

The gear warning tone or the "LANDING GEAR" aural warning, if the aural system is installed, will sound any time the flaps are selected past the T.O. & APPR. position with the gear not down and locked. The warning cannot be silenced with the "Horn Silence" button when the airplane is in this configuration.

The flaps have an additional position called GROUND FLAPS (60°) which provides additional drag during the landing roll. Selection of the GROUND FLAPS (60°) position in flight is prohibited. If the flap handle is placed in the GROUND FLAPS position in flight the FLAPS >35° annunciator and MASTER CAUTION will illuminate after an eight-second delay. Even though the GROUND FLAPS position is prohibited from use in flight, it has been demonstrated that the airplane can be safely flown if that position should inadvertently be selected. If the GROUND FLAPS position is inadvertently selected during landing approach a high sink rate may be expected. In such a case, engine thrust should be increased and the flaps raised to a normal landing setting. On the ground selecting GROUND FLAPS also extends the speed brakes. If GROUND FLAPS deploy in flight, the speed brakes will deploy if the throttles are below 85% N<sub>2</sub> RPM and retract with the throttles above 85% N<sub>2</sub>. Avoid cycling the throttles above and below 85% N<sub>2</sub>, as the speed brakes will cycle.

## CONTROL LOCK

The control lock is mechanically operated and, when engaged, locks the ailerons, elevators and rudder in the neutral position and the throttles in the OFF position. The control lock handle, located below the instrument panel on the left side, controls the system. When the handle is pulled straight aft to the detent, the flight controls and throttles are locked. To release the control lock system, rotate the T-handle 45 degrees clockwise and push it in. With the control lock engaged, the maximum deflection of the nosewheel is restricted to 60 degrees either side of center. Exceeding this amount of turn will cause excessive force to be placed on the control lock mechanism and rudder control cables. Towing the airplane with the control lock engaged should be avoided. The controls should be neutralized before engaging the lock.

## ELECTRICAL

### GENERAL

Electrical power is normally supplied by two 29-volt direct current (DC), 300-ampere, engine-driven starter/generators. A 24-volt, 42-ampere hour (44 ampere-hour optional) battery is located in the tailcone compartment to supply power for starting and emergency requirements. A receptacle below the left engine pylon is provided for connection of an external power unit.

### DIRECT CURRENT (DC) POWER

The direct current (DC) power distribution system consists of the starter/generators, battery, indicators, switches and bus network. The DC buses supply power for all DC functions except engine starting. Normally, the left generator powers the left main DC bus and the right generator the right main DC bus. Both operate in parallel, but in the event either generator is off the line, the crossfeed bus acts as a cross tie so that the remaining generator will power both main DC buses. The crossfeed bus is protected at each end, where it connects to the left and right busses, by a 225 ampere fuse.

DC power to the avionics equipment is controlled by the AVIONIC POWER ON/OFF switch, which serves as an avionics master switch.

Each main DC bus is controlled by a power relay, so that loss of one complete bus, in a common type of failure, will require the failure of one relay and at least one of the 225 ampere bus connecting fuses. This arrangement also protects the opposite bus, in the unlikely case of a bus-to-ground failure. The circuit breakers in Figure 2-16 are color coded to indicate the equipment items powered by each main bus.

An emergency DC bus powers those items of equipment which are required in an emergency. Placing the DC POWER switch to EMER will enable this equipment to be powered by the battery. The hot battery bus, which allows power to some items at all times when the battery is installed, completes the bus system.

## GENERATORS

A generator control unit provides starter regulation, overvoltage, feeder fault and ground fault protection for each generator. Three-position L and R generator switches are marked GEN, OFF and RESET. In the GEN position, generator control is automatic for regulation, protection and load bus connection. This is the normal switch position for battery starting and all flight modes. Placing the switch to OFF isolates the generator from its load bus. The momentary RESET position resets a generator that has been tripped as a result of an overvoltage, feeder fault or engine fire switch actuation.

Each starter/generator is capable of a 50 percent overload (450 amps) for two minutes. A single generator is normally capable of supporting the entire electrical system, however if usage of electrical equipment is especially high it may be advisable to reduce the electrical load. For ground operations, generators are limited to 250 amps.

## BATTERY

The battery is a secondary source of direct current (DC) power available to supply the distribution system prior to start, during battery starts, or in the event of dual generator failure. The three-position control switch is labeled BATT, OFF and EMER. Placing the switch to the BATT position closes the battery and emergency relays and powers the battery bus, emergency bus and both main DC buses. This position also enables external power to supply the entire system. In the OFF position, battery or external power is isolated from all but the hot battery bus. A battery disconnect (NORMAL/DISC) switch is located on the left side of the cockpit above the pilot's armrest; it is used to remove battery power from the system in case of a failed starter contactor or other malfunction. The battery disconnect switch should not be left in the DISC position for an extended period of time, since it draws current from the battery to hold the battery disconnect relay in the disconnect position, and will therefore eventually discharge the battery. If it becomes necessary to use the DISC position in flight, refer to the Airplane Maintenance Manual for proper maintenance procedures, as damage to the battery may have occurred. The battery disconnect relay, between the battery and ground, is located under the forward side of the battery installation.

The hot battery bus is energized any time the battery is installed, the battery disconnect switch is in NORMAL, and/or external power is connected. The hot battery bus powers the emergency exit lights, tailcone light, nose baggage compartment light, an aft compartment light, an aft baggage light, the wing anti-ice overtemperature sensors and the wing anti-ice valves.

During each engine start using external power, the battery disconnect relay will automatically open interrupting battery power to the hot battery bus. The relay will close automatically at the end of the start cycle.

The EMER (emergency) position of the battery switch will provide at least 30 minutes operation for selected instruments and systems. The following are powered from the emergency bus:

COMM 1	Standby Altimeter/Airspeed (Vibrator)
NAV 1	Standby Gyro (internal battery)
Overhead Flood Lights	Standby HSI (Copilot's AHRS)
Pilot's and Copilot's Audio Panels	Standby Engine N <sub>1</sub> Indicator
Voltmeter	Landing Gear Monitor
Flap Control	Landing Gear Control
RH Pitot Static Heater	

A battery temperature sensor system continuously monitors the battery temperature. A battery temperature exceeding 63°C (145°F) is annunciated by a steady illumination of the red BATT O'TEMP light on the annunciator panel as well as flashing illumination of the MASTER WARNING. If the aural warning system is installed a voice announcement of "BATTERY OVER TEMP" will be heard. A battery temperature exceeding 71°C (160°F) is shown by a flashing BATT O'TEMP and >160° annunciator lights, a more rapid voice announcement of "battery over temp" (if the aural warning system is installed), and a flashing MASTER WARNING.

The battery must be serviced per the Maintenance Manual when the battery temperature exceeds 63°C (145°F).

### EXTERNAL POWER

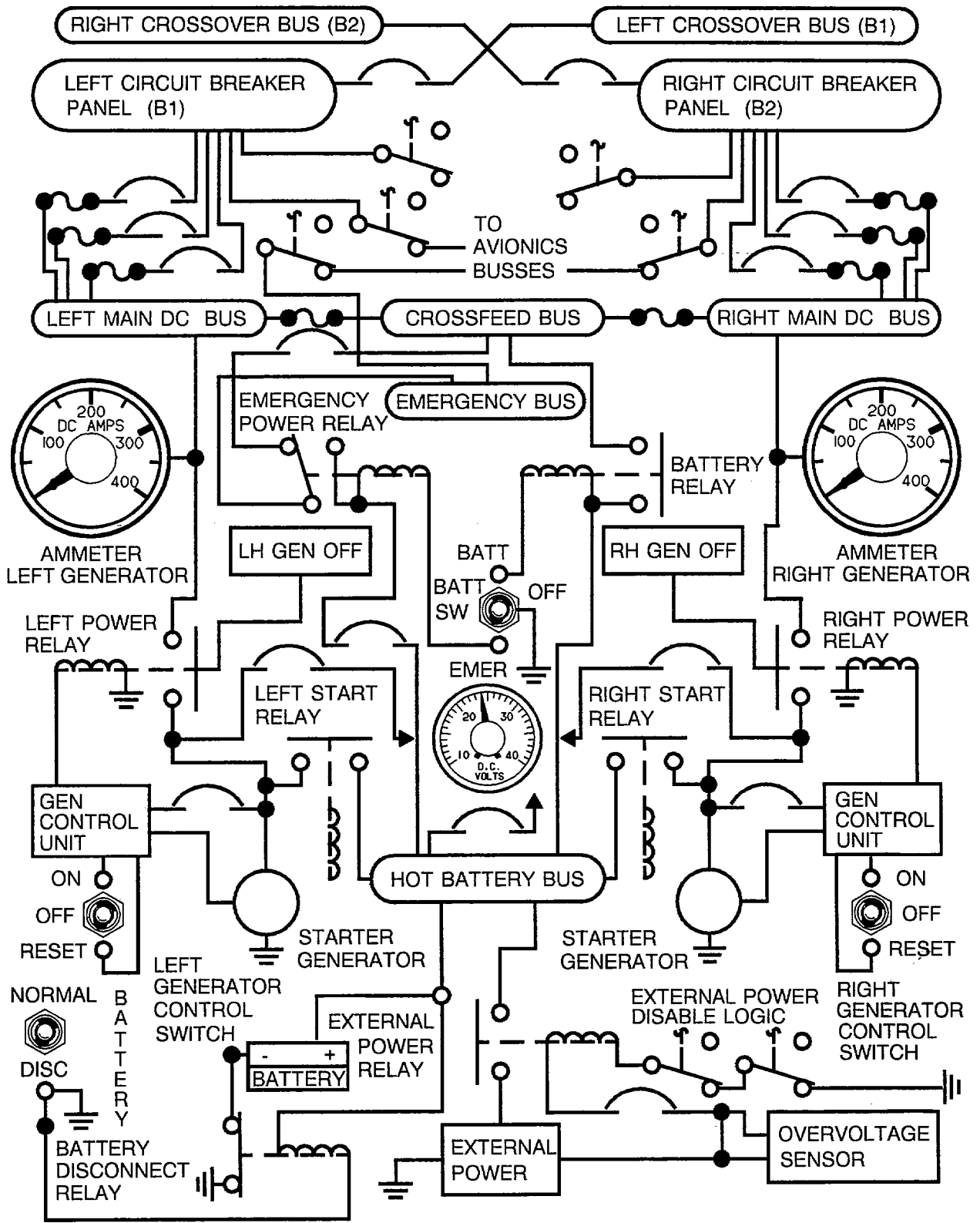
External 28-volt direct current (DC) power can be connected to the airplane through a receptacle located on the aft tailcone behind the baggage door. When external power is connected, the external power relay energizes and connects the power source to the hot battery bus. Positioning the battery switch to BATT energizes the battery and emergency relays allowing external power to be connected to the entire DC system. The battery should be disconnected if the airplane is to be left unattended on external power, to avoid the possibility of thermal damage to the battery. Access to the quick disconnect for the battery is through an access door in the aft wall of the baggage compartment. Most external power units are not monitored and should not be used to charge the battery. The external power unit voltage should be 28 to 29 volts and it should have a capacity of 800 to 1100 amperes if it is being used to start engines.

### DIRECT CURRENT (DC) POWER INDICATORS

The indicators consist of two ammeters, a voltmeter and two amber generator failure lights (GEN OFF, L and R). The ammeters function as loadmeters indicating the load being carried by each generator.

The voltmeter is wired through the battery switch and will indicate the voltage of the hot battery bus any time the battery switch is in the BATT or EMER position. The voltmeter selector switch can be rotated to the L or R GEN positions to check generator voltage output. Since the voltmeter reads the highest voltage on the bus, an accurate check of one generator is obtained only with the opposite generator off the line.

Should either generator fail, the associated power relay will open, removing the generator from the system and illuminating the appropriate L or R GEN OFF amber annunciator panel light and the MASTER CAUTION light, and causing a voice announcement of "GENERATOR FAILURE". Should both generators fail, the MASTER WARNING light will also illuminate. This is the only condition under which amber annunciator light illumination will trigger the master warning.



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Figure 2-15. Direct Current Electrical System Schematic

## EMERGENCY BATTERY

Placing the battery switch in the EMER position opens the battery relay. The emergency relay will energize closed. This disconnects the main direct current (DC) busses and the crossfeed bus from the battery and connects the battery directly to the emergency bus. With both generators off, all electrical equipment will be inoperative except COMM 1, NAV 1, standby HSI, pilot's and copilot's audio panels, copilot's AHRS, right pitot-static heater, standby altimeter/airspeed (vibrator), standby  $N_1$  indicator, flap control, landing gear monitor, landing gear control, standby gyro (internal battery) and overhead flood lights. The standby gyro will still be operational from its own system battery.

Switching to EMER with either or both generators on the line will have no effect on the electrical equipment except that the battery will not charge. Placing the battery switch to OFF with either or both generators on the line will not result in loss of power to the emergency bus, since the emergency power relay remains de-energized as long as generator power is available.

## ENGINE STARTING

Depressing either engine start button closes the respective start relay and provides DC power to the engine starter. Power to close the solenoid start relays and energize ignition comes from the battery bus, requiring the battery switch to be in the BATT position. When the throttles are advanced out of the cutoff position automatic ignition sequencing takes place when the engine ignition switches are in the NORM position.

A white light in each starter button indicates power on the contacts of the respective start relay. The starter operation is terminated when the speed sensor in the generator control unit removes power from the start relay, engine igniters and the start button light (approximately 45 percent  $N_2$  RPM). The automatic start sequence can be terminated at any time by pushing the cockpit starter disengage button, located between the start buttons, which will open the start relay and halt the start sequence. During engine start, when the generator output exceeds battery voltage and/or is in parallel with the other generator (within 40 amperes), the starter/generator reverts to generator operation. The power relay closes and supplies power to the respective DC bus. Current will then flow from either main DC bus through the battery bus, battery relay and hot battery bus, providing battery charging.

The airplane is equipped with a cross start capability which utilizes the generator of an operating engine to assist starting the second. This is accomplished by both start relays closing when the second start is initiated, routing power through the hot battery bus to the other engine. On all cross starts, the operating engine should be set at idle RPM. Cross generator start capability is disabled with weight off the left main gear squat switch, in order to prevent cross starts in flight. A generator assisted cross start in flight would result in a significant voltage drop during the start, which would interrupt and possibly damage avionics equipment.

Starts being made on external power may be accomplished with the generator switches in either the GEN or OFF position; however, it is recommended that they be turned OFF during the start. If the generator switch is placed in the GEN position the generator control unit will automatically initiate the generator mode after engine start, disconnecting the external power, and the second start will be generator assisted. If the generator switch is placed in the OFF position, the generator mode will be initiated by manually placing the generator switch to the GEN position. External power is automatically disconnected when either generator is supplying power to the bus.

### **CAUTION**

- ABOVE 8000 FEET MSL FIELD ELEVATION BATTERY STARTS ARE PROHIBITED.
- CURRENT IN EXCESS OF 1000 AMPERES MAY DAMAGE THE STARTERS

### **NOTE**

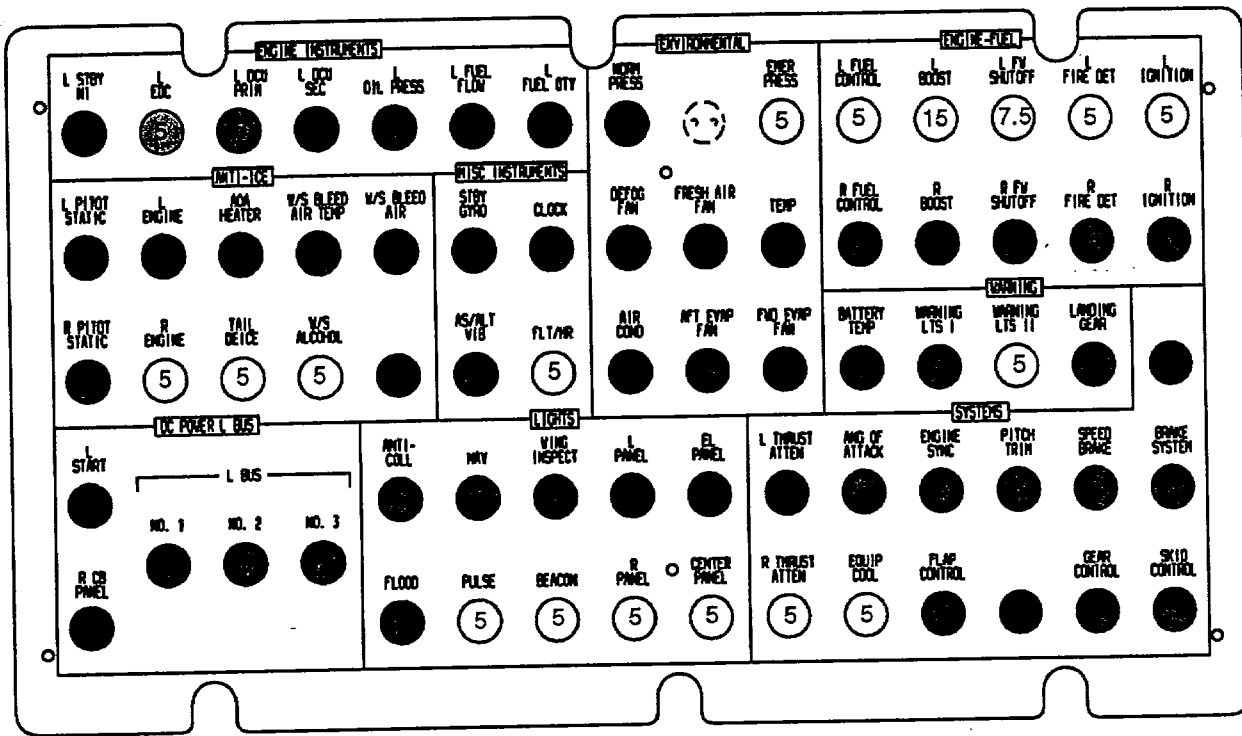
A 28 volt DC ground power cart of from 800 to 1000 amperes capacity is required for engine starting from an external power source.

If a high current capacity ground power unit with a variable maximum current limiter is used, the ground power unit current limiter should be set to 1100 amperes for start. Under some conditions, the starter may draw slightly more than 1000 amperes for a few seconds. This short duration will not harm the starter, but may cause the ground power unit to trip off line during the start, if the limiter is set to 1000 amperes or less.

An overvoltage protection system is provided during use of an auxiliary power unit. The control unit monitors the external power unit voltage and will deenergize the external power relay if the voltage is above 32.5 volts. During an engine start using the external power unit, a voltage signal is applied to the control unit. If the signal should exceed 32.5 volts the control unit will deenergize the external power relay and terminate the start. External power cannot be reapplied to the airplane until the voltage has been interrupted after the start termination. Reducing voltage to below 32.5 volts will not result in power being reapplied.

For battery starts and under all normal flight conditions, the generators are left in the GEN position.

A13498



LEFT CIRCUIT BREAKER PANEL (TYPICAL)

9912T595-3







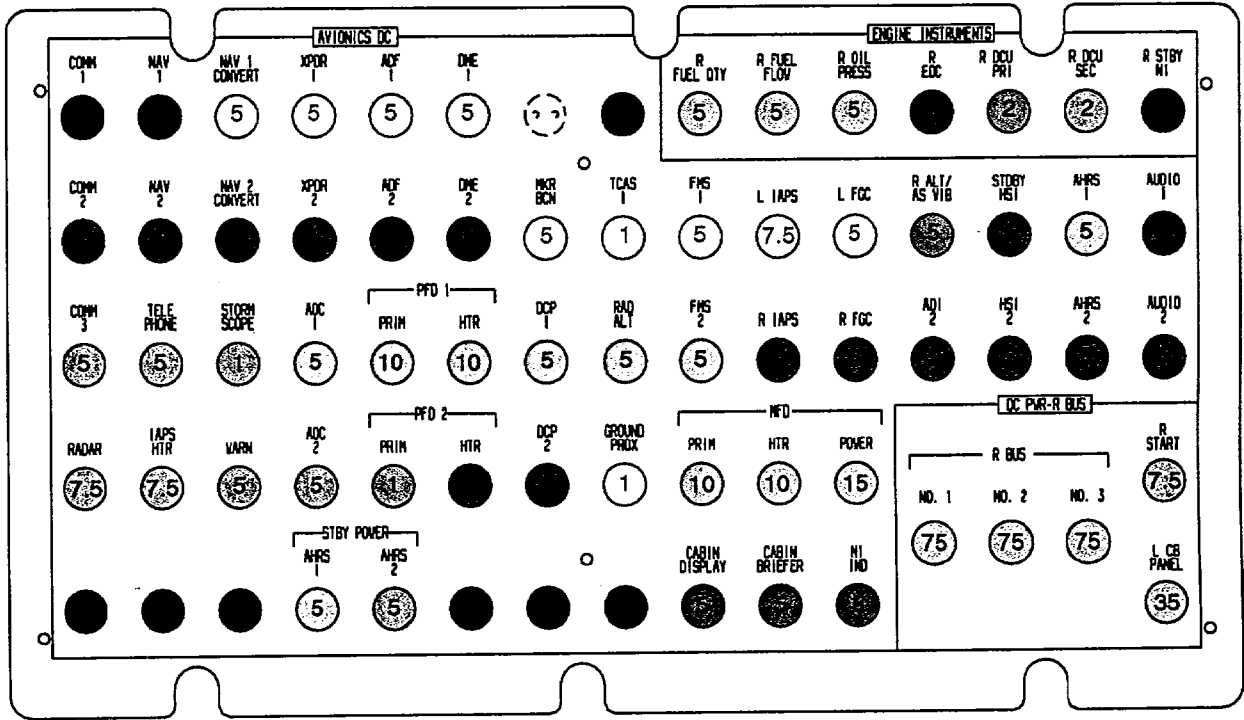
-  PLUG BUTTON
-  LEFT MAIN DC BUS
-  RIGHT MAIN DC BUS
-  EMERGENCY BUS
-  AVIONICS BUS NO. 1
-  AVIONICS BUS NO. 3

Figure 2-16 Circuit Breaker Panels (Sheet 1 of 2)

A13499



RIGHT CIRCUIT BREAKER PANEL (TYPICAL)

9912T596-4









-  EMERGENCY DC BUS-EMERGENCY RELAY
-  DC BUS #1-AVIONICS BUS NO. 1
-  DC BUS #2-AVIONICS BUS NO. 2
-  DC BUS #1-AVIONICS BUS NO. 3
-  DC BUS #2-AVIONICS BUS NO. 4
-  DC BUS #2A
-  HOT BATTERY (VIA STANDBY GYRO SWITCH)
-  PLUG BUTTON

Figure 2-16 Circuit Breaker Panels (Sheet 2)