CHAPTER 7 – ELECTRICAL

LIST OF ILLUSTRATIONS

1. INTRODUCTION

The aircraft uses both 115 Volts AC and 28 volts DC power. AC electrical power is provided by two engine-driven generation systems. Each system includes an integrated drive generator (IDG) and a generator control unit (GCU). An auxiliary power unit (APU) generator is also available as a back AC power source to replace either or both IDGs.

In the event of total AC power loss, emergency AC power is available from an in-flight air-driven generator (ADG). The ADG assembly is stowed in a compartment on the right side of the nose section.

DC power is supplied by five transformer rectifier units (TRU) which rectifies AC input power into DC output power. Another source of DC power is from a main battery and APU battery. The main and APU batteries are connected into the aircraft DC electrical power system and are charged by their respective battery chargers. Power for starting the APU is provided by the APU battery.

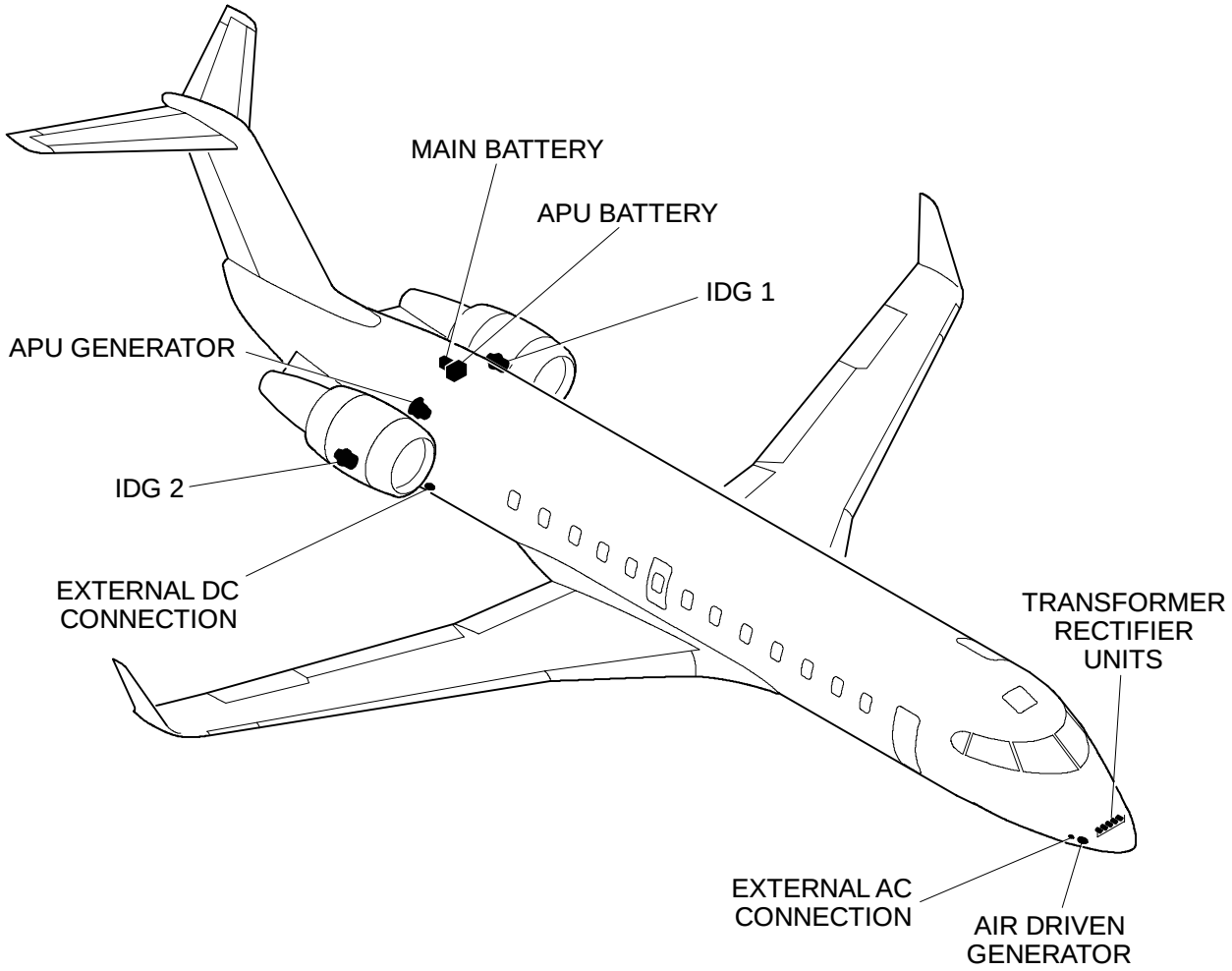
Electrical contactors, switches and relays located throughout 13 junction boxes in the aircraft, are used for connecting AC and DC power to the appropriate buses and components. Power connection is dependent on system configuration and health. The following is a list of all the aircraft electrical system buses:

AC BUSSES	DC BUSSES
AC BUS 1 AC BUS 2 AC ESSENTIAL BUS AC SERVICE BUS ADG BUS AC UTILITY BUS 1 AC UTILITY BUS 2	DC BUS 1 DC BUS 2 DC ESSENTIAL BUS DC SERVICE BUS LEFT AND RIGHT BATTERY BUS DC EMERGENCY BUS DC UTILITY BUS 1 DC UTILITY BUS 2 MAIN BATTERY DIRECT BUS APU BATTERY DIRECT BUS

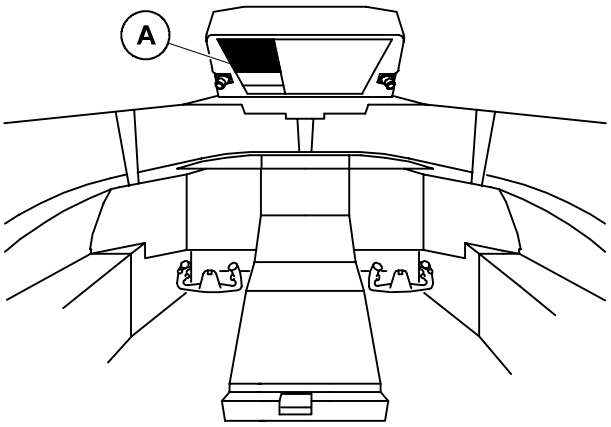
On the ground, the aircraft can receive external AC power through a receptacle located on the forward right side of the fuselage. The aircraft can also receive external DC through a receptacle located on the aft right side of the fuselage.

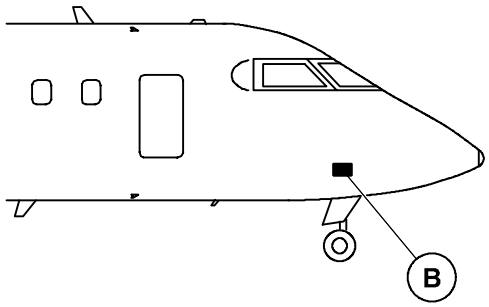
The electrical power services panel (EPSP) in the flight compartment, and the external service panel on the right forward fuselage, contain the AC and DC system control switches. The switches are used for manual and automatic control of the electrical power generating system and external power operation.

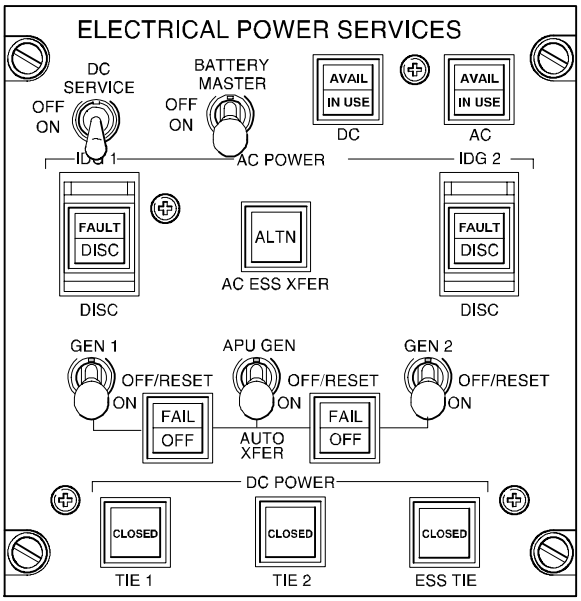
Electrical system warnings and cautions are displayed on the EICAS primary page. Status and advisory messages are displayed on the EICAS status page. General views of the electrical systems are displayed on the EICAS, AC and DC synoptic pages. The AC and DC synoptic pages are accessed through the EICAS control panel (ECP). One push of the ELEC key on the ECP will display the AC synoptic page. Pushing the ELEC key a second time will display the DC synoptic page.



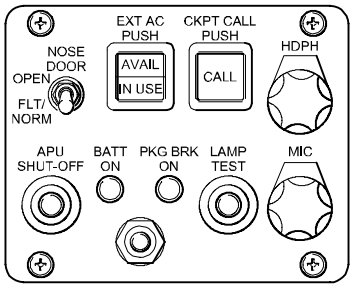
Electrical Power Layout
Figure 07–10–1



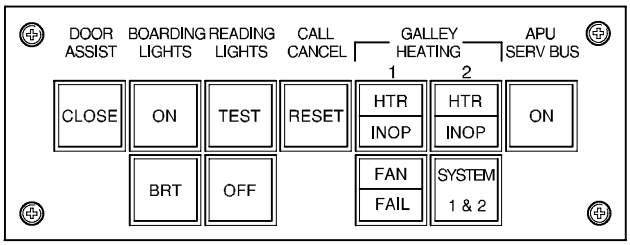




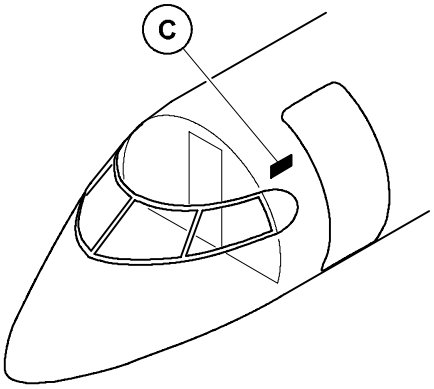
A Electrical Power Panel
Overhead Panel



B External Service Panel
Right Forward Fuselage



C Flight Attendant Panel



Control Panels
Figure 07–10–2

1. AC ELECTRICAL SYSTEM

AC power for the aircraft electrical systems is provided by two engine-driven, integrated drive generators (IDGs) which supply power to all AC buses during normal operations. An APU generator provides a backup AC power source in flight if an IDG is inoperative or when the aircraft is on the ground with the engines off. If all AC power is lost in flight, emergency AC power is provided automatically by a deployable air-driven generator (ADG). The AC distribution system is controlled by the respective IDG and APU generator control units (GCUs). Each generator is monitored by the GCU's for voltage, frequency and kilovolt amps (KVA) to provide system fault protective shutdowns. An AC power distribution schematic and system parameters are displayed on the EICAS AC synoptic page.

A. Integrated Drive Generator (IDG)

Each IDG consists of a constant speed drive (CSD) and a generator. The CSD uses an internal oil system to hydro-mechanically change the variable input speed from the engine accessory gearbox to a constant output speed to the generator to produce 115-volts AC and to maintain a constant frequency of 400 Hz. Each generator is rated at 30 kilovoltamperes (KVA) up to an altitude of 35,000 ft., then 25 KVA to 41,000 ft.

An oil cooler cools the oil used by the IDG. Each IDG is monitored for low oil pressure or high oil temperature. In the event of low oil pressure or high oil temperature, an (amber) FAULT light (cover-guarded) on the EPSP will illuminate. Lifting the cover-guard and pushing the switchlight will manually disconnect the IDG from the engine gearbox.

The IDG will automatically disconnect if a severe oil overtemperature or overtorque condition occurs. Once disconnected, either manually or automatically, the IDG cannot be reconnected in flight. If the IDG was disconnected manually, it can only be reset on the ground, with the engine shutdown. If the IDG was disconnected automatically, it must be replaced.

Each generator control unit (GCU) controls and monitors the related AC generator system and provides voltage and frequency regulation and fault protection for its respective generator. The GCU also protects the electrical system from overcurrent and differential current faults. In the event of a malfunction, the GCU will automatically disconnect the faulty generator from the respective AC buses. The generator may be reset when the malfunction is corrected or no longer exists, by selecting the generator switch to the OFF/RESET position then back to ON.

B. APU Generator

The APU generator is driven, directly by the APU gearbox, at a constant speed to maintain a constant frequency output. The generator provides 115-volts, 400 Hz AC power and is rated at 30 KVA from sea level to 37,000 ft. A GCU, identical to the IDG GCU, provides the same regulation and protection functions as the IDG GCUs.

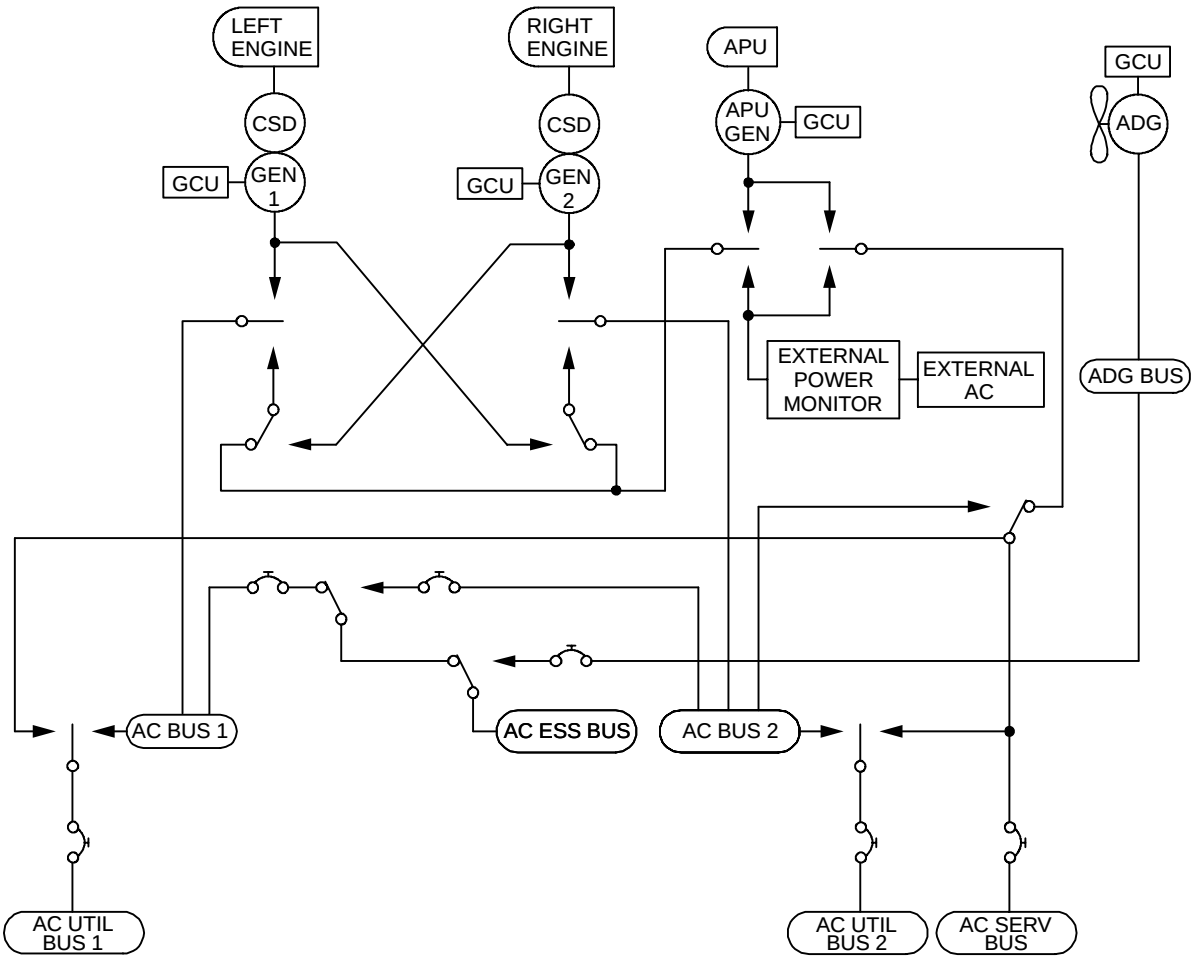
C. AC Distribution

Two different configurations of AC power distribution are available, Full configuration and Service configuration.

In Full configuration, all the AC buses are powered using either IDG 1, IDG 2, the APU generator or external AC. For normal AC distribution, AC power from IDG 1 and IDG 2 is distributed to all the AC buses via GCU controlled contactors in junction box 1 (JB1). There is a priority control of AC power distribution. During normal operation, IDG 1 powers AC bus 1 and IDG 2 powers AC bus 2. The failure of a generator, for any reason other than a fault on its associated bus, will automatically transfer the load from the failed IDG to the remaining operative IDG. When the APU generator is available, it can then be used to replace the failed IDG to power the respective AC bus. On the ground, if the aircraft is being powered with external AC power and either the APU or an IDG is brought on line, the external power will be automatically disconnected and the respective APU or IDG generator will power all the AC buses. When external power is not available, the APU generator provides electrical power to all the AC buses. If an IDG is powering its respective AC bus and the APU generator is powering the other AC bus, when the remaining IDG is brought on line the APU generator will be automatically taken off line.

In service configuration, either external AC power or the APU generator is used to power specific buses for general servicing of the aircraft on the ground. Only AC Utility bus 1, AC Utility bus 2, the AC service bus and the DC service bus are powered.

IDG 1	APU GENERATOR	IDG 2
Failed	Not available	Both AC Bus 1 and AC Bus 2
Failed	AC Bus 1	AC Bus 2
Both AC Bus 1 and AC Bus 2	Not available	Failed
AC Bus 1	AC Bus 2	Failed
Failed	Both AC Bus 1 and AC Bus 2	Failed



AC System Distribution
Figure 07–20–1

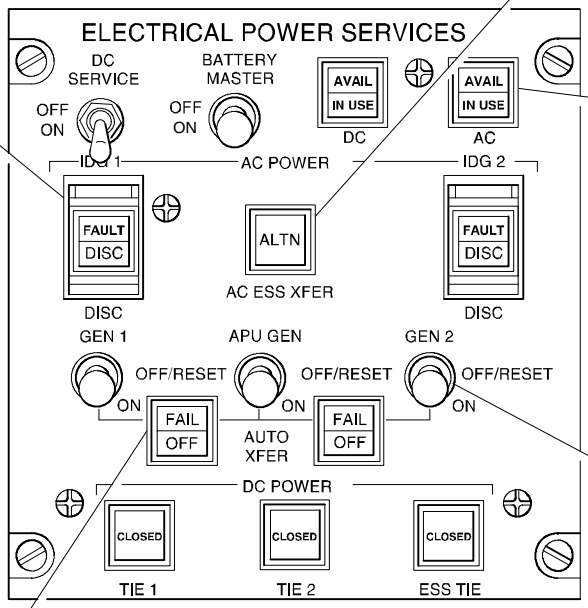
AC ESS XFER
Used to switch essential bus feed from AC bus 1 to AC bus 2.
- ALTN (white) light indicates essential bus is fed from AC bus 2.

Transfer is automatic during an AC bus 1 failure.

IDG 1 and 2 DISC (Guarded)
Used to disconnect IDG from engine.
- DISC (white) light indicates selected disconnect is successful.
- FAULT (amber) light indicates a fault within IDG (low oil pressure or high oil temperature).

IDG will automatically disconnect, when an overtemperature or overtorque condition occurs.

Once disconnected, the IDG cannot be reset with the engines running.



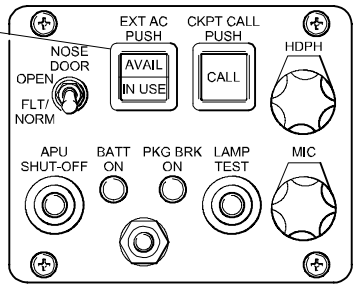
Electrical Power Panel
Overhead Panel

AC
Used to select external AC power.
- AVAIL (green) light indicates external power is connected and is ready to use.
- IN USE (white) light indicates that the external AC power unit is supplying the electrical system.

GEN 1, 2 and APU GEN
- AUTO – Connects generator to associated bus.
- OFF/RESET – Disconnects generator from associated bus and/or resets the generator control circuit.

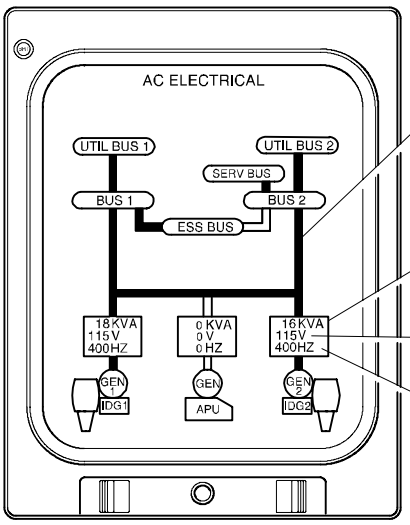
AUTO XFER
Used to disable automatic transfer of associated IDG.
- OFF (white) light indicates autotransfer is selected off.
- FAIL (amber) light indicates a fault preventing autotransfer.

EXT AC PUSH
Used to select external AC power.
- AVAIL (green) light indicates external power is connected and is ready to use.
- IN USE (white) light indicates that the external AC power unit is supplying the electrical system.



External Service Panel
Right Forward Fuselage

AC Electrical System
Figure 07–20–2



Flow Lines
- Green – Bus energized.
- Blank – Bus not energized.

Generator Load
Displays the load on the generator.

Generator Voltage
Displays the generator voltage level.

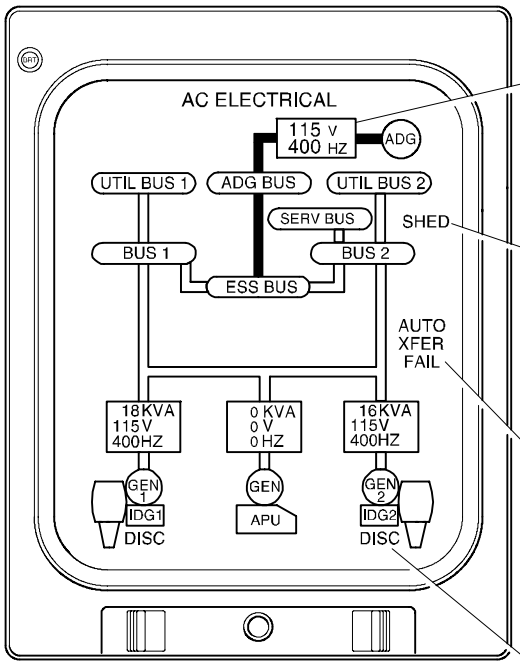
Generator Frequency
Displays the generator frequency level.

AC Electrical Page

EICAS DIGITAL READOUT	GREEN	AMBER	WHITE	HALF INTENSITY MAGENTA	AMBER DASHES
XX KVA	Generator loaded	Generator overload	Generator not loaded	Invalid data	–
XXX V	Voltage 100-125 VAC	–	Voltage not in range	–	Invalid data
XXX HZ	Frequency 375-425 Hz	–	Frequency not in range	–	Invalid data

EICAS OUTLINE	GREEN	AMBER	WHITE	HALF INTENSITY MAGENTA	HALF INTENSITY CYAN
GEN	Generator on	Generator off with engine / APU running	Both generator and engine / APU are off	Invalid data	–
IDG	Constant speed drive on	Low oil pressure or high oil temperature	Engine is off or IDG has disconnected	Invalid data	–
APU	–	–	Engine / APU off	Invalid data	Engine / APU running and ready to load
BUS 1	Bus powered (generator line contactor 1)	Bus not powered	–	Invalid data	
BUS 2	Bus powered (generator line contactor 2)	Bus not powered	–	Invalid data	
ESS BUS	Bus powered	Bus inoperative (essential bus fail)	–	Invalid data	
SERV BUS	Bus powered	Bus inoperative (AC service bus fail)	–	Invalid data	
UTIL BUS 1	Bus powered	–	Bus not powered (shed)	Invalid data	
UTIL BUS 2	Bus powered	–	Bus not powered (shed)	Invalid data	

AC Electrical System Synoptic Page
Figure 07–20–3 Sheet 1



AC Electrical Page

ADG Features
Displayed when ADG voltage is more than 10 volts and frequency is more than 300 Hz.

SHED (white)
Indicates that the respective AC utility bus has been automatically shed.

AUTO XFER OFF (white)
Indicates that corresponding automatic transfer has been selected off.

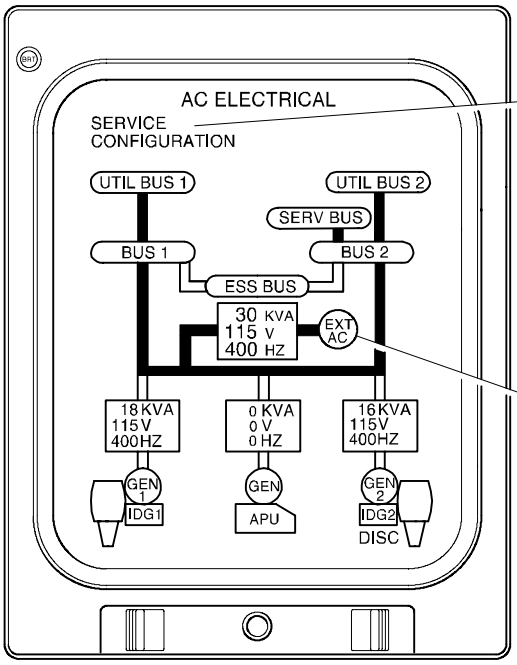
AUTO XFER FAIL (amber)
Indicates that corresponding automatic transfer has failed.

DISC (white)
Indicates that IDG has been disconnected.

EICAS DIGITAL READOUT	GREEN	WHITE	AMBER DASHES
XXX V	Between 108 and 130 volts	Less than 108 volts or more than 130 volts	Invalid data
XXX HZ	Between 360 and 440 Hz	Less than 360 Hz or more than 440 Hz	Invalid data

EICAS OUTLINE	GREEN	WHITE
ADG BUS	ADG outline green	ADG outline white
ADG	Voltage and frequency digital readouts green	Voltage or frequency digital readouts white

AC Electrical System Synoptic Page
Figure 07–20–3 Sheet 2



AC Electrical Page

SERVICE CONFIGURATION (green)
The message is displayed:
- When external AC power is available and the AVAIL switchlight on the external service panel has been selected, or
- When APU power is available and the APU SERV BUS switchlight on the forward F/A panel has been selected.

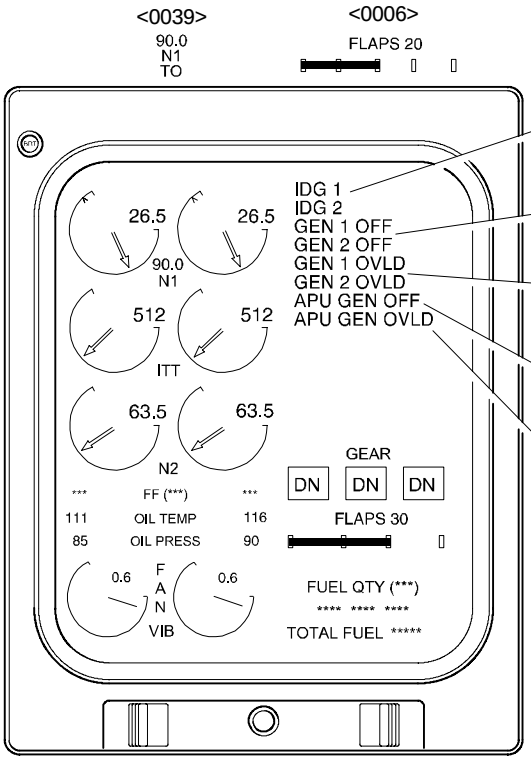
For either selection, only the AC service bus, AC utility bus 1, AC utility bus 2, and the DC service bus will be powered.

External AC Power Features
Displayed when external AC voltage is more than 10 volts and frequency is more than 50 Hz.

EICAS DIGITAL READOUT	GREEN	AMBER	WHITE	HALF INTENSITY MAGENTA	AMBER DASHES
XX KVA	Loaded	Overload	Not loaded	Insufficient data	Invalid data
XXX V	Between 106 and 124 volts	–	Less than 106 volts or more than 124 volts	–	Invalid data
XXX HZ	Between 370 and 430 Hz	–	Less than 370 Hz or more than 430 Hz	–	Invalid data

EICAS OUTLINE	GREEN	WHITE	HALF INTENSITY MAGENTA
EXT AC	External AC available or in use	External AC not available and not in use	Invalid data

AC Electrical System Synoptic Page
Figure 07–20–3 Sheet 3



Primary Page

IDG 1 or 2 caution (amber)
Indicates that IDG has low oil pressure or high oil temperature.

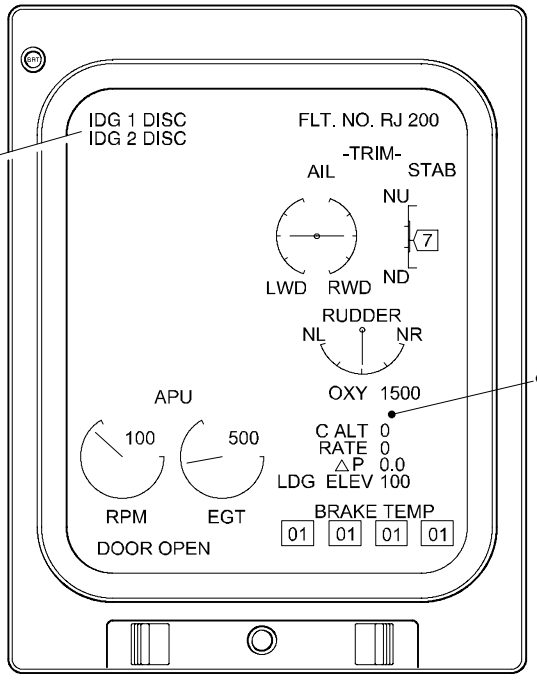
GEN 1 or 2 OFF caution (amber)
Indicates that generator is off.
(Indications are inhibited during start)

GEN 1 or 2 OVLD caution (amber)
Indicates that generator control unit has detected a load of greater than 40 kVA.

APU GEN OFF caution (amber)
Indicates that APU generator is off and APU is ready to load.

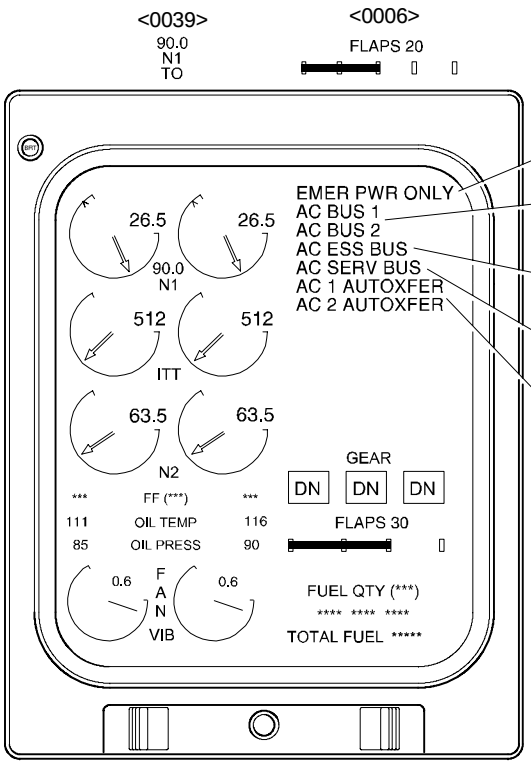
APU GEN OVLD caution (amber)
Indicates that generator control unit has detected a load of greater than 40 kVA.

IDG 1 or 2 DISC status (white)
Indicates that IDG has been disconnected, either automatically or manually.



Status Page

AC Electrical System EICAS Indication (Generators) <MST
Figure 07–20–4



Primary Page

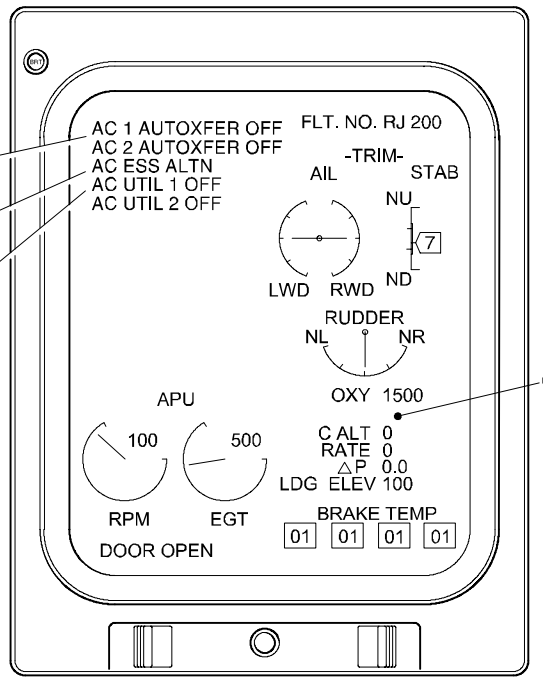
EMER PWR ONLY warning (red)
Indicates that the ADG has deployed.

AC BUS 1 or 2 caution (amber)
Indicates that the associated bus is not powered.

AC ESS BUS caution (amber)
Indicates that AC essential bus is less than 90 Volts.

AC SERV BUS caution (amber)
Indicates that AC bus 2 is powered and AC service bus is less than 90 Volts.

AC 1 or 2 AUTOXFER caution (amber)
Indicates that the corresponding automatic bus transfer has failed.



Status Page

AC 1 or 2 AUTOXFER OFF status (white)
Indicates that the corresponding automatic bus transfer has been selected off.

AC ESS ALTN status (white)
Indicates that AC essential bus is being fed from AC bus 2.

AC UTIL 1 or 2 OFF status (white)
Indicates that corresponding AC utility bus is not powered.

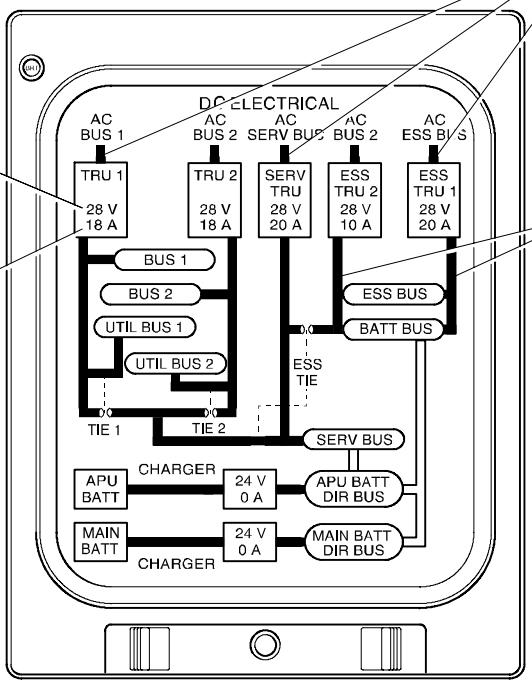
AC Electrical System EICAS Indications (Busses) <MST>
Figure 07-20-5

AC BUS to TRU Flow Lines
- Green – Respective AC bus is powering TRU.

TRU Voltage Readouts
Displays, in increments of 1 VDC, the rectifier's voltage level.

TRU Output Flow Lines
- Green – Respective TRU is on-line and output is 18 VDC or greater.

TRU Load Readouts
Displays, in increments of 1 amp, the load on the rectifier.



DC ELEC Page
EICAS Secondary Display
Center Instrument Panel

EICAS DIGITAL READOUT	GREEN	WHITE	AMBER DASHES
xx V	Between 22 and 29 VDC	Less than 22 VDC or more than 29 VDC	Invalid data
xx A	Between 3 and 99 amp	Less than 3 amp or more than 99 amp	Invalid data

EICAS OUTLINE		GREEN	WHITE	AMBER	HALF-INTENSITY MAGENTA
TRU 1 V A	TRU 1	18 VDC or greater	Less than 18 VDC	–	Invalid data
TRU 2 V A	TRU 2	18 VDC or greater	Less than 18 VDC	–	Invalid data
SERV TRU 2 V A	Service TRU	18 VDC or greater Load more than 2 amp	Less than 18 VDC Load less than 2 amp	–	Invalid data
Ess TRU 2 V A	Essential TRU 2	18 VDC or greater Load more than 3 amp	Less than 18 VDC Load less than 3 amp	TRU failure	Invalid data
Ess TRU 1 V A	Essential TRU 1	18 VDC or greater Load more than 3 amp	Less than 18 VDC Load less than 3 amp	TRU failure	Invalid data

Transformer Rectifier Units
Figure 07–20–6

The AC essential bus is normally powered by AC bus 1. If a fault exists on AC bus 1, the GCU will automatically transfer the power supplied to the AC essential bus, from AC bus 1 to AC bus 2. The crew can also manually transfer the AC essential bus supply power, from AC bus 1 to AC bus 2, using the AC ESS XFER switchlight on the electrical panel. In flight, the AC service bus is normally powered from AC bus 2. On the ground, it can be powered from the APU generator or from external AC power.

The AC service bus supplies power to those circuits necessary for ground-servicing operations, without having to power the entire electrical system.

The AC utility buses are normally powered (in full configuration) by their respective AC bus. In flight, the AC utility buses are automatically SHED if only one generator is operational. In service configuration, the AC utility buses are powered from either the APU generator or from external AC power.

D. AC Loads Distribution

AC BUS 1	AC BUS 2	AC ESSENTIAL
Hydraulic Pumps 2B and 3B	HSTA (Ch-1)	HSTA (Ch-2)
Left Windshield Heater	Hydraulic Pumps 3A and 1B	Bleed Leak Controllers (L / R)
Probe Heaters (R) (AOA and Pitot) and TAT	Right Windshield Heaters	Left Window Heater
Left -Navigation, Landing and Taxi Lights	Right Window Heater	Probe Heaters (L) (AOA and Pitot)
Ground Proximity Warning System (GPWS)	Ice Detector 2	Ice Detector 1
Enhanced Ground Proximity Warning System (EGPWS) <0040>	Instrument Lights (copilot and overhead), Landing and Taxi Lights (R)	Engine Ignition A
Flight Recorder Power	Inertial Reference System (2) <0025>	Instrument Lights (Pilot's and Center)
Hydraulic System Fan	ARINC Display Fan, Galley and Cabin Fan	CB Panel Integral Lights
Display Cooling Fan (R)	Flap Power Drive Unit (2)	Inertial Reference System (1) <0025>
Exhaust and Cockpit Fan	ADG Deploy Sensor	Head-up Guidance System <0026>
Flap Power Drive Unit (1)	TRU 2, DC Essential bus	Traffic Alert and Collision Avoidance (TCAS)
Engine Vibration Monitor		ARINC Chassis and Display Cooling Fans (L)
ADG Deploy Sensor		Essential TRU 1
TRU 1, DC essential bus		

AC UTILITY BUS 1	AC UTILITY BUS 2	AC SERVICE BUS	ADG Bus
Galley (1) and Coffee Maker	Galley (2) and Water System	Service TRU	Hydraulic Pump 3B
Main Battery Charger	APU Battery Charger	Vacuum Cleaner	Flaps
Power Sensing Relay	Power Sensing Relay	Toilet Motor/pump	

E. Air Driven Generator (ADG)

In the event of a complete AC power failure in flight, the ADG will automatically deploy and supply 115-volts, 400 Hz AC emergency power to the ADG bus. The ADG generator is rated at 15 KVA. The ADG bus will then supply emergency power to the AC essential bus and the 3B hydraulic pump. The AC essential bus will then power essential TRU 1, which will power the DC essential bus.

If the automatic deploy function fails, the ADG can be deployed manually by pulling the ADG manual release handle on the ADG CONTROL control panel at the rear of the center console.

If either main generator is restored, the crew can override the ADG by pressing the PWR TXFR OVERRIDE button on the ADG control panel. This will reconnect the restored IDG to power AC bus 1, AC bus 2 and the AC essential bus. The ADG will continue to power the critical flight controls and the ADG bus. The flaps will move at half speed when powered from the ADG bus.

The ADG generator, voltage, frequency and ADG bus indications on the EICAS, AC ELECTRICAL synoptic page are only displayed when the ADG bus is powered.

The ADG will continue to operate and supply power to the ADG bus until the airspeed decreases below approximately100 kts. At that point, if the APU generator or IDG has not been restored, the only power available will be from the batteries.

The ADG cannot be restowed in flight. It is restowed manually, on the ground, by maintenance personnel.

NOTE

After ADG deployment or APU generator switching, intermittent failure of the pilot's and copilot's air data systems may occur. These failures may result in uncommanded changes to the pilot's or copilot's flight instruments. The barometric altimeter setting, altitude preselector, V-speeds and speed bug settings should be checked and reset as required.

Automatic deployment of the ADG is inhibited, on the ground, when the parking brake is set.

The ADG system circuits can be checked through a LAMP/UNIT test switch on the ADG control panel. When the switch is set to LAMP, a ground is supplied to check that the green TEST light illuminates. The UNIT test has two modes, Pre-takeoff and Inflight:

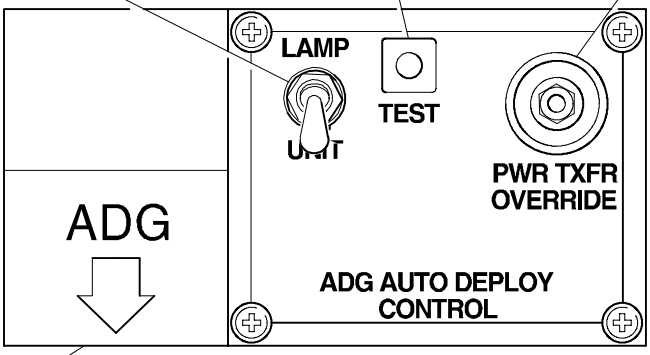
- Pre-takeoff,
  When the test switch is set to UNIT the ADG system circuits are checked and the TEST light will illuminate within 1 second and remain ON for 2 seconds.

- Inflight,
  When the test switch is set to UNIT the ADG system circuits are checked and the TEST light will illuminate after 5 seconds and remain ON for 2 seconds.

LAMP/UNIT Switch
Used to test auto-deploy system. Test can only be accomplished with two generators selected ON and both main AC busses powered.

TEST Light (green)
Comes on after successful completion of auto-deploy system test.

PWR TXFR OVERRIDE
Used to transfer AC essential bus power source from the ADG bus back to the main AC bus.



ADG Manual Deploy Handle and Auto-Deploy Panel Center Pedestal

ADG Manual Deploy Handle
Used to manually deploy the ADG.

Air Driven Generator (ADG)
Figure 07-20-7

F. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
AC Electrical Power	Generators	IDG 1 DISC	DC BATTERY BUS	1	P9	
		IDG 2 DISC			P10	
	Generator Control	GCU 1			Q10	
		GCU 2			Q11	
		GCU 3			Q12	
	ADG Deploy	ADG AUTO	APU BATTERY DIRECT BUS	5	B10	
		ADG MAN			B11	
		ADG DEPLOY AUTO	DC BATTERY BUS	2	N6	
		ADG DEPLOY MAN		2	N7	
		ADG DEPLOY SENS	AC BUS 1	1	C10	
		STBY PWR CONT	MAIN BATTERY DIRECT BUS	5	A7	
AC Distribution	AC Essential Bus	AC ESS FEED	ADG BUS	3	A8	
		AC ESS FEED	AC BUS 1	1	C2	
		ESS PWR CONT	APU BATTERY DIRECT BUS	5	B13	
		ESS AC XFR CONT	DC BATTERY BUS	1	Q9	
	AC Utility Bus 1	AC UTLY BUS FEED	AC UTILITY 1		E2	
		PWR SENS			E7	
		AC UTLY BUS CONT	DC BUS 2		J4	
	AC Utility Bus 2	AC UTLY BUS FEED		2	E2	
		AC UTLY BUS SENS	AC UTILITY 2		E7	
		AC UTLY BUS CONT	DC BUS 1		J4	
	AC Service Bus	AC SERV BUS FEED	AC SERV		R2	

1. DC ELECTRICAL SYSTEM

Five transformer rectifier units (TRU's) and two batteries (Main and APU) provide the aircraft with DC electrical power. DC power is also available through an external DC receptacle on the right aft fuselage.

A. Transformer Rectifier Units (TRU)

There are five TRU's located in the nose avionics compartment. Each TRU converts 115 VAC input power to 28 VDC output power for powering the aircraft DC buses. The TRU's are rated at 100 amps. Normal distribution of the TRU outputs is shown in the following table:

INPUT BUS	TRU	OUTPUT BUS
AC Bus 1	TRU 1	DC Bus 1 and DC Utility Bus 1
AC Bus 2	TRU 2	DC Bus 2 and DC Utility Bus 2
	Essential TRU 2	DC Essential Bus and Battery Bus
AC Service Bus	Service TRU	DC Service Bus
AC Essential Bus	Essential TRU 1	DC Essential Bus and Battery Bus

B. Batteries

The main and APU nickel-cadmium batteries and their battery chargers are located in the aft equipment compartment. The batteries provide DC power to their respective DC battery direct buses.

The 17 AMP./HR, 24, volt main battery provides backup power to the attitude heading reference system (AHRS), proximity sensing electronic unit (PSEU), data concentrator units (DCU's), aircraft clocks, and the APU electronic control unit (ECU). The main battery also provides power to the flight compartment lighting system.

The 17 AMP./HR, 24 volt, main battery provides backup power to the inertial reference system (IRS), proximity sensing electronic unit (PSEU), data concentrator units (DCU's), aircraft clocks, and the APU electronic control unit (ECU). The main battery also provides power to the flight compartment lighting system. <0025>

The 43 AMP./HR, 24 volt, APU battery provides the cranking power for starting the APU.

Battery chargers maintain the batteries at full charge. The main battery charger is powered from AC Utility bus 1 and the APU battery charger is powered from the AC Utility bus 2. Battery charging is controlled automatically. Each charger monitors the battery voltage and temperature to control the battery charge rate. If a battery reaches the overtemperature set point (as sensed by the charger), the charging will stop to prevent overheating (thermal runaway).

Effectivity:

- Airplanes 7001 to 7220

NOTE

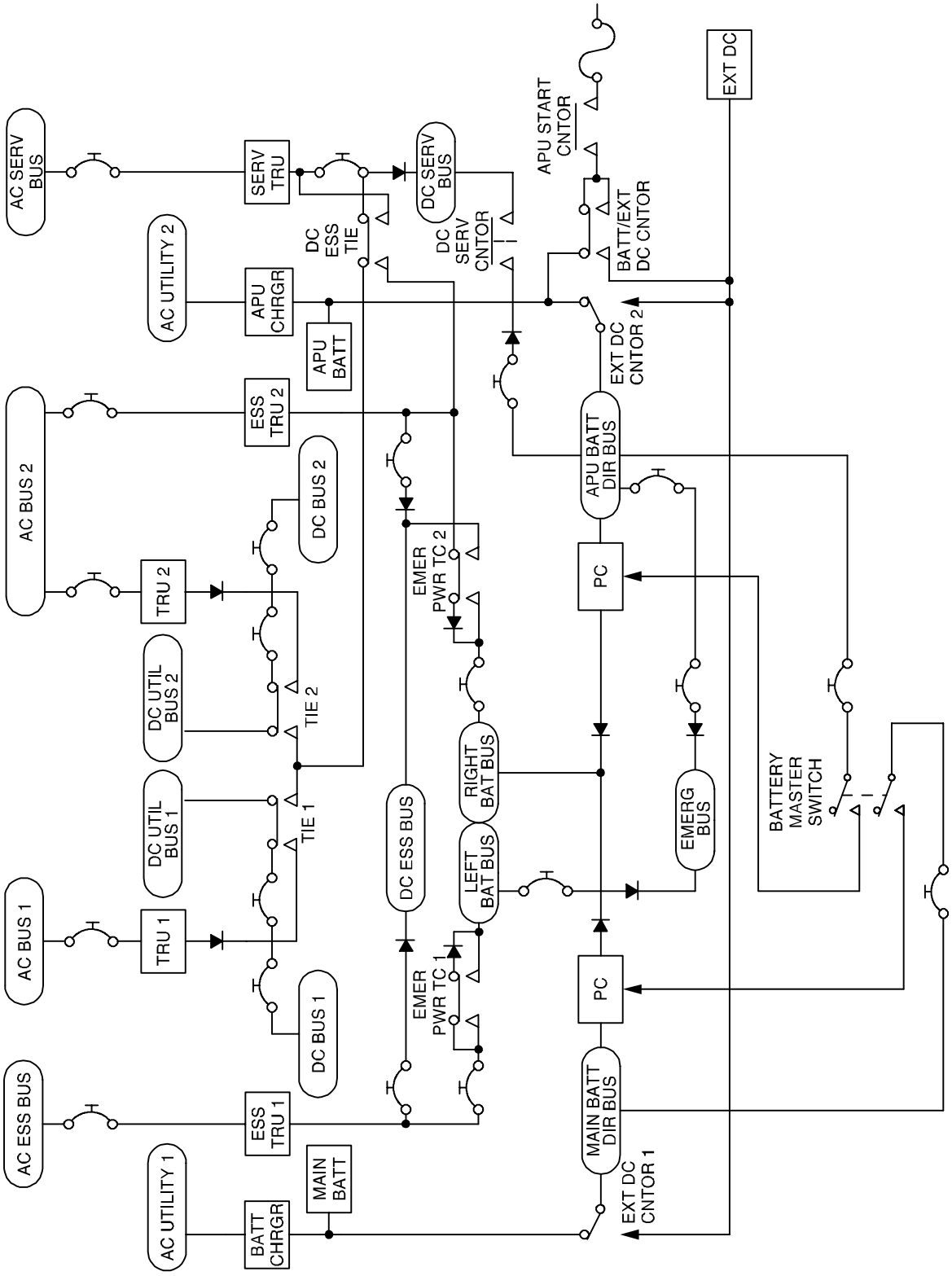
In flight, both chargers will be shed during single generator operations. On the ground, both chargers are shed if external AC power is connected and the flaps are out of the 0 detent, and the passenger door is closed.

Effectivity:

- Aircraft 7221 and subsequent

NOTE

In flight, both chargers will be shed during single generator operations. On the ground, both chargers are shed if external AC power is connected, the flaps are out of the 0 detent, and the passenger and service doors are closed.



DC Distribution System
Figure 07–30–1

DC SERVICE
Used to connect the DC service bus to the APU battery direct bus.

BATTERY MASTER
Used to connect the APU and main battery direct busses to the battery bus.

NOTE

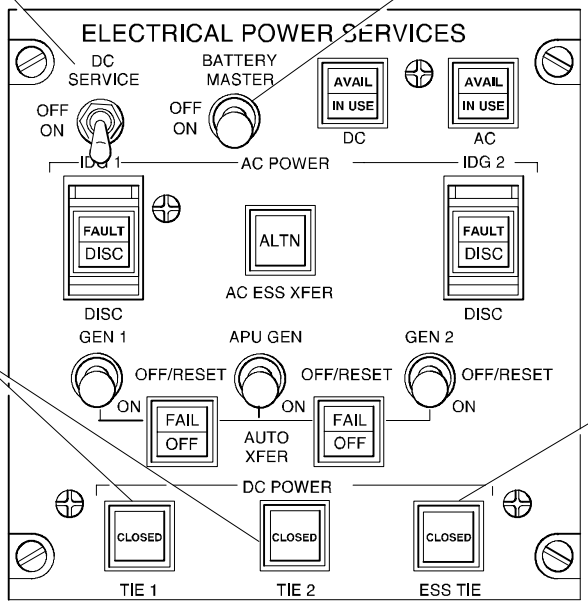
Battery master should always be in the ON position in flight.

BUS TIE 1 or 2 Switch/Lights

- CLOSED – Come on white to indicate that the corresponding DC bus has been automatically tied to the service TRU during an abnormal condition, or has been pressed in, to manually tie corresponding bus to the service TRU.

  CLOSED light (white) comes on.

  Corresponding utility bus is shed when switch/light indicates CLOSED.



Electrical Power Panel
Overhead Panel

Essential Bus Tie Switch/Light

- CLOSED – When pressed in, comes on white to indicate that ESS Bus has been manually tied to the service TRU during a DC essential TRU failure.

  ESS TIE switch/light can only be selected manually.

DC Electrical System
Figure 07–30–2

C. External DC Power

The aircraft can be connected to 28 volts DC from an external receptacle located on the right aft fuselage below No. 2 engine. External DC is used for ground operations to save battery power and can be used to start the APU. When external DC is connected to the aircraft, an external DC contactor is energized to provide power to the APU start contactor. At the same time, the AVAIL lamp in the DC switchlight illuminates. Pressing the switchlight closes two contactors to connect the external DC to the Main and APU battery direct buses and the IN USE lamp in the switchlight illuminates.

D. DC Distribution

DC power is distributed to the DC system by five TRU's. DC bus 1 and DC Utility bus 1 are powered from TRU 1. DC bus 2 and DC Utility bus 2 are powered from TRU 2. The DC essential bus and battery buses are normally powered from the essential TRUs. The emergency bus is powered from the battery bus and the APU battery direct bus. The service TRU powers the DC service bus. In the event that an essential TRU fails, the DC essential bus and battery bus will remain powered from the operating essential TRU. If both essential TRU's fail, the essential DC bus and battery bus may still be powered from the service TRU by selecting the ESS TIE switchlight on the electrical panel. In the event that a main TRU fails, the respective DC tie will close to maintain power to the respective DC bus 1/2 from the service TRU. At the same time the corresponding utility bus will be SHED.

The Main battery direct bus, APU battery direct bus, and the emergency bus are all hot buses (they are continuously powered at all times from the batteries). When the BATTERY MASTER switch is selected ON, an input signal is supplied to the two power controllers (PC). The power controllers monitor for AC power, and if AC power is not available then the controllers will connect their respective batteries to the battery bus. When AC power is available, for the TRU's to power the DC system, the power controllers will disconnect the batteries from the battery bus. Each battery direct bus can power the DC battery bus. Both the battery bus and the APU battery direct bus power the DC emergency bus. The DC service bus is normally powered from the service TRU. If the DC SERVICE switch on the electrical panel is selected ON, the DC service bus will be powered from the APU battery direct bus.

NOTE

Although there is only one battery bus, it is split between circuit breaker panel 1 and 2 and is referred to as the left and right battery bus.

In flight, if the power controllers sense a complete loss of AC power, they will reconnect the batteries to the battery bus and at the same time the DC emergency ties will close to connect the battery bus to the DC essential bus. Once the ADG bus is online to power essential TRU 1 and the DC essential bus, the batteries will act as a backup power source to the DC essential bus.

ESS TRU 1 caution (amber)
Indicates that the essential TRU voltage is less than 18 VDC, when the AC essential bus is powered.

ESS TRU 2 caution (amber)
Indicates that the essential TRU voltage is less than 18 VDC, when the AC bus 2 is powered.

DC BUS 1 or 2 caution (amber)
Indicates that the corresponding DC bus is not powered with either AC bus 1 or 2 on line.

DC EMER BUS caution (amber)
Indicates that emergency bus is not powered.

DC ESS BUS caution (amber)
Indicates that essential bus is not powered (Both AC buses or both essential TRU's have failed).

DC SERV BUS caution (amber)
Indicates that service bus is not powered with either AC bus 1 or 2 on line.

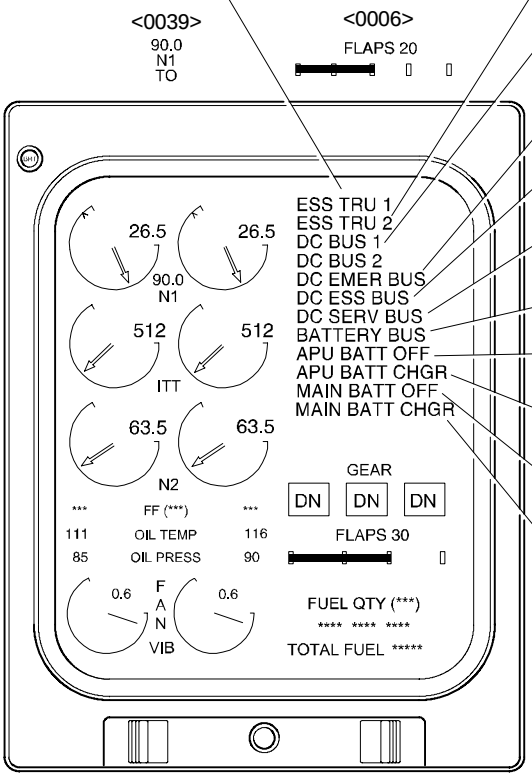
BATTERY BUS caution (amber)
Indicates that battery bus is not powered.

APU BATT OFF caution (amber)
Indicates the APU battery is not available (less than 18 volts).

APU BATT CHGR caution (amber)
Indicates APU battery overheat condition is found, charger 2 has failed or AC Utility bus 2 is not powered.

MAIN BATT OFF caution (amber)
Indicates the main battery is not available (less than 18 volts).

MAIN BATT CHGR caution (amber)
Indicates main battery overheat condition is found, charger 1 has failed or AC Utility bus 1 is not powered.



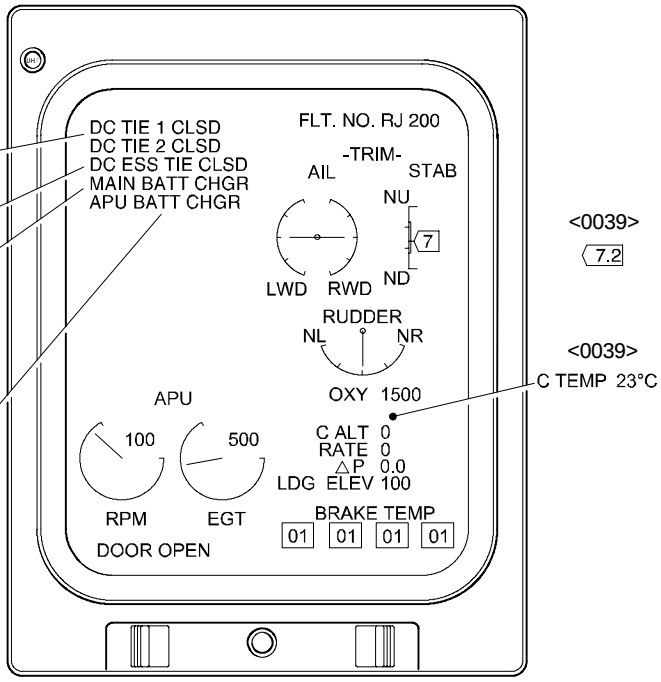
Primary Page

DC TIE 1 or 2 CLSD status (white)
Comes on to indicate that corresponding TIE 1 or TIE 2 switch/light has been operated CLOSED.

DC ESS TIE CLSD status (white)
Comes on to indicate that ESS TIE switch/light has been operated CLOSED.

MAIN BATT CHGR status (white)
Indicates main battery overheat condition is found, charger 1 has failed or AC Utility bus 1 is not powered.

APU BATT CHGR status (white)
Indicates APU battery overheat condition is found, charger 2 has failed or AC Utility bus 2 is not powered.



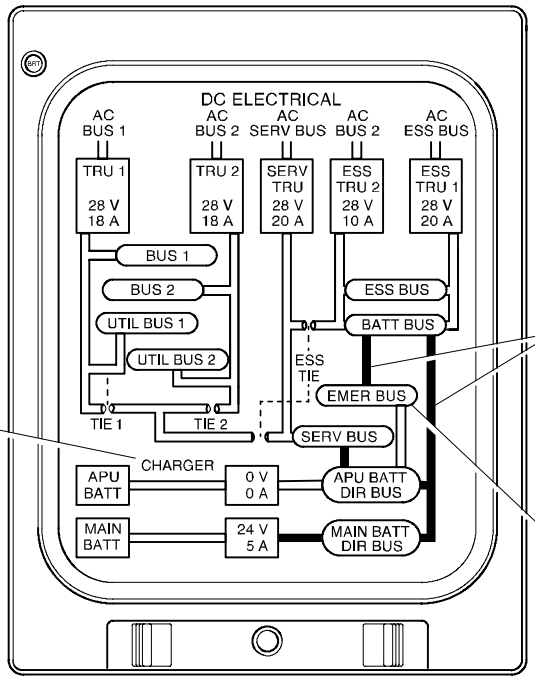
Status Page

DC Electrical System EICAS Indications <MST>
Figure 07–30–3

CHARGER (White) <0039>
CHARGER (Amber)
Indicates that the corresponding charger is not charging.

NOTE

During normal operation, when the DC emergency bus is powered by both the battery bus and the APU battery direct bus, the DC emergency bus outline and respective flow lines are not displayed.



DC ELEC Page
EICAS Display
Center Instrument Panel

DC Emergency Bus Flow Lines

- Green – DC emergency bus is powered through the respective flow line only, or the respective feeder bus is available to feed the failed DC emergency bus.
- White – DC emergency bus is not powered through the respective flow line.

DC Emergency Bus Outline

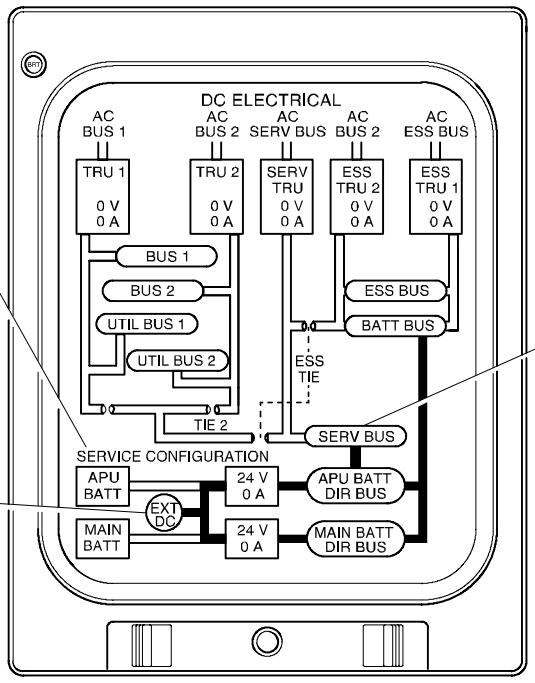
- Green – DC emergency bus is powered by only one of the following:
  - Battery bus or,
  - APU battery direct bus.
- Amber – DC emergency bus is not powered

EICAS BUS BAR OUTLINE	GREEN	AMBER	WHITE	HALF-INTENSITY MAGENTA
BUS 1 / BUS 2	Bus powered	Bus not powered	–	Invalid data
UTIL BUS 1 / UTIL BUS 2	Bus powered	–	Bus not powered	Invalid data
ESS BUS	Bus powered	Bus not powered	–	Invalid data
BATT BUS	Bus powered	Bus not powered	–	Invalid data
SERV BUS	Bus powered	Bus not powered	–	Invalid data
APU BATT DIR BUS	Battery 18 VDC or greater	Battery less than 18 VDC	–	Invalid data
MAIN BATT DIR BUS	Battery 18 VDC or greater	Battery less than 18 VDC	–	Invalid data

EICAS BUS BAR OUTLINE	GREEN	WHITE	AMBER	HALF-INTENSITY MAGENTA
APU BATT / MAIN BATT	Battery 18 VDC or greater	External dc in use	Battery less than 18 VDC	Invalid data
V A Battery Direct Bus Status	Always displayed between 18V & 32V.	Less that 18V or greater than 32V.	–	–

DC Emergency Bus <MST>
Figure 07–30–4

SERVICE CONFIGURATION (Amber)
Indicates that the DC SERVICE switch has been selected ON. Only the DC service bus will be powered.



External DC Flow Line
Displayed when external DC power is connected. Corresponds to DC AVAIL/IN USE switch/light.

SERVICE BUS (Service Configuration)
- Displayed when the DC Service switch is selected ON.

NOTE
Either the battery master switch or external DC must be selected ON.

DC ELEC Page
EICAS Secondary Display
Center Instrument Panel

External DC Flow Line
Figure 07–30–5

E. DC Loads Distribution

DC BUS 1 (CBP-1)		
Spoiler Electronic Unit	Maintenance Diagnostic Computer	DC Tie Control
Spoiler Electronic Control System (PWR 1)	DME 1	Bus 1 Feed Utility
Heaters, Static (R) and ADS Controller (R)	Radio Altimeter	Bus 1 Feed
Cockpit Temperature Control	Flight Data Recorder Control	DC 1 power Sensing
Left Windshield Heat Controller	Weather Radar (receiver, transmitter and control)	TRU 1 Power Sensing
14th-Stage Bleed Air Isolation and Shutoff Valve (L)	EICAS Primary Display	AC Utility Bus Control
10th-Stage Bleed Air Isolation and Shutoff Valve (L)	EICAS Secondary Display	Left Air Conditioning Unit
Anti-ice Automatic NORM (1)	Left Lamp Driver Unit	DME (1)
Proximity Sensor (Landing Gear Control/Door 1) (Weight-on-wheels 1)	Bright/dim Power supply unit	Smoke detector
Lights (cockpit floor, rear anti-collision, wing inspection)	Data Loader	Passenger signs
	Flap Control (CH 1)	Overboard shutoff Valve
	Nose Landing Lights	Pilots Wiper (motor and control)
	Brake Temperature Monitor	Anti-Skid
	FMS (CDU 1) <0024><0050>	GPS (1) <0027><0047>
		Hydraulic System (AC pump control 2 and 3B, fan control, Indicator 2)

DC BUS 2 (CBP-2)		
Horizontal Stabilizer Trim Control Unit (CH 1)	Avionics Cooling (controller 2, cockpit shutoff valve, overboard shutoff valve	Brake Pressure Indicator
Spoiler Electronic Unit (2A)	IAPS (AFCS) (right fan)	Anti-Skid
Spoiler Electronic Control System (PWR 2)	EFIS Control Panel 2	Copilots Wiper (motor and control)
Clock 2	DCU 3 (CH A,B) <0019>.	Hydraulic System (AC pump control 1 and 3A, Indicator 1)
Cabin Temperature Controller and Manual Controller	Audio Control Panel (observers)	DC Tie Control
Right Windshield and Window Heater Controller	ADF 2	Bus 2 Feed Tie and Utility
14th-Stage Bleed Air Isolation and Shutoff Valve (R)	DME 2	DC 2 power Sensing
10th-Stage Bleed Air Isolation and Shutoff Valve (R)	VHF Nav radio 2	TRU 1 Power Sensing
Anti-ice Automatic NORM (2)	VHF Comm radio 2	AC Utility Bus Control
Fuel Pump Control (R)	PFD 2	Right Air Conditioning Unit
Proximity Sensor (Landing Gear Control/Door 2) (Weight-on-wheels 2)	MFD 2	Flap Control (CH 2)
	RTU 2	Nose Wheel Steering
	Air Data Computer (2)	Clock 2
	ATC Transponder 2	Lights (copilot map and wing anti-collision)
	GPS 2 <0027>	

DC ESSENTIAL BUS (CBP-4)		
Horizontal Stabilizer Trim Control Unit (CH-2)	Thrust Reverser (Auto, stow, 1 and 2)	EFIS Panel 1
Spoiler Electronic Unit (1A, 2B)	Fuel (Transfer shutoff valve and control)	Audio Control Panel (copilot's)
Spoiler Electronic Control System 1-2 (PWR 3)	Oil Pressure (R)	ADC 1
Heater, Static and ADS Heater Control (L)	Passenger Door Control	ADF 1
Cabin Pressure Controllers (1 and 2) and Control Panel	Proximity Sensor (Landing Gear Control)	VHF Nav Radio (1)
Left Window Heater Control	Pilot's Floodlights	Cockpit Voice Recorder
10th-stage Bleed air Isolation Valve	Emergency Lights	PFD 1
Bleed Air Leak Test	EFIS, CRT, Dimming Panel 1	MFD 1
Anti-ice Manual (L) STBY	Avionic Cooling Controller (1)	RTU 1
	Stall Protection (CH-R)	Clock 1
	DCU 1 (CH A, B)	ATC Transponder 1
		Head-up Guidance System <0026>
		IAPS (AFCS) (left fan)

BATTERY BUS (CBP-1)	BATTERY BUS (CBP-2)
Passenger Oxygen (manual deploy and left passengers)	Clock 1
Fuel System Control	Ram Air Shutoff Valve
Left Fuel Pump (Control and Power)	CPAM
Fuel X-Feed Control	Crew Oxygen Monitor
Left Engine oil Pressure	Passenger Oxygen (auto deploy and right passengers)
Passenger Address	Anti-ice Valves (L and R manual 2)
Lights (Standby instrument and compass, map dome,chart holder,overhead and copilot flood)	Proximity Sensor (Landing Gear Control/Door 1 and 2) (Weight-on-wheels 1 and 2)
Fire Detector (A, B, Test)	EICAS Control Panel
Passenger Signs	DCU 1 and 2 (CH A and B)
EICAS/RTU Dimming	Standby Horizon Indicator
Stall Protection (stick pusher CH 1)	EICAS Display 1 (ED1)
Audio Control Panel (pilot's)	EICAS Display 2 (ED2)
Air Data Computer(1 and 2) Alternate power supply	Lamp Driver Unit
	Bright/Dim Power Supply Unit
VHF Comm Radio 1	Hyd System 3 (Gauges)
Emergency Tuning Unit	ADG Controller (auto and manual)
IDG Disconnect (1 and 2)	Essential TRU (power 1 and 2 sensing)
Essential AC Transfer Control	Feed 1 (battery and DC essential)
GCU (1, 2 and 3)	Feed 2 (battery and DC essential)
DC Emergency bus Feed	Battery Bus (power sensing)
Engine Ignition (A & B) Control	RCCB Control (Main and APU battery)
Engine Start (L and R)	FMS (CDU 2) <0024>
Transfer/APU (manual x-flow, fuel pump, controller, ECU)	Overheat Detector (Main landing gear bay)

MAIN BATTERY DIRECT BUS (CBP-5)	APU BATTERY DIRECT BUS (CBP-5)	BATTERY BUS (CBP-5)
Main Battery Contactor APU ECU DCU's 1 and 2 Standby Power Controller Attitude Heading Clocks 1 and 2 PSEU Lights (service, boarding and maintenance)	APU Battery Contactor Service Bus Feed Oil Bypass Indicator Engine Oil Replenishment System ADG (auto and manual deploy) External DC Power Essential Power Control Refuel/Defuel Panel Emergency Refuel	Engine Ignition System (B)

DC UTILITY BUS 1 (CBP-1)	DC UTILITY BUS 2 (CBP-2)	DC SERVICE BUS (CBP-2)
Left Cabin Reading Lights Power sensing	Right Cabin Reading Lights Power sensing	Lights (navigation, toilet and galley dome) Cabin Lighting, Upward and Downward (L and R) Service Bus Feed from CBP-5 Power Sensing (service bus and TRU)

F. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
DC Power Distribution	DC Bus 1	TRU 1	AC BUS 1	1	B2	
		FEED	DC BUS 1		E12	
		DC 1 PWR SENS			E14	
		TRU 1 PWR SENS			E15	
	DC Bus 2	TRU 2	AC BUS 2		B2	
		FEED	DC BUS 2	2	E12	
		DC 2 PWR SENS			E14	
		TRU 2 PWR SENS			E15	
	DC TIE CONTACTS	DC TIE CONTROL	DC BUS 1	1	E11	
		TIE AND UTLY	DC BUS 2	2	E11-E13	
	DC Essential Bus	ESS TRU 1	AC ESS	3	A2	
		FEED 1 DC ESS	DC BAT	2	M6	
		FEED 2 DC ESS			M8	
		ESS TRU 1 PWR SENS	DC ESSENTIAL		M3	
		ESS TRU 2 PWR SENS		2	M4	
		28 VDC ESS SENS		4	B3	

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
DC Power Distribution	Battery Bus	FEED 1 BATT BUS	DC BAT	2	M5	
		FEED 2 BATT BUS			M7	
		BAT BUS PWR SENS			M9-M10	
	DC Utility Bus 1	UTLY BUS 1 FEED	DC BUS 1	1	E13	
		PWR SENS	DC UTIL 1		L10	
	DC Utility Bus 2	UTLY BUS 2 FEED	DC BUS 2	2	E13	
		PWR SENS	DC UTIL 2		L10	
	DC Service Bus	SERVICE BUS FEED	APU BATT DIRECT BUS	5	B3	
		BUS FEED	DC SERVICE BUS	1	T5	
		SERVICE TRU	AC SERVICE BUS		R5	
		PWR SENS/SERV BUS	DC SERVICE BUS	2	T6	
		PWR SENS/SERV TRU			T7	
	DC Emergency Bus	APU BATT DIRECT FEED	DC EMER BUS	1	S6	
Main and APU Batteries	APU Battery	APU BATT CONT	APU BAT DIR	5	B2	
		EMER BUS FEED			B4	
		RCCB CONT/APU BATT	BATT & 28VDC ESS CONT	2	M12	
		APU CHARGER	AC UTIL 2		E5	

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Main and APU Batteries	Main Battery	MAIN BATT CONT	MAIN BATTERY DIRECT BUS	5	C5	
		RCCB CONT/MAIN BATT	BATT & 28VDC ESS CONT	2	M11	
		MAIN BATT CHARGER	AC UTIL 1	1	E5	

1. CIRCUIT BREAKER PANELS

There are six circuit breaker panels (CBP's) located in the aircraft. Four CBP's (numbered 1 to 4) are located in the flight compartment. One CBP is located in the aft equipment compartment (number 5) and one CBP is located on the galley control panel.

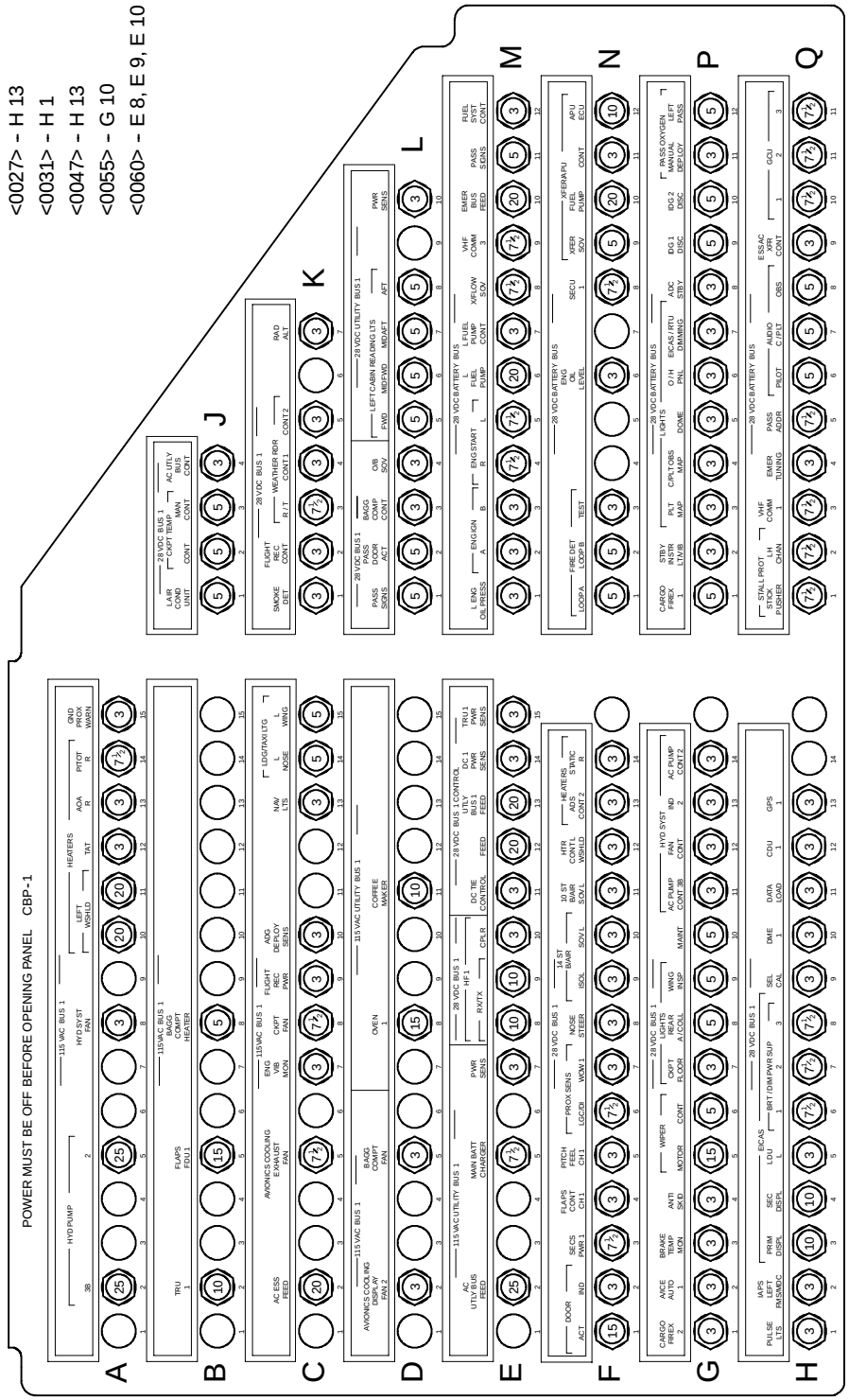
The circuit breakers are clearly identified. For circuit breaker referencing, each circuit breaker panel is laid out in an alphanumeric grid with letters running down the side of the panel and numbers running across each row. For example, the location of a circuit breaker on circuit breaker panel 1, in the 3rd row, column 2, would be identified as CBP1-C2. In this instance, C2 is the circuit breaker for the AC ESS FEED.

CIRCUIT BREAKER PANEL 1
(Behind Pilot's Seat)

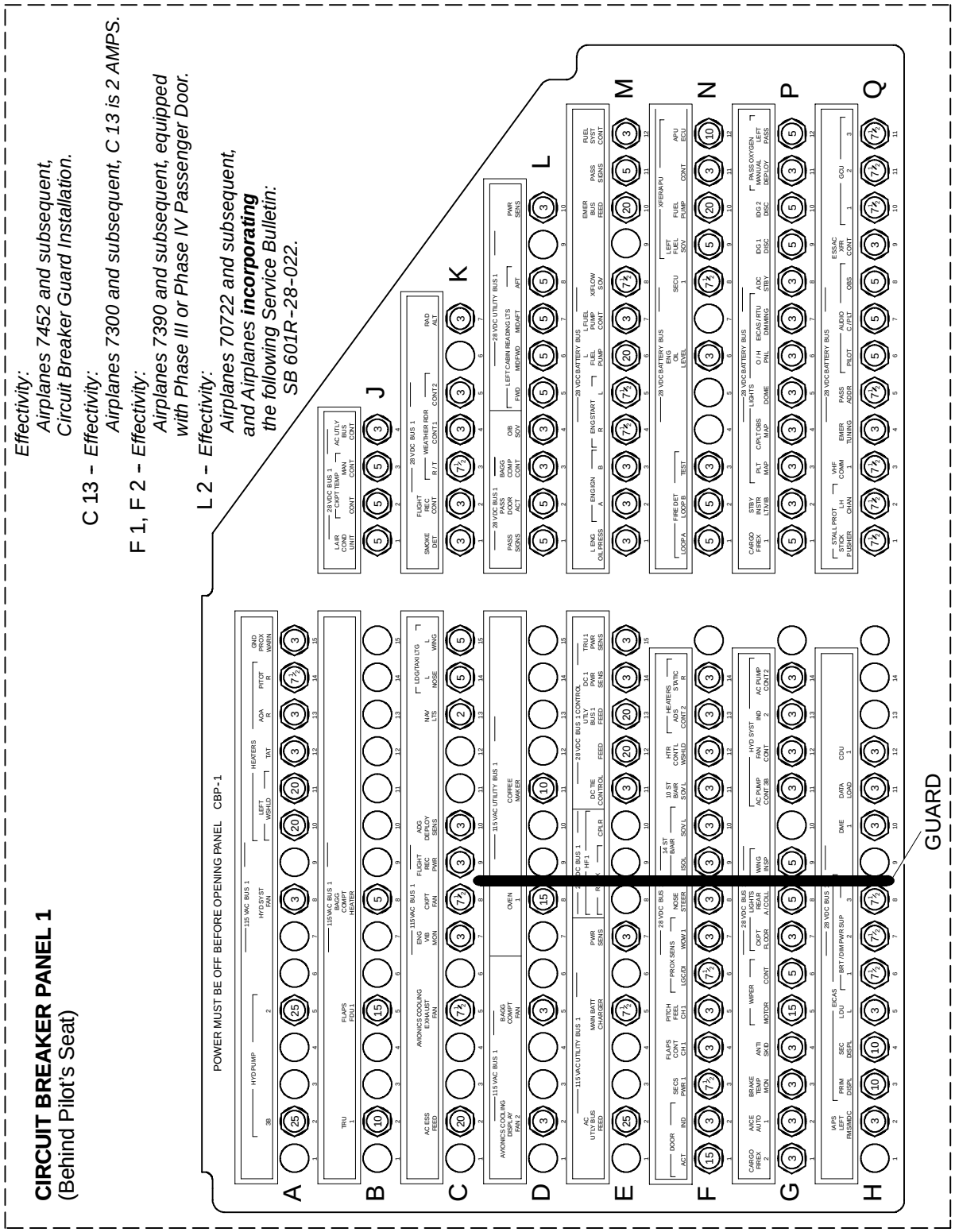
NOTE

For single HF installation <0011>, circuit breakers E-8 to E-10 are deactivated (collared) and labeled as inoperative.

<0008> - M 9
<0010> - H 9
<0011> - E 8, E 9, E 10
<0014> - M 9
<0027> - H 13
<0031> - H 1
<0047> - H 13
<0055> - G 10
<0060> - E 8, E 9, E 10



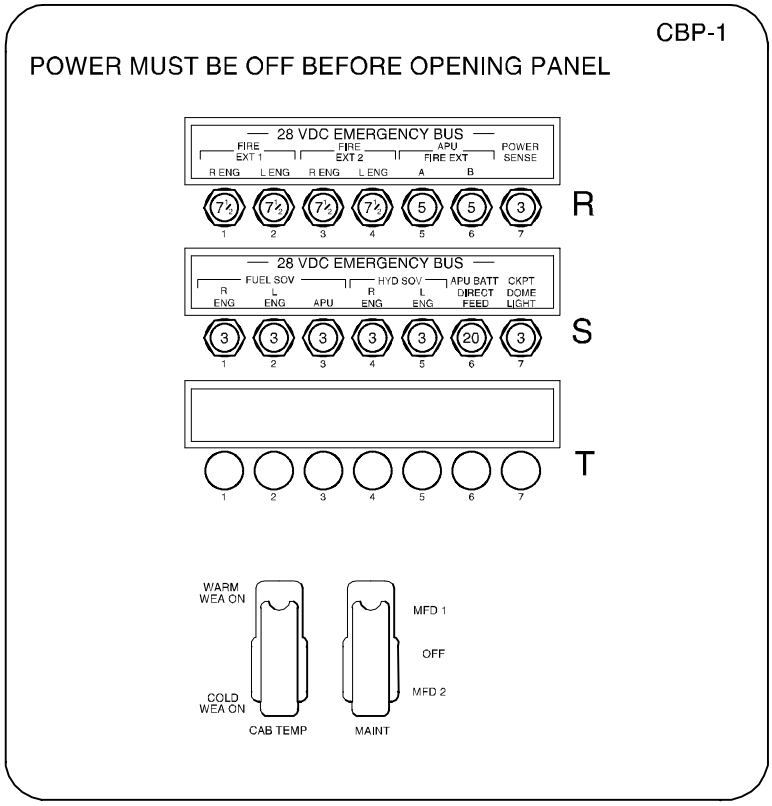
Circuit Breaker Panel 1 <MST>
Figure 07–40–1 Sheet 1



Circuit Breaker Panel 1 <7072 & subs, SB601R-28-022><7300 & subs><7390 & subs><7452 & subs>
Figure 07–40–1 Sheet 2

CIRCUIT BREAKER PANEL 1
(Sub-Panel)

Effectivity:
*Airplanes 7003 to 7067, 7069 and subsequent, **incorporating** the following Service Bulletin:*
SB 601R-21-039.



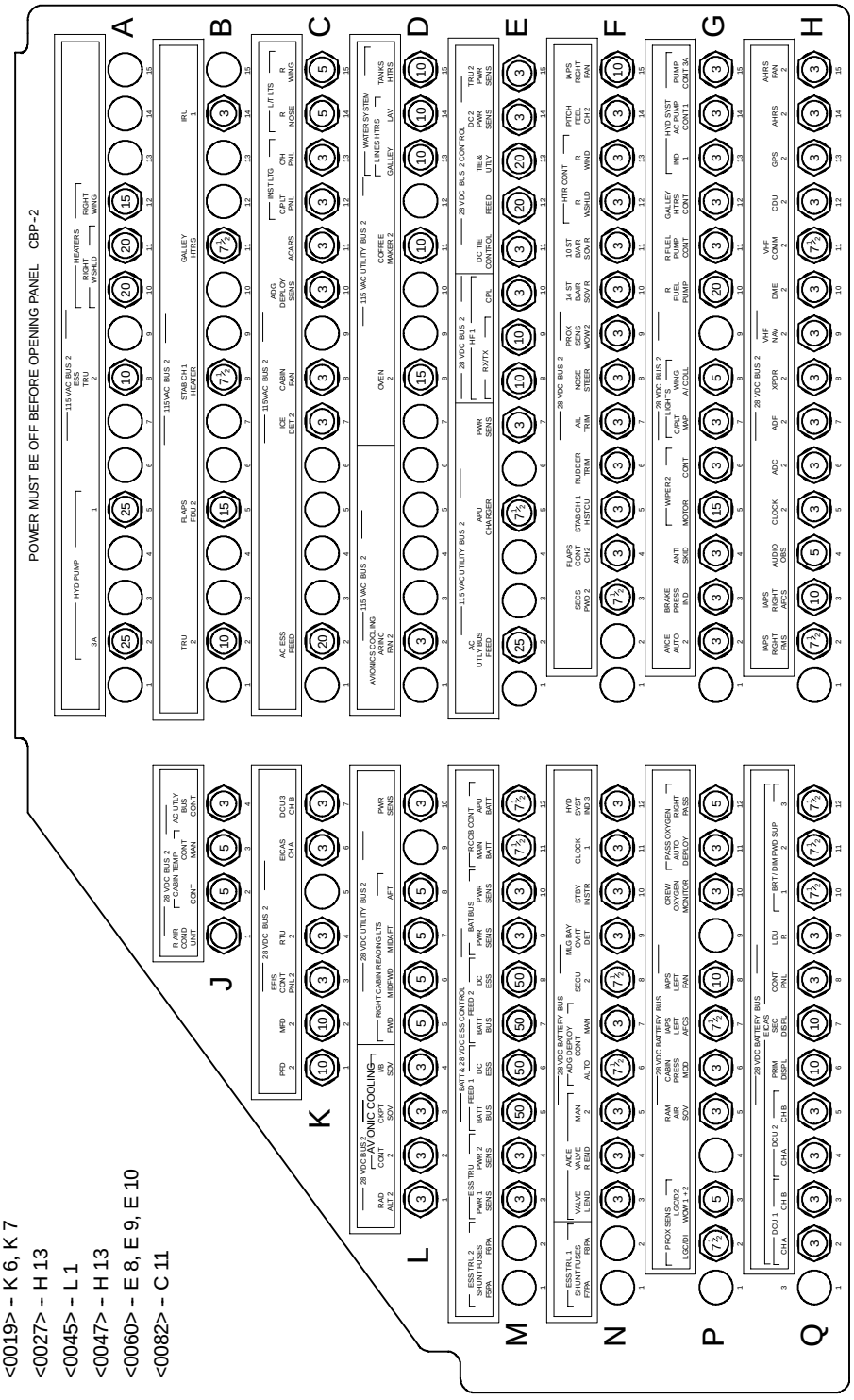
Circuit Breaker Panel 1 (Sub–Panel) <Aircraft 7003 to 7067, 7069 & subs,SB601R-21-039>
Figure 07–40–2

CIRCUIT BREAKER PANEL 2
(Behind Copilot's Seat)

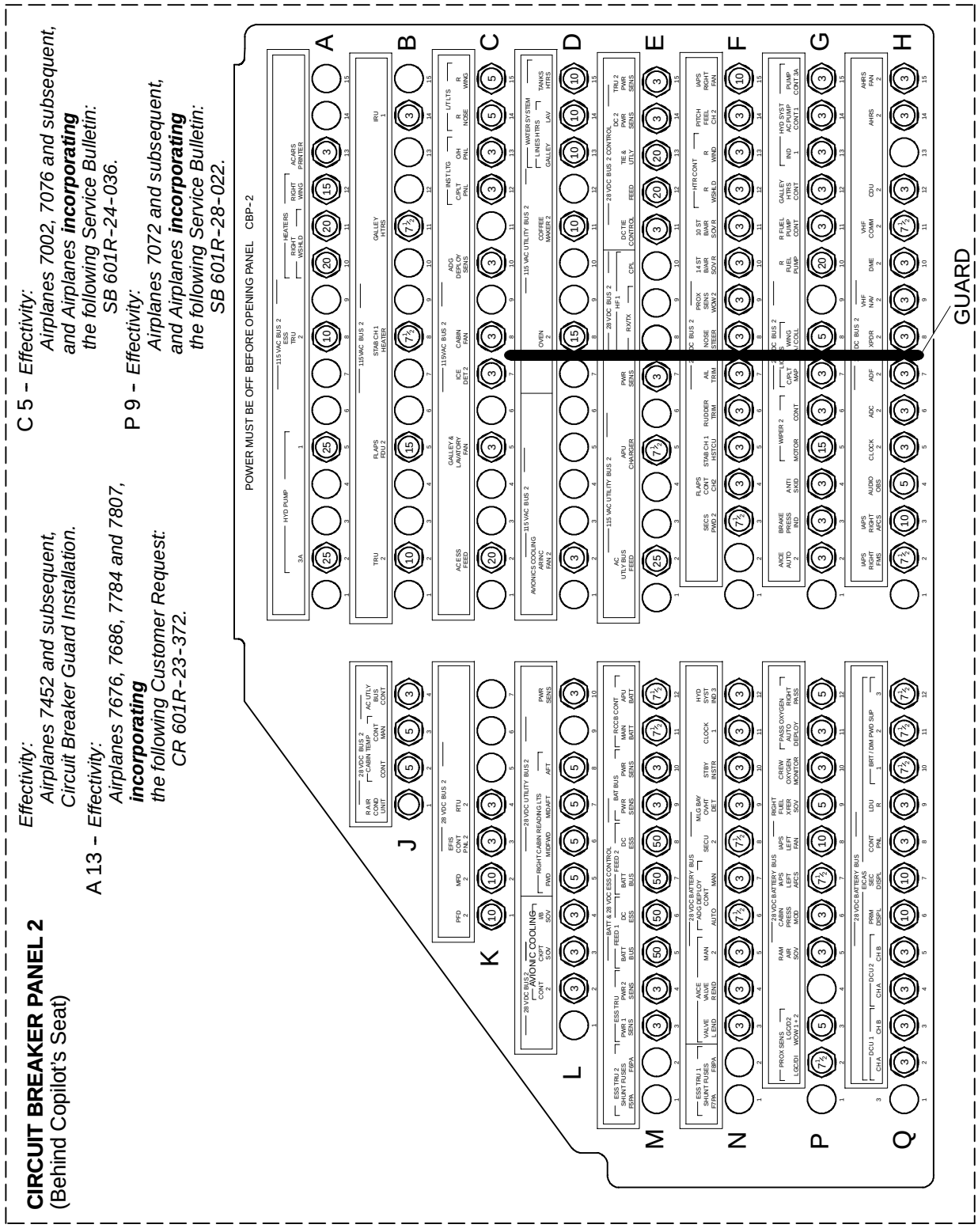
<0011> - E 8, E 9, E 10
<0019> - K 6, K 7
<0027> - H 13
<0045> - L 1
<0047> - H 13
<0060> - E 8, E 9, E 10
<0082> - C 11

NOTE

For single HF installation <0011>, circuit breakers E–8 to E–10 are deactivated (collared) and labeled as inoperative.



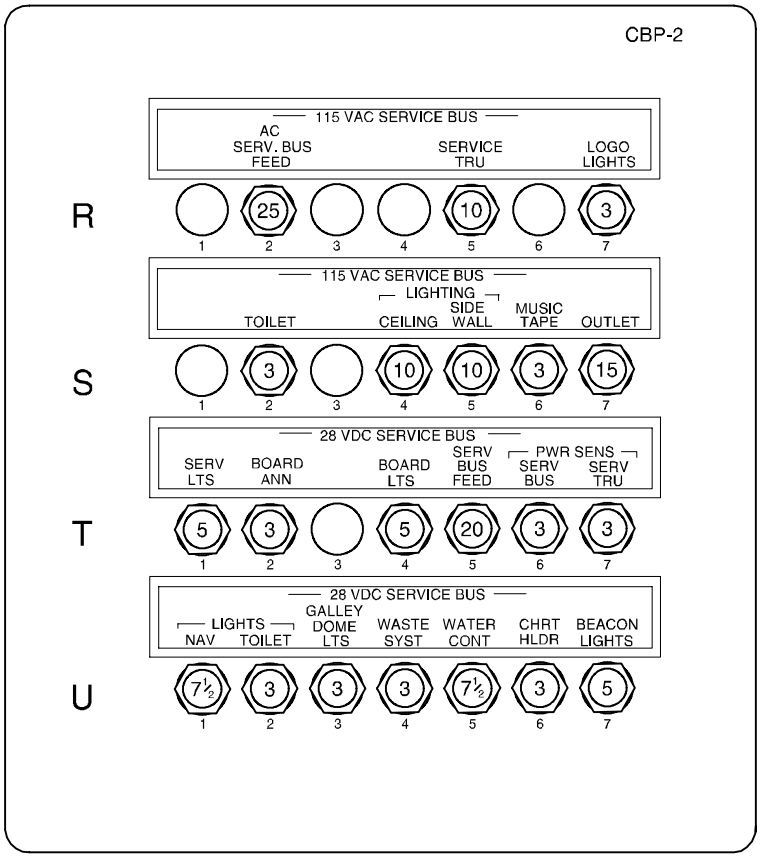
Circuit Breaker Panel 2 <MST>
Figure 07–40–3 Sheet 1



Circuit Breaker Panel 2 <7002, 7076 & subs, SB601R-24-036><7072 & subs, SB601R-28-022><7452 & subs><7676, 7686, 7784 and 7807>
Figure 07–40–3 Sheet 2

CIRCUIT BREAKER PANEL 2
(Sub–Panel)

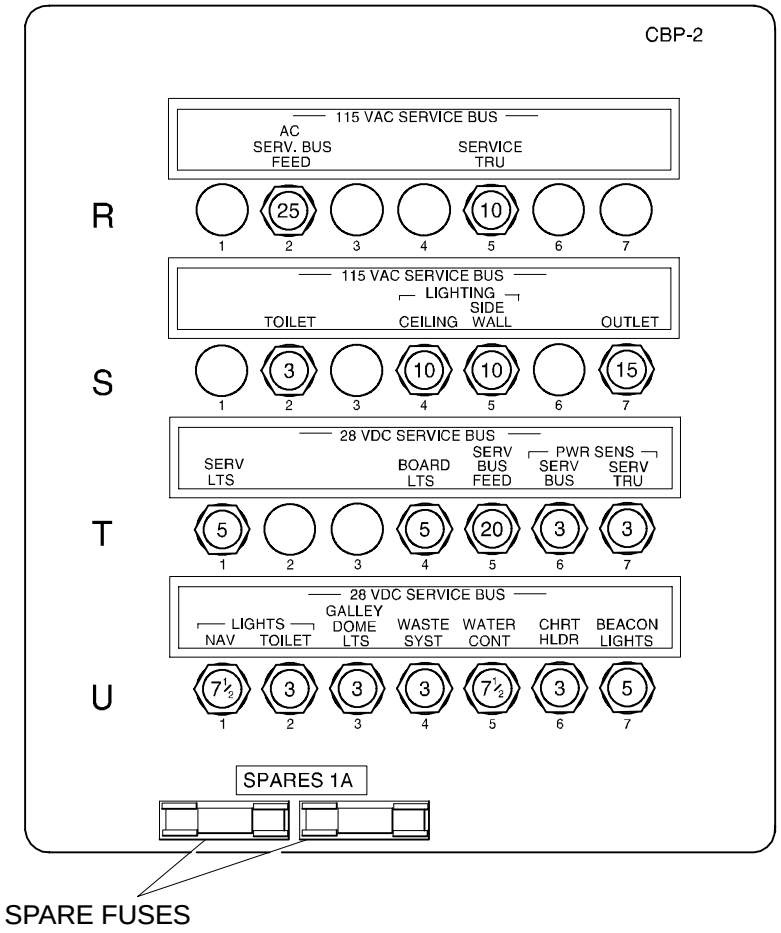
<0009> – S 6
<0020> – R 7
<0035> – T 2



Circuit Breaker Panel 2 (Sub–Panel) <MST>
Figure 07–40–4 Sheet 1

CIRCUIT BREAKER PANEL 2
(Sub-Panel)

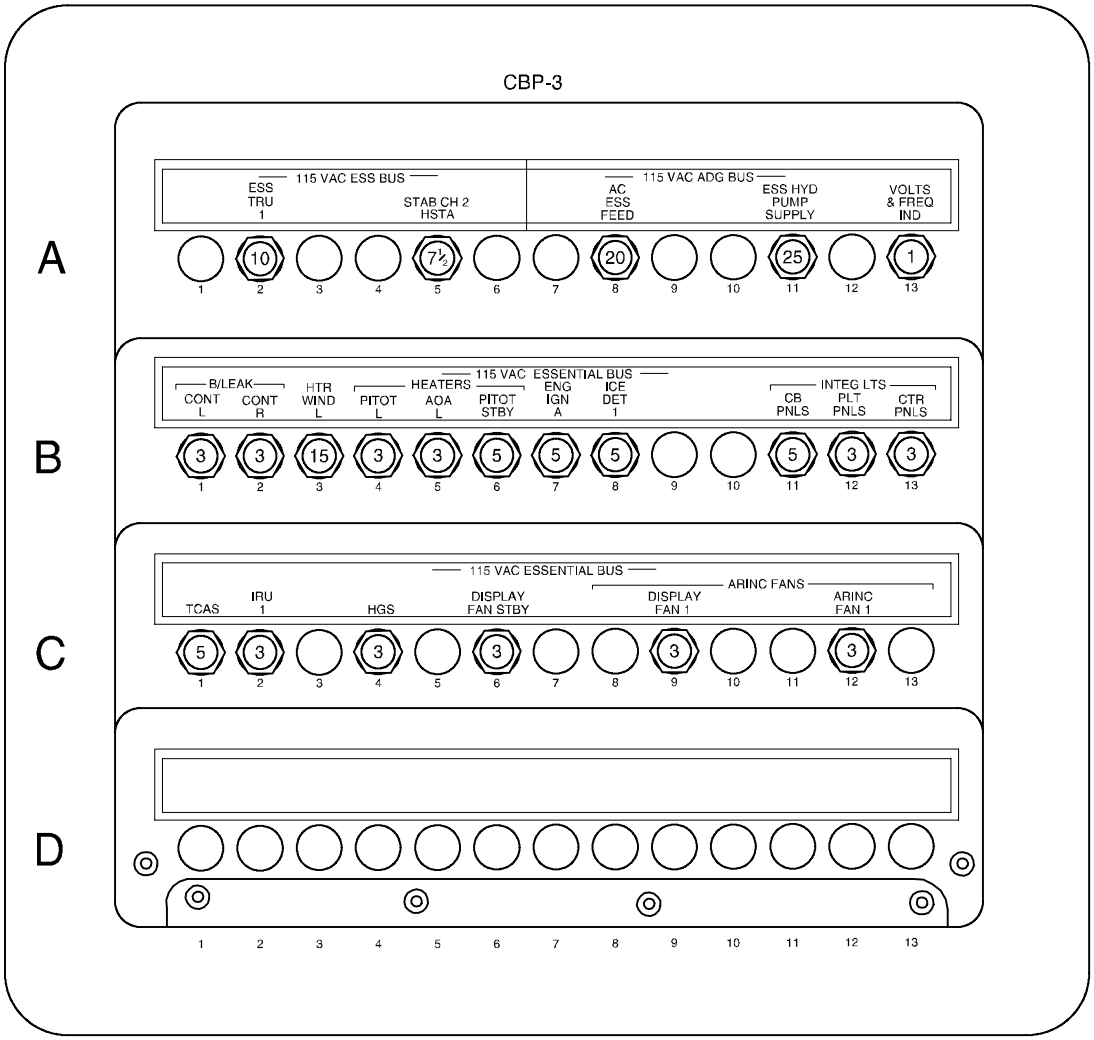
Effectivity:
Airplanes 7036 and subsequent, ***incorporating*** *the following Service Bulletin:*
SB 601R-24-017.



Circuit Breaker Panel 2 (Sub–Panel) <7036 & subs, SB601R-24-017>
Figure 07–40–4 Sheet 2

CIRCUIT BREAKER PANEL 3

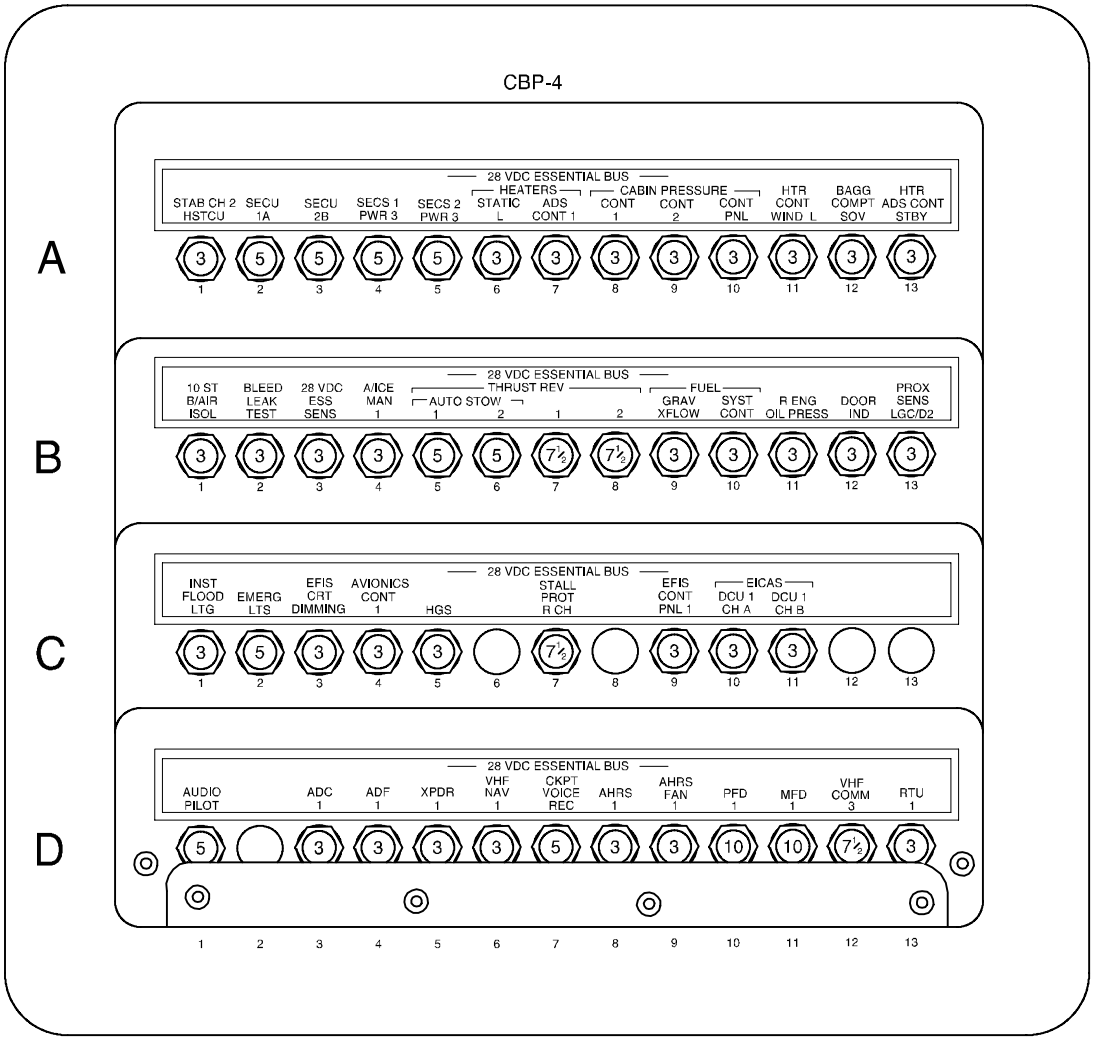
<0026> - C 4



Circuit Breaker Panel 3 <MST>
Figure 07-40-5

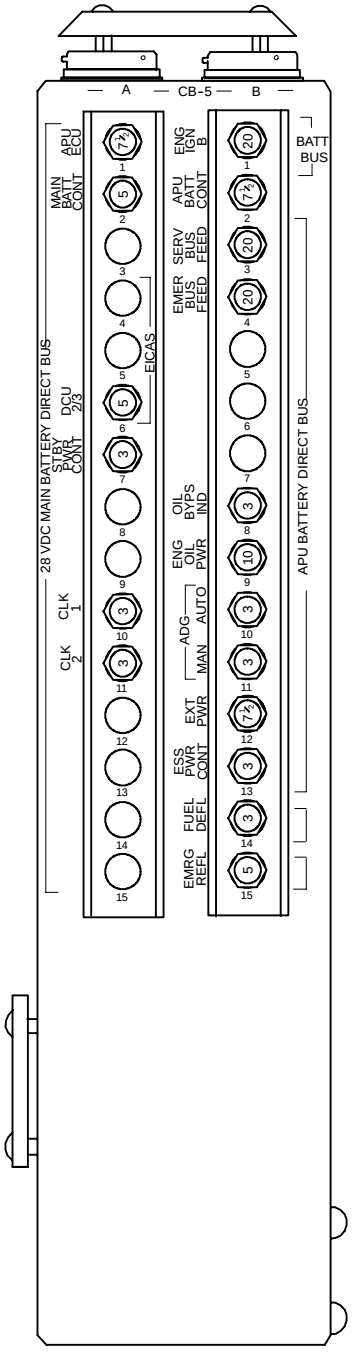
CIRCUIT BREAKER PANEL 4

<0008> - D 12
<0014> - D 12
<0026> - C 5
PRE <0026> - D 8, D 9



Circuit Breaker Panel 4 <MST>
Figure 07–40–6

CIRCUIT BREAKER PANEL 5
(AFT side of JB–5 in
AFT Compartment)



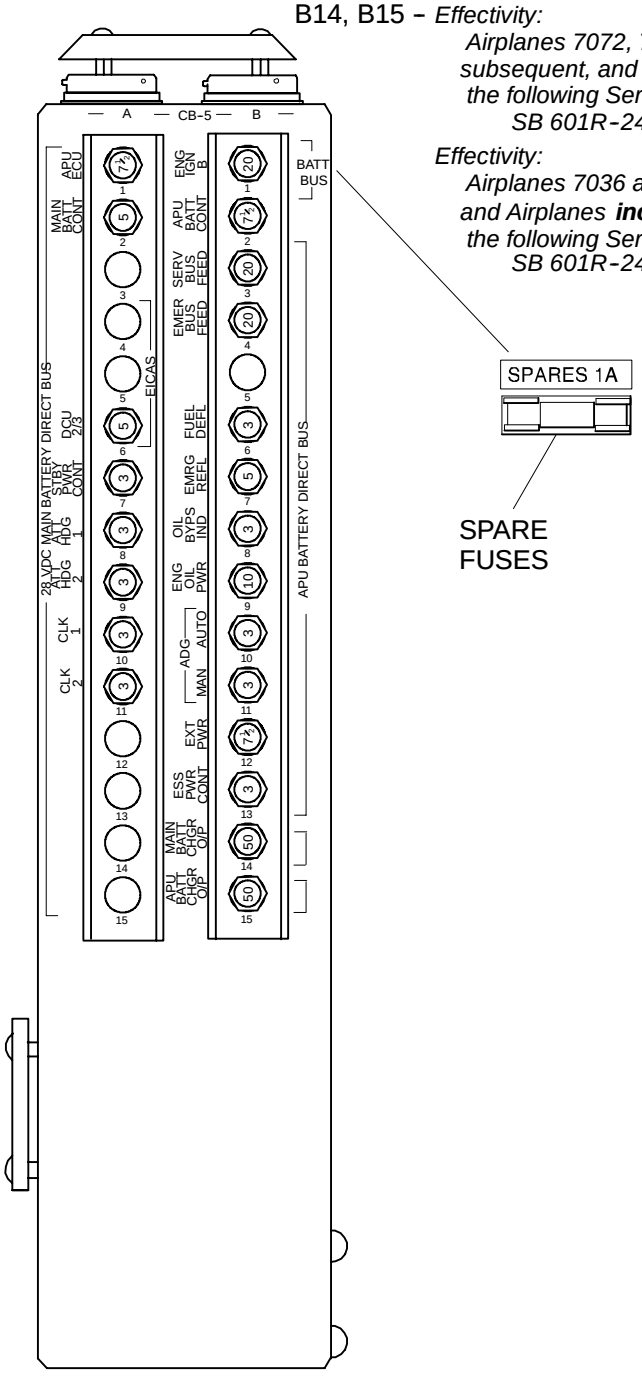
Circuit Breaker Panel 5
Figure 07–40–7 Sheet 1

CIRCUIT BREAKER PANEL 5
(AFT side of JB-5 in
AFT Compartment)

A 8, A 9 - *Effectivity:*
Airplanes 7002, 7068 and subsequent, ***incorporating*** *the following Service Bulletin:*
SB 601R-34-045.

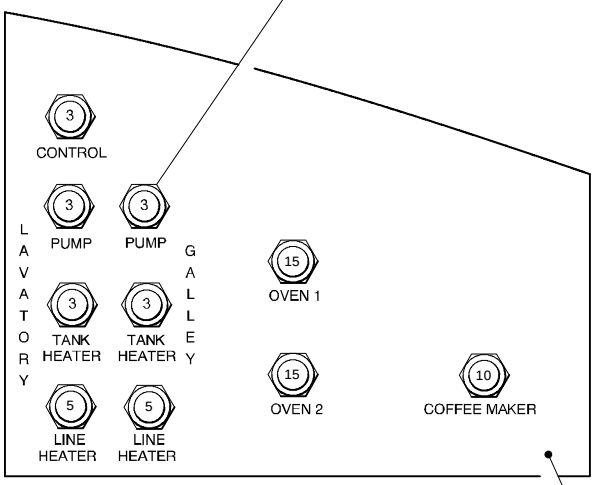
B 6, B 7
B14, B15 - *Effectivity:*
Airplanes 7072, 7068, 7295 and subsequent, and Airplanes ***incorporating*** *the following Service Bulletin:*
SB 601R-24-090.

Effectivity:
Airplanes 7036 and subsequent, and Airplanes ***incorporating*** *the following Service Bulletin:*
SB 601R-24-017.



Circuit Breaker Panel 5 <7072, 7068 & subs, SB601R-34-045><7072, 7068, 7295 & subs, SB601R-24-090><7036 & subs, SB601R-24-017>
Figure 07-40-7 Sheet 2

Water System Circuit Breakers
Used to protect the following:
- Control logic circuits.
- Galley and lavatory pumps.
- Galley and lavatory line heaters, waste valve, and drain mast heaters.



Water System Control Panel (1)
Galley Area

Galley System Circuit Breakers
Used to protect ovens and coffee maker.

Miscellaneous Panels
Figure 07–40–8

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