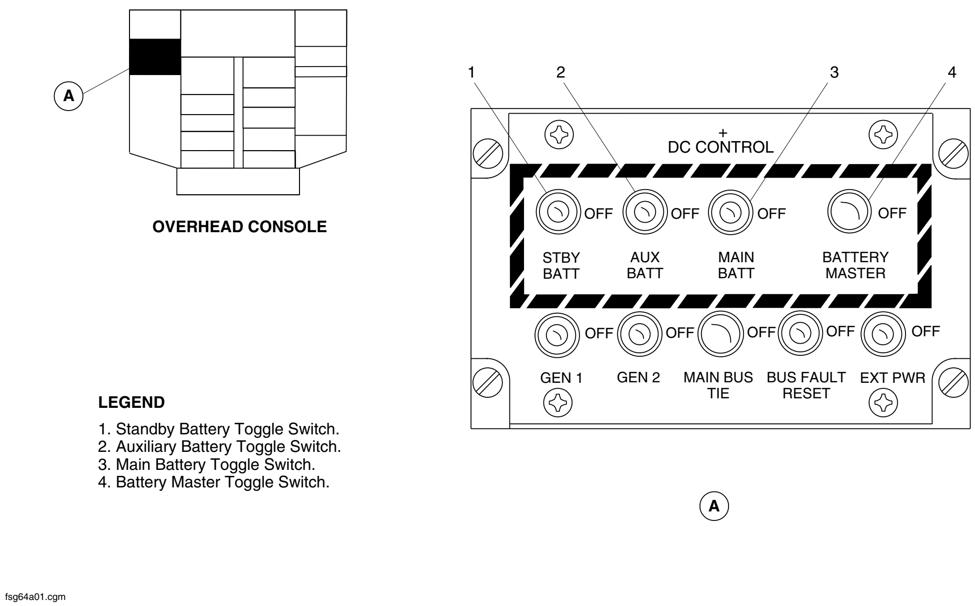
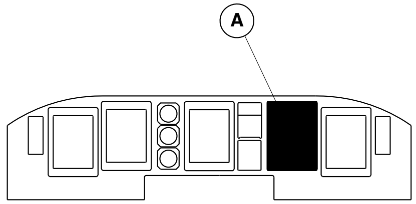
EIS, 28 VDC GENERATION SYSTEM INDICATIONS
Figure 9



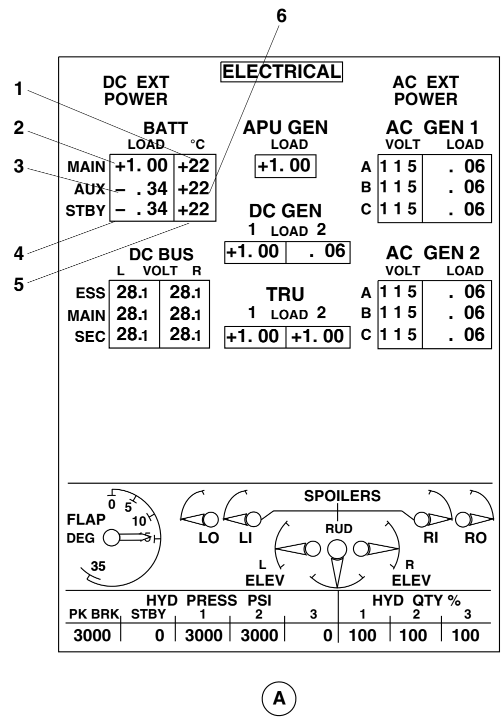
Battery System Block Diagram
Figure 10



BATTERY SYSTEM, DC CONTROL PANEL
Figure 11



MAIN INSTRUMENT PANEL



LEGEND

1. Main Battery Temperature Digital Indication.
2. Main Battery Load Digital Indication.
3. Auxiliary Battery Load Digital Indication.
4. Standby Battery Load Digital Indication.
5. Standby Battery Temperature Digital Indication.
6. Auxiliary Battery Temperature Digital Indication.

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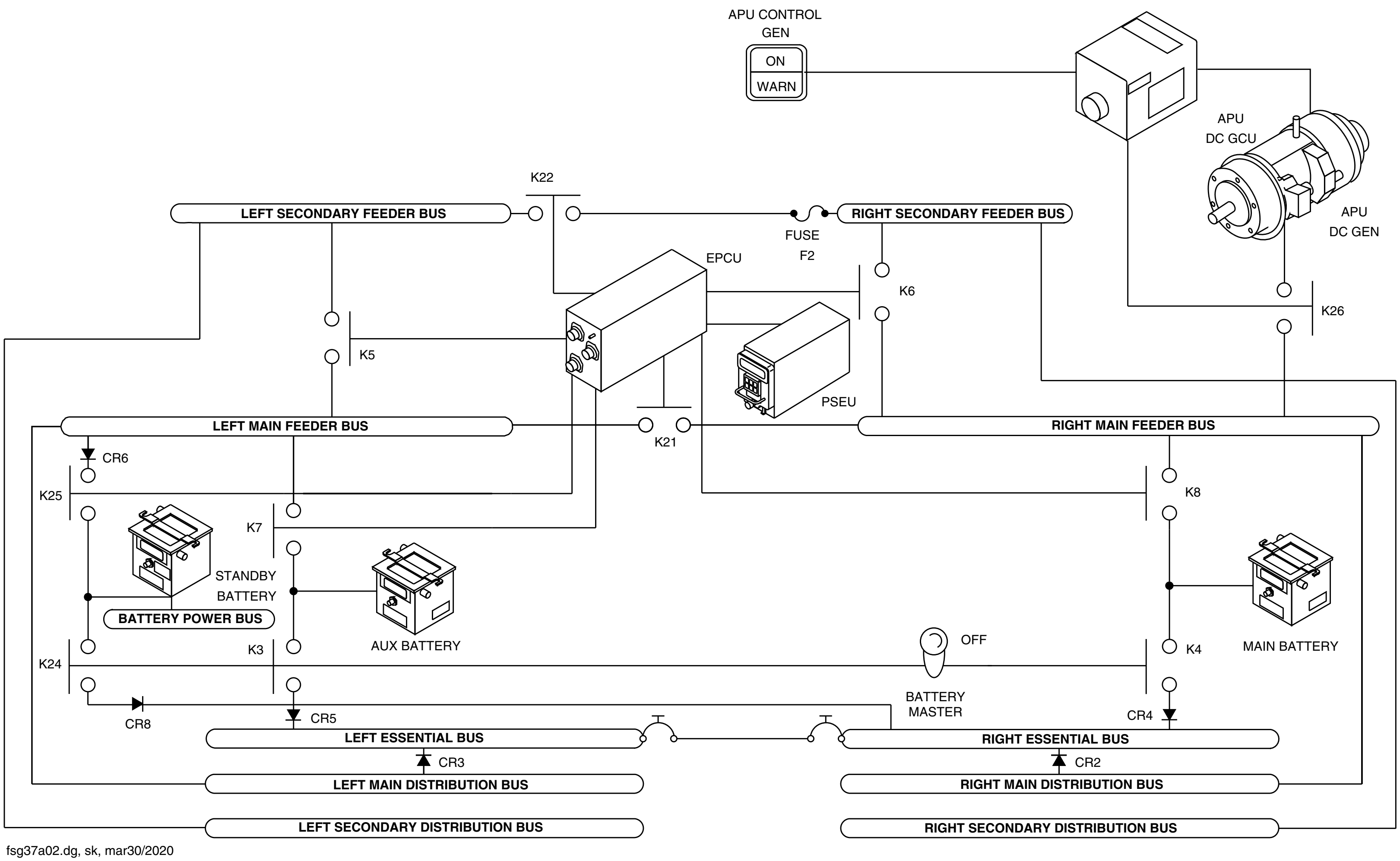
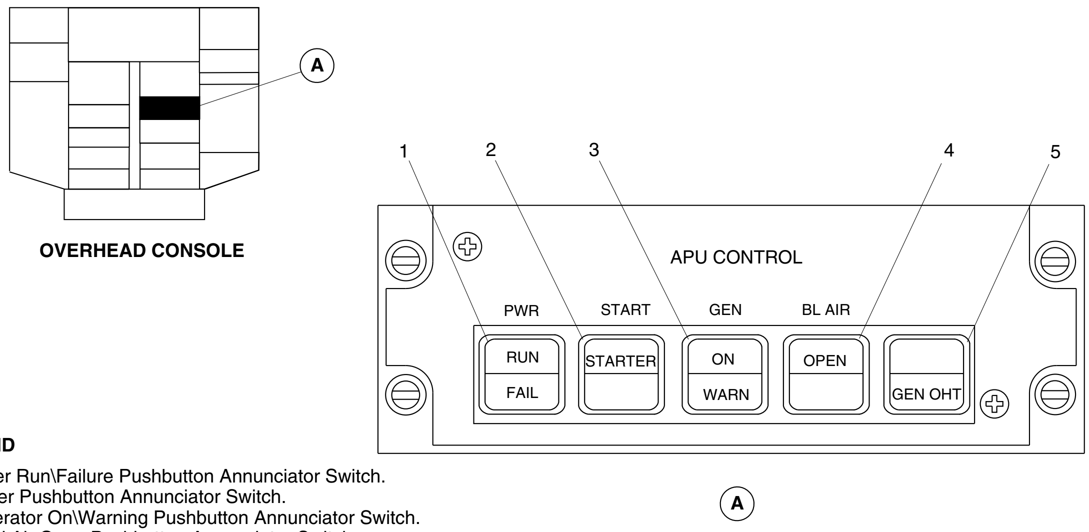
EIS, BATTERY SYSTEM INDICATIONS
Figure 12



APU Power Block Diagram
Figure 13



LEGEND

1. Power Run\Failure Pushbutton Annunciator Switch.
2. Starter Pushbutton Annunciator Switch.
3. Generator On\Warning Pushbutton Annunciator Switch.
4. Bleed Air Open Pushbutton Annunciator Switch.
5. Generator Overheat Annunciator Light.

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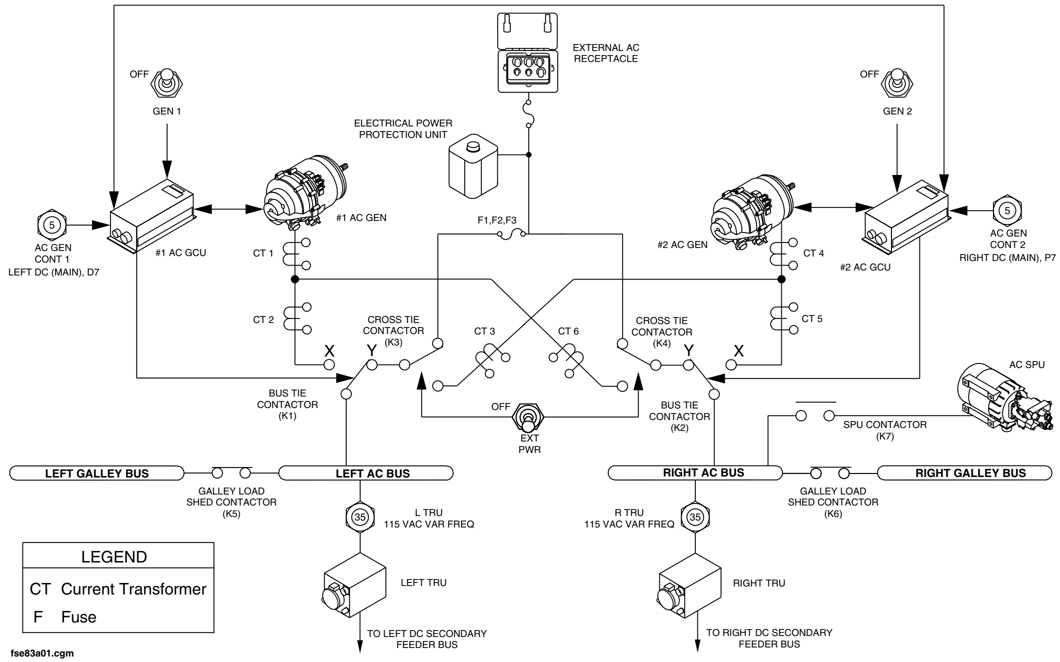
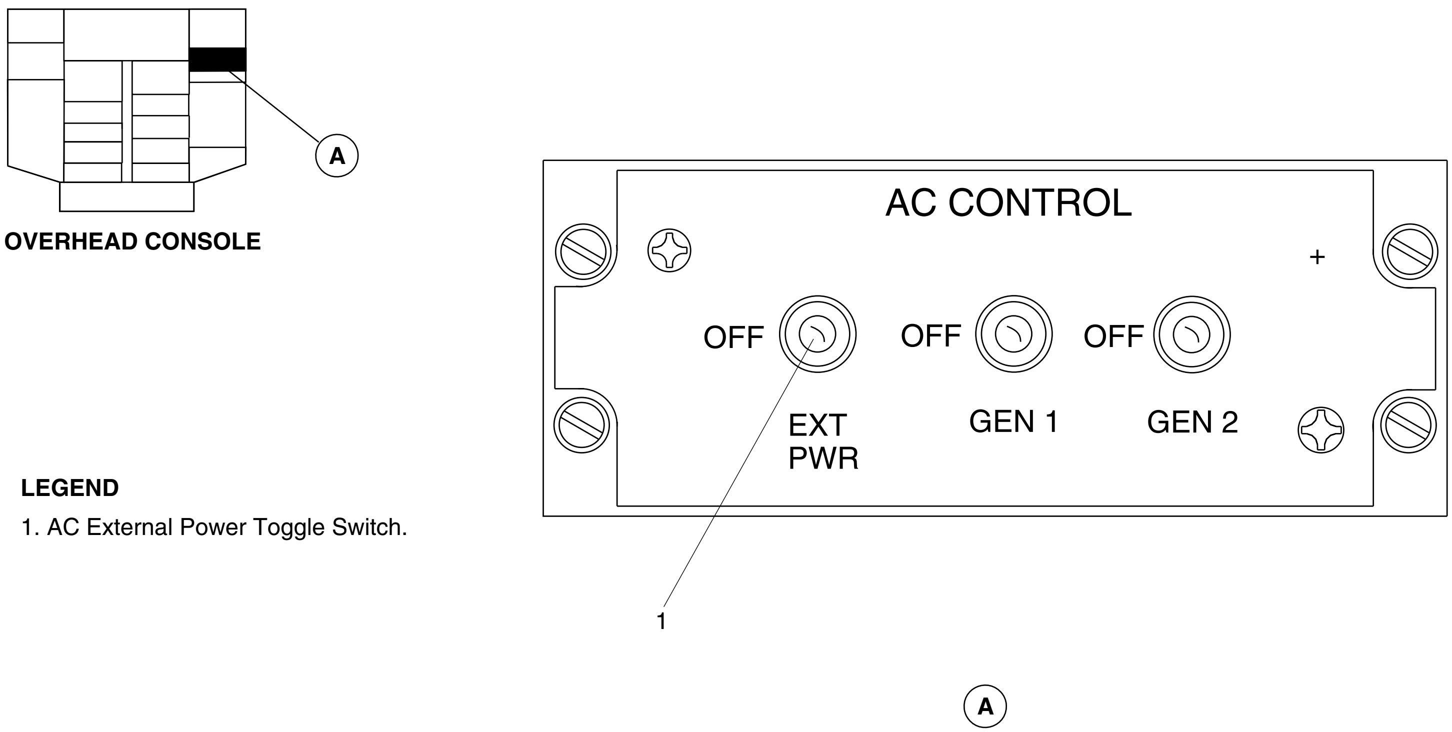
APU CONTROL PANEL
Figure 14



AC EXTERNAL POWER BLOCK DIAGRAM
Figure 15



LEGEND

1. AC External Power Toggle Switch.

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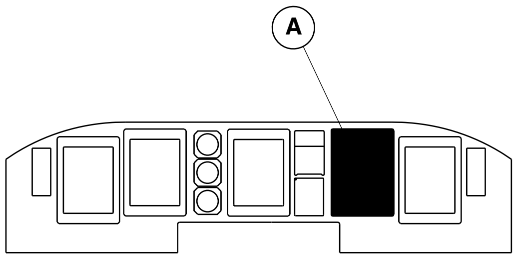
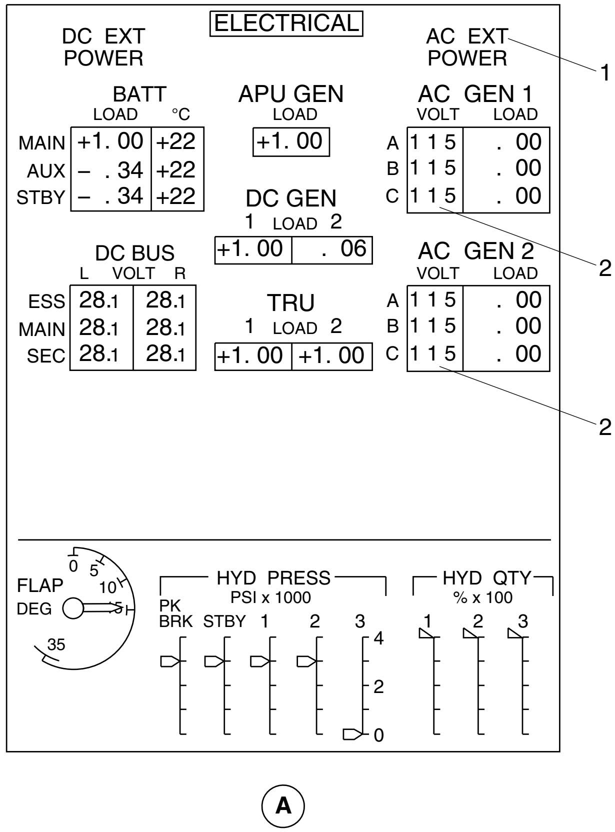
AC CONTROL PANEL EXTERNAL POWER SWITCH
Figure 16





LEGEND

1. AC External Power Message.
2. AC External Power Voltage Indication.

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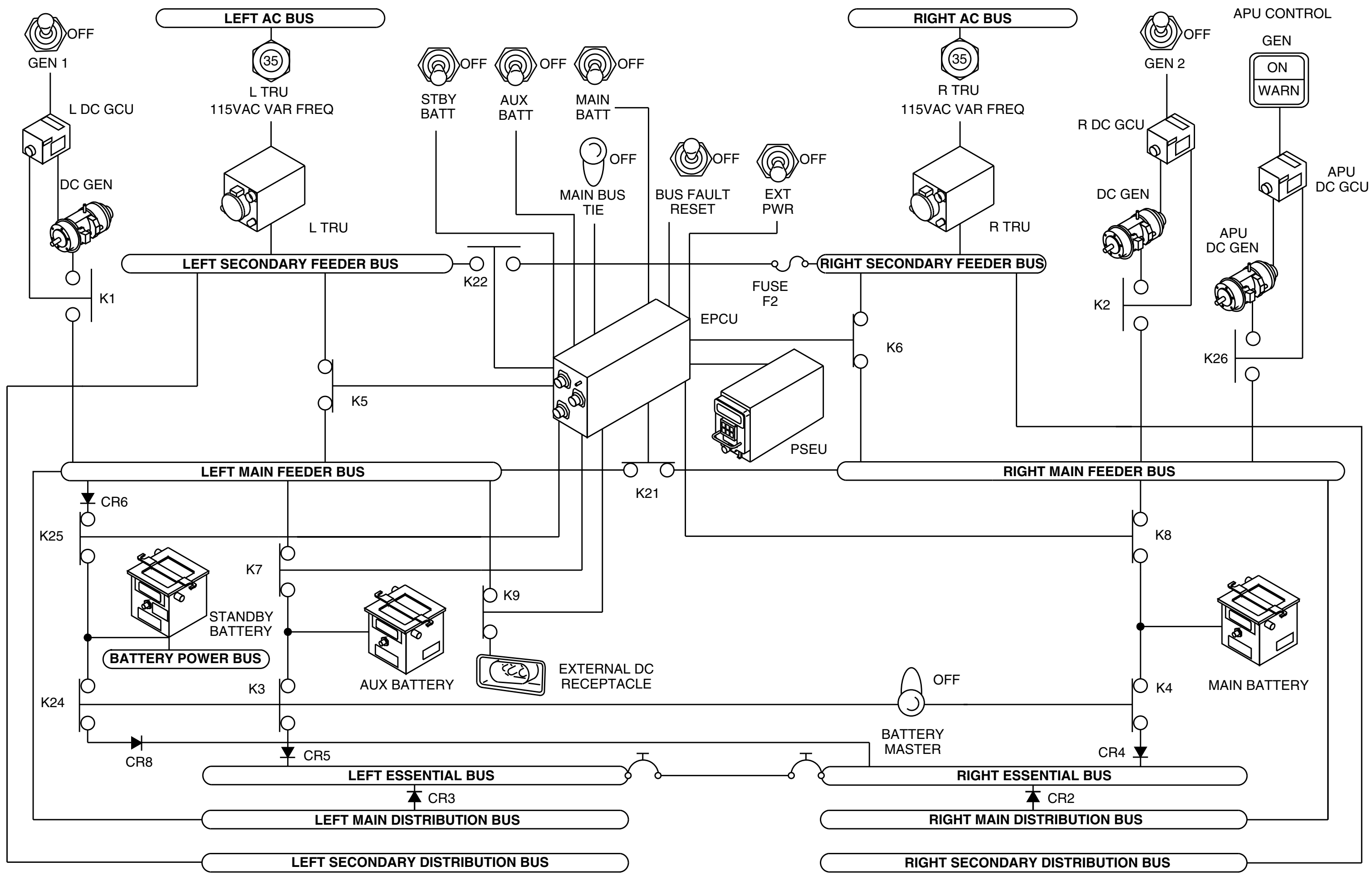
EIS, AC EXTERNAL POWER SYSTEM INDICATIONS
Figure 17



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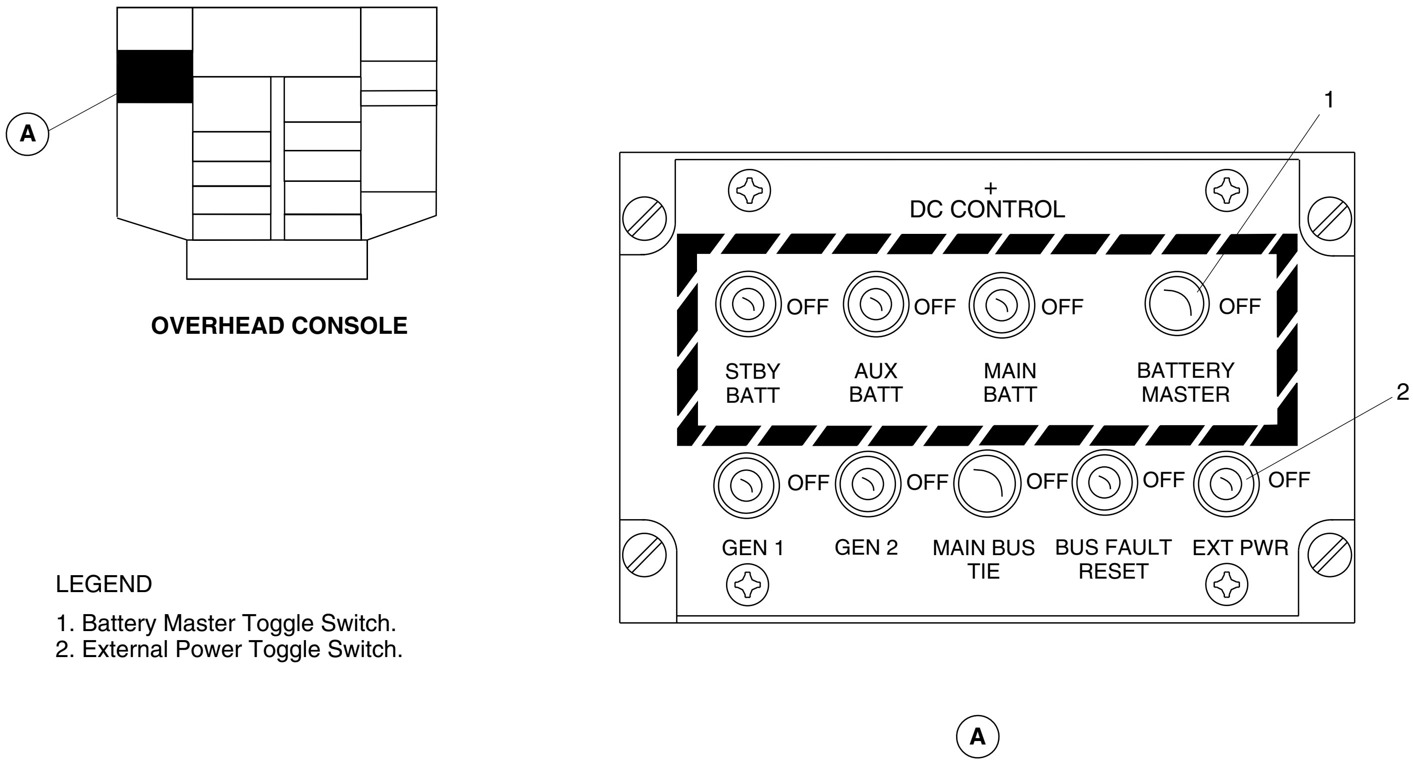
28 VDC External Power Block Diagram
Figure 18



LEGEND

1. Battery Master Toggle Switch.
2. External Power Toggle Switch.

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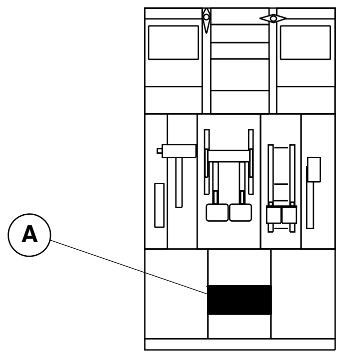
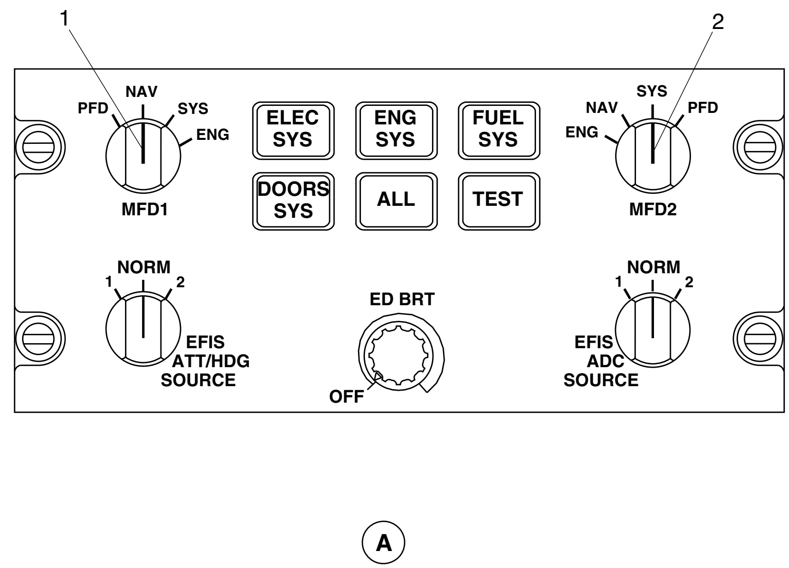
DC CONTROL PANEL
Figure 19





LEGEND

1. MFD 1 Reversion Selector.
2. MFD 2 Reversion Selector.

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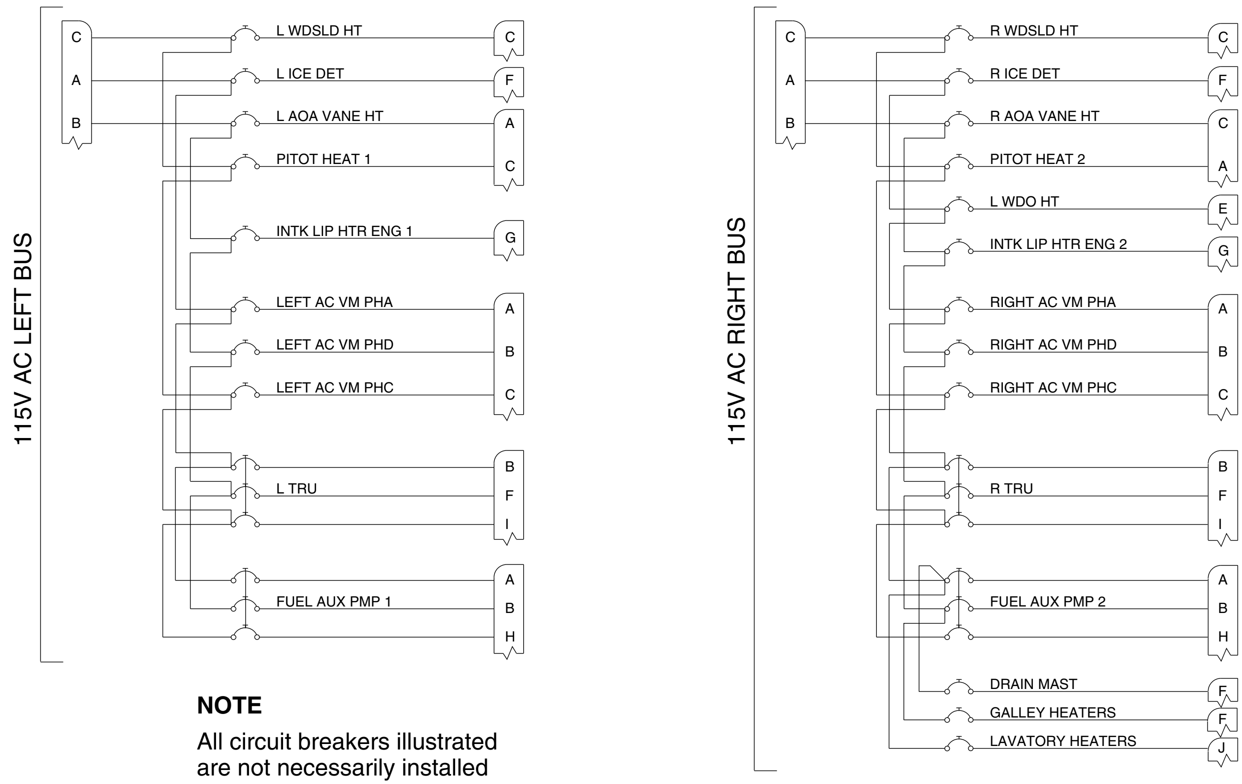
EIS, ELECTRICAL SYSTEM PAGE SELECTION
Figure 20



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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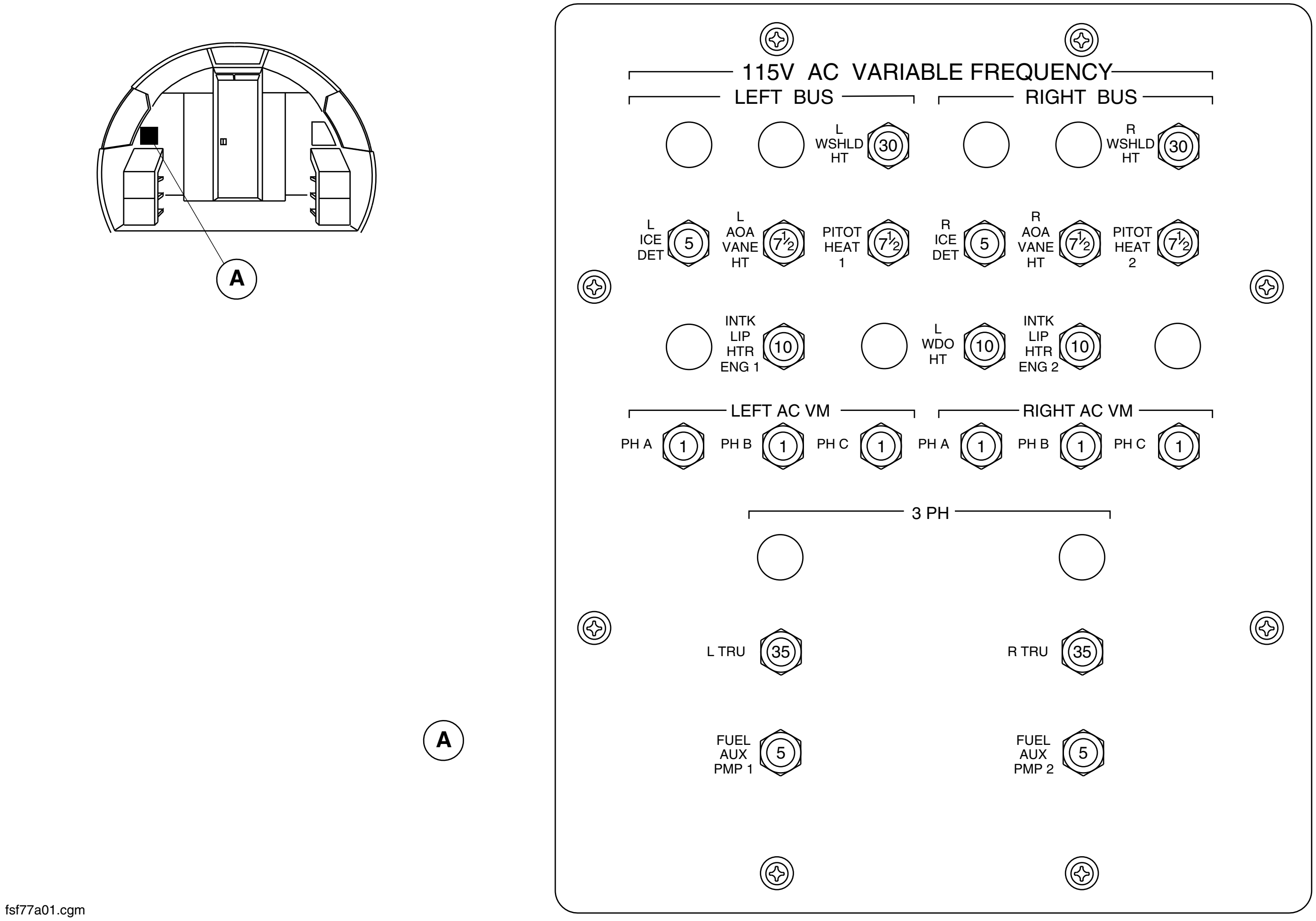
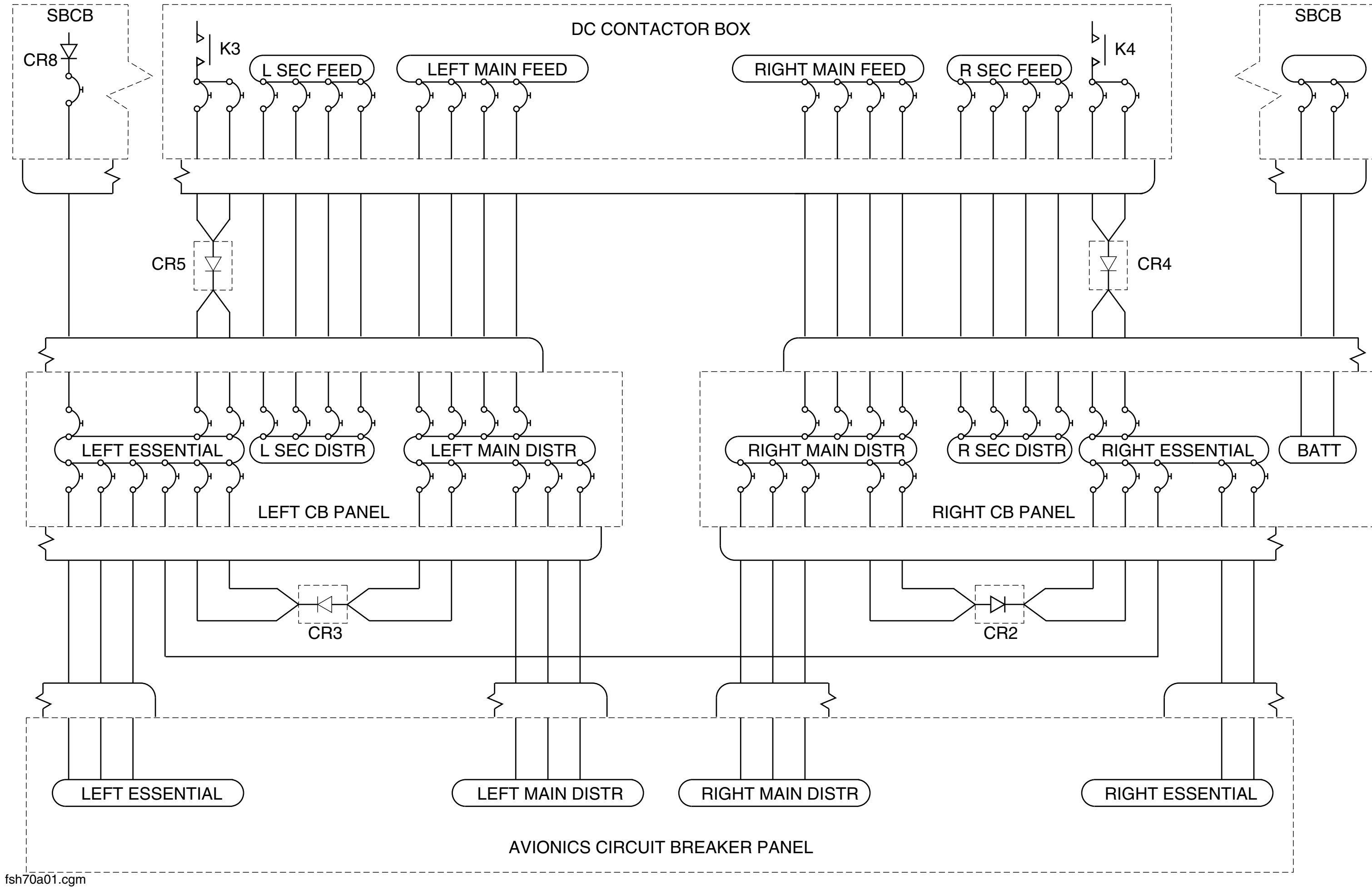
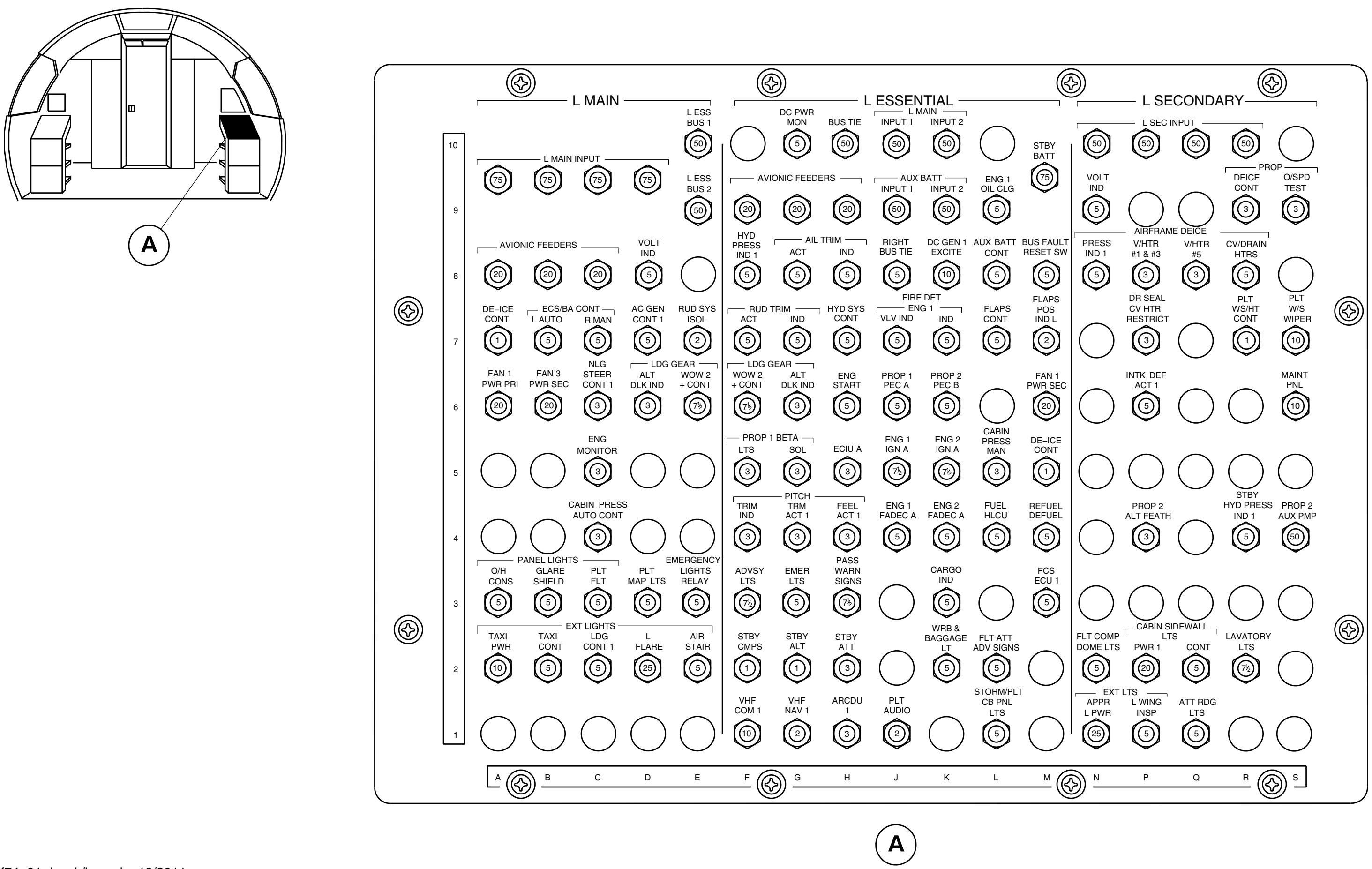
AC ELECTRICAL LOAD DISTRIBUTION
Figure 21



115 VAC CIRCUIT BREAKER PANEL
Figure 22



DC ELECTRICAL LOAD DISTRIBUTION
Figure 23



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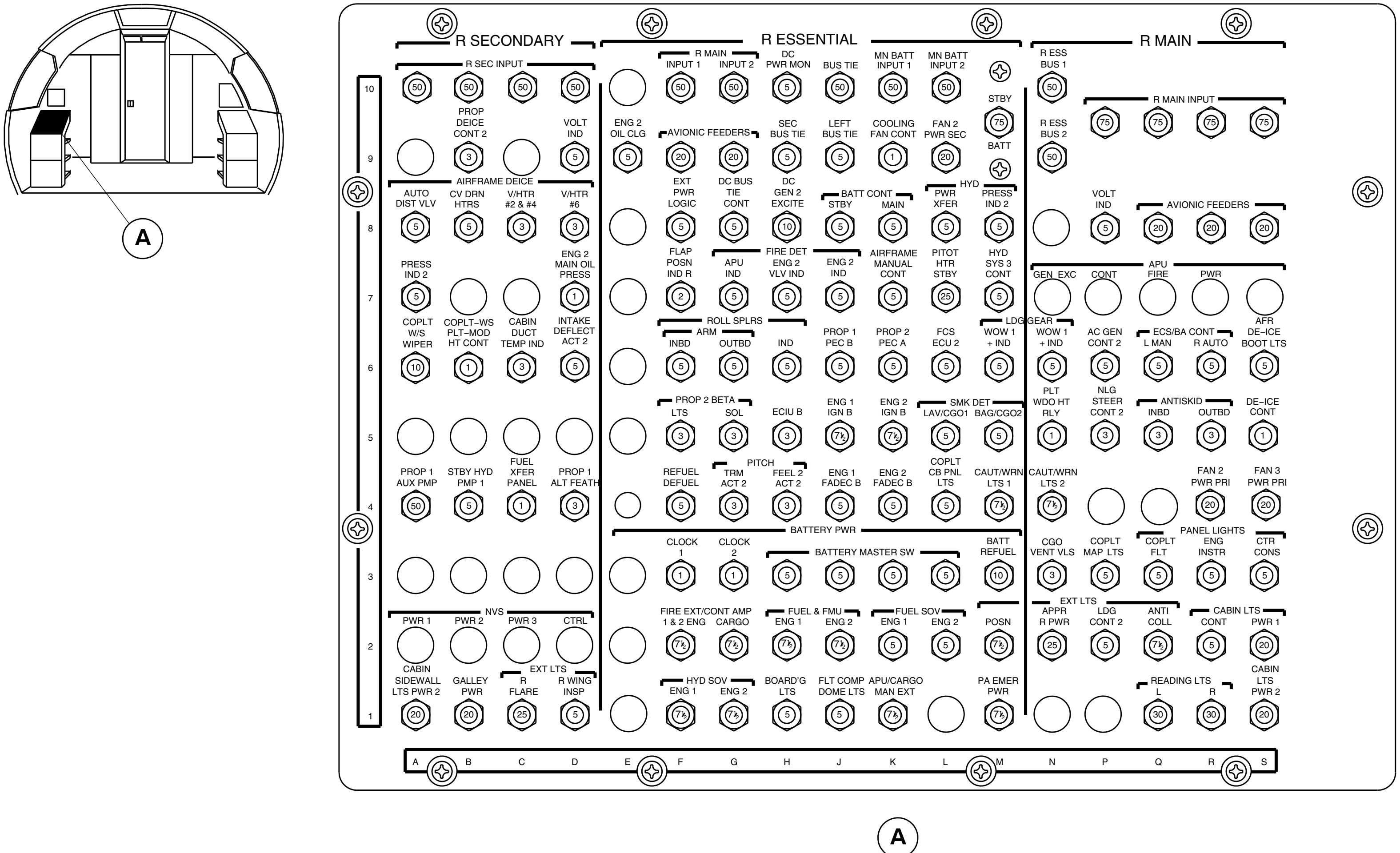
LEFT DC CIRCUIT BREAKER PANEL
Figure 24



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Right DC Circuit Breaker Panel
Figure 25

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24–20–00–001

AC GENERATION SYSTEM

Introduction

The alternating current variable frequency system makes and supplies 115 V alternating current (Vac) variable frequency electrical power to the 115 Vac variable frequency busses.

General Description

Refer to Figures 1 and 2.

The ac variable frequency system makes 115 Vac three phase electrical power for ac systems that are not frequency sensitive, such as deicing heaters, fuel auxiliary pumps, and the Standby Power Unit (SPU) hydraulic pump. It also supplies power to the Transformer Rectifier Units (TRUs), which are part of the direct current (dc) generation system.

Two ac generators are installed, one on each engine, to supply power independently to the left and right ac bus systems. An ac external power receptacle and control circuitry allows the system to be powered from an external power source while the aircraft is on the ground. When one generator malfunctions, the ac variable frequency system automatically connects the two ac busses to the serviceable generator and disconnects the two galley buses.

Toggle switches located on the ac control panel in the flight compartment give manual control of the alternating current variable frequency system. The Engine and System Integrated Display (ESID) system shows alternating current variable frequency system electrical indications.

The ac variable frequency system has the components that follow:

- Generators, ac (24–21–01)
- Units, AC Generators Control (24–21–06)
- Panel, AC Control (24–21–11)
- Boxes, AC Contactor (24–21–16)
- Contactors, AC Contactor Box (24–21–21).

The ac variable frequency system has current sensors in the left and right ac contactor boxes. The current sensors measure A, B, and C phase currents and supplies the data to the Generator Control Units (GCUs) and the Electrical Power Control Unit (EPCU) for monitoring. The EPCU also measures A, B, and C phase voltage from the ac generators and busses.

Detailed Description

The alternating current variable frequency system functions in the modes that follow:

- Normal
- Protection
- Fault tolerant

– Diagnostics and monitoring.

Refer to Figure 3.

Normal Function: The ac generators supply ac electrical power to the 115 Vac variable frequency circuit breaker panel in the flight compartment through the ac contactor boxes.

When the aircraft engines are operating with no external ac power connected, and the ac generator toggle switches located on the ac control are set to GEN 1 or GEN 2 positions, the ac generators are connected to their related ac buses for normal operation. The related AC GCU automatically disconnects its ac generator when it senses an ac generator malfunction.

Each ac generator is turned by its propeller gear box. The output frequency of each generator, changes with propeller speed but its output voltage stays the same. The ac generator output is controlled by its related ac Generator Control Unit (GCU).

Each AC GCU automatically controls operation of its ac generator by monitoring output voltage, current, and speed. The AC GCU regulates its generator output and controls the operation of its bus contactor. When the AC GCU senses an ac generator malfunction, it will cause the bus contactor to move to a cross–tie position to connect its bus to the other ac generator.

The two ac generators supply variable frequency, 340 to 560 Hz ac power through the two position bus contactors, K1 and K2 to their related 115 Vac variable frequency bus. The AC GCUs control the bus contactor operation. When the AC GCU senses an ac generator malfunction, it will cause the bus contactor, K1or K2 to move to a cross–tie position to connect its bus to the other ac generator.

The current transformers in the ac generators supply current data to its related AC GCU to control its ac generator output and current transformers in each ac contactor boxes supply current information to the AC GCUs for system control. A separate transformer in the ac contactor box supplies current information to the EPCU for indication.

When ac external power is supplied and selected, each bus contactor is automatically moved to the cross–tie position by its related AC GCU, and the external power contactors connect the external power to the left and right ac busses. The ac generator operation is inhibited while external power is selected.

Refer to Figure 4.

An input from an external ac power source requires a manual selection from the flight compartment. When the ac external power toggle switch located on the ac control panel is set to EXT PWR, the ac external power source is connected to the two ac busses. The selection causes contactors, K3 and K4 to move to the ground power position and cross–tie contactors K1 and K2 to the cross–tie position.

The ac electrical power is distributed to the ac busses through two contactor boxes located in the Left and Right Nacelles of the airplane. The contactor boxes, Right ac Contactor Box (RACCB) and Left ac Contactor Box (LACCB), contain the switching, protection and measuring components. The ac generator electrical power is supplied to the ac distribution busses in the flight compartment through the generator bus contactors, K1 and K2. These two contactors are located in the RACCB and LACCB. The two cross–tie contactors, K3 and K4, are also located in the RACCB and LACCB. The two ac busses usually operate in isolation but are automatically cross–tied together when one ac generator is functioning. The ACCBs also contain their related galley contactors, K5 and K6 and the RACCB contains the Standby Power Unit (SPU) contactor K7.

The AC GCU senses its related generator speed while the ac generator toggle switch is set to the GEN position. When the ac generator has a stable speed, the ac GCU regulates its related ac generator's output voltage and controls the contactors to supply ac generator electrical power to the aircraft busses. The ac GCU also monitors the generator current and limits the current when the output exceeds acceptable limits.

Protection Function: The protective functions in the ac variable frequency system prevent damage to the ac generators when other related equipment malfunctions or there is an overload condition.

The ac variable frequency system continuously monitors itself. When a fault is sensed, it isolates the effect of the fault from the remaining system to allow continued operation.

The ac variable frequency system protective functions are classified as passive protection and active protection.

The ac variable frequency system uses circuit breakers and fuses for passive protection so that a malfunction condition will not cause damage to the ac generator sources. The circuit breakers and fuses are protection devices that open circuit during an excessive current flow condition. Unlike fuses, circuit breakers can be reset without having to be replaced.

The ac variable frequency system uses its ac GCUs to control the contactors for active protection so that a fault condition will not cause damage to the ac generators. It uses the protective functions that follow:

- Over voltage
- Under voltage
- Over current
- Differential feeder protection
- Under frequency.

Over Voltage: When the voltage from the ac generator is more than 125 Vac, its ac GCU de−energizes the ac generator field and connects its bus to the other ac generator. This protection has an inverse time delay to make sure that the disconnect time is inversely proportional to the magnitude of the over voltage level.

Under voltage: When the voltage from the ac generator is less than 100 Vac, its ac GCU de−energizes the ac generator field and connects its bus to the other generator. If the ac GCU senses an under voltage and over current at the same time, the over current protection function will occur.

Over Current: When the current from the ac generator is more than 135 A for more than 7 seconds, the related ac GCU de−energizes its related ac generator field. It does not connect its bus to the other generator. When the ac GCU senses an overcurrent condition, the ac generator will supply current for a maximum of 7 seconds, to let the fault clear itself before disconnecting the ac generator.

Differential Feeder Protection: The current flow in the ac generator and feeder transformers are compared by the ac GCU differential current sensing circuits. When the differential feeder current is more than 20 A, the AC GCU de−energizes its related ac generator field and connects its bus to the other ac generator. Time delay circuits in the ac GCU prevent usual transients caused by on and off switching of different loads to cause contactor operation.

The ac GCU will de−energize and disconnect the generator from its bus when the differential feeder current is more than 20 A.

Under Frequency: The ac GCU disconnects the ac generator from its bus when the ac generator frequency is less than 300 Hz. It will automatically reconnect the ac generator when the frequency is more than 320 Hz. This will occur only if the system was not previously disconnected by the system's protective function. As the ac generator frequency goes below 340 Hz, the output voltage decreases relative to the frequency until the ac generator is disconnected at 300 Hz.

Fault Tolerant: To protect the ac generators, the alternating current variable frequency system monitors itself for the faults that follow:

– Source
– Bus.

When source or bus faults occur, the contactors open, and stay open until the ac GCU is reset to prevent a reconnection to a fault condition. The GEN toggle switch on the ac control panel is set to the OFF position and then back to GEN to reset the ac GCU.

Refer to Figure 5.

Source Fault: When a source fault is sensed, the ac GCU will automatically reconfigure the electrical power flow. The ac generator that does not operate is isolated and its related bus is reconnected to the opposite ac generator.

Each ac generator usually supplies its own ac bus. When an ac generator or ac GCU malfunctions, its related bus contactor, K1 or K2 will automatically move to connect its bus to the opposite generator and to cause galley contactors K5 and K6 to disconnect the two galley busses.

The bus contactor positions that relate to ac generator or ac GCU failures is shown in the table that follows:

Table 1: Table 1.

Source Malfunction		Reconfiguration Logic	
No. 1 AC Generator	No. 2 AC Generator	K1	K2
on	on	left	right
on	off	left	left
off	on	right	right

Bus Faults: The ac bus faults are sensed and then isolated by the ac GCUs.

Refer to Figure 6.

When an ac bus fault occurs and a circuit breaker in the malfunctioning system does not open in less than 7 seconds, the related bus contactor K1 or K2 opens to disconnect the bus fault from the ac generator. The galley contactor K5 or K6 will also open.

Refer to Figure 7.

When both ac busses are energized by one ac generator and that ac generator or its ac GCU malfunctions, an over current condition is allowed to exist for up to 7 seconds to let a circuit breaker open. If the over current condition stops, the circuit breaker has isolated the load.

Refer to Figure 8.

If the over current continues for 6.5 seconds, the opposite bus contactor will open. If the over current stops, then the opposite bus is at fault.

Refer to Figure 9.

If the over current continues for 7 seconds, the opposite bus contactor will reconnect and the related bus contactor will open. A bus fault on the related bus is isolated while electrical power is supplied to the opposite bus.

Refer to Figure 10.

If none of the two actions isolate the bus fault, then the related bus contactor is opened. No ac electrical power is supplied to the ac busses.

Diagnostics and Monitoring Mode: The electrical power system uses an on condition monitoring and diagnostic system. The system operational status is monitored by flight compartment indications and ac GCU functions. The Generator Control Units (GCUs) give continuous monitoring of sub–system operation. The integrity of the protective functions in the ac GCU is checked by an Initated Built In Test (IBIT) function so that other components are not affected by a defective test circuit.

Refer to Figure 11.

The ac GCUs have an Initiated built–in Test (IBIT) function to show possible ac GCU problems. To check the IBIT function, the main busses must be de–energized with the ac GEN toggle switches set to the OFF position and the ac generator is not operating. When the push–to–test switch on the ac GCU is pushed, the amber LED comes on for 5 seconds to show that the check is in progress. If all related systems are serviceable, the amber LED goes out and the green LED comes on. If a protective function, overvoltage, undervoltage, underfrequency, feeder fault, is unserviceable, the amber and green LEDs flash at the same time.

Refer to Figure 12.

The Electrical Power Control Unit (EPCU) records some ac variable frequency system fault conditions. It has an interface panel on its front face to look at the fault codes that represent fault conditions sensed by the Continuous Built in Test (CBIT). It uses FAULT REVIEW and CLEAR pushbutton switches and a digital display to view the fault codes.

The CBIT operates only when the aircraft is on the ground. A blank indication shows that no fault conditions sensed by the CBIT. When the indication is out of view, the FAULT REVIEW pushbutton switch is pushed to do display test. It will show 88 for correct operation.

The two ac generator systems are checked at the same time. The EPCU compares the ac generator voltage difference measured by the EPCU and the ac GCU Point Of Regulation (POR). If the value is excessive, the EPCU display will show fault code 25 or 26.

When the EPCU does not receive a correct field signal status from the ac GCU while the generator is turning, it will show fault code 27 or 28 for the malfunction.

Refer to Figure 13.

When the aircraft engines are operating with no ac external power connected, and the ac generator toggle switches located on the ac control panel are set to GEN 1 and GEN 2, the ac generators are connected to their related ac buses for operation.

The ac generator toggle switches are set to the OFF position to de–energize the ac generators and reset latched functions in the ac GCU.

The Electrical Power Control Unit (EPCU) supplies indication data through the two Input/Ouput Processors (IOP1, IOP2) located in the Integrated Flight Cabinets (IFCs) to the Electronic Instruments System (EIS).

Refer to Figure 14.

The MFD1 and MFD2 reversion switches located on the ESID Control Panel (ESCP) are used to select the electrical page on the multi–functional displays.

Refer to Figure 15.

The electrical page shows the ac generator indications that follow:

- Digital indication of the ac generator voltage
- Digital indication of ac generator load.

The ac generator voltage and load indication has an ac GEN1 and ac GEN2 title in white fonts to show the voltage and load of the A, B, and C phases.

AC Generator Voltage Indication: The ac generator voltage indication shows the ac bus voltage for each phase in white numbers.

ac Generator Load Indication: The ac generator load indication shows the ac generator output load for each phase in white numbers. The numbers show the ac generator load as a percentage of the total rated output. A 1.00 indication is used to show 100% .

A + symbol before the numbers is used to show an overload condition of the ac generator. It is out of view when the load is in less than 100%.

Refer to Figure 16.

When the voltage or load data malfunctions, the digits are replaced by white dashes.

Refer to Figure 17.

The ac variable frequency system malfunctions are shown with the caution lights that follow:

- #1 AC GEN
- #2 AC GEN
- LEFT AC BUS
- RIGHT AC BUS
- #1 AC GEN HOT
- #2 AC GEN HOT

#1 AC GEN, #2 AC GEN Caution Light: The #1 AC GEN or #2 AC GEN caution light comes on to show that the generator is not connected to its bus because of a source fault condition, the AC generator toggle switches are set to the OFF position, or external AC power is energizing the left and right busses.

LEFT AC BUS, RIGHT AC BUS Caution Light: The LEFT AC BUS or RIGHT AC BUS caution light comes on to show that the generator is not connected to its bus because of a bus fault condition. If the bus fault is reset, the indication will go out.

The LEFT AC BUS or RIGHT AC BUS caution light also comes on to show that the ac generator contactor is in the center position while the generator is operating and the ac generator toggle switch is set to the ON position.

#1 AC GEN HOT, #2 AC GEN HOT Caution Light: The #1 AC GEN HOT or #2 AC GEN HOT caution light comes on to show that the generator temperature is more than 330 °F (166 °C) and goes out when the temperature is less than 305 °F (152 °c).

The left main and right main busses supply electrical power through 5 A circuit breakers to the related AC Generator Control Units (GCUs). The circuit breakers are located in position D7 on the left circuit breaker panel and P7 on the right circuit breaker panel.

Generators, AC

Refer to Figure 18.

The ac generator is an electromagnetic machine. When it rotates, it will change engine input mechanical torque to output ac electrical power. The generator is a multi–stage, brushless, three–phase, Y connected variable speed generator that is attached to the aircraft propeller reduction gearbox.

The ac generator operation is controlled and monitored by the AC Generator Control Unit (GCU). It supplies the field excitation to the generator to make ac power. To make power without slip rings, the ac generator has the three stages that follow.

- Permanent Magnet Generator (PMG)
- Exciter
- Main alternator field.

The first stage has a Permanent Magnet Generator (PMG) which uses a permanent magnet so that it can make output power without an external excitation source. The three–phase output from the PMG is sent to the ac GCU to control the second stage. The second stage is the exciter. It is a reverse built synchronous generator with a stationary direct current excited stator and a three–phase armature that rotates. A diode assembly that turns on a shaft supplies its output to the main alternator field winding to rectify the output. In the third stage, the current supplied to the main alternator field is amplified by the rotational energy of the engine and the power is transferred through an air gap to the main stator and the generator output terminals.

The torque force is transmitted to the generator through a quill splined shaft that connects to the aircraft propeller reduction gearbox. The ac generator attaches to the gearbox with a Quick–Attach/Detach (QAD) adapter that, once installed, stays attached to the gearbox when the ac generator is removed. The ac generator connects to the QAD with a V band clamp to secure the assembly.

The ac generator receives a supply of pressurized oil from the gearbox to cool and lubricate the internal components. The oil is moved through tubes from the gearbox, through the QAD adapter, to the generator. To prevent oil leakage, the tubes are sealed with O–rings at each end. The oil to the ac generator is routed through galleries cast into the housing to the other end. When oil enters the shaft, it is sprayed radially outward to cool the windings and lubricate the bearings. The cooling oil moves by gravity to the bottom of the ac generator where it is collected in the sump. The oil is removed through a scavenge port that is located in the sump by the engine scavenge pump to route the oil through galleries in the casting, through the QAD adapter transfer tubes back to the engine.

The ac generator electromagnetic components are sealed in a cast aluminum cylindrical structure that contains cooling fluid. The attached winding assemblies that form part of the magnetic circuit are located around the inner circumference of the housing. These stators operate with windings that turn on a longitudinal shaft attached to the two ends by ball bearings. The relative motion between the rotor and stator give the electrical output. Inputs and outputs of the stator windings are given by connections on the body of the ac generator. Low current connections are made with a circular connector and high power three−phase output connections are made to studs mounted on a terminal block. A bonding stud on the housing of the generator is used to connect it to the airframe ground potential.

The ac generator has a temperature switch that closes a set of contacts when the temperature of the ac generator is excessive. It gives continuity through two pins on the ac generator connector to make the AC GEN HOT indication come on in the caution and warning lighting panel.

The neutral lines in the ac generator windings have a three−phase current transformer that supplies current information to the AC GCU.

AC Generator Control Units

Refer to Figure 19.

The main feeder bus must be energized or the aircraft engine must operate to turn the ac generator to start AC GCU operation. The Permanent Magnet Generator (PMG) stage in the ac generator makes electrical power that is routed to the AC GCU. The AC GCU measures the ripple frequency of the PMG output to calculate speed of the ac generator. When the AC GCU senses that the ac generator has correct speed and that its ac generator toggle switch located on the ac control panel is set to the GEN 1 or GEN 2 position, the AC GCU supplies power to the exciter windings to cause the ac generator to output electrical power through the voltage regulator circuit. The voltage regulator is a closed loop regulator that adjusts the duty cycle of the exciter field voltage to give a constant voltage at the Point of Regulation (POR) under different load and speed conditions. The AC GCU uses the average of the three−phase output for regulation. A high phase takeover circuit is used to prevent the voltage from one phase going more than the regulation limits. The AC GCU also uses current transformers in the system that continuously monitor the ac generator current and limits the current when its output is more than the acceptable limits. When a stable output is available, the AC GCU causes its bus contactor to close to apply ac generator power to the ac bus. If one AC GCU and generator do not operate, the opposite serviceable AC GCU senses the condition through connections between the AC GCUs. The serviceable AC GCU will control the opposite bus contactor to energize the two ac busses. The communication between the two AC GCUs is through a transfer request signal. This signal is active when there is no need for transfer and is removed when there is a need. When ac external power is supplied to the aircraft, a signal is sent to the AC GCU to control the bus contactor so that ac external power is supplied to the ac busses and the ac generators are disconnected.

The AC GCU supplies two output signals to the caution and warning lights panel to turn on the AC GEN or AC BUS caution light to show system malfunctions to the pilots.

AC Control Panel

Refer to Figure 20.

The ac control panel gives manual control of the ac variable frequency system. It has two toggle switches for generators on and off control and one toggle switch for ac external power. The toggle switches are used to open and close ac variable frequency system electrical circuits.

The switches are identified as GEN 1, GEN 2, and EXT POWER. The three switches have an OFF label to show their off position.

The ac generator switches are positive break, two pole, toggle switches. The toggle lever is connected to a mechanism located in the body of the switch that moves in the opposite direction as the toggle lever. The ac external power switch is positive break, four pole, toggle switch. The wires from the receptical connector are connected to the switch terminals with lugs. The toggle switches are attached to the backing panel with mounting nuts and lock washers.

The ac control panel is attached to the overhead console using four DZUS fasteners. The fasteners and a bonding wire directly connected to the chassis makes a ground continuity connection between backing panel and the aircraft structure.

AC Contactor Boxes

Refer to Figures 21 , 22 and 23.

The Left AC Contactor Box (LACCB) and Right AC Contactor Box (RACCB) are assemblies that are used to distribute and control the three–phase ac power. The ACCBs contain monitor and protection components in a protected environment. The box cover allows access to the internal Line Replaceable Units (LRUs).

The electrical power connections between contactors in the ACCBs are made with bus bars. They are attached by a mounting plate assemby that secures the bus bars in the ACCBs. Standard cable is used to make the connections between the mounting plate assembly and the box connectors. The LACCB and RACCB have circuit breakers to protect the feeder cables that are routed directly to the aircraft equipment or to the ac variable frequency circuit breaker panel. The ACCB cover must be removed to get access to the circuit breakers.

When the galleys are installed, the LACCB and RACCB have galley contactors to energize the galley buses. The galley contactor K5 with its related connectors and circuit breakers are located in the LACCB and galley contactor K6 with related connectors and circuit breakers are located in the RACCB.

The ACCBs are not Line Replaceable Units (LRUs). They do not require replacement unless they are damaged. The components in the ACCBs are easily accessed when their covers are removed.

The components in the LACCB and RACCB gives control and distribution of the ac power source from the two ac generators or ac external power source.

The LACCB and RACCB contain the components that follow:

- Generator bus contactors, K1 and K2
- Cross tie contactor, K3 and K4
- Current transformers
- AC variable frequency bus circuit breakers
- Propeller anti–ice circuit breaker
- Optional galley load shed relays.

Generator bus Contactor: Two ac generator bus contactors connect the ac generator three–phase output between their related or opposite busses.

Each contactor box has a two–position center–off bus contactor with a 150 A three–pole double throw (3PDT) contact arrangement and associated auxiliary contacts. Two separate coil windings are used to move the contact arms to connect the ac busses to their related or the opposite generator (cross−tie position). The contactor arms also move to the cross−tie position when the external ac power is selected.

The ac generator bus contactor has X and Y coil windings to move the bus contactor arms to one closed position or to the other. The X position of the bus contactor is controlled by its related AC GCU and the Y position is controlled by the opposite AC GCU.

Cross−Tie Contactor: The cross−tie contactor connects external ac power through it to the generator bus contactors to the ac busses.

Each contactor box has a two−position cross−tie contactor with three−pole double throw (3PDT) contact arrangement. When the cross−tie contactor is de−energized, it gives a cross−tie connection to the bus contactors. When the coil is energized, the contacts move to the other position to supply external ac power through the bus contactors to the ac busses.

The cross−tie contactor coil is energized when the external ac power is available and the EXT PWR toggle switch on the ac control panel is set to the external power position.

Current Transformers: For indication and use by the ac variable frequency system, the current transformers sense the parameters that follow:

- Total generator current
- Main feeder current
- Cross−tie current.

Total Generator Current: Two current transformers, designated CT1 and CT4, located in the LACCB and RACCB, are used to sense the total generator output current for the left and right ac generators. The total generator current transformers supply current data to the EPCU for indication.

Main Feeder Current: Two current transformers, designated CT2 and CT5, located in the LACCB and RACCB, are used to sense the current flow in the main feeders. The main feeder current transformers supply current data to its GCU's differential current sense circuits.

Cross−Tie Current: Two current transformers, designated CT3 and CT6, located in the left ACCB and Right ACCB, are used to sense the cross−tie currents. The cross−tie current transformers supply current data to the opposite AC GCU to sense current only when an ac generator bus contactor is in the cross−tie position (one generator supplies the two ac buses).

Each current transformer assembly has three toroidal (ring−type) current transformers. The cable from each phase of the system is passed through a toroid. A multi−pin connector is used to make electrical connections between the toroids and the other components. The toroidal current transformers are contained in an aluminum case and have mounting holes that are not symmetrical to prevent improper installation.

AC Variable Frequency Bus Circuit Breakers: A 3−phase, 50 A circuit breaker is installed in the LACCB and RACCB to protect the ac variable frequency feeder cables that are routed to the circuit breaker panel in the flight compartment.

Propeller De−Ice Circuit Breaker: A 3−phase, 35 A circuit breaker is installed in the LACCB and RACCB to protect the propeller de−ice heater feeder cables.

Galley Load Shed Contactors: When the galley power option is installed, the galley load shed contactors control the application and removal of electrical power to the galleys.

Each contactor box has a normally open galley contactor with a 50 A two–pole single throw (2PST) contact arrangement.

The galley load shed contactors are energized to supply electrical power to the galley busses when the ac busses are energized by their related generator or external power. A malfunction of one ac generator will cause the two galley load contactors to de–energize and open circuit the ac busses and the galley busses.

A 3–phase, 15 A circuit breaker is installed in the LACCB and RACCB to protect the galley feeder cables.

The RACCB contains the components that follow:

- External Power Protection Unit (EPPU)
- SPU Contactor
- SPU Circuit Breaker
- Protective Fuses.

External Power Protection Unit (EPPU): The EPPU makes sure that good ac external power is allowed to energize the ac busses.

The EPPU checks the external power source for the parameters that follow:

Table 2: Table 2.

PARAMETER	TRIP POINT
Over Voltage	124 VAC
Under Voltage	106 VAC
Over Frequency	450 Hz
Under Frequency	370Hz

The Standby Power Unit (SPU) Contactor controls application and removal of electrical power to the SPU.

SPU Contactor: The RACCB has a normally open SPU contactor with a 50 A two–pole single throw (2PST) contact arrangement.

When the SPU contactor is de–energized, it opens the circuit to the AC SPU. When the coil is energized, the contacts are moved to connect the AC SPU to the right ac bus.

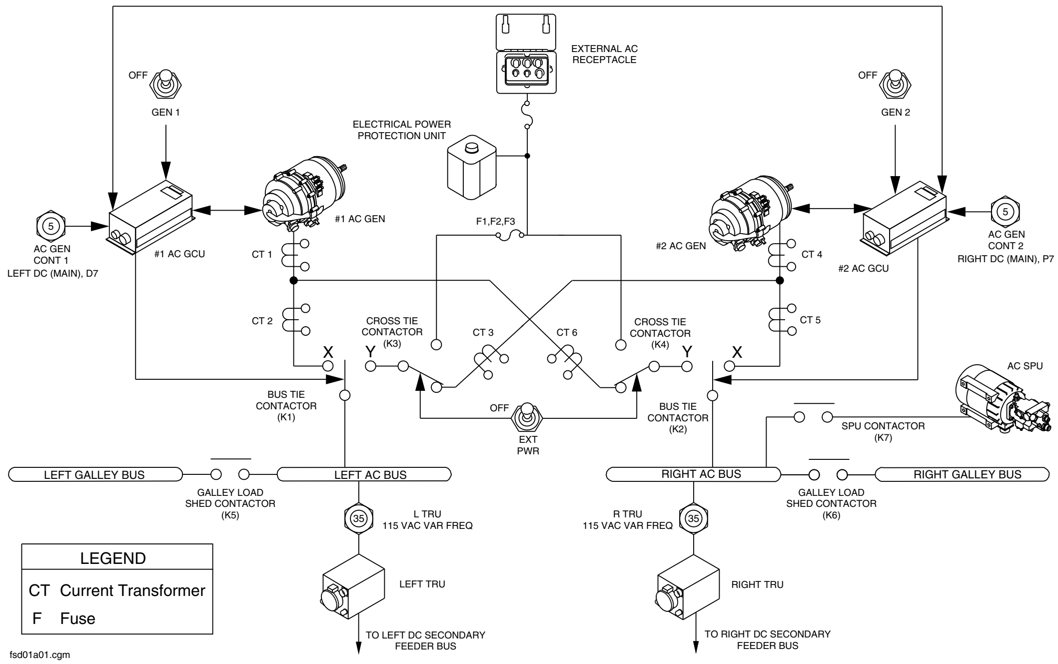
The SPU coil is energized automatically when the ac power is available on the right ac bus and the STBY HYD PRESS pushbutton switchlight on the Hydralic Control panel is pushed.

SPU Circuit Breaker: A 3–phase, 60 A circuit breaker is installed in the RACCB to protect the SPU feeder cables.

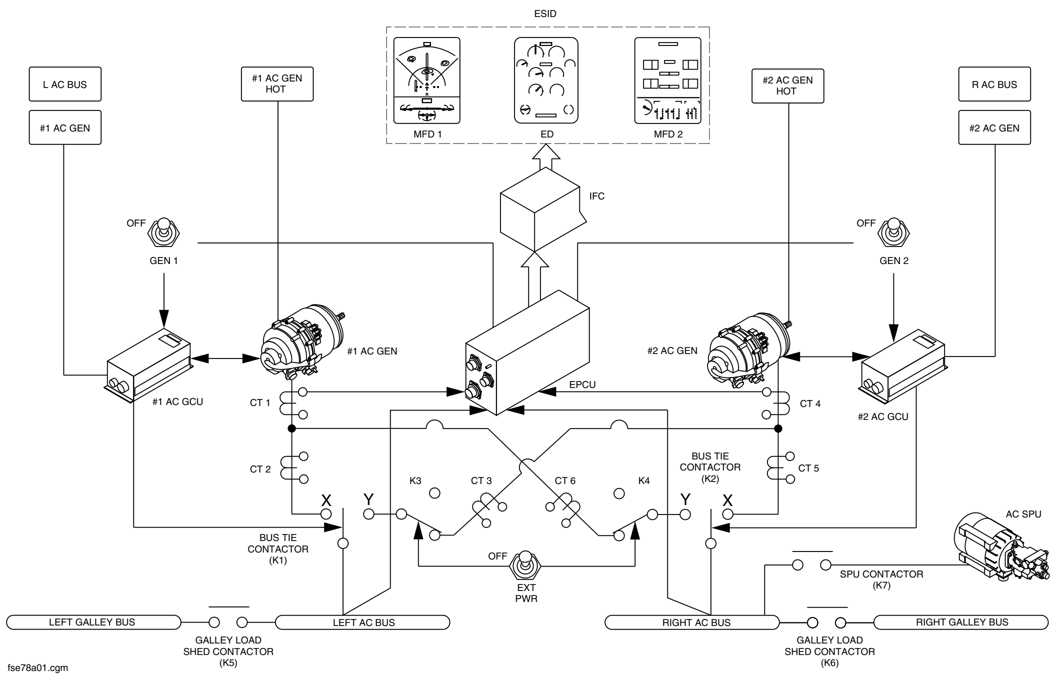
Protective Fuses: Three 100 A fuses are installed in the RACCB to protect the three feeder cables that go to the LACCB.

Natural convection and conduction through the mount locations cool the ACCB. The ACCBs have angled vent blocks to prevent water in the nacelle from going in.

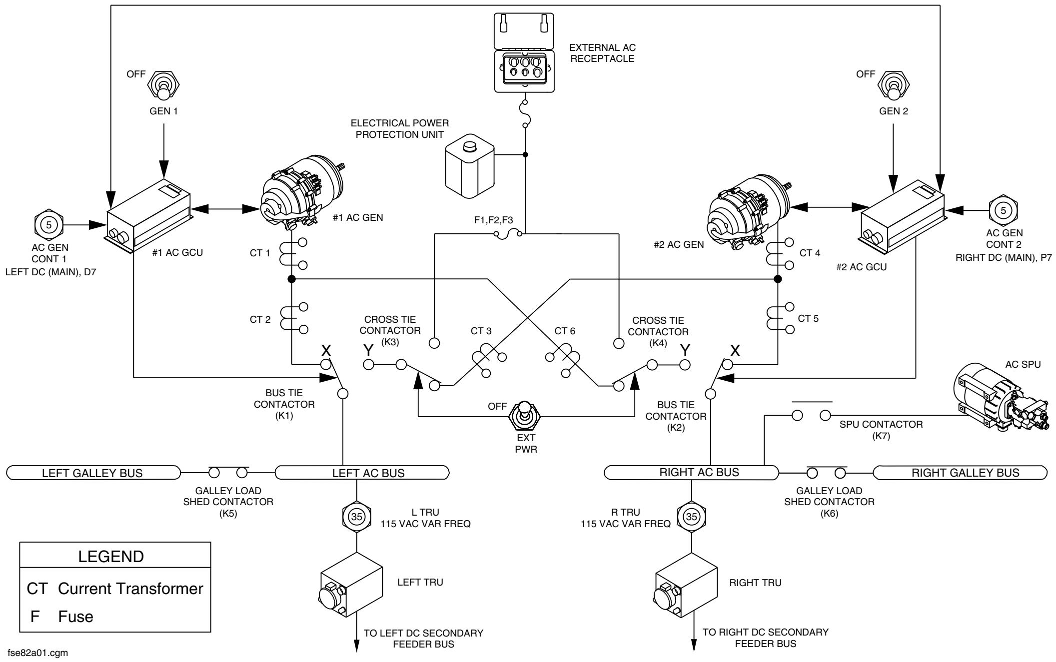
The box mounting feet are secured to the aircraft structure with bolts screwed into anchor nuts.



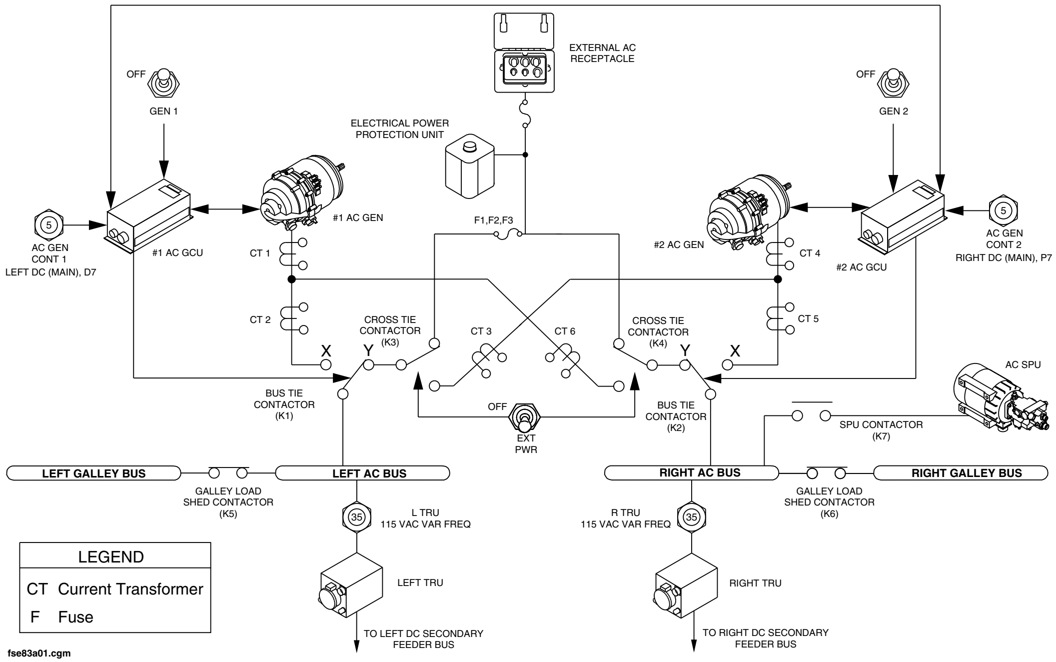
AC VARIABLE FREQUENCY SYSTEM BLOCK DIAGRAM, CONTROL
Figure 1



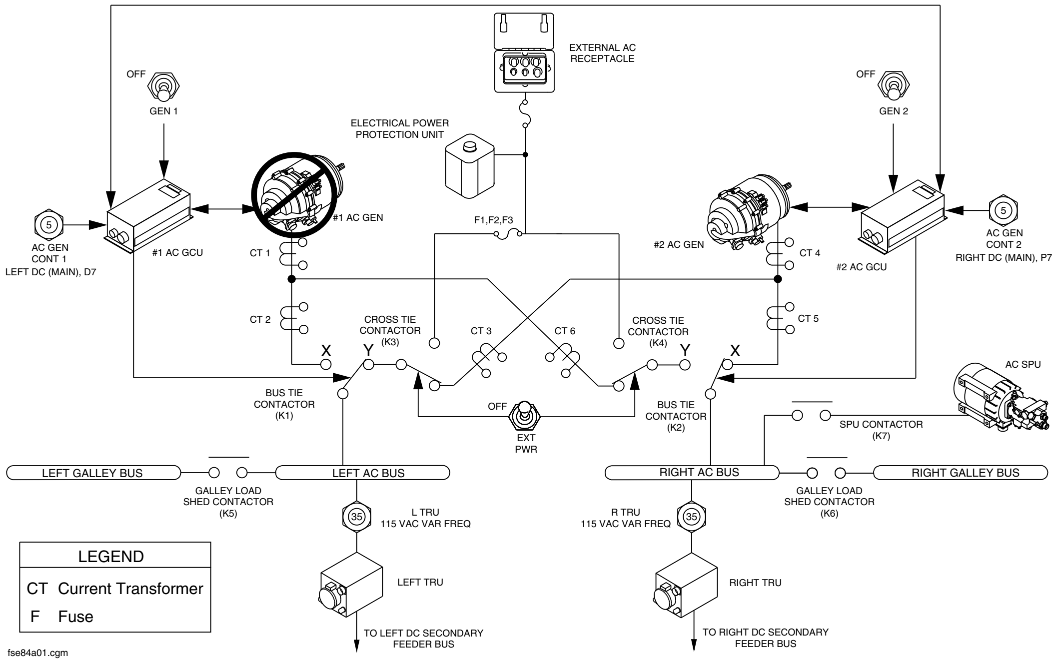
AC VARIABLE FREQUENCY SYSTEM BLOCK DIAGRAM, INDICATION
Figure 2



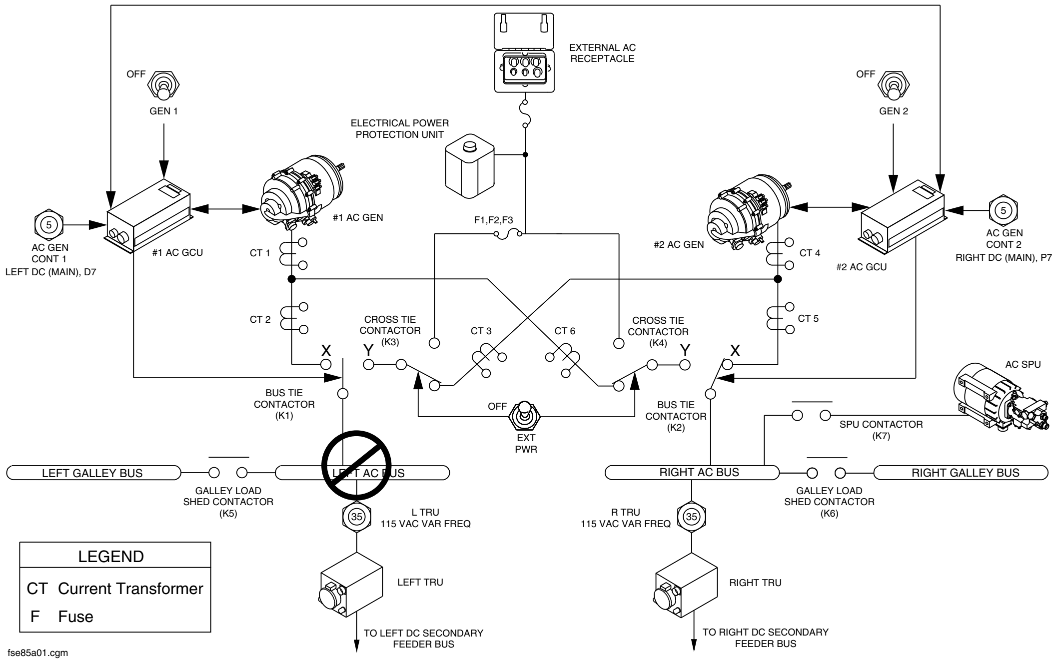
AC VARIABLE FREQUENCY SYSTEM OPERATION
Figure 3



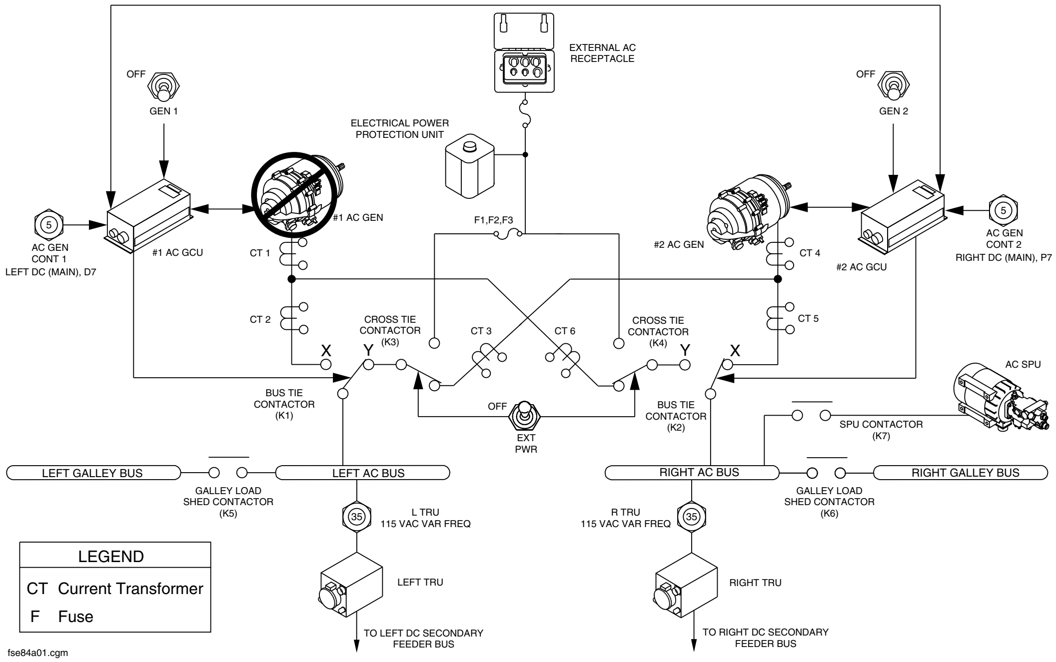
AC VARIABLE FREQUENCY SYSTEM, EXTERNAL POWER OPERATION
Figure 4



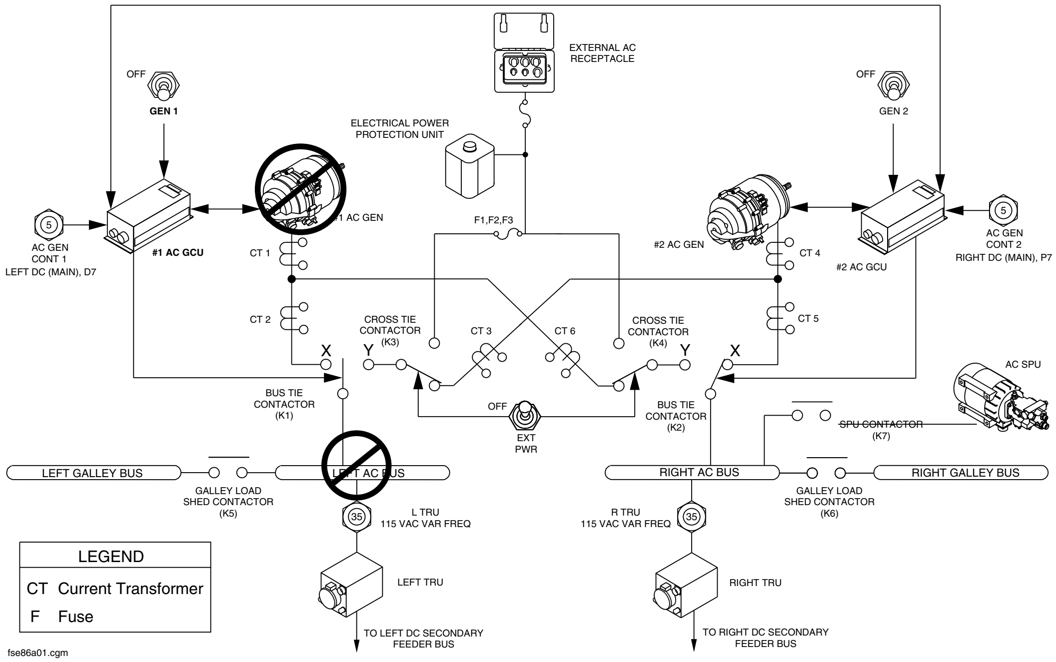
AC VARIABLE FREQUENCY SYSTEM, AC GENERATOR NO. 1 SOURCE FAULT PAGE 1
Figure 5



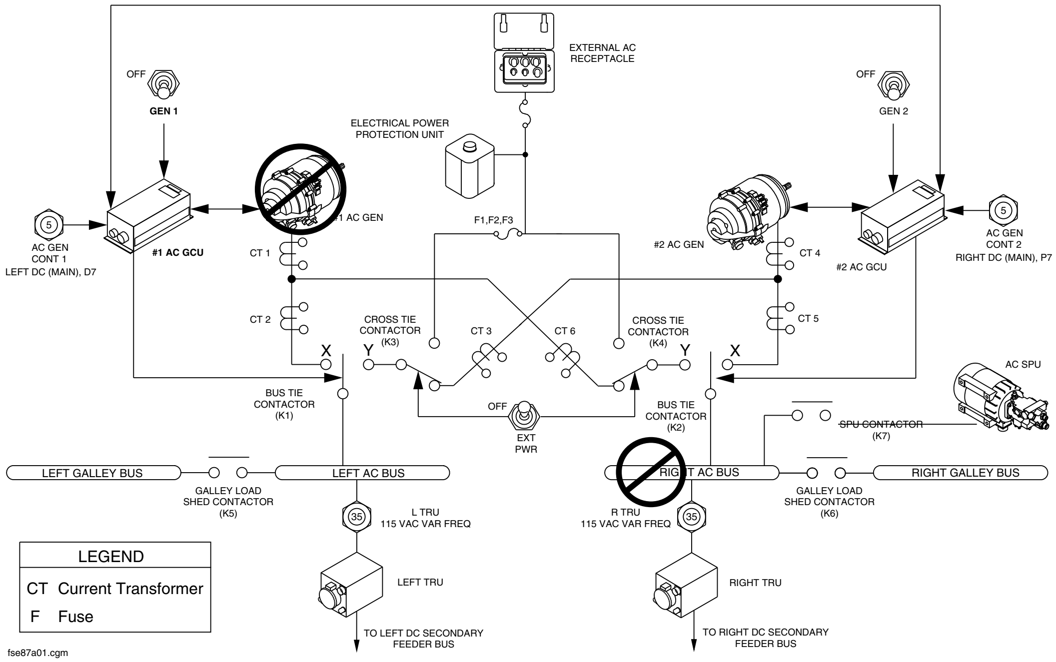
AC VARIABLE FREQUENCY SYSTEM, LEFT AC BUS FAULT
Figure 6



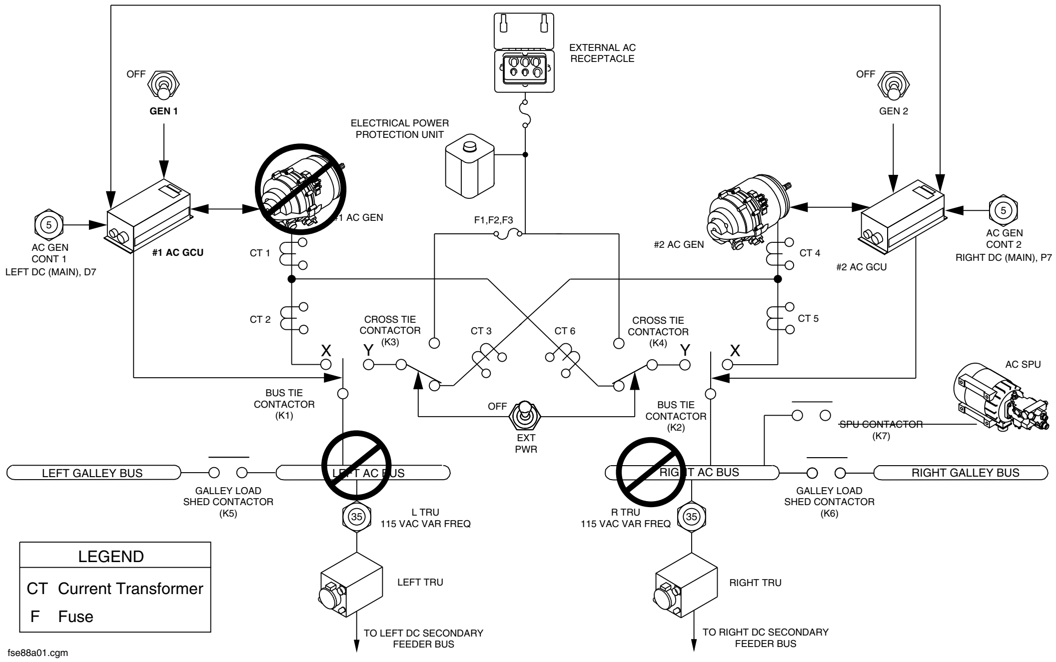
AC VARIABLE FREQUENCY SYSTEM, AC GENERATOR NO. 1 SOURCE FAULT PAGE 2
Figure 7



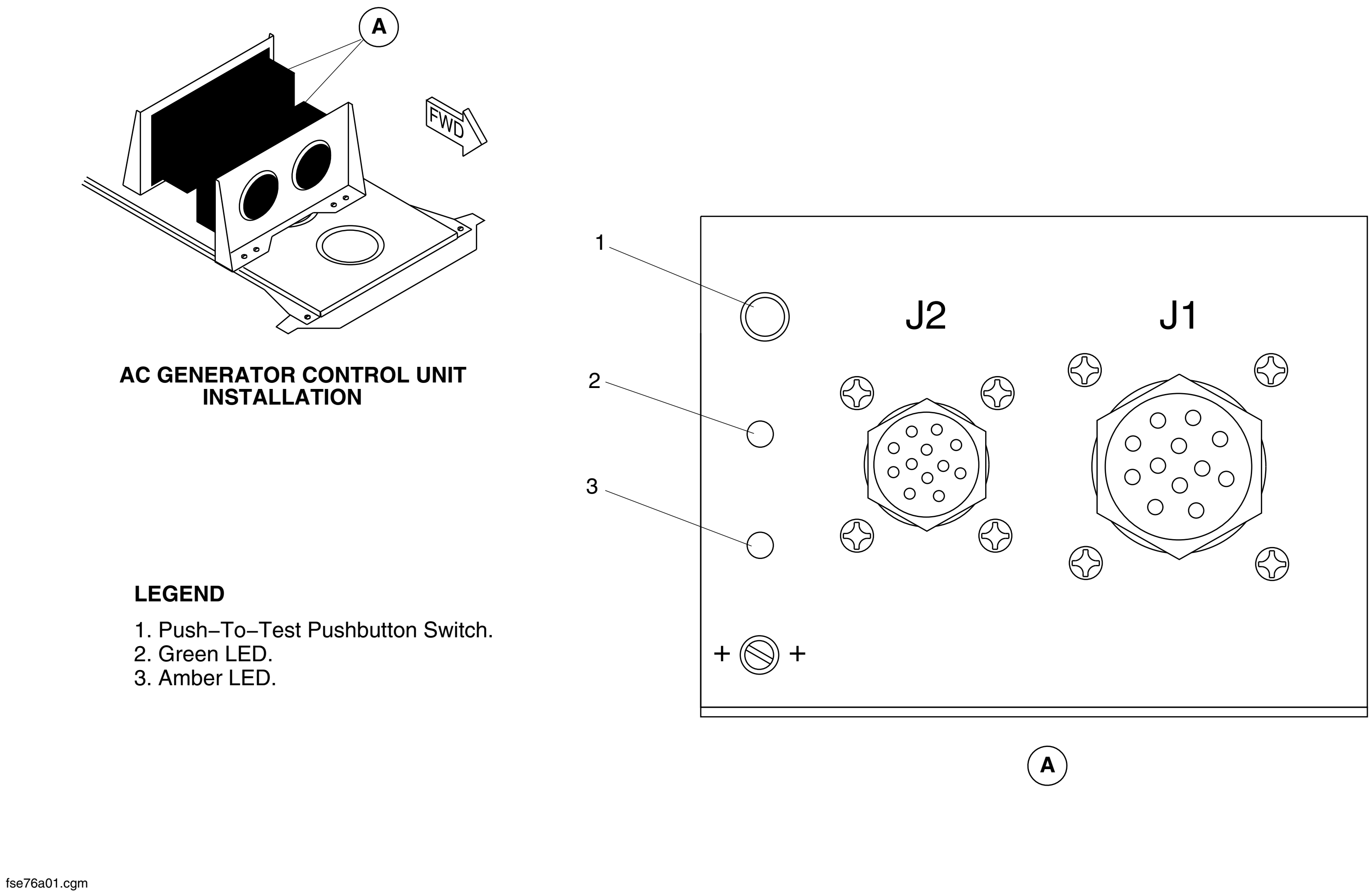
AC VARIABLE FREQUENCY SYSTEM, AC GENERATOR NO. 1 AND LEFT AC BUS FAULT, SEQUENCE 1
Figure 8



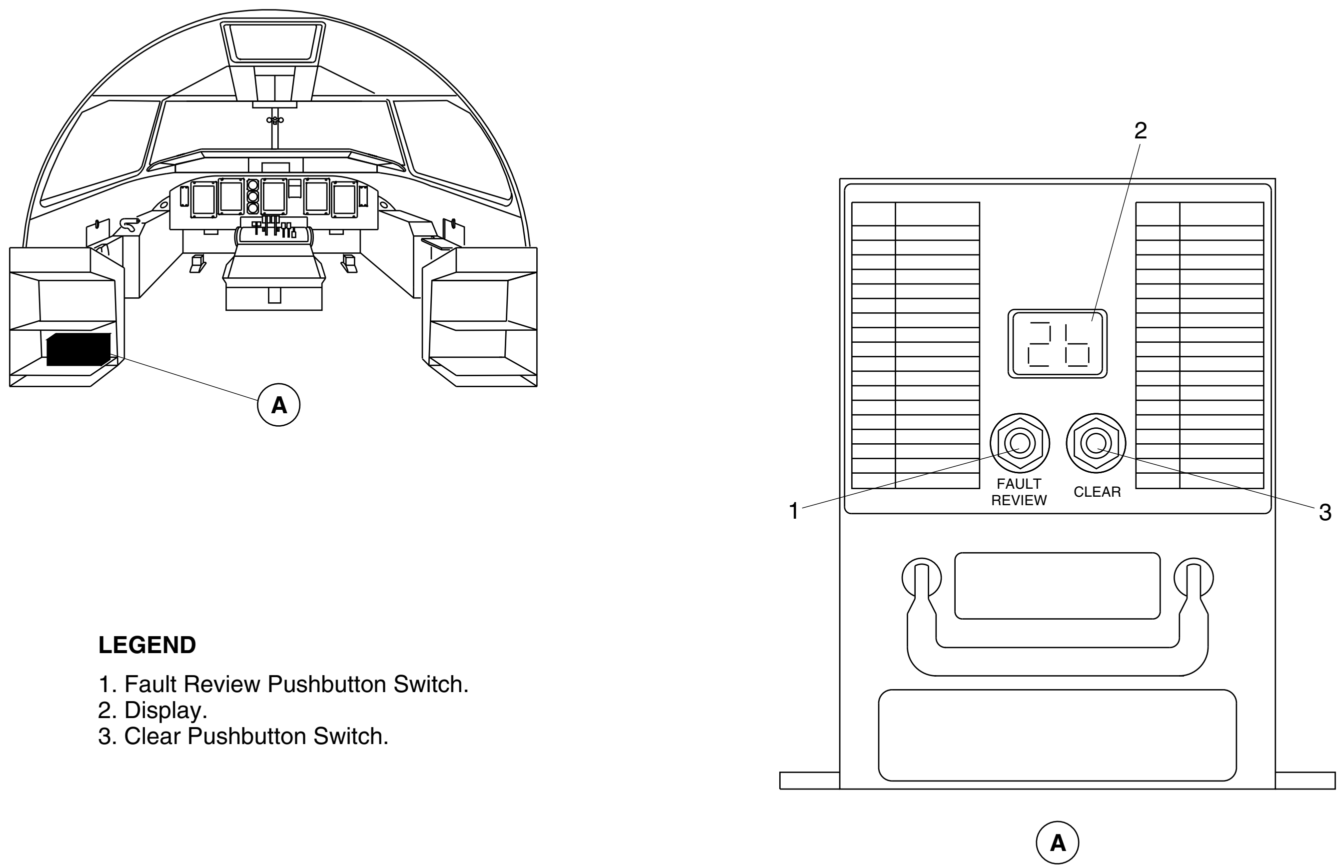
AC VARIABLE FREQUENCY SYSTEM, AC GENERATOR NO. 1 AND LEFT AC BUS FAULT, SEQUENCE 2
Figure 9



AC VARIABLE FREQUENCY SYSTEM, AC GENERATOR NO. 1 AND LEFT AC BUS FAULT, SEQUENCE 3
Figure 10



AC VARIABLE FREQUENCY SYSTEM, AC GCU
Figure 11

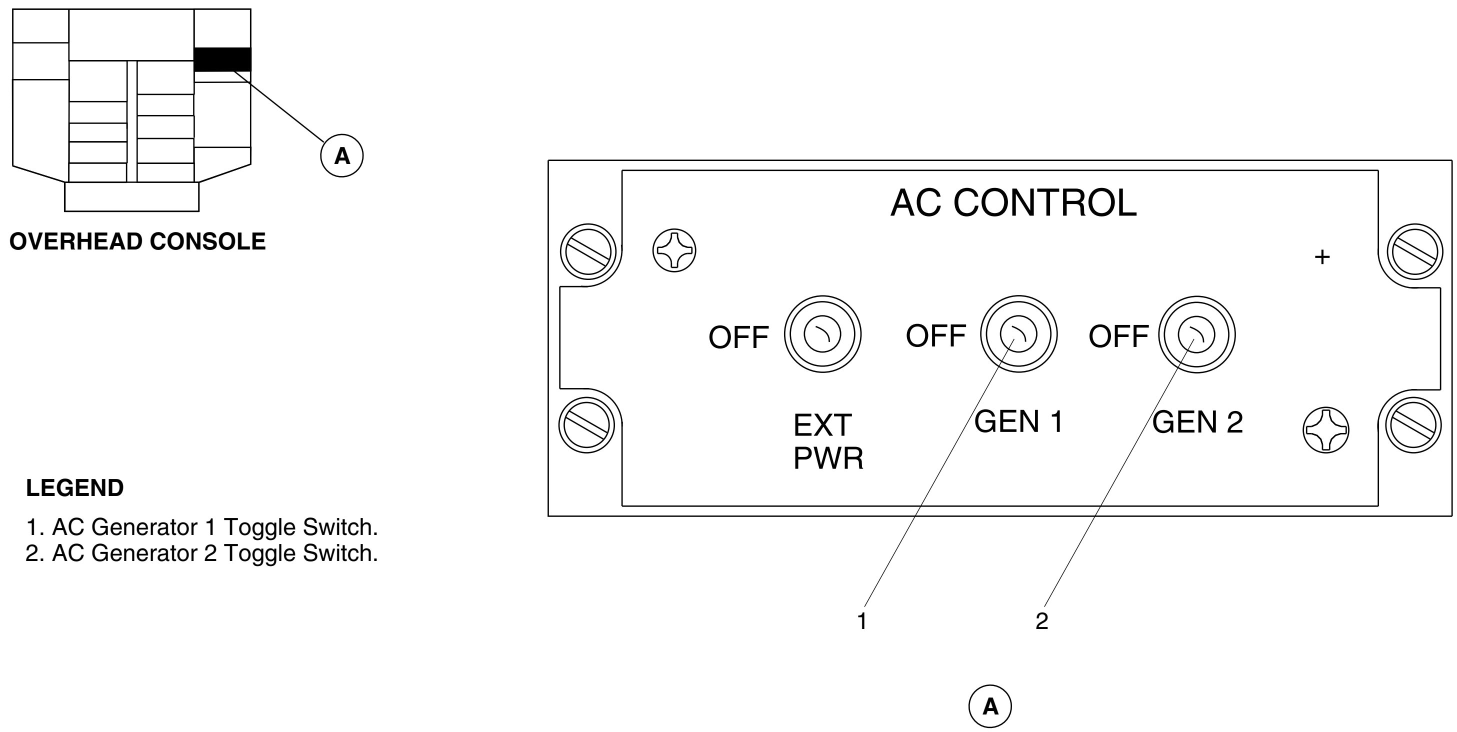


LEGEND

1. Fault Review Pushbutton Switch.
2. Display.
3. Clear Pushbutton Switch.

fsg01a01.cgm

MAIN 28 VDC GENERATION SYSTEM, EPCU
Figure 12

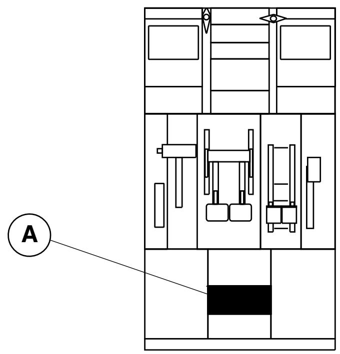


LEGEND

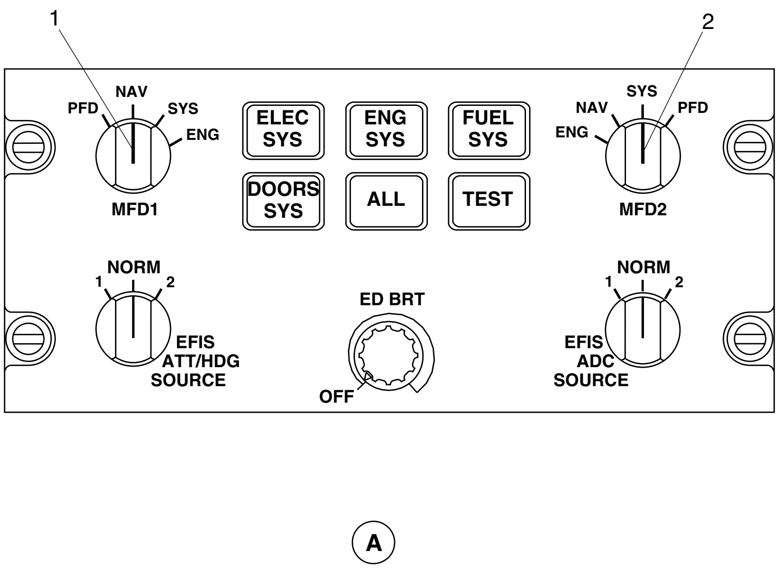
1. AC Generator 1 Toggle Switch.
2. AC Generator 2 Toggle Switch.

fse75a02.cgm

AC VARIABLE FREQUENCY SYSTEM, AC CONTROL PANEL
Figure 13



CENTRE CONSOLE

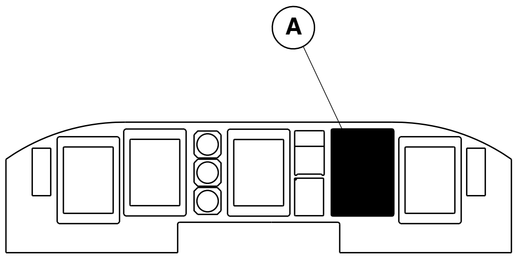


LEGEND

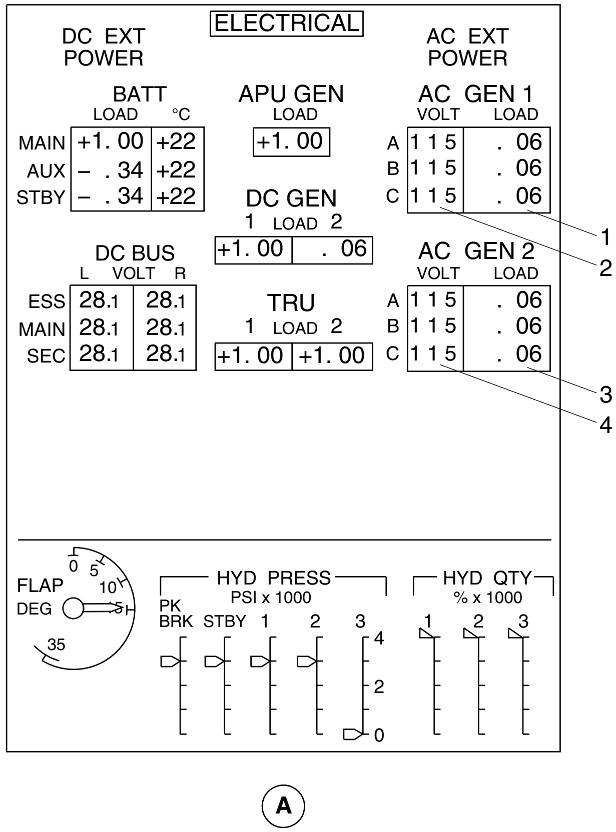
1. MFD 1 Reversion Selector.
2. MFD 2 Reversion Selector.

fs750a01.cgm

EIS, ELECTRICAL SYSTEM PAGE SELECTION
Figure 14



MAIN INSTRUMENT PANEL



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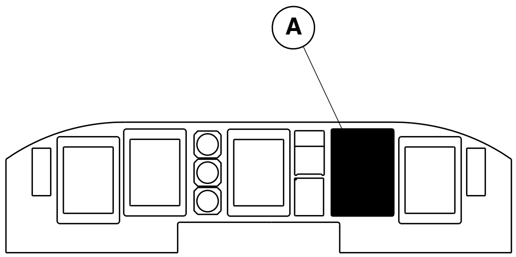
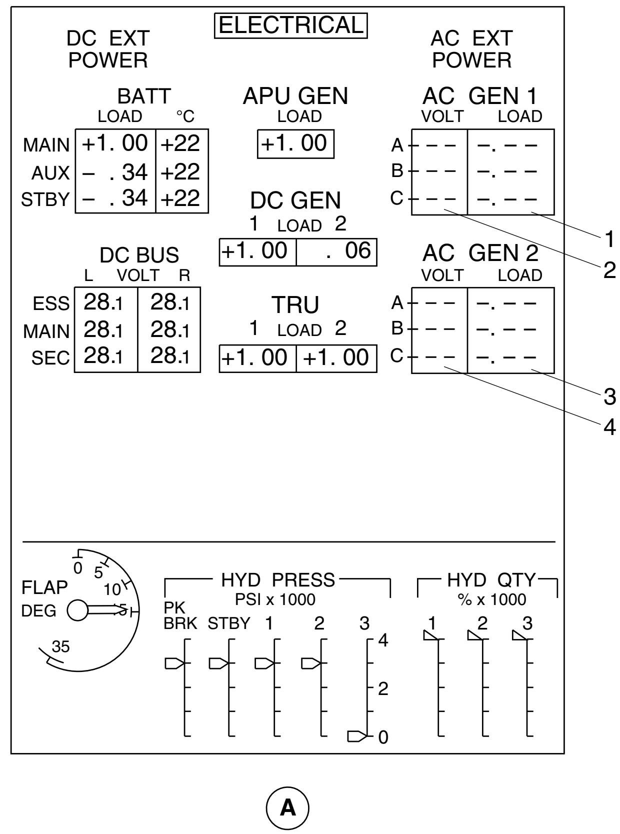
LEGEND

1. AC GEN 1 Load Indications.
2. AC GEN 1 Volt Indications.
3. AC GEN 2 Load Indications.
4. AC GEN 2 Volt Indications.

EIS, AC VARIABLE FREQUENCY SYSTEM INDICATIONS
Figure 15



MAIN INSTRUMENT PANEL



LEGEND

1. AC GEN 1 Load Fail Annunciation.
2. AC GEN 1 Volt Fail Annunciation.
3. AC GEN 2 Load Fail Annunciation.
4. AC GEN 2 Volt Fail Annunciation.

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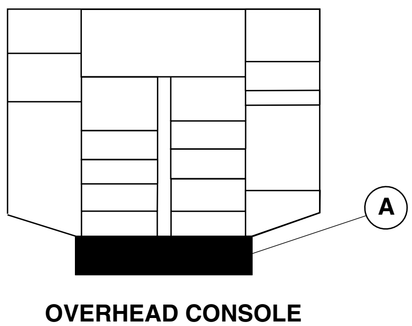
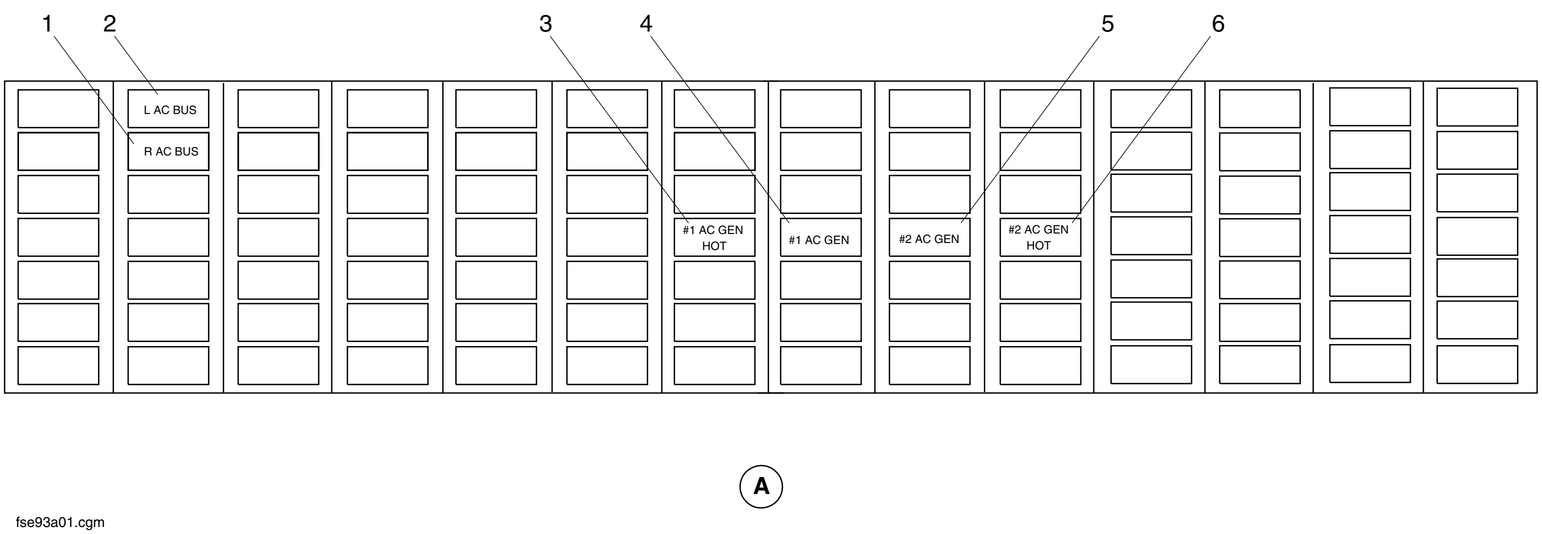
EIS, AC VARIABLE FREQUENCY SYSTEM MALFUNCTION INDICATIONS
Figure 16

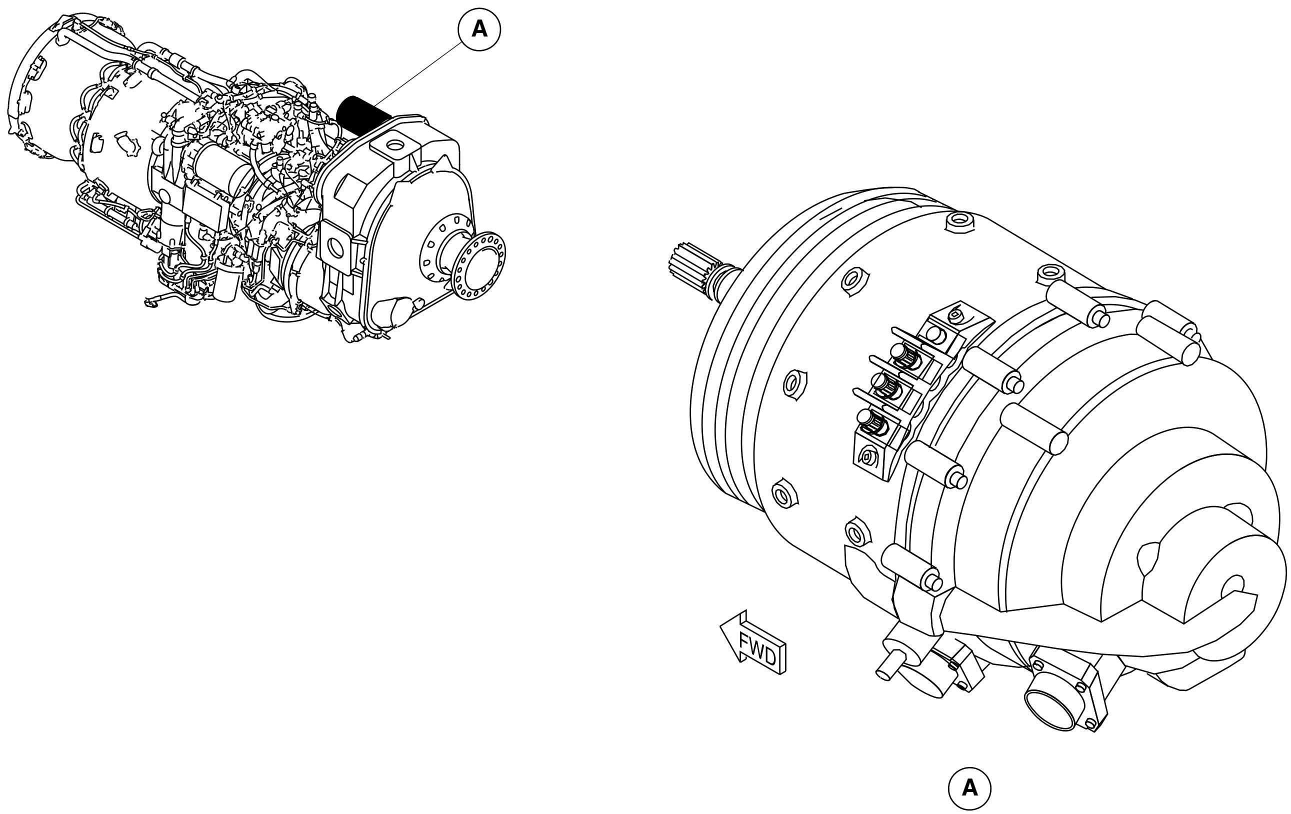


LEGEND

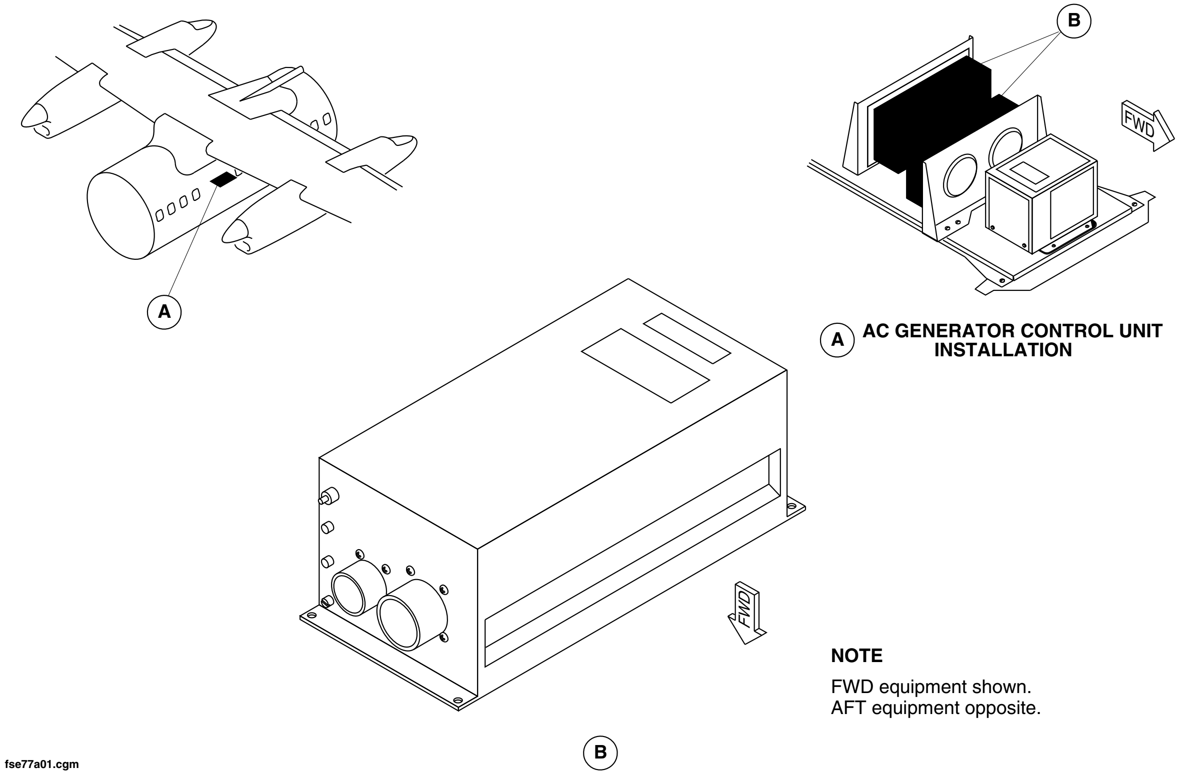
1. Right AC BUS.
2. Left AC BUS.
3. #1 AC GEN HOT.
4. #1 AC GEN.
5. #2 AC GEN.
6. #2 AC GEN HOT.



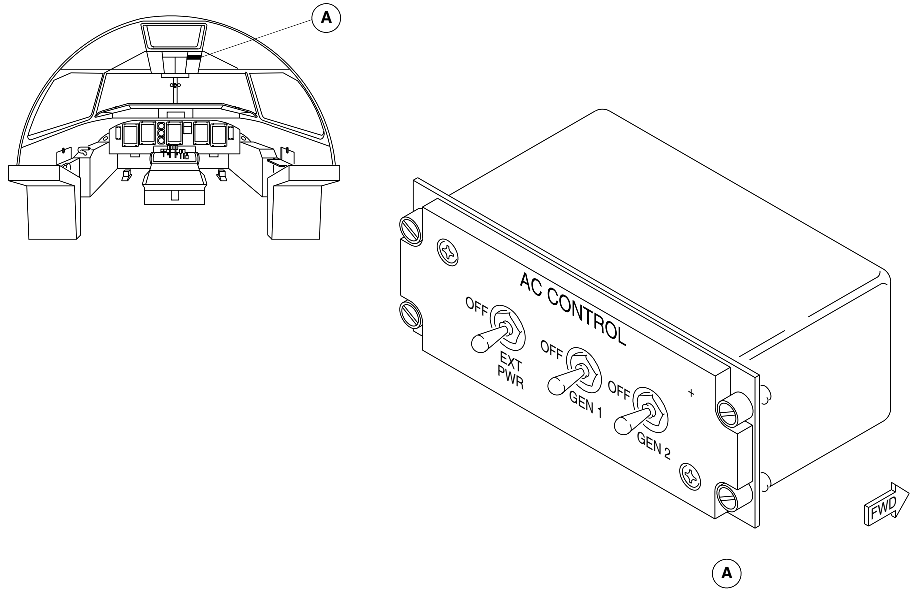
CAUTION AND WARNING PANEL, AC VARIABLE FREQUENCY SYSTEM CAUTION INDICATIONS
Figure 17



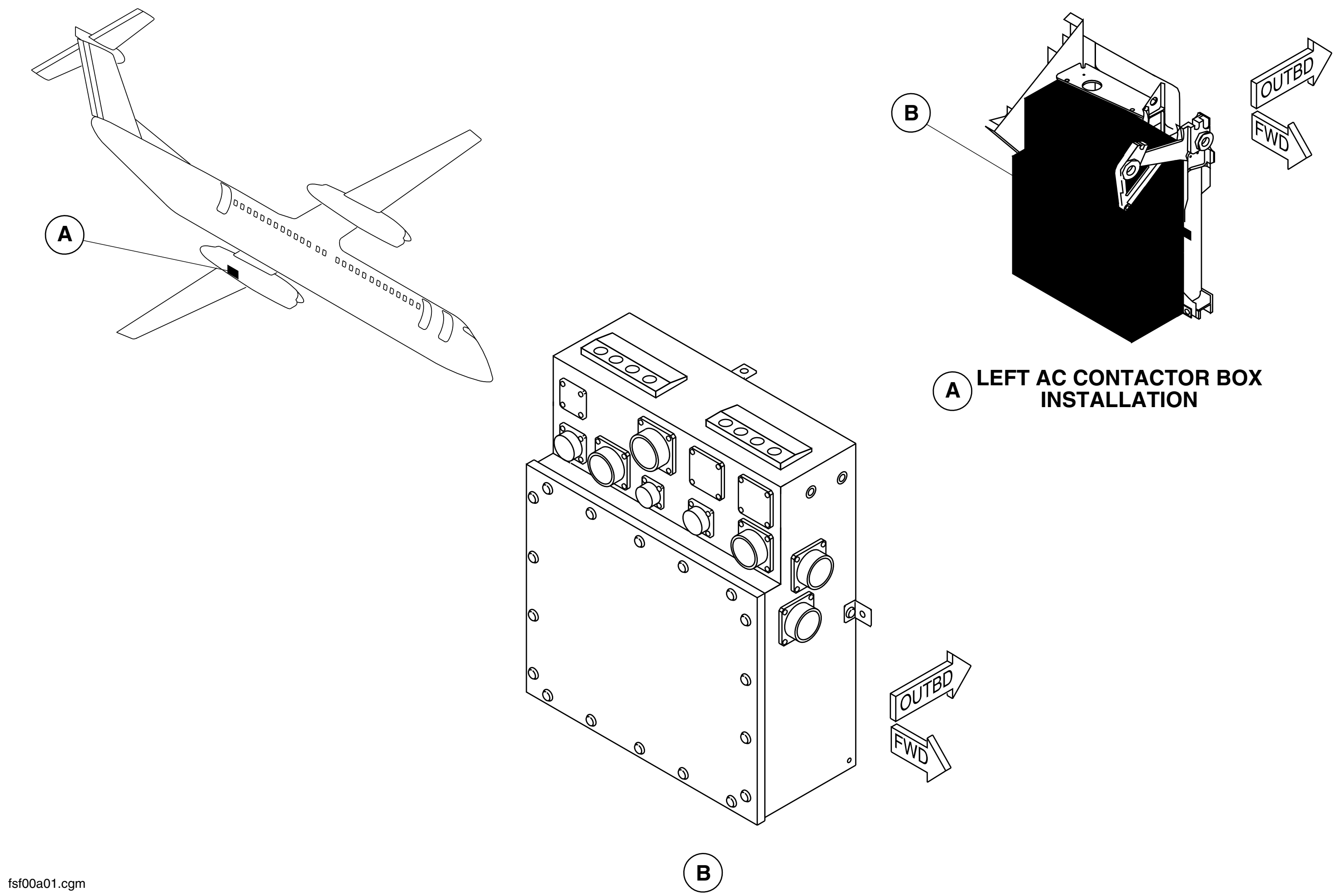
AC GENERATOR LOCATOR
Figure 18



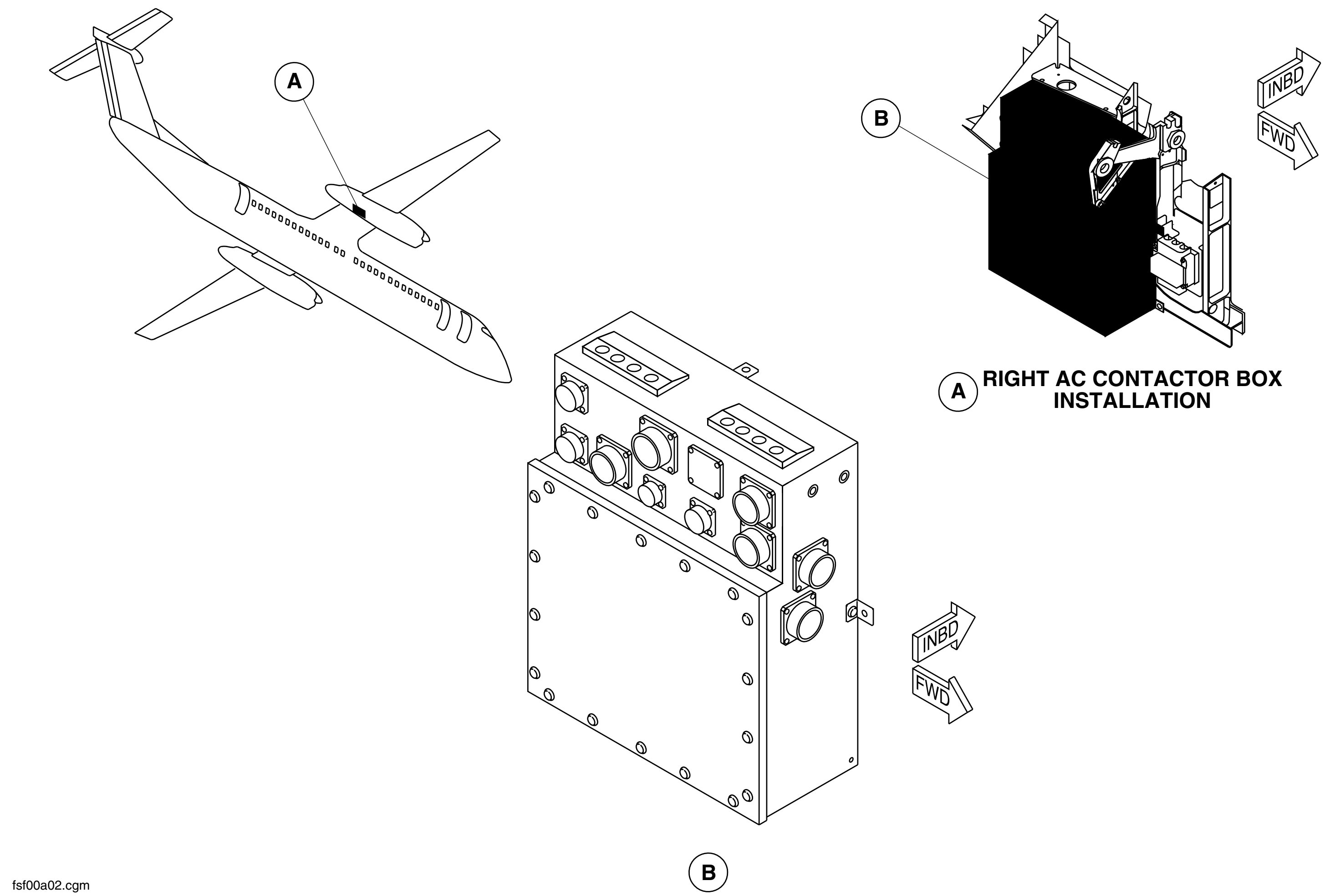
AC GENERATOR CONTROL UNIT LOCATOR
Figure 19



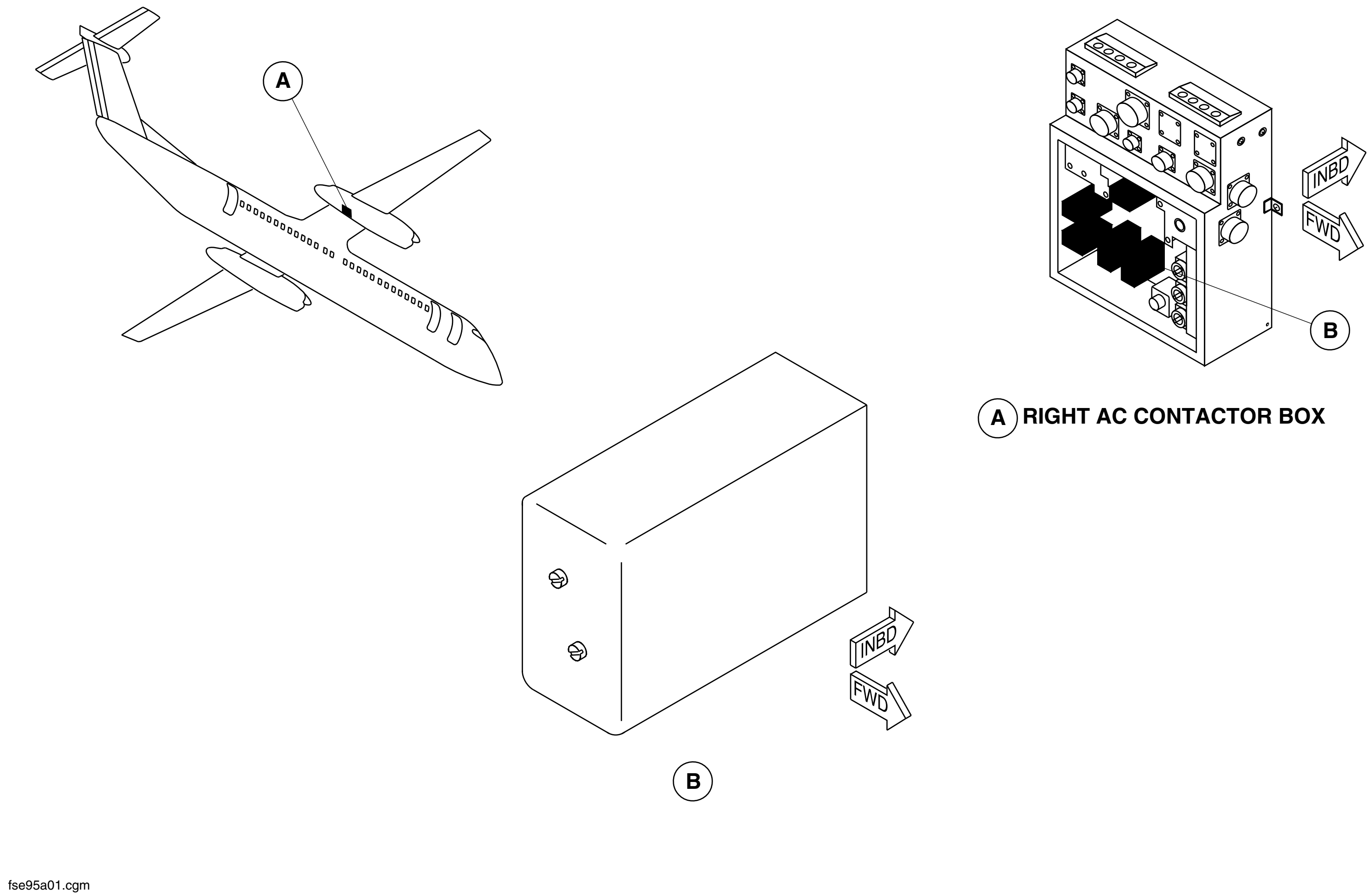
AC GENERATOR CONTROL PANEL LOCATOR
Figure 20



LEFT AC CONTACTOR BOX (LACCB) LOCATOR
Figure 21



RIGHT AC CONTACTOR BOX (RACCB) LOCATOR
Figure 22



AC CONTACTORS LOCATOR
Figure 23

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24–30–00–001

DC GENERATION SYSTEM

Introduction

The DC Generation System makes 28 Vdc and supplies the electrical power to the aircraft dc busses. The DC generation system monitors the distribution, storage, control, protection, and indication of dc electrical power.

General Description

Refer to Figure 1.

The DC Generation System has three dc starter/generators, one on each engine, and one on the APU. In addition, two Transformer Rectifier Units (TRUs) supply electrical power independently to the left and right dc bus systems.

The main and the auxiliary batteries are connected to the main feeder busses to supply electrical power to start the engines. During an engine start, the standby battery is disconnected from the main feeder bus, but stays connected to the essential busses to maintain a minimum voltage level on the essential bus. The main, auxiliary, and standby batteries are connected to the main feeder busses to receive a charging current.

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

The DC Generation System has the sub–systems that follow:

- Main 28 Vdc generation (24–31–00)
- Battery (24–32–00)
- Auxiliary Power Unit (APU) 28 Vdc (24–33–00)

Detailed Description

The direct current (dc) system functions in the modes that follow:

- Normal
- Protection
- Fault Tolerant
- Emergency
- Diagnostics and Monitoring.

Normal Function: The dc electrical power from dc starter/generators and Transformer Rectifier Units (TRUs) is distributed to the dc busses through a dc contactor box located in the nose compartment of the aircraft. The contactor box contains the switching, protection, and measurement components.

When the aircraft engines are operating with no external dc power connected, and the dc generator toggle switches located on the dc control are set to GEN 1 or GEN 2 positions, the dc generators are connected to their related main feeder busses for normal operation. The related dc GCU automatically disconnects its dc starter/generator when it senses a dc starter/generator malfunction.

Protection Function: The protective functions in the 28 Vdc generation system prevent damage to the dc starter/generators, TRUs, or other related equipment malfunctions, or there is an overload condition.

The 28 Vdc generation system protective functions are classified as passive protection and active protection.

For passive protection, the main 28 Vdc generation system uses circuit breakers and fuses so that a malfunction condition will not cause damage.

The 28 Vdc generation system uses its DC GCUs and EPCU to control the contactors for active protection so that a fault condition will not cause damage to the dc starter/generators and TRUs. It uses the protective functions that follow:

- Over voltage
- Over current
- Differential feeder protection
- Build–up ground fault
- Reverse current
- External power monitor
- TRU under voltage detection.

Refer to Figure 2.

The multi–function displays located on the pilot and co–pilot instrument panels will display the electrical page when selected on the ESID control panel MFD reversion switches. The electrical page shows the dc generation system indications that follow:

- Digital indication of the dc essential, main, and secondary bus voltages
- Digital indication of the dc essential, main, and standby voltages
- Digital indication of dc starter/generator loads
- Digital indication of TRU loads.
- Digital indication of APU loads.

Main 28 Vdc Generation (24–31–00)

The main 28 Vdc generation system has two dc starter/generators, one on each engine, and two Transformer Rectifier Units (TRUs) to supply electrical power independently to the left and right dc bus systems.

Two dc starter/generators energize their related main feeder and essential distribution busses. The left and right main feeder busses are isolated and are connected to each other automatically or manually through a bus tie contactor. The left and right essential busses are connected together through circuit breakers.

When a dc starter/generator or TRU malfunctions, the main 28 Vdc generation system automatically connects its bus to another serviceable electrical source for continuous operation.

Battery (24–32–00)

Refer to Figure 3.

The battery power system of the aircraft has three batteries and the switching devices required to supply electrical power to the essential busses.

The main, auxiliary, and standby batteries are connected to the main feeder busses. The main and auxiliary batteries are connected to the main feeder busses to supply electrical power to start the engines. During an engine start condition, the standby battery is disconnected from the main feeder bus, but stays connected to the essential busses to maintain a minimum voltage level on the essential bus.

Each battery is connected to the main feeder busses by a related battery toggle switch to receive a charging current.

During an emergency condition, the batteries are the electrical power sources for the main 28 Vdc generation system. Contactors will open to disconnect the batteries from their related main feeder bus.

Auxiliary Power Unit (APU) 28 Vdc (24–33–00)

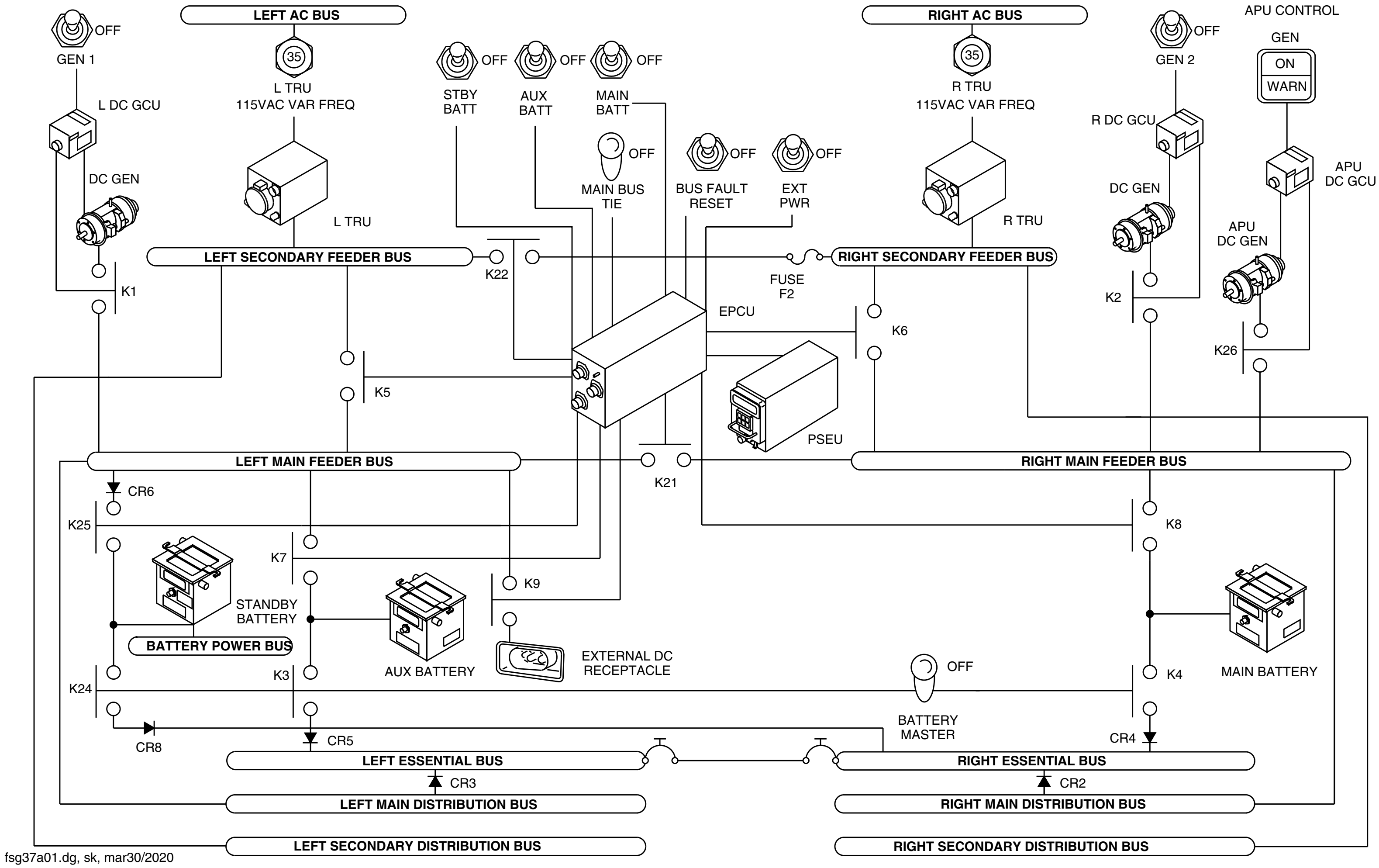
Refer to Figure 4.

The APU supplies 28 Vdc to the main, essential and secondary dc buses on the ground.

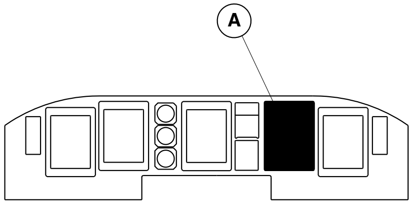
The EPCU automatically controls and monitors the APU 28 Vdc generating system. Sensors in the Electrical Power Control Unit (EPCU) monitors the APU 28 Vdc power source for voltage and polarity. The EPCU will allow good dc APU power to energize the aircraft busses

Switchlights located on the APU control panel in the flight compartment give manual control of the APU 28 Vdc generation system. The Engine and System Integrated Display (ESID) system shows main 28 Vdc generation system electrical indications.

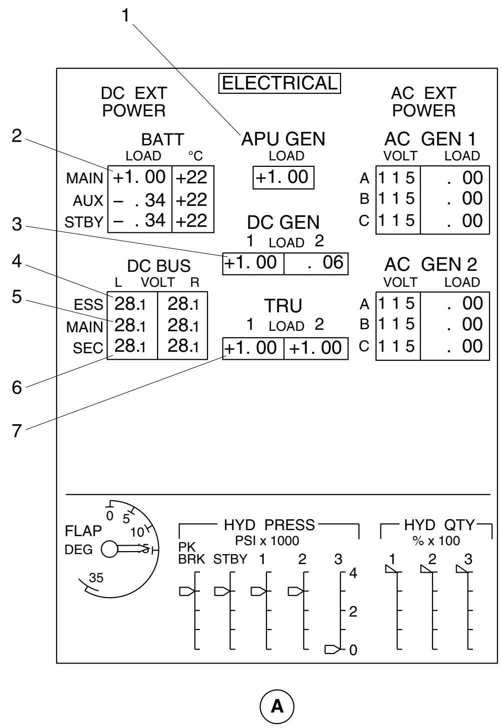
After the APU is started, the starter/generator is available to supply power in parallel with the batteries to assist start the aircraft engines. The APU generator is connected to the right main feeder bus and automatically cross ties to the left main feeder bus to supply 28 Vdc electrical power to the dc busses.



Main 28 VDC Generation System Block Diagram
Figure 1



MAIN INSTRUMENT PANEL



LEGEND

1. APU Generator Load Digital Indication.
2. Main Battery Load Digital Indication.
3. DC Starter / Generator Load Digital Indications.
4. Essential DC Bus Voltage Digital Indication.
5. Main DC Bus Voltage Digital Indication.
6. Secondary DC Bus Voltage Digital Indication.
7. TRU Load Digital Indication.

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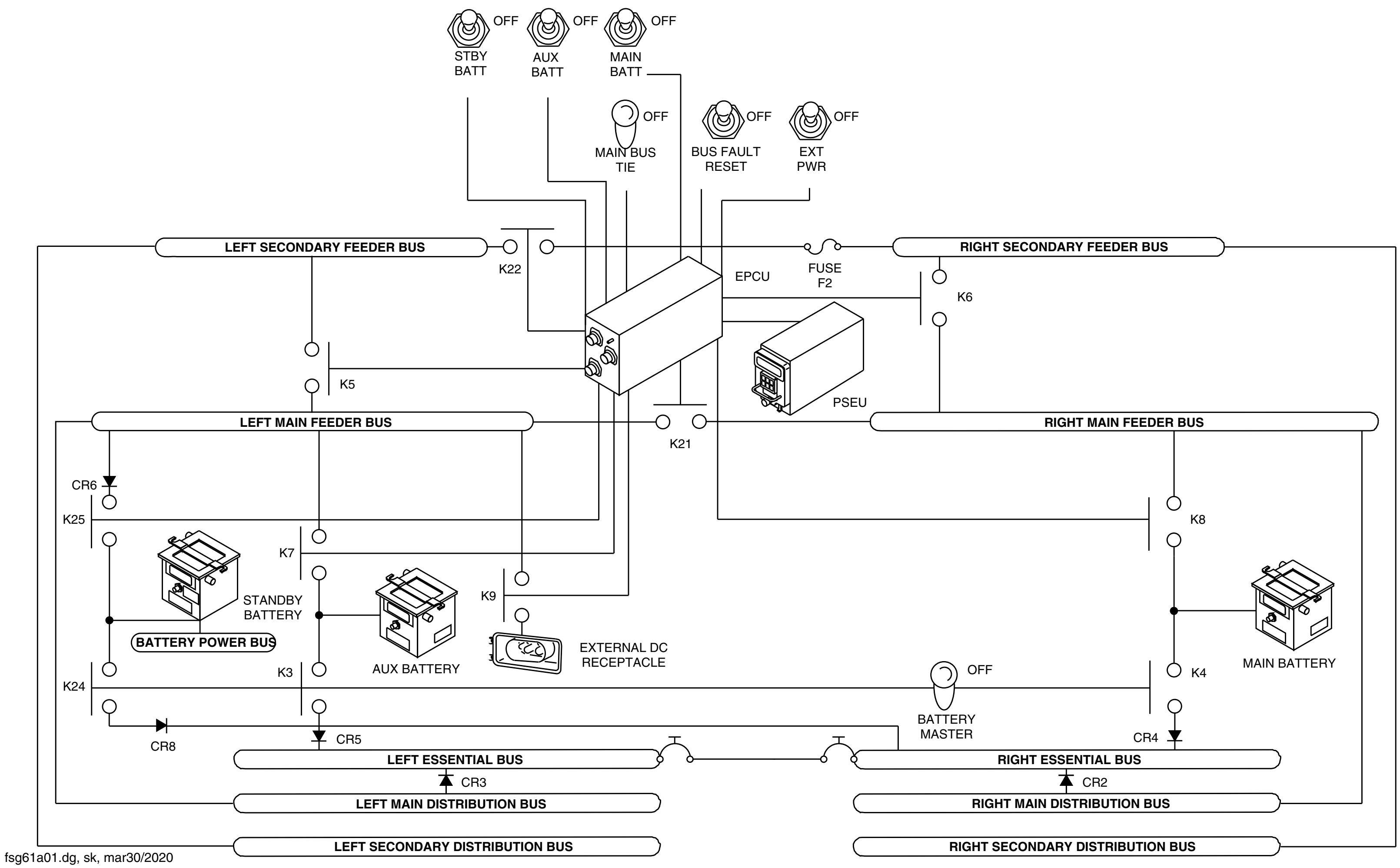
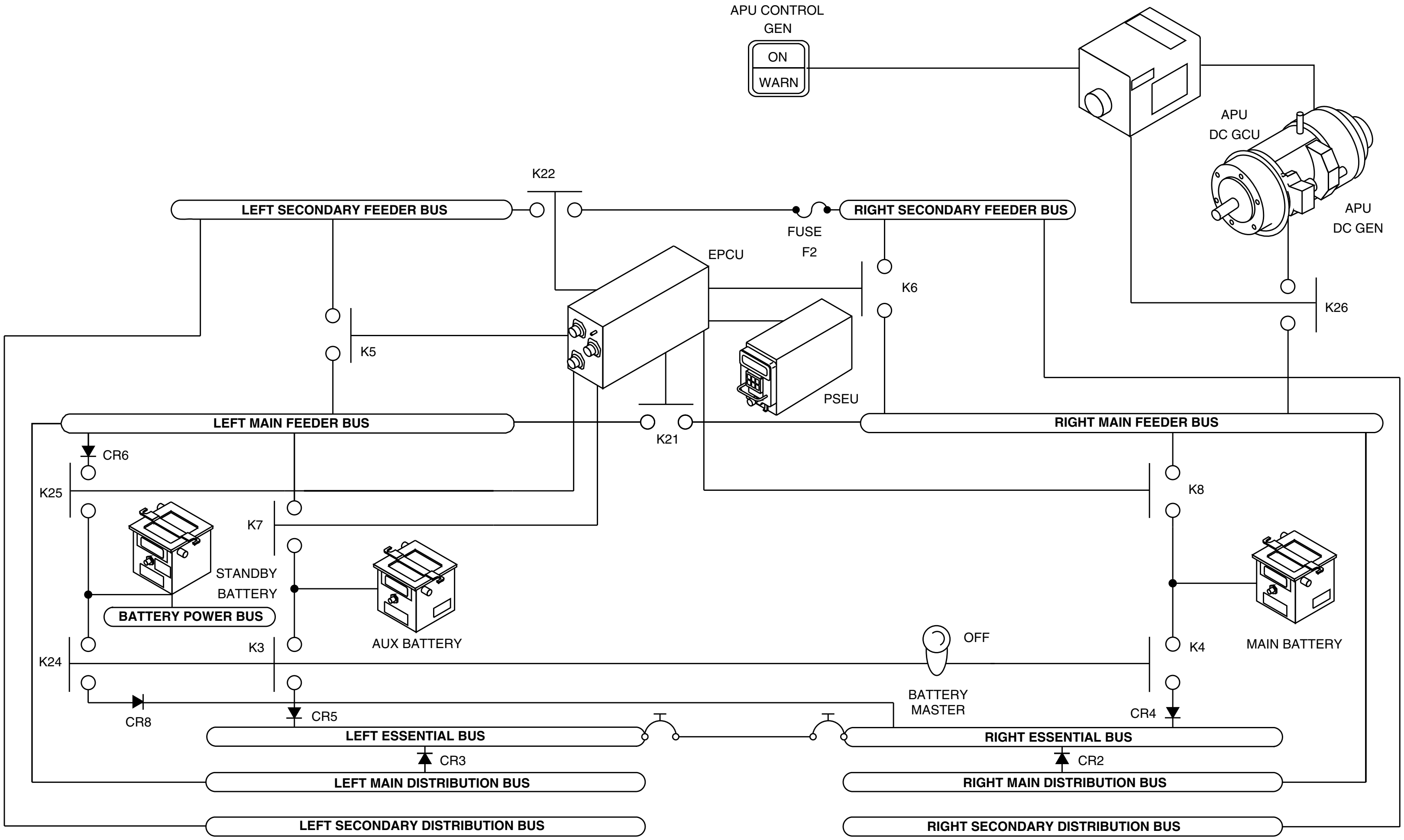
EIS, MAIN 28 VDC GENERATION SYSTEM INDICATIONS
Figure 2



Battery System Block Diagram
Figure 3



APU System Block Diagram
Figure 4

**ON A/C ALL

24–31–00–001

MAIN 28 VDC GENERATION SYSTEM

Introduction

The main 28 Vdc generation system makes and supplies 28 Vdc electrical power to the aircraft DC busses.

General Description

Refer to Figures 1 and 2.

The main 28 Vdc generation system has two dc starter/generators, one on each engine, and two Transformer Rectifier Units (TRUs) to supply electrical power independently to the left and right DC bus systems.

When a DC starter/generator or TRU malfunctions, the main 28 Vdc generation system automatically connects its bus to another serviceable electrical source for continuous operation.

A DC external power receptacle and control circuitry allows the system to be powered from an external power source while the aircraft is on the ground.

Toggle switches on the DC control panel in the flight compartment give manual control of the main 28 Vdc generation system. The Engine and System Integrated Display (ESID) system shows main 28 Vdc generation system electrical indications.

The Main 28 Vdc Generation System has the components that follow:

- Starter/Generators, DC (24–31–01)
- Units, DC Generator Control (24–31–06)
- Units, Electrical Power Control (24–31–11)
- Panel, DC Control (24–31–16)
- Units, DC Transformer Rectifier (24–31–21)
- Boxes, DC Contactor (24–31–26)
- Contactors, DC Contactor Box (24–31–31)
- Box, Standby Contactor (24–31–36)
- Transformers, DC Current (24–31–46)
- Shunts, Current (24–31–51)

Detailed Description

The direct current (DC) system operates in the modes that follow:

- Normal
- Protection
- Fault Tolerant
- Emergency
- Diagnostics and Monitoring.

Refer to Figure 3.

Normal Function: The DC electrical power from DC starter/generators and Transformer Rectifier Units (TRUs) is supplied to the DC busses through a DC contactor box located in the nose compartment of the aircraft. The contactor box contains the switching, protection, and measurement components.

When the aircraft engines are operating with no external DC power connected, and the DC generator toggle switches on the DC control are set to GEN 1 or GEN 2 positions, the DC generators are connected to their related main feeder busses for normal operation. The related DC GCU automatically disconnects its DC starter/generator when it senses a DC starter/generator malfunction.

Each DC starter/generator is turned by the engine auxiliary gearbox. The DC starter/generator is controlled by its related DC Generator Control Unit (GCU).

Each DC GCU automatically controls the operation of its DC starter/generator by monitoring output voltage, current, and speed. After an engine start, the DC GCU controls its generator output and controls the operation of its bus contactor K1 or K2. When the Electrical Power Control Unit (EPCU) senses a DC starter/generator malfunction, it will cause the main feeder bus tie contactor, K21 to move to a cross–tie position to connect its main feeder bus to the other DC starter/generator. When the main feeder bus tie toggle switch on the DC control panel is set to the MAIN BUS TIE position, the main feeder busses are manually connected together through main feeder bus tie contactor, K21.

The two DC generators supply 28 Vdc electrical power through the bus contactors, K1 and K2 to their related left or right main feeder bus. When the DC GCU senses a DC starter/generator malfunction, it will cause the bus contactor, K1 or K2 to open the circuit of the DC starter/generator source.

DC current transformers at the negative (–) and positive (+) connections of the DC starter/generator supply current data to the DC GCUs to control the DC starter/generator's output. Current shunts at the – connection of the DC starter/generators supply current data to the EPCU for indication.

The TRU electrical power is supplied to the DC secondary distribution busses in the flight compartment through the secondary feeder busses located in the DC contactor box.

When the EPCU senses a TRU malfunction, it will cause the secondary feeder bus tie contactor, K22 to move to a cross–tie position to connect its secondary feeder bus to the other TRU.

Current shunts at the "–" connection of the TRUs supply current data to the EPCU for indication.

Refer to Figure 4.

The input from an external DC power source is selected from the flight compartment. When the DC external power toggle switch located on the DC control panel is set to EXT PWR, the DC external power source is connected to the main, essential, and secondary DC busses. The DC external power condition is sensed by the EPCU and it operates as follows:

– The external power contactor K9 connects the dc external power source to the left main bus
– The main bus tie contactor K21 connects the left main feeder bus to the right main feeder bus
– The secondary/main feeder bus contactors, K5 and K6 connect the secondary feeder busses to the main feeder busses.
– An inhibit signal is sent from the EPCU to the DC GCUs to open the bus contactors K1, K2 and to de–energize the DC starter/generator while external power is selected.

The DC electrical power is supplied to the DC distribution busses through a DC contactor box in the nose compartment of the aircraft. The DC starter/generator electrical power is supplied to the main distribution busses in the flight compartment through the main feeder busses and the generator bus contactors, K1 and K2 located in the DC contactor box. The main distribution busses supply their related essential distribution busses through isolation diodes, CR3 and CR2. The isolation diodes make sure that the left and right main distribution busses energize their related essential distribution busses and that the essential distribution busses cannot energize the main feeder busses. When electrical power is not available from the main feeder busses, the essential busses are energized by the standby, auxiliary, and main batteries through battery bus contactors K24, K3, and K4, and isolation diodes, CR8, CR5 and CR4.

NOTE

The left and right essential distribution busses are connected together through circuit breakers on each essential distribution bus.

When the DC GCU senses a DC starter/generator malfunction, it will cause the bus contactor, K1 or K2 to open circuit the DC starter/generator. A fault signal is sent to the EPCU to cause the main bus tie contactor, K21 to connect the bus to the other DC starter/generator.

The TRU electrical power is supplied to the secondary distribution busses in the flight compartment through the main feeder busses in the DC contactor box.

When the EPCU senses a TRU malfunction, it will cause its bus to connect to the other TRU through the secondary bus tie contactor, K22.

The DC GCUs sense their related DC starter/generators speed and voltage while the DC generator toggle switch is set to the DC GEN position. The DC GCU controls its DC starter/generator voltage when the DC starter/generator speed and voltage are stable. The DC GCU controls the contactors to supply DC starter/generator power to the aircraft busses. The DC GCU also monitors the DC starter/generator current and controls its bus contactor.

The EPCU automatically controls the main 28 Vdc generating system. Toggle switches in the flight compartment are used to control the main 28 Vdc generating system when the EPCU malfunctions.

Protection Function: The protective functions in the main 28 Vdc generation system prevent damage to the DC starter/generators, TRUs, or other related equipment malfunctions, or there is an overload condition.

The main 28 Vdc generation system continuously monitors itself. When a fault is sensed, it isolates the effect of the fault from the remaining system to allow continued operation.

The main 28 Vdc generation system protective functions are classified as passive protection and active protection.

The main 28 Vdc generation system uses circuit breakers and fuses for passive protection so that a malfunction condition will not cause damage to the DC starter/generator and TRUs. The circuit breakers and fuses are protection devices that open circuit during excessive current flow. Unlike fuses, circuit breakers can be reset without having to be replaced.

Circuit breakers in the DC contactor box are thermally compensated for an operating temperature range of −55° C to +71° C. Each circuit breaker current rating is dependent on the circuit that it protects.

Fuses are used in the DC Contactor Box (DCCB) to protect the environment cooling system fan power, and the secondary bus cross−tie and contactor K22.

The main 28 Vdc generation system uses its DC GCUs and EPCU to control the contactors for active protection so that a fault condition will not cause damage to the DC starter/generators and TRUs. It uses the protective functions that follow:

- Over voltage
- Over current
- Differential feeder protection
- Build−up ground fault
- Reverse current
- External power monitor
- TRU under voltage detection.

Over Voltage: When the voltage from a DC starter/generator is more than 32.5 ±0.5 VDC, its DC GCU de−energizes the DC starter/generator and opens its related bus−tie contactor, K1 or K2. The EPCU connects its bus to the other DC starter/generator. This protection has an inverse time delay to make sure that the disconnect time is inversely proportional to the magnitude of the over voltage level.

Over Current: When the current from the DC starter/generator is more than 700 A for more than 5 seconds, the EPCU sends a trip signal to the related DC GCU to de−energize its DC starter/generator and open its related bus−tie contactor, K1 or K2. If the EPCU does not supply a trip signal to the DC GCU, the DC GCU de−energizes its DC starter/generator and opens its related bus−tie contactor, K1 or K2 after 7 seconds. The DC starter/generator will supply current for a maximum of 7 seconds to let the fault clear itself before disconnecting the DC starter/generator. The EPCU does not connect its bus to the other generator.

NOTE

A current limit signal is supplied to the DC GCU to limit its DC starter/generator’s output current at 400 A during an opposite engine start condition.

Differential Feeder Protection: The current flow at “–” and “+” connections of the DC starter/generator is compared by the DC GCU differential current sensing circuits. When the differential feeder current is more than 75 A, the DC GCU de−energizes its related DC starter/generator and opens its related bus−tie contactor, K1 or K2. The EPCU connects its bus to the other DC starter/generator. Time delay circuits in the DC GCU prevent usual transients caused by on and off switching of different loads to cause contactor operation.

DC current transformers at the “–” and “+” connections of the DC starter/generators supply DC current data to the DC GCUs to control the DC starter/generator’s output.

Reverse Current: The DC GCU monitors for a reverse current condition. When a reverse current condition exceeds 10% of the rated load, the DC GCU de−energizes its related DC starter/generator and opens its related bus−tie contactor, K1 or K2. The EPCU connects its bus to the other DC starter/generator.

External Power Monitor: The EPCU makes sure that good DC external power is allowed to energize the DC busses.

The EPCU checks the external power source for the parameters that follow:

Table 1: Table 1.

PARAMETER	TRIP POINT
Over Voltage	31 Vdc
Under Voltage	22 Vdc
Polarity	Reversed

When the DC external power source is more than the permitted limits, the EPCU de–energizes the DC external power contactor K9. The DC external power contactor K9 opens the circuit between the left main feeder bus and the DC external power source.

TRU Under Voltage Detection: If the TRU output voltage is less than 15 Vdc for more than 7 seconds, the TRU is considered defective. The EPCU will cause the secondary bus cross–tie contactor, K22 to connect the two secondary feeder busses together.

Fault Tolerant: The EPCU monitors the main 28 Vdc generation system symptoms for active malfunctions. If a malfunction is sensed, the EPCU will send the required signals to reconfigure the DC bus system. To protect the AC generators, the alternating current variable frequency system monitors itself for the faults that follow:

- Source
- Bus.

When source or bus faults occur, the contactors open, and stay open until the EPCU is reset to prevent a reconnection to a fault condition. The BUS FAULT toggle switch on the DC control panel is set to the RESET position and then back to OFF position.

Refer to Figure 5.

Source Fault: Each DC starter/generator usually supplies its own main feeder bus. When a DC starter/generator or DC GCU malfunctions, its related bus contactor, K1 or K2 will open to disconnect the DC starter/generator. Its related main feeder bus is energized by the other DC starter/generator. The EPCU will cause the main feeder bus tie contactor, K21 to connect the busses. In this reconfigured condition, all aircraft loads stay energized.

Refer to Figure 6.

Each TRU supplies its own secondary feeder bus. When a TRU malfunctions, its related secondary feeder bus is energized by the other TRU. The EPCU will cause the secondary feeder bus tie contactor, K22 to connect the busses. In this reconfigured condition, all aircraft loads stay energized.

Refer to Figure 7.

When the two DC starter/generator or DC GCU malfunction, their related bus contactors, K1 and K2 will open to disconnect the DC starter/generators. Their related main feeder bus will be energized by the related TRUs. The EPCU will cause the secondary/main feeder bus tie contactors, K5 and K6 to connect the busses. In this reconfigured condition, all aircraft loads stay energized.

Refer to Figure 8.

When the two TRUs malfunction, their related secondary feeder bus will be energized by the related DC starter/generators. The EPCU will cause the secondary/main feeder bus tie contactors, K5 and K6 to connect the busses. In this reconfigured condition, all aircraft loads stay energized.

Refer to Figure 9.

When one DC starter/generator or DC GCU and one TRU malfunction, the related bus contactors, K1 or K2 will open to disconnect the DC starter/generator. Its related main feeder bus will be energized by the other DC starter/generator. The EPCU will cause the main feeder bus tie contactor, K21 to connect the busses. When a TRU malfunctions, its related secondary feeder bus will be energized by the other TRU. The EPCU will cause the secondary feeder bus tie contactor, K22 to connect the busses. In this reconfigured condition, all aircraft loads stay energized.

Refer to Figure 10.

When one DC starter/generator or DC GCU and two TRUs malfunction, the related bus contactors, K1 or K2 will open to disconnect the DC starter/generator. Its related main feeder bus will be energized by the other DC starter/generator. The EPCU will cause the main feeder bus tie contactor, K21 to connect the busses. In this reconfigured condition, the secondary feeder busses are not energized. The main and essential aircraft loads stay energized.

Refer to Figure 11.

When two DC starter/generators or DC GCUs and two TRUs malfunction, the related bus contactors, K1 or K2 will open to disconnect the DC starter/generator. The EPCU will cause the contactors, K7, K8, and K25 to disconnect the busses. In this reconfigured condition, the secondary feeder busses and main feeder busses are not energized. The essential aircraft loads stay energized.

Bus Fault: The EPCU and the DC GCUs sense bus faults and reconfigure the main 28 Vdc generation system to make sure that the main feeder busses and secondary feeder busses are protected.

Refer to Figure 12.

The DC GCU uses the interpole voltage to sense an overcurrent condition of the DC starter/generator. The interpole series winding voltage in a DC starter/generator changes in relation to the load current of the generator. When the DC GCU senses an interpole voltage level that is more than twice the usual level, an overcurrent signal is sent to the EPCU.

Refer to Figure 13.

With two DC starter/generators and two TRUs available, the EPCU locks out the main feeder bus tie contactor, K21 one second after an over current condition is sensed. The secondary/main feeder bus tie contactors, K5 and K6 are locked out 100 ms later. If the over current condition continues for more than 5 seconds, the EPCU sends a trip signal to the DC GCU. The related bus contactor, K1 or K2 will open to disconnect the DC starter/generator. The EPCU also causes contactors, K25 and K7 or K8 to open to disconnect the standby and auxiliary batteries or the main battery from the main feeder bus.

Refer to Figure 14.

When a DC starter/generator or DC GCU malfunctions, its related bus contactor, K1 or K2 will open and the main feeder bus tie contactor, K21 will close.

Refer to Figure 15.

With one DC starter/generator energizing the left and right main feeder busses and an over current condition is sensed for more than one second, the EPCU causes the main feeder bus tie contactor, K21 to open. If the over current condition continues, within seven seconds, the EPCU sends a trip signal to the DC GCU. The related bus contactor, K1 or K2 will open to disconnect the online DC starter/generator from the faulty bus. The EPCU also causes the shorted bus side battery contactors K8, or K25 and K7 to open, to disconnect the main battery or the standby and auxiliary batteries from the main feeder bus. The contactor K22 will close to tie the secondary busses and the contactor K5 or K6 closes to energize the remaining main bus.

NOTE

The contactor K22 will get closed to prevent overloading of one TRU. It is necessary for both the TRUs to be serviceable for this scenario to work.

Refer to Figure 16.

If the over current condition stops after the main feeder busses are isolated, the bus fault is on the other main feeder bus. After 200 milliseconds the EPCU causes contactors, K25 and K7 or K8 to open to disconnect the standby and auxiliary batteries or the main battery from the main feeder bus.

Refer to Figure 17.

An over current condition on a secondary feeder bus causes its related TRU circuit breaker to open. The EPCU then senses a TRU source fault and causes the secondary feeder bus tie contactor, K22 to close after 7 seconds. The high current condition causes the cross tie fuse that protects the other TRU from the effect of the bus fault to open.

Refer to Figure 18.

When the two DC starter/generator or DC GCU malfunction, their related bus contactors, K1 and K2 will open and the secondary/main feeder bus tie contactors, K5 and K6 will close.

Refer to Figure 19.

An over current condition on a main feeder bus causes the TRU circuit breaker to open. The EPCU then senses a TRU source fault and causes the secondary feeder bus tie contactor, K22 to close after 7 seconds. The high current condition causes the cross tie fuse that protects the other TRU from the effect of the bus fault to open. After 100 milliseconds the EPCU causes the secondary/main feeder bus tie contactors, K5 and K6 to open.

NOTE

With one TRU operating, the main 28 Vdc generation system operates in the emergency mode. Contactors, K25, K7, and K8 open to disconnect the standby and auxiliary batteries or the main battery from the main feeder bus. The standby, auxiliary, and main batteries will supply the essential distribution busses only.

Refer to Figure 20.

When two TRUs malfunction, the secondary/main feeder bus tie contactors, K5 and K6 will close.

Refer to Figure 21.

An over current condition on a secondary feeder bus causes the TRU circuit breaker to open. After 1 second the EPCU causes the secondary/main feeder bus tie contactors, K5 and K6 to open to isolate the bus fault.

Refer to Figure 22.

The main 28 Vdc generation system reconfiguration logic for source malfunctions is summarized.

Emergency Mode: The main 28 Vdc generation system operates in the emergency mode when the two main feeder busses are disconnected from all DC power sources caused by source or bus fault conditions. Contactors, K25, K7, and K8 open to disconnect the standby and auxiliary batteries or the main battery from the main feeder bus. The standby, auxiliary, and main batteries will supply the essential distribution busses only.

The emergency mode is caused by the conditions that follow:

- Electrical power is not available from the two DC starter/generators
- Electrical power is not available from one or two TRUs, and
- The aircraft is in flight.

When a source or bus fault occurs, the main 28 Vdc generation system reconfigures, and stays reconfigured until the EPCU is reset by a main bus tie toggle switch selection. This feature is known as anti–cycling.

The contactors that the EPCU controls is summarized in the table that follows:

Table 2: Table 2.

CONTACTOR	OPERATION
K21	K21 is activated closed when the DC bus tie toggle switch input to the EPCU is energized. This function is locked out by the EPCU when a bus fault is sensed. A reset is done by supplying a reset signal to the SPCU. K21 is also controlled automatically by the EPCU to tie the main feeder buses if:
1	No overcurrent is sensed by the DC GCUs, and
2	Bus tie toggle switch is set, or
3	One DC starter/generator is defective, or
4	DC external power is supplied, or
5	APU power is supplied

CONTACTOR	OPERATION
K9	External power is connected to the aircraft busses through contactor K9 if:
1	Battery master toggle switch set to the on position, and
2	External power toggle switch set to the on position, and

CONTACTOR	OPERATION
3	DC and APU GCU not sense an overcurrent condition
K9	When DC external power toggle switch is set to the off position, the K10 control signal will switch after a short delay to avoid power interruptions from DC external power to aircraft sources.
K8	The K8 contactor connects the main battery to the right main feeder bus. The contactor is closed by switching 28 Vdc through the battery master and main battery toggle switches. The contactor is prevented from closing if the EPCU senses an over current condition sent by the opposite DC GCU for 1 second or from the related DC GCU for 5 seconds. The contactor is prevented from closing when an emergency condition is sensed. **NOTE** The EPCU has an electromechanical relay with normally closed contacts to bypass the EPCU and let the pilots operate K8 when the EPCU is de–energized.
K25	The K25 contactor connects the standby battery to the left main feeder bus. The contactor is closed by switching 28 Vdc through the battery master and standby battery toggle switches. The contactor is prevented from closing if the EPCU senses an over current condition sent by the opposite DC GCU for 1 second or from the APU GCU for 5 seconds. The contactor is prevented from closing when an emergency condition is sensed.

CONTACTOR	OPERATION
K7	The K7 contactor connects the auxiliary battery to the left main feeder bus. The contactor is closed by switching 28 Vdc through the battery master and auxiliary battery toggle switches. The contactor is prevented from closing if the EPCU senses an over current condition sent by the opposite DC GCU for 1 second or from the related DC GCU for 5 seconds.
K7	The contactor is prevented from closing when an emergency condition is sensed. **NOTE** The EPCU has an electromechanical relay with normally closed contacts to bypass the EPCU and let the pilots operate K7 when the EPCU is de–energized.
K5, K6	Contactors K5 and K6 connect the main feeder busses to the secondary feeder busses. The contactors close if:
1	Two dc starter/generators malfunction, DC external power is not available, two TRU’s are available, there is no overcurrent condition sensed, and a start selection is not made or
2	Two TRUs malfunction, two DC starter/generators are available, there is no overcurrent condition sensed, and a start selection is not made, or
3	DC external power is available and the two TRUs are defective, or

CONTACTOR	OPERATION
4	APU starter/generator power is available, there is no overcurrent condition sensed, and a start selection is not made.
5	When an over current condition is sensed, K5 and K6 are opened and locked out with K21.

Diagnostics and Monitoring: The electrical power system uses an on condition monitoring and diagnostic system. The system operational status is monitored by flight compartment indications, DC GCU, EPCU functions. The DC Generator Control Units (GCUs) and EPCU give continuous monitoring of subsystem operation. The integrity of the protective functions in the DC GCU is checked by an Initiated Built In Test (IBIT) function in the EPCU so that other components are not affected by a defective test circuit.

Refer to Figure 23.

The Electrical Power Control Unit (EPCU) records main 28 Vdc generation system fault conditions. It has an interface panel on its front face to look at the fault codes that represent fault conditions sensed by the Continuous Built in Test (CBIT). It uses FAULT REVIEW and CLEAR push–button switches and a digital display to show the fault codes.

The CBIT operates only when the aircraft is on the ground. A blank indication shows that no fault conditions sensed by the CBIT. When the indication is out of view, the FAULT REVIEW push–button switch is pushed to do a display test. It will show “88” for correct operation.

Three seconds after the display test indication or after the FAULT REVIEW push–button switch is pushed again and there are fault codes recorded, the EPCU will show the first fault code recorded.

The EPCU display shows codes 01 through 37 for faults that are sensed by the CBIT. The FAULT REVIEW push–button switch on the face of the EPCU is pushed again to access more recorded fault codes. A “99” indications shows that there are no more fault codes. If the FAULT REVIEW push–button switch is pushed again, the EPCU will show the first fault code that was recorded.

NOTE

A fault error code is recorded once.

The EPCU fault codes are shown in the table that follows:

Table 3: Table 3.

FUNCTION	CODE
#1 DC generator wiring	01
#2 DC generator wiring	02
APU generator wiring	03
#1 DC GCU	04
#1 DC generator	05
#2 DC GCU	06
#2 DC generator	07
APU GCU	08
APU generator	09

FUNCTION	CODE
K1 contactor open	10
K2 contactor open	11
K3 contactor	12
K4 contactor	13
K5 contactor open	14
K5 contactor closed	15
K6 contactor open	16
K6 contactor closed	17
K9 contactor	18
K21 contactor	19
K22 contactor	20
K24 contactor	21
K26 contactor open	22
K3 (AC) contactor closed	23
K4 (AC) contactor closed	24

FUNCTION	CODE
#1 AC generator wiring	25
#2 AC generator wiring	26
#1 AC GCU	27
#2 AC GCU	28
EPCU K25 drive	29
EPCU K5 drive	30
EPCU K6 drive	31
EPCU K7 drive	32
EPCU K8 drive	33
EPCU K9 drive	34
EPCU 21 drive	35
EPCU K22 drive	36
DC external power over voltage	37

After the “99” indication is viewed, the CLEAR push–button switch is pushed to clear the stored faults. The indication shows “88” then “AA” and then the indication goes out of view.

Refer to Figure 24.

When the aircraft engines are operating with no external AC and DC power connected, and the DC starter/generator toggle switches located on the DC control panel are set to GEN 1 and GEN 2, the DC starter/generators are connected to their related DC main feeder busses for operation.

The DC starter/generator toggle switches are set to the OFF position to de−energize the DC generators and reset latched functions in the DC GCU. The bus fault toggle switch is set to BUS FAULT RESET position to reset latched functions in the EPCU.

The Electrical Power Control Unit (EPCU) supplies indication data through the two Input/Output Processors (IOP1, IOP2) located in the Integrated Flight Cabinets (IFCs) to the Electronic Instruments System (EIS).

Refer to Figure 25.

The MFD1 and MFD2 reversion switches located on the ESID Control Panel (ESCP) are used to set the electrical page on the multi−functional displays.

Refer to Figure 26.

The electrical page shows the DC starter/generator indications that follow:

- Digital indication of the DC essential, main, and secondary bus voltages
- Digital indication of DC starter/generator loads
- Digital indication of TRU loads.

The DC voltage indication has a DC BUS L and DC BUS R title in white fonts to show the voltage of the essential, main, and secondary busses. The DC load indication has a DC GEN1 and DC GEN2 title in white fonts to show the load of the DC starter/generators and it has a TRU1 and TRU2 title in white fonts to show the load of the TRUs.

DC Voltage Indication: The DC voltage indication shows the DC essential, main, and secondary bus voltage in white numbers.

DC Starter/Generator and TRU Load Indication: The DC starter/generator load indication shows the DC starter/generator output load. The numbers show the DC starter/generator output load as a percentage of the total rated output. A 1.00 indication is used to show 100% .

A “+” symbol before the numbers is used to show an overload condition of the DC starter/generator or TRU. It is out of view when the load is in less than 100%.

Refer to Figure 27.

When the voltage or load data malfunctions, the digits are replaced by white dashes.

Refer to Figure 28.

The main 28 Vdc generation system malfunctions are shown with the caution lights that follow:

- #1 DC GEN
- #2 DC GEN
- L TRU
- R TRU
- DC BUS
- #1 DC GEN HOT

– #2 DC GEN HOT
– L TRU HOT
– R TRU HOT.

#1 DC GEN, #2 DC GEN Caution Light: The #1 DC GEN or #2 DC GEN caution light comes on to show that the generator is not connected to its bus because of a source fault condition, the DC starter/generator toggle switches are set to the OFF position, or external DC power is energizing the left and right main feeder busses.

L TRU, R TRU Caution Light: The L TRU or R TRU caution light comes on to show that the a secondary feeder bus is not energized by its related TRU because of a source fault condition or the AC generator toggle switches are set to the OFF position.

DC BUS Caution Light: The DC BUS caution light comes on to show that the EPCU has reconfigured the main 28 Vdc generation system because of a source or bus fault condition. If the bus fault is reset, the indication will go out.

#1 DC GEN HOT, #2 DC GEN HOT Caution Light: The #1 DC GEN HOT or #2 DC GEN HOT caution light comes on to show that the generator temperature is more than 330° F. It goes out when the temperature is less than 300 °F (149 °C).

L TRU HOT, R TRU HOT Caution Light: The L TRU HOT or L TRU HOT caution light comes on to show that the generator temperature is more than 160 °F (71.1 °C) and goes out when the temperature is less than 155 °F (68 °C).

The left main and right main busses supply electrical power through 5 A circuit breakers to the related AC Generator Control Units (GCUs). The circuit breakers are located in position D7 on the left circuit breaker panel and P7 on the right circuit breaker panel.

The left essential bus supplies electrical power through a 5 A circuit breaker to connector J1 of the EPCU. The circuit breaker is located in position G10 on the left circuit breaker panel.

The right essential bus also supplies electrical power through a 5 A circuit breaker to connector J2 of the EPCU. The circuit breaker is located in position H10 on the right circuit breaker panel.

The Proximity Sensor Electronics Unit (PSEU) supplies a Weight On Wheels (WOW) signal to the EPCU.

DC Starter/Generator

Refer to Figure 29.

The DC starter/generator is an electromagnetic machine. When it rotates, it will change engine input mechanical torque to output DC electrical power. In the starter mode, it changes input electrical DC electrical power into a mechanical output torque. The DC starter/generator operation is controlled and monitored by the DC Generator Control Unit (GCU).

The DC starter/generator is a four–pole, shunt connected, fully compensated DC generator with inter–pole windings, brush commutation, and an internal cooling fan. It is attached to the aircraft accessory gearbox.

The DC starter/generator has a permanent magnet so that it can make output voltage without an external excitation source. The output from the DC starter/generator is sent to the DC GCU. The DC GCU supplies the DC starter/generator with its output voltage until the DC GCU starts regulation. When regulating, the DC GCU supplies a modulated current to the DC starter/generator to maintain a 28.5 Vdc output.

The DC starter/generator has stator and rotor assemblies contained in a cylindrical shaped housing. The housing is made of a high iron content material. It is part of the magnetic circuit for the starter assembly. The rotor assembly has a rotor winding that connects to the fixed input terminals on the machine housing through a brush/commutator assembly. The machine housing has 4 poles with a four brush block assembly to switch the input or output current to the correct rotor winding.

The rotor is held at each end by ball bearings that are mounted in the housing. The ball bearings are pre lubricated with grease when installed and service is not necessary until overhaul.

The DC starter/generator has a fan to supply a forced air flow axially through it to cool the rotor and starter windings, the commutator assembly, and the bearings. Air is drawn from outside the nacelle through NACA vents to keep the operating temperatures satisfactory. The brushes that are used in the DC starter/generator have optimum life when blast cooling is supplied by propeller thrust to lower their temperature.

The DC starter/generator electrical power circuit has a 4 pole shunt that operates at 12,000 rpm. The electrical circuit of the DC starter/generator has interpole windings to help the flux path between the stator and rotor to increase generator efficiency.

The DC GCU supplies a control current to the shunt field winding of the DC starter/generator to control its output voltage. The shunt field winding current is amplified by the rotational energy of the engine to make the rated output of 400 A at 30 Vdc.

The DC starter/generator supplies information to the DC GCU for system protection through tapping of the interpole winding voltage. This voltage is proportional to generator current and is continuously monitored by the DC GCU to sense unusual current levels.

The DC starter/generator terminal voltage is monitored by the EPCU for CBIT functions.

Inputs and outputs of the stator windings are given by connections on the body of the DC starter/generator. Low current connections are made with a circular connector and high power output connections are made to studs mounted on a terminal block. A bonding stud on the housing of the DC starter/generator is used to connect it to the airframe ground potential.

The DC starter/generator has a temperature switch that closes a set of contacts when the temperature of the DC starter/generator is excessive. It gives continuity through two pins on the DC starter/generator connector to make the DC GEN HOT indication come on in the caution and warning lighting panel.

The torque force is transmitted to the DC starter/generator through a splined shaft that connects to the engine auxiliary gearbox. The DC starter/generator’s drive shaft has a shear section that breaks to protect the accessory gear box drive train from damage when too much torque is supplied.

The DC starter/generator attaches to the accessory gearbox with a Quick−Attach/Detach (QAD) adapter that, once installed, stays attached to the gearbox when DC starter/generator is removed. The DC starter/generator connects to the QAD with a V−band clamp to secure the assembly. The QAD has an opening that connects to an airframe duct to exhaust cooling air outside of the engine nacelle.

DC Generator Control Units (GCU)

Refer to Figure 30.

The DC GCU controls the DC starter/generator start and regulation modes. The DC GCU senses the DC starter/generator speed and it stops the start mode when the speed of the engine is more than 50% NH. At the end of the start mode, the DC GCU opens the bus contactor and de–energizes the DC starter–generator.

When the DC GCU senses a voltage output from the DC starter/generator, a field control contactor in the DC GCU switches from the field build up circuits to a voltage regulator circuit. The voltage regulator is a closed loop control circuit. It adjusts the duty cycle of the exciter field voltage to maintain a constant voltage at the Point of Regulation (POR) under different load conditions.

The DC starter/generator speed and voltage will increase when the engine is operating. When the output voltage is ±1 Vdc of the bus voltage, the DC GCU will cause the bus contactor to connect the DC starter/generator to its main feeder bus.

When the two main feeder busses are connected together by a MAIN BUS TIE toggle switch selection, a signal is to each DC GCU to make the DC starter/generator load share.

The DC GCU regulates the DC starter/generator’s output and gives the protective functions that follow:

Table 4: Table 4.

PARAMETER	VALUE
Over voltage	32.5 ±0.5 VDC
Differential Feeder Fault Detection	75 A ±25A
Bus Fault Detection	700 A
Parallel Load Sharing	10% rated current

The DC Generator Control Unit (GCU) contains the voltage regulation and protection circuits for the DC starter/generator. Printed circuit cards, discrete power semiconductors, and electromechanical contactors are put in an aluminum box without the need for convection cooling through the box.

The DC GCU is cooled by conduction through the chassis mounting locations and by convection of air over the surface of the box. Power dissipating components in the DC GCU are attached to chassis heat sinks to transfer heat to it.

Electrical connections are made with a single connector that is attached to the end of the DC GCU enclosure.

Electrical Power Control Unit (EPCU)

Refer to Figure 31.

The EPCU manually or automatically controls the operation of some contactors in the main 28 Vdc generation system.

It manually controls contactors by flight compartment toggle switch selections. For example, a manual external DC power selection causes the EPCU to close the external power contactor.

Automatic functions are used to reduce pilot work load and to start protective functions that cannot tolerate the time delay associated with a pilot selection. For example, the EPCU automatically causes the external power contactor to open when an over voltage condition is sensed.

Digital logic control is used as the primary control of the main 28 Vdc generation system. Analogue to digital circuits in the EPCU changes the analogue inputs to digital format to control the system. The output signals are supplied through output drives that use current limiting for isolation.

The critical aircraft operating functions use circuits with normally closed contactors to let the flight compartment toggle switches control the main 28 Vdc generation system when the EPCU is de−energized.

The voltage and current parameters are supplied to the Electronic Instruments System (EIS) through the Integrated Flight Cabinets (IFC1, IFC2) for indication. The data supplied for indication is not used for the control functions.

The EPCU has a Continuous Built In Test (CBIT) function to record main 28 Vdc generation system malfunctions. The CBIT does not control EPCU functions. It has an interface panel on its front face to let maintenance personnel look at fault codes that represent fault conditions. The EPCU has a FAULT REVIEW and CLEAR push−button switches and a digital display to view fault codes. The legend placard on the front of the EPCU is used to decode the fault codes.

The CBIT circuit operates only when the aircraft is on the ground. A display test is done when the segments are out of view by pushing the FAULT REVIEW push−button switch. An “88” indication will show correct operation. If no faults are recorded, the segments go out of view. Three seconds after the display test indication or after the FAULT REVIEW push−button switch is pushed again and there are fault codes recorded, the digital display will show the first fault code recorded. The FAULT REVIEW push−button switch is pushed to show more fault codes. A “99” indication shows that there are no more fault codes.

The recorded fault codes are erased by a CLEAR push−button selection. an “AA” indication for 3 seconds shows that the fault codes have been cleared. If all fault conditions have been cleared and none sensed, the digital display indications will go out of view.

The CBIT Operator Interface Panel operation is summarized in the table that follows:

Table 5: Table 5.

CODE	FUNCTION	DESCRIPTION
01 02 03	DC starter/ generator wiring	The voltage difference measured by the EPCU between the DC starter/generator output and the POR while the engine is not starting. If the value is excessive, a fault code is shown for the #1, #2 or APU DC starter/generator wiring.
05 07 09	DC starter/ generators	The voltage is measured by the EPCU at the DC starter/generator output while the engine is not starting and no over current conditions are sensed by the DC GCUs.

CODE	FUNCTION	DESCRIPTION
CONT	DC starter/ generators	If the field current value is sensed in normal range and the difference between the generator output voltage and the POR is more than 10 Vdc, then the generator is considered defective. A fault code is shown for the #1, #2 or APU DC starter/generator.
04 06 08	DC GCU	The EPCU checks bus contactors (K1, K2 or K26). If it senses a closed position while the DC GCU power ready signal is not available or DC external power is available. A fault code is shown for the #1, #2 or APU DC GCU.
10 11 22	K1, K2, K26	The EPCU checks the generator contactors. The fault detection will monitor the K1, K2 and K26 contactors status signals (position). If the contactor position is open while the DC GCU indicates power ready and has previously sensed fault 04, or during and engine start, the EPCU will show a fault code for K1, K2 or K26.

CODE	FUNCTION	DESCRIPTION
12 13 21	K3, K4 or K24	The EPCU checks the battery contactors. The fault detection will monitor the K3 and K4 signals (position). If the contactor position is open while the master battery toggle switch is set to the ON position or closed while the master battery toggle switch is set to the OFF position, the EPCU will show a fault code for K4 or K24.
14 16 15 17	K5 or K6	The EPCU checks the bus contactors. The fault detection will monitor the K5 and K6 signals (position). If the contactor position is open while commanded closed, the EPCU will show a fault code 14 or 16 for K5 or K6. If the contactor position is closed while commanded open, the EPCU will show a fault code 15 or 17 for K5 or K6.
18	K9	The EPCU checks the DC external power contactor. The fault detection will monitor the K9 signals (position). If the contactor position is open while commanded closed, or closed while commanded open the EPCU will show a fault code for K9.
19	K21	The EPCU checks the main feeder bus cross tie contactor. The fault detection will monitor the K21 signals (position). If the contactor position is open while commanded closed, or closed while commanded open the EPCU will show a fault code for K21.

CODE	FUNCTION	DESCRIPTION
20	K22	The EPCU checks the secondary feeder bus cross tie contactor. The fault detection will monitor the K22 signals (position). If the contactor position is open while commanded closed, or closed while commanded open the EPCU will show a fault code for K22.
23 24	K3 or K4	If the contactor status signal does not match the AC external power toggle switch selection, the EPCU will show a fault code K3 or K4.
25 26	AC generator wiring	The voltage difference measured by the EPCU between the AC generator output and the POR while the engine is not starting. If the value is excessive, a fault code is shown for the #1 AC generator #2 AC generator wiring.
27 28	AC GCU	If there is no field voltage while the AC generator is turning, the AC GCU is considered defective by the EPCU. A fault code is shown for the #1 AC GCU or #2 AC GCU.
29 30 31 32 33 34 35 36	K25, K5, K6, K7, K8, K10, K21, K22 Drive	If the contactor status changes state 5 times in less than 1 second, the EPCU will show a fault code.
37	DC external power over voltage	If the aircraft is on the ground and the external DC power toggle switch is set to the ON position and the voltage supplied by the external dc power source is more that 31 Vdc, the DC external power is considered defective. The EPCU will show a fault code.

The EPCU fault detection circuitry is designed to help maintenance personnel isolate and troubleshoot a problem in the electrical system. It is recommended that the EPCU be used as follows:

- Review and record the existing fault code messages stored in the EPCU.
- Erase the EPCU fault code memory.
- Run the effected/failed system or channel to verify the failure.
- When the failure has been verified, shutdown the effected system or channel.
- Review and record the fault code(s) stored in the EPCU.

– Troubleshoot the fault code(s) as specified in the fault isolation manual (FIM).

NOTE

The EPCU does not erase fault codes automatically from memory after each flight. Not all the fault codes that are shown will be related to the current fault. If the memory is erased and the fault is verified again, the EPCU will then show only those fault codes related to the current fault. This will let maintenance personnel to more quickly isolate the source of the fault, if it is because of an LRU, wiring, or some other issue. After the fault cause is corrected, a procedure to erase the memory is done. The EPCU will now be prepared to store fault codes during the subsequent flights.

The EPCU has daughter printed circuit card assemblies and a mother board contained in an aluminum enclosure. The daughter printed circuit card assemblies connect to a mother board that connects to interface connectors. The daughter circuit card assemblies connect to the motherboard using thermal card guides for support and thermal dissipation.

The EPCU is cooled by conduction through the mounting feet of the unit to the airframe and by natural convection through cooling holes near high power dissipation devices. The high power devices are attached to heat sinks on the circuit card assemblies that contact the thermal card guides when it is installed.

The box enclosure has three connectors that connect to the remaining part of the system. One connector is used for the APU interface functions.

The EPCU has an interface panel with two push–button switches and a digital display on its front face to access fault codes.

A carrying handle is supplied for transporting the EPCU.

The EPCU has hard mounting points as an alternative to rack mounting.

DC Control Panel

Refer to Figure 32.

The DC control panel gives manual control of the main 28 Vdc generation system. It has toggle switches to control the systems that follow.

- Batteries
- DC starter/generators
- External DC power
- Main feeder bus tie
- Bus fault reset.

The DC starter/generator, standby, auxiliary, and main battery toggle switches are positive break, two pole, double throw, toggle switches. The battery master toggle switch is a four pole, double throw switch. The main bus tie and DC external power toggle switches are positive break, single pole, double throw toggle switches and the main bus tie toggle switch has a locking mechanism that locks the selection to the set position. The bus fault reset toggle switch is a four pole, double throw switch. The toggle lever is connected to a mechanism located in the body of the switch that moves in the opposite direction as the toggle lever. The wires from the receptacle connector are connected to the switch terminals with lugs except the bus fault reset toggle switch that has solder wire connections. The toggle switches are attached to the backing panel with mounting nuts and lock washers.

The DC control panel is attached to the overhead console using four DZUS fasteners. The fasteners and a bonding wire are directly connected to the chassis to make a ground continuity connection between the backing panel and the aircraft structure.

DC Transformer Rectifier Units (TRU)

Refer to Figure 33.

The Transformer Rectifier Unit (TRU) is a self contained, solid state power conversion device that changes 115 Vac variable frequency AC electrical power to 28 Vdc electrical power. The TRU receives three phase 115 Vac power through a circular connector on the front face of the enclosure. The output 28 Vdc power is available through positive and negative studs also located on the front face of the enclosure.

The TRU supplies an indication of its status for indication in the flight compartment through the EPCU.

The TRU stays energized during AC generator under frequency and under voltage condition. When the frequency and voltage are decreased because of AC generator under speed operation during propeller feathering, the TRU stays connected to the load for a maximum of 10 seconds. The AC generator output voltage is reduced proportionally with the frequency to prevent damage to the TRU.

No active control to connect or disconnect the TRU from the AC generator is necessary. A short circuit in the TRU or related aircraft wiring will open its 3 phase AC circuit breaker.

The TRU has a thermal sensor to automatically control the cooling fan. The cooling fan pulls in ambient air and releases it outside the aircraft through a flange on the TRU attached to an airframe duct.

If the TRU overheats, the thermal sensor supplies a signal to the aircraft to show the overheat condition.

The TRU enclosure has a rectangular shape, with the cooling air flow driven from the front face along the length of the enclosure to the rear face, where provision is included to attach ducting for routing of the hot exhaust air. The cooling air is pushed through the unit using a fan installed in the TRU at the front face. This fan is powered from within the TRU without the need for external activation and is thermostatically controlled so as to only be operational when the unit requires cooling. As part of this temperature control, the TRU includes an over temperature status indication output to indicate if the unit is operating hot. The enclosure provides for mounting by incorporating four hard mounting feet that bolt to the aircraft structure.

The TRU has a common wye connected primary transformer that connects to the secondary of the two wye and delta to minimize the DC ripple at the output. Each secondary winding has a diode bridge to change the AC voltage to DC voltage.

The power diodes are attached to heat sinks in an integrated assembly to minimize the operating temperature. The DC output from the rectifier assembly is filtered to ensure a good electrical output. An AC input is also filtered to decrease the total harmonic distortion of the TRU.

The TRU has the parameters that follow:

Table 6: Table 6.

PARAMETER	VALUE
Output Voltage	28.5 Vdc ±1.5 Vdc
Output current	300 A
Overload	400 A for two minutes 900 A for 5 seconds
Short Circuit	1500 A

DC Contactor Boxes

Refer to Figures 34 , 35 and 36.

The DC Contactor Box (DCCB) assembly is used to distribute and control the main 28 Vdc electrical power. The DCCB contains monitor and protection components in a protected environment. The box has covers to allow access to the internal line replaceable units (LRUs).

The electrical power connections between contactors in the DCCB is made with bus bars. They are attached by a mounting plate assembly that secures the bus bars in the DCCB. Standard cable is used to make the connections between the mounting plate assembly and the box connectors. The DCCB has circuit breakers to protect the feeder cables that are routed directly to the aircraft equipment or to the circuit breaker panels in the flight compartment. The DCCB cover must be removed to get access to the circuit breakers.

The DCCB is not a line replaceable unit (LRU). It does not require replacement unless it is damaged. The components in the DCCB is easily accessed when its covers are removed.

The components in the DCCB give control and distribution of the DC power source from the two DC starter/generators transformer rectifier units, main and auxiliary batteries, or DC external power source.

The DCCB contains the components that follow:

- DC starter/generator bus tie contactors, K1 and K2
- Main feeder bus tie contactor, K21
- Secondary feeder bus tie contactor, K22
- Secondary/main feeder bus tie contactors, K5 and K6
- DC external power contactor, K9
- Battery bus tie contactor, K7 and K8
- Diodes
- Current transformers
- DC circuit breakers
- Protective fuses.

DC Contactors: The DC contactors in the DC contactor box connect the DC electrical sources to the main and secondary feeder busses.

Each contactor has 400 A single pole, single throw contact arrangement with 2 sets of 5 A auxiliary contacts. Coil windings are used to move the contact arms. The contactor are attached to a connector using two mounting screws.

Diodes: Diodes are electronic devices that are used to isolate the direct current power sources.

Current Transformers: Two current transformers, designated CT1 and CT3, located in the DCCB, are used to sense the current flow in the main feeder busses. The main feeder current transformers supply current data to the EPCU differential current sense circuits.

Each current transformer assembly a toroidal (ring–type) current transformers. The cable from each phase of the system is passed through a toroid. A multi–pin connector is used to make electrical connections between the toroids and the other components. The toroidal current transformers are contained in an aluminum case and have mounting holes that are not symmetrical to prevent improper installation.

DC Circuit Breakers: The circuit breakers are installed in the DCCB to protect the feeder cables that are routed to the circuit breaker panel in the flight compartment.

Protective Fuses: Two fuses are installed in the DCCB to protect the feeder cables that go to the loads. A 100 A fuse protects the ECS recirculation fan and a 150 A fuse protects the TRUs and the secondary feeder bus tie contactor, K22.

The DCCB weighs 76 lb (34.47 kg) and it is 47.5 in. (1.2 m) long, 9.2 in. (233.7 mm) high and 16 in. (406.4 mm) wide. It is installed in the nose compartment and is secured to the airframe with six mounting bolts.

Standby Battery Contactor Box

Refer to Figures 37 , 38 , 39 and 40.

The Standby Battery Contactor Box (SBCB) assembly is used to supply electrical power to the powered rear elevator and battery busses in the flight compartment. The SBCB contains monitor and protection components in a protected environment. The box has a cover to allow access to the internal line replaceable units (LRUs).

The electrical power connections between contactors in the SBCB is made with bus bars. They are attached by a mounting plate assembly that secures the bus bars in the SBCB. Standard cable is used to make the connections between the mounting plate assembly and the box connectors. The SBCB uses three circular connectors to interface with the other aircraft system components in the main 28 Vdc generation system. The SBCB has circuit breakers to protect the feeder cables that are routed directly to the aircraft equipment or to the circuit breaker panels in the flight compartment. The SBCB cover must be removed to get access to the circuit breakers.

The SBCB is not a line replaceable unit (LRU). It does not require replacement unless it is damaged. The components in the SBCB is easily accessed when its covers are removed.

The components in the SBCB gives control and distribution of the DC power source from the standby battery.

The SBCB contains the components that follow:

- DCMP power contactor, K23
- Main Bus contactor, K25
- Essential Bus contactor, K24
- Diode, CR 8
- Circuit Breakers.

DC Contactors: The DC contactors in the standby contactor box connect the standby battery to the hydraulic DCMP and battery busses in the flight compartment.

Each contactor has 400 A single pole, single throw contact arrangement with 2 sets of 5 A auxiliary contacts. Coil windings are used to move the contact arms. The contactor are attached to a connector using two mounting screws.

Diodes: Diodes are electronic devices that are used to isolate the direct current power sources. A 100 A diode is located in the SBCB. It is connected between the standby battery and the right essential distribution bus. The diode allows power to reach the right essential bus but prevents the right essential bus from being the source of power.

DC Circuit Breakers: The circuit breakers are installed in the DCCB to protect the feeder cables that are routed to the hydraulic DCMP and circuit breaker panel in the flight compartment.

The SBCB weighs 14 lb (6.35 kg) and it is 12.1 in. (307.3 mm) long, 5.9 in. (150 mm) high and 12.03 in. (305.56 mm) wide. It is installed in the nose compartment or aft fuselage compartment and is secured to the airframe with four mounting bolts.

DC Current Transformers

Refer to Figure 41.

The DC current transformers are electromagnetic components used with the DC GCU to sense differential feeder fault protection. Two DC current transformers are used in the main 28 Vdc generation system with one unit located at the DC starter/generator output and the other is located close to the negative feeder cable grounding connection. The DC current transformers are used to monitor the DC starter/generator power feeder cables. They monitor the left DC starter/generator and right DC starter/generator, and the APU starter/generator current in the DCCB. The DC current transformers in the DCCB are used with an identical external DC current transformer attached to the airframe to sense differential protection. The sensed current is summed to cancel each other out when a feeder fault is not present by the DC GCUs.

When a DC GCU senses the voltage in one DC current transformer different than the voltage in its related DC current transformer, the DC GCU de–energizes the DC starter/generator and the line contactor.

The DC current transformer is a torroidal core wound unit. It has a number of windings that sense an induced voltage from a current that passes through the toroid body. The toroid assemblies are enclosed in an aluminum case that provides the protection and mount the assembly.

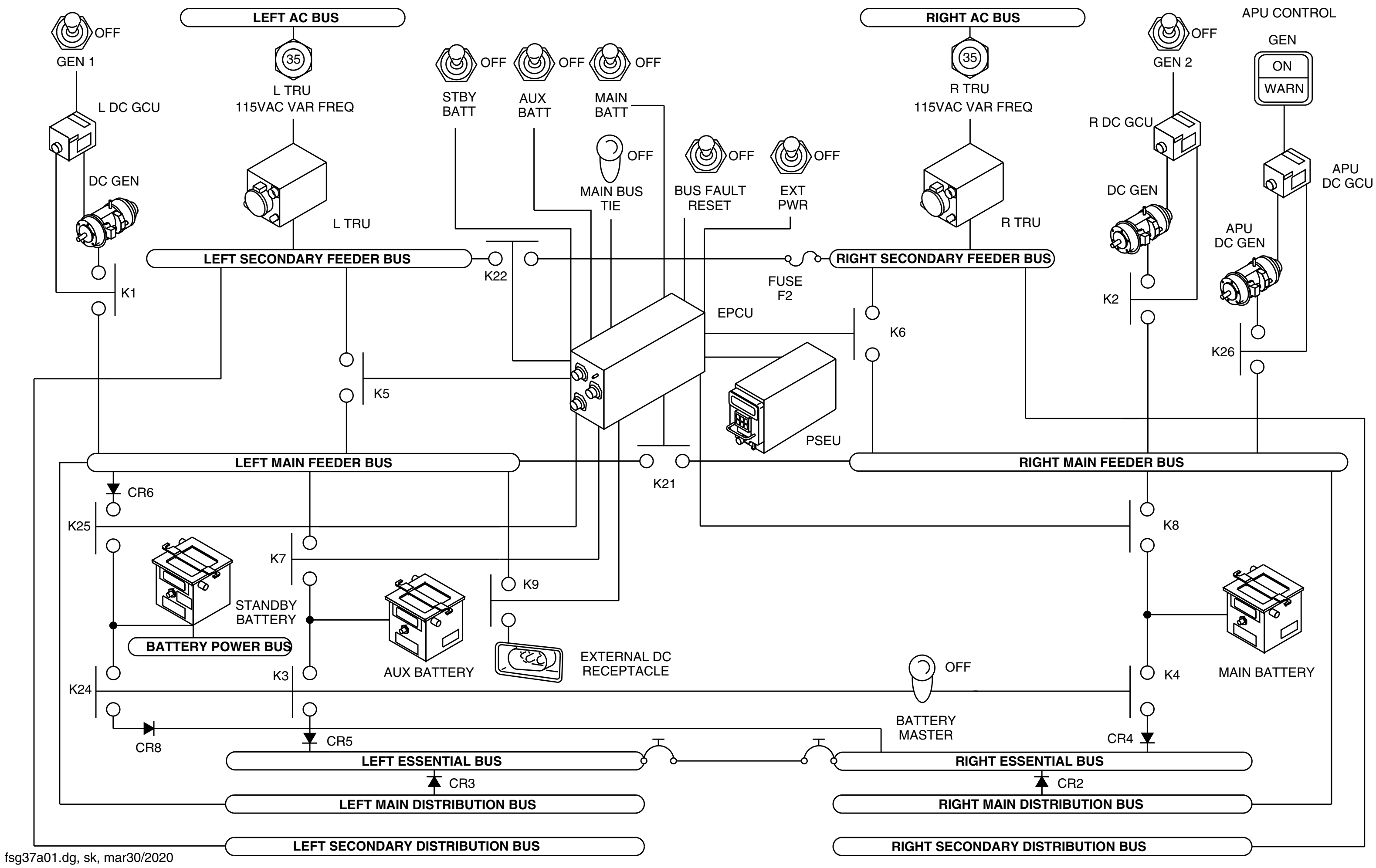
The case has 90–degree outward flanged feet with holes for mounting the unit to structure. These holes are not symmetrical to make sure that the orientation of the unit is correct when installed. The DC current transformer also has two terminal studs on the top of the unit to which the interfacing wires are bolted. The DC feeder cable passes through a hole in DC current transformer.

The DC current transformers are located in the centre fuselage section.

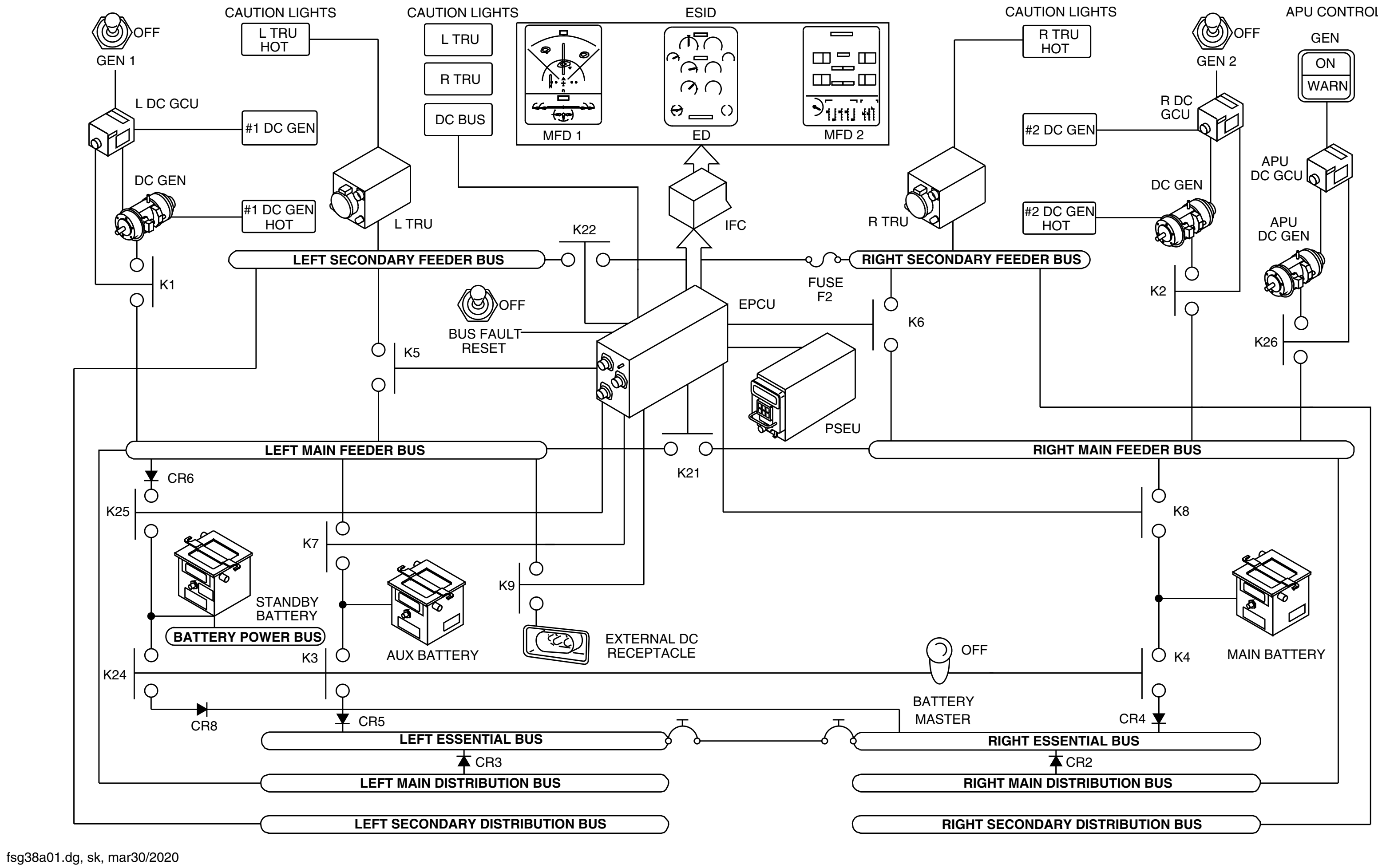
Current Shunts

Refer to Figures 42 , 43 and 44.

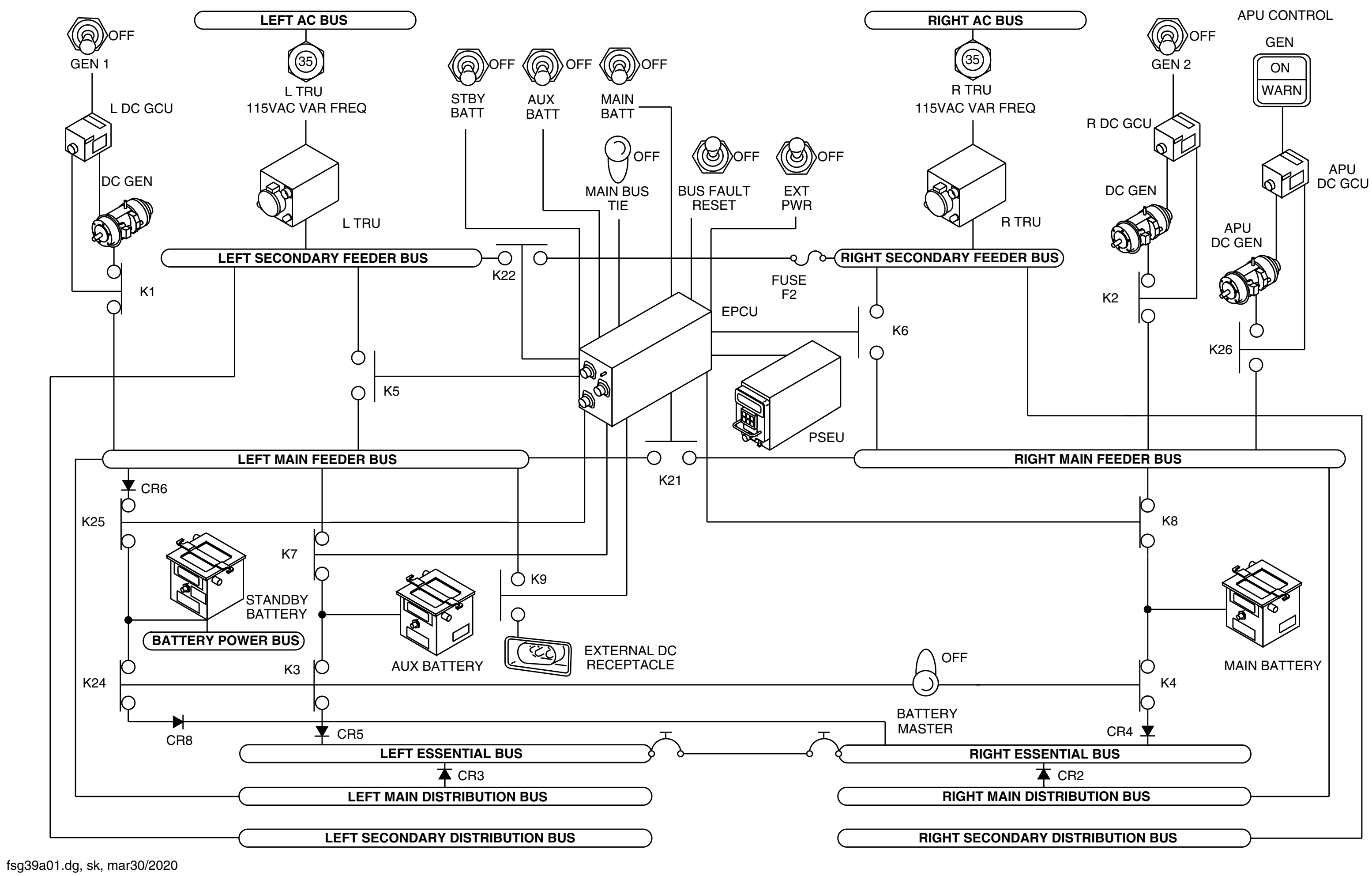
The current shunts supply output current data from the left and right TRUs, left and right DC starter/generators and batteries to the EPCU for indication. The negative terminal of each TRU, DC starter/generator, and battery and is connected through separate current shunts to airframe ground potential. The TRU and battery current shunts are located in the nose compartment shelf near the TRUs and batteries. The DC starter/generator current shunts are located in centre fuselage section.



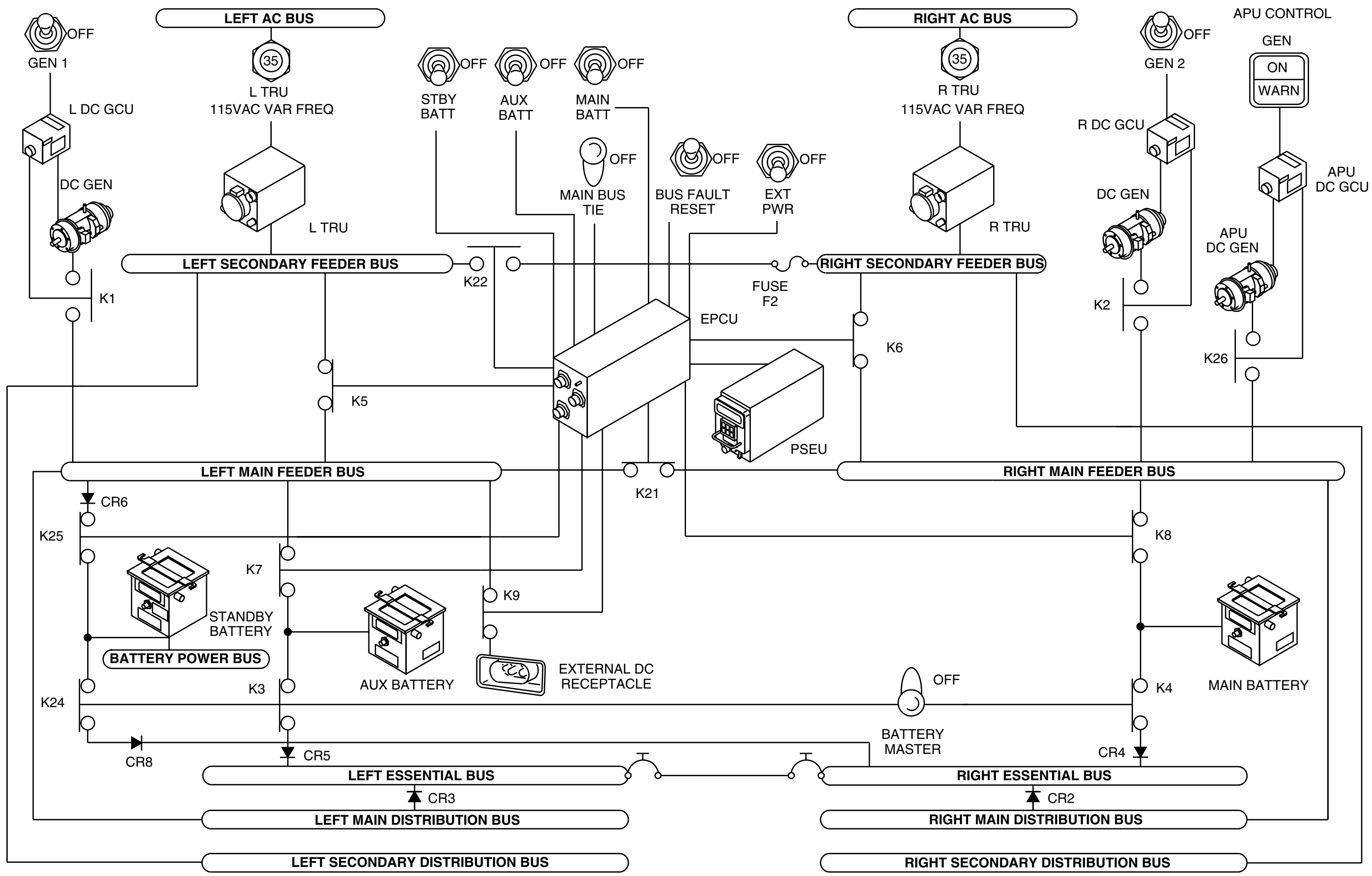
Main 28 VDC Generation System Block Diagram, Controls
Figure 1



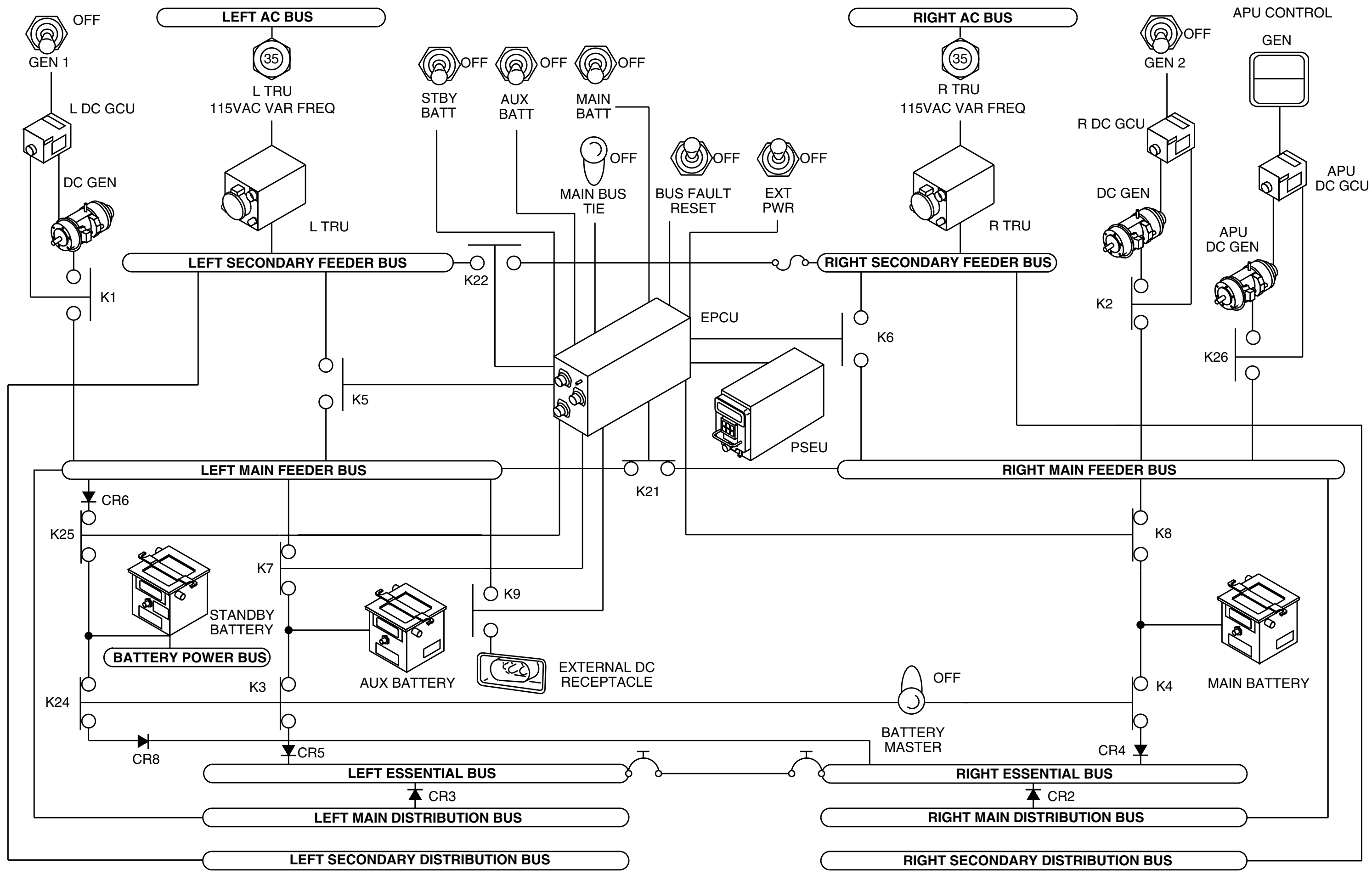
Main 28 VDC Generation System Block Diagram, Indication
Figure 2



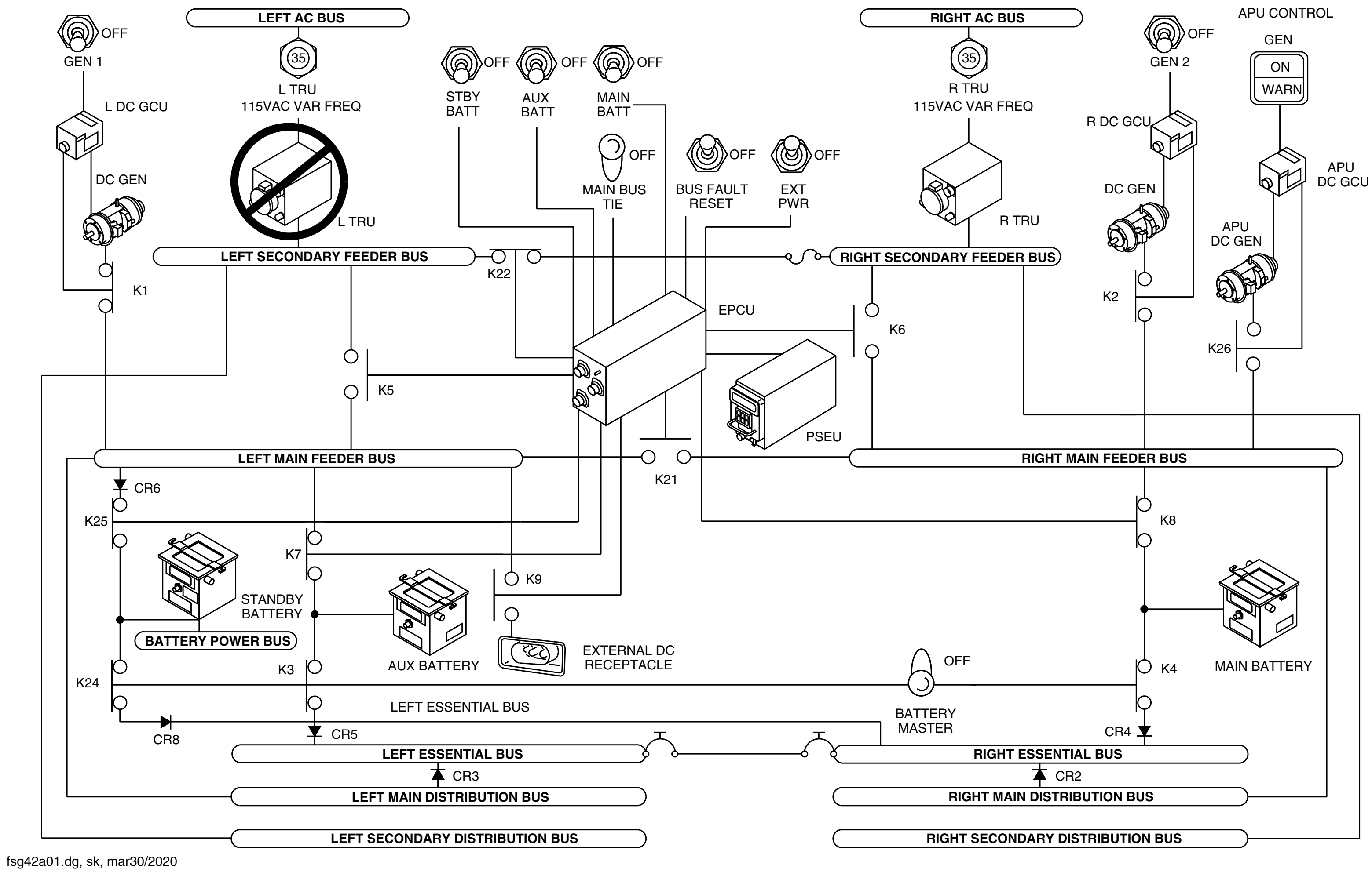
Main 28 VDC Generation System Operation
Figure 3



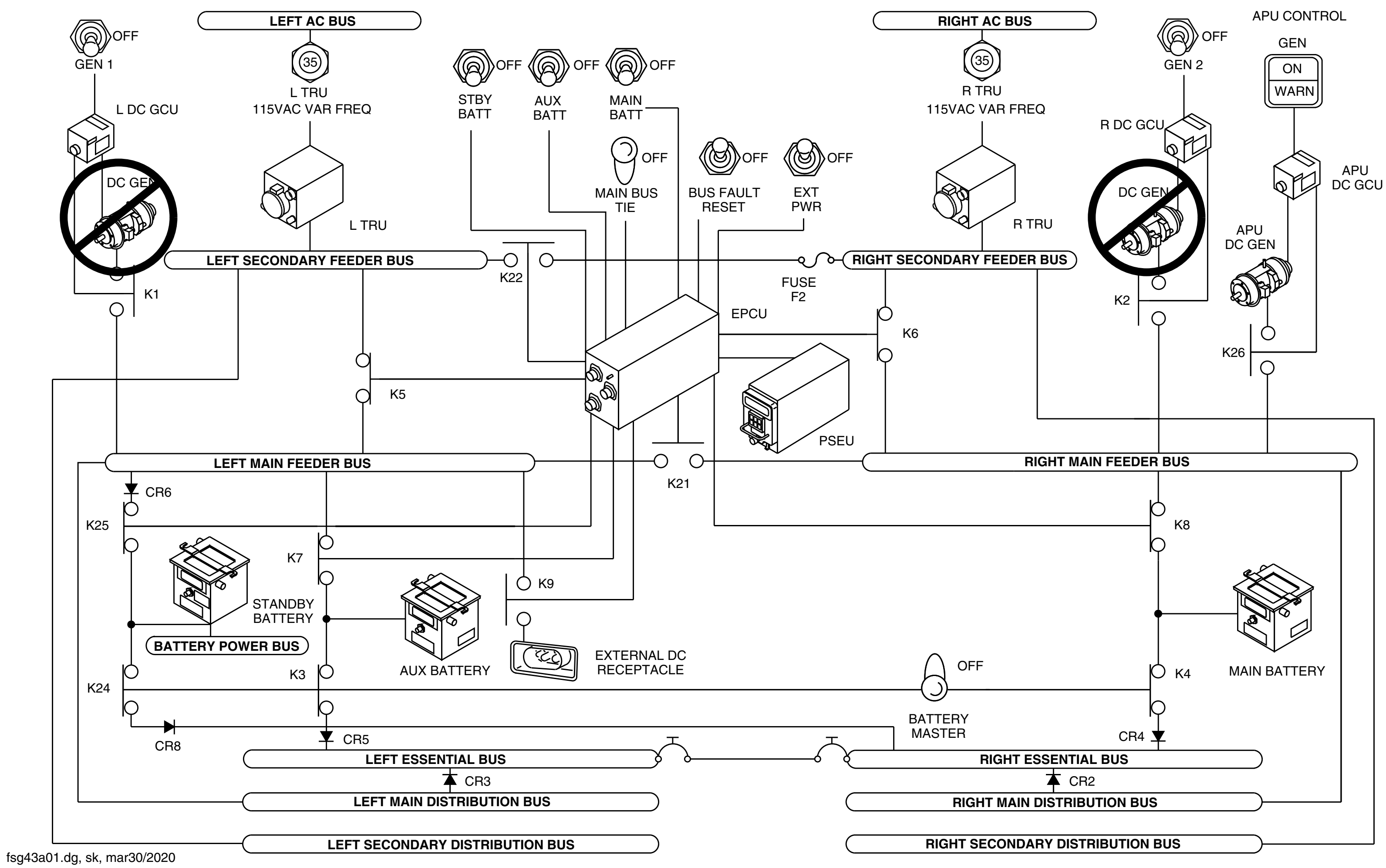
Main 28 VDC Generation System, External Power Operation
Figure 4



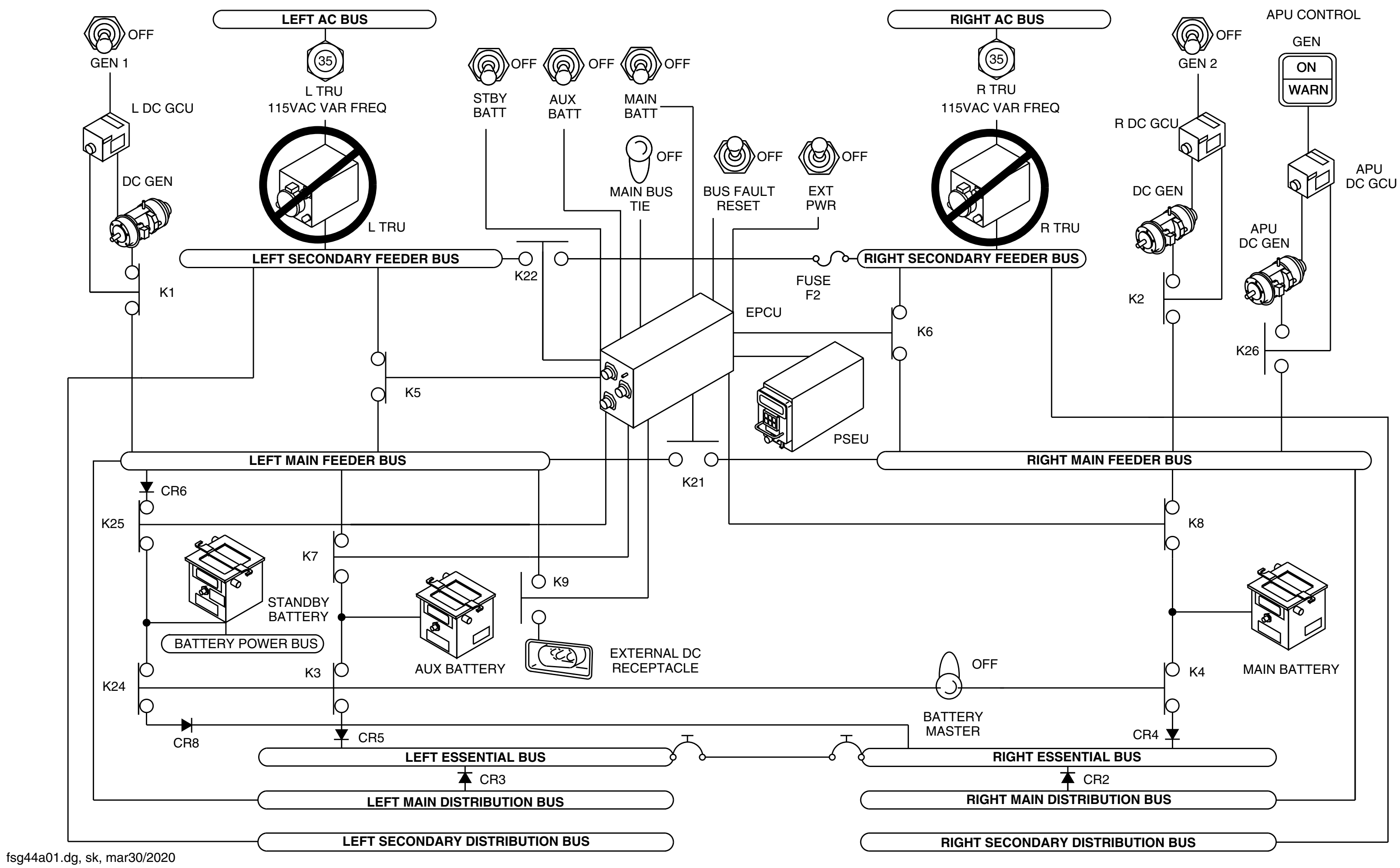
Main 28 VDC Generation System, DC Starter/Generator No. 1 Source Fault Page 1
Figure 5



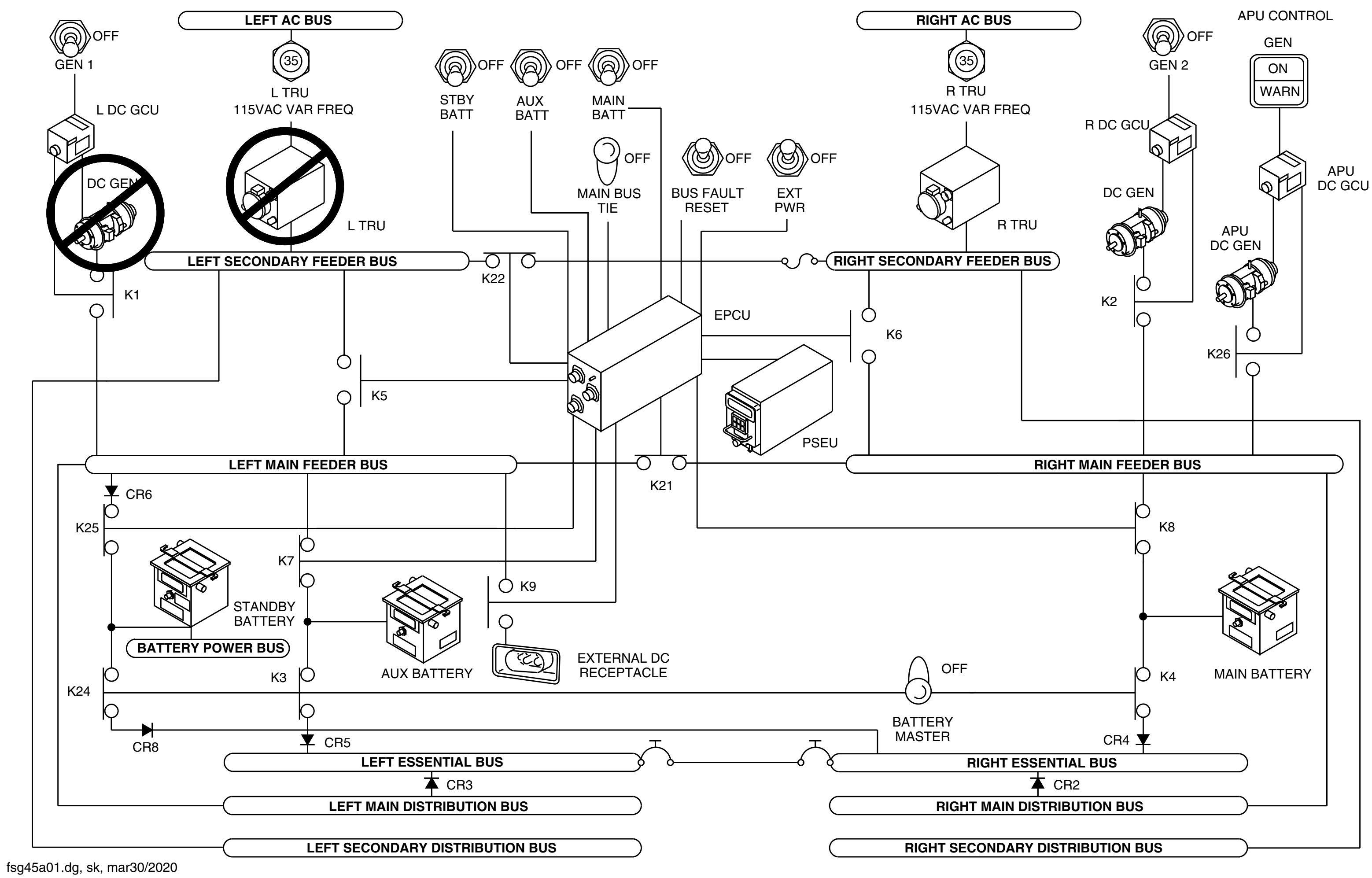
Main 28 VDC Generation System, Left TRU Source Fault
Figure 6



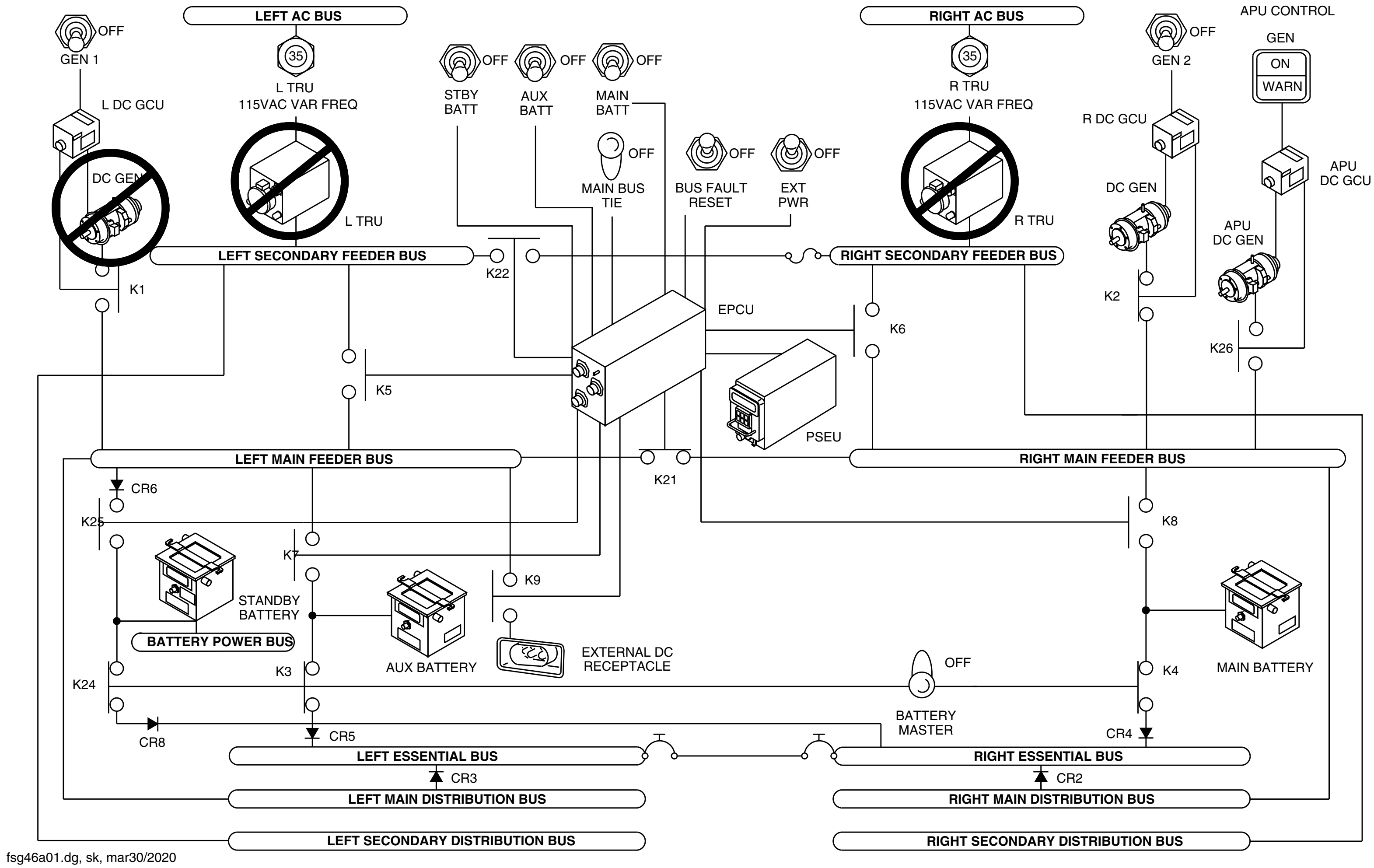
Main 28 VDC Generation System, Two DC Starter/Generator Source Fault Page 1
Figure 7



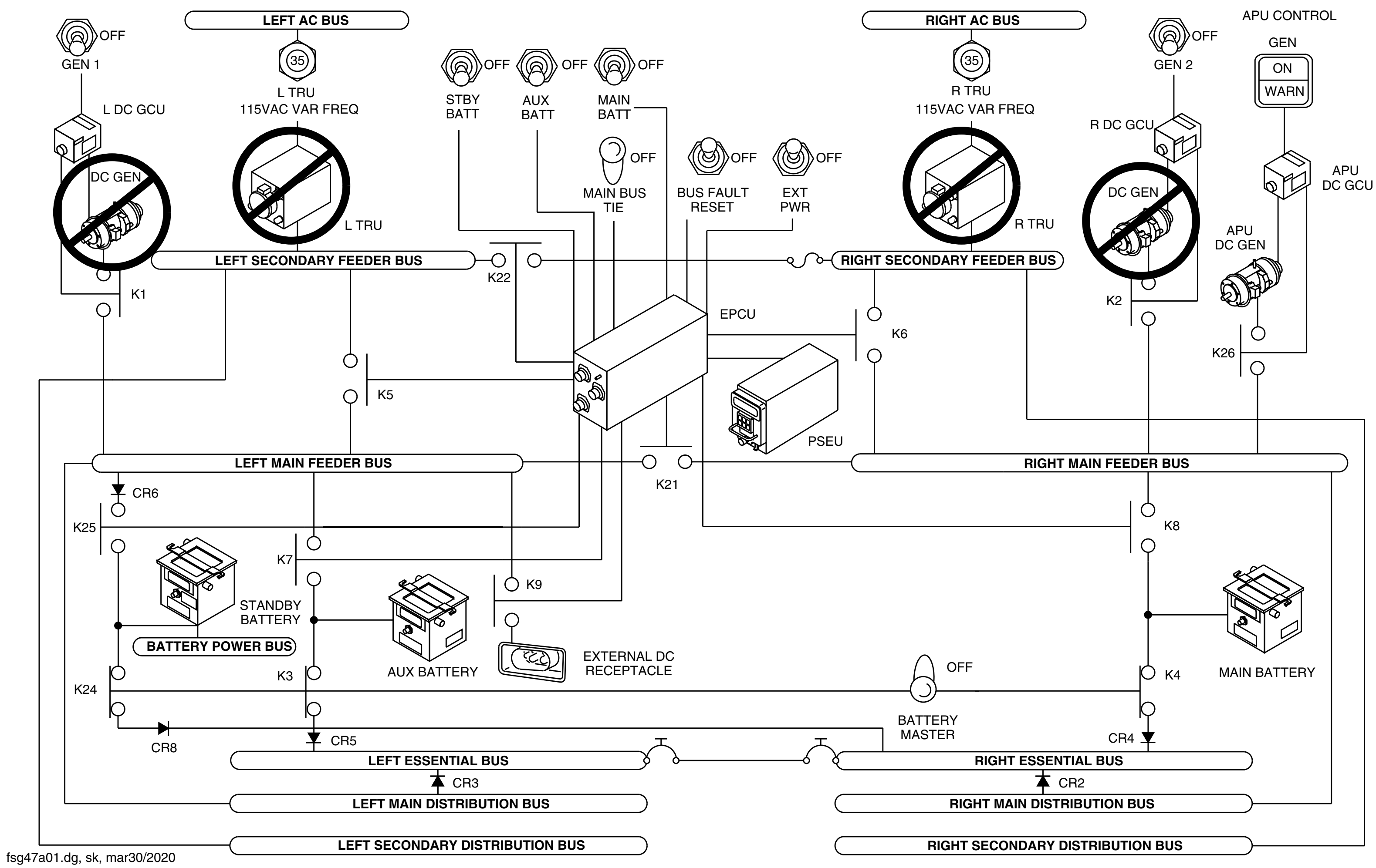
Main 28 VDC Generation System, Two TRU Source Fault Page 1
Figure 8



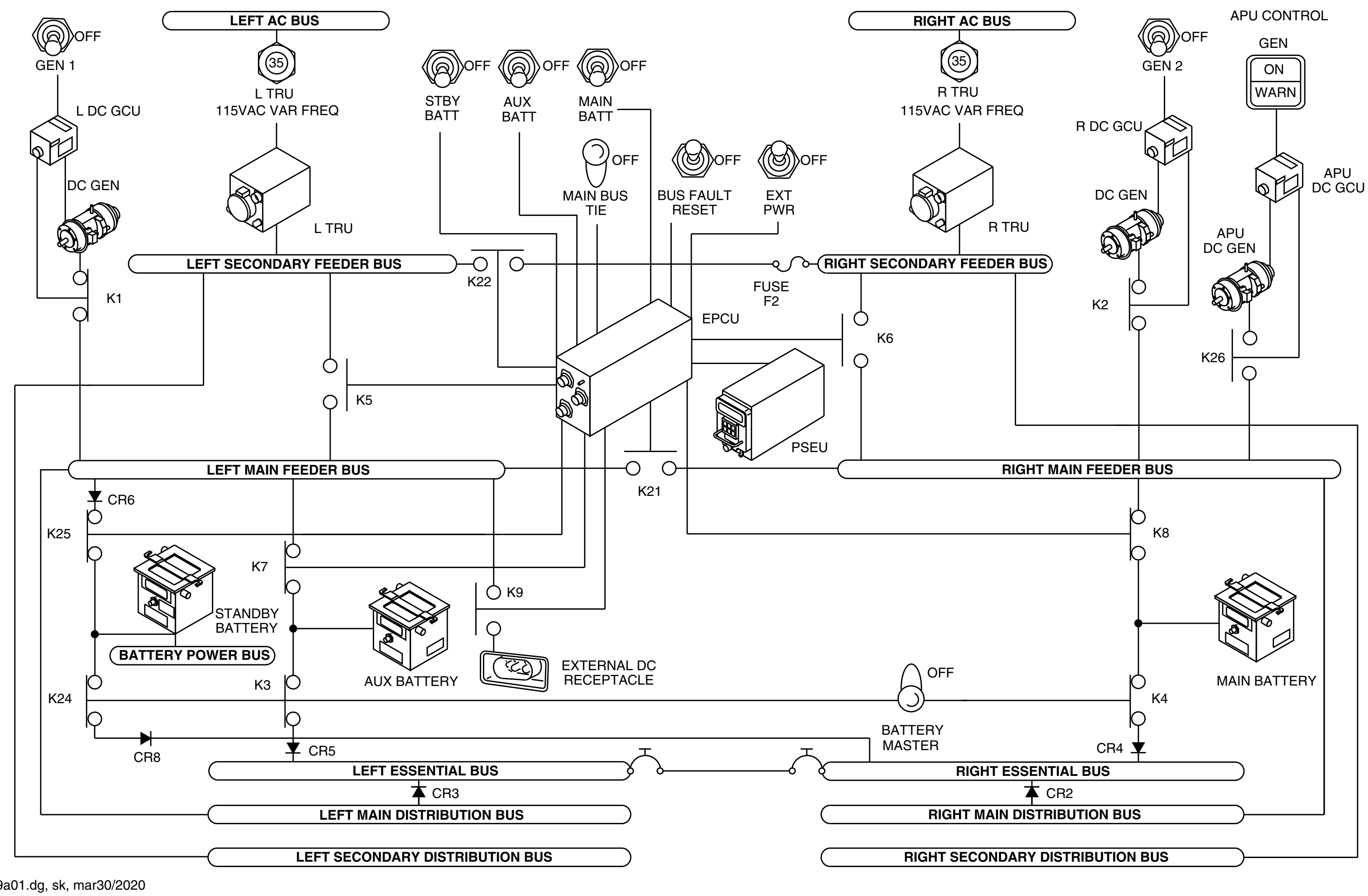
Main 28 VDC Generation System, DC Starter/Generator No. 1 and Left TRU Source Fault
Figure 9



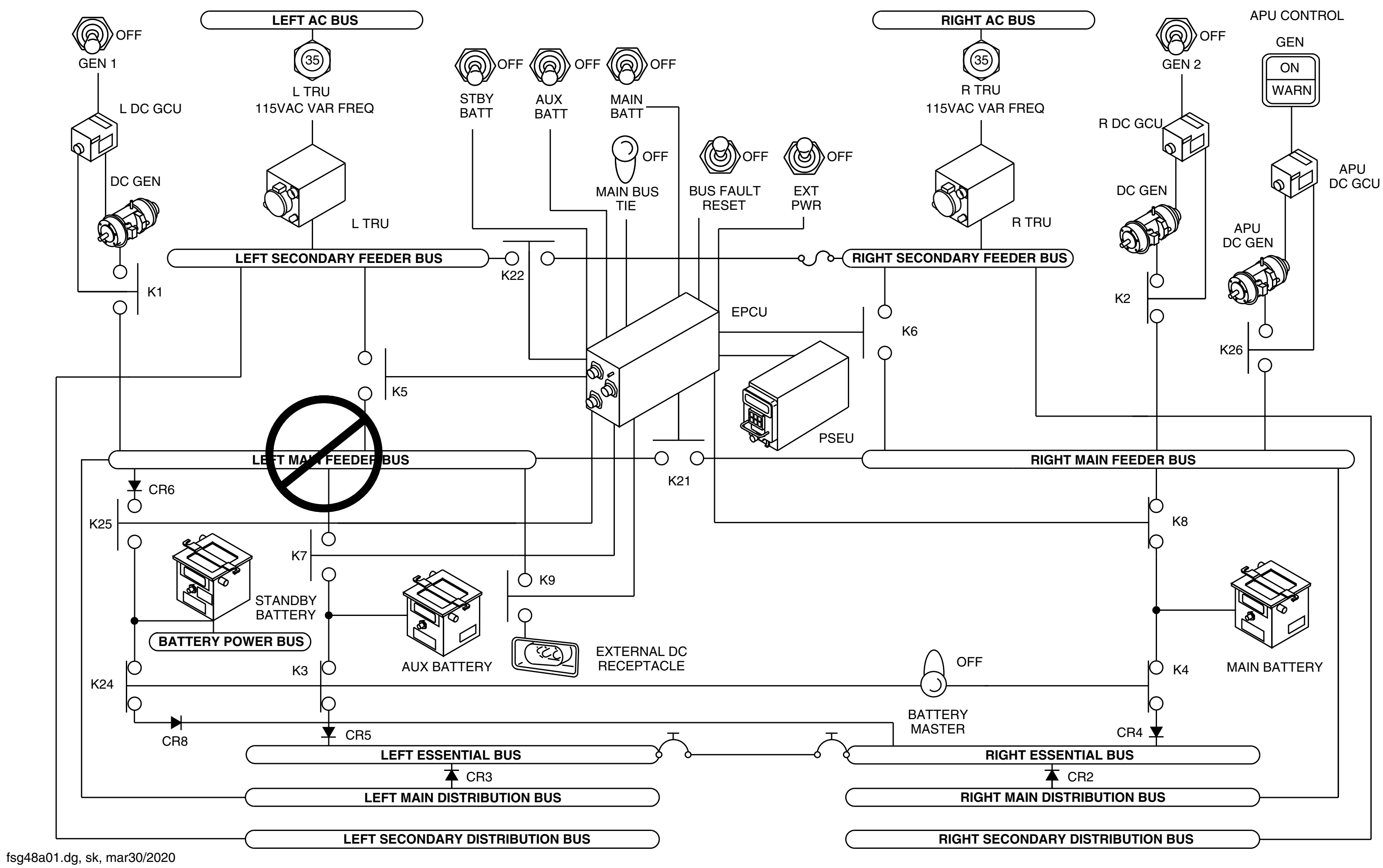
Main 28 VDC Generation System, DC Starter/Generator No. 1 and Two TRU Source Fault
Figure 10



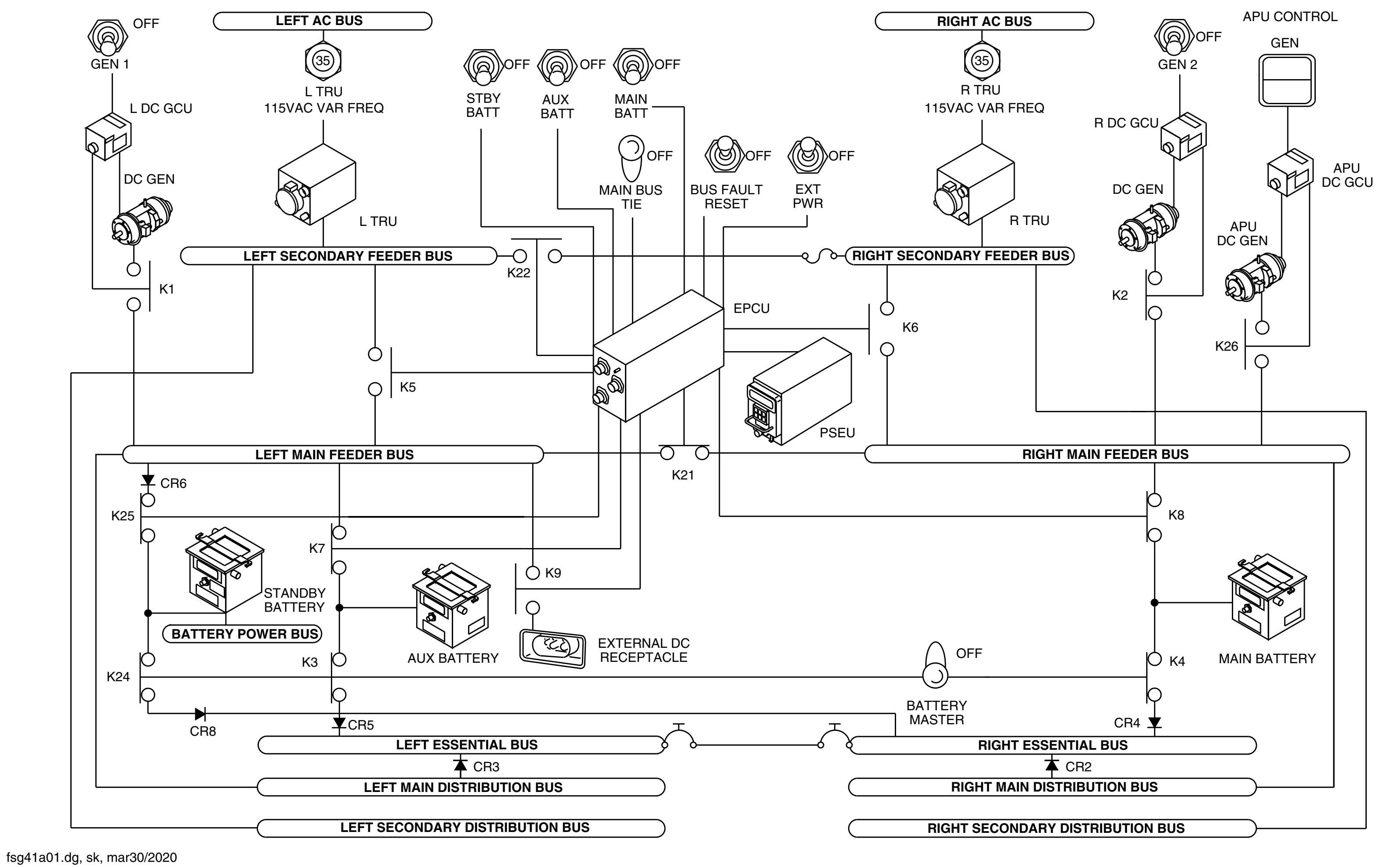
Main 28 VDC Generation System, Two DC Starter/Generator and Two TRU Source Fault
Figure 11



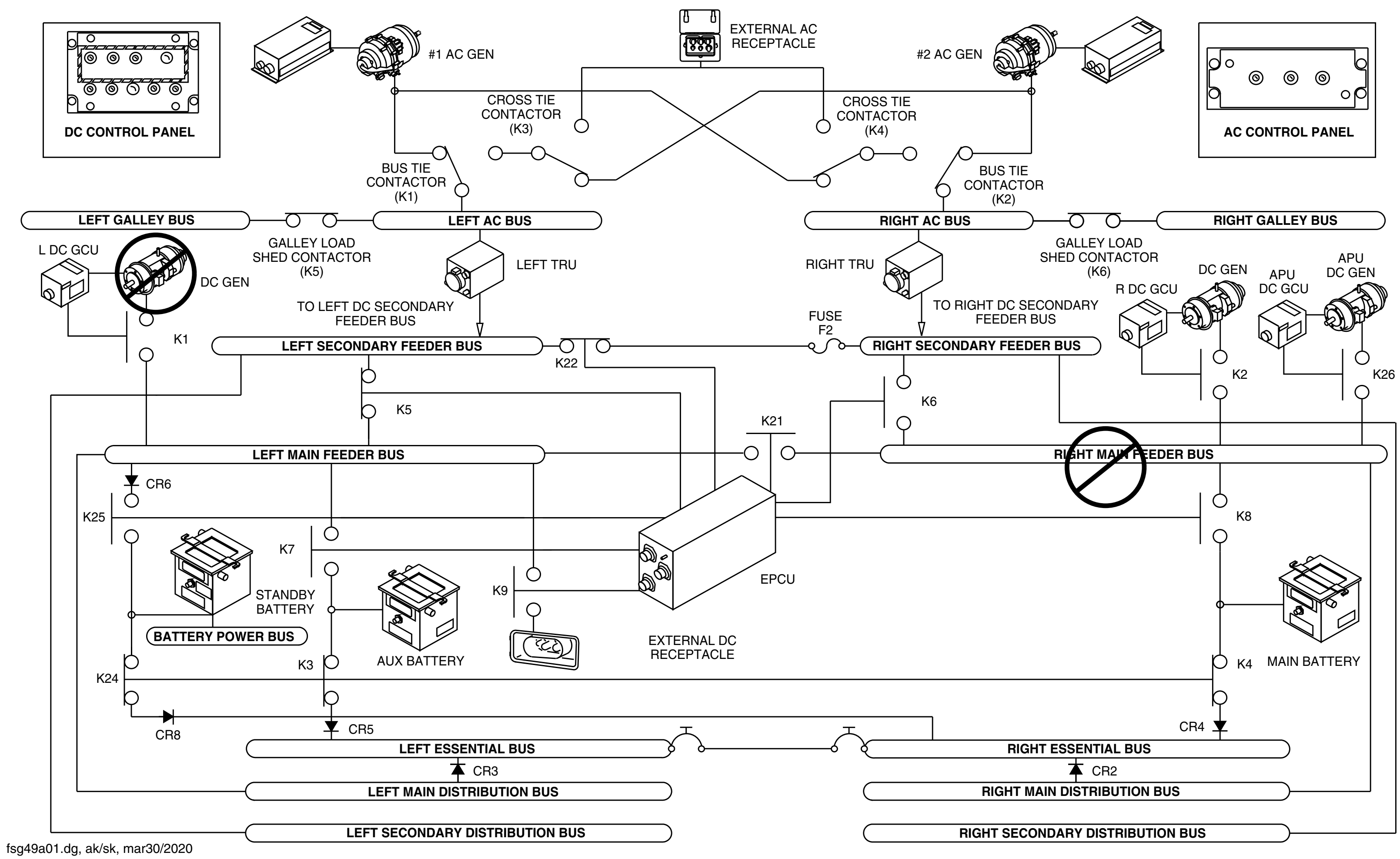
Main 28 VDC Generation System, Normal Operation
Figure 12



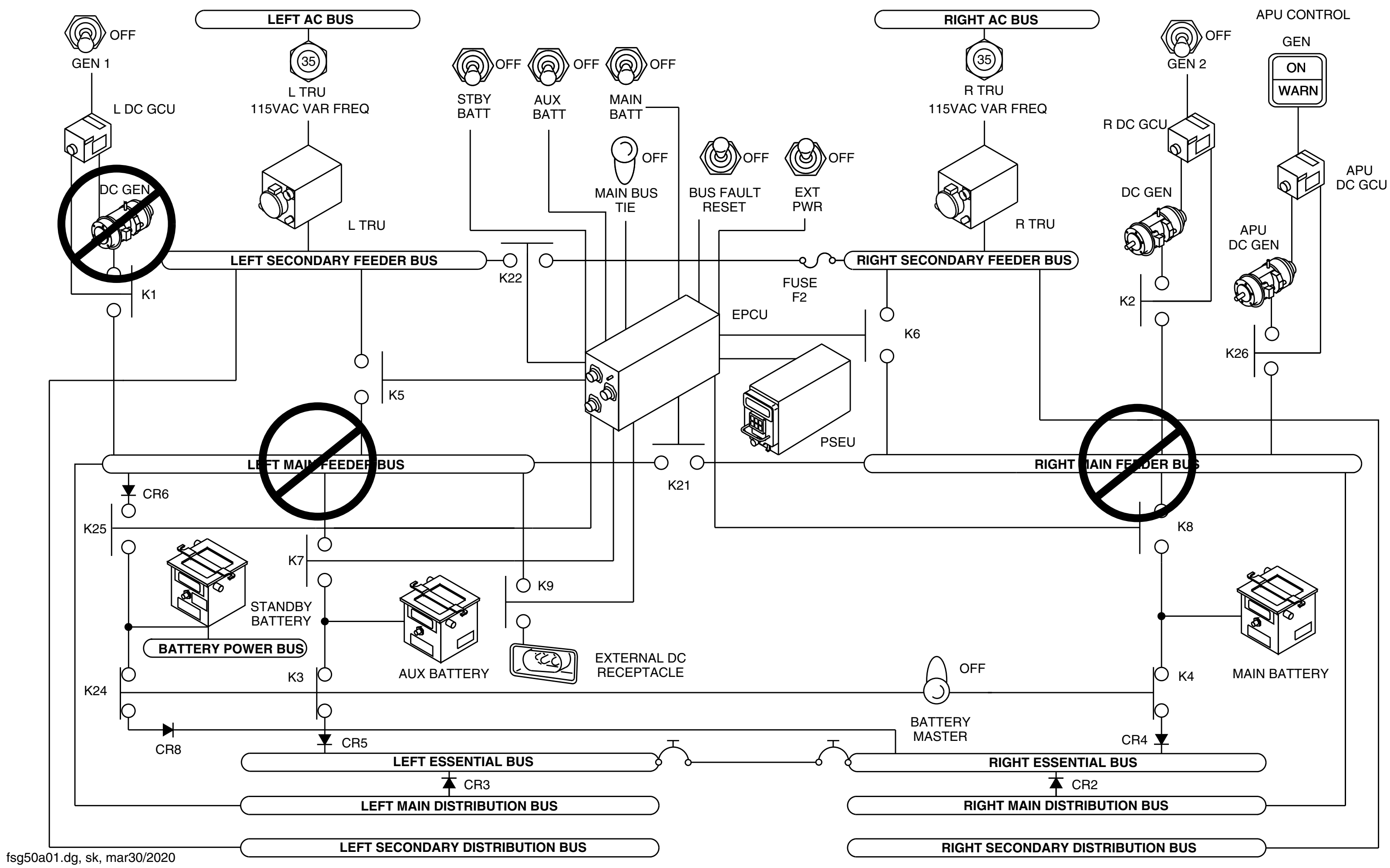
Main 28 VDC Generation System, Left Main Feeder Bus Fault
Figure 13



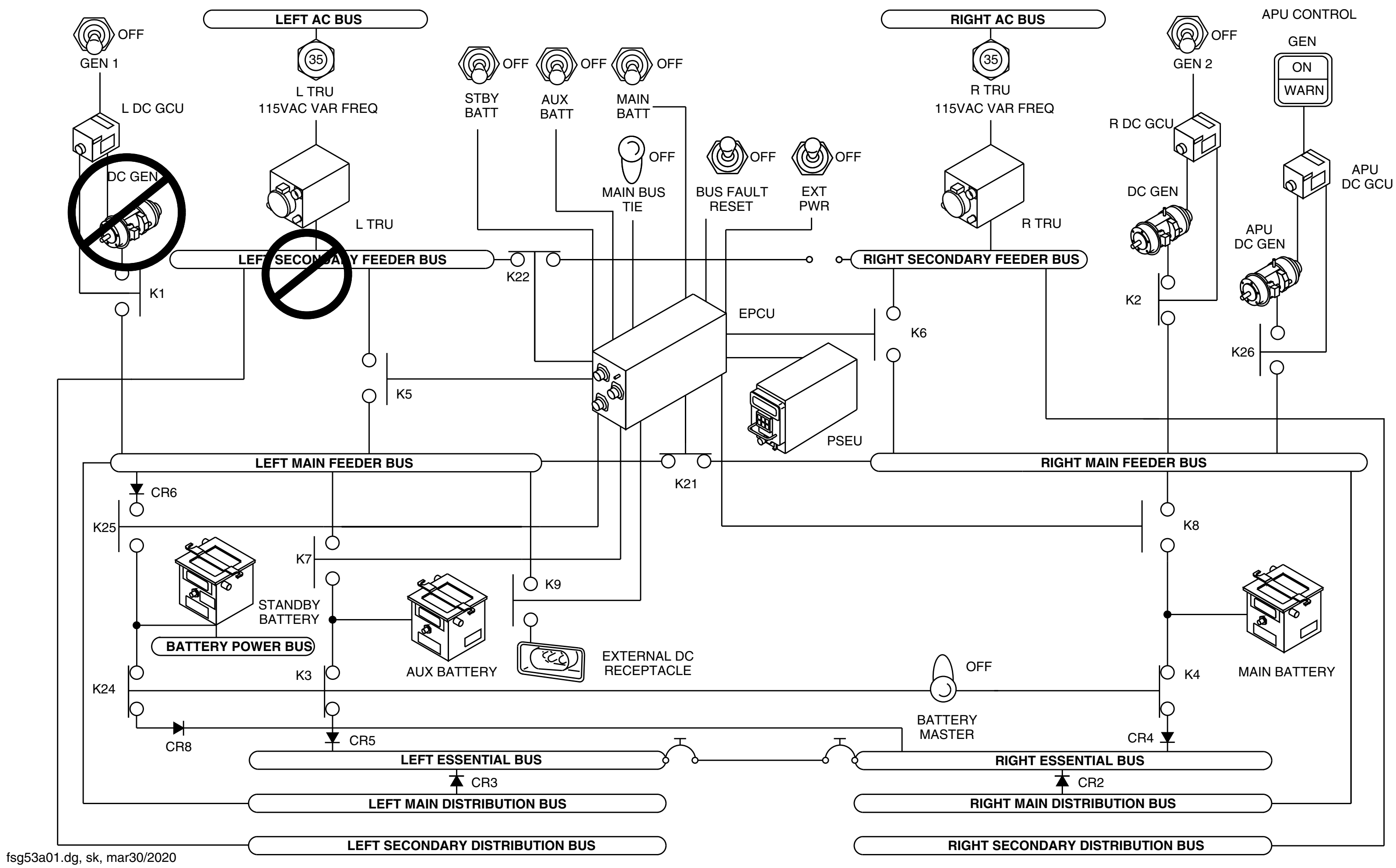
Main 28 VDC Generation System, DC Starter/Generator No. 1 Source Fault Page 2
Figure 14



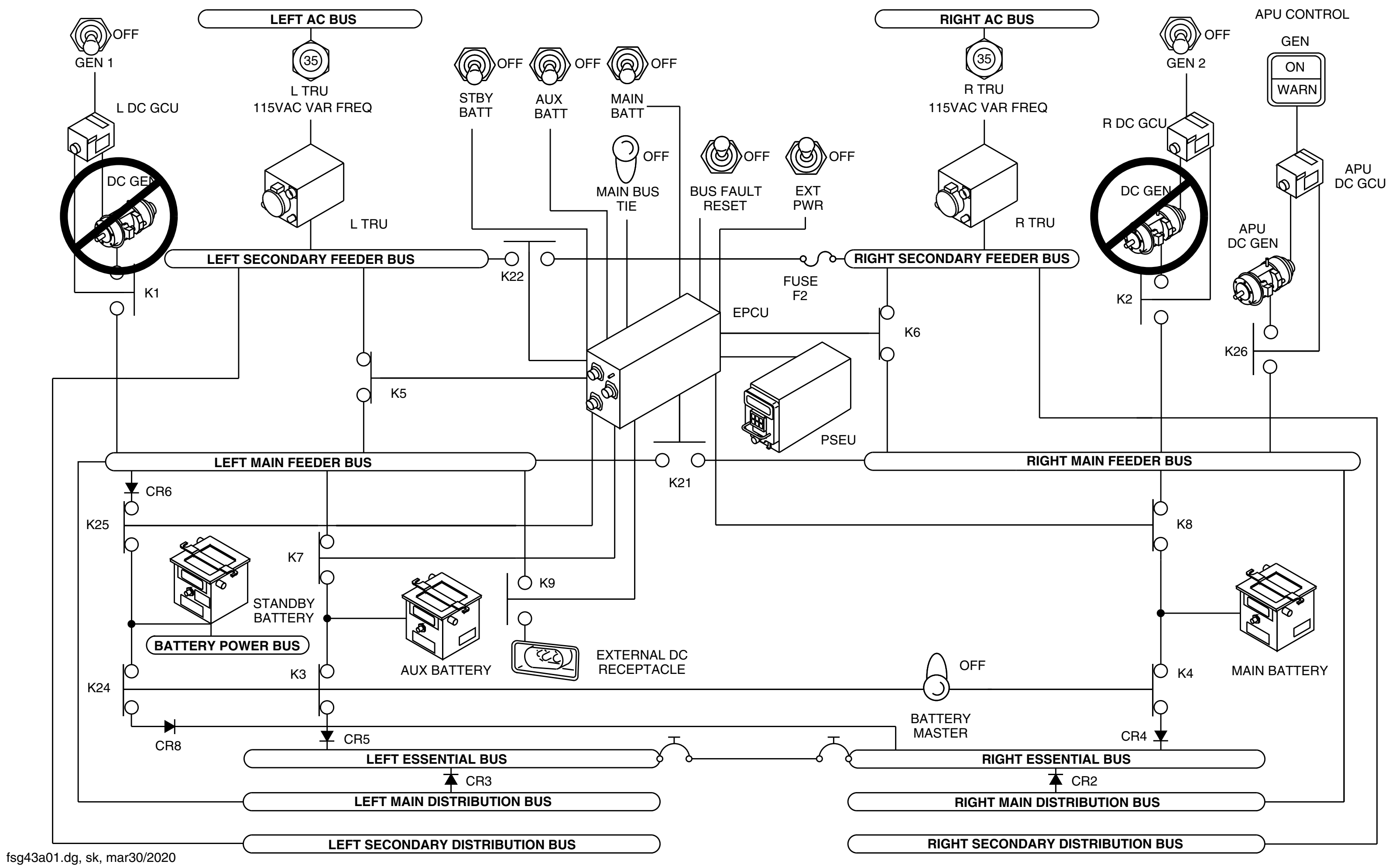
Main 28 VDC Generation System, DC Starter/Generator No. 1 Source and Main Feeder Bus Faults Page 1
Figure 15



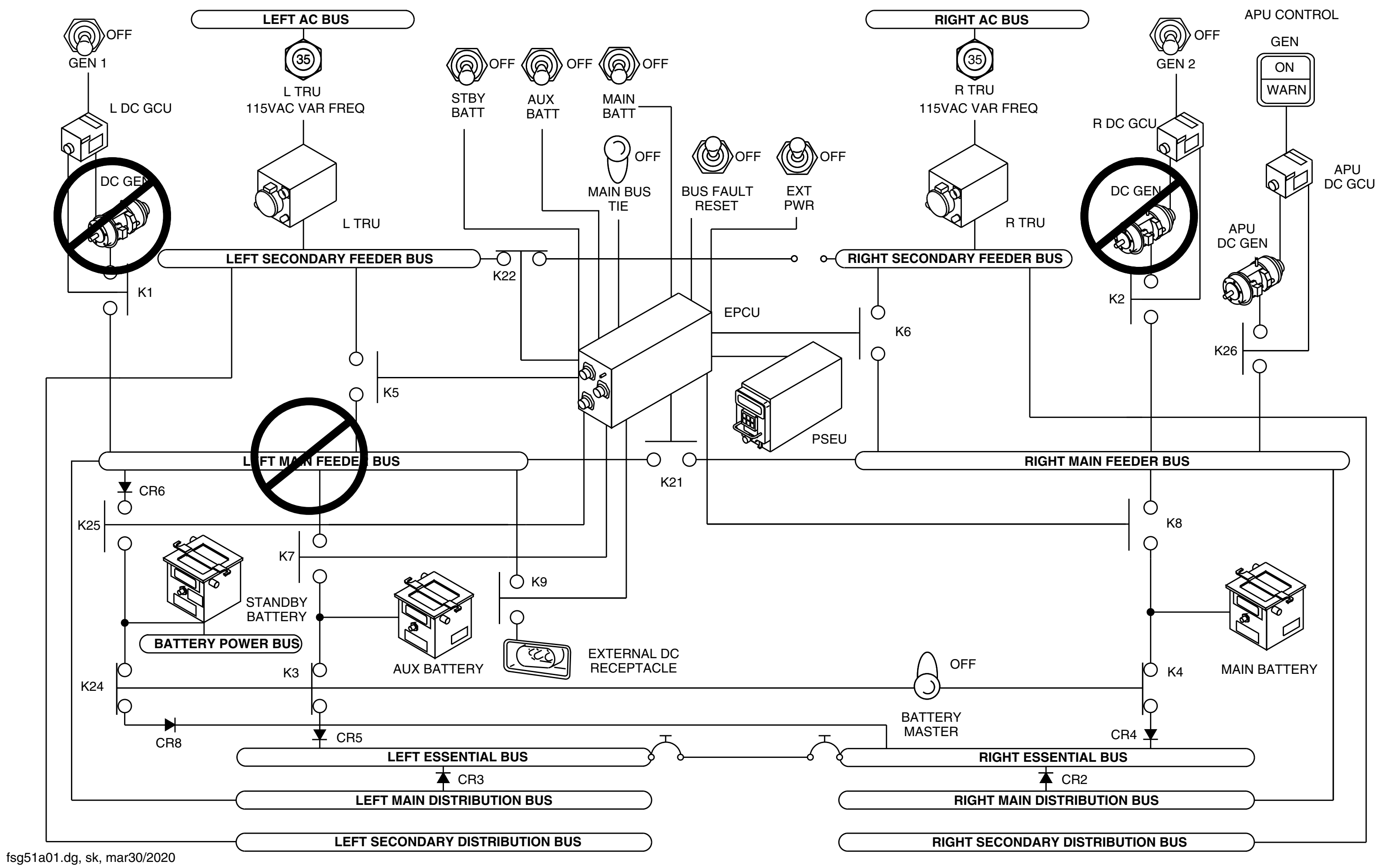
Main 28 VDC Generation System, DC Starter/Generator No. 1 Source and Main Feeder Bus Faults Page 2
Figure 16



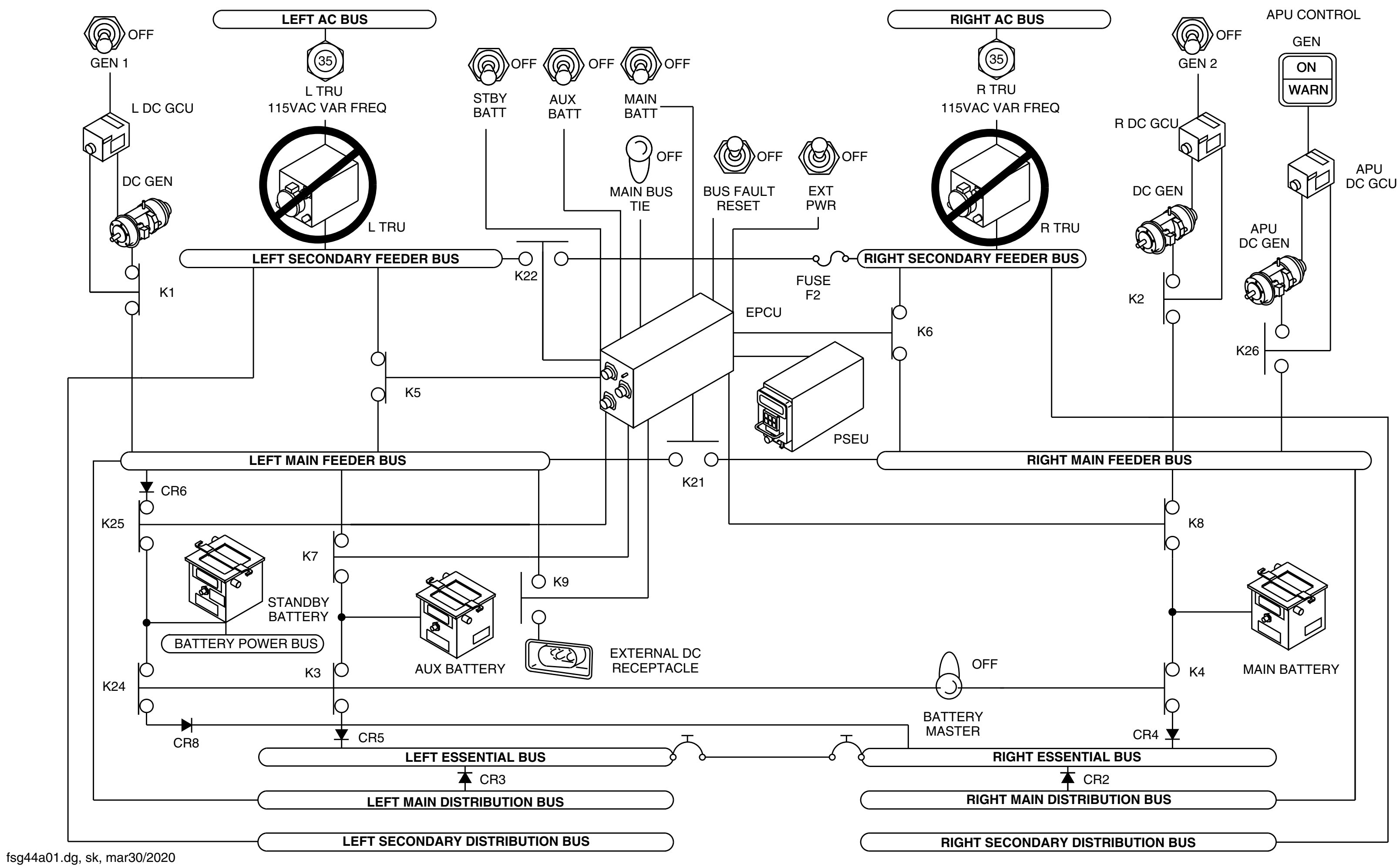
Main 28 VDC Generation System, DC Starter/Generator No. 1 Source and Secondary Feeder Bus Faults
Figure 17



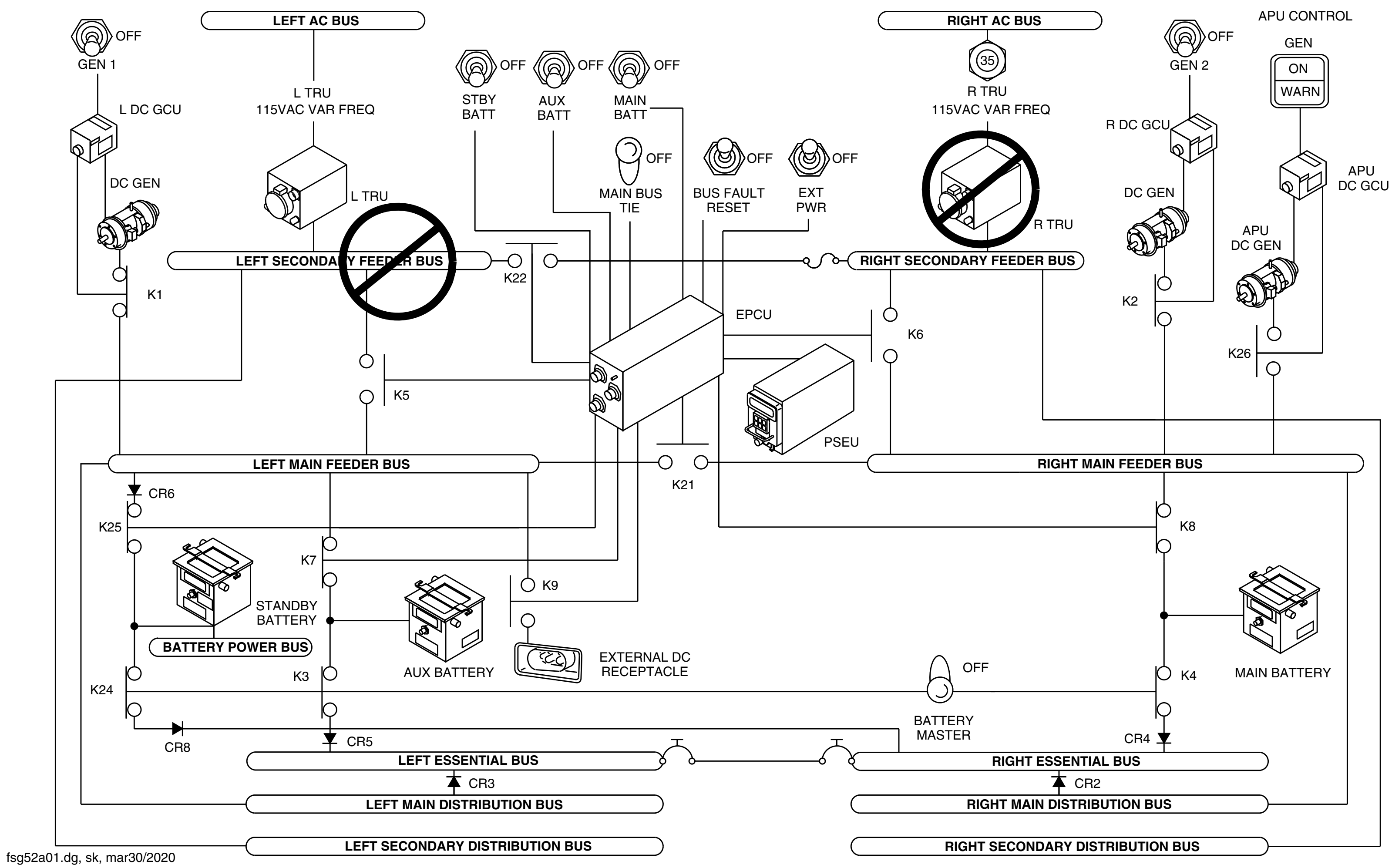
Main 28 VDC Generation System, Two DC Starter/Generator Source Fault Page 2
Figure 18



Main 28 VDC Generation System, Two DC Starter/Generator Source and Main Feeder Bus Faults
Figure 19



Main 28 VDC Generation System, Two TRU Source Fault Page 2
Figure 20



Main 28 VDC Generation System, Two TRU Source and Secondary Feeder Bus Faults
Figure 21

DC SOURCE FAILURE				RECONFIGURABLE LOGIC			
#1 GEN K1	#2 GEN K2	LEFT TRU	RIGHT TRU	MAIN BUS TIE K21	SECONDARY BUS TIE K22	LEFT TRU TIE K5	RIGHT TRU TIE K6
ON	ON	ON	ON	OPEN	OPEN	OPEN	OPEN
ON	ON	ON	OFF	OPEN	CLOSED	OPEN	OPEN
ON	ON	OFF	ON	OPEN	CLOSED	OPEN	OPEN
ON	ON	OFF	OFF	OPEN	OPEN	CLOSED	CLOSED
ON	OFF	ON	ON	CLOSED	OPEN	OPEN	OPEN
ON	OFF	ON	OFF	CLOSED	CLOSED	OPEN	OPEN
ON	OFF	OFF	ON	CLOSED	CLOSED	OPEN	OPEN
ON	OFF	OFF	OFF	CLOSED	OPEN	OPEN	OPEN
OFF	ON	ON	ON	CLOSED	OPEN	OPEN	OPEN
OFF	ON	ON	OFF	CLOSED	CLOSED	OPEN	OPEN
OFF	ON	OFF	ON	CLOSED	CLOSED	OPEN	OPEN
OFF	ON	OFF	OFF	CLOSED	OPEN	OPEN	OPEN
OFF	OFF	ON	ON	OPEN	OPEN	CLOSED	CLOSED
OFF	OFF	ON	OFF	OPEN	CLOSED	OPEN	OPEN
OFF	OFF	OFF	ON	OPEN	CLOSED	OPEN	OPEN
OFF	OFF	OFF	OFF	OPEN	OPEN	OPEN	OPEN

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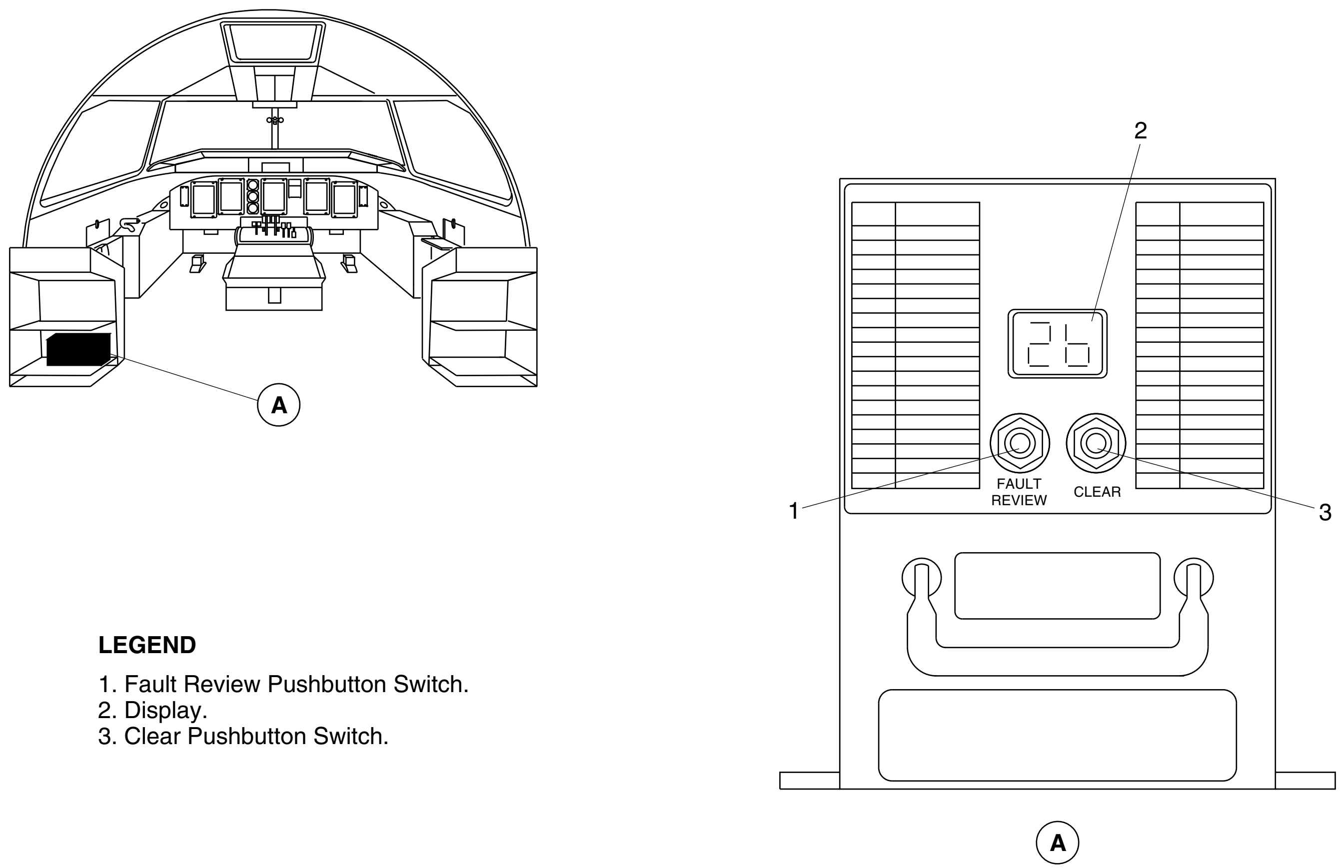
MAIN 28 VDC GENERATION SYSTEM, RECONFIGURATION LOGIC FOR SOURCE MALFUNCTIONS
Figure 22



LEGEND

1. Fault Review Pushbutton Switch.
2. Display.
3. Clear Pushbutton Switch.

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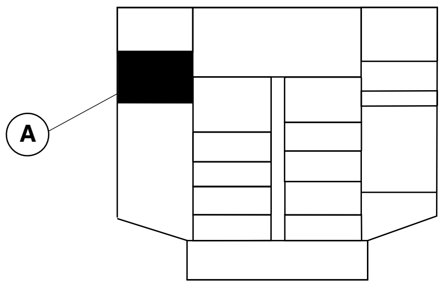
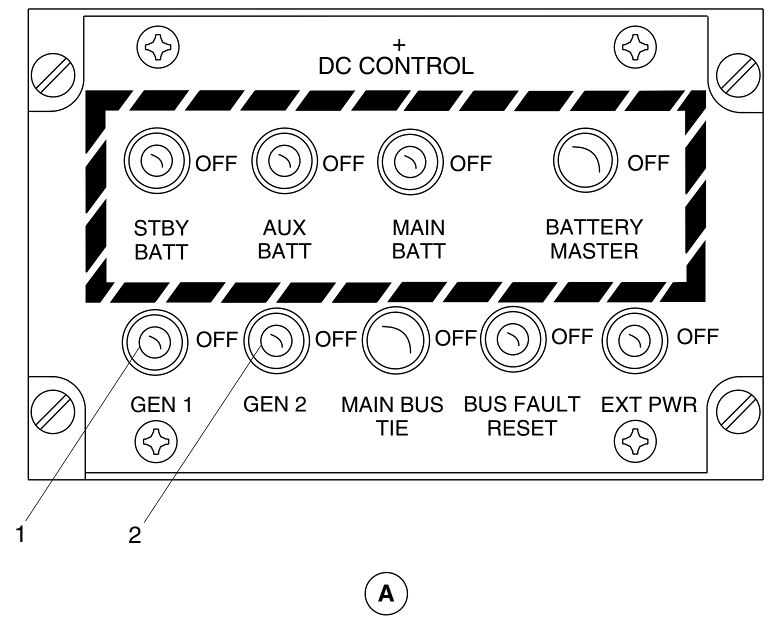
MAIN 28 VDC GENERATION SYSTEM, EPCU
Figure 23



OVERHEAD CONSOLE



LEGEND

1. Generator 1 Toggle Switch.
2. Generator 2 Toggle Switch.

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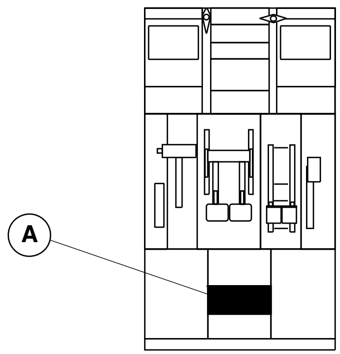
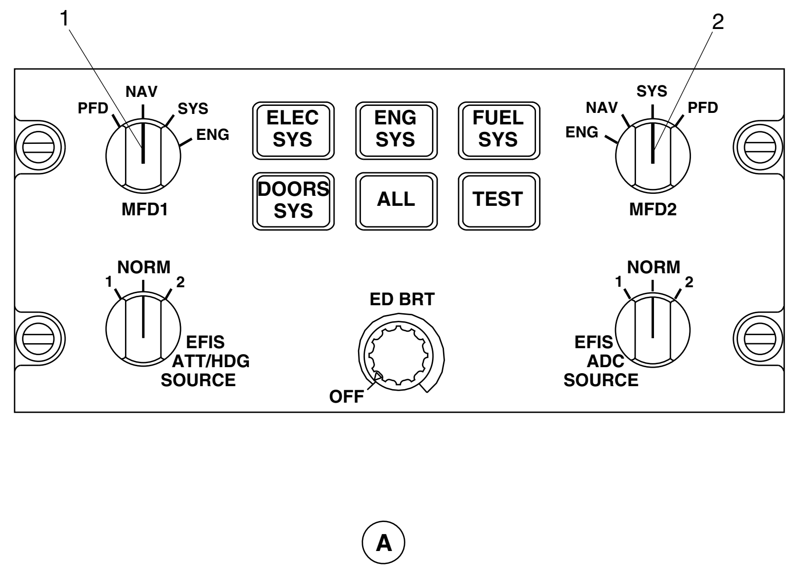
MAIN 28 VDC GENERATION SYSTEM, DC CONTROL PANEL
Figure 24





LEGEND

1. MFD 1 Reversion Selector.
2. MFD 2 Reversion Selector.

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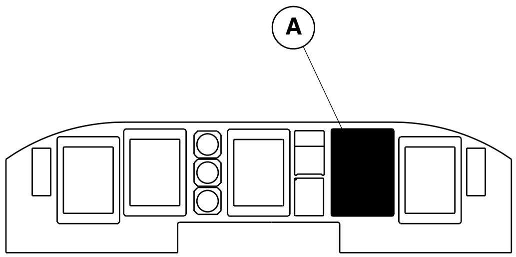
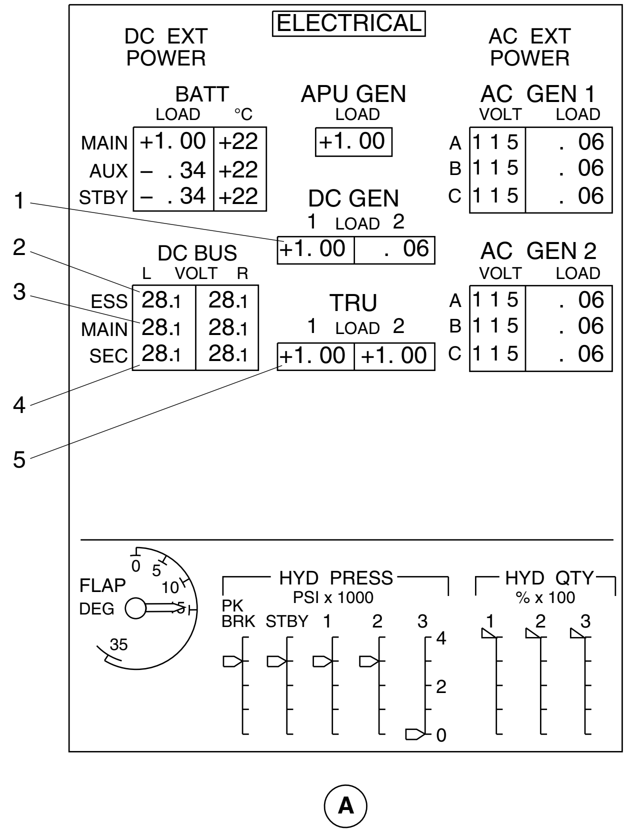
EIS, ELECTRICAL SYSTEM PAGE SELECTION
Figure 25



MAIN INSTRUMENT PANEL



LEGEND

1. DC Starter / Generator Load Digital Indications.
2. Essential DC Bus Voltage Digital Indication.
3. Main DC Bus Volatage Digital Indication.
4. Secondary DC Bus Voltage Digital Indication.
5. TRU Load Digital Indication.

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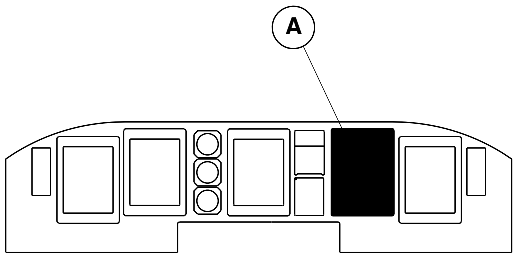
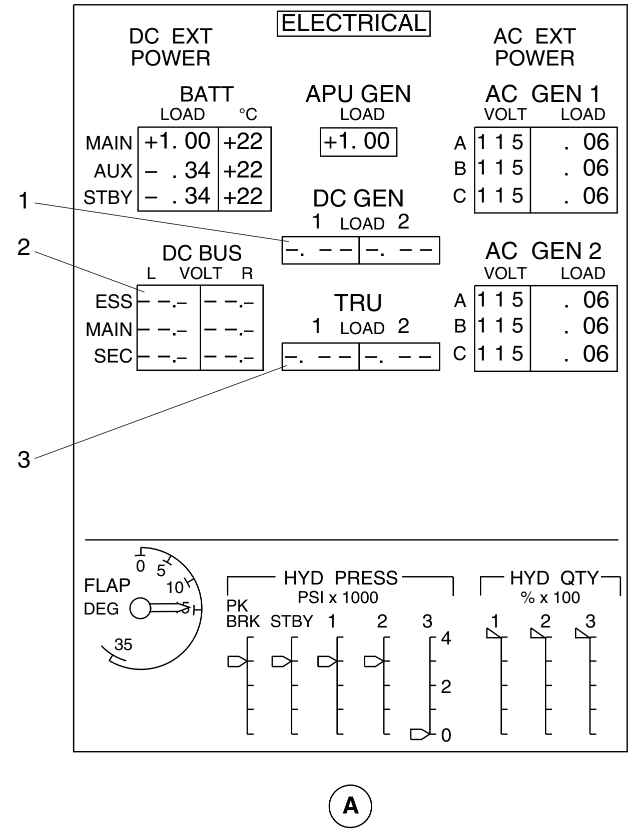
EIS, MAIN 28 VDC GENERATION SYSTEM INDICATION CALLOUTS
Figure 26



MAIN INSTRUMENT PANEL



LEGEND

1. DC Starter / Generator Load Digital Fail Indications.
2. DC Bus Digital Fail Indications.
3. TRU Load Digital Fail Indications.

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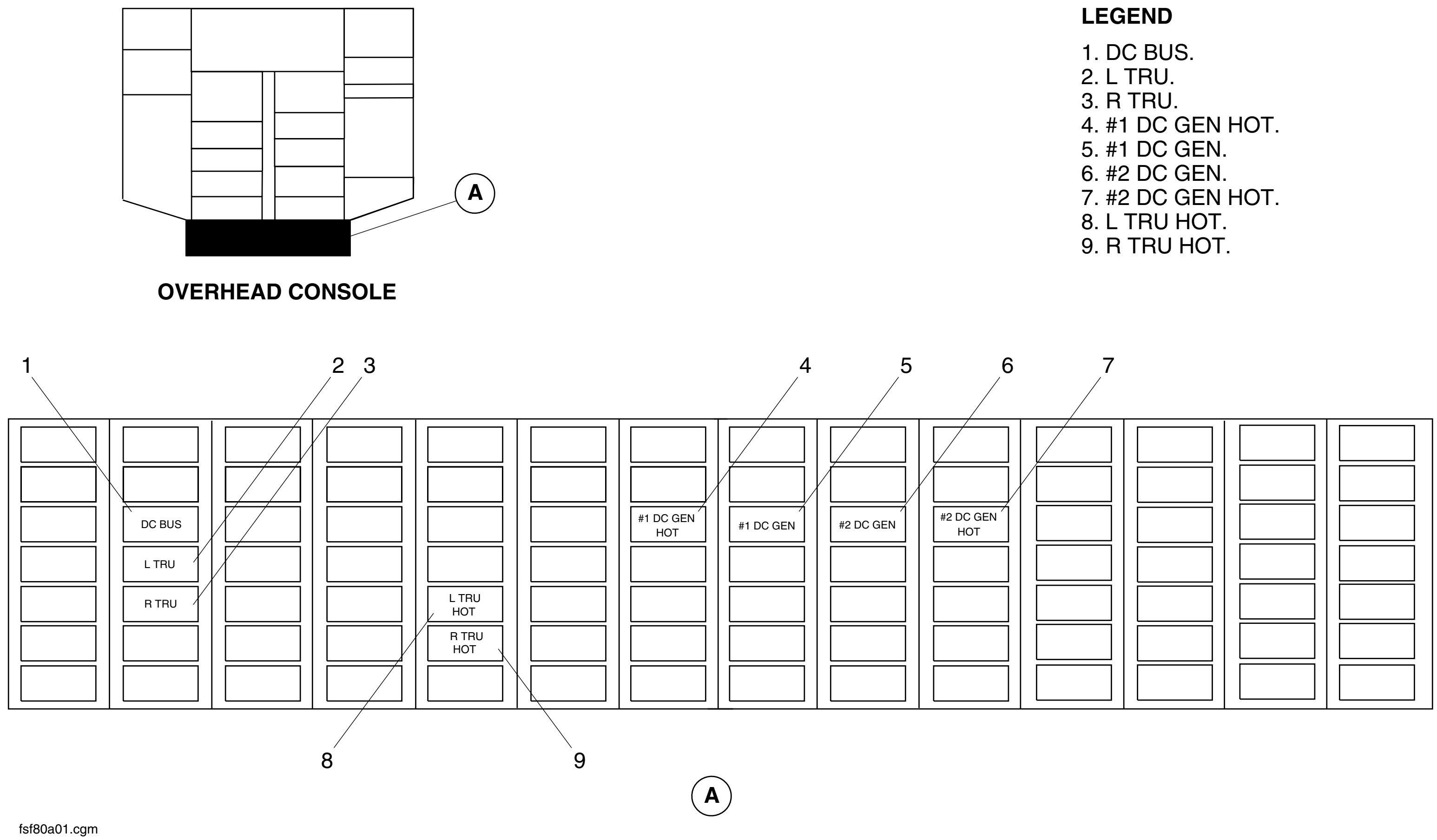
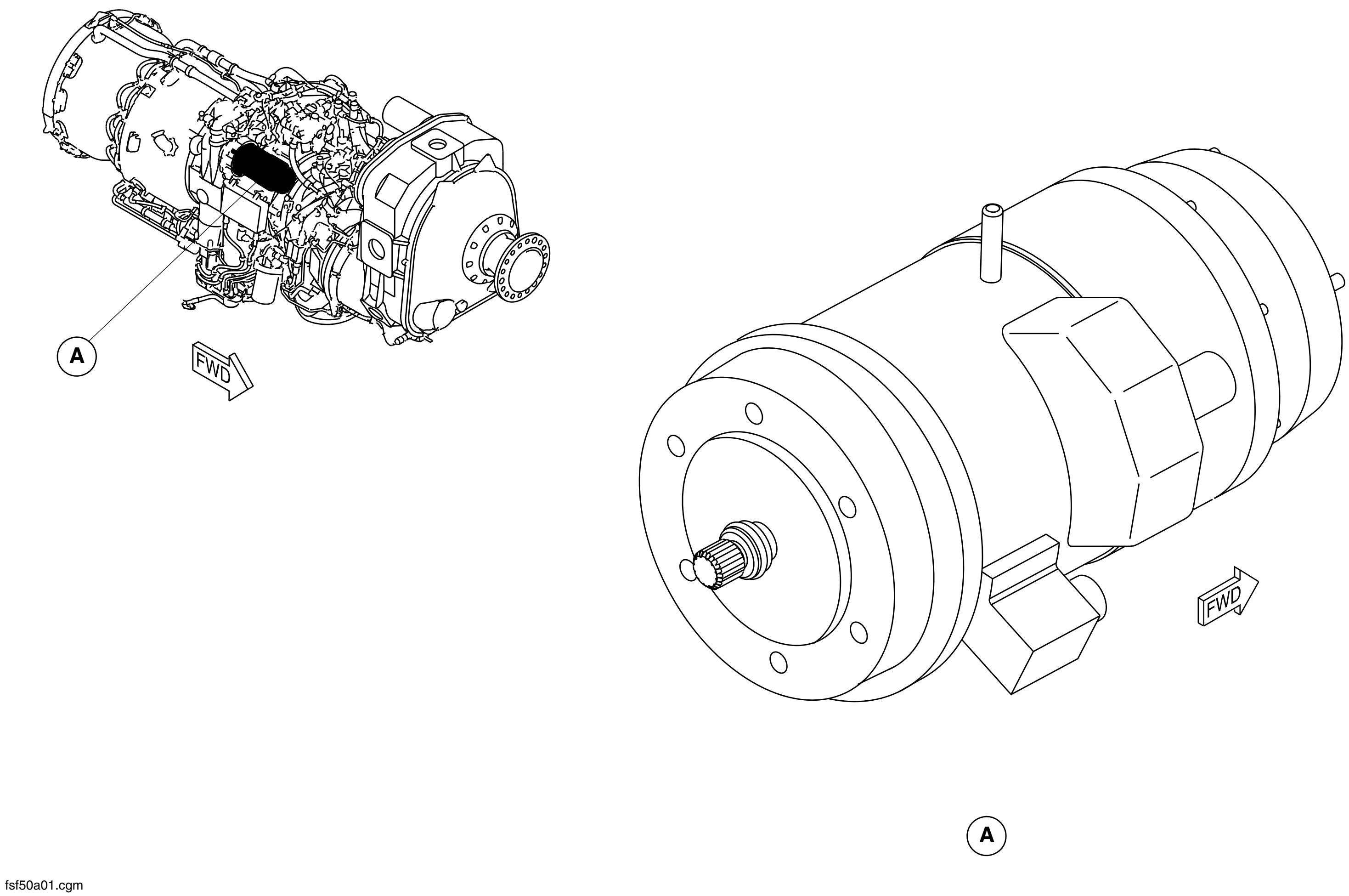
EIS, MAIN 28 VDC GENERATION SYSTEM MALFUNCTION INDICATIONS
Figure 27



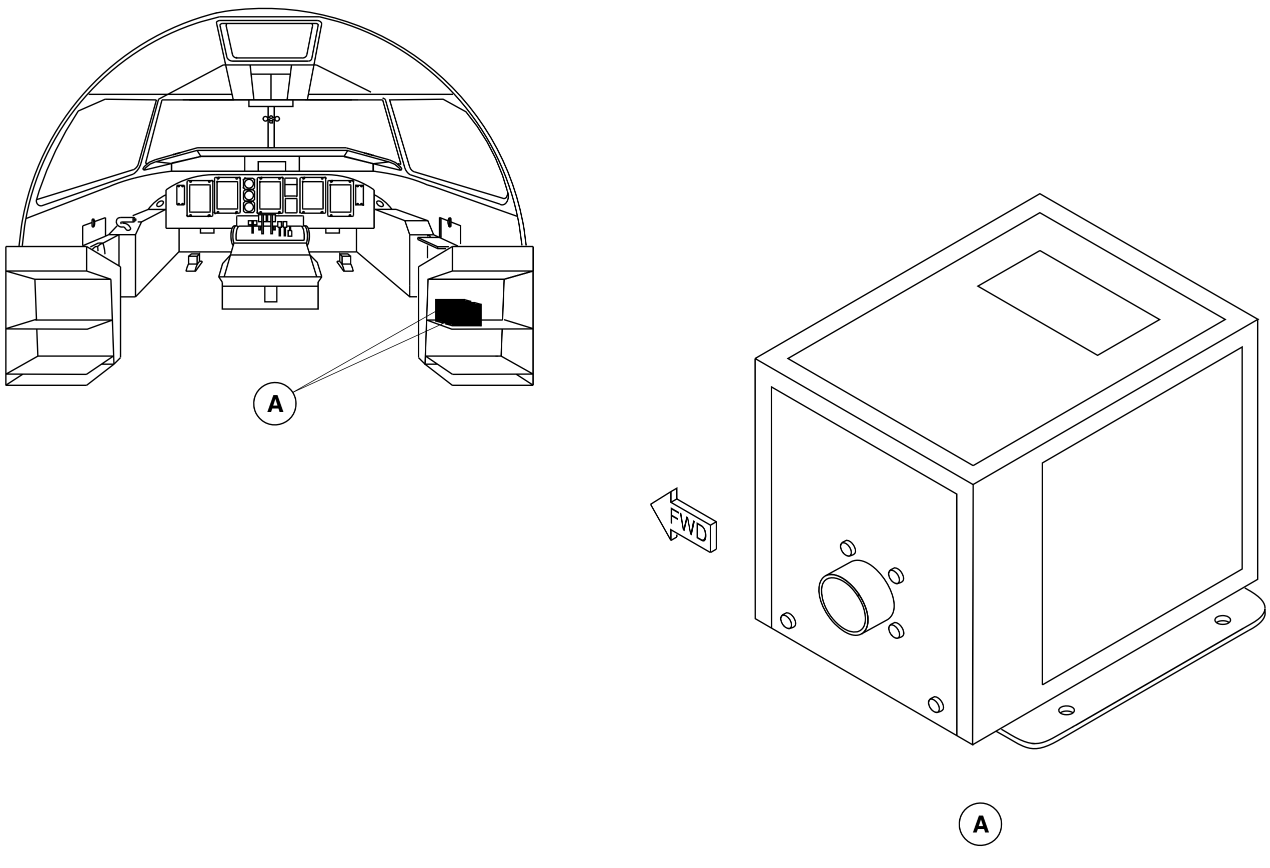
LEGEND

1. DC BUS.
2. L TRU.
3. R TRU.
4. #1 DC GEN HOT.
5. #1 DC GEN.
6. #2 DC GEN.
7. #2 DC GEN HOT.
8. L TRU HOT.
9. R TRU HOT.

CAUTION AND WARNING PANEL, MAIN 28 VDC GENERATION SYSTEM CAUTION INDICATIONS
Figure 28



DC STARTER/GENERATOR LOCATOR
Figure 29



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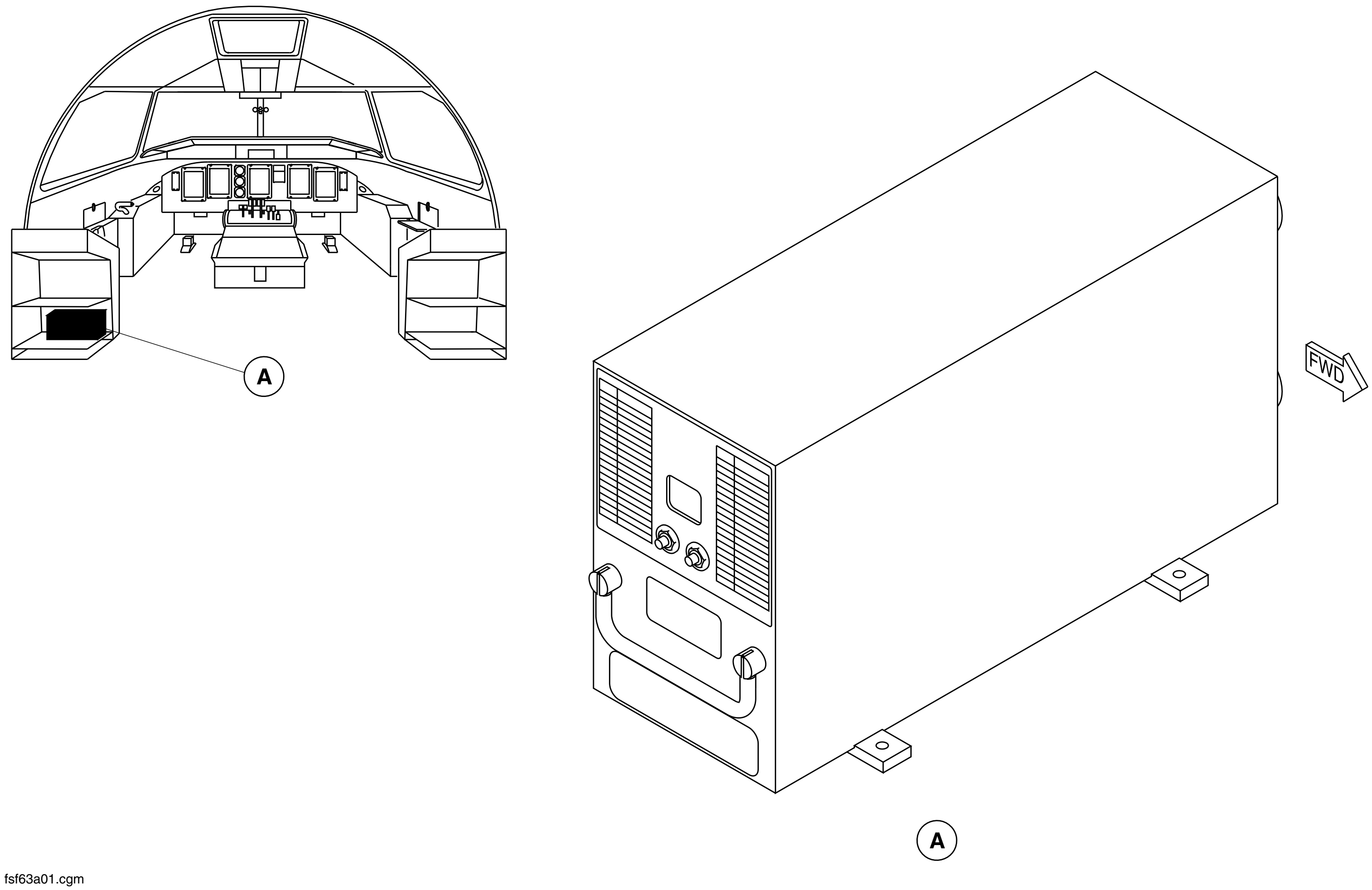
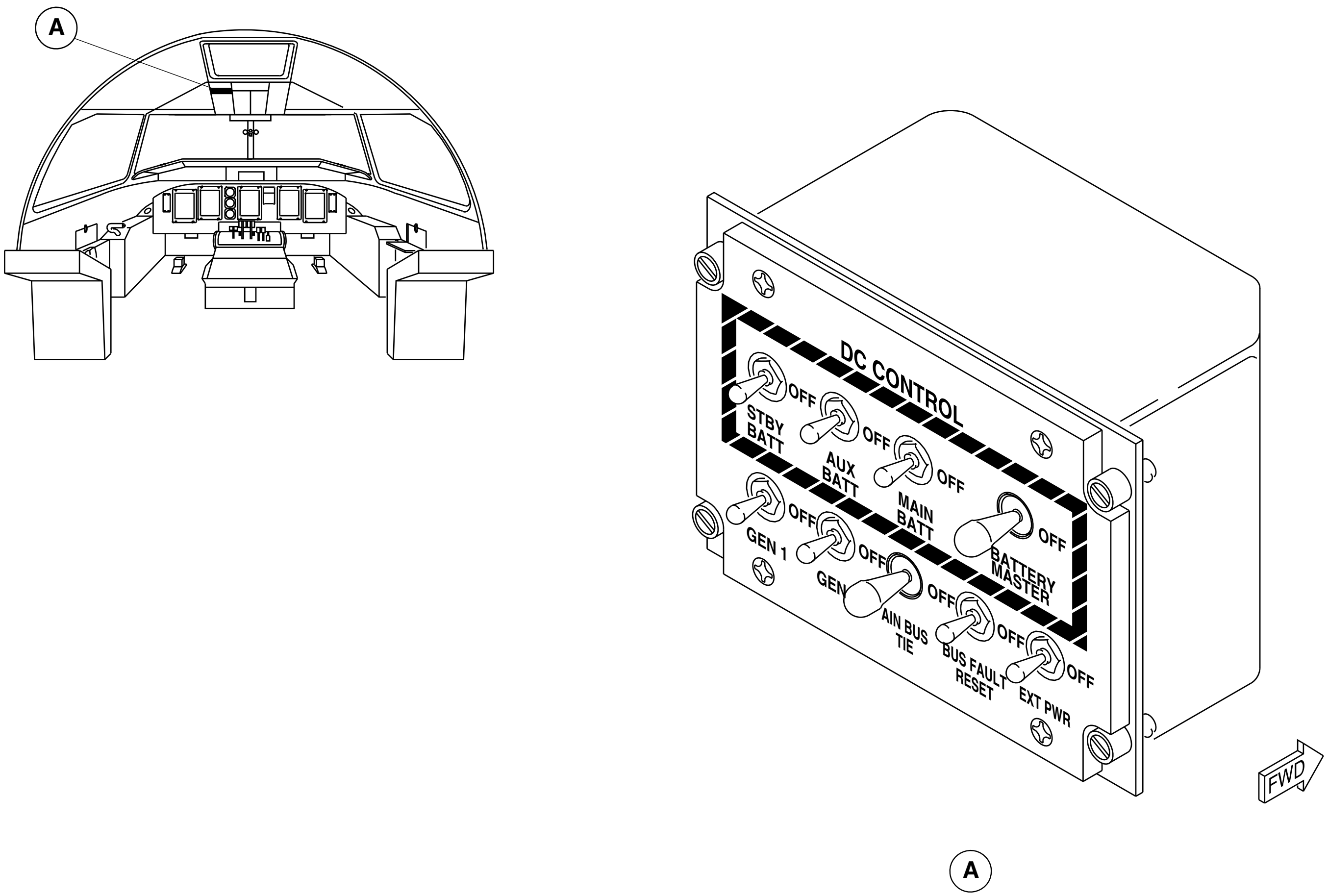
DC STARTER/GENERATOR GENERATOR CONTROL UNIT (GCU) LOCATOR
Figure 30



ELECTRICAL POWER CONTROL UNIT (EPCU) LOCATOR
Figure 31



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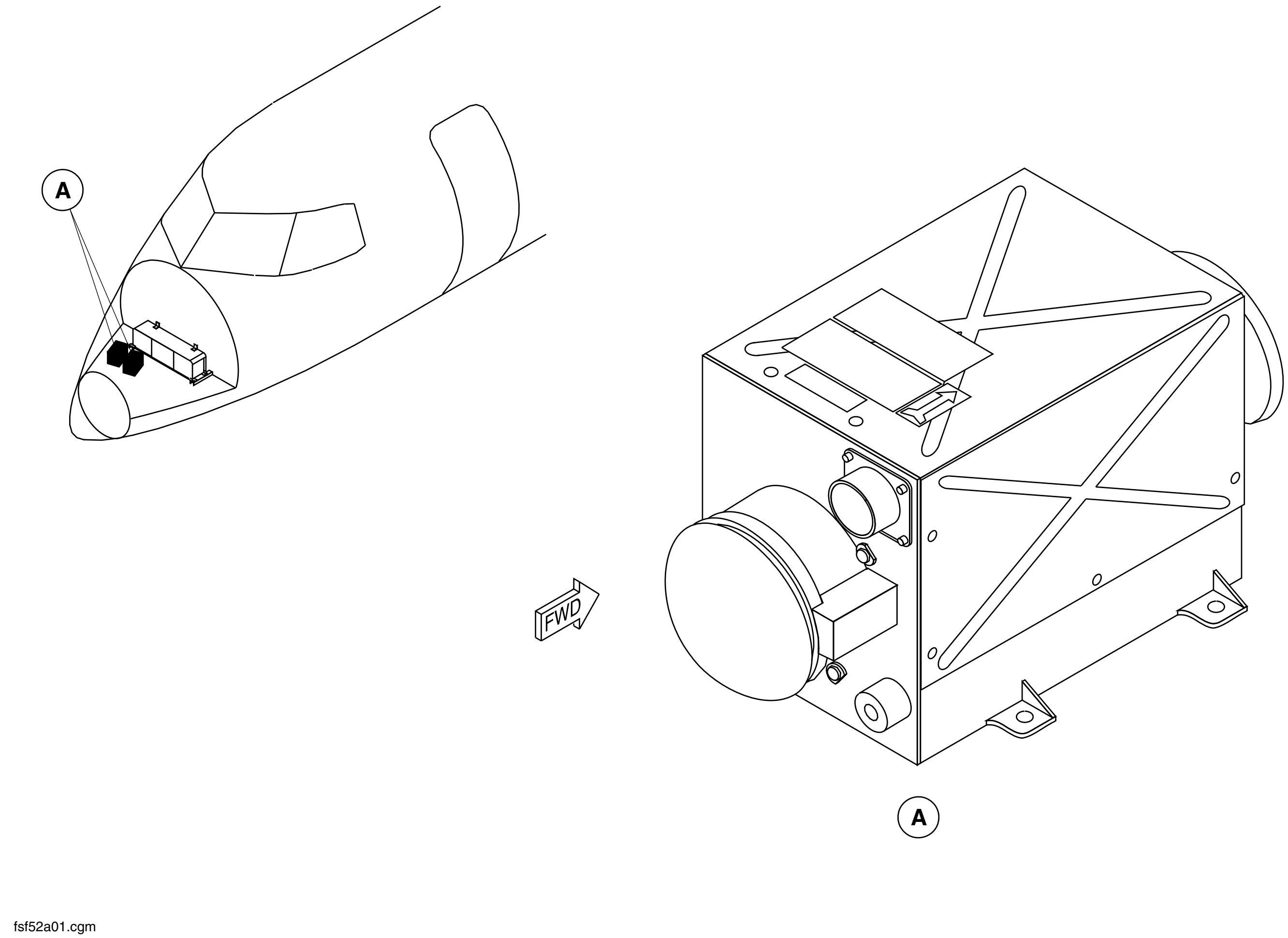
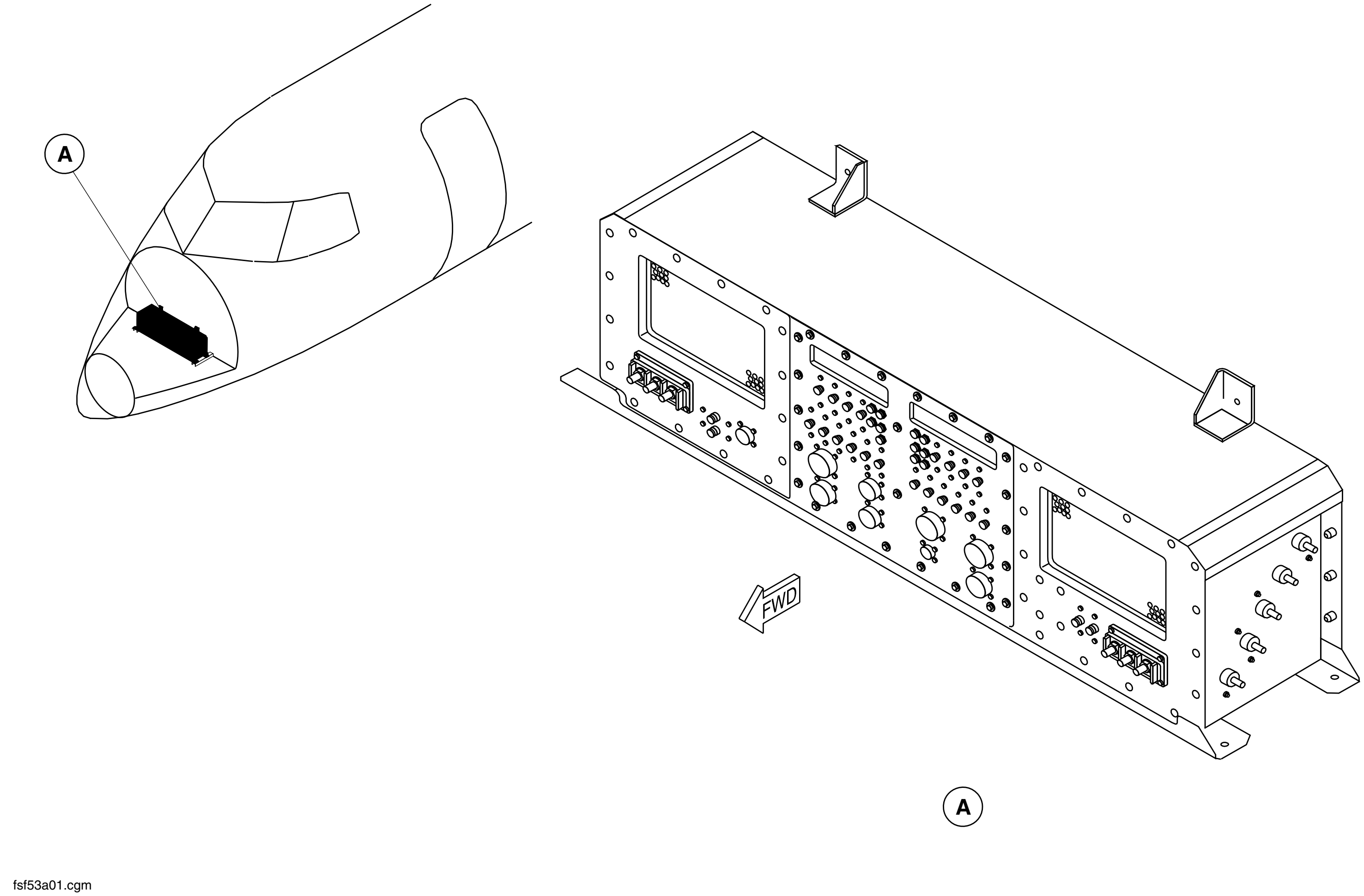
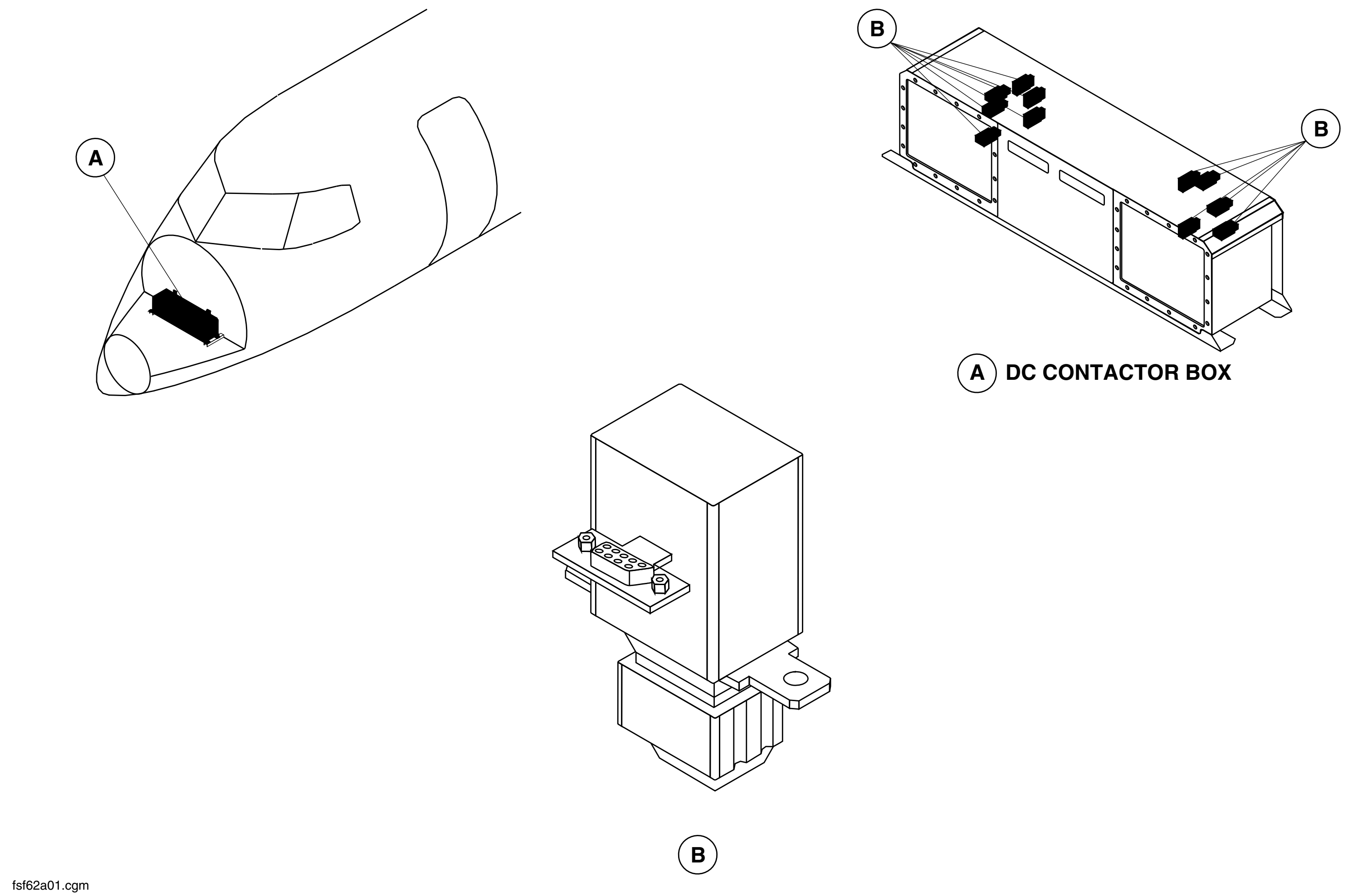
DC CONTROL PANEL LOCATOR
Figure 32



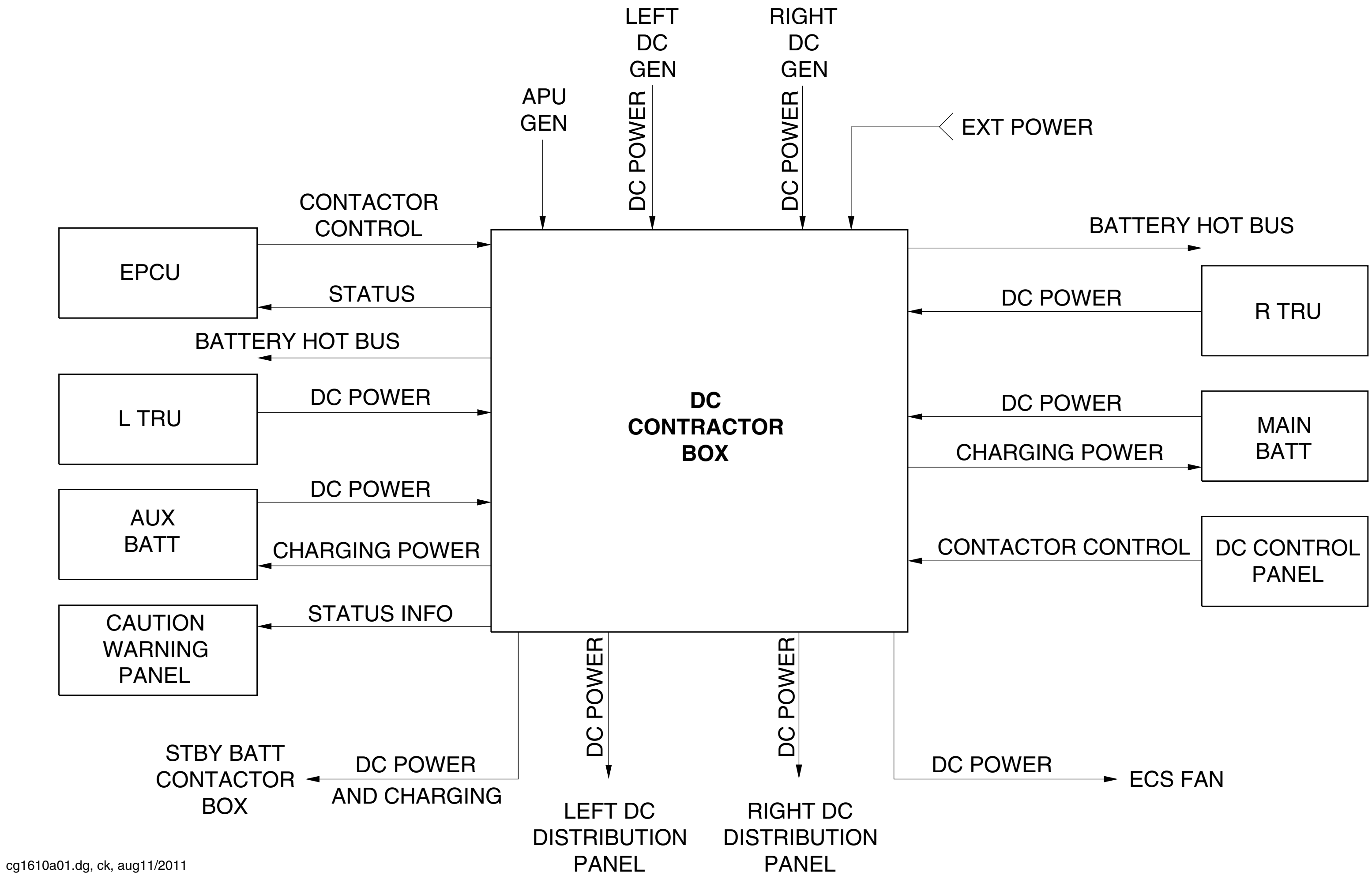
TRANSFORMER RECTIFIER UNITS (TRU) LOCATOR
Figure 33



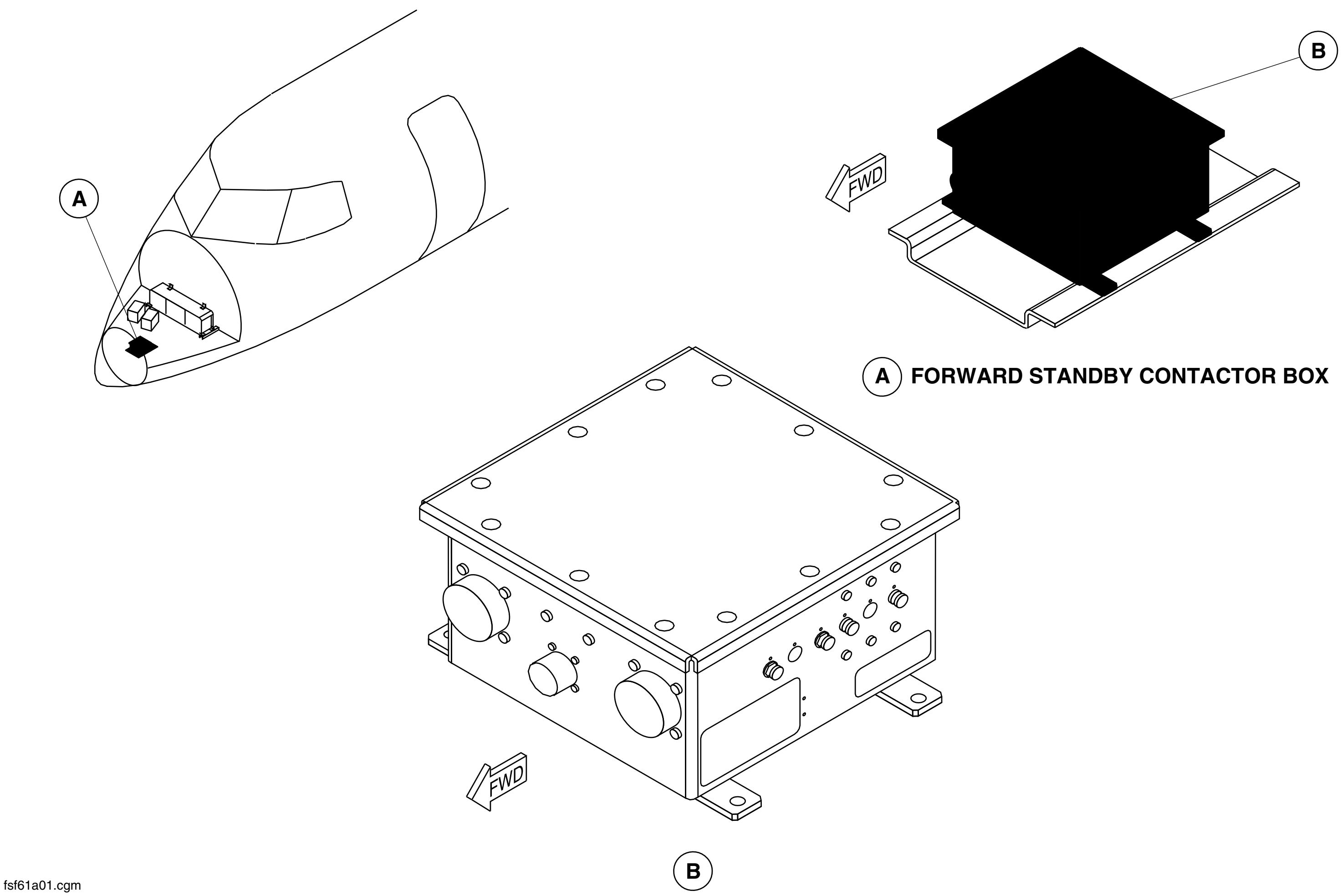
DC CONTACTOR BOX (DCCB) LOCATOR
Figure 34



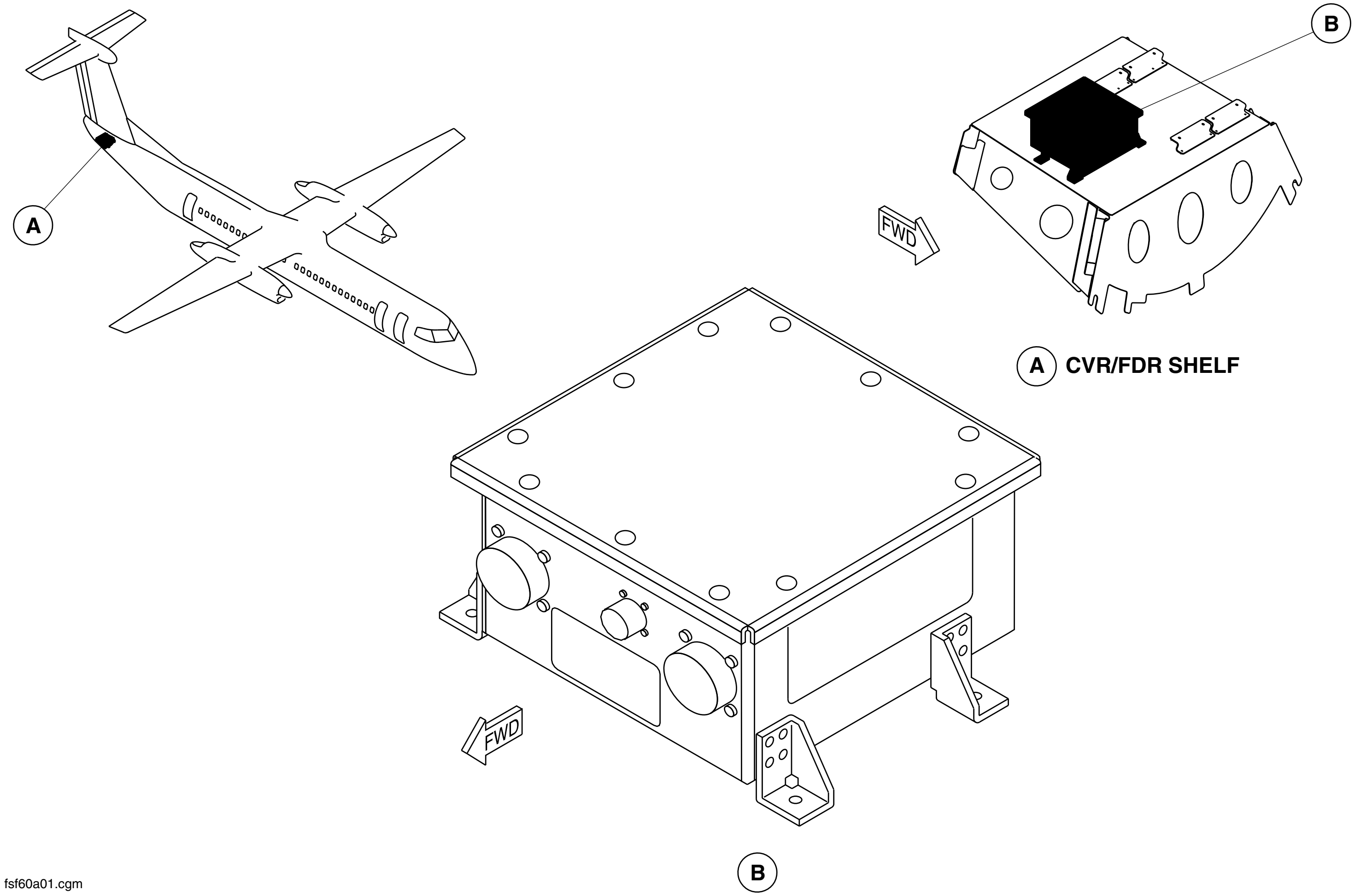
DC CONTACTORS LOCATOR
Figure 35



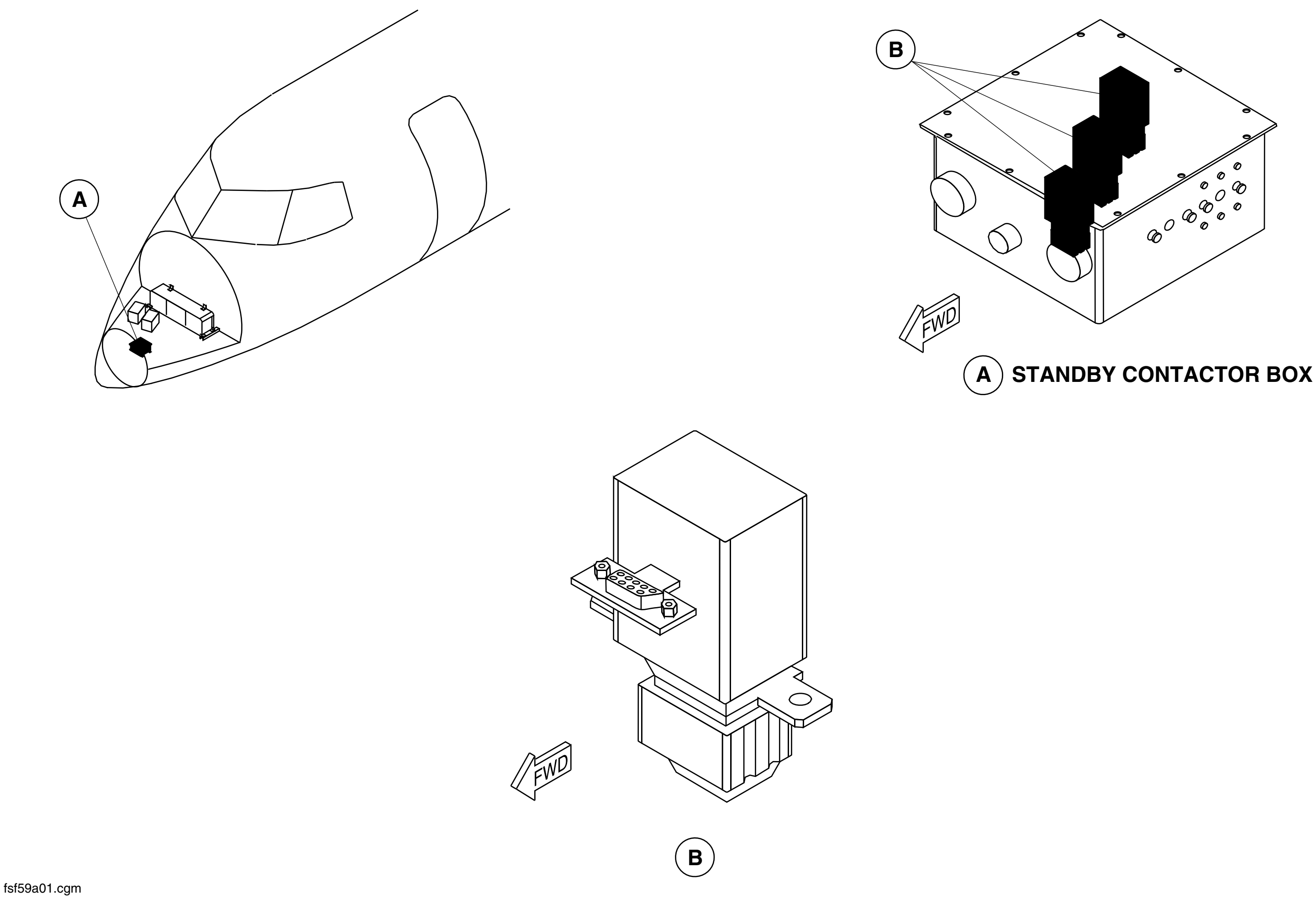
DCCB External Interfaces
Figure 36



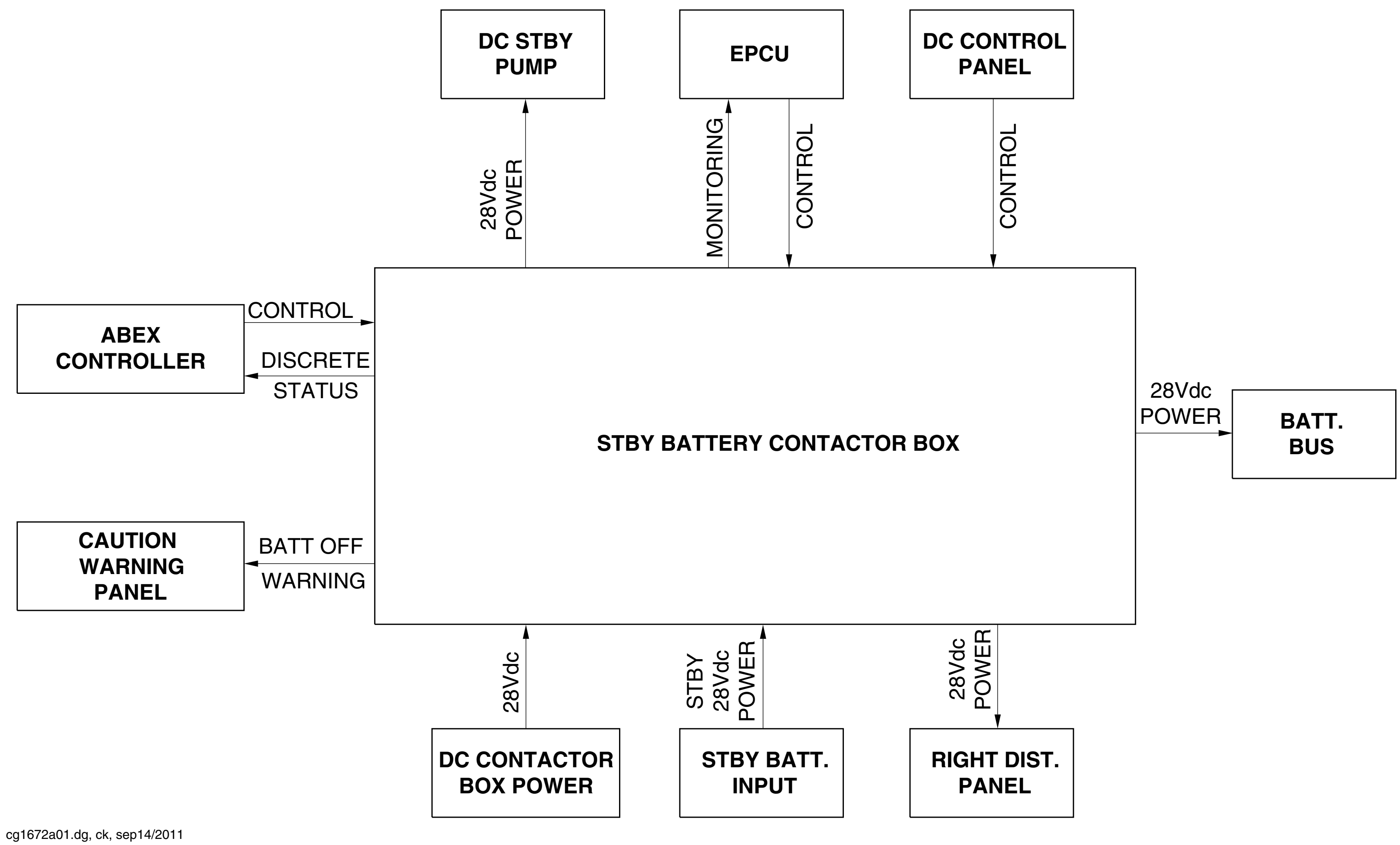
STANDBY BATTERY CONTACTOR BOX (SBCB) LOCATOR, FORWARD
Figure 37



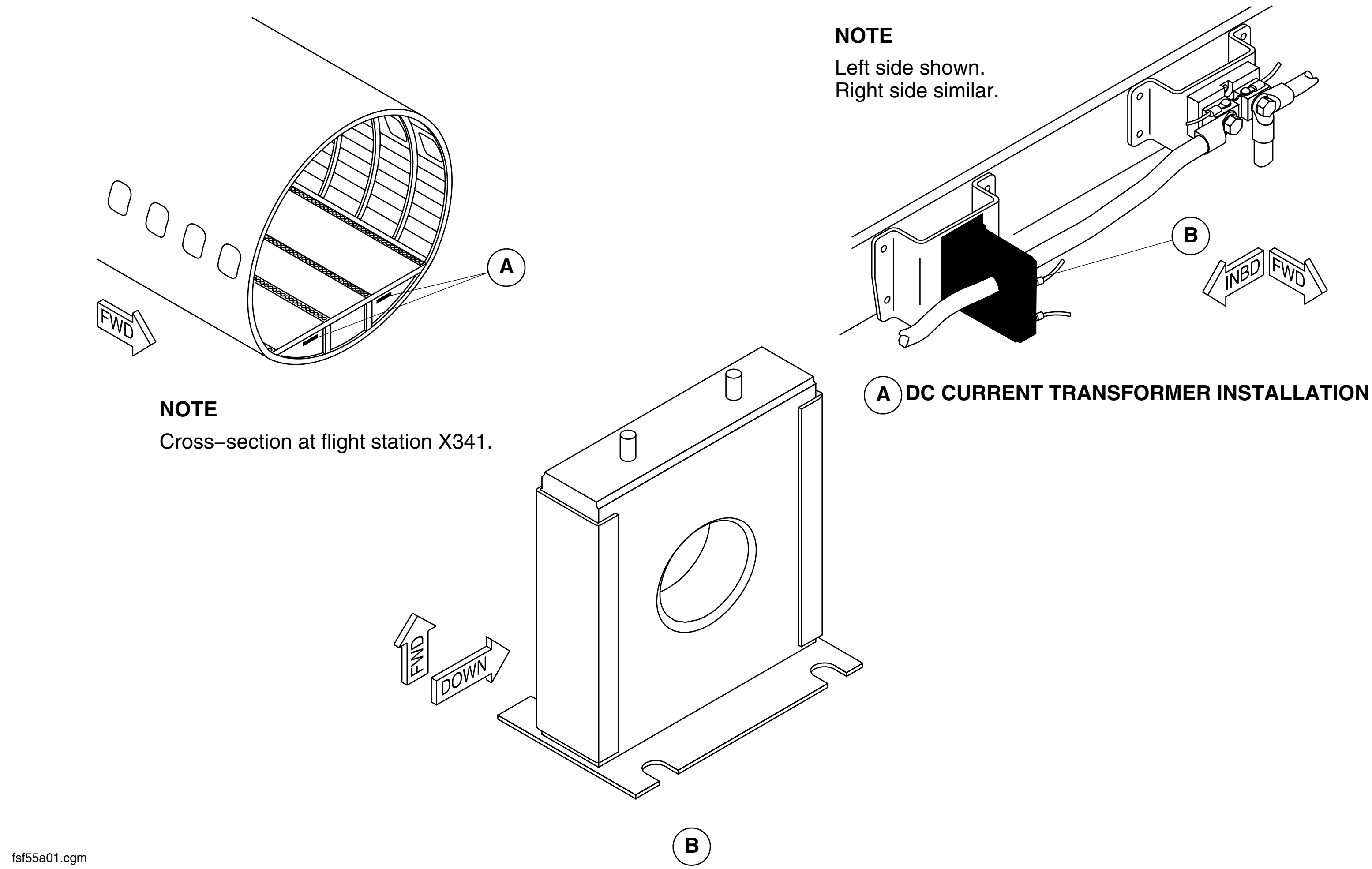
STANDBY BATTERY CONTACTOR BOX (SBCB) LOCATOR, AFT
Figure 38



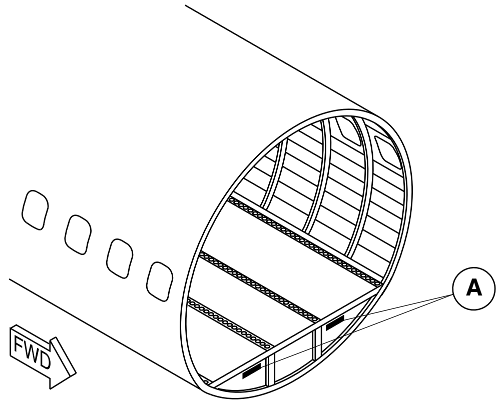
STANDBY BATTERY CONTACTORS LOCATOR
Figure 39



Standby Battery Contactor Box External Interfaces
Figure 40



DC CURRENT TRANSFORMERS LOCATOR
Figure 41

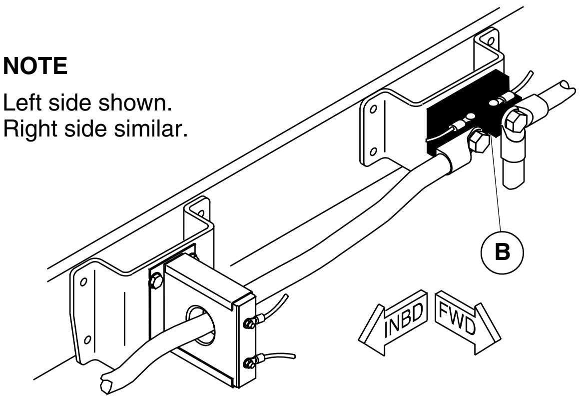


NOTE

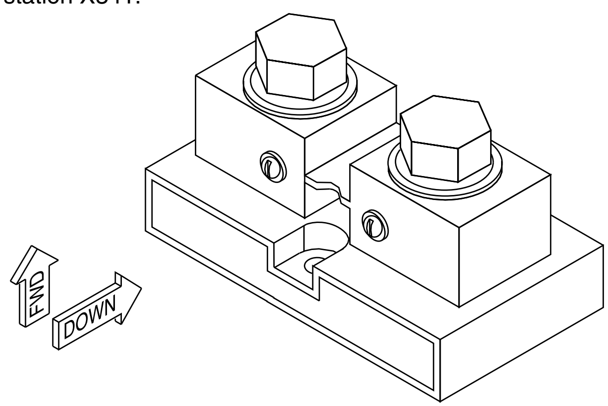
Cross–section at flight station X341.

NOTE

Left side shown.
Right side similar.



A DC CURRENT SHUNT INSTALLATION



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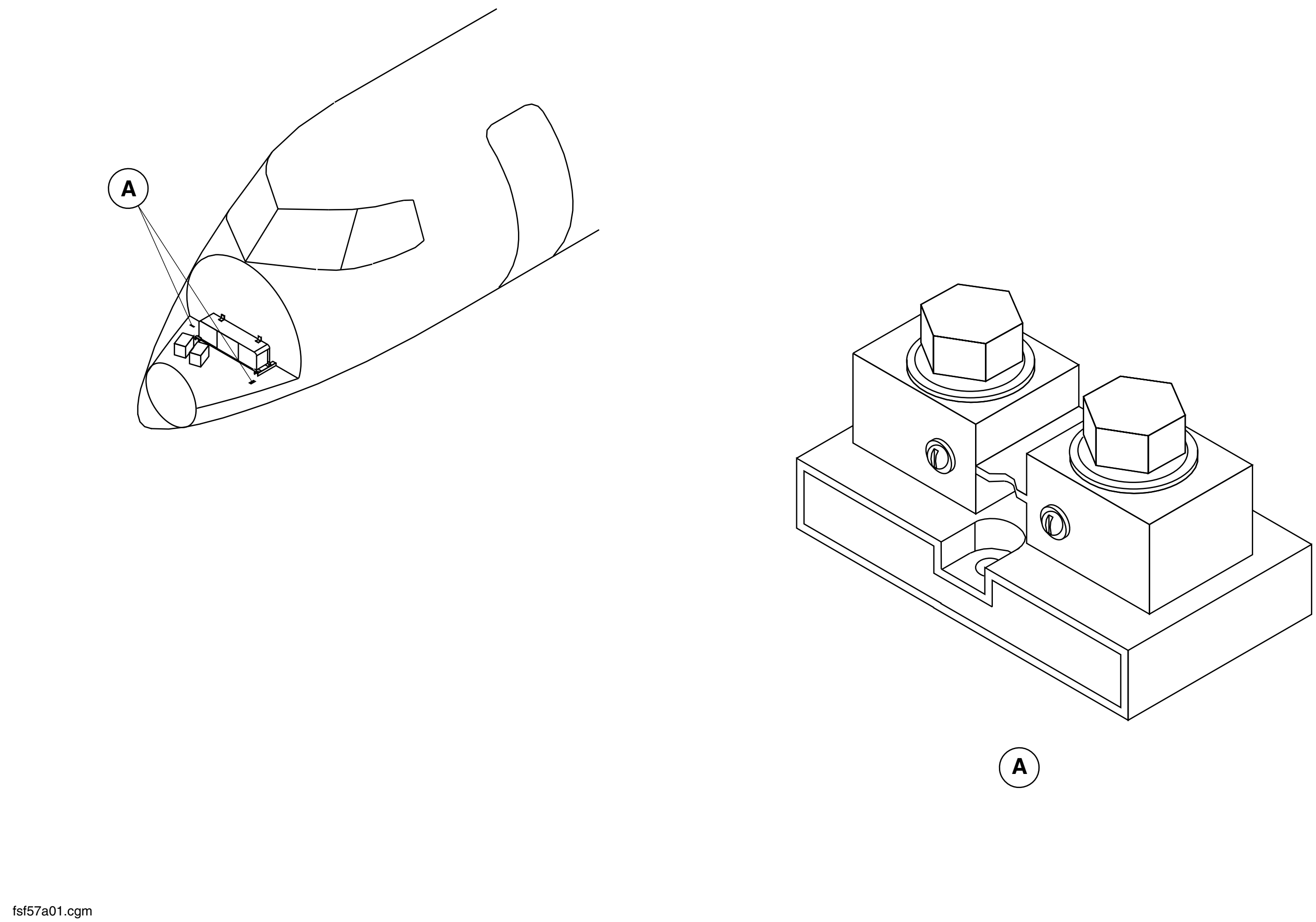
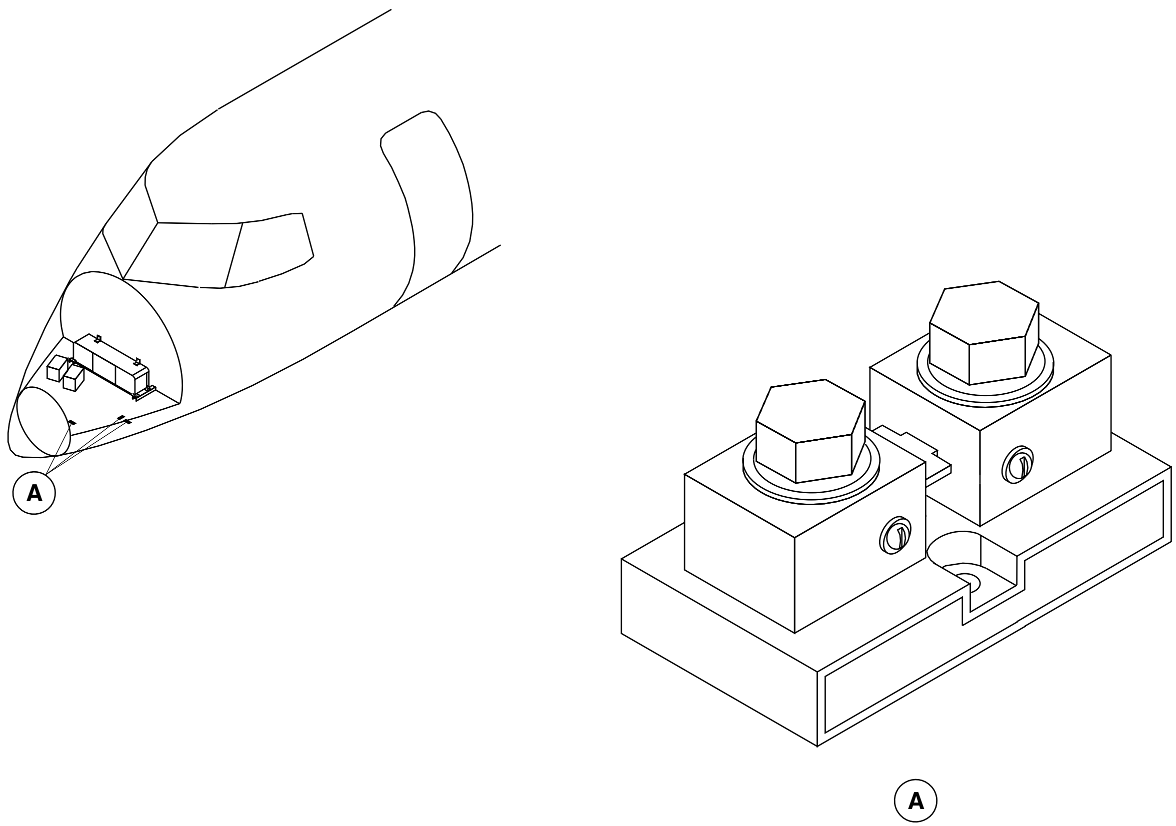
DC STARTER/GENERATOR CURRENT SHUNTS LOCATOR
Figure 42



TRU CURRENT SHUNTS LOCATOR
Figure 43



BATTERY CURRENT SHUNTS LOCATOR
Figure 44

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24–32–00–001

BATTERY SYSTEM

Introduction

The battery system supplies emergency 28 Vdc electrical power to the aircraft dc essential busses and to the #3 Standby Hydraulic Pump.

General Description

Refer to Figures 1 and 2.

The battery power system of the aircraft has three batteries and switching devices to supply electrical power to the essential busses during emergency flight conditions.

The main, auxiliary, and standby batteries are connected to the main feeder busses to receive a charging current. The main and the auxiliary batteries also connected to the main feeder busses to supply electrical power to start the engines. During an engine start condition, the standby battery is disconnected from the main feeder bus, but stays connected to the essential busses to maintain a minimum voltage level on the essential bus.

The dc control panel in the flight compartment has the toggle switches to control the battery system. The Engine and System Integrated Display (ESID) system shows main 28 Vdc generation system electrical indications.

The Battery system has the components that follow:

- Battery and Box, Main (24–32–01)
- Vent and Drains, Main Battery (24–32–06)
- Battery and Box, Auxiliary (24–32–11)
- Vent and Drains, Auxiliary Battery (24–32–16)
- Battery and Box, Standby (24–32–21)
- Vent and Drains, Standby Battery (24–32–26)

The contactors to connect the main and auxiliary batteries are located in the DC Contactor Box (DCCB) and the contactors that control the standby battery operation are located in the Standby Battery Contactor Box (SBCB). Refer to SDS 24–31–00, Main 28 VDC Generation System.

Detailed Description

Refer to Figure 3.

The BATTERY MASTER toggle switch is set to the ON position to close battery contactors K3, K4 and K24 and connect the three batteries to the essential busses of the aircraft. Contactor K3, K4 and K24 are controlled directly by the BATTERY MASTER toggle switch. Their operation is independent of the Electrical Power Control Unit (EPCU). The essential busses energize the EPCU.

The BATTERY MASTER toggle switch must be set to the ON position before the battery toggle switch selections are made to connect the batteries to the main feeder busses.

Each battery is connected to the main feeder busses by a related battery toggle switch to receive a charging current. A STBY BATT toggle switch selection, will cause the standby battery to connect to the left main feeder bus through contactor K25. An AUX BATT toggle switch selection, will cause the auxiliary battery to connect to the left main feeder bus through contactor K7. A MAIN BATT toggle switch selection, will cause the main battery to connect to the right main feeder bus through contactor K8.

During an emergency condition, the batteries are the electrical power sources for the main 28 Vdc generation system. Contactors K25, K7 and K8 will open to disconnect the standby, auxiliary and main batteries from their related main feeder bus. The essential distribution busses stay energized by the standby, auxiliary and main batteries.

The emergency mode is caused by the conditions that follow:

– Electrical power is not available from the two dc starter/generators, and
– Electrical power is not available from one or two TRUs, and
– The aircraft is airborne.

If a start attempt is made during the emergency condition, the batteries will automatically reconnect to the main feeder busses for the duration of the start sequence.

The AUX BATT and MAIN BATT toggle switches connect directly to their contactor. The other connection to the contactor is routed through normally closed contacts of a relay in the EPCU.

The relay in the EPCU is controlled by logic. In some conditions, the relays in the EPCU open to disable the contactor.

The batteries disconnect from the main feeder busses by the conditions that follow:

– APU or DC GCUs senses an over current condition
– Batteries are disconnected when charging is not allowed. The batteries can be charged by an ac external power source through the TRUs.

NOTE

Battery charging must be monitored.

A manual STBY BATT toggle switch selection will connect the standby battery to the left main feeder bus by closing contactor K25.

The EPCU causes contactor K25 to close when conditions that follow are correct:

– No engine is in start sequence
– An emergency condition is not sensed.

The batteries are charged while they are connected to the main feeder busses. The charging sources are either the dc starter/generators, the dc external power, or the aircraft Transformer Rectifier Units (TRUs).

A constant potential voltage is supplied to the battery terminals to charge the batteries. When the dc starter/generators are used to charge the batteries, a regulated 28.5 Vdc output is supplied to the batteries.

When the batteries are charged from a dc external power source or ac external power source through the TRUs, the charging current, voltage and temperature of the batteries must be visually monitored.

The battery current shunts supply output current data from the standby, auxiliary, and main batteries to the EPCU for EIS indication.

The negative terminal of each battery is connected through separate current shunts to airframe ground potential. The battery current shunts are located near the batteries.

The batteries have two independent internal sensors that sense battery temperature. A thermal sensor supplies battery temperature data to the EPCU for EIS indications, and a bi–metalic temperature switch supplies temperature exceedance data to the caution and warning system for warning indications. The internal sensor wires are routed through a circular connector attached to the battery case.

Refer to Figure 4.

When the battery toggle switch located on the dc control panel is set to BATTERY MASTER position, the standby, auxiliary and main batteries energize the essential busses if no other dc power source is available.

Refer to Figure 5.

When the battery toggle switches are set to STBY BATT, AUX BATT, and MAIN, the standby, auxiliary and main batteries will connect to the main feeder busses to receive a charging current.

The Electrical Power Control Unit (EPCU) supplies indication data through the two Input/Output Processors (IOP1, IOP2) located in the Integrated Flight Cabinets (IFCs) to the Electronic Instruments System (EIS).

Refer to Figure 6.

The MFD1 and MFD2 reversion switches located on the ESID Control Panel (ESCP) are used to select the electrical page on the multi–functional displays.

Refer to Figure 7.

The electrical page shows the dc starter/generator indications that follow:

- Digital indication of the standby, auxiliary and main battery loads
- Digital indication of standby, auxiliary and main battery temperature.

The battery indication has a BATT title in white letters. The indication has MAIN, AUX and STBY titles in white fonts to show the load and temperature of the main, auxiliary and standby batteries.

Battery Load Indication: The battery load indication shows the battery load in white numbers.

The numbers show the battery output load as a percentage of the total rated output. A + symbol before the numbers is used to show an overload condition of the battery. The symbol is out of view when the load is less than 100%. A — symbol shows a discharge condition.

Battery Temperature Indication: The battery temperature indication shows the battery temperature in degrees Celsius in white numbers. The indication changes to yellow when temperature is more than 50 and less than 65 °C. If the temperature is more than 65 °C, the indication will change to red.

Refer to Figure 8.

When the voltage or load data malfunctions, the digits are replaced by white dashes.

Refer to Figure 8.

The battery system malfunctions are shown with the caution lights that follow:

- STBY BATT
- AUX BATT
- MAIN BATT

Refer to Figure 10.

The battery system malfunctions are shown with the warning lights that follow:

- STBY BATT HOT
- AUX BATT HOT
- MAIN BATT HOT

STBY BATT, AUX BATT, MAIN BATT Caution Lights: The STBY BATT, AUX BATT or MAIN BATT caution light comes on to show that the battery is not connected to its main feeder bus for charging.

STBY BATT HOT, AUX BATT HOT, MAIN BATT HOT Warning Lights: The STBY BATT HOT, AUX BATT HOT or MAIN BATT HOT warning light comes on to show that the battery temperature is more than 71 °C. It goes out when the temperature is less than 63 °C.

Main and Auxiliary Batteries

Refer to Figure 11.

Refer to Figure 12.

Refer to Figure 13.

The main and auxiliary batteries are self contained power sources that operate in the charge and discharge modes.

The main 28 Vdc generation system supplies electrical power to the battery during the charge mode. The amount of charge current is determined by the state of charge and the internal resistance of the battery. After a long discharge period, the initial charge current can peak at 200 A. The current rapidly decreases as the battery starts to charge.

During the discharge mode, the battery supplies electrical power. The battery output voltage decreases as the current load increases.

The 40 A hour batteries have a rated discharge of 40 A for one hour. The discharge rate is not linear. The capacity is usually less than the rated value when the discharge current is more than the nominal value.

Note: The voltage at the battery terminals cannot be used as an indication of the battery state of charge.

The battery has nickel and cadmium (NiCad) plates with potassium hydroxide electrolyte. The NiCad battery has relatively constant voltage for most of the discharge condition.

A main power positive and negative electrical connection to the battery terminals is made with a power plug connector attached to the case.

The batteries have two independent internal sensors that sense battery temperature. A Resistive Temperature Device (RTD) thermal sensor is used to measure the battery temperature for an EIS indication and a bi–metalic temperature switch is used to sense a temperature exceedance for a warning indication. The internal sensor wires are routed through a circular connector attached to the battery case.

On aircraft without ModSum 4–309299 incorporated, the batteries are 40 A hour batteries with an assembly of individual cells contained in a steel case. Each cell is connected in series to make 24 Vdc at the terminals. Solid copper bus bars are used to connect the cells.

The main and auxiliary batteries weigh 76.5 lb (34.7 kg). They are 10.25 in. (260.4 mm) wide, 10.5 in. (266.7 mm) long and 9.7 in. (246.4 mm) high.

On aircraft with ModSum 4–309299 incorporated, the batteries are 43 A hour batteries with an assembly of individual cells contained in a steel case. Each cell is connected in series to make 24 Vdc at the terminals. Nickel plated copper plates are used to connect the cells.

The main and auxiliary batteries weigh 80 lb (36.29 kg). They are 10.3 in. (262 mm) wide, 11.8 in. (300 mm) long and 9.9 in. (251 mm) high.

The left lower nose compartment door must be opened to access the batteries. The battery is secured to the airframe in the nose compartment by tabs that are part of the battery case cover. The case is a steel box with a removable cover to gain access for inspection. It also has a vent port that attaches to a tube that routes the gas overboard through a containment vessel.

Standby Battery

Refer to Figure 14.

Refer to Figure 15.

Refer to Figure 16.

The Standby battery is a self contained power source that operates in charge and the discharge modes.

The main 28 Vdc generation system supplies electrical power to the battery during the charge mode. The amount of charge current is determined by the state of charge and the internal resistance of the battery. After a long discharge period, the initial charge current can peak at 200 A. The current rapidly decreases as the battery starts to charge.

During the discharge mode, the battery supplies electrical power. The battery output voltage decreases as the current load increases.

The 17 A hour batteries have a rated discharge of 17 A for one hour. The discharge rate is not linear. The capacity is usually less than the rated value when the discharge current is more than the nominal value.

Note: The voltage at the battery terminals cannot be used as an indication of the battery state of charge.

The battery has nickel and cadmium (NiCad) plates with potassium hydroxide electrolyte. The NiCad battery has relatively constant voltage for most of the discharge condition.

A main power positive and negative electrical connection to the battery terminals is made with a power plug connector attached to the case.

The battery has two independent internal sensors that sense battery temperature. A Resistive Temperature Device (RTD) thermal sensor is used to measure the battery temperature for an EIS indication and a bi–metalic temperature switch is used to sense a temperature exceedance for a warning indication. The internal sensor wires are routed through a circular connector attached to the battery case.

On the aircraft without ModSum 4–309300 incorporated, the battery is a 17 or 40 A hour battery with an assembly of individual cells contained in a steel case. Each cell is connected in series to make 24 Vdc at the terminals. Solid copper bus bars are used to connect the cells.

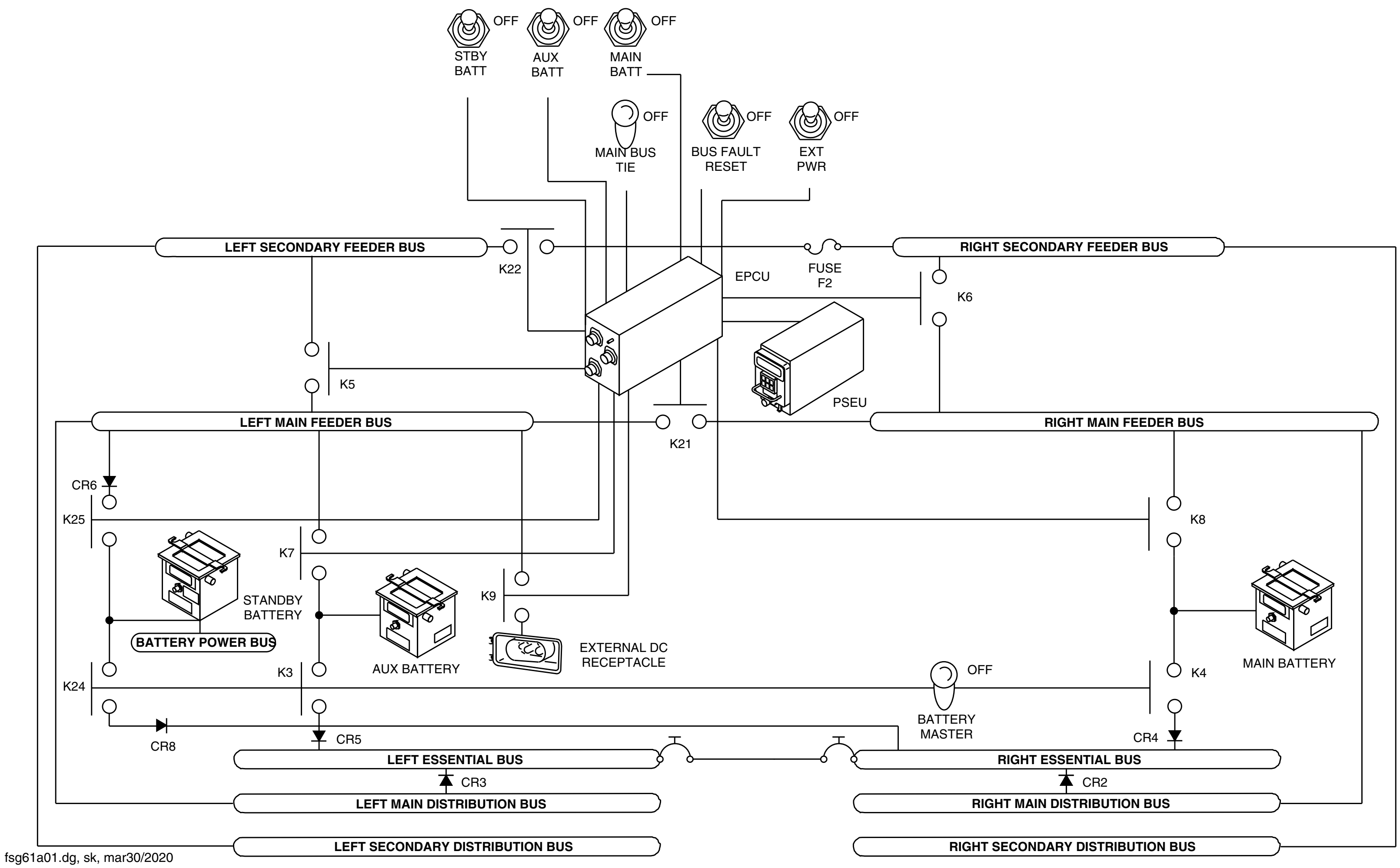
The standby battery weighs 38.5 lb (17.46 kg) or 76 lb (35 kg). It is 7.7 in. (195.6 mm) wide, 8.5 in. (215.9 mm) long and 9.75 in. (247.7 mm) high.

On the aircraft with ModSum 4–309300 incorporated, the battery is a 43 A hour battery with an assembly of individual cells contained in a steel case. Each cell is connected in series to make 24 Vdc at the terminals. Nickel plated copper plate bus bars are used to connect the cells.

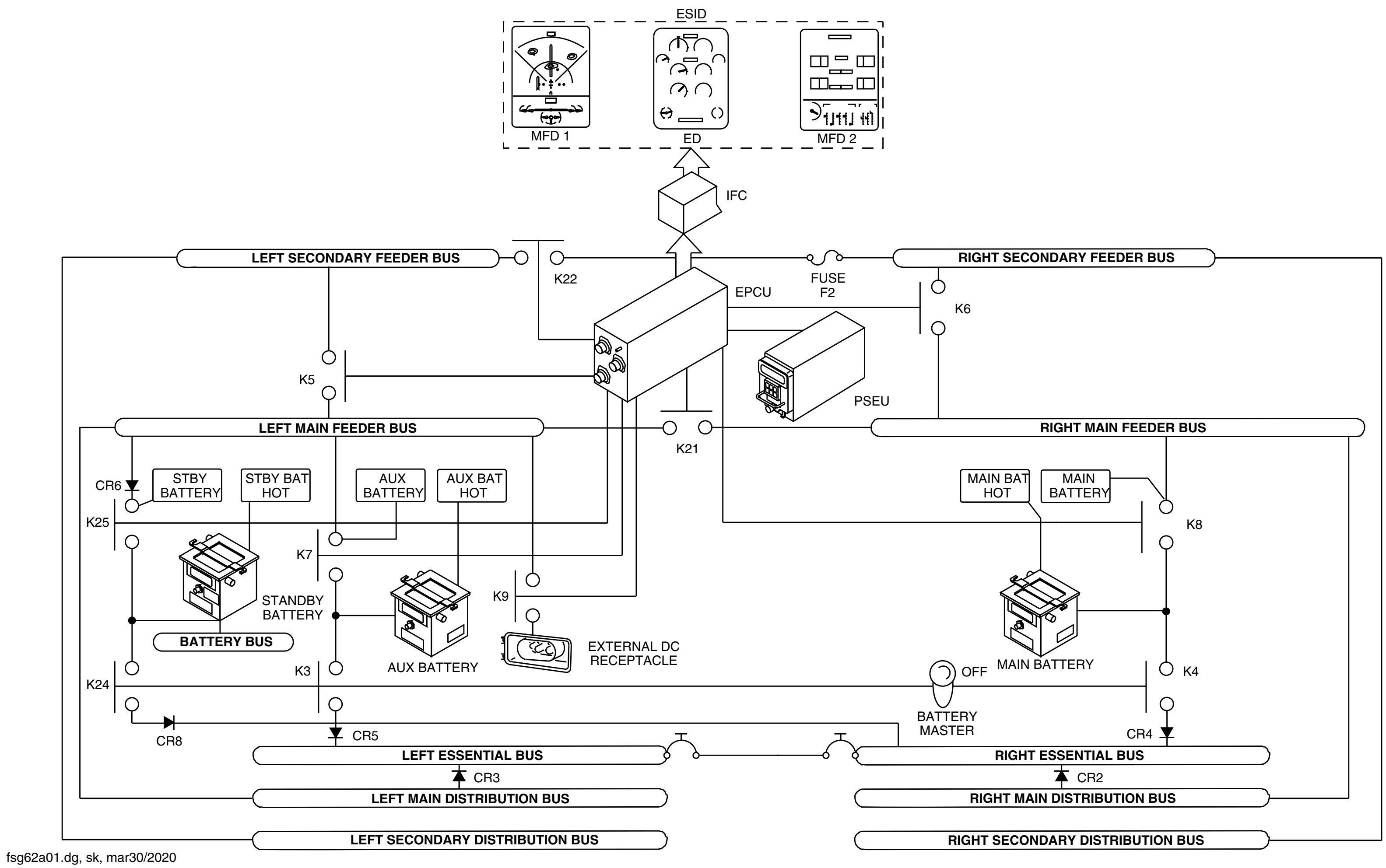
The standby battery weighs 80 lb (36.30 kg). It is 10.3 in. (262 mm) wide, 11.8 in. (300 mm) long and 9.9 in. (251 mm) high.

If the aircraft has a 17 A hour or 40 A hour or 43 A hour standby battery installed with Auxiliary Power Unit (APU), it is located in the forward fuselage nose compartment. The left upper nose compartment door must be opened to access the battery. The battery is secured to the airframe in the nose compartment by tabs that are part of the battery case cover. The case is a steel box with a removable cover to gain access for inspection. It also has a vent port that attaches to a tube that routes the gases overboard through a containment vessel.

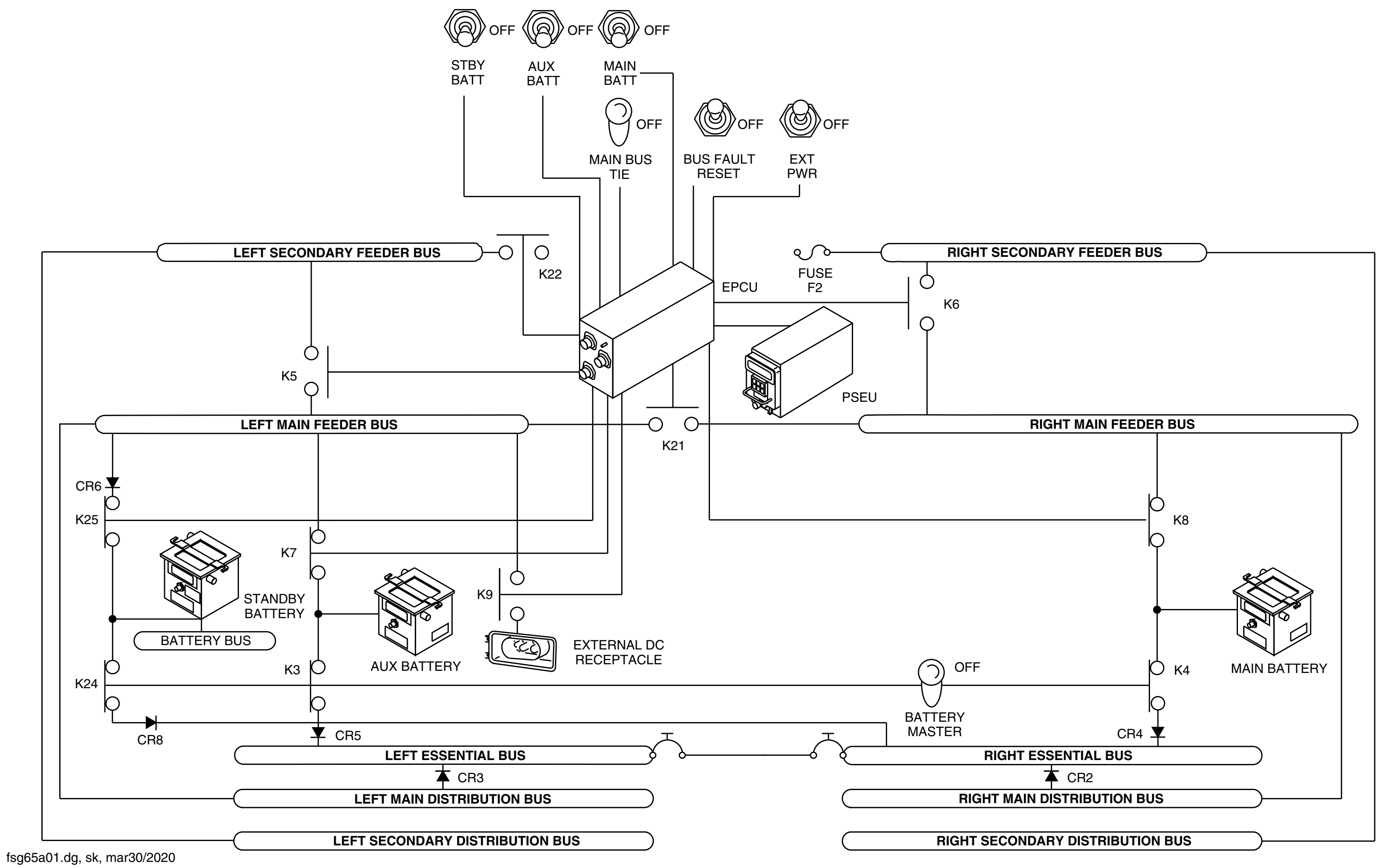
If the aircraft has a 40 A hour standby battery installed with no Auxiliary Power Unit (APU), it is located in the aft fuselage compartment. The aft fuselage compartment door must be opened to access the battery. The battery is secured to a shelf by tabs that are part of the battery case cover. It also has a vent port that attaches to a tube that routes the gases overboard through a containment vessel near the battery.



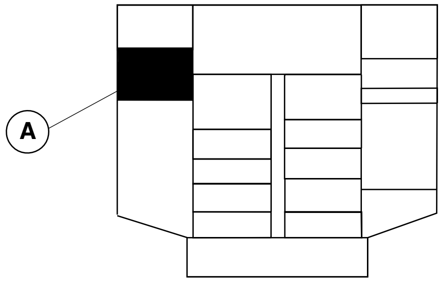
Battery System Block Diagram, Controls
Figure 1



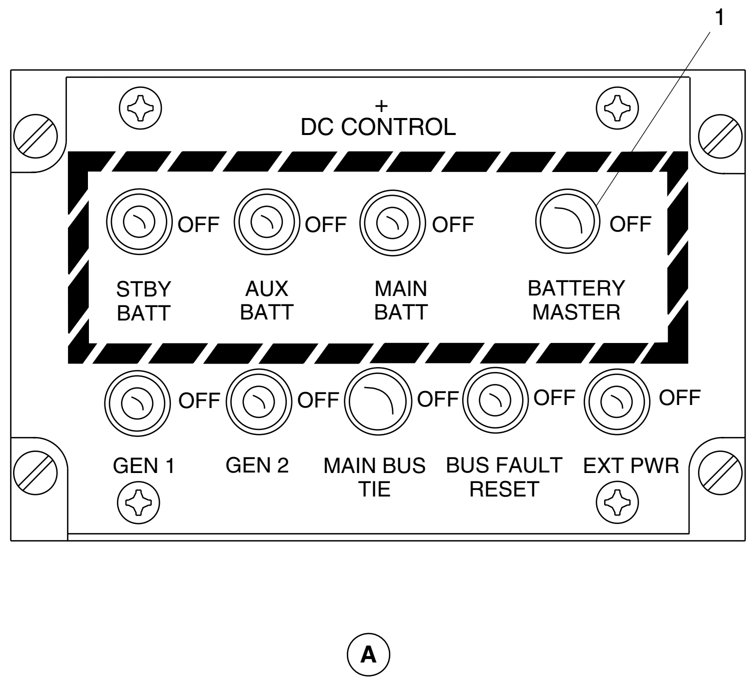
Battery System Block Diagram, Indication
Figure 2



Battery System Block Diagram, Operation
Figure 3



OVERHEAD CONSOLE



LEGEND

1. Battery Master Toggle Switch.

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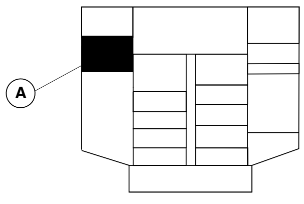
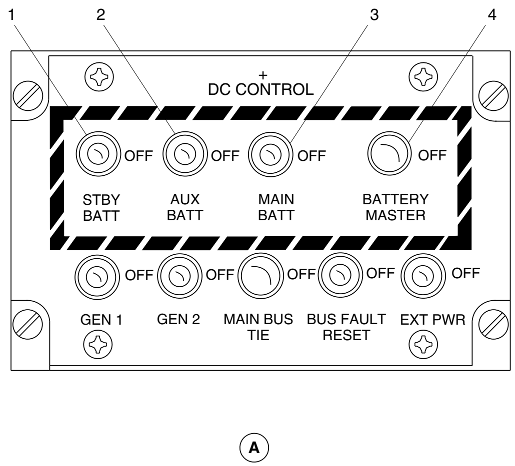
BATTERY SYSTEM, DC CONTROL PANEL PAGE 1
Figure 4





LEGEND

1. Standby Battery Toggle Switch.
2. Auxiliary Battery Toggle Switch.
3. Main Battery Toggle Switch.
4. Battery Master Toggle Switch.

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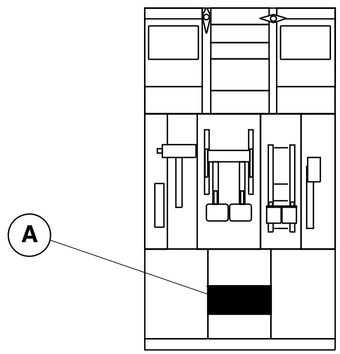
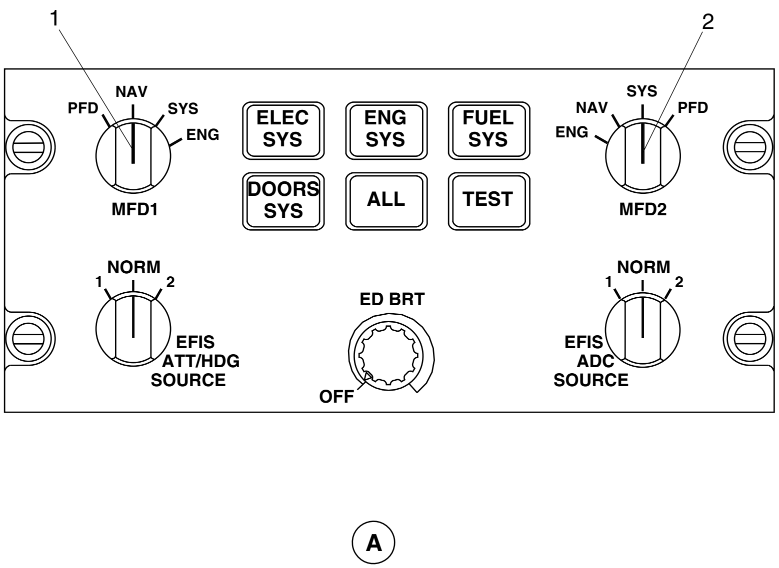
BATTERY SYSTEM, DC CONTROL PANEL PAGE 2
Figure 5





LEGEND

1. MFD 1 Reversion Selector.
2. MFD 2 Reversion Selector.

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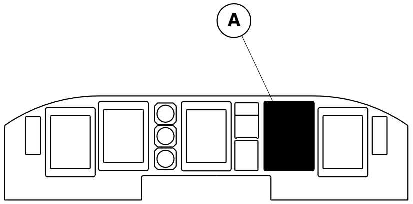
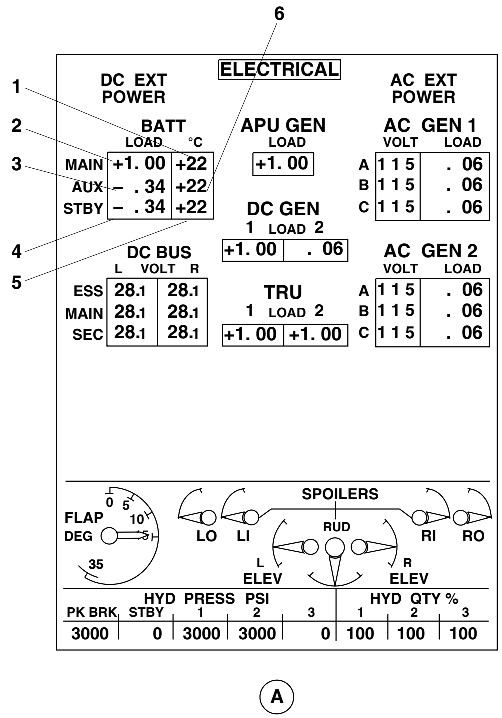
EIS, ELECTRICAL SYSTEM PAGE SELECTION
Figure 6



MAIN INSTRUMENT PANEL



LEGEND

1. Main Battery Temperature Digital Indication.
2. Main Battery Load Digital Indication.
3. Auxiliary Battery Load Digital Indication.
4. Standby Battery Load Digital Indication.
5. Standby Battery Temperature Digital Indication.
6. Auxiliary Battery Temperature Digital Indication.

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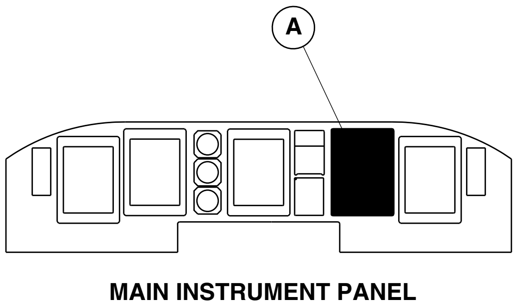
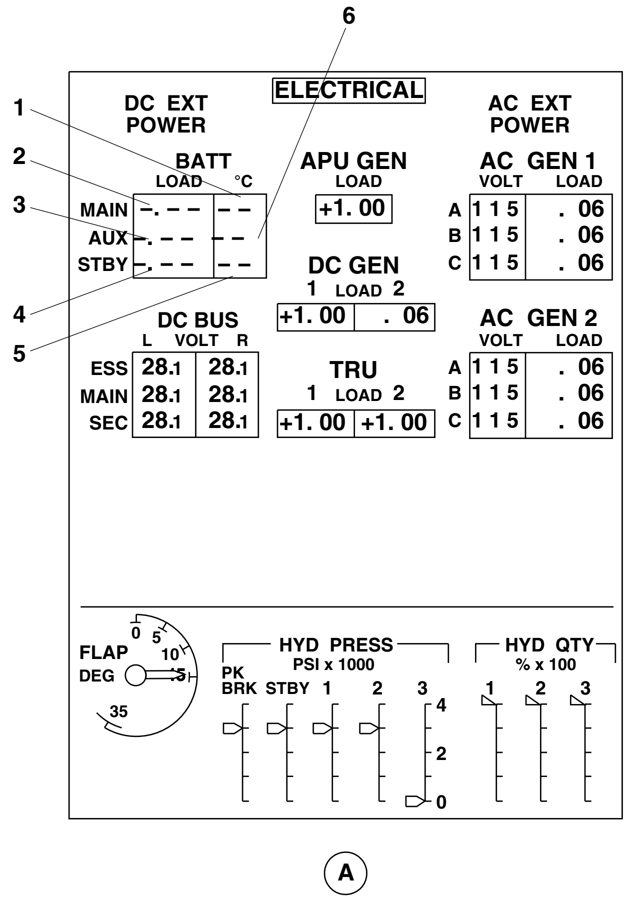
EIS, BATTERY SYSTEM INDICATIONS
Figure 7





LEGEND

1. Main Battery Temperature Fail Digital Indication.
2. Main Battery Load Fail Digital Indication.
3. Auxiliary Battery Fail Digital Indication.
4. Standby Battery Fail Digital Indication.
5. Standby Battery Temperature Fail Digital Indication.
6. Auxiliary Battery Temperature Fail Digital Indication.

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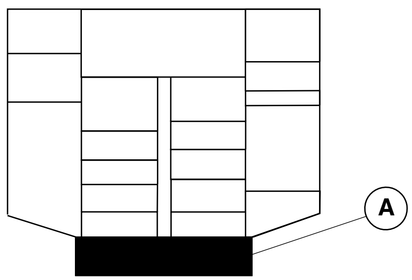
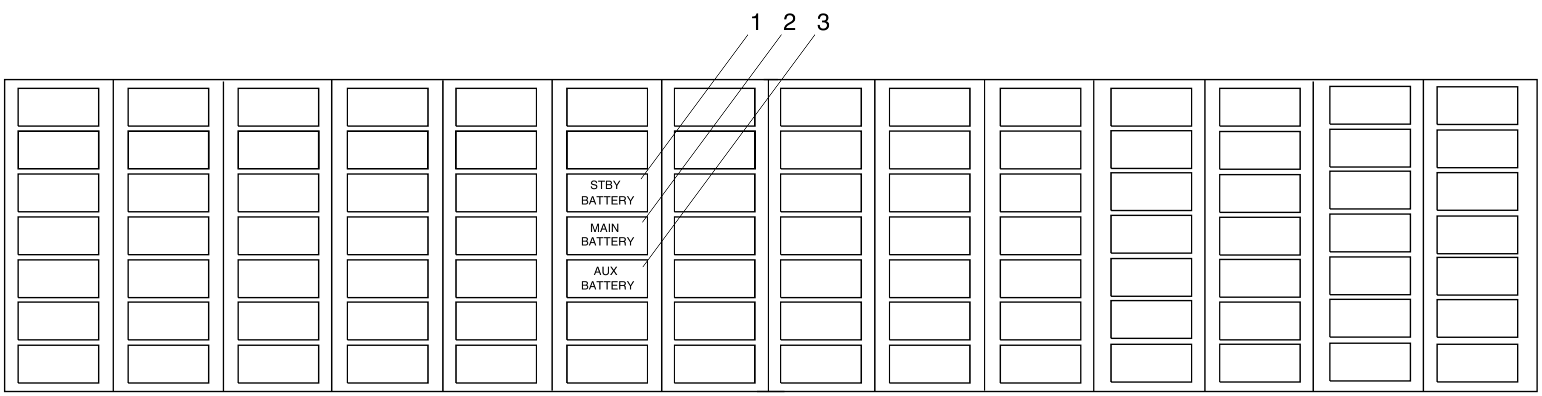
EIS, BATTERY SYSTEM MALFUNCTION INDICATIONS
Figure 8



OVERHEAD CONSOLE

LEGEND

1. STBY BATTERY.
2. MAIN BATTERY.
3. AUX BATTERY.



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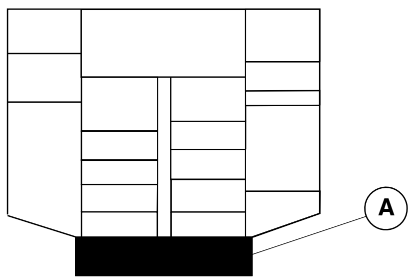
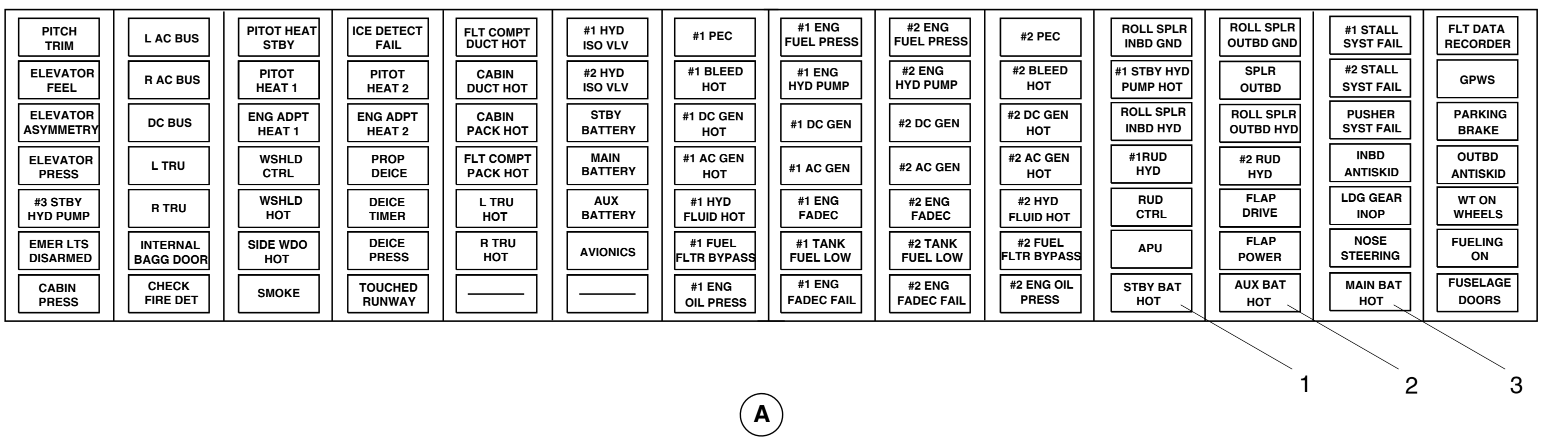
CAUTION AND WARNING PANEL, BATTERY SYSTEM CAUTION INDICATIONS
Figure 9



LEGEND

1. Standby Battery Hot.
2. Main Battery Hot.
3. Auxiliary Battery Hot.



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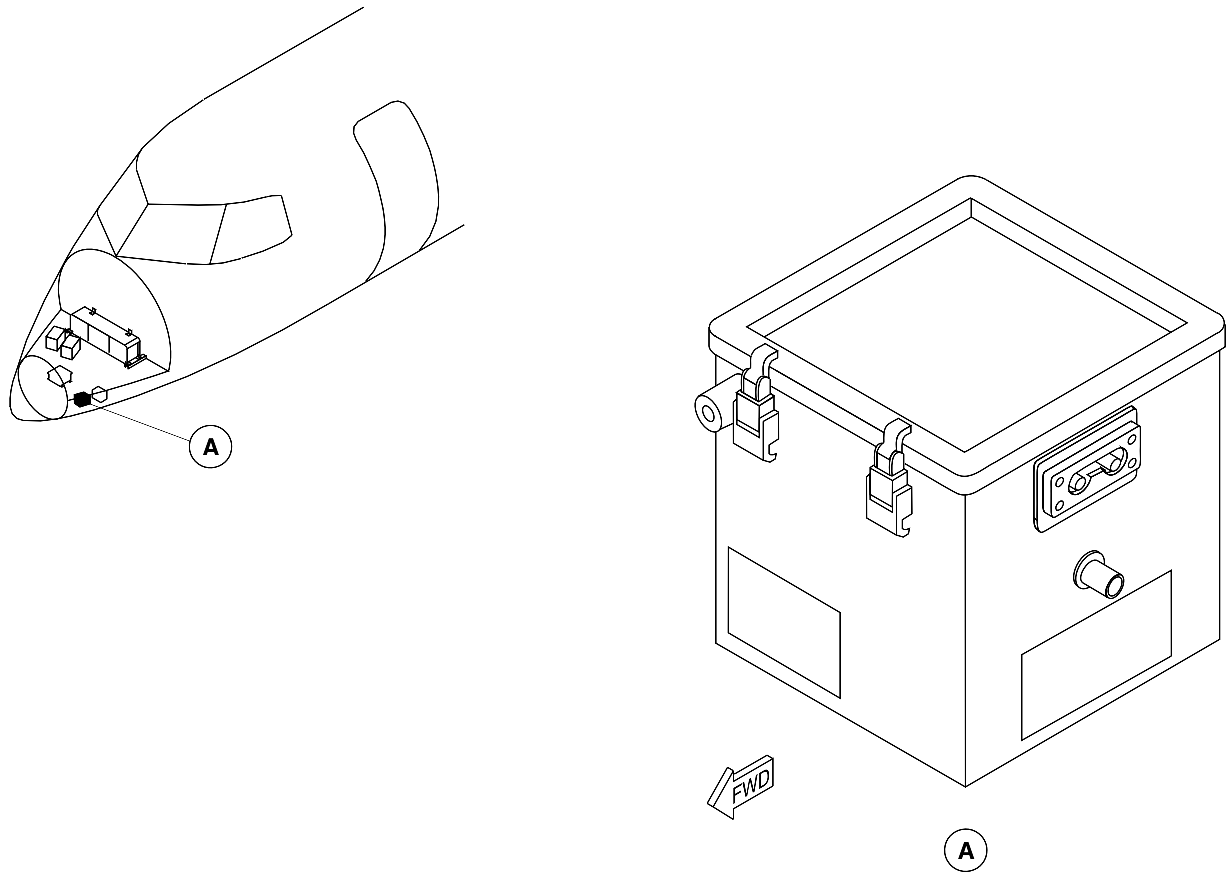
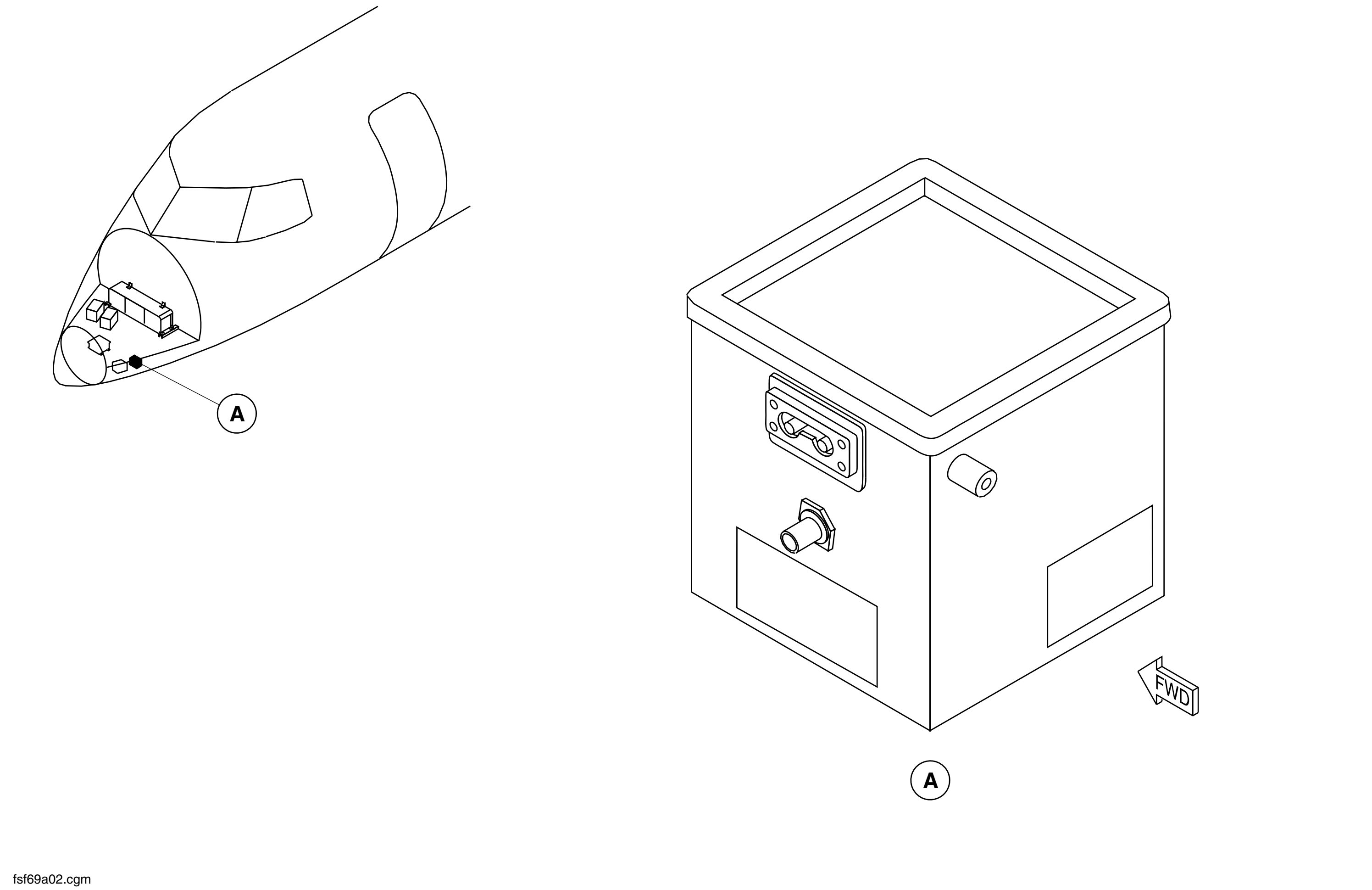
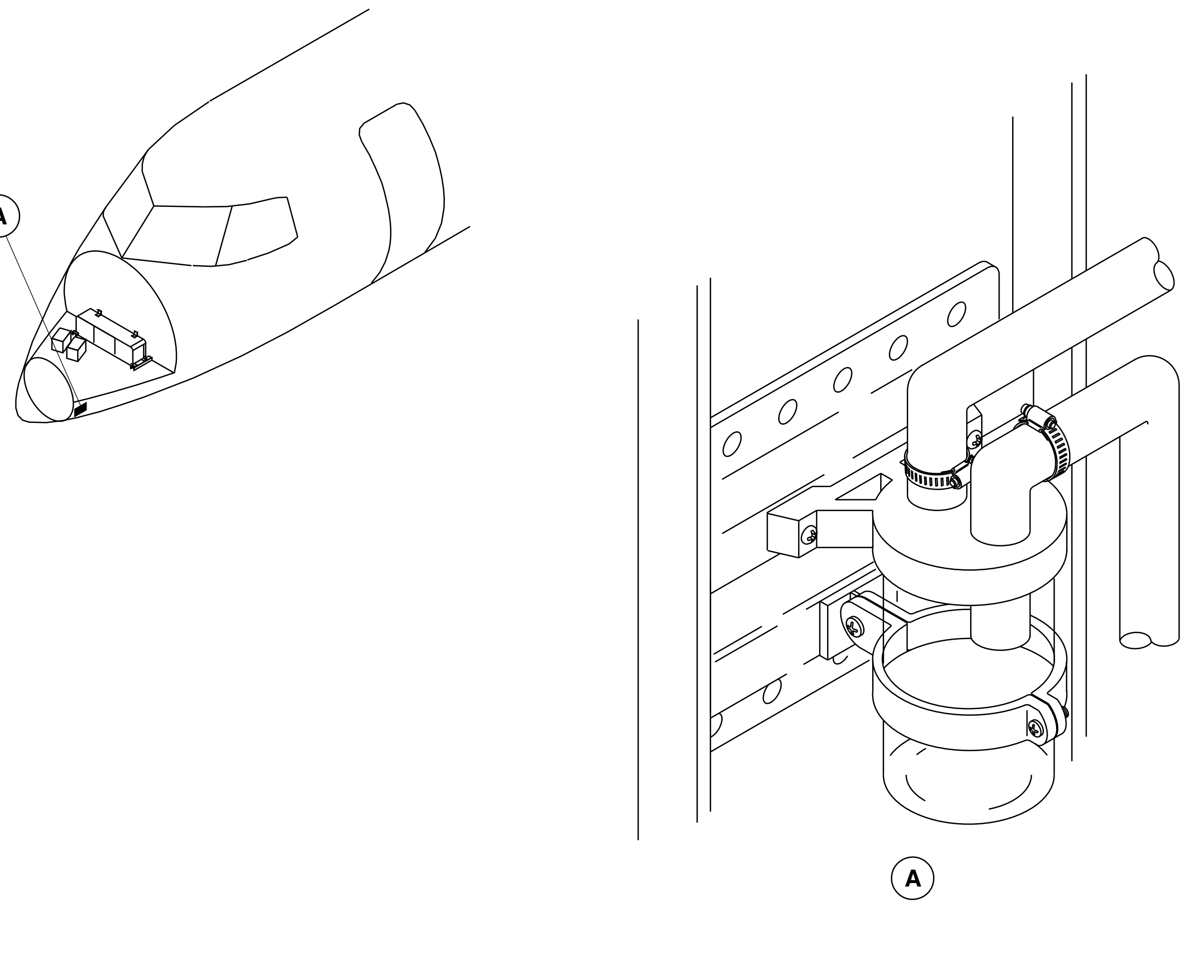
CAUTION AND WARNING PANEL, BATTERY SYSTEM WARNING INDICATIONS
Figure 10



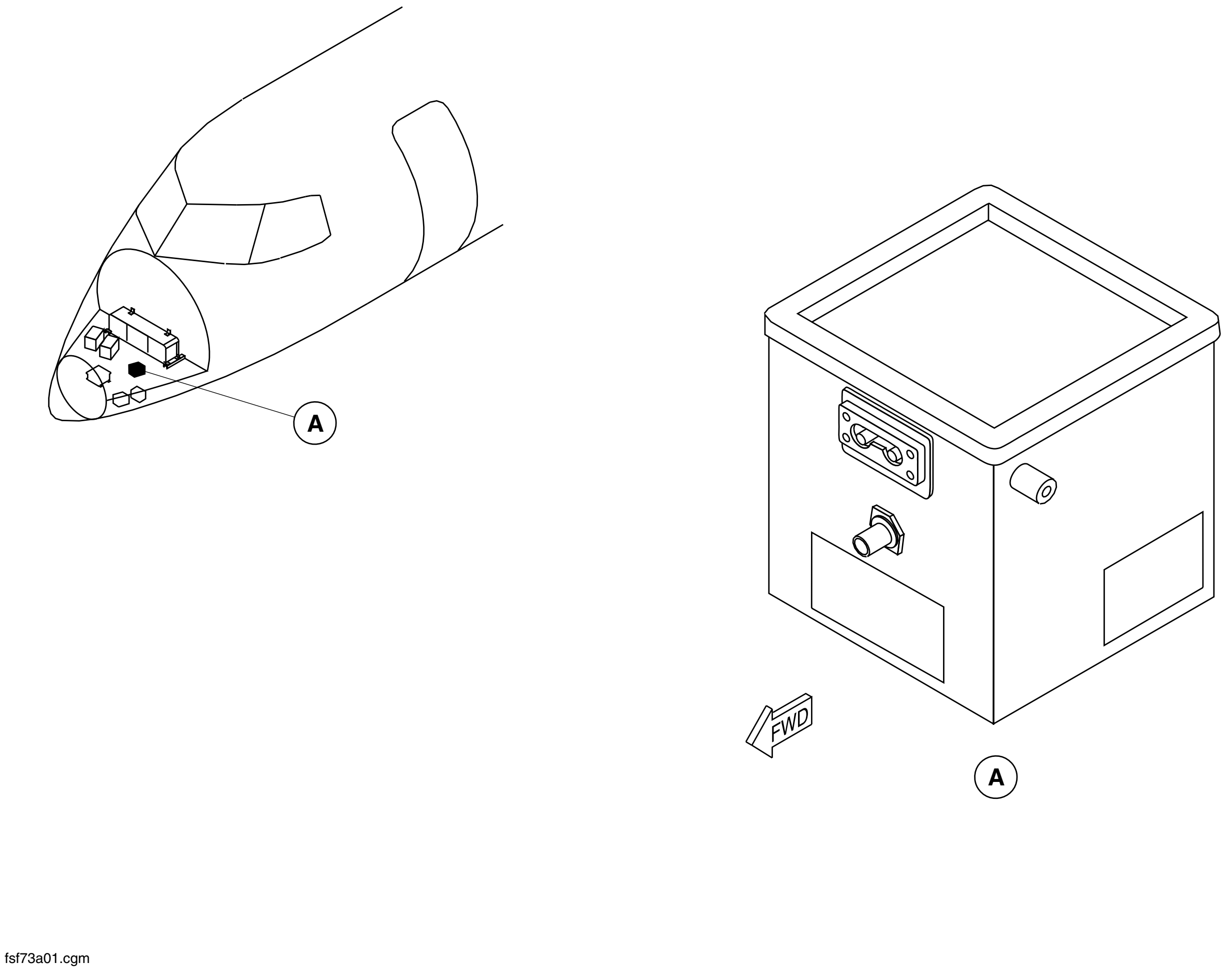
MAIN BATTERY LOCATOR
Figure 11



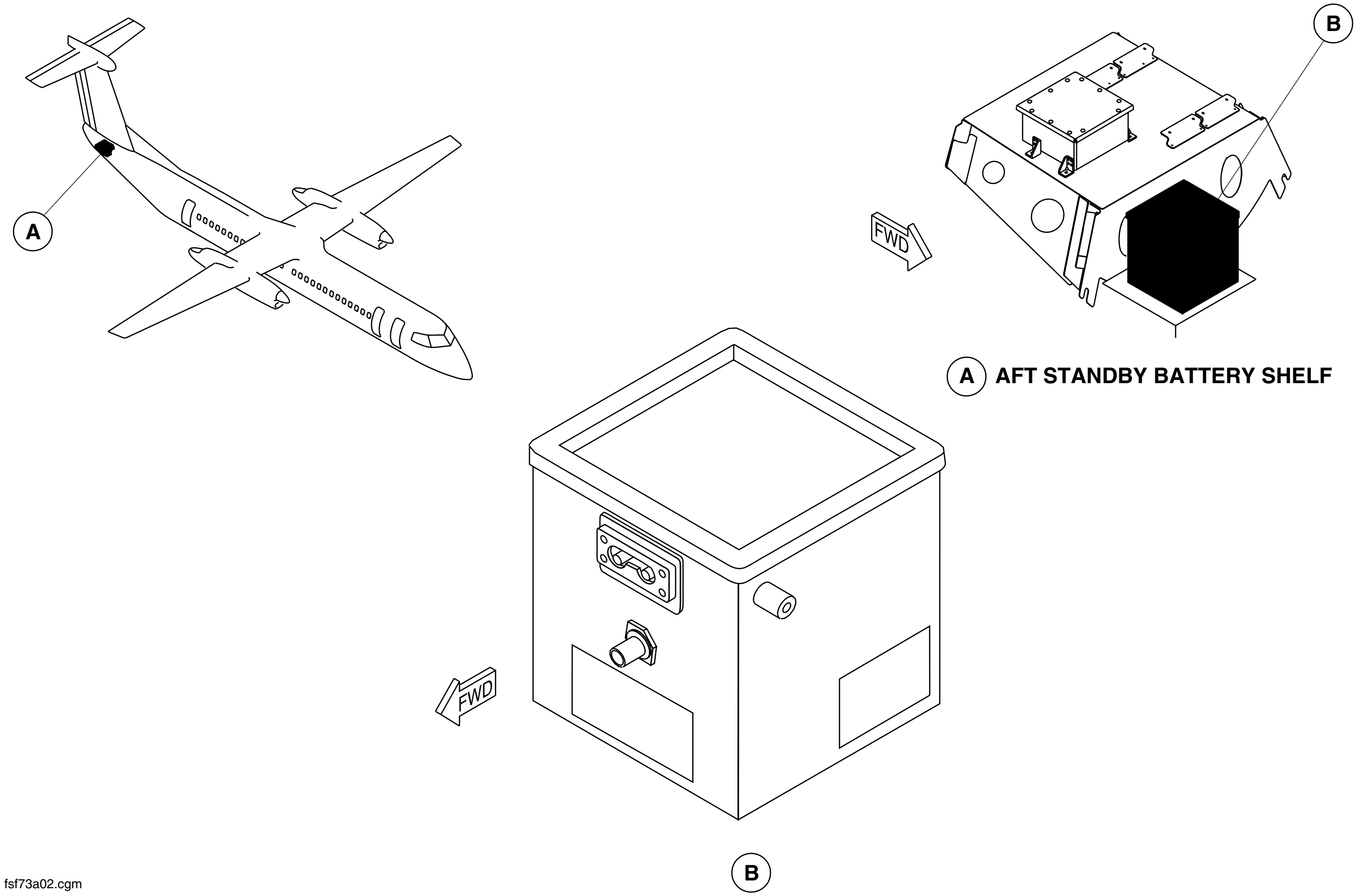
AUXILIARY BATTERY LOCATOR
Figure 12



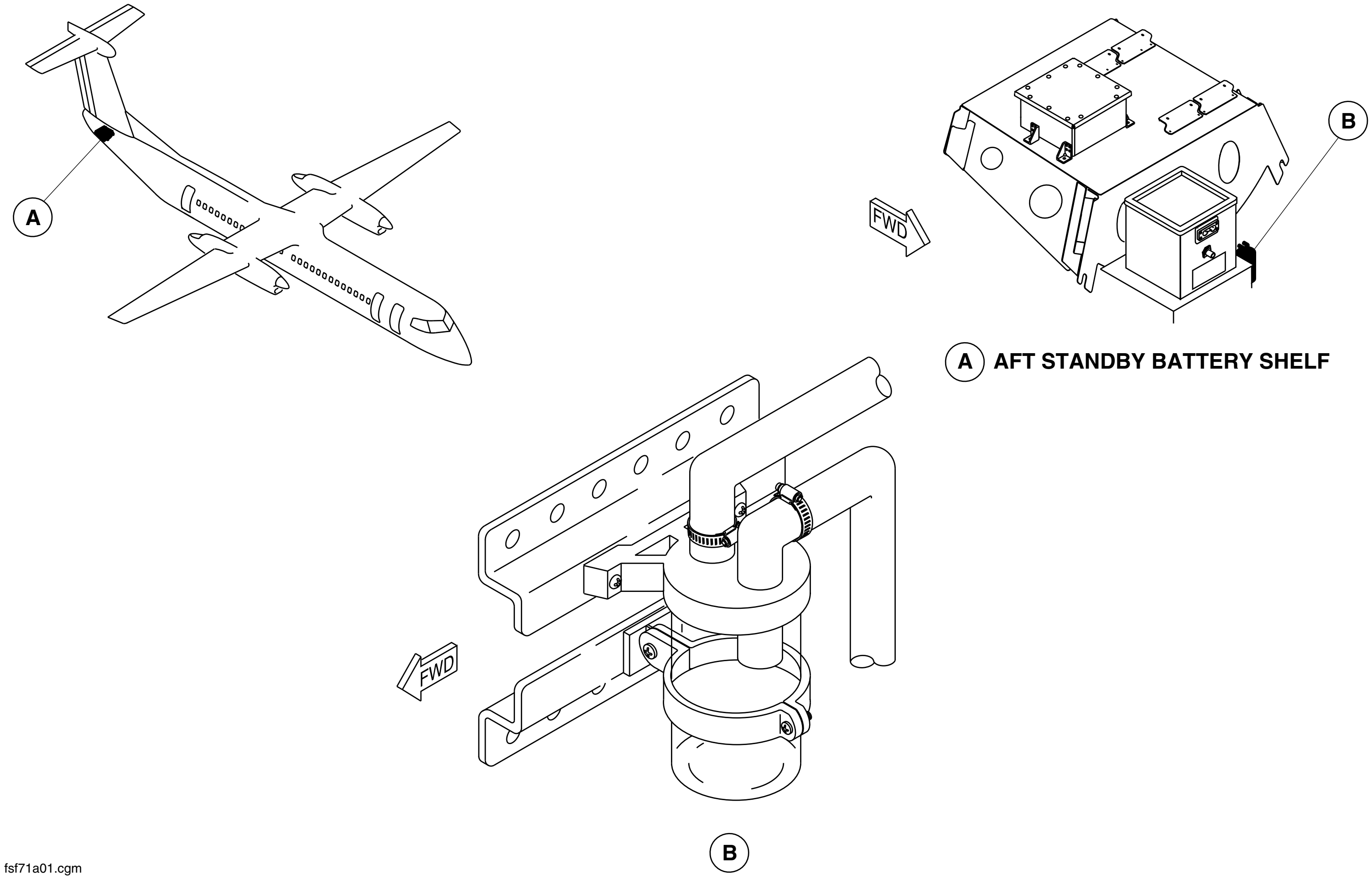
BATTERY CONTAINMENT VESSEL LOCATOR, FORWARD
Figure 13



STANDBY BATTERY LOCATOR, FORWARD
Figure 14



STANDBY BATTERY LOCATOR, AFT
Figure 15



BATTERY CONTAINMENT VESSEL LOCATOR, AFT
Figure 16

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24–33–00–001

APU 28 VDC GENERATION SYSTEM

Introduction

The APU 28 Vdc generation system makes and supplies 28 Vdc electrical power to the aircraft 28 Vdc busses.

General Description

Refer to Figure 1.

The APU supplies 28 Vdc to the main, essential and secondary dc buses while the aircraft is on the ground.

The annunciator switches located on the APU control panel in the flight compartment give manual control of the APU 28 Vdc generation system. The Engine and System Integrated Display (ESID) system shows main 28 Vdc generation system electrical indications.

After the APU is started, the APU dc generator is available to supply power in parallel with the batteries to assist start the aircraft engines. The APU generator is connected to the right main feeder bus and automatically cross ties to the left main feeder bus to supply 28 Vdc electrical power to the dc busses.

The APU 28 Vdc electrical power system has the components that follow:

– Generators, APU DC (24–33–01)
– Unit, APU DC Generator Control (24–33–06)
– Transformers, DC Current (24–33–46)
– Shunts, Current (24–33–51).

Detailed Description

The APU 28 Vdc generation system supplies 28 Vdc electrical power from a APU dc generator to the aircraft 28 Vdc busses.

The dc external power system functions in the modes that follow:

– Normal
– Monitoring and protection.

Normal Function: The Electrical Power Control Unit (EPCU) monitors the APU power that supplies dc electrical power to the 28 Vdc circuit breaker panel in the flight compartment.

When the APU dc power is supplying 28 Vdc to the aircraft dc busses and the external power toggle switch on the dc control panel is set to the EXT PWR position, the EPCU will cause the external power source to energize the 28 Vdc busses and remove APU electrical power from the dc busses.

For APU power operation, the APU GCU controls the APU bus–tie contactor K26 and the EPCU controls the contactors that follow:

– Main feeder bus tie contactor, K21
– Secondary/main feeder bus tie contactors, K5 and K6.

The APU generation system supplies 28 Vdc electrical power through the APU bus–tie contactor K26 to the right main feeder bus. When the APU GCU receives a dc external power signal from the

EPCU, it will cause the bus tie contactor K26 to disconnect the APU dc generator from the right main feeder bus.

When the dc busses are energized by the two dc starter/generators and APU power is selected, the APU bus−tie contactor K26 closes to connect the generators in parallel.

The APU 28 Vdc generation system supplies electrical power to the busses that follow:

- Left and right main feeder busses
- Left and right secondary feeder busses
- Left and right main distribution busses
- Left and right secondary distribution busses
- Left and right essential busses.

When the APU GCU senses an APU power source malfunction, it will cause the APU bus−tie contactor K26 to open. The left and right essential busses stay energized because the battery operation is independent of the EPCU.

The DC Contactor Box (DCCB) contains the contactors and protection components for the APU 28 Vdc generation system.

After the engine start sequence, with the dc starter/generator toggle switches set to the GEN1 and GEN2 positions, the dc GCUs will connect the dc starter/generators to the main feeder busses. The APU, GEN1 and GEN2 dc starter/generators will energize the dc busses.

The APU GCU prevents parallel operation of the dc external power source and the APU dc generator. When a dc external power source is energizing the dc busses, the cross tie contactors supply an inhibit signal to the two dc GCUs and APU GCU. The inhibit function will make the generator operate in a standby condition. The APU bus−tie contactor K26 will stay in the open position while the external power signal is available.

Monitoring and protection: The protective functions in the Electrical Power Generation and Distribution System (EPGDS) prevent damage to the aircraft dc systems. When the APU 28 Vdc generation system source malfunctions or if there is an overload condition the EPCU will open the APU bus−tie contactor K26.

The APU 28 Vdc generation system is continuously monitored by the EPCU. When a malfunction is sensed, it disconnects the APU power from the aircraft busses.

The APU 28 Vdc generation system has passive and active protection.

The APU 28 Vdc generation system uses circuit breakers and fuses for passive protection so that a malfunction condition will not cause damage to the aircraft wiring. The circuit breakers and fuses are protection devices that open the circuit during excessive current flow conditions. Unlike fuses, circuit breakers can be reset without having to be replaced.

The APU 28 Vdc generation system uses the EPCU and GCU to automatically control the APU contactor for active protection so that a fault condition will not cause damage to the aircraft wiring. The automatic functions do not need a manual selection from the flight compartment. It uses the protective functions that follow:

- Over voltage: MIL−STD−704E Figure 11
- Over current
- Differential feeder fault
- Build up ground fault

– Reverse Current

Over Voltage: When the voltage from an APU dc generator is more than 32.5 ±0.5 VDC, the APU GCU de−energizes the APU dc generator and opens APU bus−tie contactor K26. This protection has an inverse time delay to make sure that the disconnect time is inversely proportional to the magnitude of the over voltage level.

Over Current: When the current from the APU dc generator is more than 700 A for more than 5 seconds, the EPCU sends a trip signal to the APU GCU to de−energize the APU dc generator and open APU bus−tie contactor K26. If the EPCU does not supply a trip signal to the APU GCU, the APU GCU de−energizes the APU dc generator and opens APU bus−tie contactor K26 after 7 seconds. The APU dc generator will supply current for a maximum of 7 seconds to let the fault clear itself before disconnecting the APU dc generator.

Differential Feeder Protection: The current flow at – and + connections of the APU dc generator is compared by the APU GCU differential current sensing circuits. When the differential feeder current is more than 75 A, the APU GCU de−energizes the APU dc generator and opens APU bus−tie contactor K26. Time delay circuits in the APU GCU prevents usual transients caused by on and off switching of different loads to cause contactor operation.

DC current transformers at the – and + connections of the APU dc generator supplies dc current data to the APU GCUs to control the APU dc generator's output.

Reverse Current: The APU GCU monitors for a reverse current condition. When a reverse current condition is more than 10% of the rated load, the APU GCU de−energizes the APU dc generator and opens APU bus−tie contactor K26.

The EPCU has a passive diagnostic CBIT function that is used to show possible problems in the APU 28 Vdc power generation system to the maintenance personnel. The EPCU CBIT system monitors the APU 28 Vdc power generation system for fault detection, isolation, and indication.

Refer to Figure 2.

The Electrical Power Control Unit (EPCU) records the dc external power system fault conditions. It has an interface panel on its front face to look at the fault codes that represent fault conditions sensed by the Continuous Built in Test (CBIT). It uses FAULT REVIEW and CLEAR pushbutton switches and a digital display to view the fault codes.

The CBIT operates only when the aircraft is on the ground. A blank indication shows when no fault conditions are sensed by the CBIT. When the indication is out of view, the FAULT REVIEW pushbutton switch is pushed to do display test. It will show 88 for correct operation.

The voltage difference between the dc starter/generator output and the POR is measured by the EPCU while the APU is not starting. If the value is excessive, the EPCU will show fault code 03.

The EPCU checks APU bus−tie contactor K26. If it senses a closed position while the APU GCU power ready signal is not available or dc external power is available, the EPCU will show fault code 08.

If the EPCU measures a voltage at the APU dc generator output while the engine is not starting and no over current condition is sensed by the APU GCU, it will show fault code 09.

The EPCU checks the APU bus−tie contactor K26. The fault detection will monitor the APU bus−tie contactor K26 status signals (position). If the contactor position is open while the APU GCU indicates power ready and has previously sensed fault 03, or during an APU start, the EPCU will show fault code 22.

Refer to Figure 3.

The APU dc generator starts the generator mode 3 seconds after the APU RPM has reached 95%. The GEN ON annunciator light on the APU Control Panel is pushed to cause the APU DC generation system to energize the dc busses when the conditions that follow are correct:

- APU power is available
- No overcurrent condition sensed
- An engine start selection is not made.

Refer to Figure 4.

The MFD1 and MFD2 reversion switches located on the ESID Control Panel (ESCP) are used to select the electrical page on the multi–functional displays.

Refer to Figure 5.

The electrical page shows the APU 28 Vdc power generation system that follow:

- Digital indication of the dc essential, main, and secondary bus voltages
- Digital indication of the APU dc generator loads

The dc voltage indication has a DC BUS L and DC BUS R title in white fonts to show the voltage of the essential, main, and secondary busses. The APU load indication has an APU title in white fonts to show the load of the APU dc generator.

DC Voltage Indication: The dc voltage indication shows the dc essential, main, and secondary bus voltage in white numbers.

APU Load Indication: The APU dc generator load indication shows the APU dc generator output load. The numbers show the dc starter/generator output load as a percentage of the total rated output. A 1.00 indication is used to show 100% .

A + symbol before the numbers is used to show an overload condition of the APU dc generator or TRU. It is out of view when the load is in less than 100%.

When the voltage or load data malfunctions, the digits are replaced by white dashes.

Refer to Figure 6.

The APU 28 Vdc power generation system malfunctions are shown with the caution lights on the APU control panel that follow:

- WARN
- GEN OHT.

WARN Caution Light: The WARN caution light comes on to show that the generator is not connected to its bus because of a source fault condition, the APU generator switch is set to the off position, or external dc power is energizing the left and right main feeder busses.

GEN OHT Caution Light: The GEN OHT caution light comes on to show that the generator temperature is more than 330° F. It goes out when the temperature is less than 300 °F (149 °C).

APU DC Generator

Refer to Figure 7.

The APU dc generator is an electromagnetic machine. When it rotates, it will change engine input mechanical torque to output dc electrical power. In the starter mode, it changes input electrical dc electrical power into a mechanical output torque. The APU dc generator operation is controlled and monitored by the APU DC Generator Control Unit (GCU).

The APU dc generator is a four–pole, shunt connected, fully compensated dc generator with inter–pole windings, brush commutation, and an internal cooling fan. It is attached to the APU gearbox.

The APU dc generator has a permanent magnet so that it can make output voltage without an external excitation source. The output from the APU dc generator is sent to the APU DC GCU. The APU DC GCU supplies the APU dc generator with its output voltage until the APU DC GCU starts regulation. When regulating, the APU DC GCU supplies a modulated current to the APU dc generator to maintain a 28.5 Vdc output.

The APU dc generator has stator and rotor assemblies contained in a cylindrical shaped housing. The housing is made of a high iron content material. It is part of the magnetic circuit for the starter assembly. The rotor assembly has a rotor winding that connects to the fixed input terminals on the machine housing through a brush/commutator assembly. The machine housing has 4 poles with a four brush block assembly to switch the input or output current to the correct rotor winding.

The rotor is held at each end by ball bearings that are mounted in the housing. The ball bearings are pre lubricated with grease when installed and service is not necessary until overhaul.

The APU dc generator has a fan to supply a forced air flow axially through it to cool the rotor and starter windings, the commutator assembly, and the bearings. Air is drawn from outside the nacelle through NACA vents to keep the operating temperatures satisfactory.

The APU dc generator electrical power circuit has a 4 pole shunt that operates at 12,000 rpm. The electrical circuit of the APU dc generator has interpole windings to help the flux path between the stator and rotor to increase generator efficiency.

The APU DC GCU supplies a control current to the shunt field winding of the APU dc generator to control its output voltage. The shunt field winding current is amplified by the rotational energy of the engine to make the rated output of 400 A at 30 Vdc.

The APU dc generator supplies information to the APU DC GCU for system protection through tapping of the interpole winding voltage. This voltage is proportional to generator current and is continuously monitored by the APU DC GCU to sense unusual current levels.

The APU dc generator terminal voltage is monitored by the EPCU for CBIT functions.

Inputs and outputs of the stator windings are given by connections on the body of the APU dc generator. Low current connections are made with a circular connector and high power output connections are made to studs mounted on a terminal block. A bonding stud on the housing of the APU dc generator is used to connect it to the airframe ground potential.

The APU dc generator has a temperature switch that closes a set of contacts when the temperature of the dc starter/generator is excessive. It gives continuity through two pins on the APU dc generator connector to make the GEN OHT indication come on in the APU control panel.

The torque force is transmitted to the APU dc generator through a splined shaft that connects to the APU gearbox. The APU dc generator's drive shaft has a shear section that breaks to protect the gearbox drive train from damage when too much torque is supplied.

The APU dc generator attaches to the APU gearbox with a Quick–Attach/Detach (QAD) adapter that, once installed, stays attached to the gearbox when APU dc generator is removed. The APU dc generator connects to the QAD with a V band clamp to secure the assembly. The QAD has an opening that connects to an airframe duct to exhaust cooling air outside of the APU nacelle.

APU DC Generator Control Unit

Refer to Figure 8.

The APU DC GCU controls the APU dc generator start and regulation modes. The APU DC GCU senses the APU dc generator speed and it stops the start mode when the speed of the APU is more than 50% NH. At the end of the start mode, the APU DC GCU opens the bus contactor and de–energizes the APU dc generator.

When the APU DC GCU senses a voltage output from the APU dc generator, a field control contactor in the APU DC GCU switches from the field build up circuits to a voltage regulator circuit. The voltage regulator is a closed loop control circuit. It adjusts the duty cycle of the exciter field voltage to maintain a constant voltage at the Point of Regulation (POR) under different load conditions.

The APU dc generator speed and voltage will increase when the APU is operating. When the output voltage is ±1 Vdc of the bus voltage, the AU DC GCU will cause the bus contactor to connect the APU dc generator to the right main feeder bus.

The APU DC GCU regulates the APU dc generator's output and gives the protective functions that follow:

Table 1: Table 4.

PARAMETER	VALUE
Over voltage	32.5 ±0.5 VDC
Differential Feeder Fault Detection	75 A ±25A
Bus Fault Detection	700 A
Parallel Load Sharing	10% rated current

The APU DC Generator Control Unit (GCU) contains the voltage regulation and protection circuits for the APU dc generator. Printed circuit cards, discrete power semiconductors, and electromechanical contactors are put in an aluminium box without the need for convection cooling through the box.

The APU DC GCU is cooled by conduction through the chassis mounting locations and by convection of air over the surface of the box. Power dissipating components in the DC GCU are attached to chassis heat sinks to transfer heat to it.

Electrical connections are made with a single connector that is attached to the end of the DC GCU enclosure.

APU DC Current Transformers

Refer to Figure 9.

The APU dc current transformers are electromagnetic components used with the APU DC GCU to sense differential feeder fault protection. Two dc current transformers are used in the APU 28 Vdc generation system with one unit located at the APU dc generator output and the other is located close to the negative feeder cable grounding connection. The dc current transformers are used to monitor the APU dc generator power feeder cables. They monitor the APU dc generator current in the DCCB. The sensed current is summed to cancel each other out when a feeder fault is not present by the APU DC GCUs.

The APU dc current transformer is a torroidal core wound unit. It has a number of windings that sense an induced voltage from a current that passes through the toroid body. The toroid assemblies are enclosed in an aluminum case that provides the protection and mount the assembly.

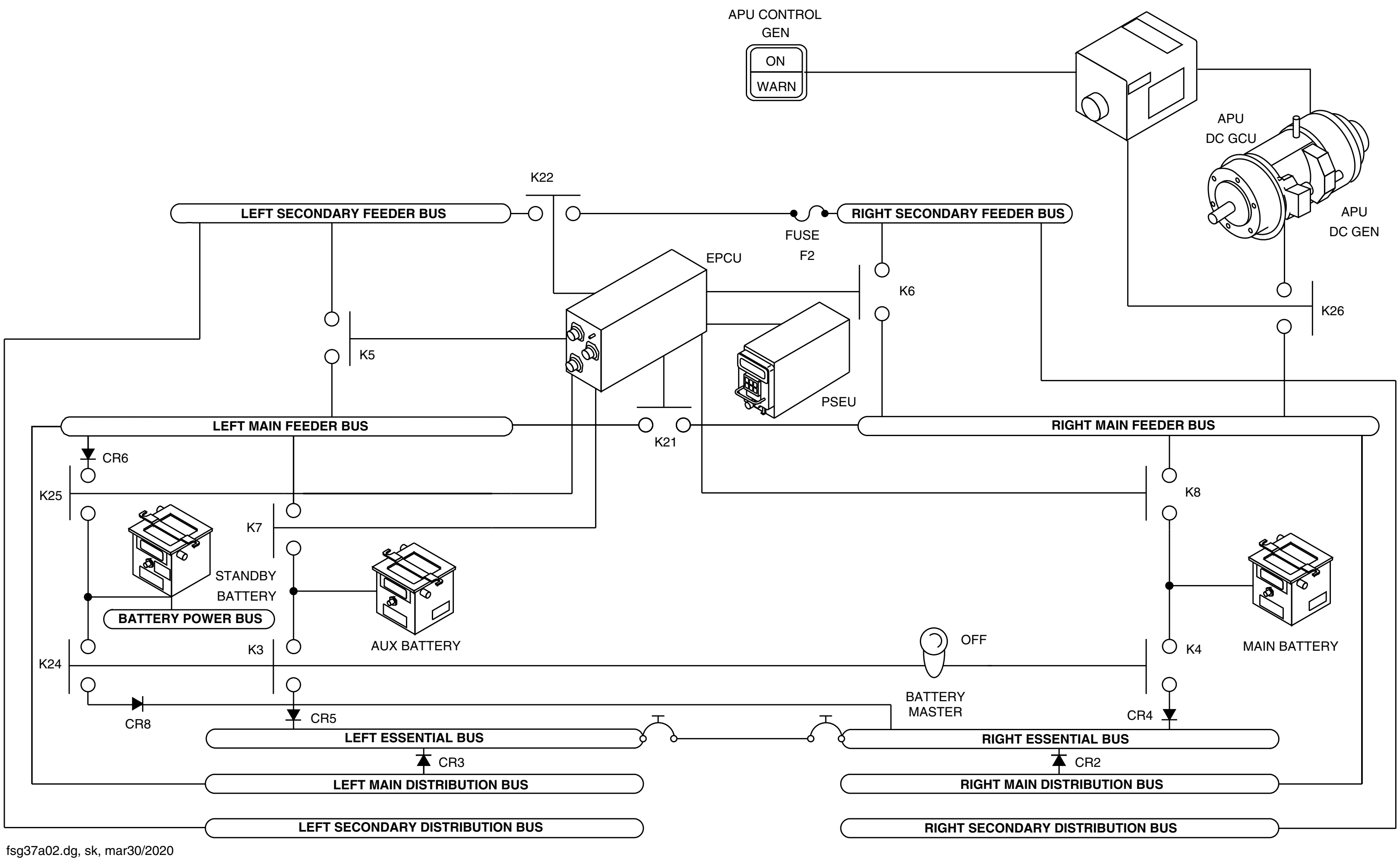
The case has 90–degree outward flanged feet with holes for mounting the unit to structure. These holes are asymmetric to make sure that the orientation of the unit is correct when installed. The APU dc current transformer also has two terminal studs on the top of the unit to which the interfacing wires are bolted. The APU dc feeder cable passes through a hole in dc current transformer.

The dc current transformers are located in the centre fuselage section.

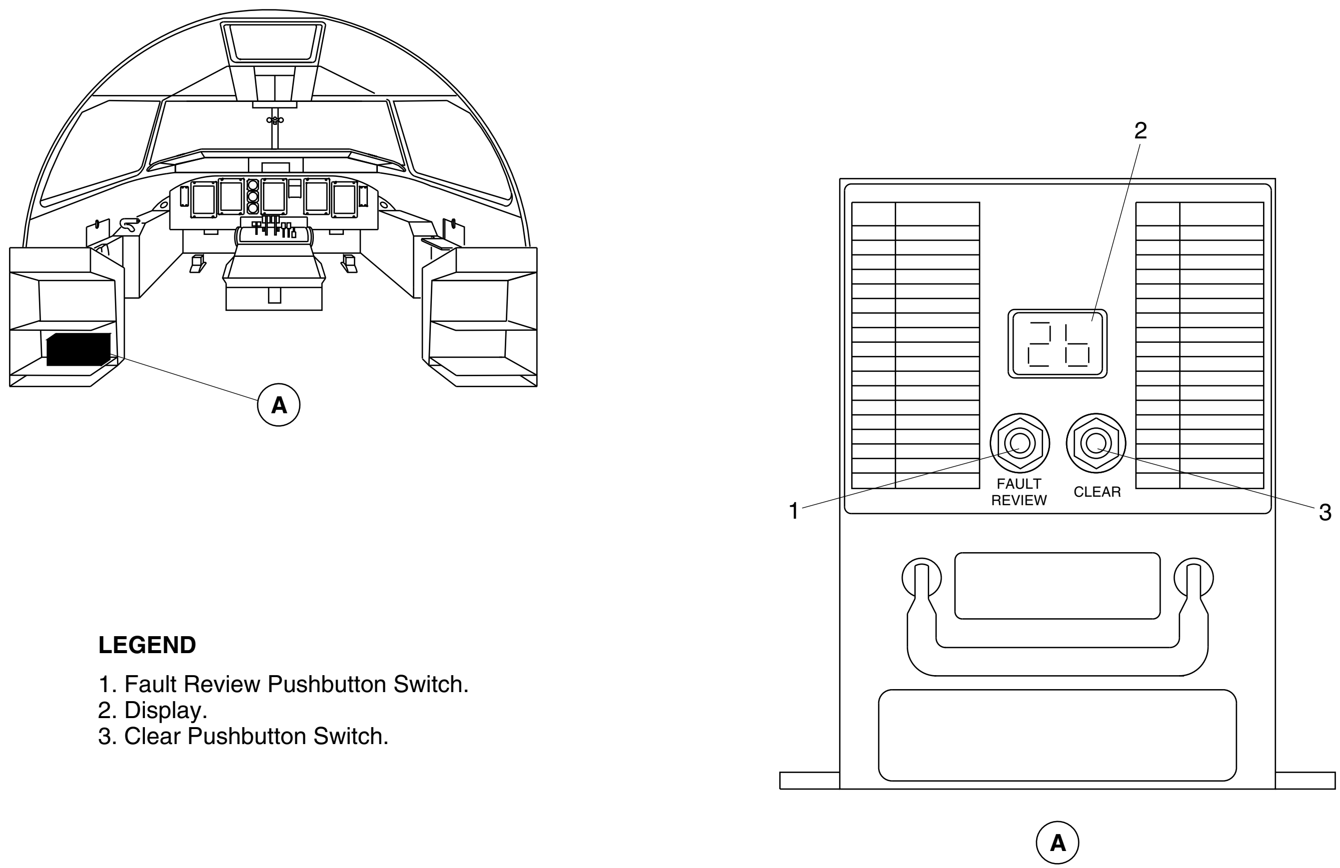
APU Current Shunt

Refer to Figure 10.

The APU current shunts supply output current data from the APU dc generator to the EPCU for indication. The negative terminal of the APU dc generator is connected through a separate current shunt to airframe ground potential. The APU dc generator current shunt islocated in centre fuselage section.



APU 28 VDC Generation System Block Diagram
Figure 1



LEGEND

1. Fault Review Pushbutton Switch.
2. Display.
3. Clear Pushbutton Switch.

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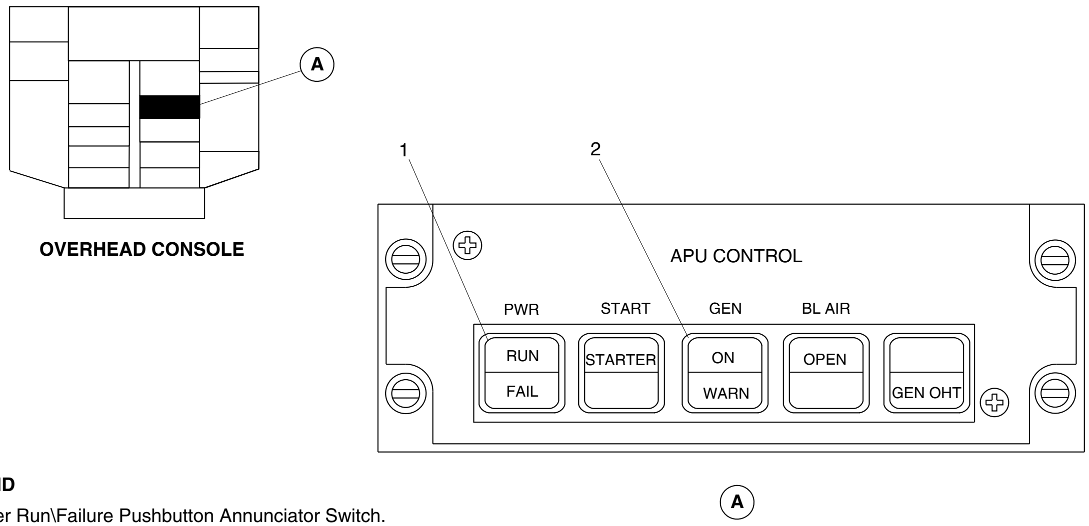
MAIN 28 VDC GENERATION SYSTEM, EPCU
Figure 2



LEGEND

1. Power Run\Failure Pushbutton Annunciator Switch.
2. Generator On\Warning Pushbutton Annunciator Switch.

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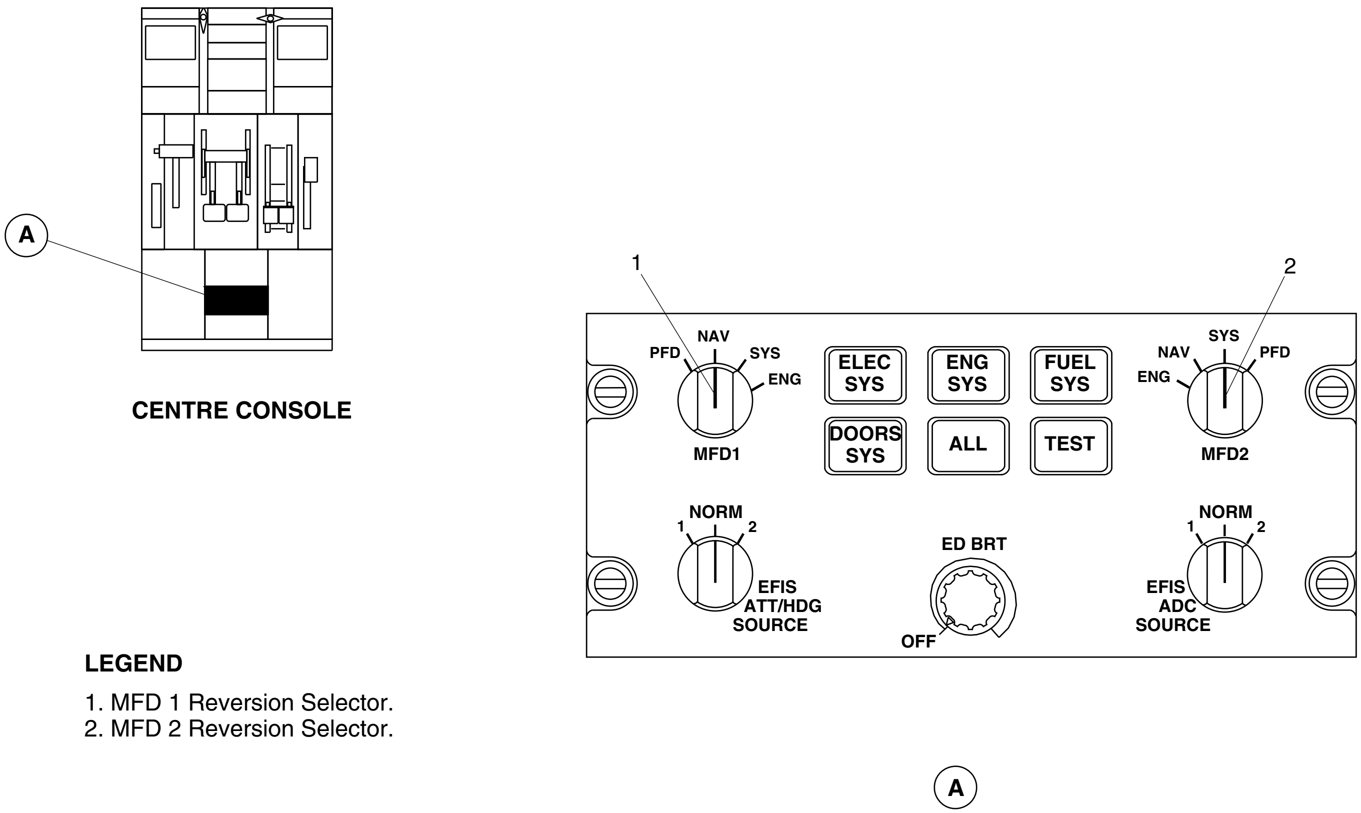
APU CONTROL PANEL, APU 28 VDC GENERATION SYSTEM CONTROL
Figure 3



LEGEND

1. MFD 1 Reversion Selector.
2. MFD 2 Reversion Selector.

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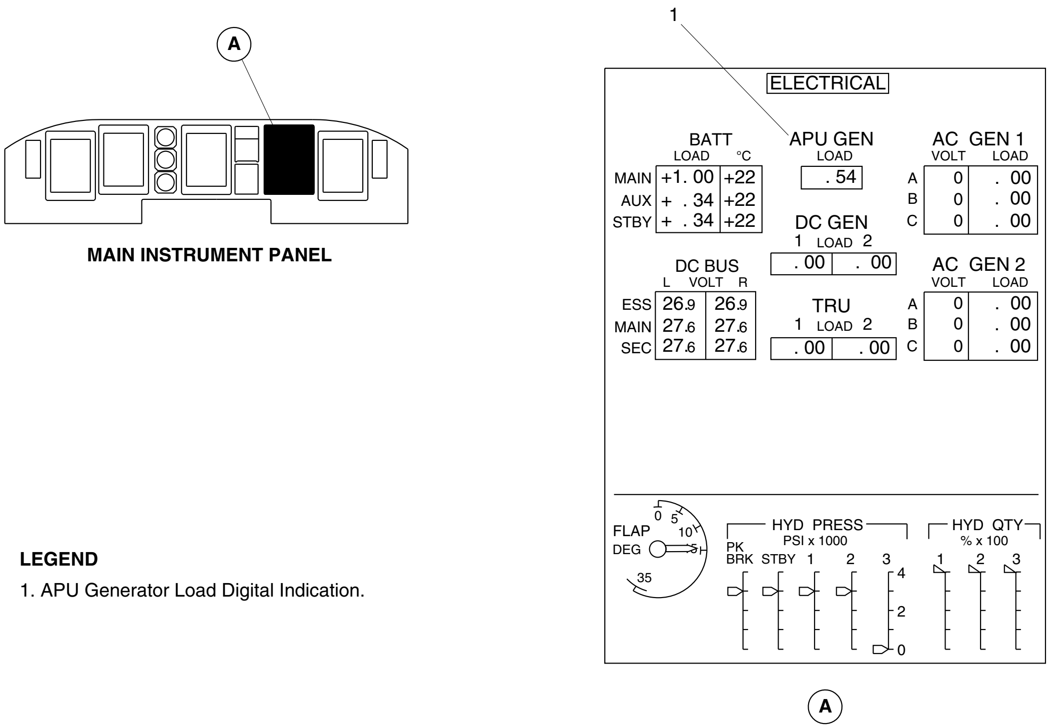
EIS, ELECTRICAL SYSTEM PAGE SELECTION
Figure 4



LEGEND

1. APU Generator Load Digital Indication.

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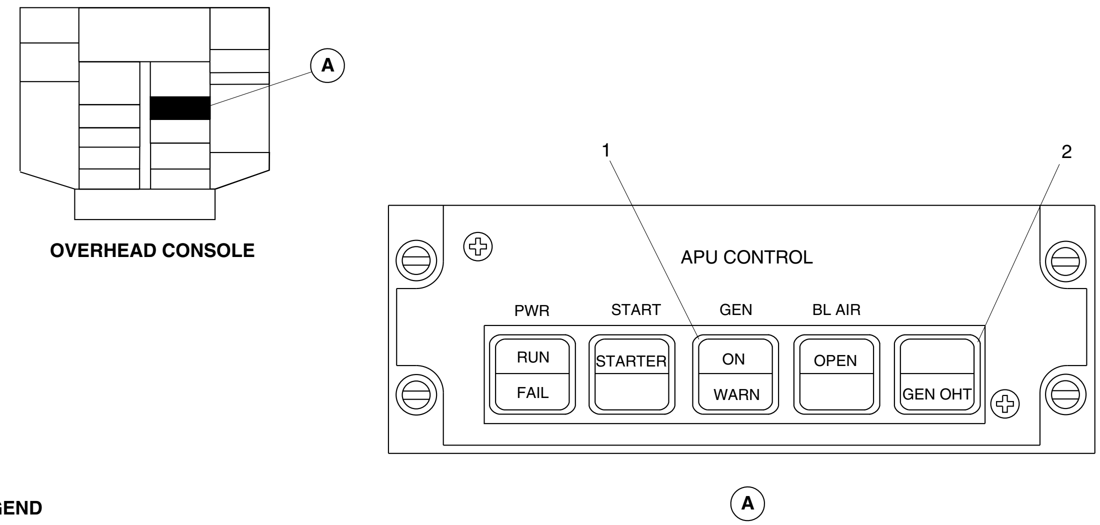
EIS, APU 28 VDC GENERATION SYSTEM INDICATIONS
Figure 5



LEGEND

1. Generator On/Warning Pushbutton Annunciator Switch.
2. Generator Overheat Annunciator Light.

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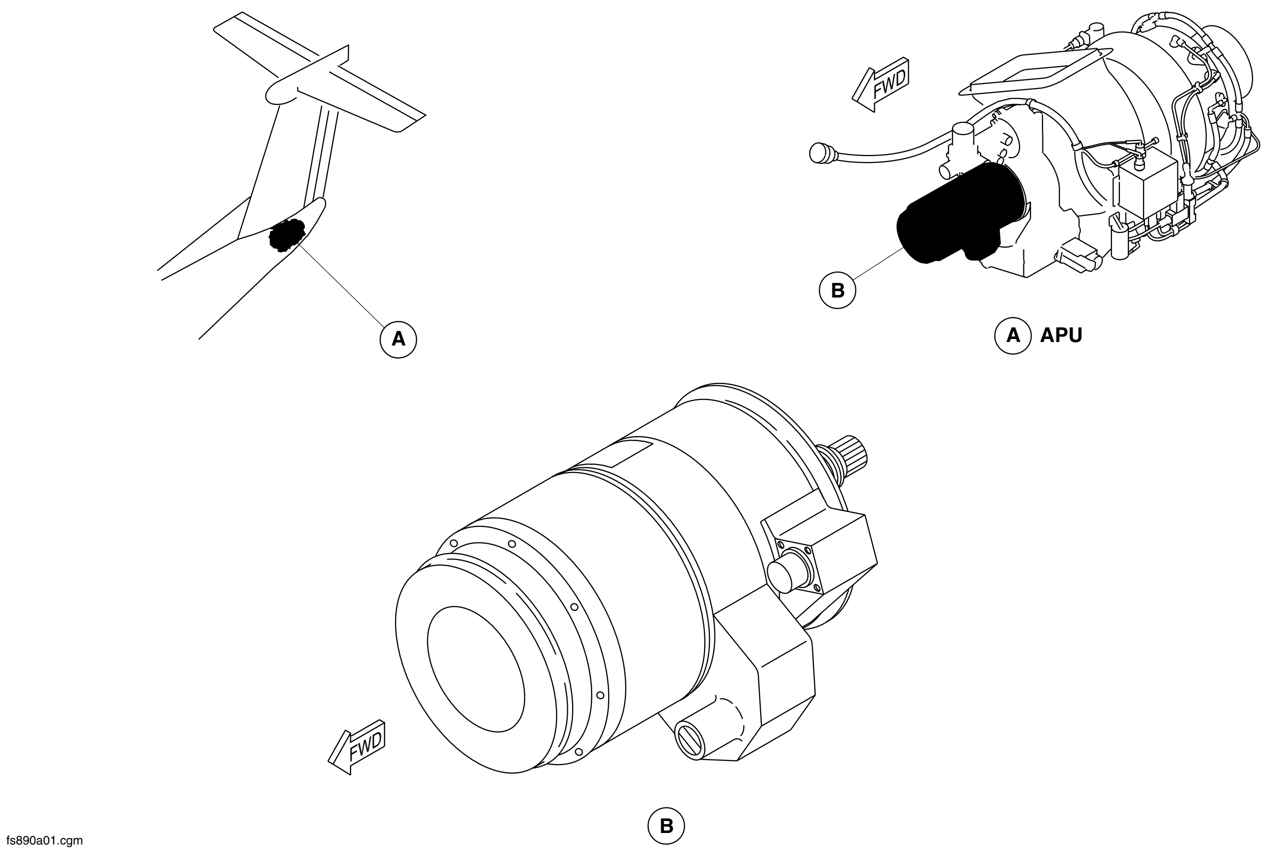
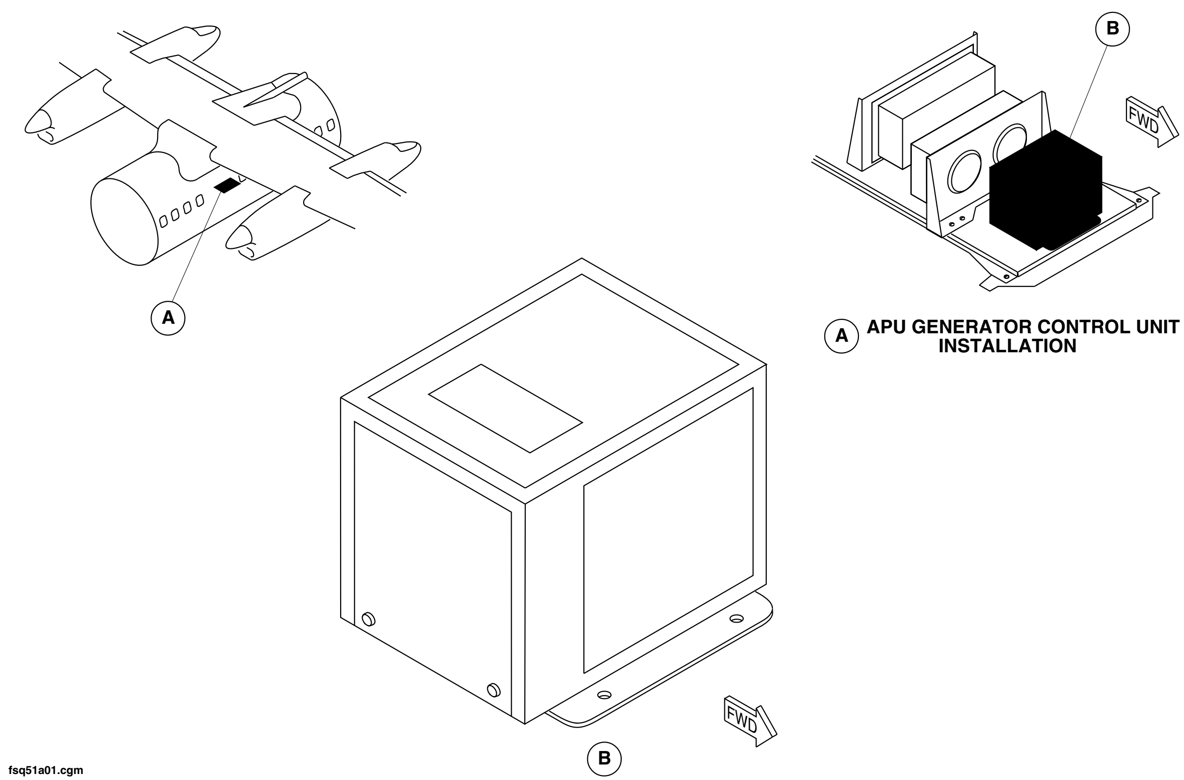
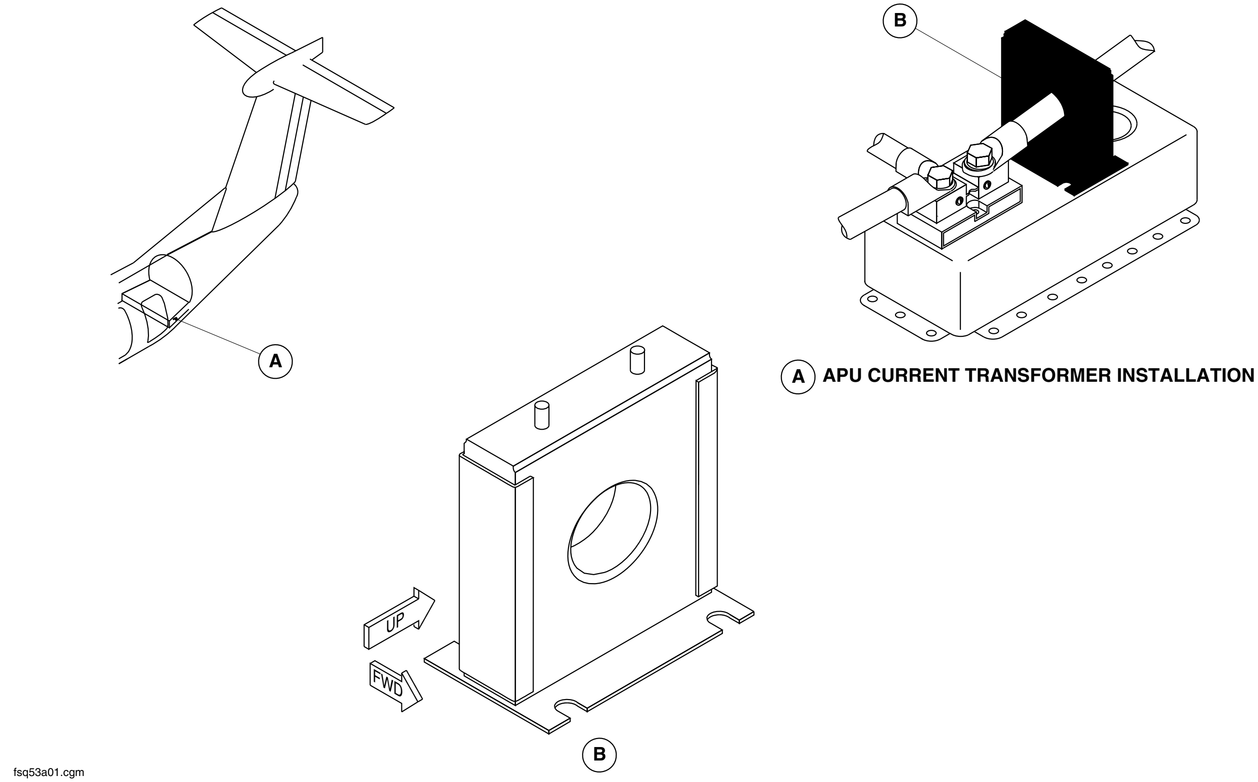
APU CONTROL PANEL, APU 28 VDC GENERATION SYSTEM INDICATIONS
Figure 6



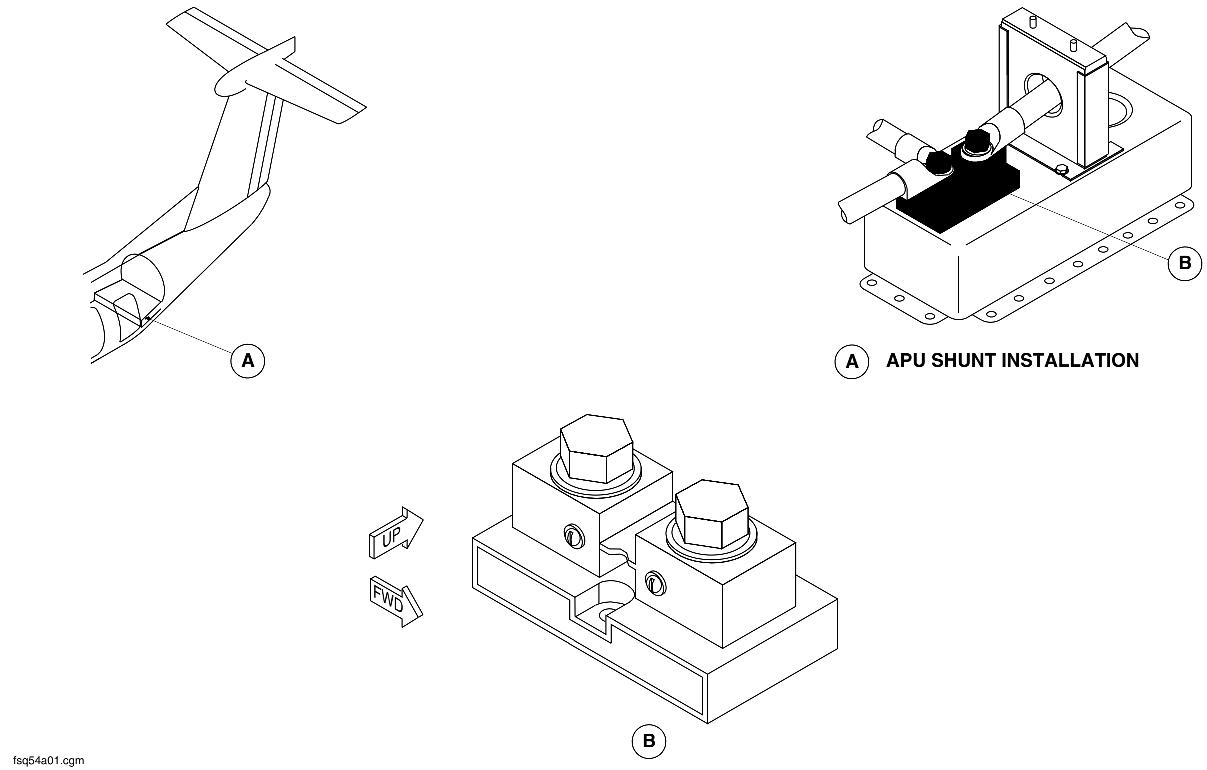
APU DC GENERATOR LOCATOR
Figure 7



APU DC GENERATOR CONTROL UNIT LOCATOR
Figure 8



APU DC CURRENT TRANSFORMERS LOCATOR
Figure 9



APU DC CURRENT SHUNT LOCATOR
Figure 10

**ON A/C ALL

24–40–00–001

EXTERNAL POWER SYSTEM

Introduction

The ac generation systems receives 115 Vac through the ac external power receptacle and control circuitry when the aircraft is on the ground.

The dc generation system receives 28 Vdc through the dc external power receptacle and control circuitry when the aircraft is on the ground.

General Description

Refer to Figures 1 and 2.

The ac external power energizes the 115 Vac variable frequency system busses and the dc external power energizes the main 28 Vdc system busses.

The ac external power receptacle is installed on left side of the right nacelle. The Electrical Power Protection Unit (EPPU) monitors the ac external power supplied to the ac busses for frequency, voltage and phase.

The dc external power receptacle is installed on left side of the forward fuselage section. Sensors in the Electrical Power Control Unit (EPCU) monitors the dc external power source for voltage and polarity.

Refer to Figure 3.

A toggle switch, EXT PWR, located on the ac control panel in the flight compartment will give manual control of the ac external power system.

Refer to Figure 4.

A toggle switch, EXT PWR, located on the dc control panel in the flight compartment will give manual control of the dc external power system.

Refer to Figure 5.

The Engine and System Integrated Display (ESID) system will show when ac and/or dc external power supplies the electrical busses.

The external power system has the components that follow:

– AC External Power Receptacle (24–41–01)
– Unit, External ac Protection (24–41–06)
– DC External Power Receptacle (24–42–01)

Detailed Description

The ac external power system supplies 115 Vac electrical power from an external ground power source to the aircraft 115 Vac variable frequency busses.

The dc external power system supplies 28 Vdc electrical power from an external ground power source to the aircraft 28 Vdc busses.

The ac and dc external power system functions in the modes that follow:

- Normal
- Monitoring and protection.

Normal Function: The External Power Protection Unit (EPPU) and Electrical Power Control Unit (EPCU) monitor the ac and dc external power sources that supplies ac and/or dc electrical power to the 115 Vac variable frequency and/or the 28 Vdc circuit breaker panels in the flight compartment.

The EPPU will let the external power source connect to the ac busses when the toggle switch on the ac control panel is set to the EXT PWR position. The EPPU will connect the external power to the ac busses when the conditions that follow are met:

- Voltage, 106 to 124 Vac
- Frequency, 370 to 450 Hz
- Phase rotation, correct

The EPCU will let the external power source connect to the dc busses when the toggle switch on the dc control panel is set to the EXT PWR position. The EPCU will connect the external power to the ac busses when the conditions that follow are met:

- Correct polarity
- Voltage, 22 to 31 Vdc

NOTE

Note: When ac and/or dc external power is connected, the battery master toggle switch located on the dc control panel is set to the BATTERY MASTER position before the ac external power toggle switch is set to EXT PWR for external power operation.

AC External Power Receptacle (24–41–01)

Refer to Figure 6.

The ac external power receptacle is used to allow repetitive connections from the aircraft to an ac external power source. When an external ground power connector is connected to the receptacle, it will supply 115 Vac from the ground power source to the ac busses. The aircraft ac power receptacle is a six male pin connector.

The ac external power receptacle is located on left side of the right nacelle of the aircraft.

Unit, External AC Protection (24–41–06)

Refer to Figure 7.

The EPPU makes sure that only correctly controlled ac external power is allowed to energize the ac busses.

The EPPU checks the external power source for the parameters that follow:

- Under voltage, less than 106 Vac
- Over voltage, more than 124 Vac
- Under frequency, less than 370 Hz

- Over frequency, more than 450 Hz
- Phase rotation.

DC External Power Receptacle (24–42–01)

Refer to Figure 8.

The dc external power receptacle is used to allow repetitive connections from the aircraft to a dc external power source. When correctly controlled dc external ground power connector is connected to the receptacle, it will supply 28 Vdc electrical power from the ground power source to the dc busses. The aircraft dc power receptacle is a three male pin connector.

The dc external power receptacle is located on left side on the forward fuselage section of the aircraft. It is attached to the aircraft structure with six mounting bolts.

Battery Depletion

Refer to Figure 9.

When ac or dc external power is connected to the aircraft with the battery master switch ON and the standby battery switch OFF for a prolonged period, it may deplete the standby battery via contactor 2431–K3/K4/K24. The standby battery must be selected to ON position to charge it via the contactor 2431–K25.

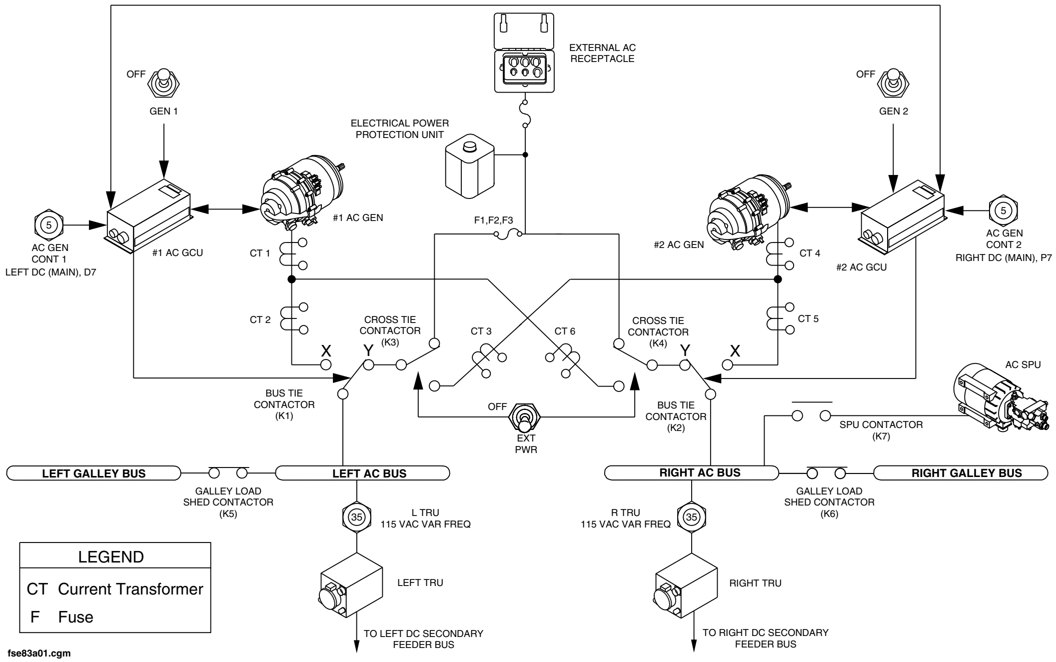
During maintenance, when the aircraft is in AIR mode with engines OFF and the DC external power ON, the MAIN/AUX/STBY battery contactors (2431–K25/K7/K8) are opened by the EPCU automatically (emergency mode logic) that prevents the batteries from charging. Since the contactors (2431–K3/K4/K24) are powered from the standby battery via the hot standby battery bus, the standby battery will get discharge after a prolonged period.

NOTE

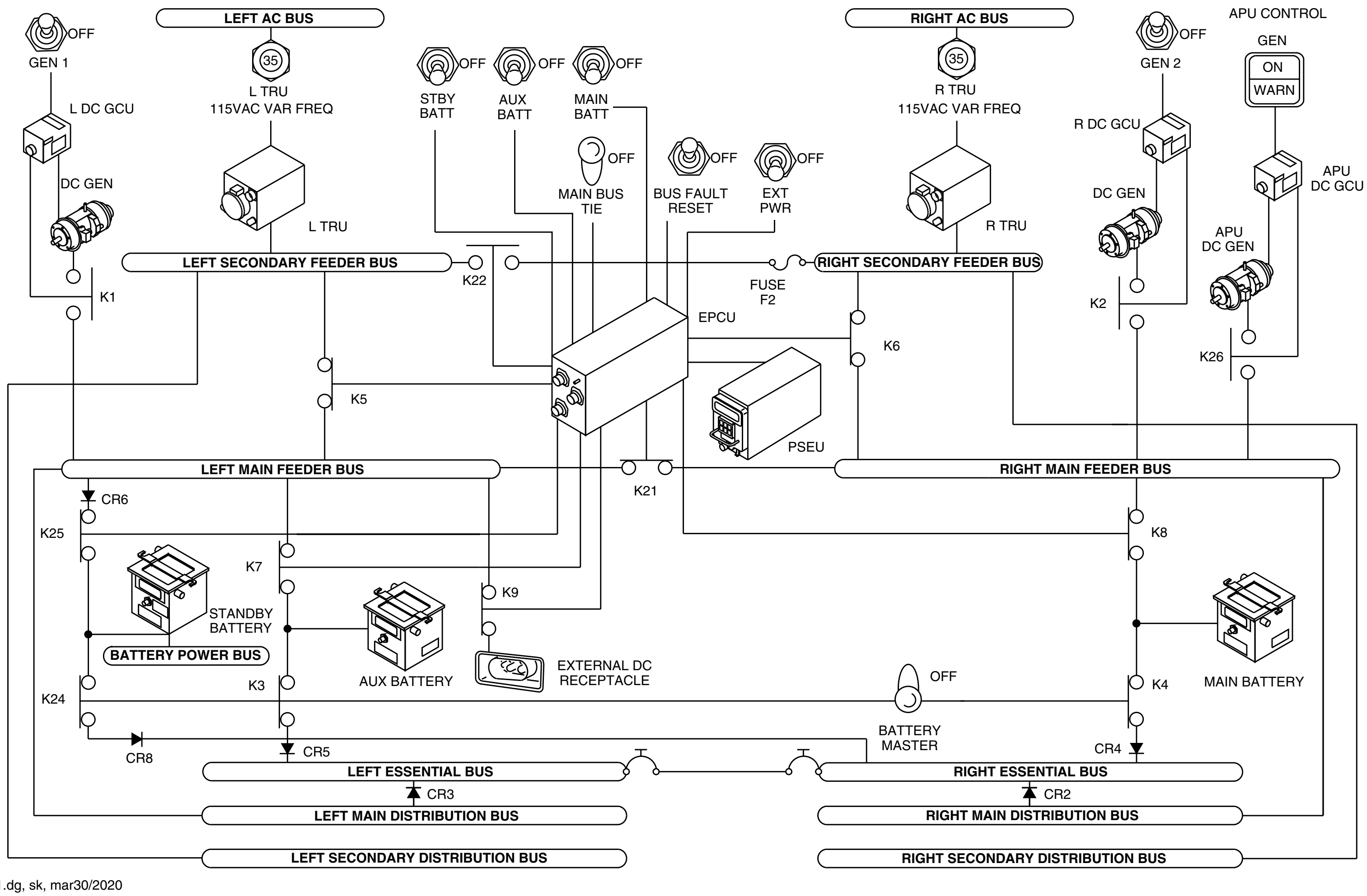
The standby battery hot bus powers the boarding lights, No. 3 hydraulic system DCMP and fuel shutoff.

The batteries act like large capacitors that absorb the voltage spikes from the Ground Power Unit (GPU). If the GPU transmits the voltage spikes and the batteries are in OFF position, damage may occur to the avionics/electrical component.

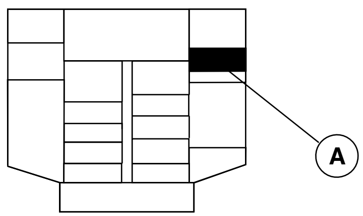
Hence it is always recommended to keep all the battery switches to the ON position with the external power ON. However, if the external power goes off, the batteries will start depleting.



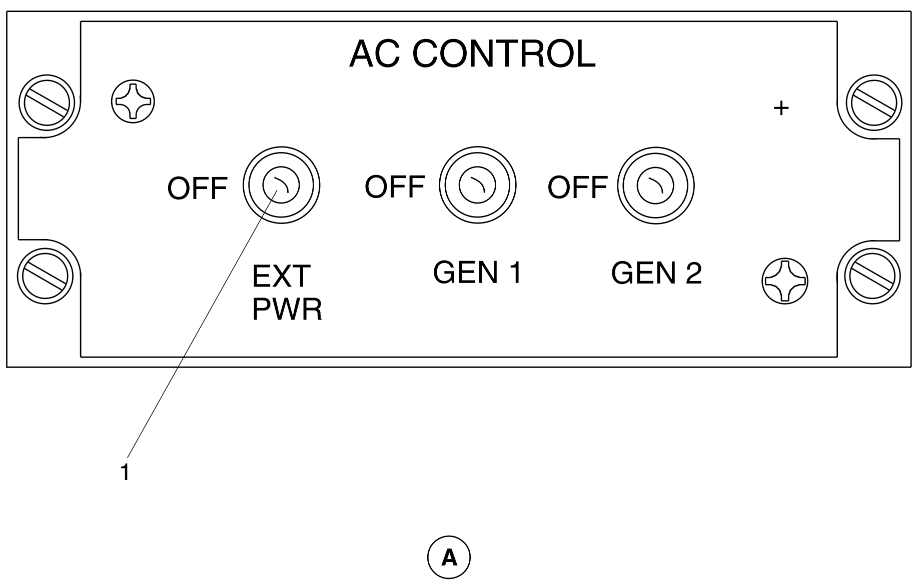
AC VARIABLE FREQUENCY SYSTEM, EXTERNAL POWER OPERATION
Figure 1



Main 28 VDC Generation System, External Power Operation
Figure 2



OVERHEAD CONSOLE



LEGEND

1. AC External Power Toggle Switch.

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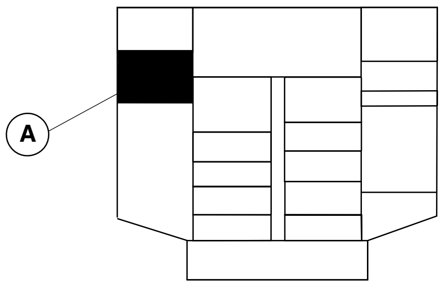
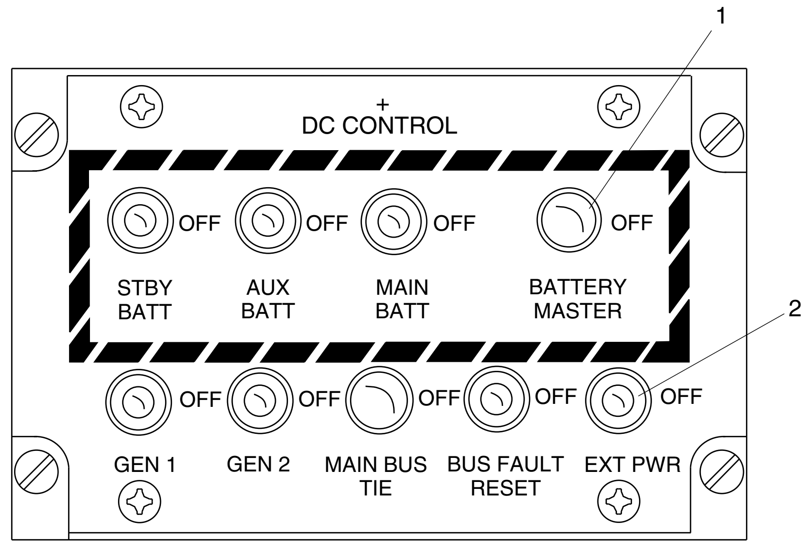
EXTERNAL POWER SYSTEM, AC VARIABLE FREQUENCY SYSTEM, AC CONTROL PANEL
Figure 3



OVERHEAD CONSOLE



A

LEGEND

1. Battery Master Toggle Switch.
2. External Power Toggle Switch.

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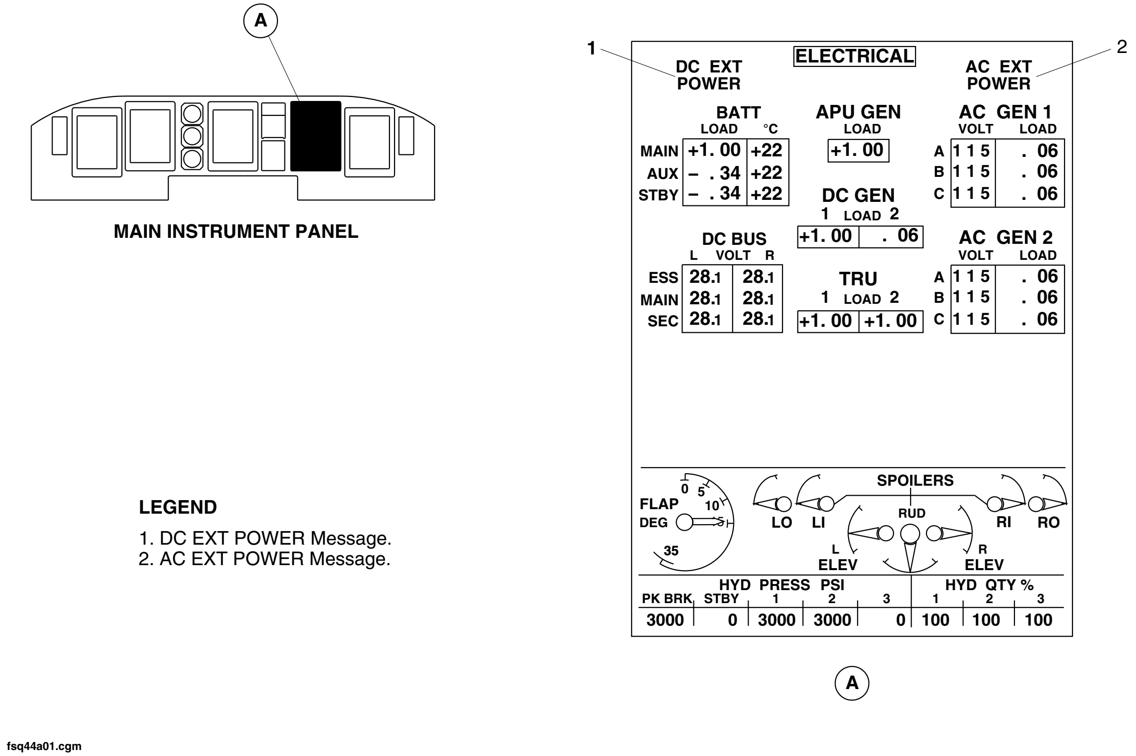
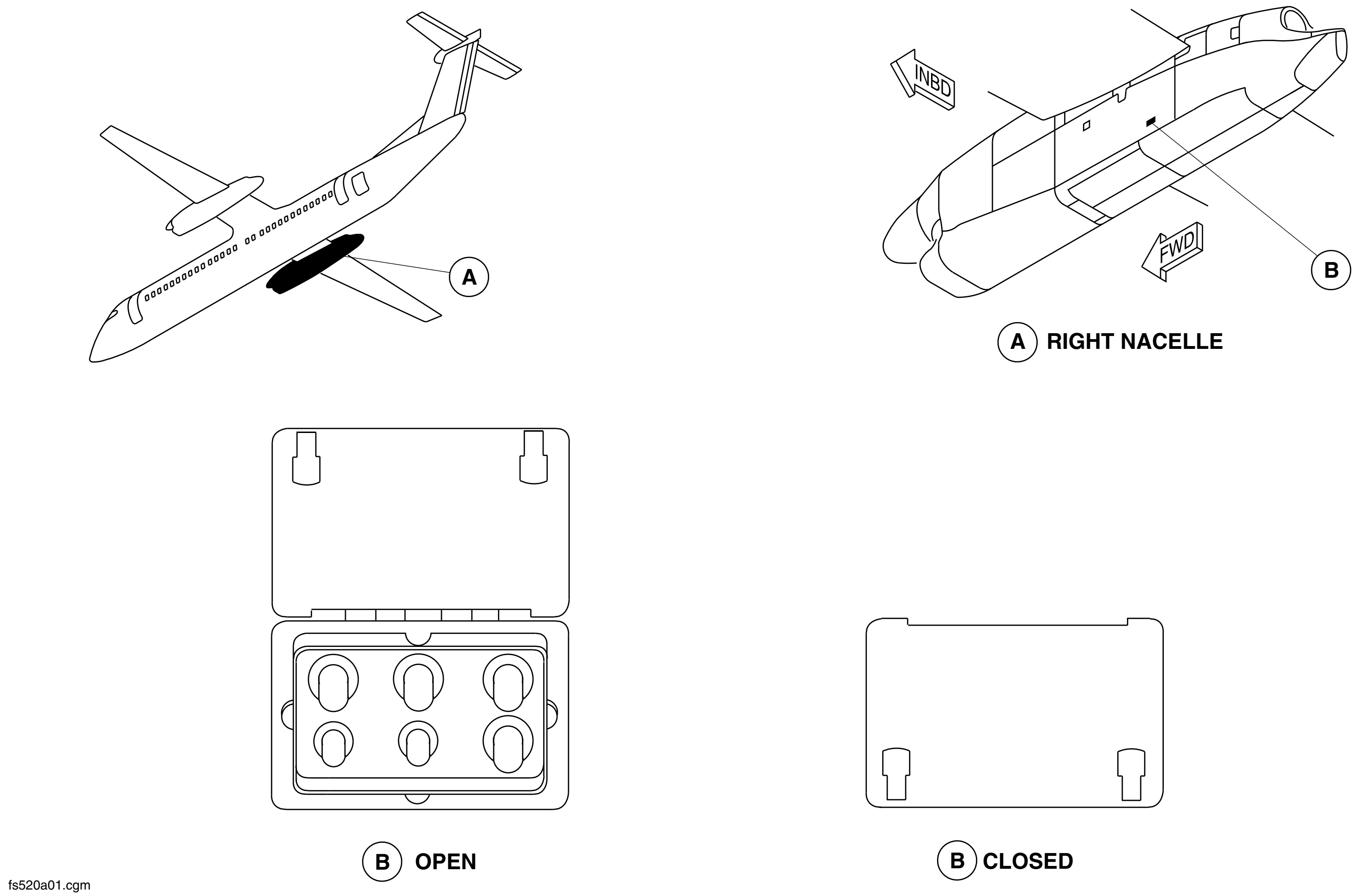
MAIN 28 VDC GENERATION SYSTEM, DC CONTROL PANEL DETAIL
Figure 4



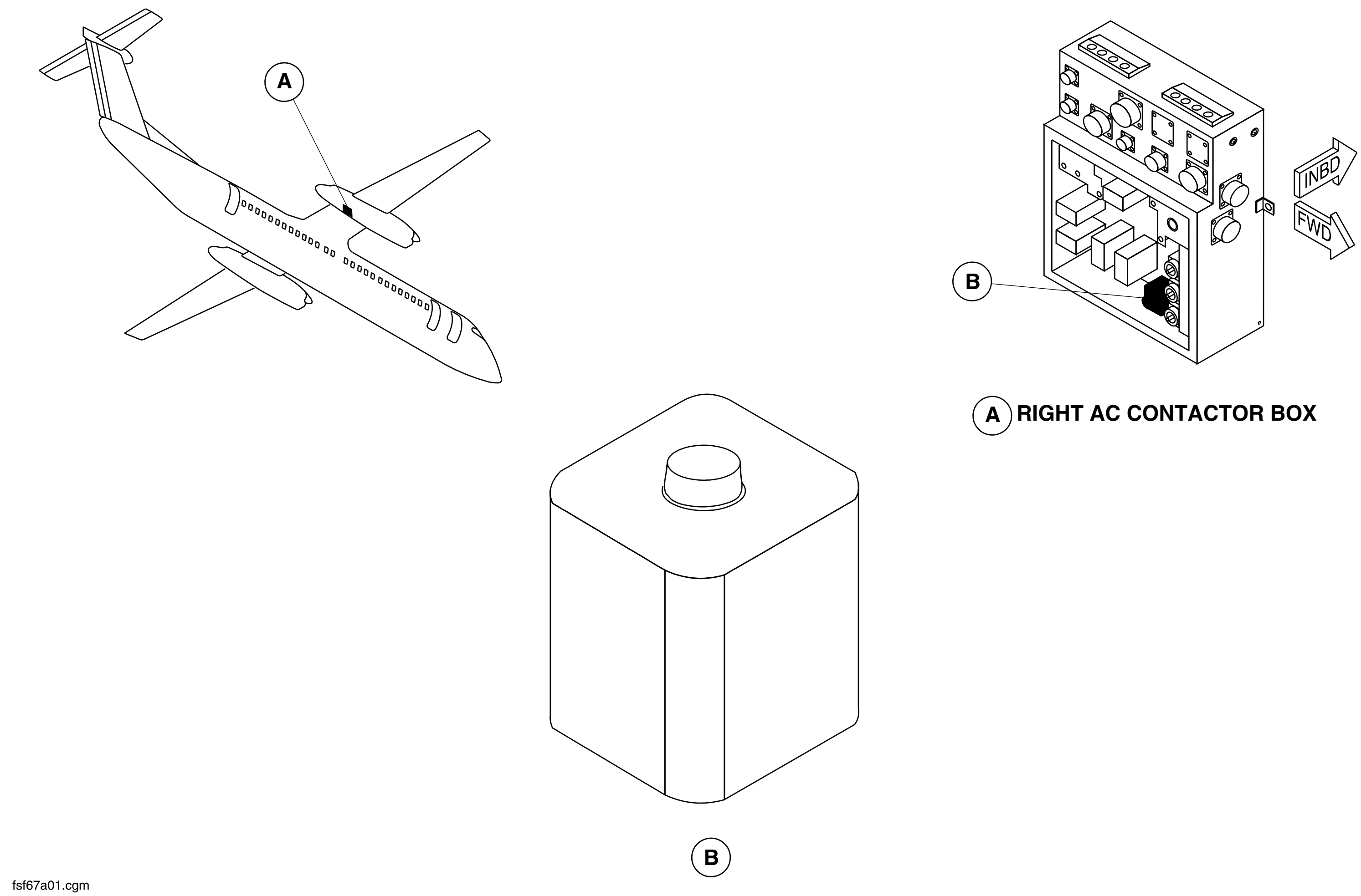
LEGEND

1. DC EXT POWER Message.
2. AC EXT POWER Message.

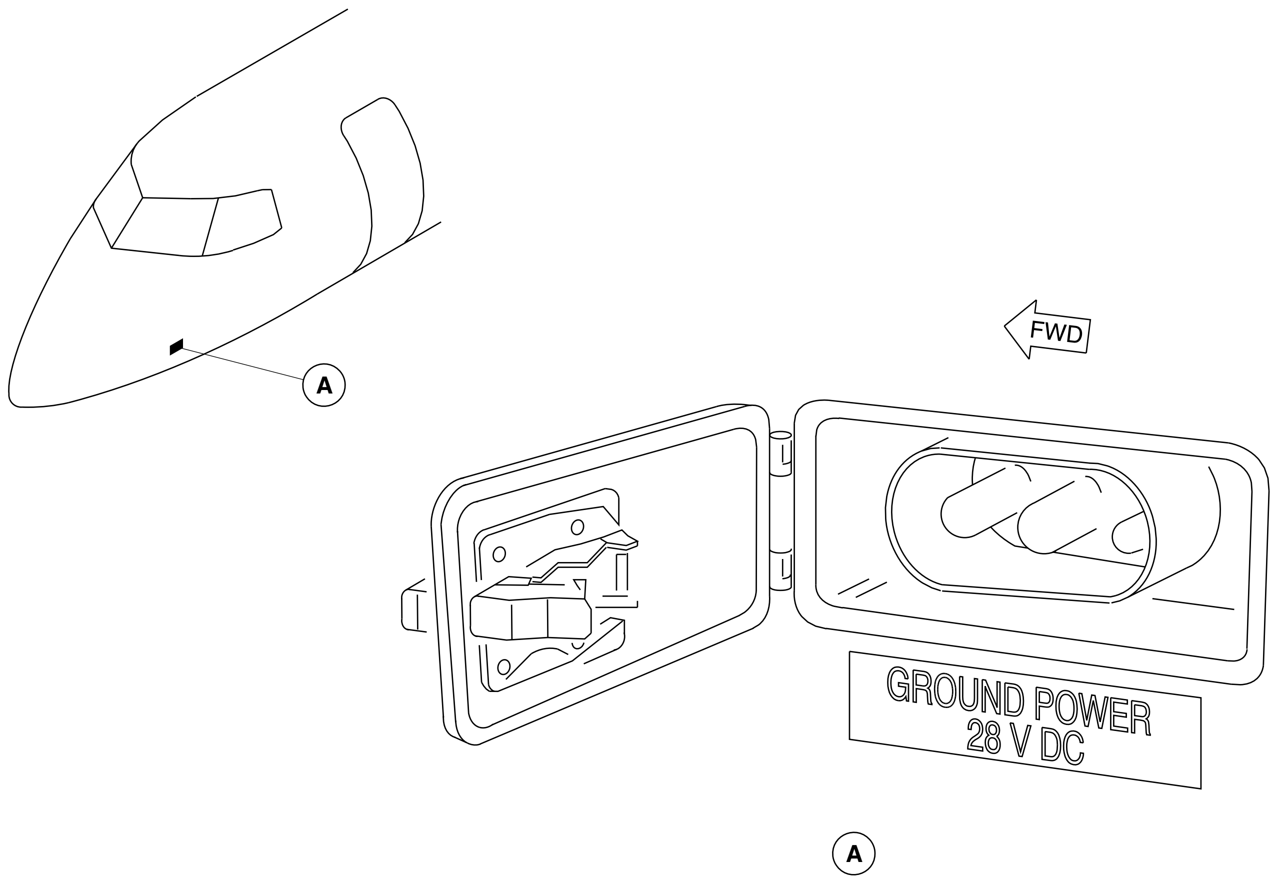
ELECTRICAL SYSTEM DISPLAY
Figure 5



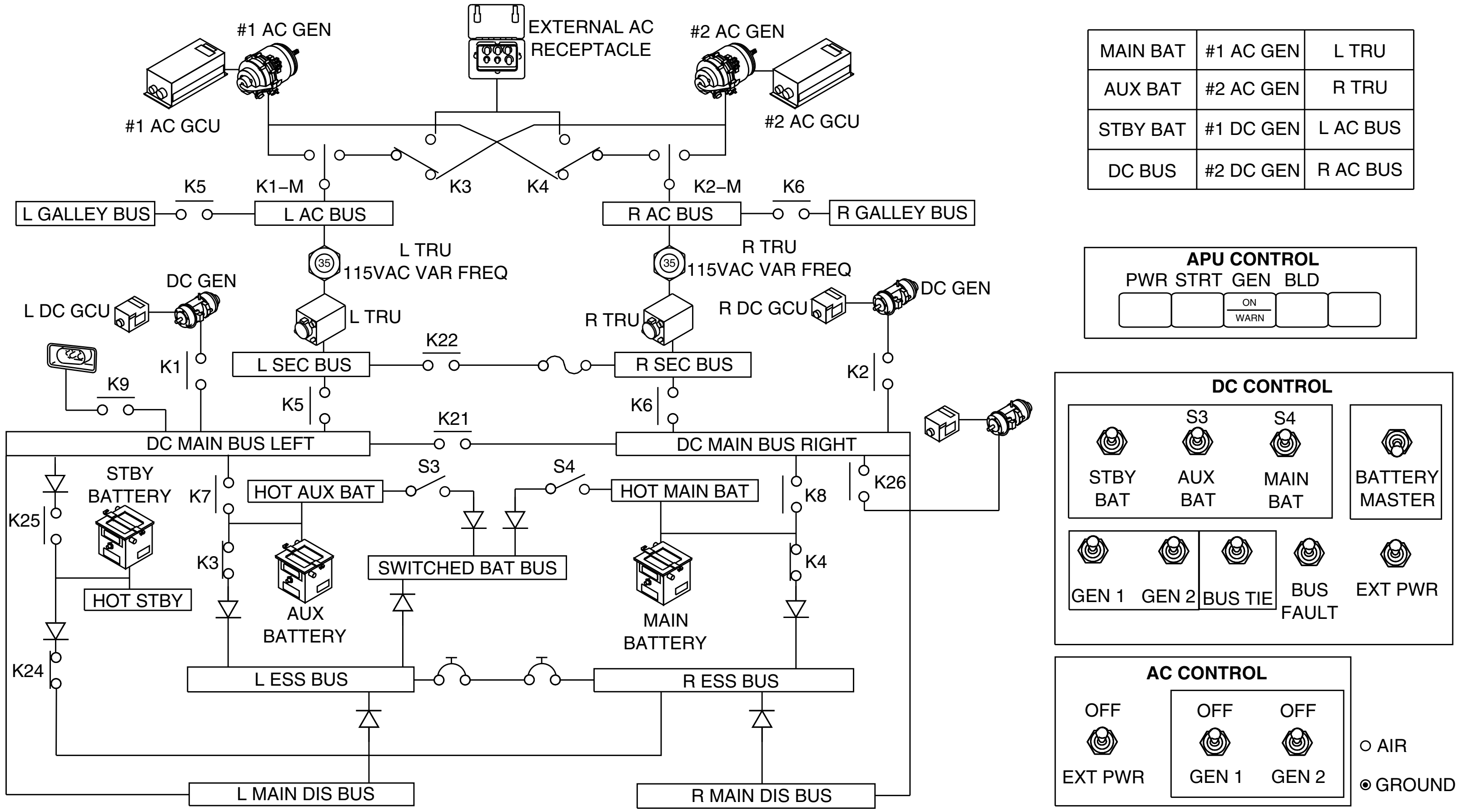
AC EXTERNAL POWER RECEPTACLE
Figure 6



AC EXTERNAL POWER PROTECTION UNIT
Figure 7



DC EXTERNAL POWER RECEPTACLE
Figure 8



MAIN BAT	#1 AC GEN	L TRU
AUX BAT	#2 AC GEN	R TRU
STBY BAT	#1 DC GEN	L AC BUS
DC BUS	#2 DC GEN	R AC BUS

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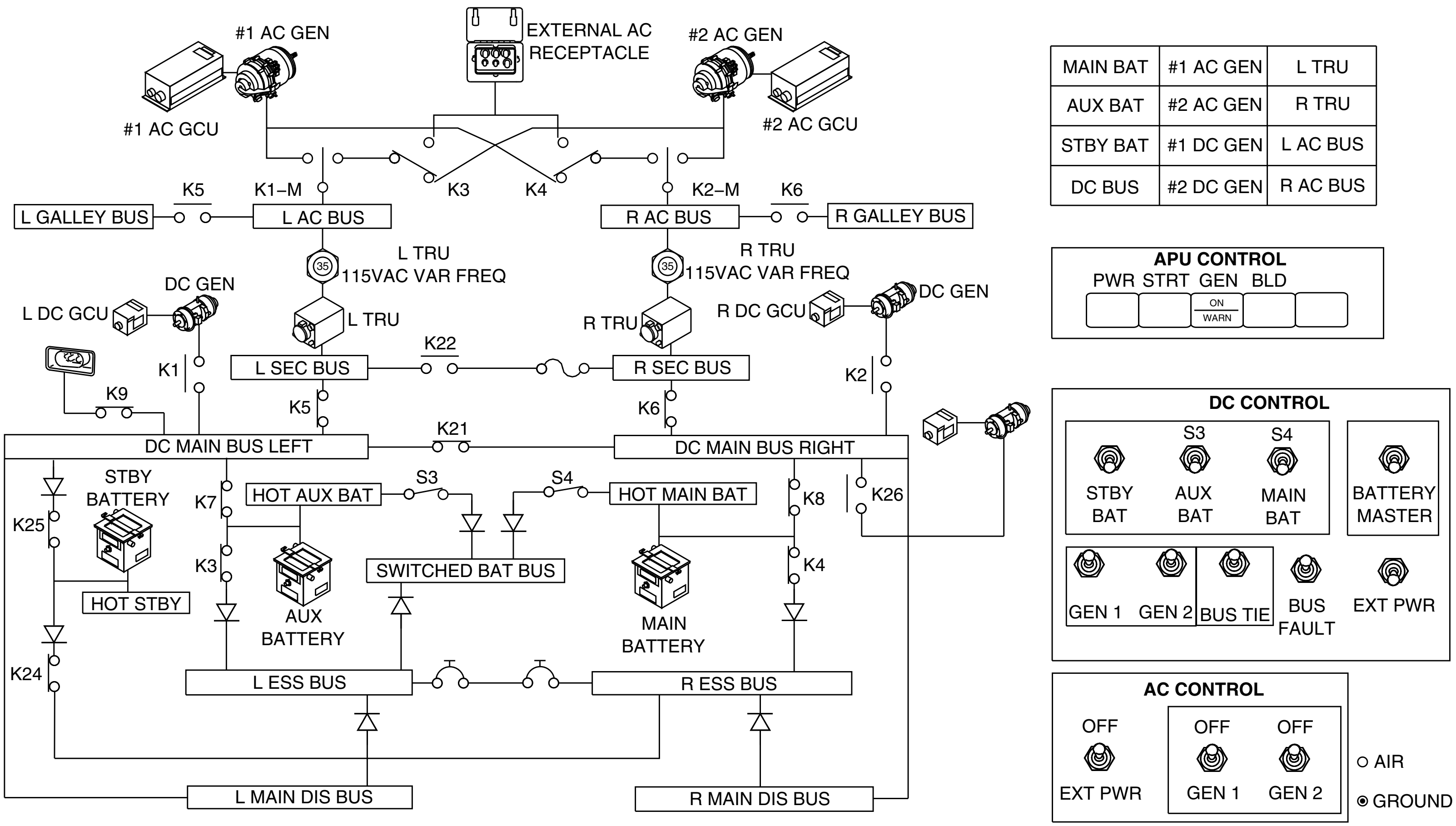
GROUND MODE WITH BATTERY MASTER SWITCH SELECTED TO ON POSITION

Electrical Power Generation System
Figure 9 (Sheet 1 of 3)



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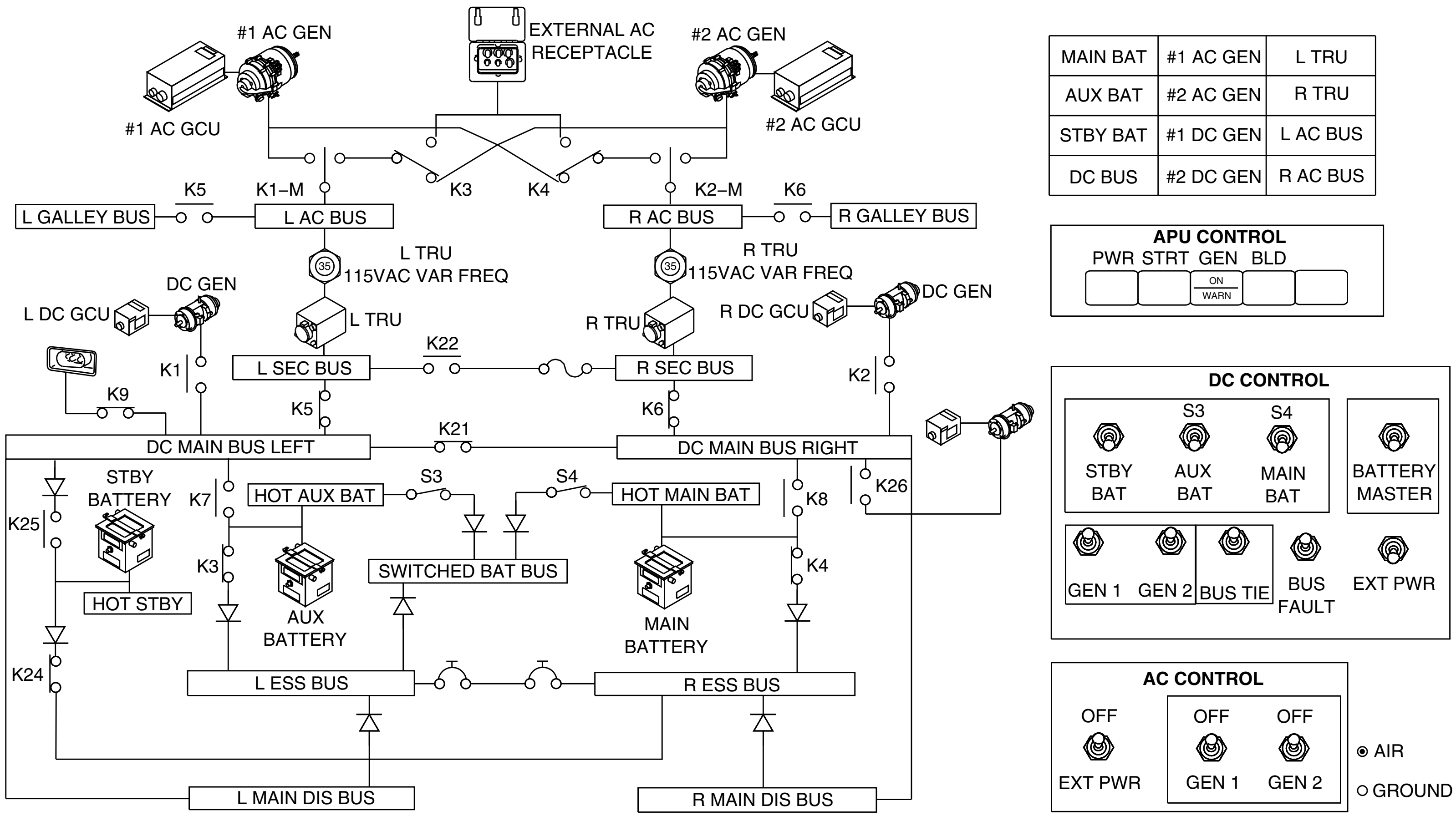
GROUND MODE WITH BATTERY MASTER SWITCH SELECTED TO ON, EXTERNAL POWER SELECTED TO ON AND STANBY/AUX/MAIN BATT SELECTED TO ON POSITION

Electrical Power Generation System
Figure 9 (Sheet 2 of 3)



AIR MODE WITH BATTERY MASTER SWITCH SELECTED TO ON, EXTERNAL POWER SELECTED TO ON AND STANBY/AUX/MAIN BATT SELECTED TO ON POSITION

cg1511a03.dg, rc, jun21/2011

Electrical Power Generation System
Figure 9 (Sheet 3 of 3)

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24–41–00–001

EXTERNAL AC POWER

Introduction

An ac external power receptacle and control circuitry allows the ac variable frequency system to be energized by an ac external power source while the aircraft is on the ground.

General Description

Refer to Figures 1 and 2.

The ac external power energizes the 115 Vac variable frequency if no aircraft power source is available.

The ac external power receptacle is installed on left side of the right nacelle. The Electrical Power Protection Unit (EPPU) monitors the ac external power supplied to the ac busses. The busses then supply ac power to the transformer rectifier unit secondary windings, which are part of the dc generation system to energize the main 28 Vdc system.

A toggle switch located on the ac control panel in the flight compartment gives manual control of the ac external power system. An external ac ground service power toggle switch selection at the ac power receptacle panel causes ac external power to energize the galley and lavatory water heaters. The Engine and System Integrated Display (ESID) system shows ac external power indications.

The ac external power system has the components that follow:

– AC External Power Receptacle (24–41–01)
– Unit, External ac Protection (24–41–06).

Sensors in the Electrical Power Protection Unit (EPPU) monitor the ac external power source for voltage and frequency. The EPPU will allow good ac external power to energize the aircraft busses.

Detailed Description

Refer to Figure 3.

The ac external power system supplies 115 Vac electrical power from an external ground power source to the aircraft 115 Vac variable frequency busses.

The ac external power system functions in the modes that follow:

– Normal
– Monitoring and protection.

Normal Function: The Electrical Power Protection Unit (EPPU) monitors the ac external power source that supplies ac electrical power to the 115 Vac variable frequency circuit breaker panel in the flight compartment.

When the ac external source is supplying electrical power to the aircraft and the external power toggle switch on the ac control panel is set to the EXT PWR position, the EPPU will let the external power source to connect to the ac variable frequency busses.

NOTE

Note: When ac external power is connected, the battery master toggle switch located on the dc control panel is set to the BATTERY MASTER position before the ac external power toggle switch is set to EXT PWR for ac external power operation.

The EPPU automatically controls operation of the cross tie contactors by monitoring output voltage, frequency, and phase rotation of the ac external power source. When the EPPU senses an external power malfunction, it will cause the cross tie contactors to move from the external power position to de−energize the ac busses.

The ac external power source supplies 115 Vac variable frequency, 370 to 450 Hz power through the two cross tie contactors, K3 and K4 and two bus tie contactors K1 and K2 to the ac busses. The ac GCUs control the bus contactor operation. When the ac GCU receives an ac external power signal it causes the bus tie contactors, K1 and K2, to move to the external power position. When the ac busses are energized by the ac external power, the ac generators are disconnected from the ac busses.

The ac electrical power is distributed to the ac busses through the left and right contactor boxes located in the left and right nacelles. The right ac contactor box (RACCB) and left ac contactor box (LACCB) contain the switching, protection and measuring components. The ac external power is supplied to the ac busses in the flight compartment through the cross tie contactors K3 and K4. These two contactors are located in the RACCB and LACCB. The two bus tie contactors K1 and K2 are also located in the RACCB and LACCB.

The ac external power is sensed by the EPPU that is located in the right ac contactor box (RACCB).

The EPPU monitors the power characteristics for proper voltage range, frequency and phase rotation. When the ac external ac power source is good, and the ac external power toggle switch is set to the EXT PWR position , the EPPU will cause the ac cross tie contactors, K3 and K4 to the cross tie position. After a 50 milliseconds time delay, the ac GCUs energize the Y coil of the bus tie contactors, K1 and K2 to the external power positions. This sequence allows the external power source to energize the left and right ac busses.

After an engine start sequence, with the ac generator toggle switches set to the GEN1 and GEN2 positions, the ac GCUs will prevent the ac generators from connecting to the ac busses.

The ac external power toggle switch must be set to the OFF position to cause the ac generator bus tie contactors to switch from the external power position to the ac generator power position. This connects ac generator power to the right ac bus and cross tie to the left ac bus. With the ac busses energized, the left and right TRUs energize the left and right secondary busses. If a dc external power source is also used, the left and right contactors, K5 and K6 open to prevent parallel operation of the TRUs and the dc external power source.

After the other engine start sequence the ac generator bus tie contactor will move to its generator power position and supply 115 Vac power to its ac bus. The secondary busses will remain disconnected from the external dc power source.

The ac GCUs prevents parallel operation of ac external power source and the ac generators. When an ac external power source is energizing the ac busses, the cross tie contactors supply an inhibit signal to the two ac GCUs. The ac GCUs use the inhibit signal to prevent the bus tie contactors from moving to the generator power position. The inhibit function will make the generator operate in a standby condition. The contactor will stay in the external power position while the external power signal is available.

Monitoring and protection: The protective functions in the ac external power system prevent damage to the aircraft ac systems when the ac external power source malfunctions or if there is an overload condition.

The ac external power is continuously monitored by the EPPU. When a malfunction is sensed, it disconnects the ac external power from the aircraft busses.

The ac external power system has passive and active protection.

The ac external power system uses circuit breakers and fuses for passive protection so that a malfunction condition will not cause damage to the aircraft wiring. The circuit breakers and fuses are protection devices that open the circuit during excessive current flow conditions. Unlike fuses, circuit breakers can be reset without having to be replaced.

The ac external power system uses the EPPU to automatically control the right cross tie contactor for active protection so that a fault condition will not cause damage to the aircraft wiring. The automatic functions do not require a manual input from the flight deck. An example of such a function is the overvoltage protection for the ac external power. It uses the protective functions that follow:

- Under voltage, 106 Vac
- Over voltage, 124 Vac
- Under frequency, 370 Hz
- Over frequency, 450 Hz
- Phase rotation.

Under Voltage: When the voltage from the external power is less than 106 Vac, the EPPU disconnects the external power.

Over voltage: When the voltage from the external power is more than 124 Vac, the EPPU disconnects the external power. This protection has an inverse time delay to make sure that the disconnect time is inversely proportional to the magnitude of the over voltage level.

Under Frequency: When the frequency from the external power is less than 370 Hz, the EPPU disconnects the external power.

Over Frequency: When the frequency from the external power is more than 450 Hz, the EPPU disconnects the external power.

Phase Rotation: External power output voltage of each phase is measured at the receptacle pins (A, B, and C). The EPPU measures the difference in degrees between the A, B, and C phase voltages. When the phase difference becomes excessive the EPPU will disconnect the external ground power.

When source or bus faults occur or the ac external power quality exceeds its limits, the contactors open, and stay open until the external power is reset to prevent a reconnection to a fault condition. The EXT PWR toggle switch on the ac control panel is set to the OFF position and then to EXT PWR again to reset the ac external power fault.

The EPCU has a passive diagnostic IBIT function that is used to show possible problems in the ac external power system to the maintenance personnel. The EPCU IBIT system monitors the ac external power system for fault detection, isolation, and indication.

Refer to Figure 4.

The Electrical Power Control Unit (EPCU) records the ac external power system fault conditions. It has an interface panel on its front face to look at the fault codes that represent fault conditions sensed by the Continuous Built in Test (CBIT). It uses FAULT REVIEW and CLEAR pushbutton switches and a digital display to view the fault codes.

The CBIT operates only when the aircraft is on the ground. A blank indication shows when no fault conditions are sensed by the CBIT. When the indication is out of view, the FAULT REVIEW pushbutton switch is pushed to do display test. It will show 88 for correct operation.

The two ac cross tie contactor K3 and K4 are checked. If the contactor position does not match the ac external power switch position, the EPCU display will show fault code 23 or 24.

Refer to Figure 5.

When ac external power is connected, and the battery master toggle switch located on the dc control panel is set to the BATTERY MASTER position and the ac external power toggle switch located on the ac control panel is set to EXT PWR, the ac external power source is connected to the ac buses for operation.

The ac generator toggle switches are set to the OFF position to de–energize the ac external power system.

The Electrical Power Control Unit (EPCU) supplies indication data through the two Input/Ouput Processors (IOP1, IOP2) located in the Integrated Flight Cabinets (IFCs) to the Electronic Instruments System (EIS).

Refer to Figure 6.

The MFD1 and MFD2 reversion switches located on the ESID Control Panel (ESCP) are used to select the electrical page on the multi–functional displays.

Refer to Figure 7.

The electrical page shows the ac generator indications that follow:

– AC EXT POWER message

– Digital indication of the ac external power voltage.

AC EXT POWER Message: The MFD shows the AC EXT POWER message when the conditions that follow are correct:

– AC external ground power is connected to the ac external power receptacle

– The ac external power is good

– The ac external power toggle switch on the ac control panel is set to the EXT PWR position

– The ac external power source is energizing the ac busses.

AC External Power Voltage Indication: The ac generator voltage indication shows the ac bus voltage for each phase in white numbers.

Refer to Figure 8.

When the voltage data malfunctions, the digits are replaced by white dashes.

Refer to Figure 9.

When ac external is energizing the caution lights that follow come on:

- #1 AC GEN
- #2 AC GEN

#1 AC GEN, #2 AC GEN Caution Light: The #1 AC GEN or #2 AC GEN caution light comes on to show that the generator is not connected to its bus because an external ac power source is energizing the left and right busses.

NOTE

Note: There is no indication for a condition where the ac external power source is connected to the aircraft and an ac external power toggle switch selection is not made.

AC External Power Receptacle (Aircraft without Option 824CH00114 and 824SO90105)

Refer to Figure 10.

The ac external power receptacle is used to allow repetitive connections to an ac external power source. When an external ground power connector is connected to the receptacle, it will supply 115 Vac from the ground power source to the ac busses. The aircraft ac power receptacle is a six male pin connector.

The ac external power receptacle is located on left side of the right nacelle of the aircraft.

AC External Power Receptacle (Aircraft with Option 824CH00114 or 824SO90105)

Refer to Figure 11.

The ac external power receptacle is used to allow repetitive connections to an ac external power source. When an external ground power connector is connected to the receptacle, it will supply 115 Vac from the ground power source to the ac busses. The aircraft ac power receptacle is a six male pin connector.

The ac external power receptacle is located on the right side of the nose fuselage of the aircraft.

External AC Power Protection Unit

Refer to Figure 12.

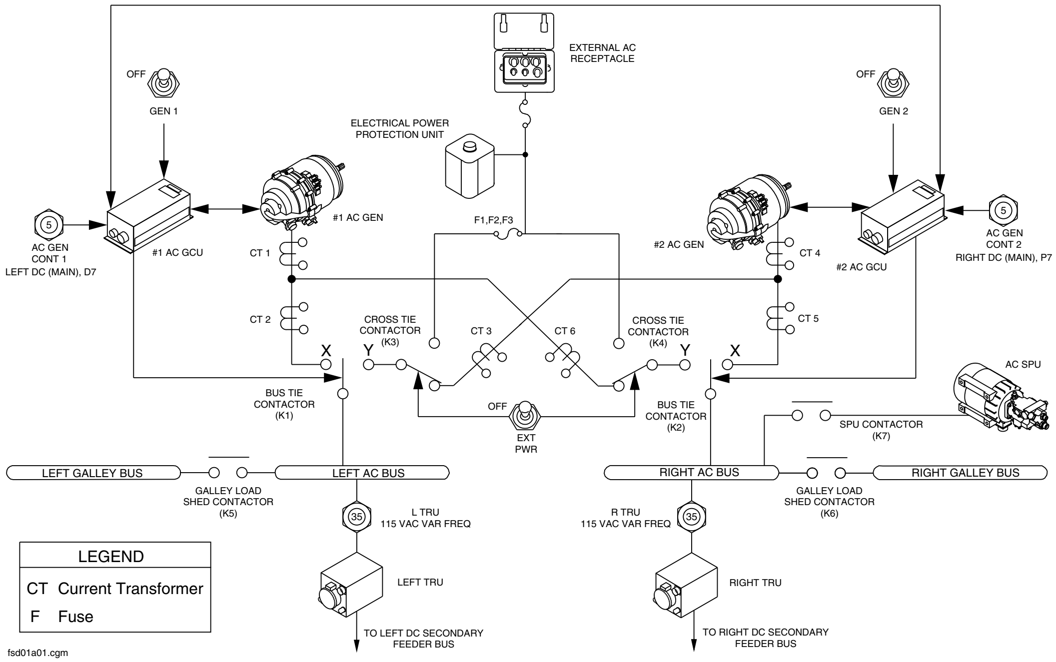
The EPPU makes sure that good ac external power is allowed to energize the ac busses.

The EPPU checks the external power source for the parameters that follow:

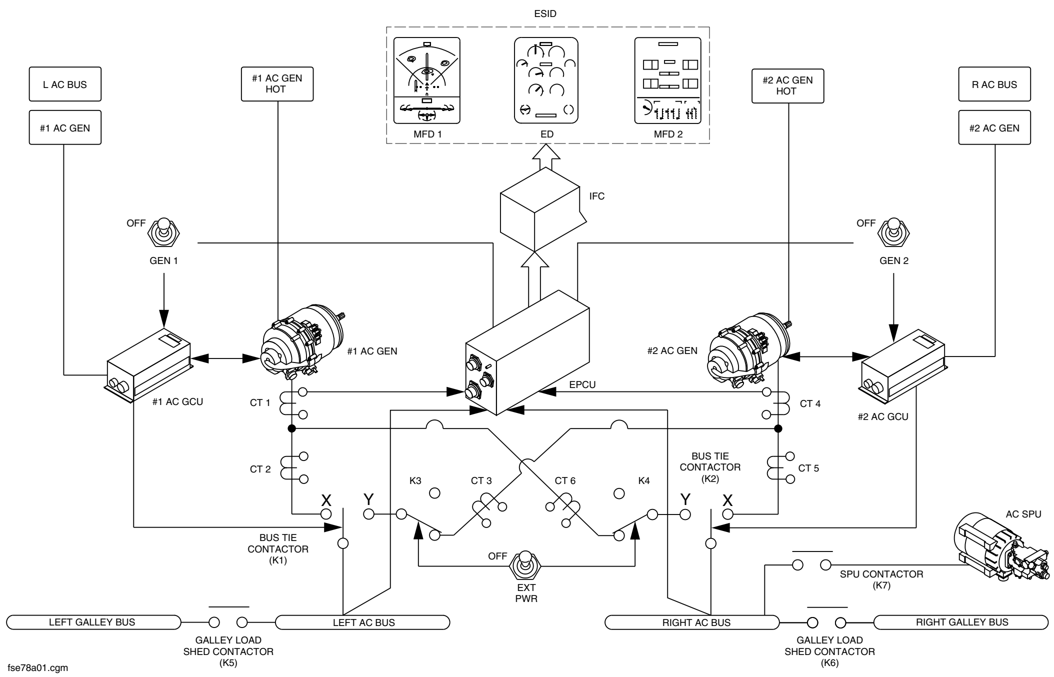
Table 1: Table 2.

PARAMETER	TRIP POINT
Over Voltage	124 VAC
Under Voltage	106 VAC

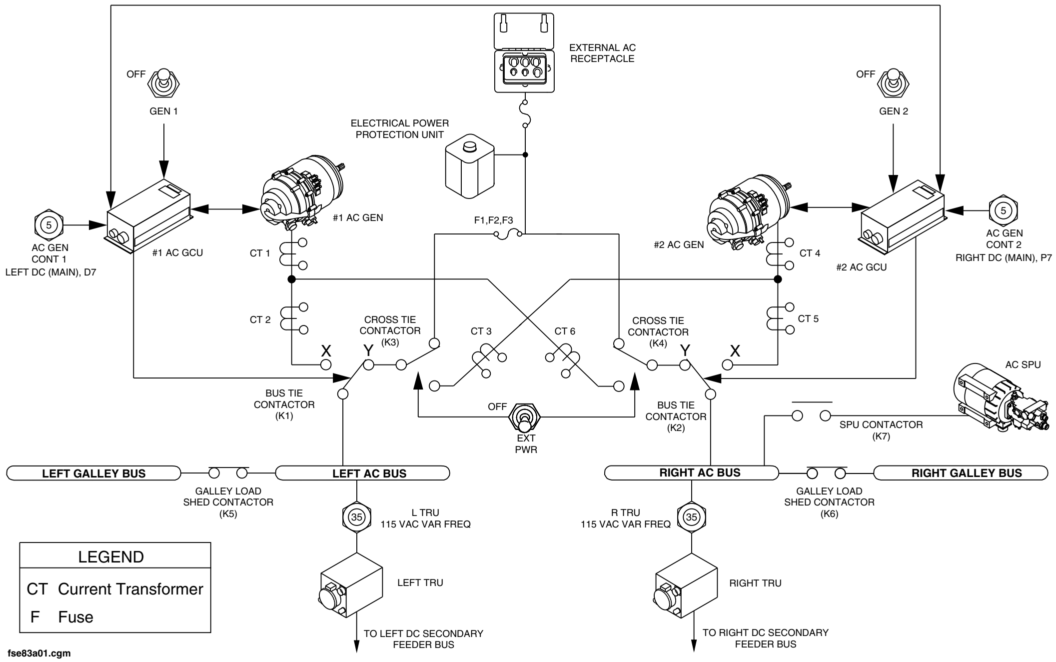
PARAMETER	TRIP POINT
Over Frequency	450 Hz
Under Frequency	370Hz



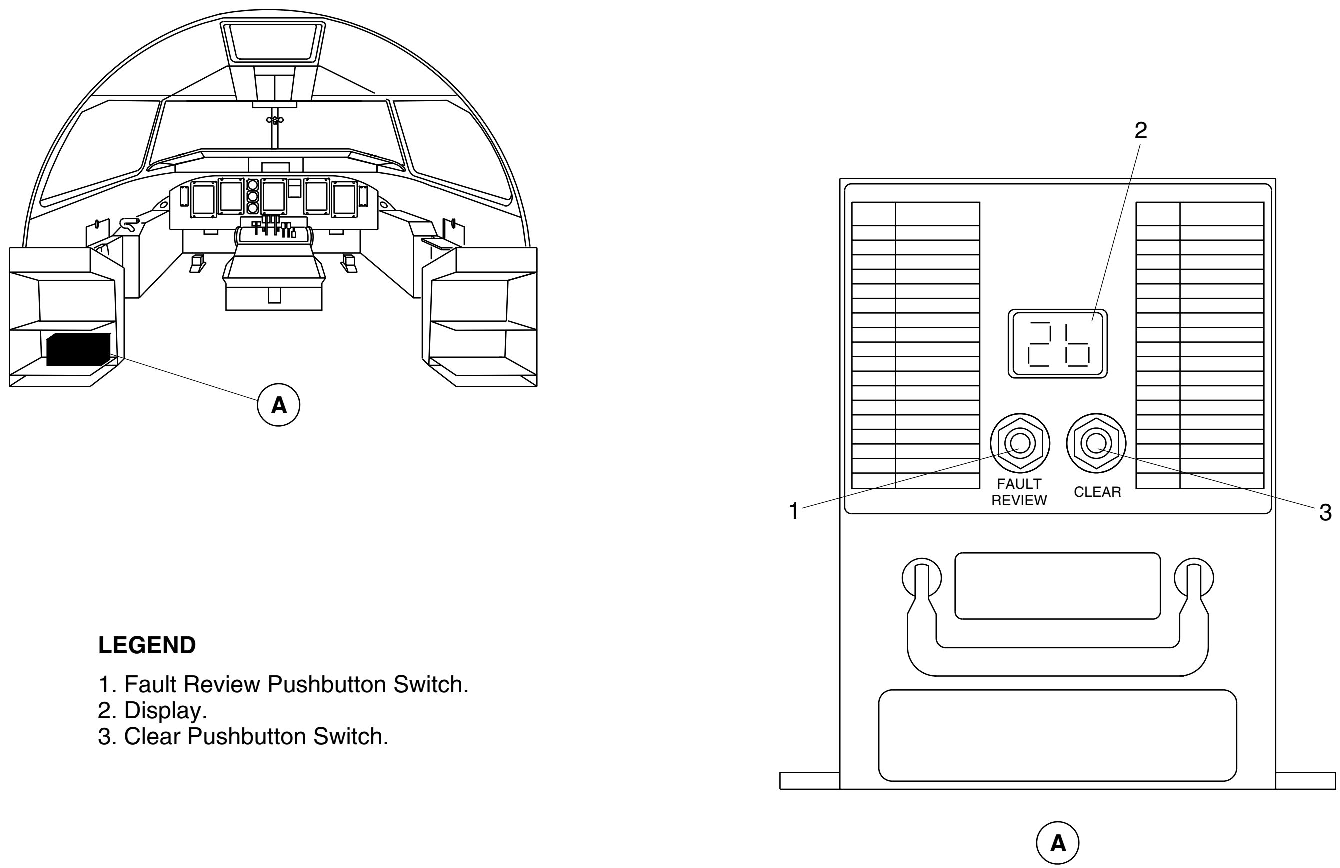
AC VARIABLE FREQUENCY SYSTEM BLOCK DIAGRAM, CONTROL
Figure 1



AC VARIABLE FREQUENCY SYSTEM BLOCK DIAGRAM, INDICIATION
Figure 2



AC VARIABLE FREQUENCY SYSTEM, EXTERNAL POWER OPERATION
Figure 3



LEGEND

1. Fault Review Pushbutton Switch.
2. Display.
3. Clear Pushbutton Switch.

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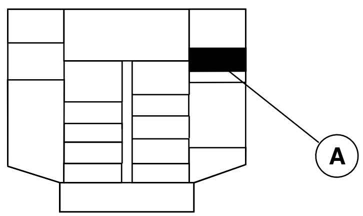
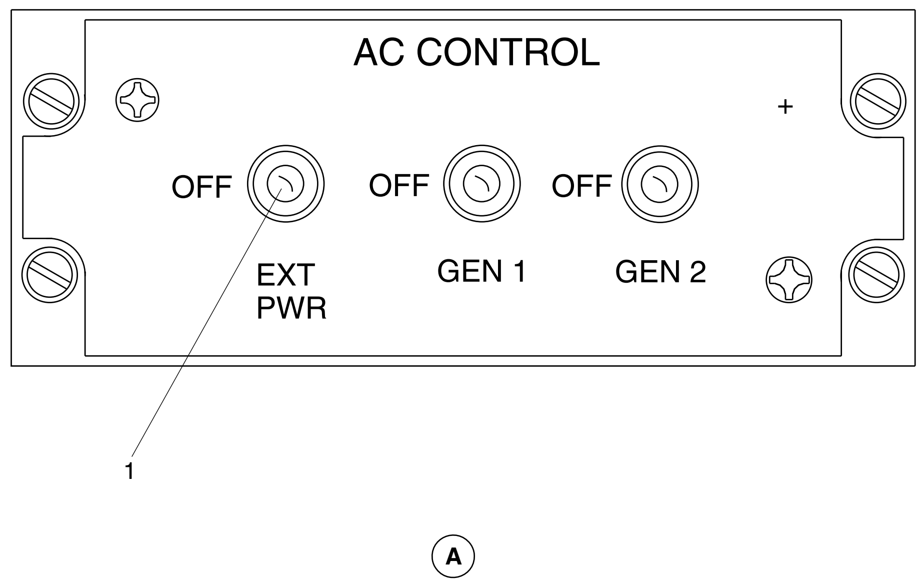
MAIN 28 VDC GENERATION SYSTEM, EPCU
Figure 4



OVERHEAD CONSOLE



LEGEND

1. AC External Power Toggle Switch.

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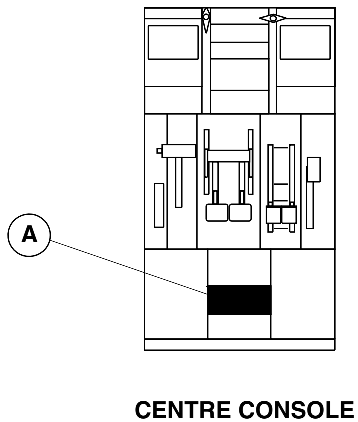
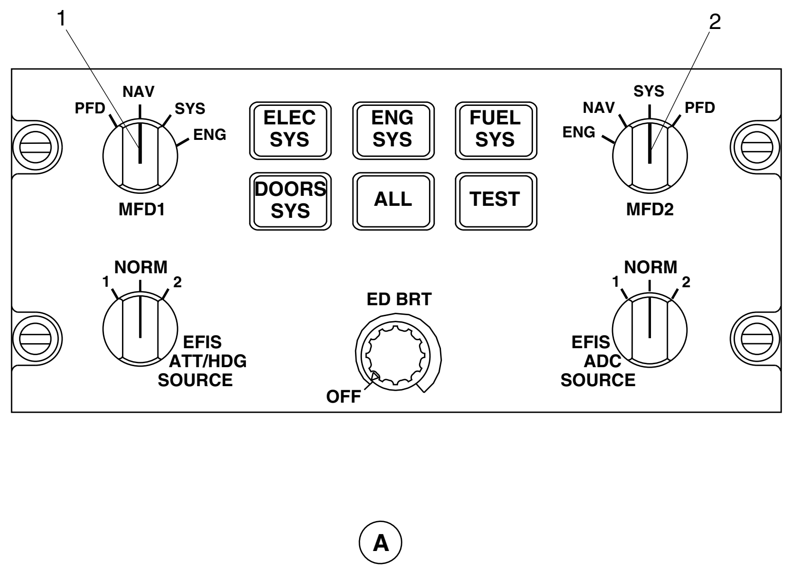
AC EXTERNAL POWER SYSTEM, AC VARIABLE FREQUENCY SYSTEM, AC CONTROL PANEL
Figure 5



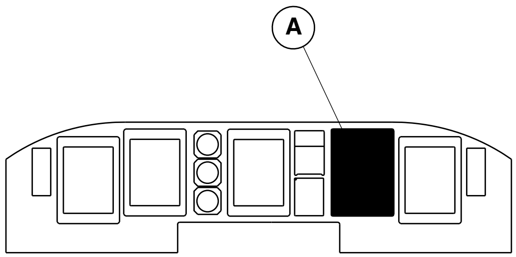


LEGEND

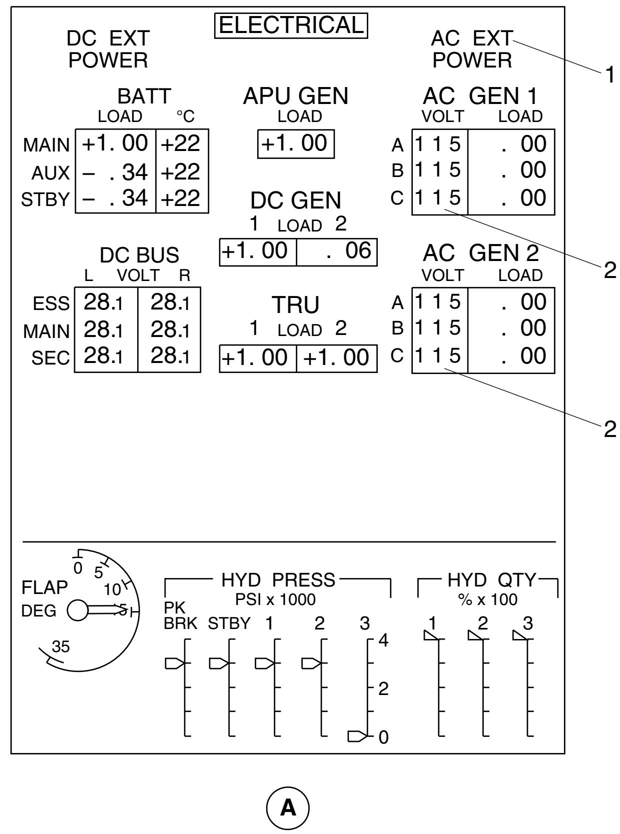
1. MFD 1 Reversion Selector.
2. MFD 2 Reversion Selector.

fs750a01.cgm

EIS, ELECTRICAL SYTEM PAGE SELECTION
Figure 6



MAIN INSTRUMENT PANEL



LEGEND

1. AC External Power Message.
2. AC External Power Voltage Indication.

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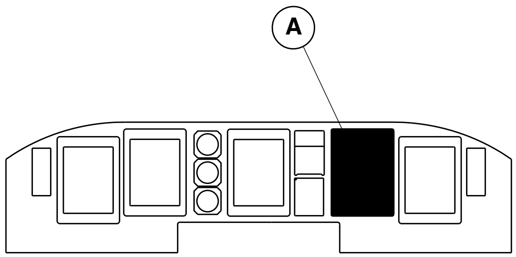
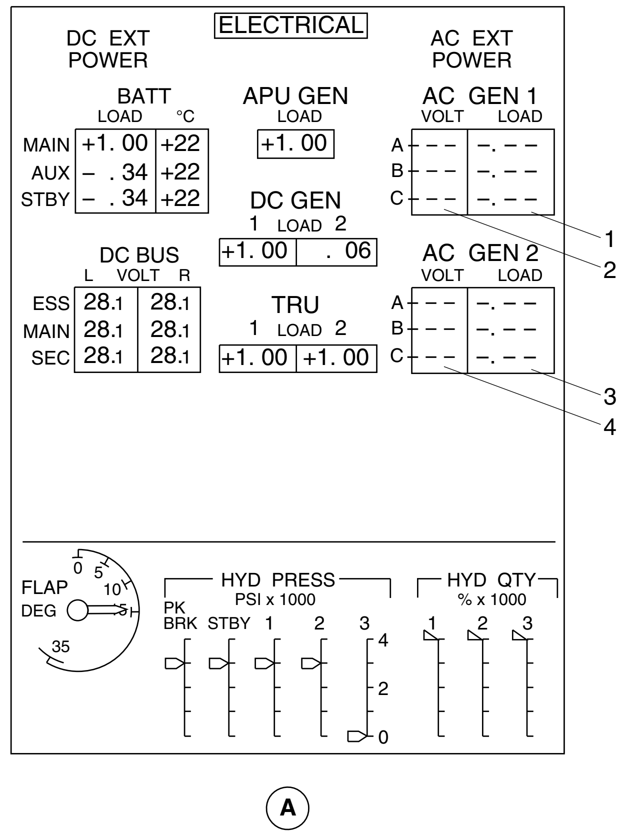
EIS, AC EXTERNAL POWER SYSTEM INDICATIONS
Figure 7



MAIN INSTRUMENT PANEL

LEGEND

1. AC GEN 1 Load Fail Annunciation.
2. AC GEN 1 Volt Fail Annunciation.
3. AC GEN 2 Load Fail Annunciation.
4. AC GEN 2 Volt Fail Annunciation.



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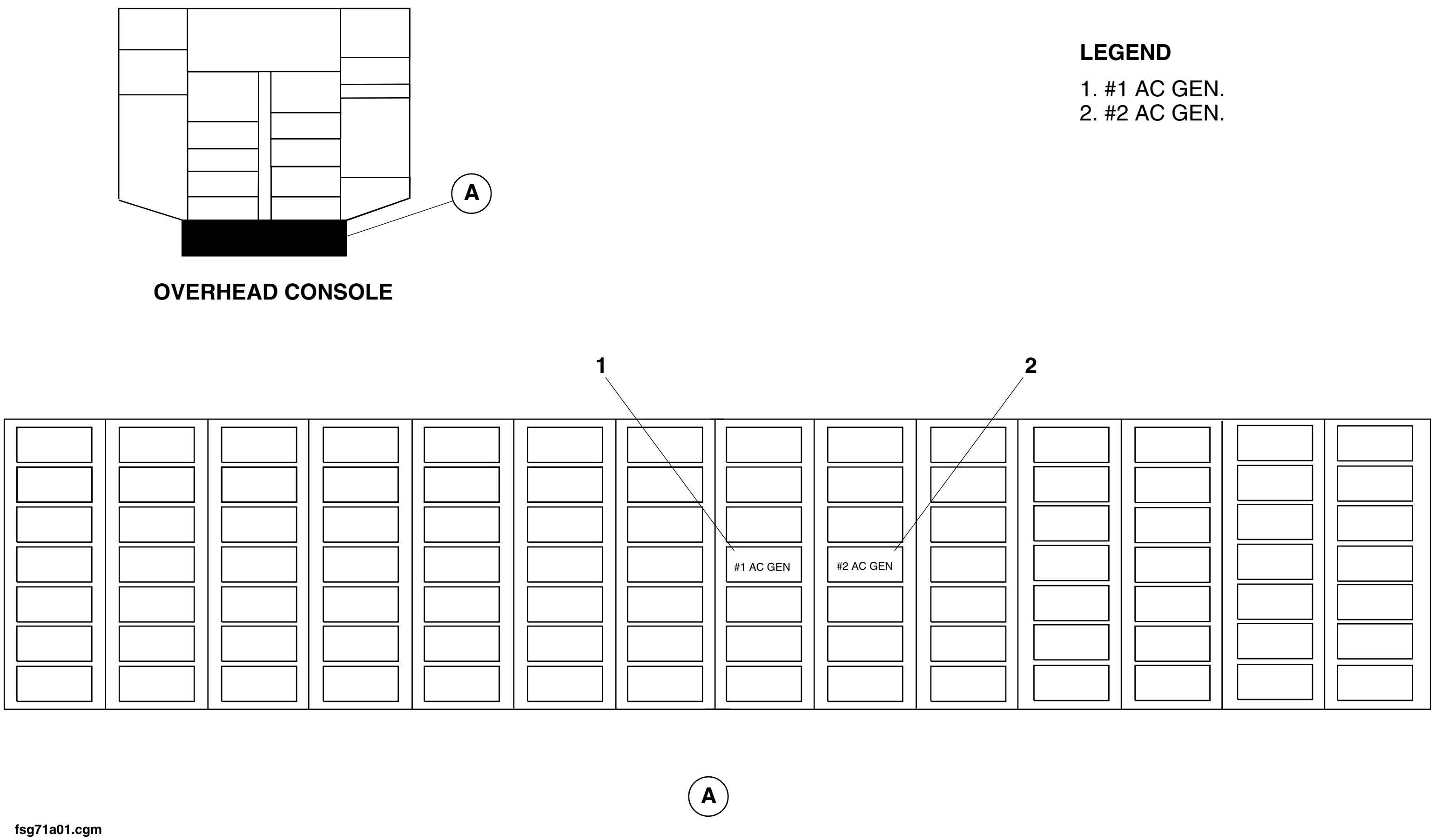
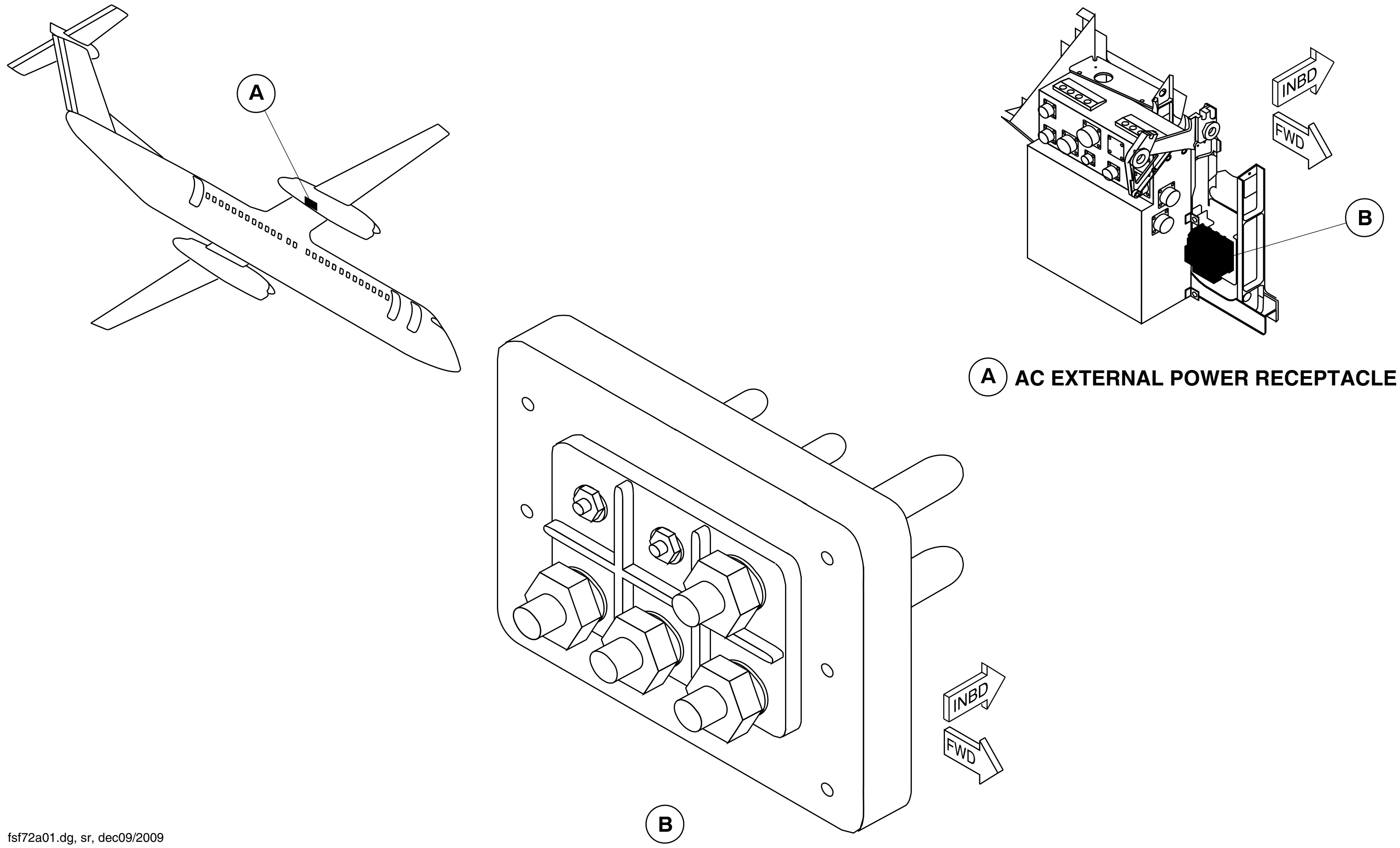
EIS, AC EXTERNAL POWER SYSTEM MALFUNCTION INDICATIONS
Figure 8



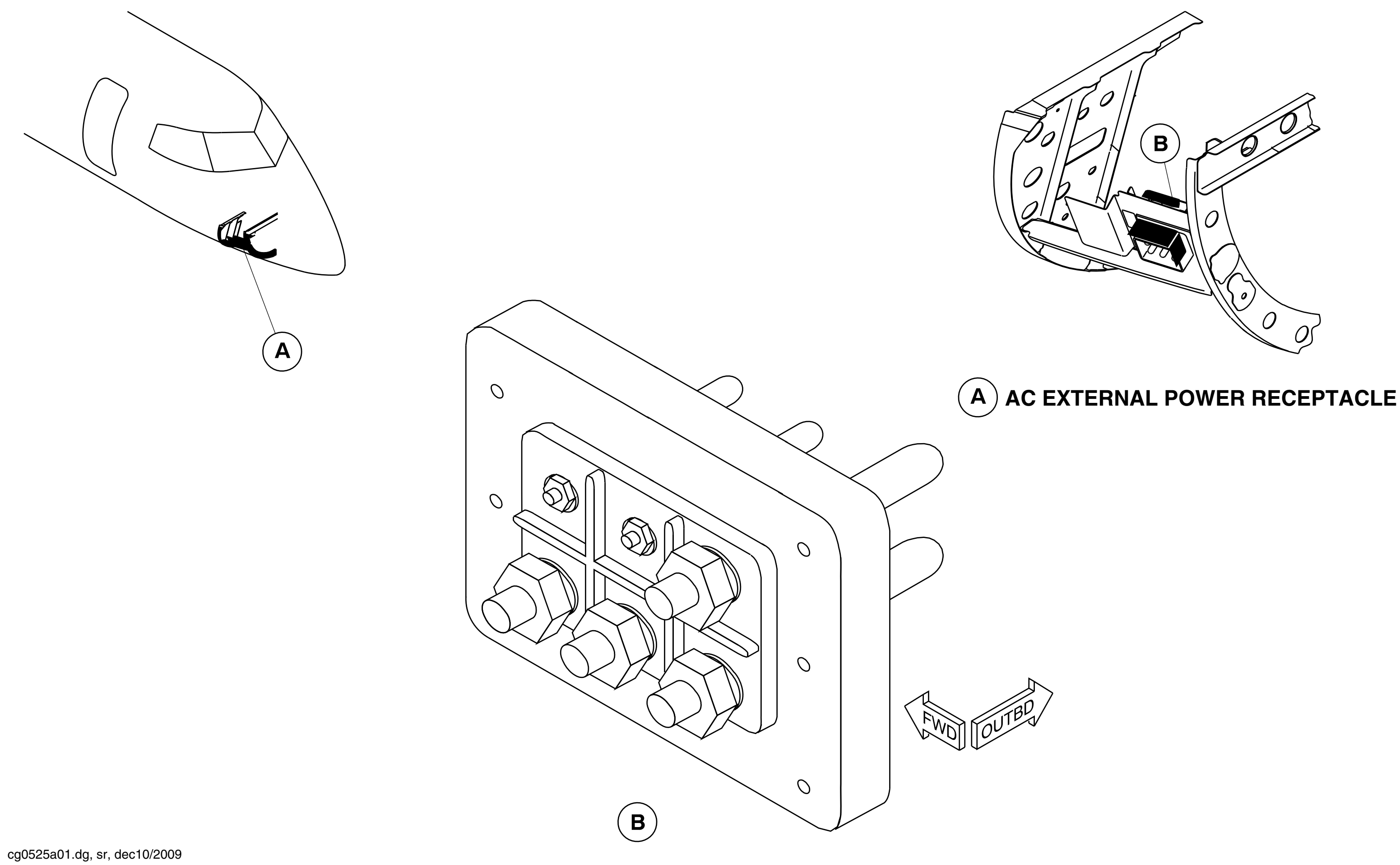
LEGEND

1. #1 AC GEN.
2. #2 AC GEN.

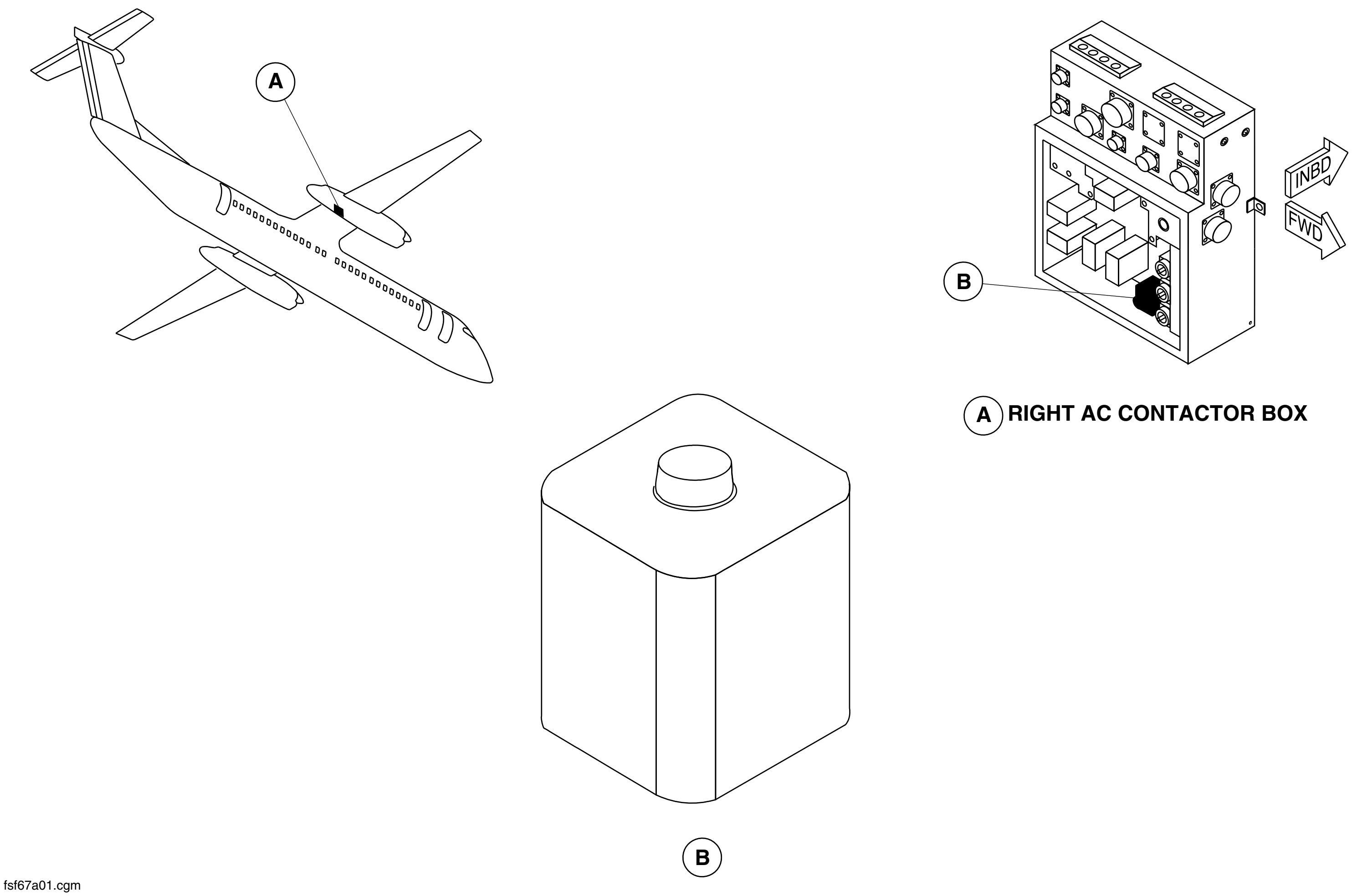
CAUTION AND WARNING PANEL, AC GENERATOR CAUTION INDICATIONS
Figure 9



AC EXTERNAL POWER RECEPTACLE (PRE OPTION 824CH00114, 824SO90105)
Figure 10



AC EXTERNAL POWER RECEPTACLE (POST OPTION 824CH00114, 824SO90105)
Figure 11



AC VARIABLE FREQUENCY SYSTEM, EPPU
Figure 12

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24–42–00–001

EXTERNAL DC POWER

Introduction

The dc external power receptacle and control circuitry allows the main Vdc generation system to be energized by an dc external power source while the aircraft is on the ground.

General Description

Refer to Figures 1 and 2.

The dc external power energizes the main 28 Vdc busses if no aircraft power source is available.

The dc external power receptacle is installed on left side of the forward fuselage section. Sensors in the Electrical Power Control Unit (EPCU) monitors the dc external power source for voltage and polarity. The EPCU will allow good dc external power to energize the aircraft busses.

A toggle switch located on the dc control panel in the flight compartment gives manual control of the dc external power system. The Engine and System Integrated Display (ESID) system shows dc external power indications.

The dc external power system has the components that follow:

– DC External Power Receptacle (24–42–01).

Detailed Description

Refer to Figure 3.

The dc external power system supplies 28 Vdc electrical power from an external ground power source to the aircraft 28 Vdc busses.

The dc external power system functions in the modes that follow:

– Normal

– Monitoring and protection.

Normal Function: The Electrical Power Control Unit (EPCU) monitors the dc external power source that supplies dc electrical power to the 28 Vdc circuit breaker panel in the flight compartment.

When the dc external source is supplying electrical power to the aircraft and the external power toggle switch on the dc control panel is set to the EXT PWR position, the EPCU will let the external power source connect to the 28 Vdc busses.

NOTE

Note: When dc external power is connected, the battery master toggle switch located on the dc control panel is set to the BATTERY MASTER position to energize the EPCU before the dc external power toggle switch is set to EXT PWR for dc external power operation.

For dc external power operation, the EPCU controls the contactors that follow:

– DC external power contactor, K9

– DC starter/generator bus tie contactors, K1 and K2

– Main feeder bus tie contactor, K21

– Secondary/main feeder bus tie contactors, K5 and K6.

The dc external power source supplies 28V dc electrical power through the external power contactor K9 to the left main feeder bus. The dc GCUs receives the inhibit signal from the EPCU to cause the bus tie contactors, K1 and K2 to disconnect the dc starter/generators from the left and right main feeder busses. The main feeder bus tie contactor K21 closes to energize the right main feeder bus and the secondary/main feeder bus tie contactors K5 and K6 close to energize the secondary feeder busses.

The dc external power system supplies electrical power to the busses that follow:

– Left and right main feeder busses
– Left and right secondary feeder busses
– Left and right main distribution busses
– Left and right secondary distribution busses
– Left and right essential busses.

When the EPCU senses an external power source malfunction, it will cause the dc external power contactor K9 to open circuit the external power source. The left and right essential busses stay energized because the battery operation is independent of the EPCU.

The DC Contactor Box (DCCB) contains the contactors and protection components for the dc external power system.

After the engine start sequence, with the dc starter/generator toggle switches set to the GEN1 and GEN2 positions, the dc GCUs will prevent the dc starter/generators from connecting to the main feeder busses.

The dc external power toggle switch must be set to the OFF position to cause the dc starter/generator bus tie contactors to close. This connects dc starter/generator power to the right main feeder bus and left main feeder bus.

The dc GCUs prevent parallel operation of dc external power source and the dc starter/generators. When a dc external power source is energizing the dc busses, the EPCU supplies an inhibit signal to the two dc GCUs. The dc GCUs use the inhibit signal to prevent the bus tie contactors from moving to the generator power position. The inhibit function will make the generator operate in a standby condition. The contactor will stay in the external power position while the external power signal is available.

Monitoring and protection: The protective functions in the dc external power system prevent damage to the aircraft dc systems when the dc external power source malfunctions or if there is an overload condition.

The dc external power is continuously monitored by the EPCU. When a malfunction is sensed, it disconnects the dc external power from the aircraft busses.

The dc external power system has passive and active protection.

The dc external power system uses circuit breakers and fuses for passive protection so that a malfunction condition will not cause damage to the aircraft wiring. The circuit breakers and fuses are protection devices that open the circuit during excessive current flow conditions. Unlike fuses, circuit breakers can be reset without having to be replaced.

The dc external power system uses the EPCU to automatically control the external power contactor for active protection so that a fault condition will not cause damage to the aircraft wiring. The automatic functions do not require a manual input from the flight deck. It uses the protective functions that follow:

– Correct polarity
– Over voltage, 31 Vdc
– Under voltage, 22 Vdc.

Correct polarity: The dc external power circuit is connected to two positive terminals and one negative terminal. This protection will make sure external power is disconnected from the dc bus before the voltage polarity is not correct.

Over voltage: When the voltage from the external power is more than 31 Vdc, the EPCU disconnects the external power.

Under voltage: When the voltage from the external power is less than 22 Vdc, the EPCU disconnects the external power.

When source or bus faults occur or the dc external power quality exceeds its limits, the contactors open, and stay open until the external power is reset to prevent a reconnection to a fault condition. The EXT PWR toggle switch on the dc control panel is set to the OFF position and then to EXT PWR again to reset the dc external power fault.

The EPCU has a passive diagnostic CBIT function that is used to show possible problems in the dc external power system to the maintenance personnel. The EPCU CBIT system monitors the dc external power system for fault detection, isolation, and indication.

Refer to Figure 4.

The Electrical Power Control Unit (EPCU) records the dc external power system fault conditions. It has an interface panel on its front face to look at the fault codes that represent fault conditions sensed by the Continuous Built in Test (CBIT). It uses FAULT REVIEW and CLEAR pushbutton switches and a digital display to view the fault codes.

The CBIT operates only when the aircraft is on the ground. A blank indication shows when no fault conditions are sensed by the CBIT. When the indication is out of view, the FAULT REVIEW pushbutton switch is pushed to do display test. It will show 88 for correct operation.

The two dc starter/generator bus tie contactors K1 and K2 are checked. If the contactor is closed while the external dc power is energizing the main 28 Vdc busses, the EPCU will show fault code 04 or 06.

The APU bus tie contactor K26 is checked. If the contactor is closed while the external dc power is energizing the main 28 Vdc busses, the EPCU will show fault code 08.

The dc external power source is checked. If the protective function causes the dc external power contactor K9 to opened while the external dc power is energizing the main 28 Vdc busses, the EPCU will show fault code 37.

Refer to Figure 5.

When dc external power is connected, and the battery master toggle switch located on the dc control panel is set to the BATTERY MASTER position and the dc external power toggle switch located on the dc control panel is set to EXT PWR, the dc external power source is connected to the dc busses for operation.

The dc starter/generator toggle switches are set to the OFF position to de–energize the dc external power system.

The Electrical Power Control Unit (EPCU) supplies indication data through the two Input/Output Processors (IOP1, IOP2) located in the

Integrated Flight Cabinets (IFCs) to the Electronic Instruments System (EIS).

Refer to Figure 6.

The MFD1 and MFD2 reversion switches located on the ESID Control Panel (ESCP) are used to select the electrical page on the multi–functional displays.

Refer to Figure 7.

The electrical page shows the dc generator indications that follow:

- DC EXT POWER message
- Digital indication of the dc external power voltage.

DC EXT POWER Message: The MFD shows the DC EXT POWER message when the conditions that follow are correct:

NOTE

The DC EXT PWR ON advisory (on the electrical page of the MFD) will stay on if the external DC power source goes off line. If the battery master switch is on, the aircraft will remain energized with battery power.

- DC external ground power is connected to the dc external power receptacle
- The dc external power is good
- The dc external power toggle switch on the dc control panel is set to the EXT PWR position
- The dc external power source is energizing the dc busses.

DC External Power Voltage Indication: The dc bus voltage indication shows the dc bus voltage for the essential, main, and secondary busses.

Refer to Figure 1.

When the voltage data malfunctions, the digits are replaced by white dashes.

Refer to Figure 1.

When dc external is energizing the caution lights that follow come on:

- #1 DC GEN
- #2 DC GEN

#1 DC GEN, #2 DC GEN Caution Light: The #1 DC GEN or #2 DC GEN caution light comes on to show that the generator is not connected to its bus because an external dc power source is energizing the left and right main feeder busses.

NOTE

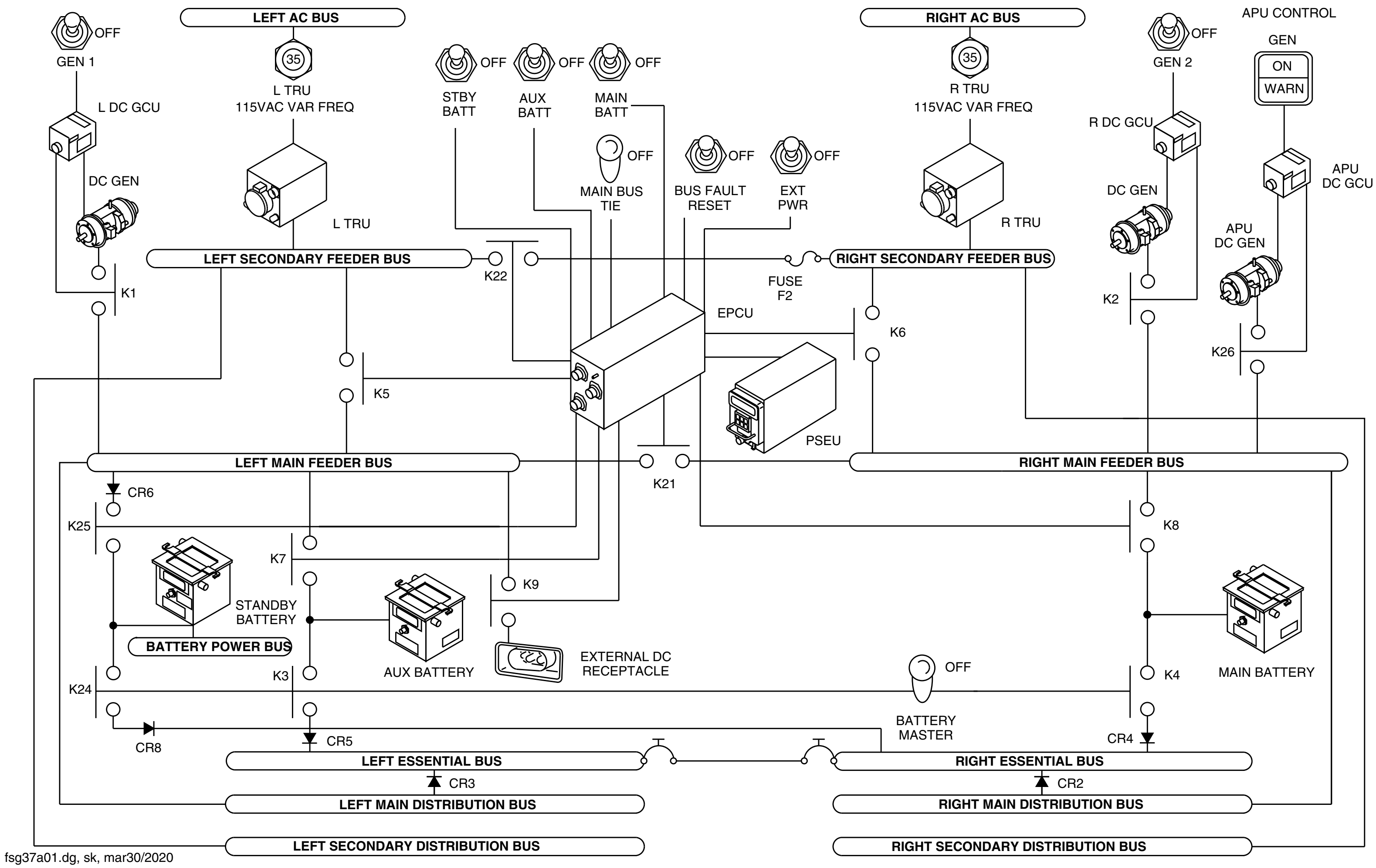
Note: There is no indication for a condition where the dc external power source is connected to the aircraft and a dc external power toggle switch selection is not made.

DC External Power Receptacle

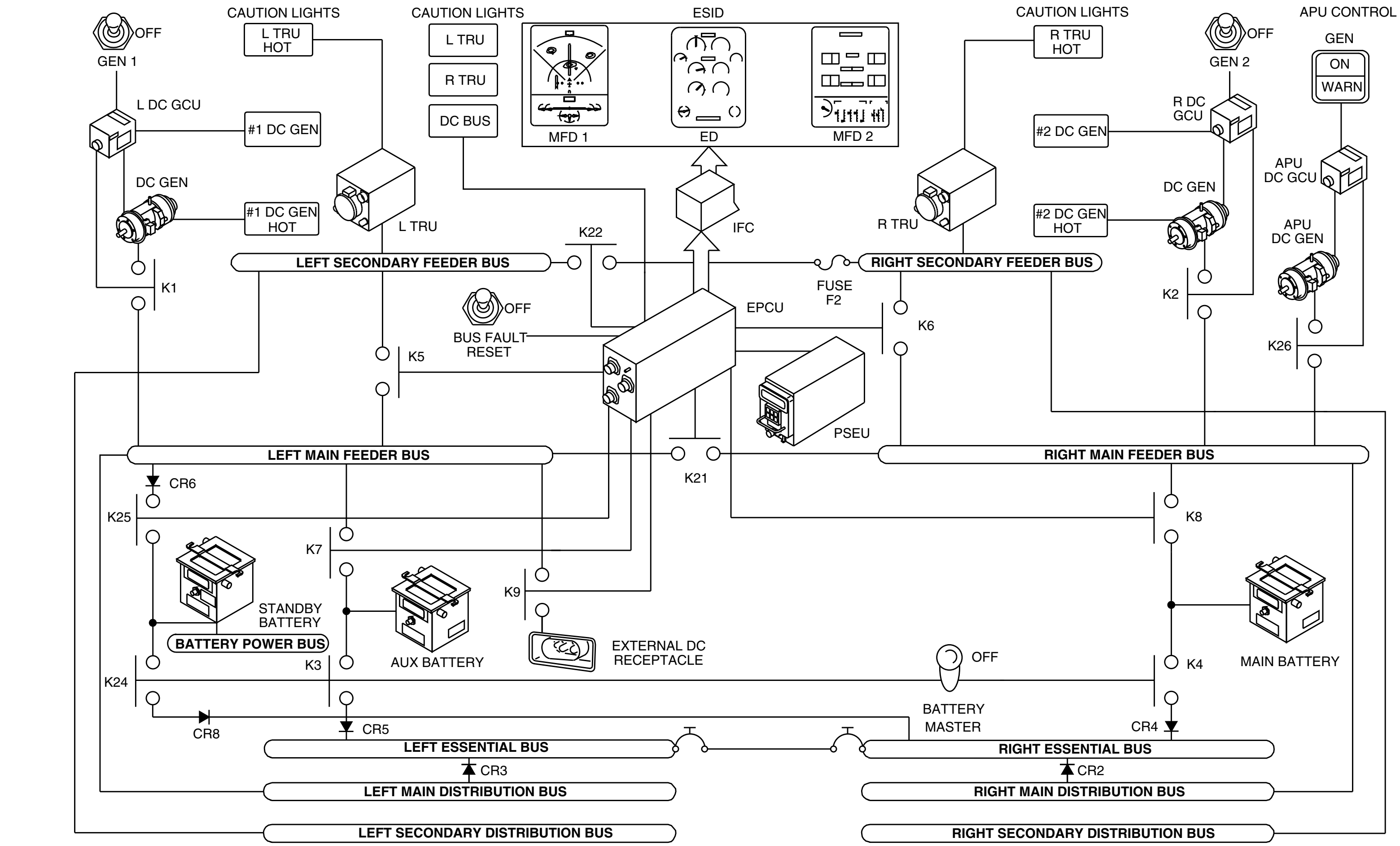
Refer to Figure 1.

The dc external power receptacle is used to allow repetitive connections to a dc external power source. When an dc external ground power connector is connected to the receptacle, it will supply 28 Vdc electrical power from the ground power source to the dc busses. The aircraft dc power receptacle is a three male pin connector.

The dc external power receptacle is located on left side on the forward fuselage section of the aircraft. It is attached to the aircraft structure with six mounting bolts.



Main 28 VDC Generation System Block Diagram, Controls
Figure 1



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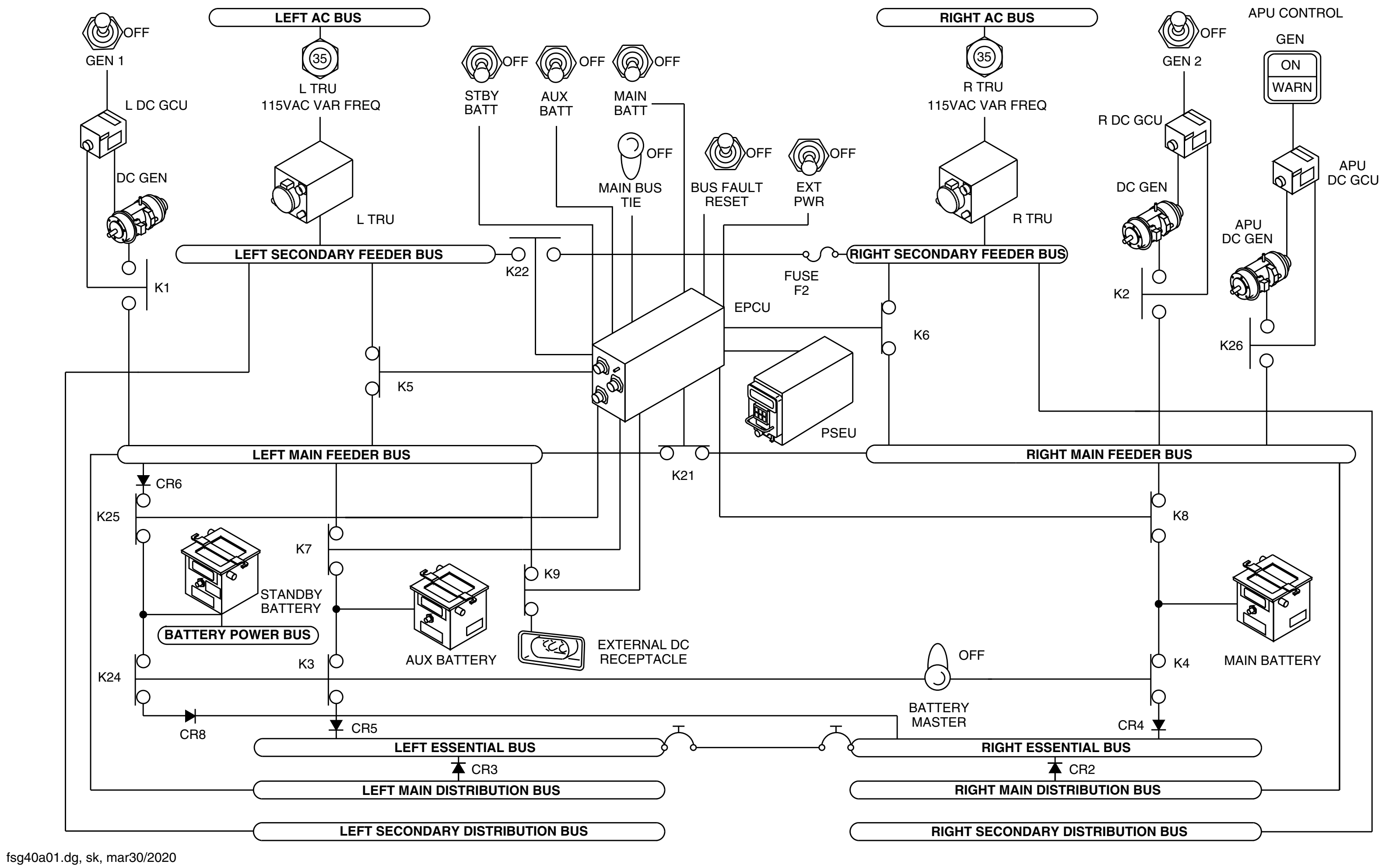
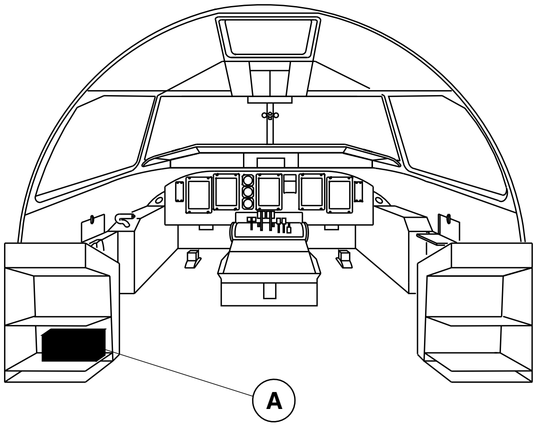
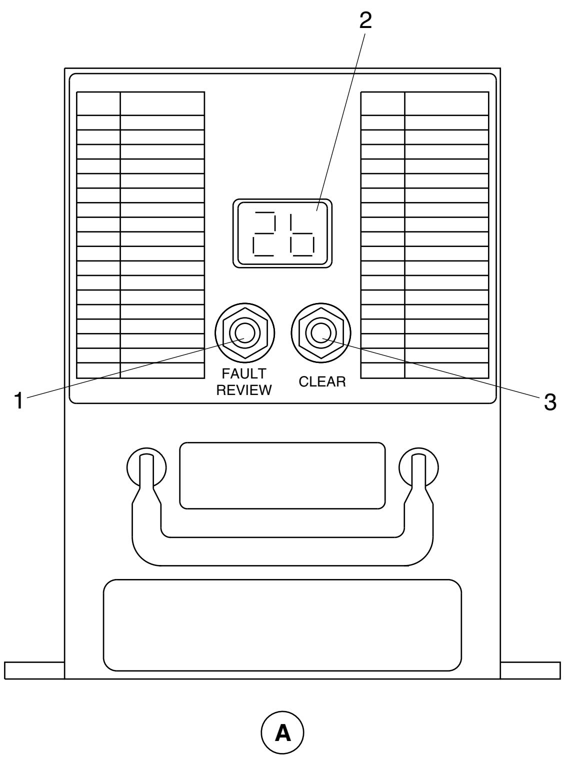
Main 28 VDC Generation System Block Diagram, Indication
Figure 2



Main 28 VDC Generation System, External Power Operation
Figure 3





LEGEND

1. Fault Review Pushbutton Switch.
2. Display.
3. Clear Pushbutton Switch.

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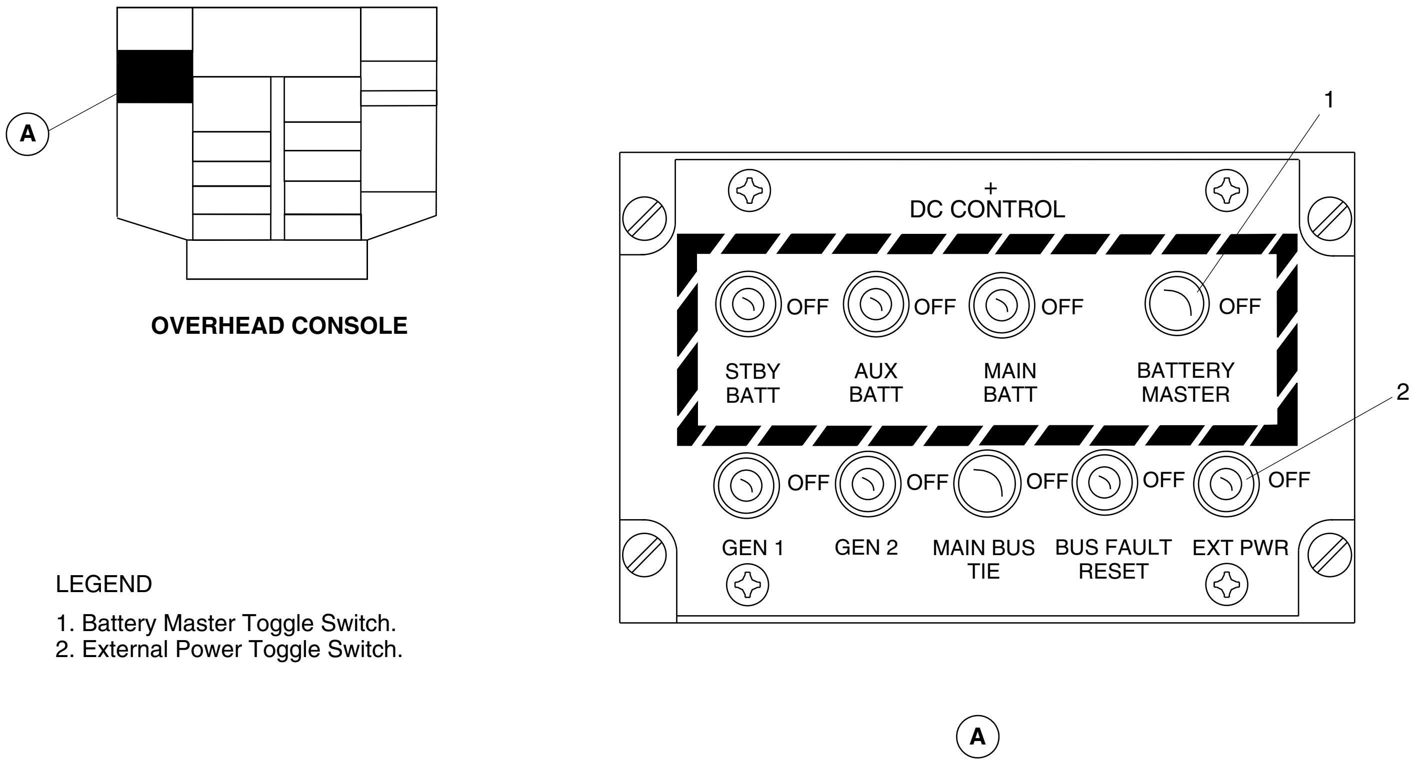
MAIN 28 VDC GENERATION SYSTEM, EPCU
Figure 4



LEGEND

1. Battery Master Toggle Switch.
2. External Power Toggle Switch.

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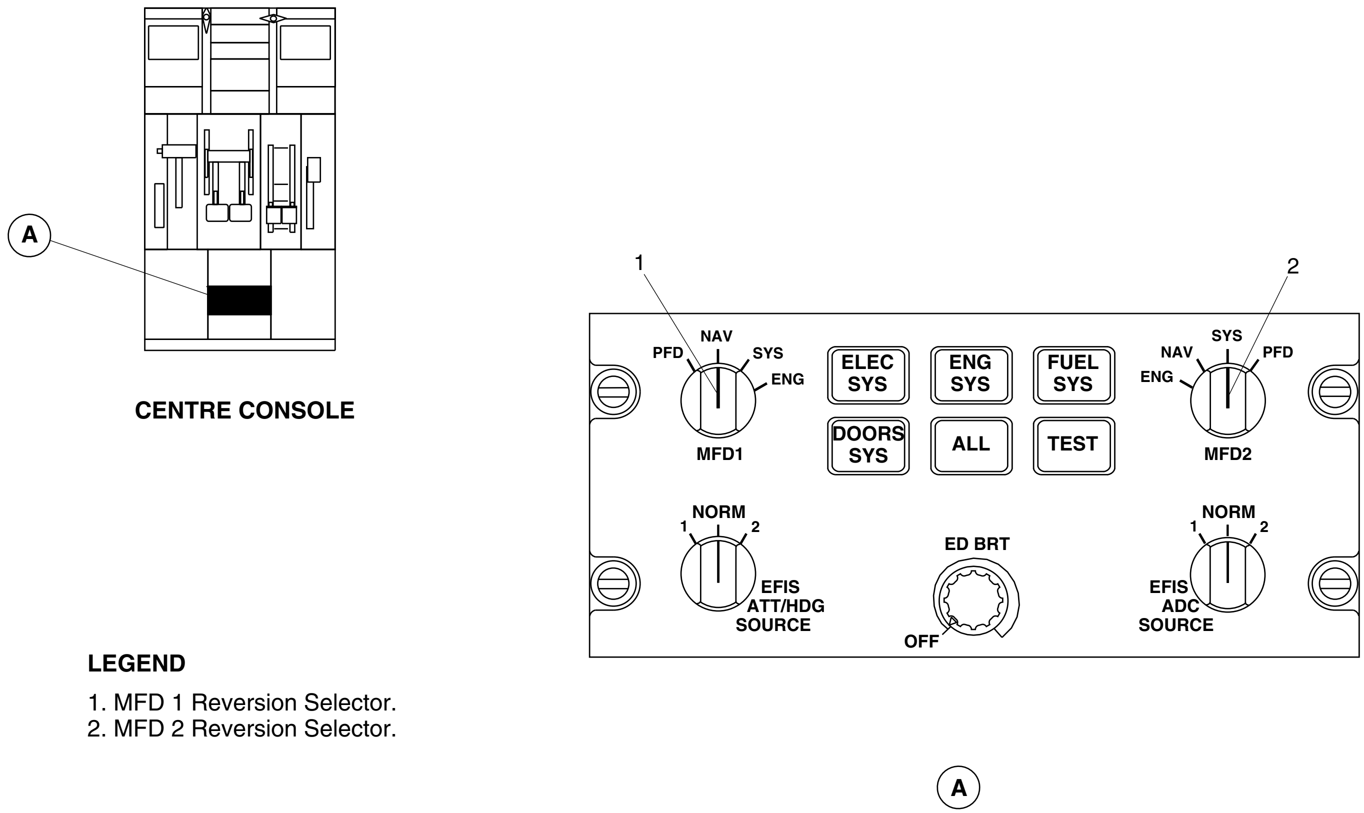
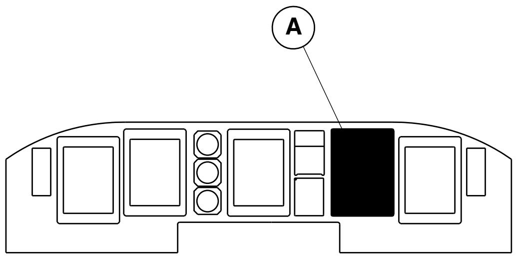
DC EXTERNAL POWER SYSTEM, MAIN 28 VDC GENERATION SYSTEM, DC CONTROL PANEL
Figure 5

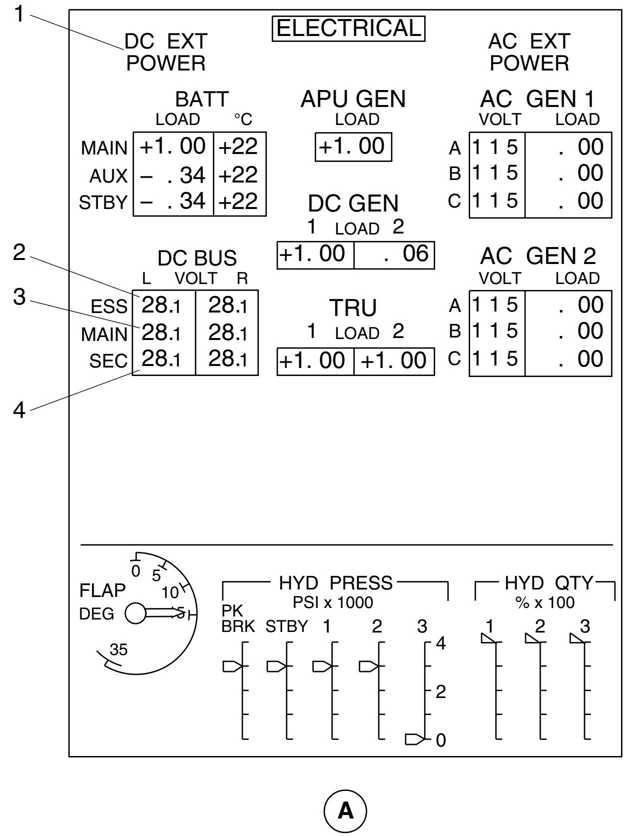


LEGEND

1. MFD 1 Reversion Selector.
2. MFD 2 Reversion Selector.

EIS, ELECTRICAL SYSTEM PAGE SELECTION
Figure 6





LEGEND

1. DC EXT POWER Message.
2. Essential DC Bus Voltage Digital Indication.
3. Main DC Bus Volatage Digital Indication.
4. Secondary DC Bus Voltage Digital Indication.

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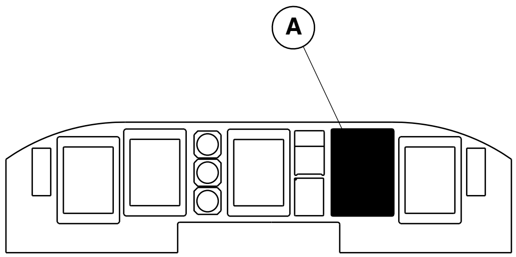
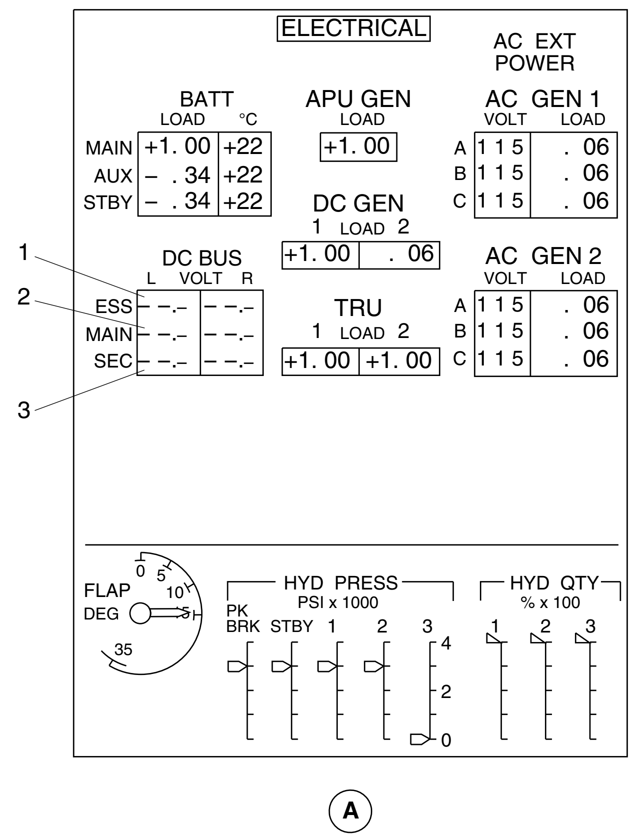
EIS, DC EXTERNAL POWER SYSTEM INDICATIONS
Figure 7



MAIN INSTRUMENT PANEL



LEGEND

1. Essential DC Bus Voltage Fail Digital Indication.
2. Main DC Bus Volatage Fail Digital Indication.
3. Secondary DC Bus Voltage Fail Digital Indication.

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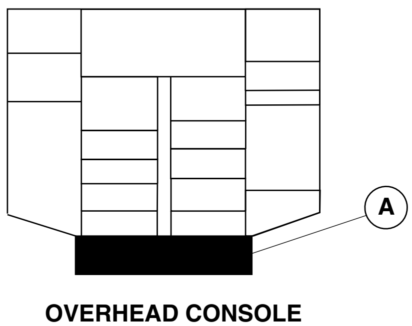
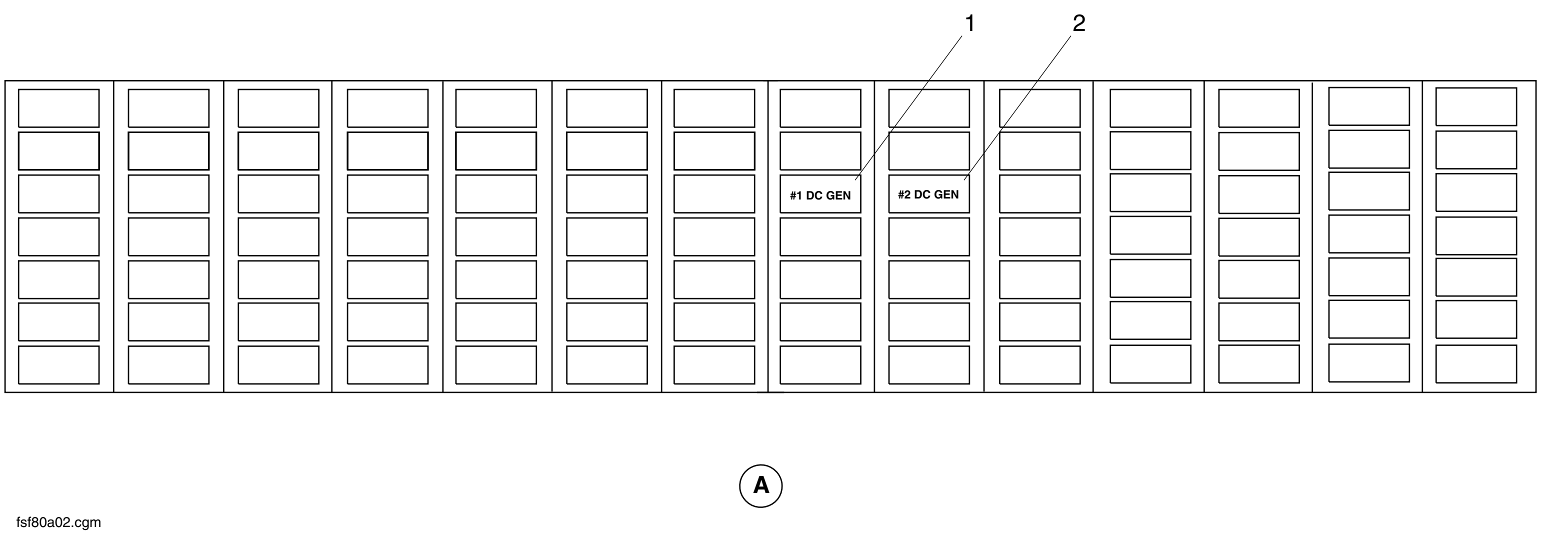
EIS, DC EXTERNAL POWER SYSTEM MALFUNCTION INDICATIONS
Figure 8

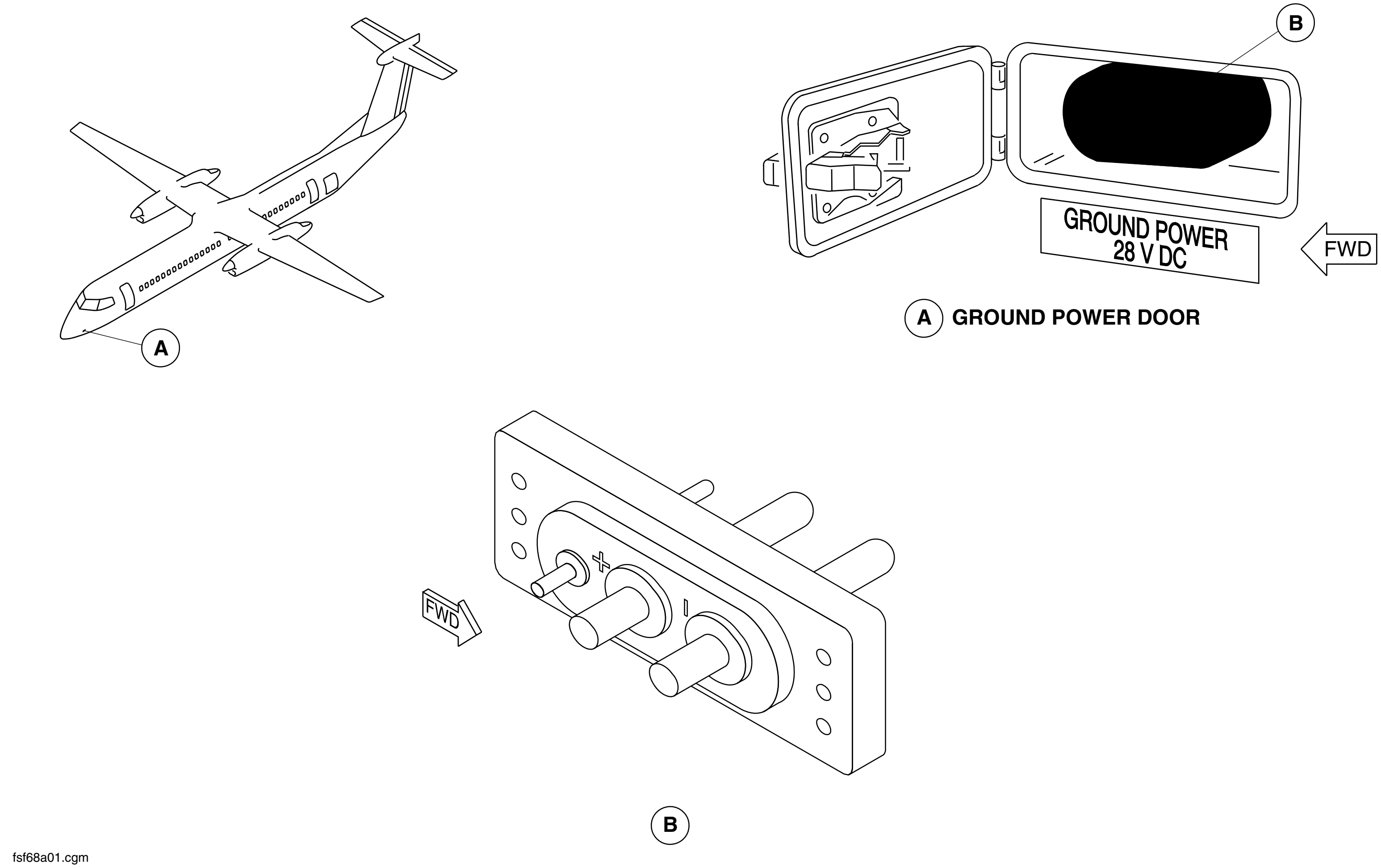


LEGEND

1. #1 DC GEN (Amber).
2. #2 DC GEN (Amber).



CAUTION AND WARNING PANEL, DC GENERATOR CAUTION INDICATIONS
Figure 9



DC – EXTERNAL – POWER – RECEPTACLE
Figure 10

**ON A/C ALL

24–50–00–001

AC ELECTRICAL LOAD DISTRIBUTION

Introduction

The 115 Vac variable frequency is distributed through a circuit breaker panel in the flight compartment to the electrical loads.

General Description

The 115 Vac variable frequency is supplied through the 115 Vac variable frequency circuit breaker panel in the flight compartment. The 115 Vac variable frequency three–phase busses and their related circuit breakers are identified on the panel.

The ac electrical load is distributed from the variable frequency ac generation system.

The variable frequency ac generation system has two internal and one external power source that follows:

– #1 AC generator
– #2 AC generator
– AC external power.

AC power is supplied to aircraft equipment loads through the circuit breaker panel that follows:

– 115 AC variable frequency circuit breaker panel (24–51–01).

Detailed Description

Refer to Figures 1 and 2.

Circuit breakers (CBs) are used to protect the ac wiring to the aircraft loads. The circuit breakers are protection devices that open circuit during excessive current flow.

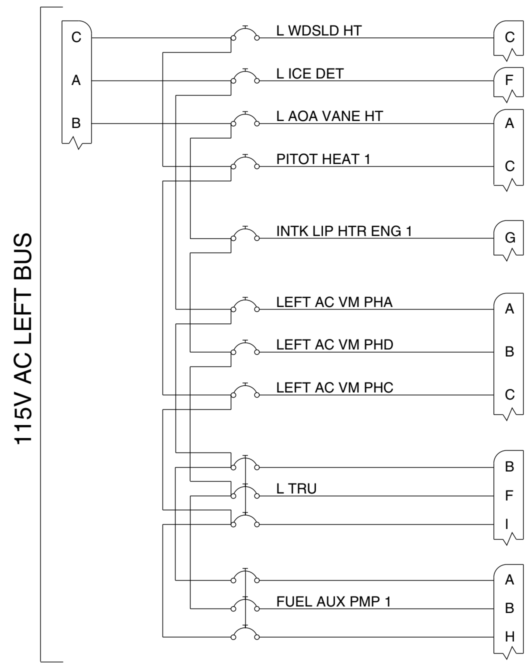
Wires are used to connect the CBs together and to other busses.

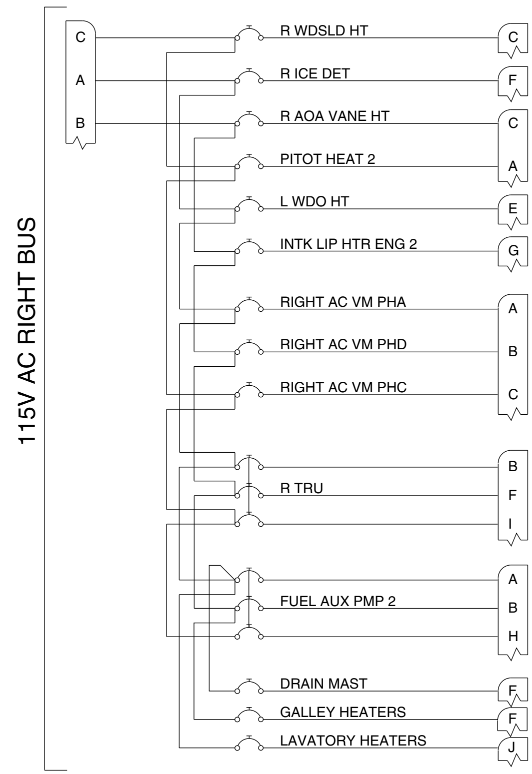
Three seperate A, B, and C phase wires from the left ac bus and three seperate A, B, and C phase wires from the right ac bus, contained in the left and right ac contactor boxes, energize the left and right ac busses in the 115 Vac variable frequency circuit breaker panel.

115 Vac Variable Frequency Circuit Breaker Panel

Refer to Figure 3.

The 115 Vac variable frequency circuit breaker panel has circuit breakers attached to the panel. The circuit breaker panel is attached to the aft right bulkhead of the flight compartment, above and aft of the right dc CB panel with eight mounting screws. Panel markings show the division of the busses and system designation of the circuit breakers.





NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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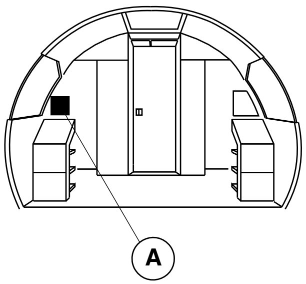
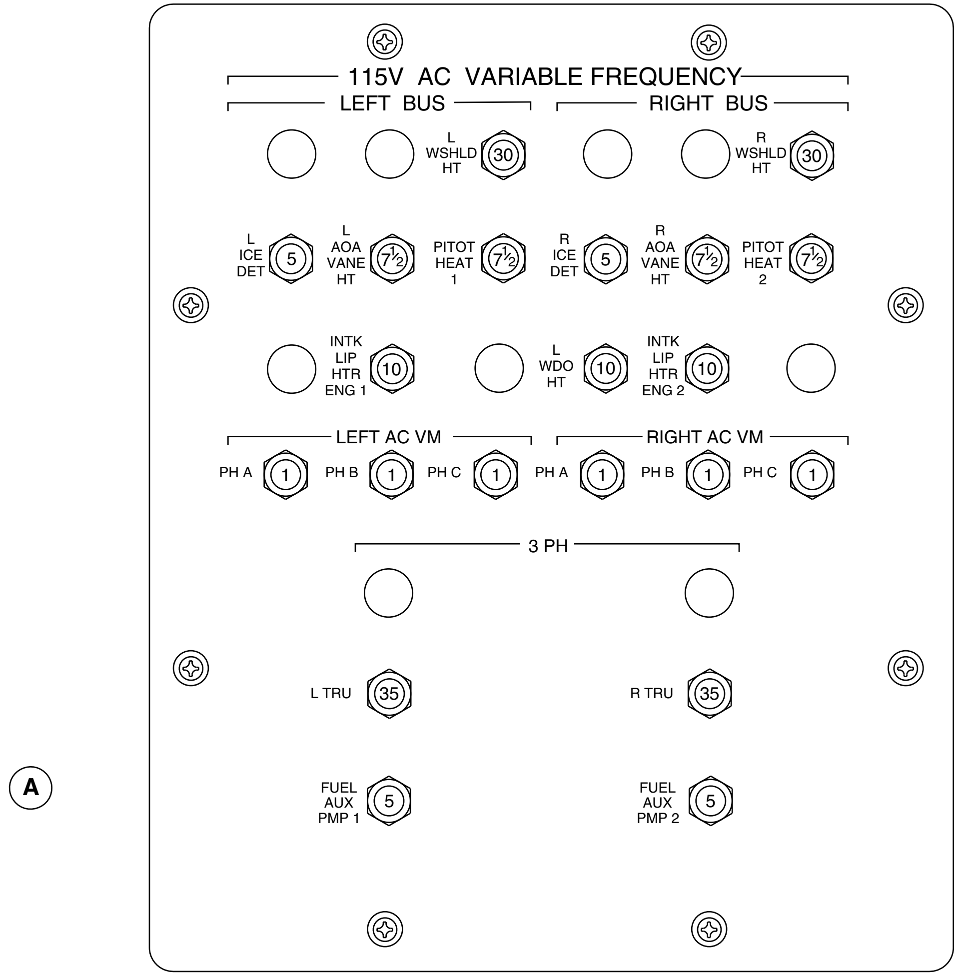
AC ELECTRICAL LOAD DISTRIBUTION
Figure 1





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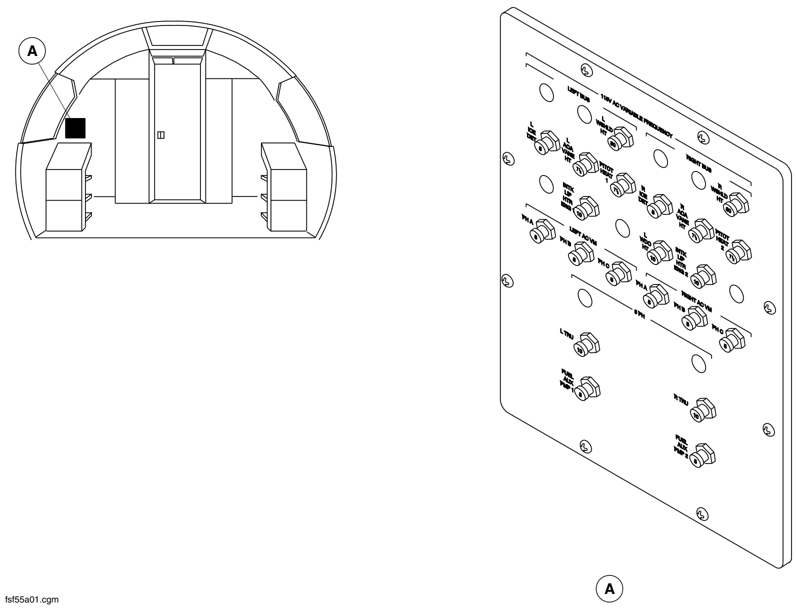
115 VAC VARIABLE FREQUENCY CIRCUIT BREAKER PANEL
Figure 2



115 VAC VARIABLE FREQUENCY CIRCUIT BREAKER PANEL LOCATOR
Figure 3

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**ON A/C ALL

24–50–60–001

RELAY JUNCTION BOX

General

Three relay junction boxes (RJB) are installed on the aircraft. Each RJB contains relays that are used in the switching functions of the various aircraft systems.

General Description

Refer to Figure 1.

.

The junction boxes are installed in the center of the fuselage below the cabin floor, aft of the flight compartment. Each RJB contains three daughter boards and each daughter board can hold up to four relays. The RJBs interface with other systems through a 100–pin ARINC 600 connector.

Detailed Description

The relays in RJB No. 1 supply the switching functions for the systems that follow:

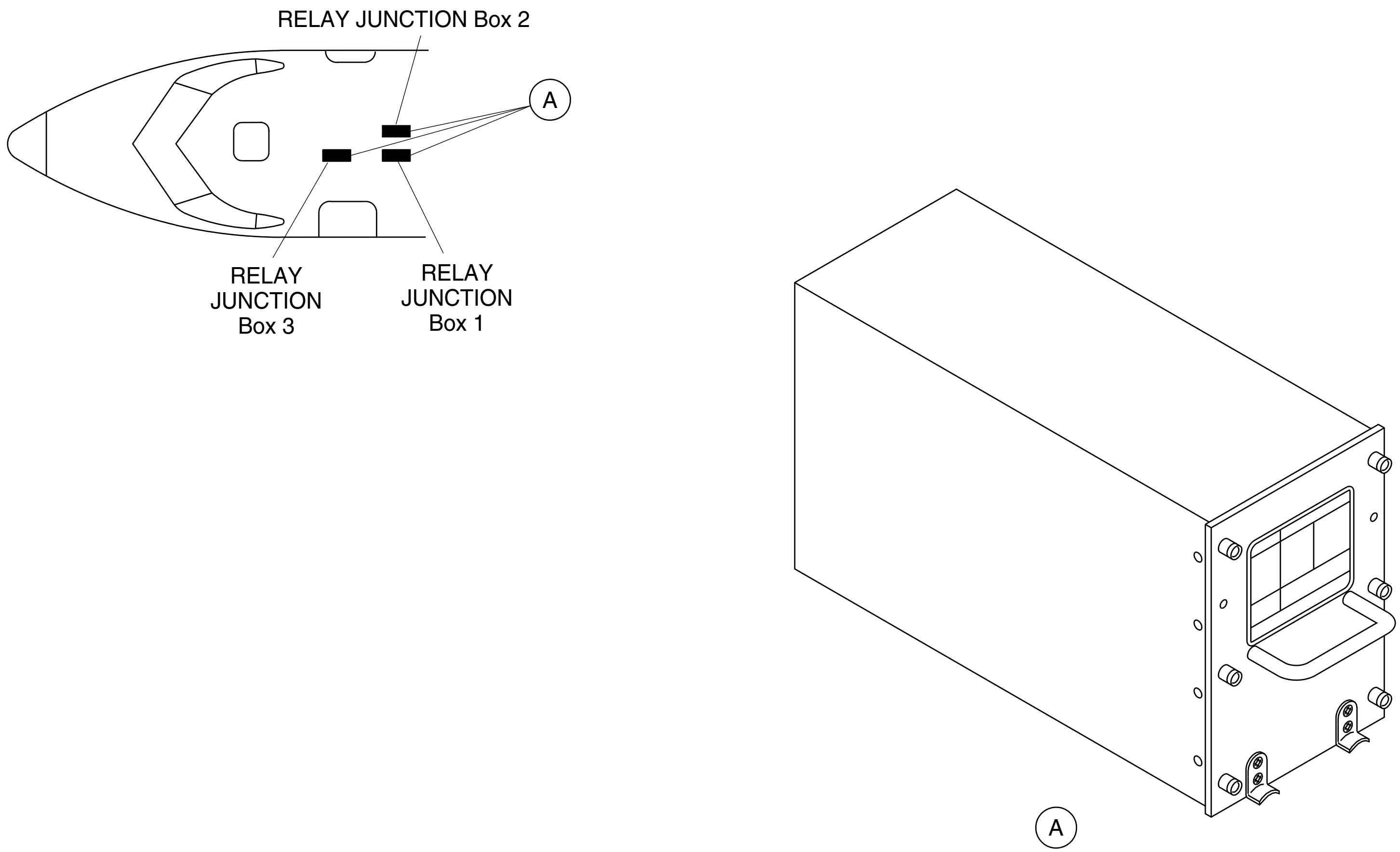
- Air data computer (ADC) and standby instruments
- Thunderstorm and dome lighting
- Avionics relays (Engine No. 2 main oil pressure)
- Airstair door seal system shut–off valve
- Wardrobe and fwd/aft baggage compartment lights
- FCS electronic control unit
- Bleed air control and indication
- No. 1 propeller control (PEC channel A and feather pump contactor)
- No. 2 propeller control (PEC channel A and feather pump contactor)
- Flight data recorder (FDR) inertia switch

The relays in RJB No. 2 supply the switching functions for the systems that follow:

- Bleed air control and indication
- Engine start (GCU)
- Landing gear control and indication
- Wardrobe and fwd/aft baggage compartment lights
- Microwave landing system (MLS)

The relays in RJB No. 3 supply the switching functions for the systems that follow:

- Standby hydraulic pump control
- Cabin master call and PA chime
- Solid state cockpit voice recorder (SSCVR)
- DC power generation



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RELAY JUNCTION BOX
Figure 1

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**ON A/C ALL

24–60–00–001

DC ELECTRICAL LOAD DISTRIBUTION

Introduction

The main 28 dc is distributed through circuit breaker panels in the flight compartment to the electrical loads.

General Description

Refer to Figure 1.

Circuit breakers (CBs) are used to protect the dc wiring to the aircraft loads. The circuit breakers are protection devices that open circuit during excessive current flow.

Wires are used to connect the CBs together and to other busses.

The dc electrical load is distributed from the dc power systems that follow:

- Main 28 Vdc generation
- Battery.

Main 28 Vdc Generation: The main 28 Vdc generation system has five internal power sources and one external power source that follows:

- Left TRU
- Right TRU
- #1 DC starter/generator
- #2 DC starter/generator
- Batteries, main, auxiliary and standby
- DC external power.

DC electrical load from the dc power sources is supplied to the aircraft equipment through the circuit breaker panels that follow:

- Left dc circuit breaker panel (24–61–01)
- Right dc circuit breaker panel (24–61–01)
- Avionics circuit breaker panel (24–61–01).

Detailed Description

Circuit breakers (CBs) are used to protect the ac wiring to the aircraft loads. The circuit breakers are protection devices that open circuit during excessive current flow.

Wires and busses are used to connect the CBs together and to other busses.

Refer to Figures 2 and 3.

Four separate wires from the left main feeder bus in the dc contactor box energizes the left main distribution bus through four 75 A L MAIN INPUT circuit breakers A9, B9, C9, and D9. The left main distribution bus energizes the left main distribution busses in the avionics breaker panel through three 20 A AVIONIC FEEDERS circuit breakers A8, B8, and C8. It also energizes the left essential bus through two 50 A circuit breakers E10 and E8.

Refer to Figure 4.

Two seperate wires from the left main distribution bus energizes the left essential bus through isolation diode CR 3 and two 50 A L MAIN

INPUT circuit breakers J10 and K10. The left essential bus is also energized through isolation diodes CR8 and CR5 and two 50 A AUX BATT INPUT 1 and AUX BATT INPUT 2 circuit breakers J9 and K9, and a 75 A STBY BATT circuit breaker M9 from the auxiliary and standby batteries.

The left essential bus energizes the left essential distribution busses in the avionics breaker panel through three 20 A AVIONIC FEEDERS circuit breakers F9, G9, and H9.

NOTE

Note: The left and right essential busses are connected together through a 50 A BUS TIE circuit breaker on each essential bus. The left BUS TIE circuit breaker is designated H10 and the right BUS TIE circuit breaker is designated J10.

Refer to Figure 5.

Four separate wires from the left secondary feeder bus in the dc contactor box energizes the left secondary distribution bus through four 50 A L SECONDARY INPUT circuit breakers N10, P10, Q10, and R10. The secondary busses operate independently of the main and essential busses.

Refer to Figures 6 and 7.

Four separate wires from the right main feeder bus in the dc contactor box energizes the right main distribution bus through four 75 A R MAIN INPUT circuit breakers P9, Q9, R9, and S9. The right main distribution bus energizes the right main distribution busses in the avionics breaker panel through three 20 A AVIONIC FEEDERS circuit breakers Q8, R8, and S8. It also energizes the right essential bus through two 50 A circuit breakers N9 and N10.

Refer to Figure 8.

Two seperate wires from the right main distribution bus energizes the right essential bus through isolation diode CR 2 and two 50 A R MAIN INPUT circuit breakers F10 and G10. The right essential bus is also energized through isolation diode CR4 and two 50 A MN BATT INPUT 1 and MN BATT INPUT 2 circuit breakers K10 and L10.

The right essential bus energizes the right essential distribution busses in the avionics breaker panel through two 20 A AVIONIC FEEDERS circuit breakers F9 and G9.

Refer to Figure 9.

Four separate wires from the right secondary feeder bus in the dc contactor box energizes the right secondary distribution bus through four 50 A R SECONDARY INPUT circuit breakers A10, B10, C10, and D10.

Refer to Figure 10.

Two separate wires from a bus in the standby contactor box energizes the battery power bus.

Refer to Figure 11.

Refer to Figures 12 , 13 and 14.Separate wires from the left main and essential distribution busses and right main and essential distribution busses in the left and right circuit breaker panels energize the busses in the avionics circuit breaker panel.

The circuit breaker panels have alpha/numeric panel markings at the bottom left edge of the panels to identify each circuit breaker location.

Left DC Circuit Breaker Panel

Refer to Figure 15.

The left circuit breaker panel is located on the top surface of the left circuit breaker console behind the pilot's seat. It contains the left main and secondary distribution busses and the left essential bus. Panel markings show the division of the busses and system designation of the circuit breakers.

Right DC Circuit Breaker Panel

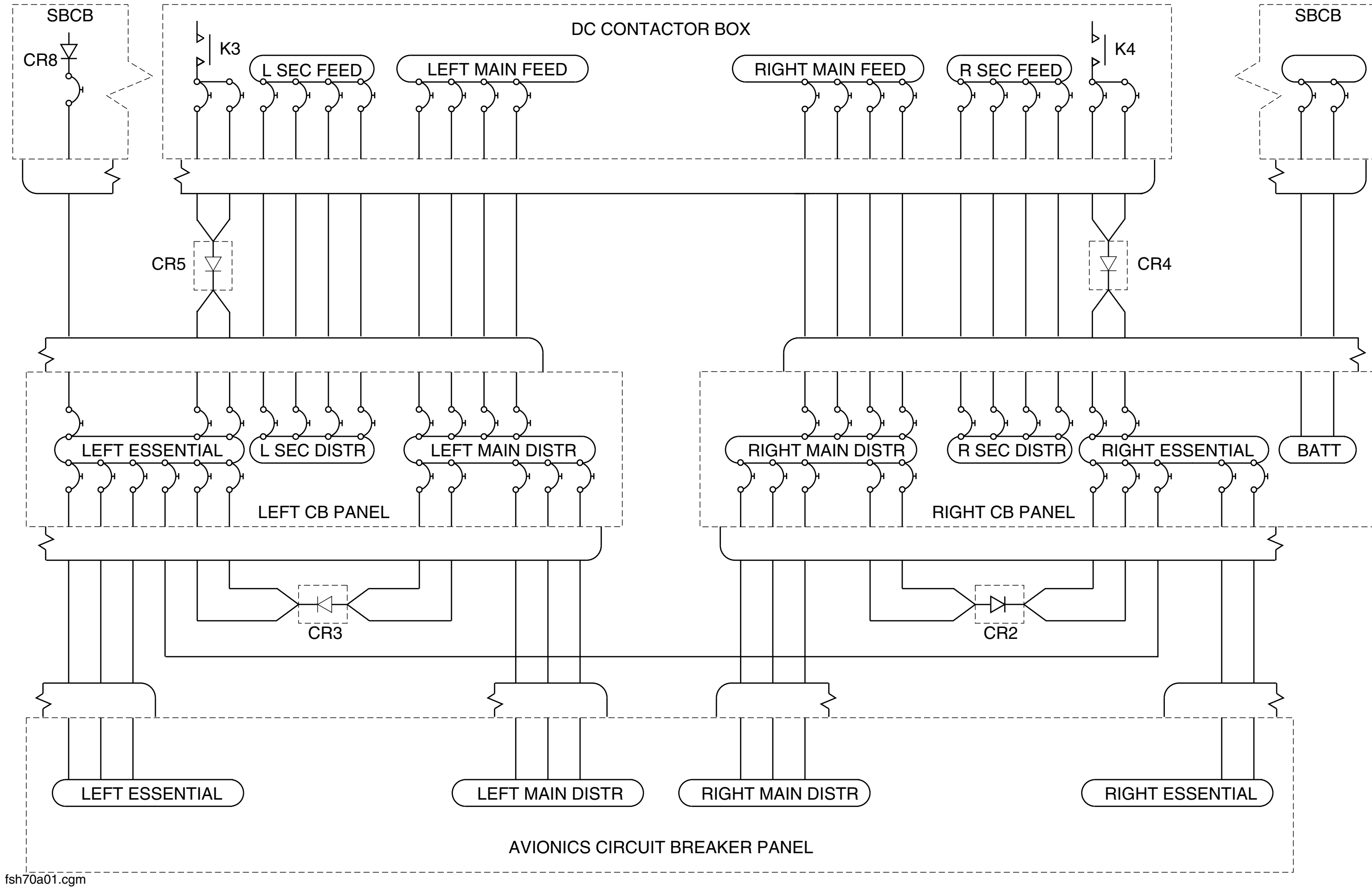
Refer to Figure 16.

The right circuit breaker panel is located on the top surface of the right circuit breaker console behind the copilot's seat. It contains the right main and secondary distribution busses and the right essential bus. It also contains the battery power bus. Panel markings show the division of the busses and system designation of the circuit breakers.

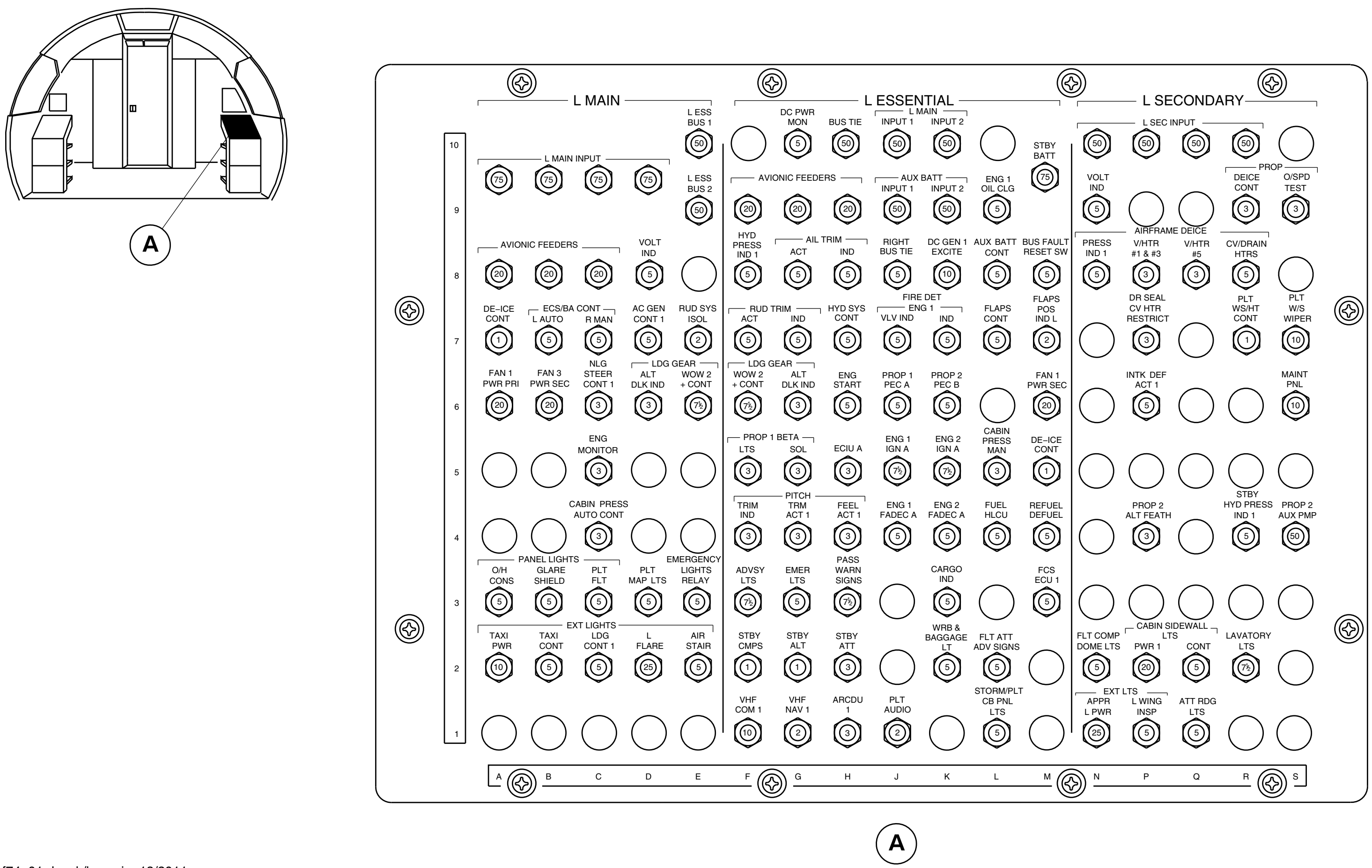
Avionics Circuit Breaker Panel

Refer to Figure 17.

The avionics circuit breaker panel is mounted on the aft left bulkhead of the flight compartment, above and behind the left dc CB panel. It distributes 28.5 Vdc to avionics and audio equipment. Panel markings identify the appropriate busses and CBs.



DC ELECTRICAL LOAD DISTRIBUTION
Figure 1



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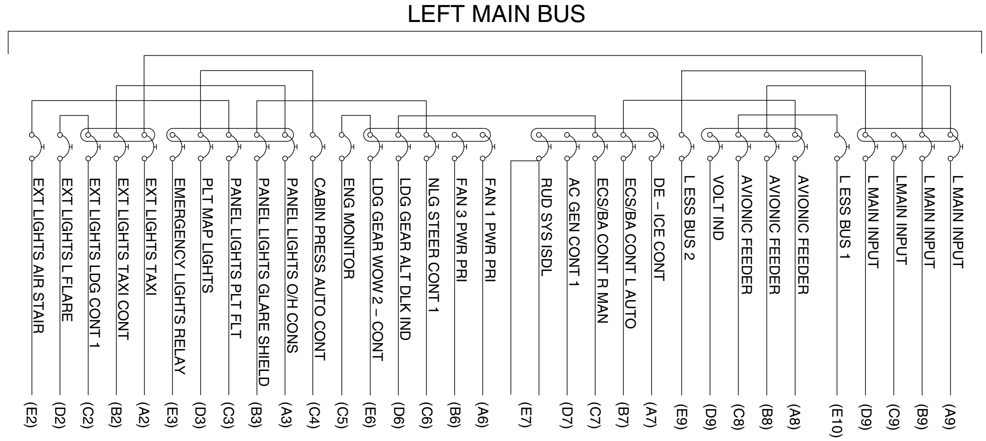
LEFT DC CIRCUIT BREAKER PANEL
Figure 2



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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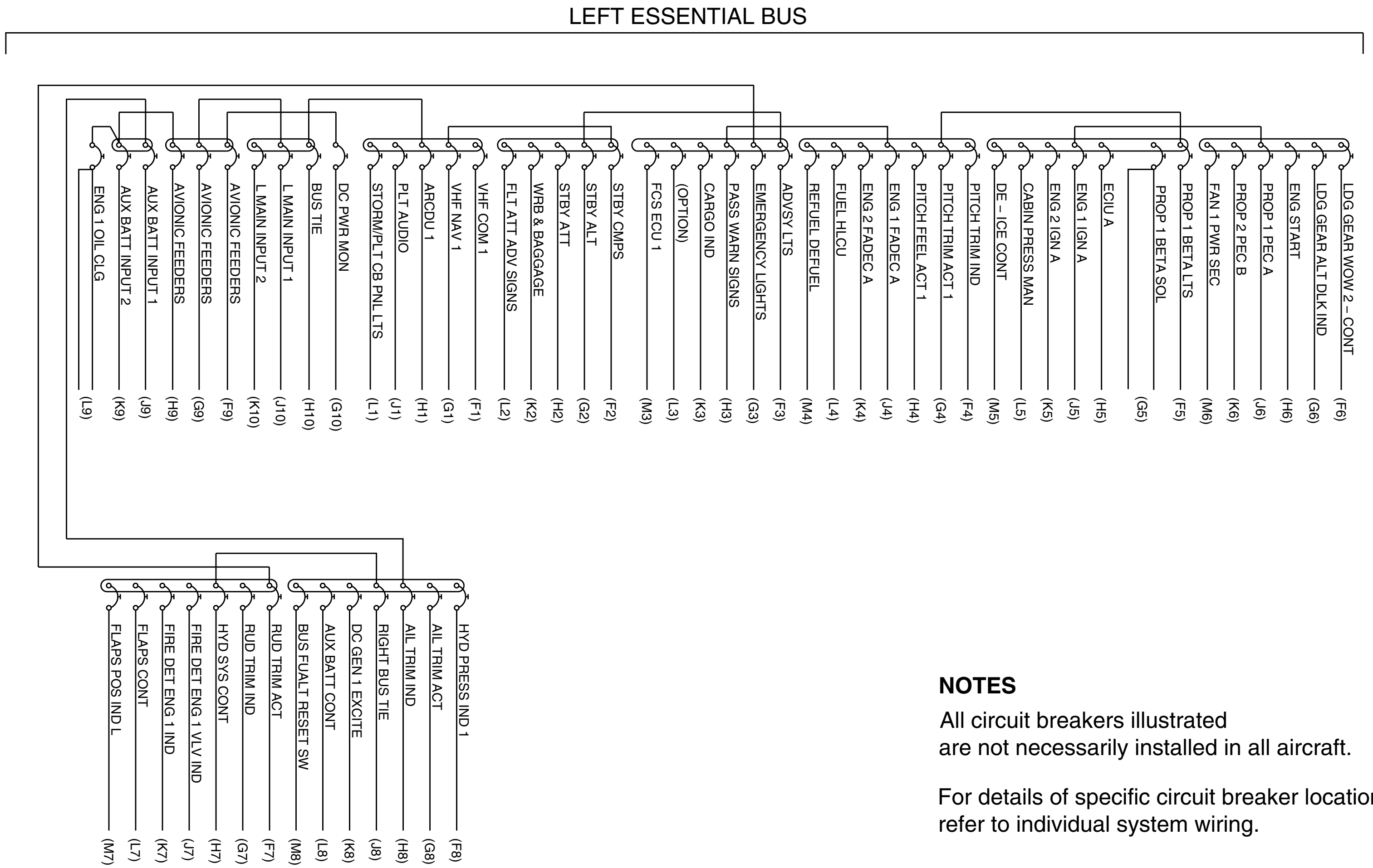
LEFT MAIN ELECTRICAL LOAD DISTRIBUTION
Figure 3



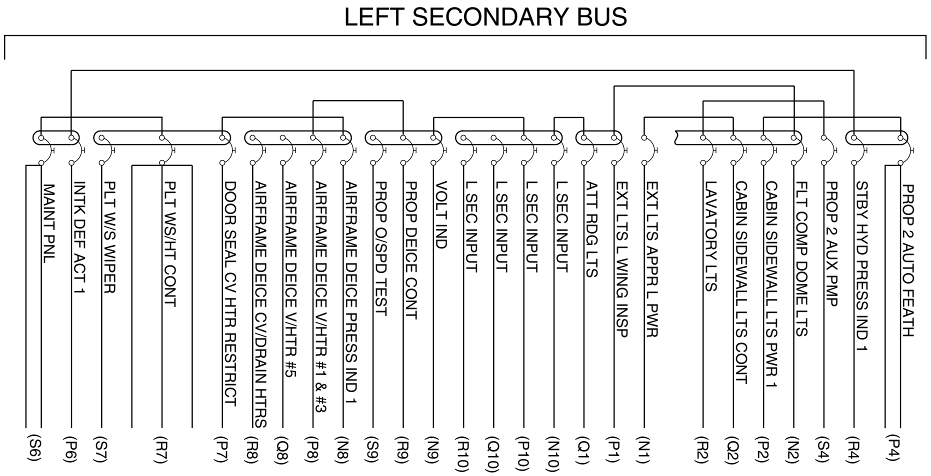
fsh51a01.dg, vk, jan20/2009

NOTES

All circuit breakers illustrated
are not necessarily installed in all aircraft.

For details of specific circuit breaker locations
refer to individual system wiring.

LEFT ESSENTIAL ELECTRICAL LOAD DISTRIBUTION
Figure 4



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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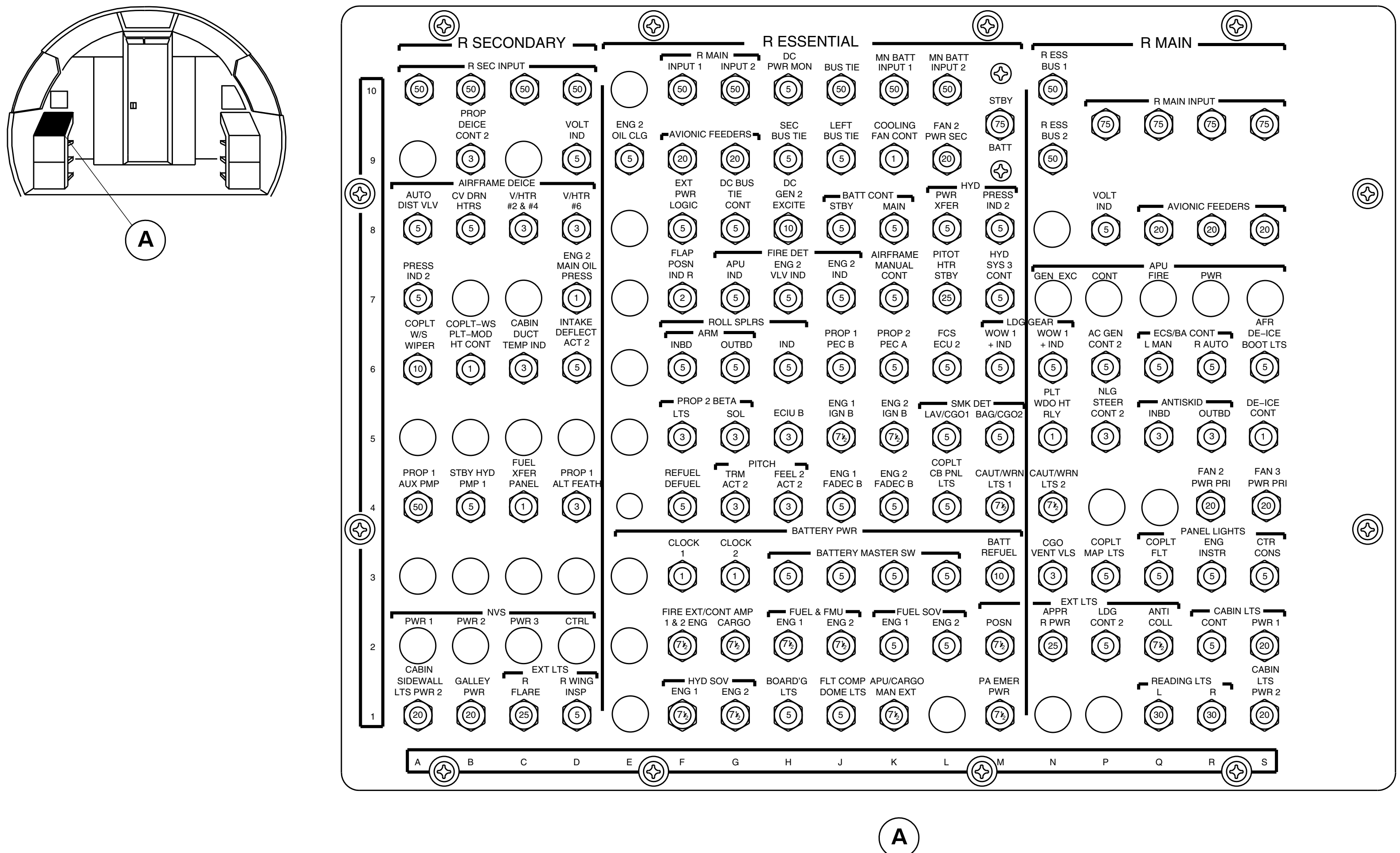
LEFT SECONDARY ELECTRICAL LOAD DISTRIBUTION
Figure 5



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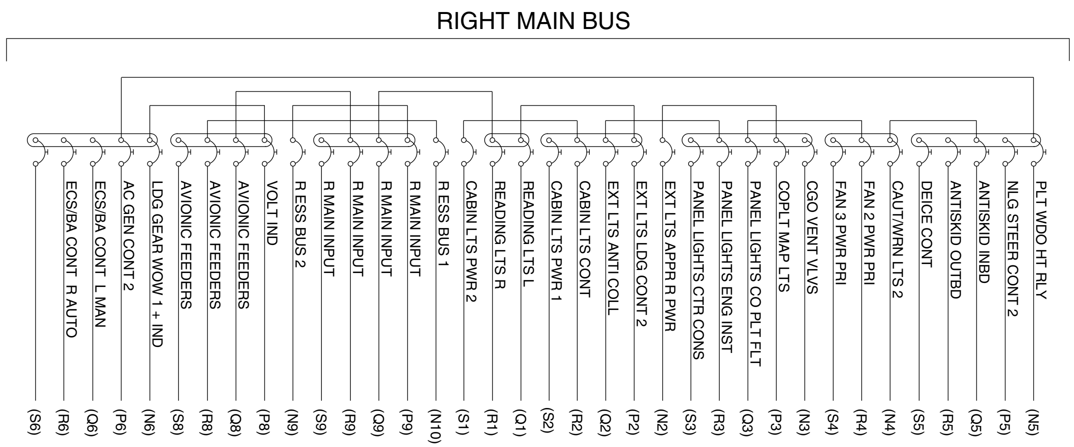
Right DC Circuit Breaker Panel
Figure 6



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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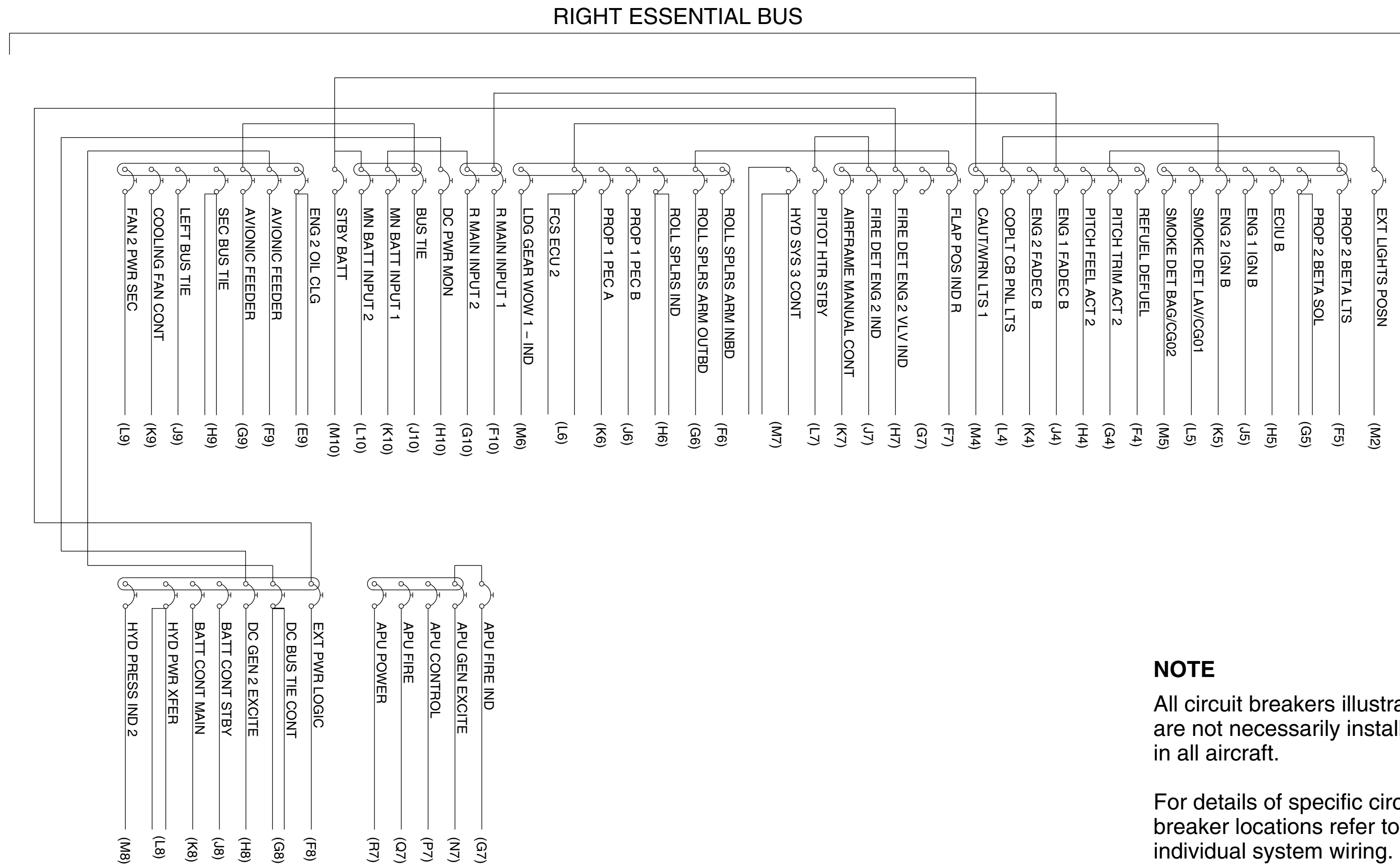
RIGHT MAIN ELECTRICAL LOAD DISTRIBUTION
Figure 7



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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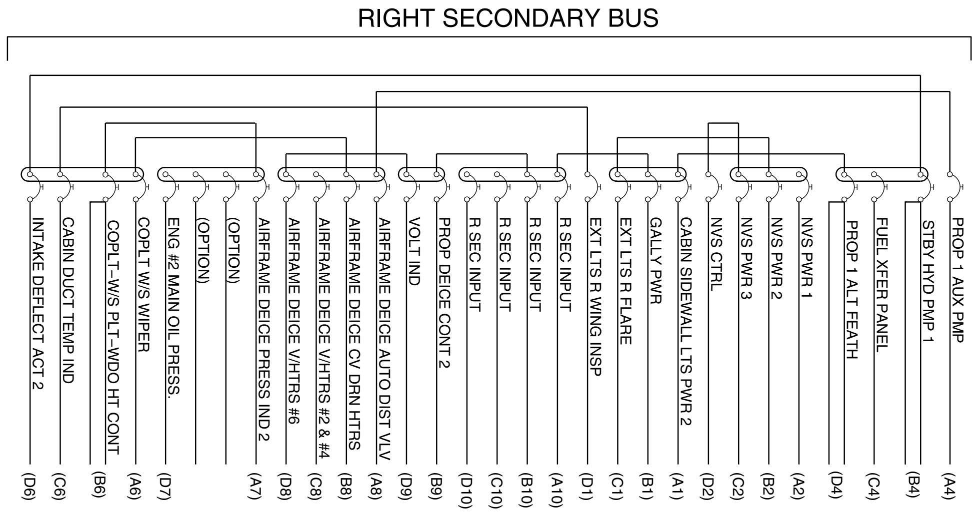
RIGHT ESSENTIAL ELECTRICAL LOAD DISTRIBUTION
Figure 8



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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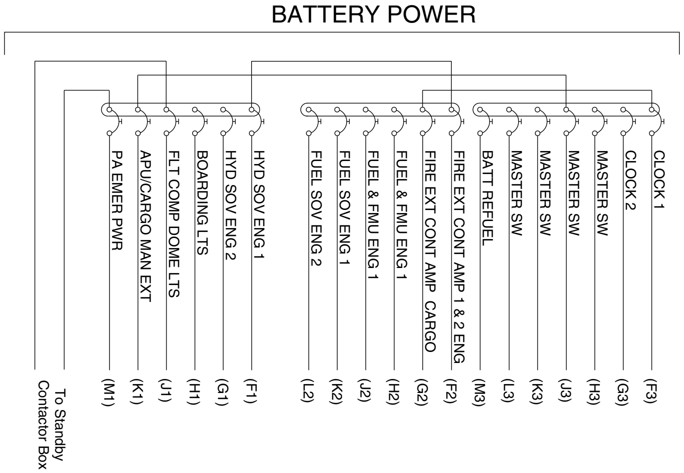
RIGHT SECONDARY ELECTRICAL LOAD DISTRIBUTION
Figure 9



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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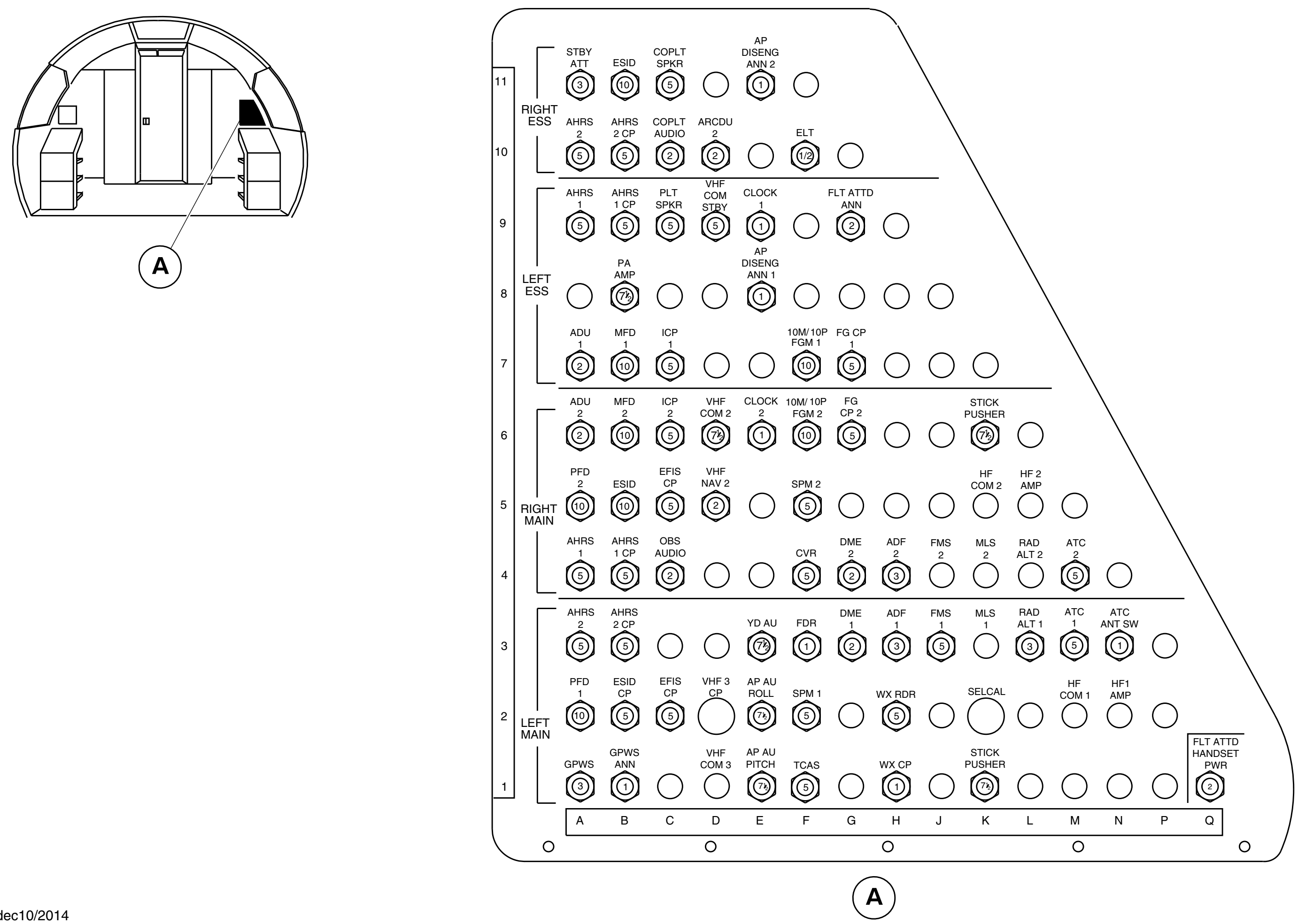
BATTERY ELECTRICAL LOAD DISTRIBUTION
Figure 10



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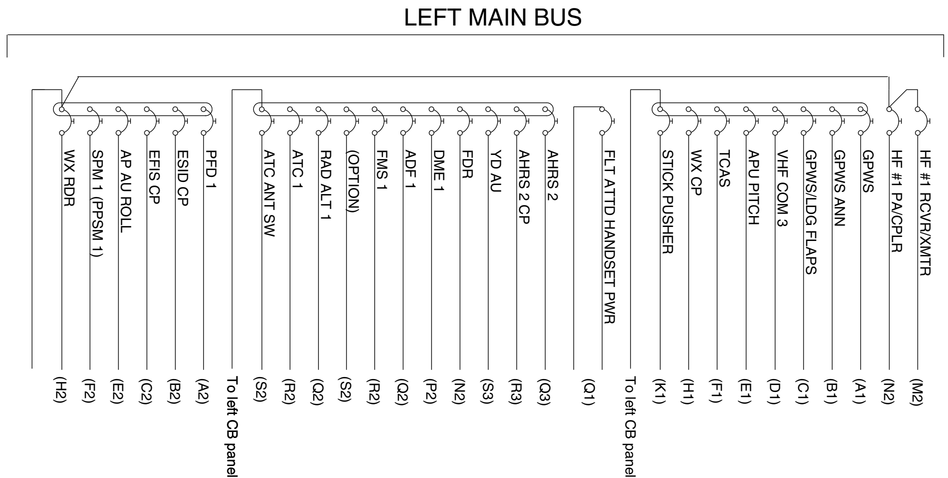
Avionics Circuit Breaker Panel
Figure 11



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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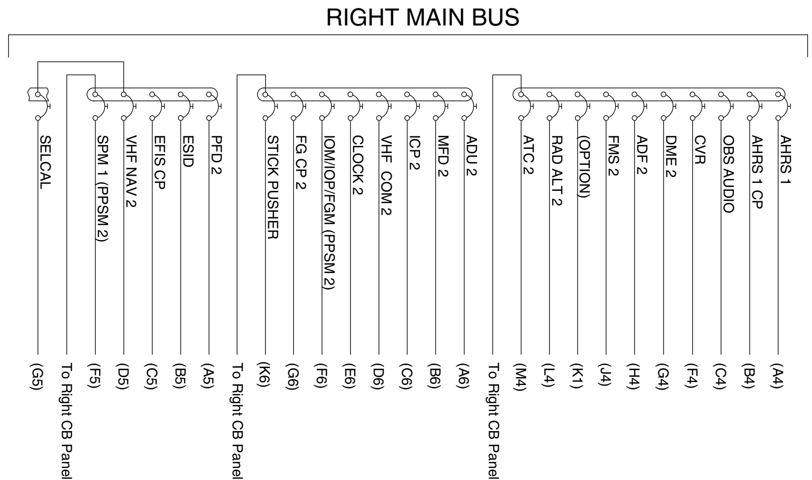
AVIONICS LEFT MAIN ELECTRICAL LOAD DISTRIBUTION
Figure 12



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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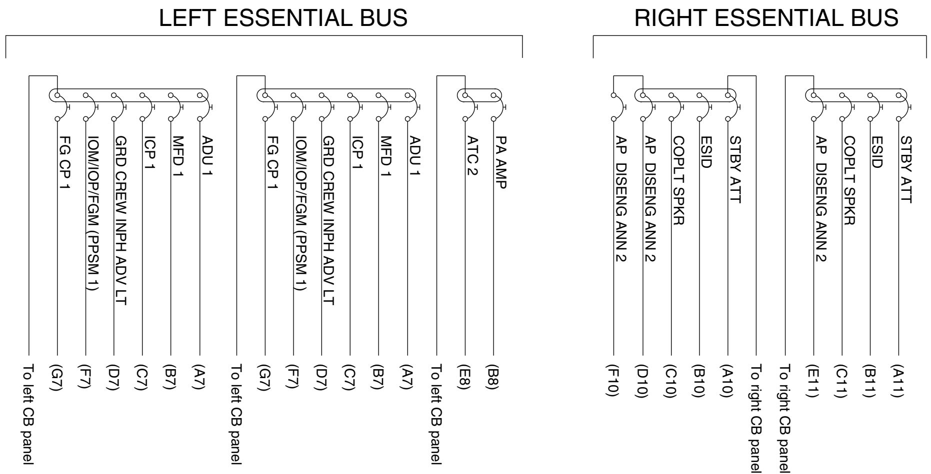
AVIONICS RIGHT MAIN ELECTRICAL LOAD DISTRIBUTION
Figure 13



NOTE

All circuit breakers illustrated are not necessarily installed in all aircraft.

For details of specific circuit breaker locations refer to individual system wiring.

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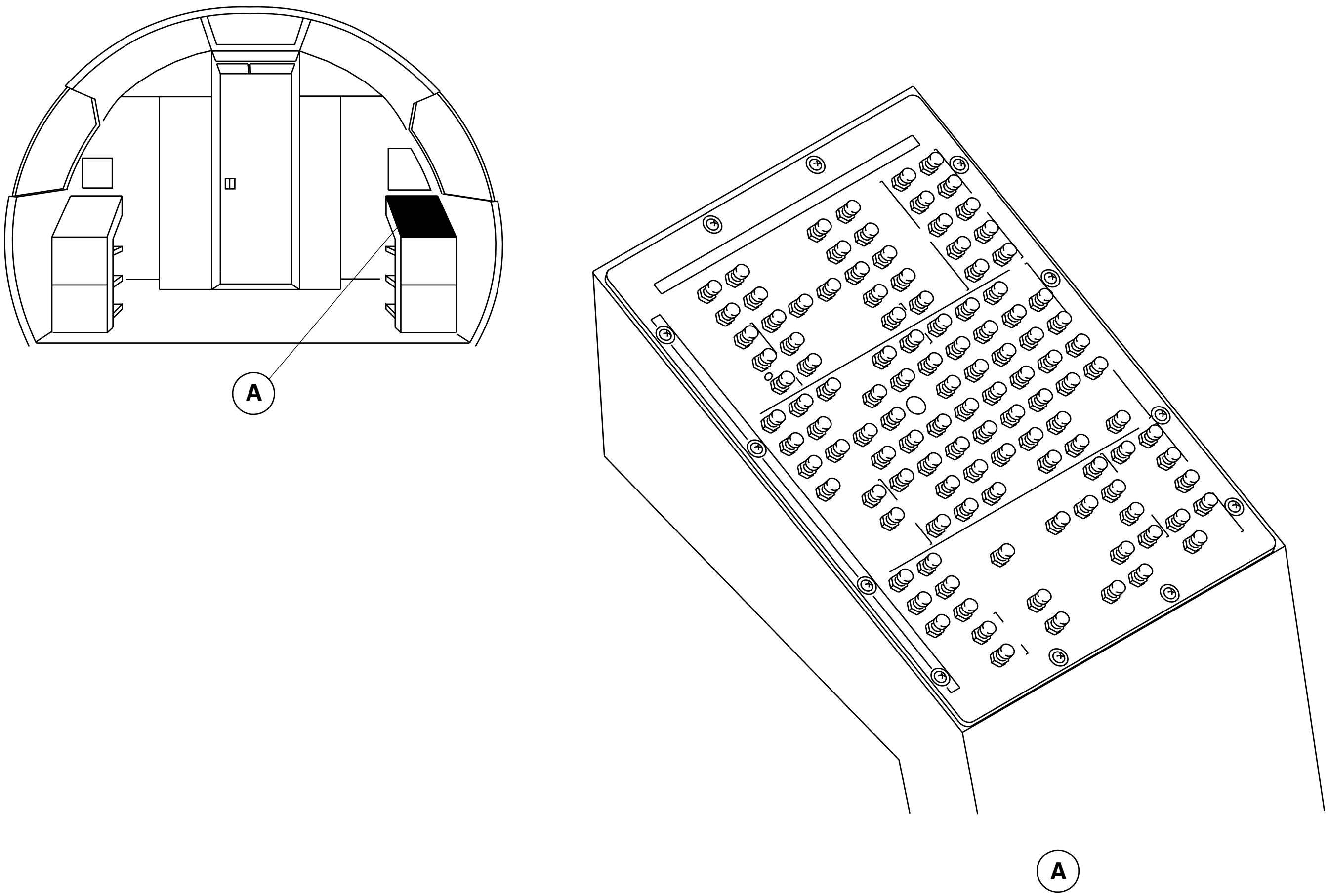
AVIONICS RIGHT AND LEFT ESSENTIAL ELECTRICAL LOAD DISTRIBUTION
Figure 14



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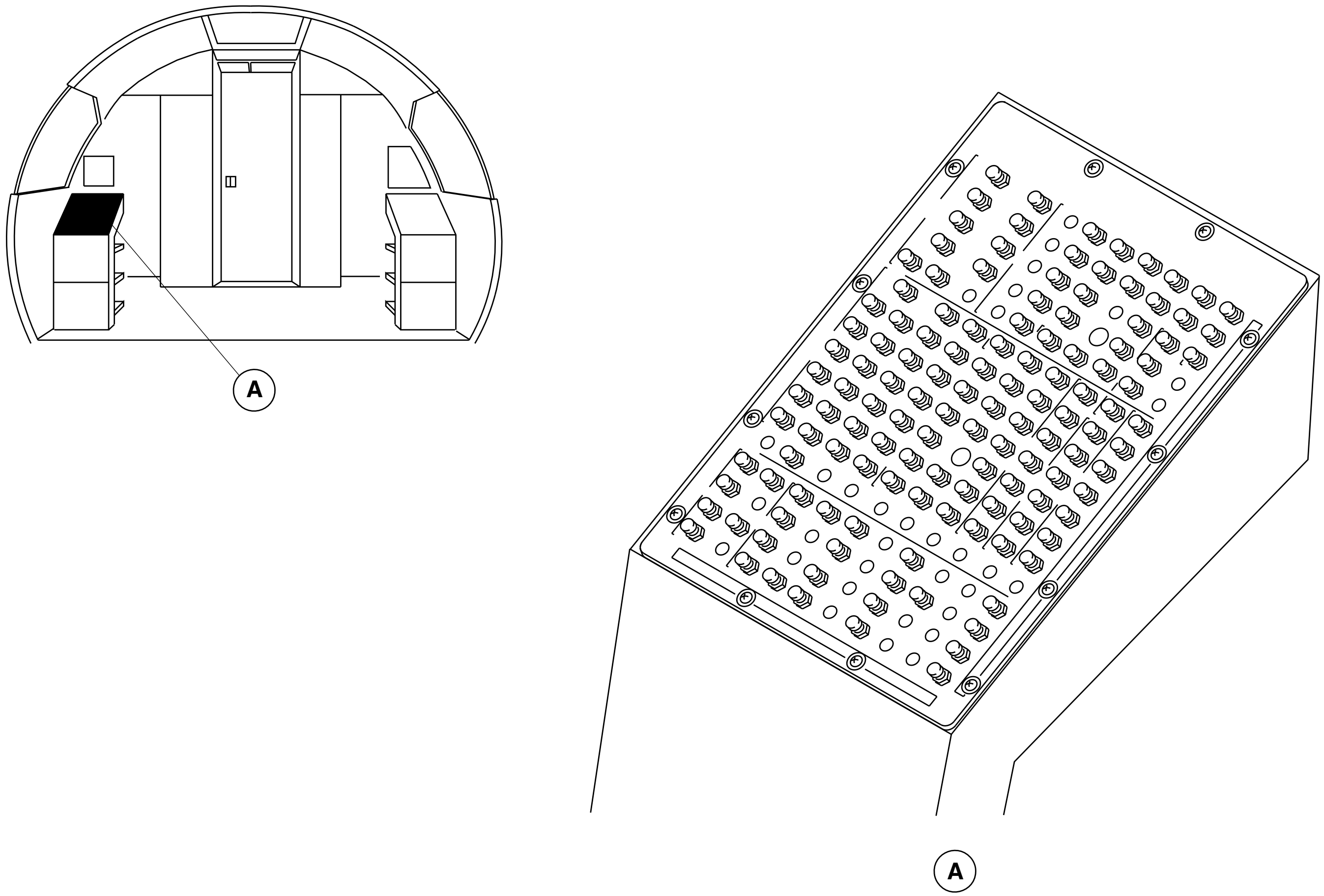
LEFT DC CIRCUIT BREAKER PANEL LOCATOR
Figure 15



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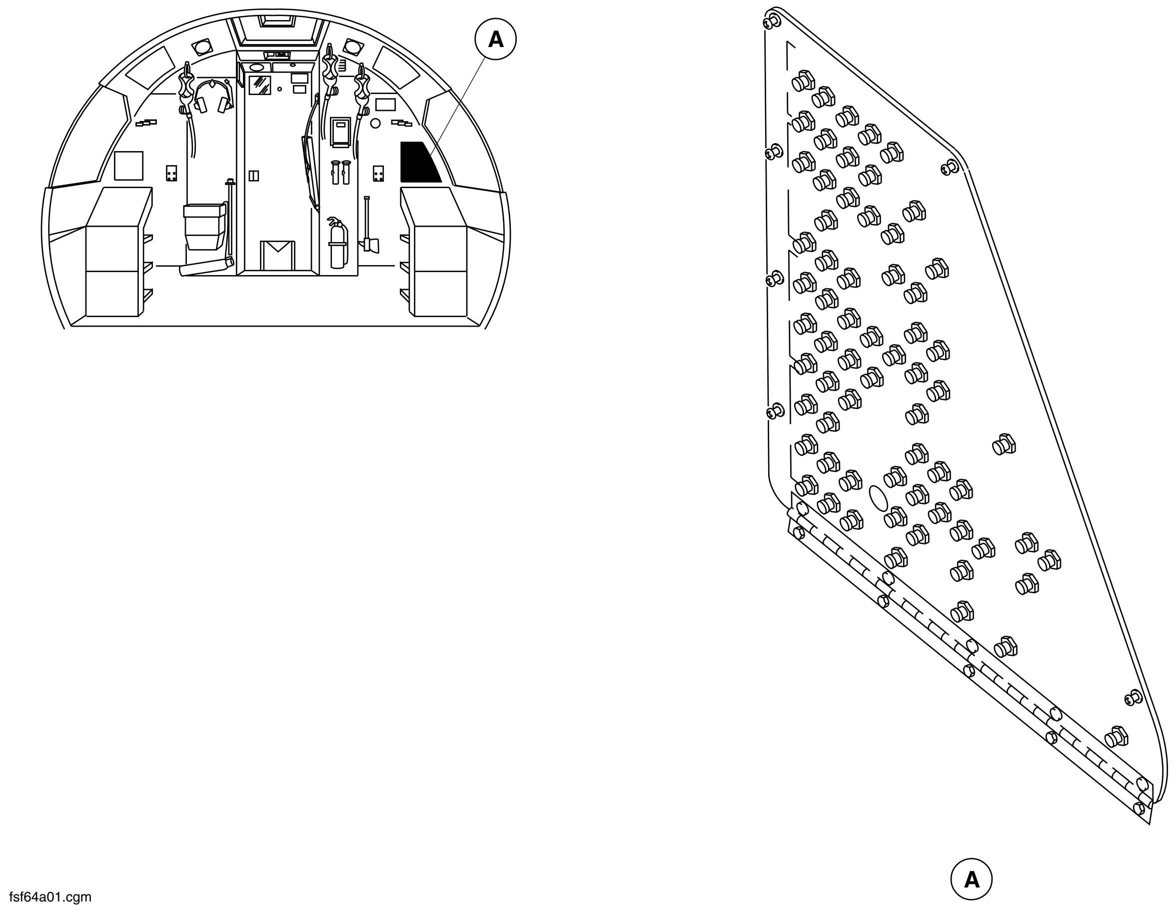
RIGHT DC CIRCUIT BREAKER PANEL LOCATOR
Figure 16



AVIONICS CIRCUIT BREAKER PANEL LOCATOR
Figure 17

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