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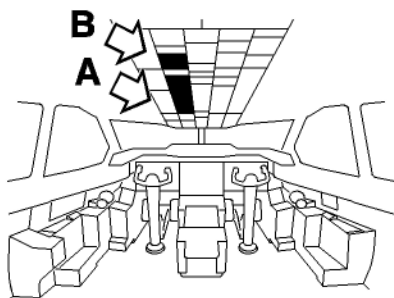
AC AND DC STAND-BY POWER

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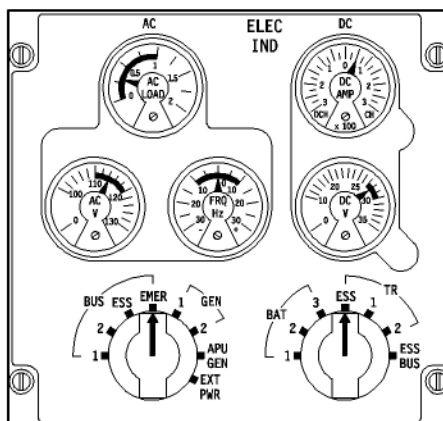
EMERGENCY AC AND DC POWER SUPPLY

OPERATIONAL DESCRIPTION

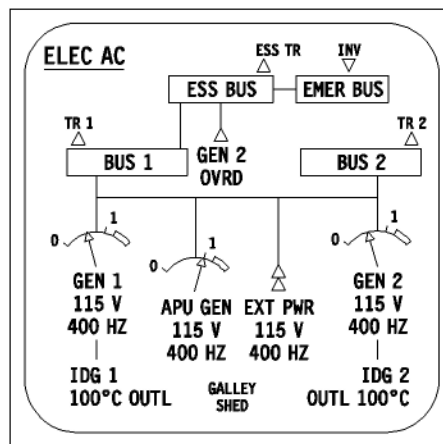
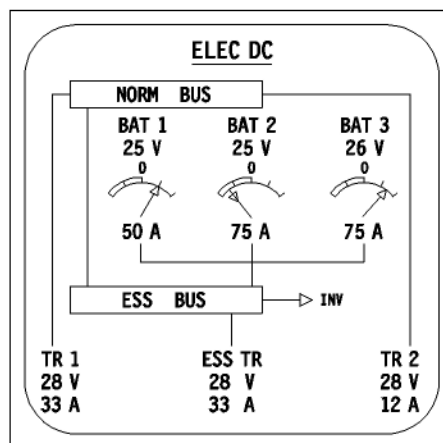
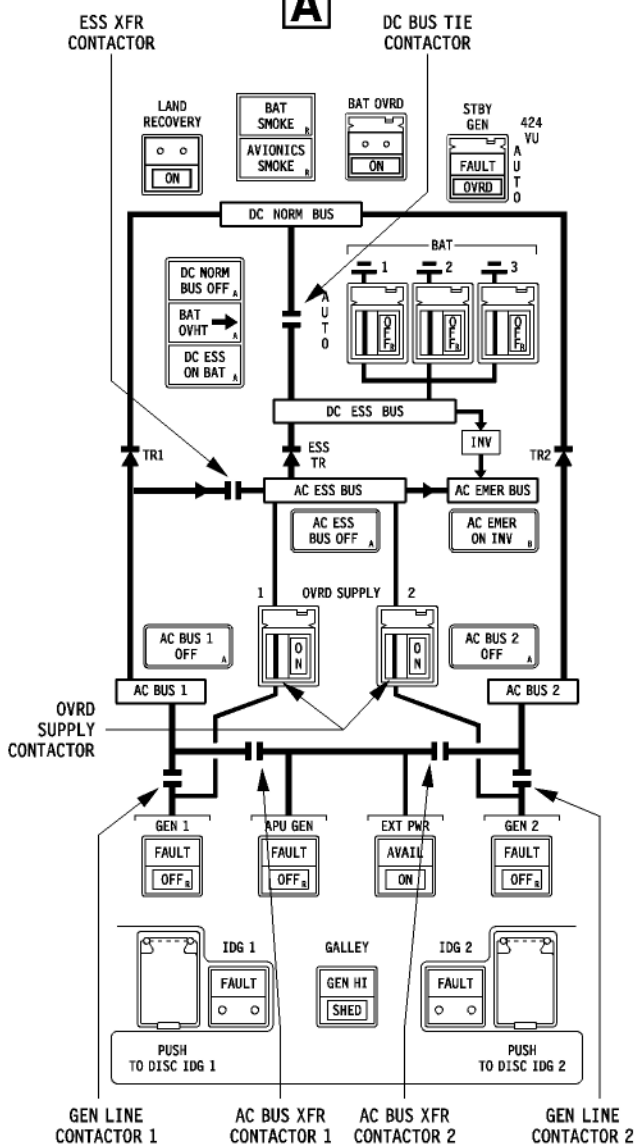
MAIN SYSTEM CONTROLS AND DISPLAYS



B



A



Electrical System**General Information,
Operational Description****GENERAL (Refer to PULL-OUT PAGE)****AC electrical system**

- The AC electrical system is normally powered by two engine driven generators.
- There are four AC bus:
 - AC BUS 1 and 2,
 - AC ESS BUS,
 - AC EMER BUS.
- The AC electrical system can also be powered by the APU generator on the ground and in-flight, or by external power on the ground.
- The AC EMER BUS can be supplied by the batteries via a static inverter under abnormal conditions.

DC electrical system

- The DC electrical system is normally powered by the AC electrical system through three identical Transformer Rectifiers (TR).
- There are two DC buses :
 - DC NORM BUS,
 - DC ESS BUS.
- The DC ESS BUS is powered either by the batteries or by the AC ESS BUS through an ESSential Transformer Rectifier.

Emergency electrical power

- Emergency power can be achieved by an AC / DC Stand by Generator which supplies:
 - the DC ESS BUS,
 - a part of the AC ESS BUS,
 - the AC EMER BUS.

Controls

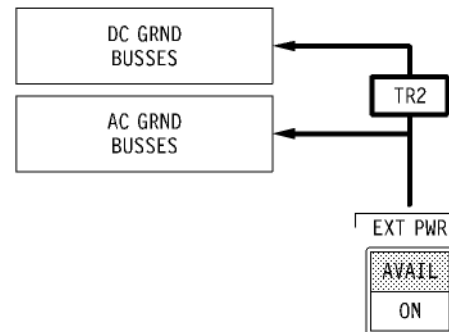
- All controls, lights and indicators are located on the overhead panel, except Maintenance check switches which are located on the Maintenance panel.

Electrical System
**External Power,
Operational Description**
GENERAL

- An external power receptacle, located aft of the nose gear, allows connection of a 3-phase 115/200 V 400 Hz Ground Power Unit.
- The Ground Power Control Unit (GPCU) automatically opens the external power line contactor in case of:
 - Overvoltage or undervoltage,
 - Overfrequency or underfrequency,
 - Missing phase or out-of-phase.
- When both the APU GEN and EXT PWR are available at the same time, EXT PWR has priority to supply the aircraft.
- GEN 1 and GEN 2 have priority over the APU GEN and EXT PWR to supply the aircraft.

EXTERNAL POWER SUPPLY OF GROUND BUSES

- On ground, when only ground services are required, the AC and DC GRND busses can be supplied directly from the external power source without supplying any of the other AC or DC busses.



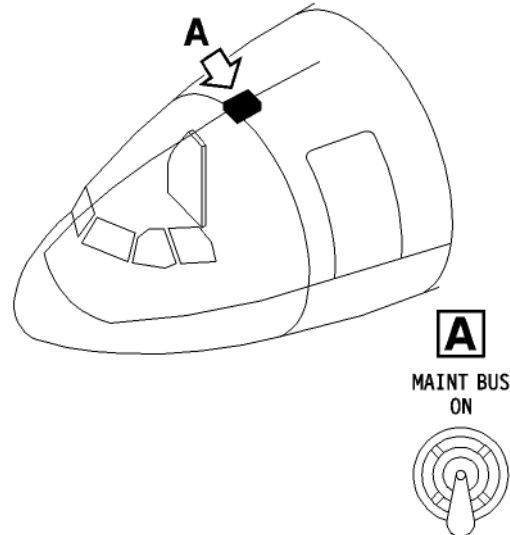
- This configuration is selected through the MAINT BUS switch.
- This switch allows power to be supplied only to the AC and DC GRND BUSES by simply connecting a Ground Power Unit to the aircraft's external power receptacle.

Note : The cockpit EXT PWR pushbutton switch does not need to be selected ON to do this, so no access to the cockpit is needed for this operation.

Electrical System
**External Power,
Controls and Indicators**
EXT PWR PUSHBUTTON SWITCH


- When a Ground Power Unit is connected to the aircraft, this pushbutton switch controls its connection to the aircraft electrical system.
- **AVAIL**
 - The AVAIL light illuminates green when:
 - External AC Ground Power Unit is plugged in,
 - Ground Power Unit EXT PWR parameters are within limits,
 - The external power line contactor is open.
- **Pressed and released**
 - If the green AVAIL light was illuminated (External power plugged-in but not on line) :
 - If the Ground Power Unit's electrical parameters are normal, the external power line contactor closes.

This connects the EXT PWR to the AC BUS 1 and AC BUS 2.
 - The ON light illuminates blue and the green AVAIL light extinguishes.
 - If the blue EXT PWR ON light was illuminated (EXT PWR on line) :
 - The external power line contactor opens, disconnecting the Ground Power Unit from the aircraft electrical system.
 - The AVAIL light illuminates (assuming external power electrical parameters are normal) and the ON light extinguishes.

MAINT BUS Switch:


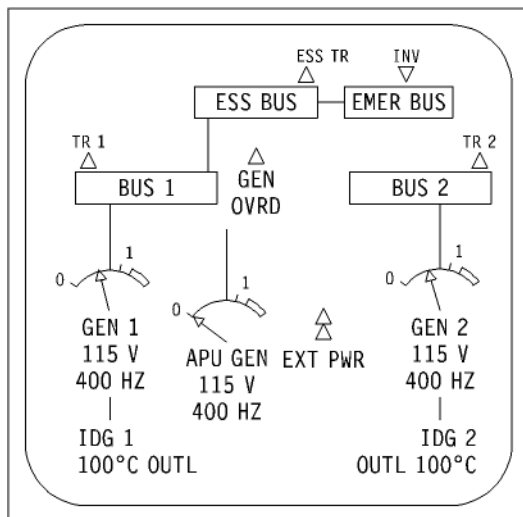
- When selected ON, the MAINT BUS toggle switch located on the FWD Cabin Circuit Brakers Panel (on the ceiling panel just aft of the cockpit door) routes the AC power directly from a Ground Power Unit to the AC GRND BUSses, and through TR2 to the DC GRND BUSses.
- **ON**
 - If the EXT PWR AVAIL light is illuminated, the toggle switch is magnetically latched ON.
 - Lighting, cargo doors operation, cargo loading and refueling systems are powered (as well as the AC/DC outlets in the cabin).
- **Off**
 - If the aircraft electrical system is not powered, the ground service busbars are not energized.

Electrical System

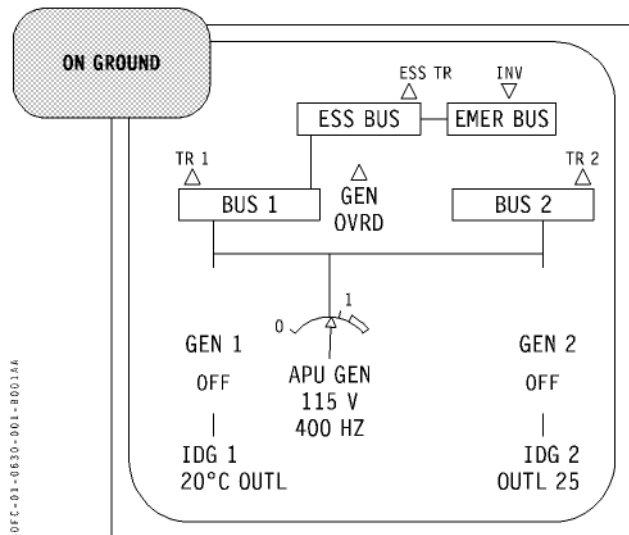
Normal AC Power, Operational Description

NORMAL AC POWER SUPPLY

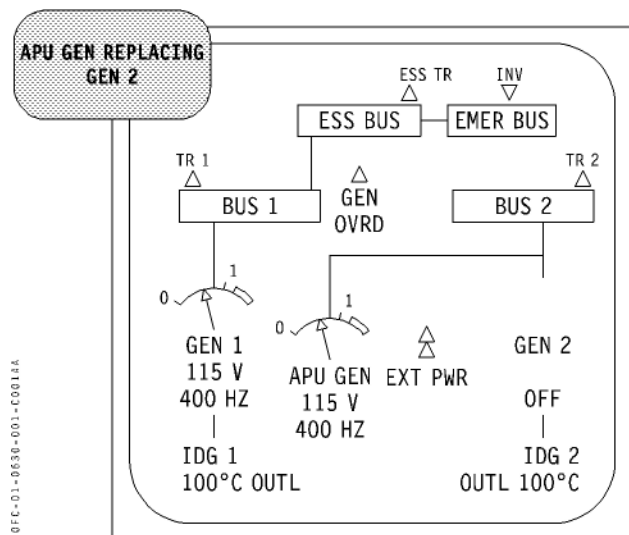
- Normal aircraft electrical power is supplied by two AC Generators, driven by the engines via a Constant Speed Drive unit (CSD).
- The combination of the engine Generator and of its Constant Speed Drive is actually a single unit called an Integrated Drive Generator (IDG).
- Under normal circumstances, each generator supplies its associated AC bus (IDG 1 supplies AC BUS 1, IDG 2 supplies AC BUS 2) :



- A third generator is driven by the Auxiliary Power Unit (APU).
 - APU GEN can be used on ground to supply the aircraft electrical network when engines are not running.



- APU GEN can also be used in flight to replace a failed engine GEN.



Electrical System
**Normal AC Power,
Operational Description**
AC POWER GENERATION
INTEGRATED DRIVE GENERATORS (IDG)

- The two Integrated-Drive Generators (IDG) convert the engine accessory gearbox variable speed into a constant rotation speed for the generators.
 - IDG oil temperature and pressure are monitored by ECAM.
- If an IDG fails, the IDG can be disconnected from the engine gearbox by pressing the corresponding guarded PUSH TO DISC IDG pushbutton switch, on the ELEC PWR overhead panel.
 - Once disconnected, an IDG can only be reset on the ground with the engine shut down.

GEN 1, GEN 2 AND APU GEN

- Either engine-driven generator and the APU-driven generator are AC generators rated at 90KVA, 115V and 400Hz.
- Anyone of the three generators is capable of supplying the electrical network for the entire aircraft electrical requirements, except the MAIN galley (See GALLEY description).
- One generator can supply both AC BUS 1 and 2, however AC BUS 1(2) can be supplied by only one GEN at a time.
- The generators cannot supply the same bus simultaneously, however if a generator is lost, power transfer is automatic.

GENERATOR CONTROL UNITS (GCU)

- Each generator is controlled by a dedicated Generator Control Unit (GCU), which :
 - regulates the generator's voltage, and
 - controls the generator connecting to or disconnecting from the AC electrical network, and
 - protects the generator and electrical network against the following fault conduction :

FAULT	GCU ACTION
Overvoltage Undervoltage Overfrequency Underfrequency	Generator is controlled off-line with automatic AC BUS transfer. (AC BUS XFR contactors close)
Differential faults: - on generator - on associated AC BUS	Generator is controlled off- line with automatic AC BUS transfer. (AC BUS XFR contactors close) Generator is controlled off- line. AC BUS XFR line not activated. (ACBUSXFR contactor does not close). Associated AC BUS is lost.
Incorrect phase sequence	Generator is controlled off-line with automatic AC BUS transfer. (AC BUS XFR contactors close)
Overcurrent	GEN HI light illuminates.

EXTERNAL POWER

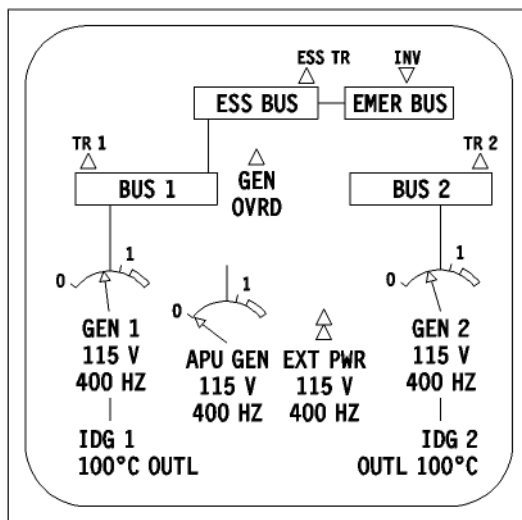
- An External Power unit can be connected aft of the nose landing gear.
- External power can supply the entire aircraft electrical network.

EMERGENCY INVERTER

- In case of loss of the AC ESS BUS, an Emergency Inverter (static inverter) converts the DC ESS BUS 28VDC power into a single-phase 115V/400Hz AC backup power to supply the AC EMER BUS.

Electrical System
**Normal AC Power,
Operational Description**
AC POWER DISTRIBUTION AND TRANSFER

- The aircraft AC electrical distribution network consists of four main busses:
 - AC BUS 1, normally supplied by GEN 1
 - AC BUS 2, normally supplied by GEN 2
 - AC ESS BUS, normally supplied by AC BUS 1, and
 - AC EMER BUS, normally supplied from AC ESS BUS

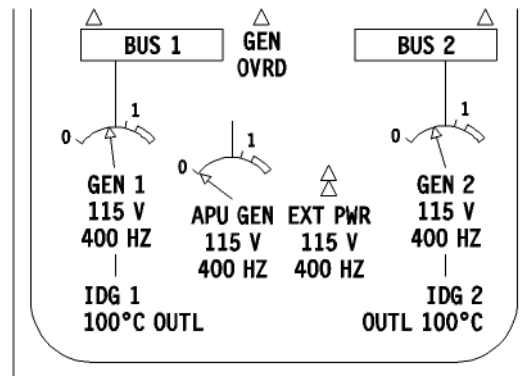


Note : Each of the four main AC Busses also has step-down transformers to provide 26 V AC power to sub-busses.

- If the normal power source for a bus is not available, automatic switching to an alternate power source occurs through the AC BUS XFR line.

AC BUS 1 and 2

- AC BUS's 1 and 2 are 3-phase busses, normally powered by their respective generator.



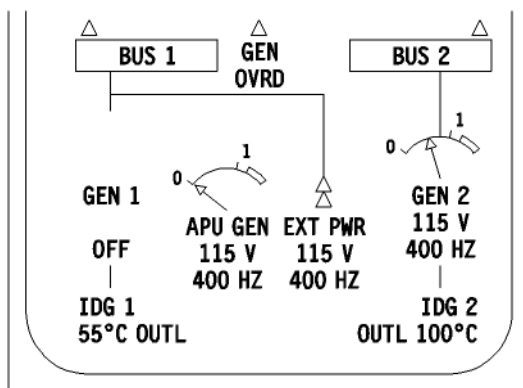
Electrical System

Normal AC Power, Operational Description

AC BUS transfer line - Power supply management

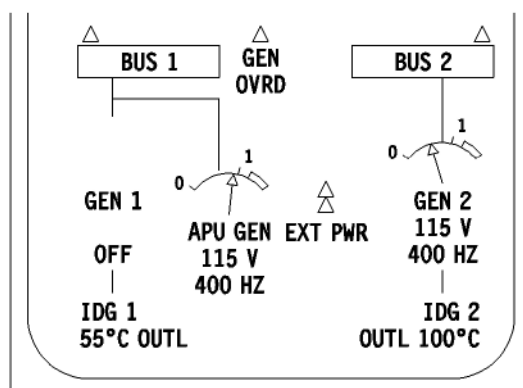
- If an Engine-Driven Generator is not available, the related AC BUS will be automatically switched to an alternate power supply source as follows:

- If EXT PWR is available (On ground and EXT PWR light ON) the related bus will be connected to EXT PWR.

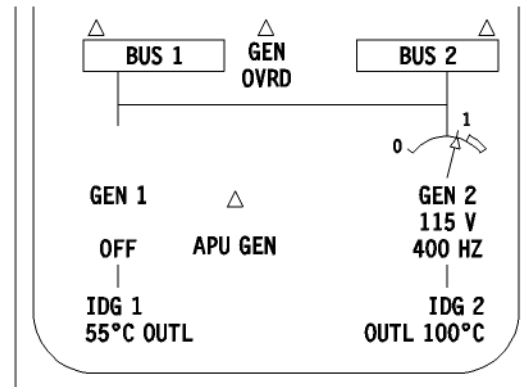


Note : If both the APU GEN and EXT PWR are available, EXT PWR has priority over the APU GEN.

- If EXT PWR is not ON or in flight, the bus will be switched to the APU GEN (if available).



- Finally, if the APU GEN is not available, the bus will receive power from the opposite Engine- Driven Generator (GEN 2 for AC BUS 1, or GEN 1 for AC BUS 2) :

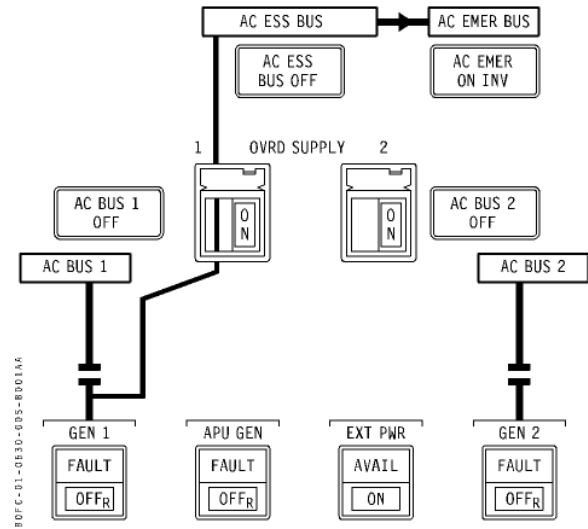
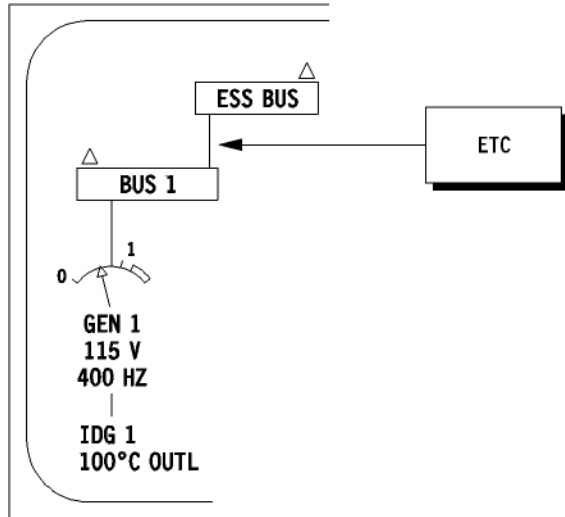


Electrical System

Normal AC Power, Operational Description

AC ESS BUS

- The AC ESS BUS is a 3-phase bus, normally supplied by the AC BUS 1 through an Essential Transfer Contactor (ETC).



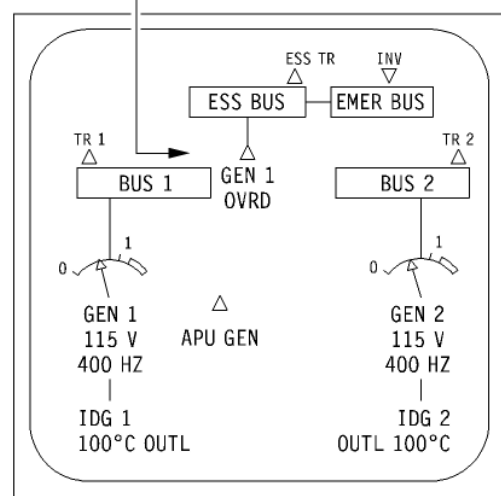
**ETC OPEN (LINE NOT DISPLAYED)
GEN 1 OVRD CONTACTOR CLOSED**

SINGLE OVRD SUPPLY - AC ESS BUS RECOVERY

- If the AC ESS BUS is lost due to the loss of the AC BUS 1 or due to the failure of the Essential Transfer Contactor:

- If GEN 1 available:

- the guarded OVRD SUPPLY 1 pushbutton switch must be selected ON.
- the OVRD SUPPLY 1 ON light (white) and the green flowbar illuminate.
- the AC ESS BUS is now supplied directly from the GEN 1.



Electrical System

Normal AC Power, Operational Description

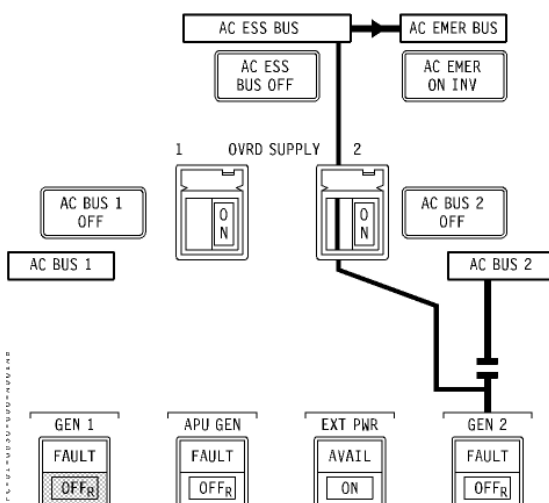
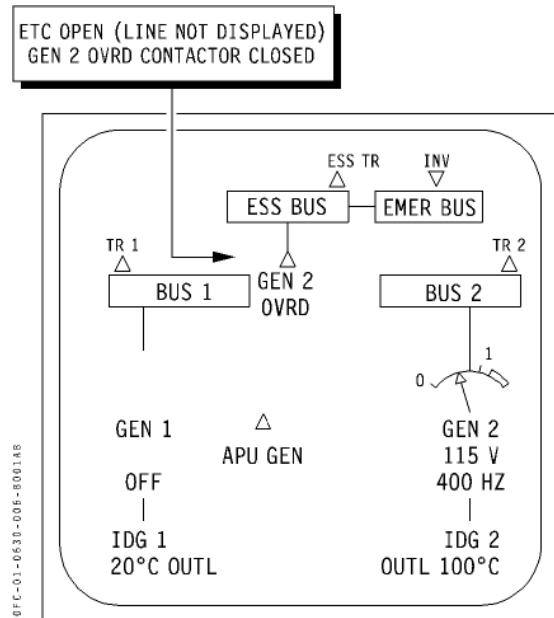
SINGLE OVRD SUPPLY - AC ESS BUS RECOVERY (Cont'd)

- If GEN 1 is not available:

- the guarded OVRD SUPPLY 2 pushbutton switch must be selected ON instead of OVRD SUPPLY 1.
- * the OVRD SUPPLY 2 ON light (white) and the green flowbar illuminate.
- * the AC ESS BUS is now supplied directly from the GEN 2.

- If GEN 1 failure while in OVRD SUPPLY 1:

- Before selecting the OVRD SUPPLY 2 pushbutton switch to ON, the OVRD SUPPLY 1 must be deselected (pushbutton released).
- Should the OVRD SUPPLY 2 be selected first, resulting in a DUAL OVRD SUPPLY condition, all normal AC and DC busses (AC BUS 1, AC BUS 2 and DC NORM BUS) would be shed.
- In this configuration, only the AC ESS BUS, AC EMER BUS and DC ESS BUS would remain supplied (refer to paragraph DUAL OVRD SUPPLY-AVIONICS SMOKE DRILL, hereafter).



Electrical System
**Normal AC Power,
Operational Description**
**DUAL OVRD SUPPLY - AVIONICS SMOKE
DRILL**

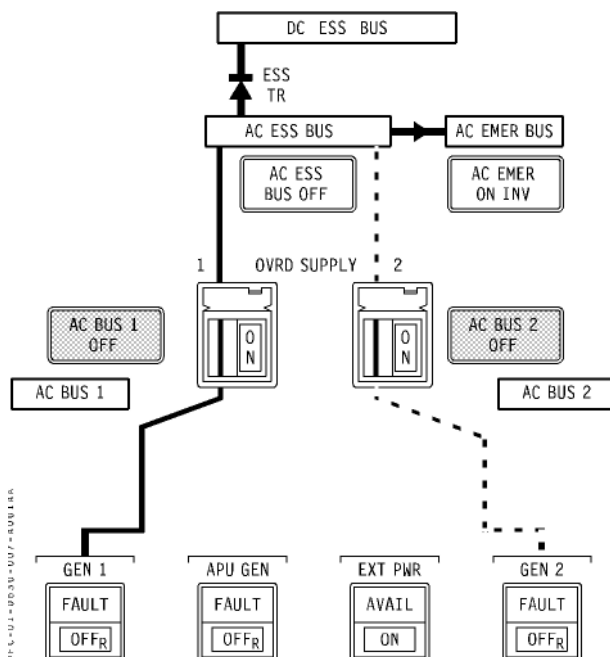
- If AVIONICS SMOKE is detected, the AVIONICS SMOKE light located on the overhead ELEC PWR panel illuminates.
- The AVIONICS SMOKE procedure (refer to procedure) calls for pressing both OVRD SUPPLY pushbutton switches:
 - both OVRD SUPPLY ON lights illuminate white.
- Provided the APU GEN is not on line, the Generator Line Contactor 1 and 2 and the Essential Transfer Contactor open in order to shed :
 - the AC BUS 1,
 - the AC BUS 2, and
 - the DC NORM BUS.

Note 1 : This removes power from the smoke source.

Note 2 : The GEN 1 supplies the AC ESS BUS. The GEN 2 is in Standby.

- The ESSential distribution network (AC ESS BUS, AC EMER BUS and DC ESS BUS) remains supplied :
 - If GEN 1 is operating:
 - . the OVRD SUPPLY contactor 1 closes and its green flowbar illuminates.
 - the AC ESS BUS is supplied directly by the GEN 1.
 - the OVRD SUPPLY contactor 2 remains open.
 - If GEN 1 supply is lost, at any time, the OVRD SUPPLY contactor 2 closes and the GEN 2 supplies the ESSential network.

(OVRD SUPPLY 1 flowbar extinguishes and OVRD SUPPLY 2 flowbar illuminates).

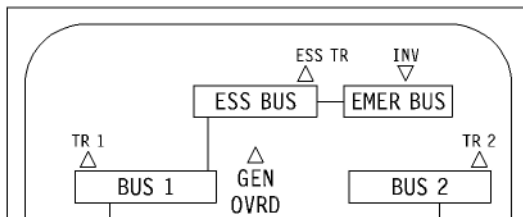
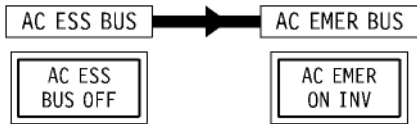


Electrical System

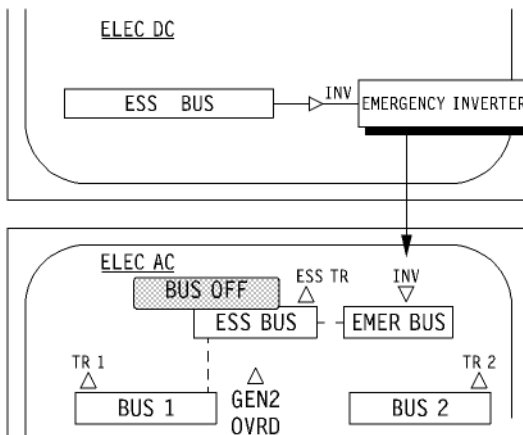
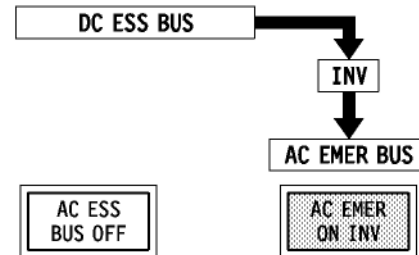
Normal AC Power, Operational Description

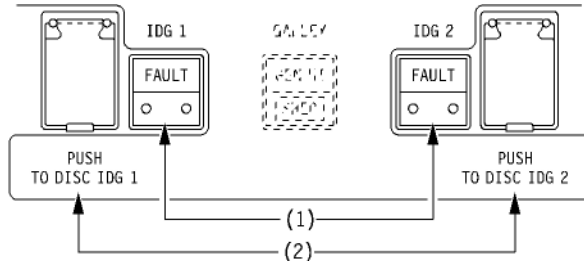
AC EMER BUS

- The ACEMER BUS is a single-phase bus, normally supplied from the AC ESS BUS:



- If AC ESS OFF light illuminated, the ACEMER BUS is automatically supplied by the Emergency Inverter from the DC ESS BUS:



Electrical System
**Normal AC Power,
Controls and Indicators**
**A. ELEC PWR PANEL (see PULL-OUT PAGE)
Integrated Drive Generators (IDG)**

(1) IDG 1 (2) FAULT:

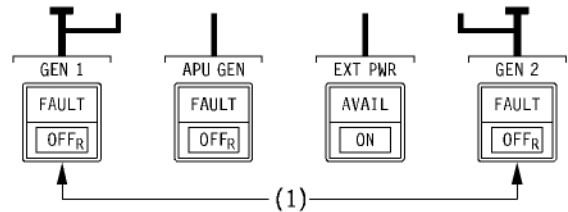
- The amber IDG FAULT light illuminates in case of:
 - IDG oil overheat, or
 - IDG low oil pressure

(2) IDG 1 (2) disconnection pushbutton switch:

- The guarded pushbutton switch controls the IDG 1 (or 2) disconnection from the engine accessory drive gear box.
- Pressing the pushbutton switch disconnects the IDG from its drive shaft.
 - Once disconnected, the IDG can only be reset on ground, with the engine stopped.

CAUTION

- The IDG must not be disconnected while engine is shut down or below ground idle (for example : IDG disconnect is not authorized on a windmilling engine)
- To avoid damaging the disengagement mechanism, the pushbutton switch must not be held for more than three seconds.

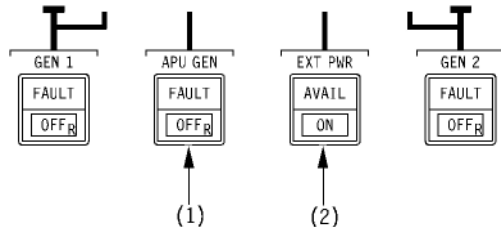
Engine Generators

(1) GEN 1 (2) pushbutton switches:

- These pushbutton switches control:
 - Generator operation and connection to the network by opening / closing the associated Generator Line Contactor, or
 - Resetting / rearming of the GCU's protection system after a fault has occurred.
- **ON (no light - pushbutton switch pressed-in)**
 - The generator is selected and the Generator Line Contactor closes if the generator's parameters (phase sequence, frequency and voltage) are normal.
- **FAULT (amber)**
 - The Generator Line Contactor has opened due to activation of GCU's protections. The generator must be set to OFF.

Note : The activation of GCU protection may results from a transient condition. Resetting the GEN OFF/R then on may be successful in recovering the affected GEN.

Note: In the following cases the Generator Line Contactor is open without GEN FAULT illumination:

- Selecting GEN pushbutton switch OFF/R,
- or selecting both OVRD SUPPLY pushbutton switches ON (Smoke Drill).
- **OFF/R (white - pushbutton switch released - out)**
 - The generator is cut off, and the Generator Line Contactor is opened.
 - This also resets/rearms the GCU fault protection system (except for differential faults, as the protection system must be rearmed on the GCU itself by maintenance action).

Electrical System
**Normal AC Power,
Controls and Indicators**
ELEC PWR PANEL (continued)

(1) APU GEN pushbutton switch:

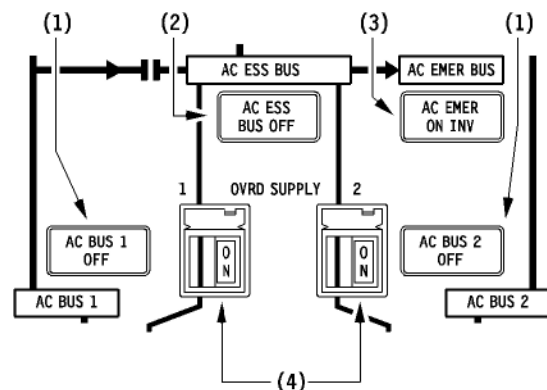
- This pushbutton switch controls:
 - APU Generator operation and connection to the network, or
 - Resetting/rearming of the APU GCU's protection system after a fault has occurred.
- **ON (no light - pushbutton switch pressed-in)**
 - The APU GEN is selected and energized if the generator's parameters (phase sequence frequency and voltage) are normal.
- **FAULT (amber)**
 - The generator must be set to OFF.

Note : The APU may be isolated (GLC open) without an APU GEN FAULT light if:

- APU GEN pushbutton switch is OFF/R, or
 - APU is not running.
- **OFF/R (white: pushbutton switch released-out)**
 - The generator is cut off and disconnected from the network.
 - This also resets/rearms the GCU fault protection system (except for differential faults, as the protection system must be rearmed by action on the GCU itself by maintenance action).

(2) EXT PWR pushbutton switch:

- (Refer to section - EXTERNAL POWER CONTROLS AND INDICATORS).


(1) AC BUS 1 (or 2) OFF light :

- The amber AC BUS 1 (or 2) OFF light illuminates when the associated AC BUS is not supplied.

(2) AC ESS BUS OFF light:

- The amber AC ESS BUS OFF light illuminates when the AC ESS BUS is not supplied.

(3) AC EMER ON INV light:

- The blue AC EMER ON INV light illuminates when AC EMER BUS is powered from DC ESS BUS via the Static Inverter.

(4) OVRD SUPPLY 1(2) pushbutton switch:

Refer to section NORMAL AC POWER “Operational Description” - OVRD SUPPLY - AC ESS BUS RECOVERY and OVRD SUPPLY – AVIONICS SMOKE DRILL.

Electrical System
**Normal AC Power,
Controls and Indicators**
ELEC PWR PANEL (continued)
(1) GALLEY pushbutton switch :

(See PULL-OUT page)

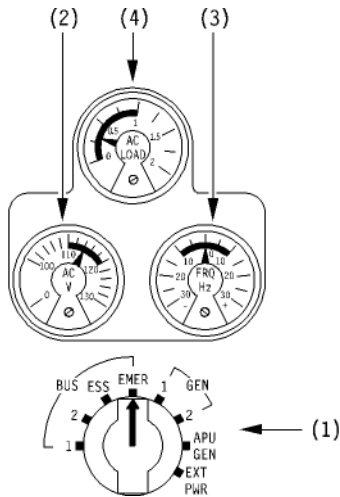


- The Galley pushbutton switch controls power to the MAIN and SECONDARY groups of galley equipment busses.
- If a generator becomes overloaded this pushbutton switch must be pressed to shed both galley busses and reduce the load.
- **ON (no light - pushbutton switch pressed-in)**
 - Power supply to the galley busses is automatic:
 - With two generators on line : both MAIN and SECONDARY galley busses are supplied.
 - If only one generator is on line : The Main galley bus is automatically shed (no light illuminates to indicate this condition).

Exception : Both galley busses can be powered by the APU generator alone when on the ground.

- **GEN HI (amber)**
 - Illuminates if any generator load is over the white arc for more than 15 sec.
 - If on ground with only the APU GEN on line, the switch trips to automatically shed both galley busses - SHED light illuminates.
 - Any other time a generator overloads, the GEN HI light only illuminates but the pushbutton switch does not trip automatically : the GALLEY pushbutton switch must be manually pressed to shed the galley busses – SHED light illuminates.

- **SHED (white - pushbutton switch released - out)**
 - Both MAIN and SECONDARY galley busses are not supplied.
 - Pushbutton switch only trips out automatically in case of APU generator overload on ground.

Electrical System
**Normal AC Power,
Controls and Indicators**
**B. AC ELECTRICAL INDICATOR
PANEL**

**(1) Rotary Selector for AC voltage (V),
frequency (FRQHz) and LOAD indicators :**

- This rotary selector selects which AC BUS or power source is displayed on the AC voltage (V), frequency (FRQHz) and LOAD indicators (2, 3 and 4).
- BUS positions:
 - AC Voltage and Frequency (no LOAD indication) of the selected AC BUS (AC BUS 1, AC BUS 2, AC ESS BUS or AC EMER BUS), are displayed on the corresponding Indicators.
- GEN 1 - GEN 2 - APU GEN - EXT PWR positions:
 - AC Voltage, Frequency and LOAD of the selected Generator (GEN 1, GEN 2, or APU GEN) are displayed on the corresponding Indicators.
 - For EXT PWR, only Voltage and Frequency (no LOAD) are displayed.

(2) AC voltage (V) Indicator :

- Indicates the voltage of the selected AC BUS or power source.
- Normal reading is within the white arc.

(3) AC frequency (FRQ Hz) Indicator :

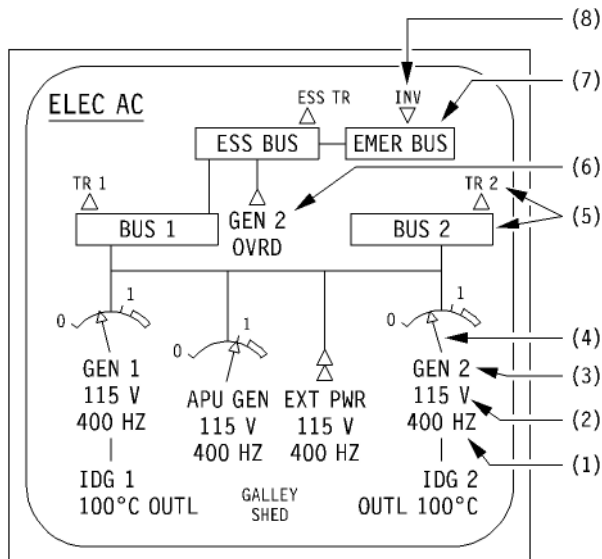
- Indicates frequency of the selected AC BUS or power source.
- Normal reading is within the white arc.

(4) AC LOAD Indicator :

- Displays the LOAD of the selected generator.
- Indicates from 0 to 200 % of the rated 90 KVA load (0.5 = 50 % rated load, 1 = 100 % rated load).
- Normal reading is within the white arc.

Note : If a BUS or EXT PWR is selected, the LOAD indication will be zero.

Note : Except as mentioned before, only the phase selected on the lateral panel PHASE SEL (A-B-C) rotary selector is displayed on the AC voltage I frequency I load indicators.

Electrical System
**Normal AC Power,
ECAM**
SYSTEM DISPLAY

(1) Generator Frequency Indication :

- Green when normal operation
- Amber if frequency is below 390Hz or above 410Hz.
- Not displayed when the GEN pushbutton switch is selected OFF/R.

(2) Generator Voltage Indication :

- Green when normal operation
- Amber if voltage is below 110V or above 120V.
- A white OFF indication replaces the voltage indication when the GEN pushbutton switch is selected OFF/R.

(3) GEN 1 (or 2) legend :

- White when normal operation
- Amber when the GEN pushbutton switch is selected OFF/R.

(4) Generator Load Indication :

- Green when normal operation
- Amber if load exceeds 110 % (1.1 on indicator).
- Not displayed if GEN pushbutton switch is selected OFF/R.

(5) BUS an TR Indications (AC BUS 1, AC BUS 2 and AC ESS BUS) :

- When the bus is powered :
 - TR indication is white.
 - BUS symbol is green.
- When the bus is not powered :
 - TR and BUS indications are amber

(6) GEN 1 (or 2) OVRD Indication :

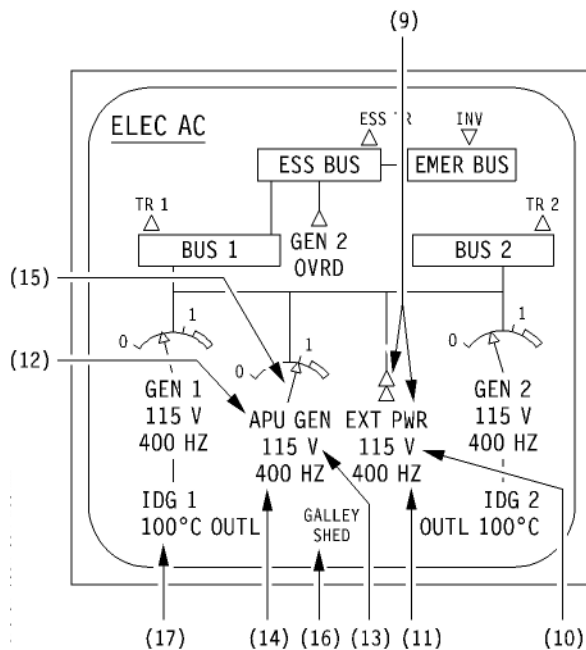
- White GEN 1 (or 2) OVRD indicates which OVRD SUPPLY contactor is closed.
- With both OVRD SUPPLY pushbutton switches selected OFF, only GEN OVRD is displayed (GEN 1 or 2 are not displayed).

(7) EMER BUS Symbol :

- Always displayed in green, whether bus is supplied or not.

(8) Emergency Inverter (INV) Indication :

- Always displayed in white, with Inverter supplying or not.

Electrical System
**Normal AC Power,
ECAM**

(9) EXT PWR legend and symbols :

These indications are only displayed on ground, and are not displayed in flight.

(10) EXT PWR Voltage Indication :

- Green when normal operation
- Amber if voltage below 110V or above 120V.
- Not displayed if voltage below 50V

(11) EXT PWR Frequency Indication :

- Green when normal operation
- Amber if frequency below 390Hz or above 410Hz.
- Not displayed if voltage below 50V

(12) APU GEN legend :

- Green when normal operation
- Turns amber if the APU GEN pushbutton switch is OFF/R while the APU MASTER SWITCH is ON.

(13) APU GEN Voltage Indication :

- Green when normal operation
- Amber if voltage below 110V or above 120V
- A white OFF indication replaces the voltage indication when the APU GEN pushbutton switch is selected OFF/R.
- No indication displayed when the APU MASTER SWITCH is OFF.

(14) APU GEN Frequency Indication :

- Green when normal operation
- Turns amber below 390Hz or above 410Hz. No indication displayed when :
- APU GEN pushbutton switch is selected OFF/R, or
- APU MASTER SWITCH is OFF.

(15) APU GEN Load :

- Green when normal operation
- Amber when load exceeds 110% (1.1 on dial)

A white triangle replaces the load indication when :

- APU GEN pushbutton switch is OFF/R, or
- APU MASTER SWITCH is OFF.

(16) GALLEY SHED legend :

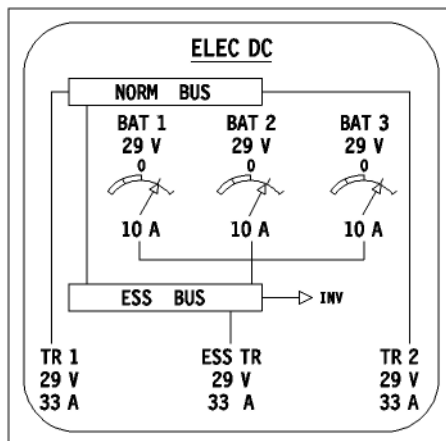
White GALLEY SHED indication is displayed when both Main and Secondary Galley Busses are shed.

(17) IDG 1 (or 2) Outlet Oil Temperature Indication :

- Green when normal operation
- Flashes when temperature between 142° C and 185°C.
- Amber if temperature above 185° C.

Electrical System
**Normal DC Power,
Operational Description**
NORMAL DC POWER SUPPLY

- DC power is generated from the main AC sources by three Transformer Rectifier (TR) units, which convert the AC power to DC and step the voltage down to 28 V DC :



- Two of the TRs supply the DC NORM BUS and the third TR supplies the DC ESS BUS.
- Each TR is rated at 150 A.

DC POWER GENERATION

- DC power is provided by three Transformer Rectifiers (TR) and three Batteries.

TRANSFORMER RECTIFIER (TR) UNIT

- The TRs convert 115 V/400 Hz AC power from the AC BUS 1, AC BUS 2 and the AC ESS BUS into 28V DC power.
- When electrically supplied by the associated AC BUS, each TR delivers up to 150 A of DC power through a TR line contactor.
- The TR line contactors open in case of :
 - Reverse current (from DC to AC), or
 - TR overheat.

BATTERIES

- The three 25 A/h batteries are contained in fire-proof boxes in the underfloor avionics compartment.
- Each battery's line contactor is operated by an automatic Battery Charge Controller (BCC).
- The BCC main functions are to :
 - connect the batteries to the DC ESS BUS, (for emergency power supply) if DC ESS BUS voltage drops.
 - control battery charging,
 - protect the battery from impending battery overheats during charging,
 - With LAND mode armed on FCU and both AP engaged, the BCC connects the batteries to the DC ESS BUS to increase the reliability of the autopilot's power supply for CAT III operations (Refer to section - AFS - LAND MODE).
- Each battery is permanently connected to an associated Hot Battery Bus (located upstream of the battery line contactor).
- With all batteries OFF, the following equipment are still powered by the Hot Battery Busses :
 - Clocks,
 - Engine and cargo fire extinguisher squibs,
 - Refuelling system (if the REFUEL / DEFUEL Panel PWR SUPPLY guarded toggle switch is set to BAT position),
 - IRS 1 (or 3 if the CAPT ATT HDG pushbutton switch is pressed).

Electrical System
**Normal DC Power,
Operational Description**
DC POWER DISTRIBUTION

- There are two main 28V DC busses :
 - The DC NORM BUS, and
 - The DC ESS BUS.

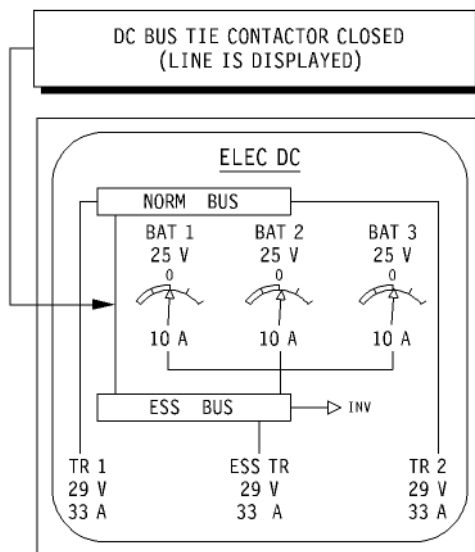
DC NORM BUS Power Supply

- The DC NORM BUS is supplied by two Transformer Rectifiers (TR 1 and TR 2).

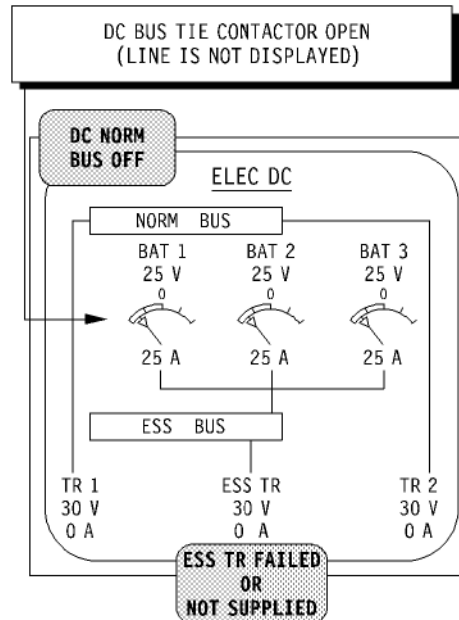
Note : TR2 is also used when supplying the AC and DC GRND / FLIGHT Busses directly from EXT PWR.

DC ESS Bus Power Supply

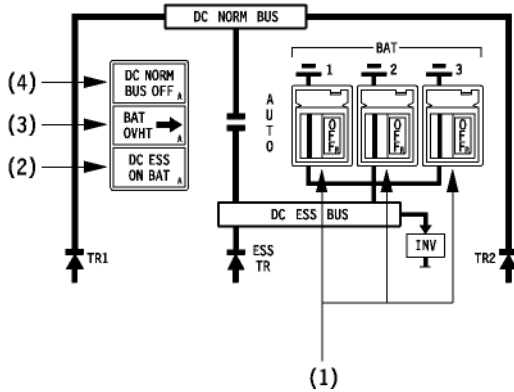
- The DC ESS BUS is supplied from :
 - The ESS TR, and
 - The DC NORM BUS, through the DC Bus Tie Contactor which closes as soon as the aircraft network is electrically supplied.



- If supply from the DC NORM BUS and ESS TR is lost, the DC ESS BUS is supplied by the Stand-by Generator or by the batteries :


DC BUS TIE CONTACTOR

- The DC Bus Tie Contactor, connecting the DC NORM BUS with the DC ESS BUS, opens automatically :
 - If AC BUS 1 OFF and AC BUS 2 OFF (to prevent any battery from supplying the DC NORM BUS),
 - Note :** This condition occurs in case of loss of all generators, or as a result of performing the AVIONICS SMOKE procedure.
 - If a reverse current is detected from the DC ESS BUS to the DC NORM BUS.
 - When LAND mode is armed on FCU and both AP are engaged. The opening of the DC Bus Tie Contactor segregates the electrical power supply for AP 1 and AP 2 to increase the AP reliability during CAT III operations.

Electrical System
**Normal DC Power,
Controls and Indicators**
A. ELEC PWR PANEL

(1) BAT 1 (or 2 or 3) pushbutton switches :

- These pushbuttons control operation of the corresponding Battery Charge Controller:
- **AUTO (No light - Pushbutton switch pressed-in)**
 - The Battery Charge Controller automatically operates its line contactor to connect/disconnect the battery to / from the DC ESS BUS.
 - When the Battery Charge Controller closes the line contactor, the green flowbar illuminates, indicating that the battery is connected to DC ESS BUS.
 - When the Battery Charge Controller has opened the line contactor, and the battery is disconnected from DC ESS BUS, the flowbar extinguishes.
 - The Battery Charge Controllers connect the batteries to DC ESS BUS :
 - To assist APU starting (when APU Master switch is set to ON).
 - For back-up power if DC ESS BUS voltage falls below 25 V.
 - When the battery requires charging.
 - When two APs are engaged in LAND mode
 - Otherwise, when fully charged the batteries are disconnected from the DC ESS BUS.

- **OFF/R (white - pushbutton switch released-out)**
 - The Battery Charge Controller unit is not operating and the battery line contactor is open. The Battery Charge Controller fault detection circuit is reset/rearmed.
 - The flowbar extinguishes to show that the battery is disconnected from DC ESS BUS.

Note: Regardless of the BAT pushbutton switch position, if BAT OVRD pushbutton switch is selected ON, the battery is forced to connect to the DC ESS BUS and the flowbar illuminates, (even with its pushbutton switch is set to OFF).

(2) DC ESS ON BAT Light:

- This light illuminates amber when the DC ESS BUS is powered only by the batteries.

Note: When supplied by batteries only, DC ESS BUS will be powered for a limited time (refer to QRH procedure).

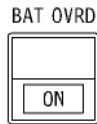
(3) BAT OVHT Light:

- This light illuminates amber when any battery's charge rate shows characteristics of a battery overheat.
- The associated Battery Charge Controller automatically disconnects the affected battery.
- The BAT OVHT light extinguishes when the affected battery's pushbutton switch is selected OFF/R.

Note : This light is inhibited when the BAT OVRD pushbutton switch is ON.

(4) DC NORM BUS OFF:

- This light illuminates amber when the DC NORM BUS is not supplied.

Electrical System
**Normal DC Power,
Controls and Indicators**
ELEC PWR PANEL (continued)
(1) BAT OVRD pushbutton switch :


- The pushbutton switch overrides the Battery Charge Controller and the BAT pushbutton switch position and forces all three batteries to connect to the DC ESS BUS, even if the BAT pushbutton switches are set to OFF.

Note : This switch is used as directed by ECAM or QRH.

- **ON (White - Pushbutton switch pressed-in)**
 - All batteries are connected to the DC ESS BUS.
 - Battery overheat detection is inhibited.
- **Off (No light - pushbutton switch released out)**
 - The BAT Line Contactors are controlled by the BAT pushbutton switches and by the Battery Charge Controllers.

(2) LAND RECOVERY pushbutton switch :


- In case of loss of DC NORM BUS, following the application of the SMOKE DRILL or in case of flight on BAT only, several systems and equipment used for approach and landing are lost.
Pressing the LAND RECOVERY pushbutton switch enables to switch over the electrical power of these systems and equipment to the AC ESS BUS, AC EMER BUS and DC ESS BUS.

- **Off (No light -pushbutton switch released out)**
 - Normal position.
- **ON (White - pushbutton switch pressed-in)**
 - The systems equipment listed hereafter are recovered.
- The following systems/equipment are recovered by selecting LAND RECOVERY :
 - SLATS (one slats motor recovered)
 - FLAPS (one flaps motor recovered)
 - SPOILERS and SPEEDBRAKES (1, 4, 6, and 7 recovered),
 - GROUND SPOILER CONTROL (using spoilers 1,4, 6, and 7),
 - ANTI-SKID (NORM recovered).
- LAND RECOVERY is used in the following procedures, as directed by the ECAM or QRH :
 - DC NORM BUS OFF,
 - LOSS OF BOTH ENG GENERATORS,
 - FLIGHT ON BAT ONLY,
 - AVIONICS SMOKE.

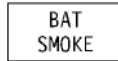
(3) AVIONICS SMOKE light:


- The AVIONIC SMOKE light illuminates red when smoke is detected in the ventilation duct from :
 - Cockpit instrument or overhead panels,
 - Circuit breakers panel,
 - Weather radar transceiver,
 - Electronic racks or IRS 2,
 - Underfloor area equipment.
- The illumination of the AVIONICS SMOKE light is accompanied by ECAM activation.

Electrical System

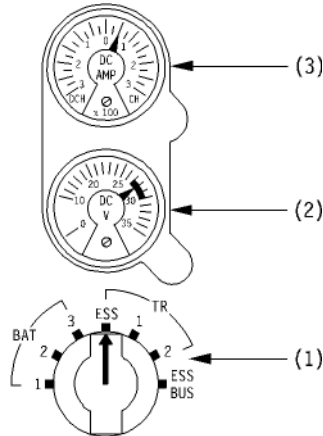
Normal DC Power, Controls and Indicators

(4) BAT SMOKE light :



- The BAT SMOKE light illuminates red when smoke is detected in the battery ventilation duct.
- The illumination of the BAT SMOKE light is accompanied by ECAM activation.

B. DC ELEC IND PANEL



(1) DC (V/AMP) Selector :

- Used to select the DC power source to be displayed on the DC V and DC AMP indicators.

Note : If any of the three BAT or any of the three TR is selected, both current (AMP) and voltage (V) are displayed.

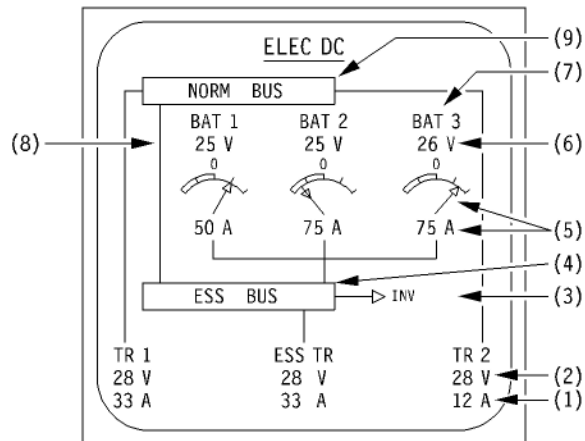
If the ESS BUS is selected, only voltage (V) is displayed.

(2) DC voltage (V) Indicator :

- Displays the voltage of the DC power source selected by the rotary selector.
- Normal readings are :
 - for a battery without load : 25 to 28 V
 - for a battery under-load : 23 to 28 V
 - for a TR unit : 27 to 30 V (white arc).

(3) DC current (AMP) Indicator :

- Displays the charge (CH) or discharge (DCH) current of the DC power source selected by the rotary selector.
- The maximum continuous DC AMP indication for a TR is 150 A.

Electrical System
**Normal DC Power,
ECAM**
SYSTEM DISPLAY

(1) TR Current indication :

- Always green but flashes when the current is below 6A.

(2) TR Voltage indication :

- Normally green but illuminates amber when the voltage is below 25 V or above 31 V.

(3) INV indication :

- The indication is white when the Emergency Inverter is supplying the AC EMER BUS.

(4) ESS BUS symbol :

- Normally green but illuminates amber when the DC ESS BUS is not powered.

(5) Digital / Analog Battery Current indications :

- Normally green but illuminates amber with a reverse arrow when the reverse current is below 5A.
- A white OFF replaces these indications when the associated BAT pushbutton switch is selected to OFF/R and the battery line contactor is open.

(6) Battery Voltage indication :

- Normally green but illuminates amber when the voltage is below 25 V or above 31 V.

(7) BAT indication :

- Illuminates white when the BAT pushbutton switch is set to AUTO.
- Illuminates amber when the BAT pushbutton switch is selected to OFF/R.

(8) DC Bus Tie Contactor line :

- Green when the DC Bus Tie contactor is closed.
- Not displayed when the DC Bus Tie contactor is open.

(9) NORM BUS symbol :

- The symbol is green when the DC NORM BUS is supplied, and is amber when the DC NORM BUS is not supplied.

Electrical System

AC and DC Stand-by Power, Operational Description

GENERATION

GENERATOR

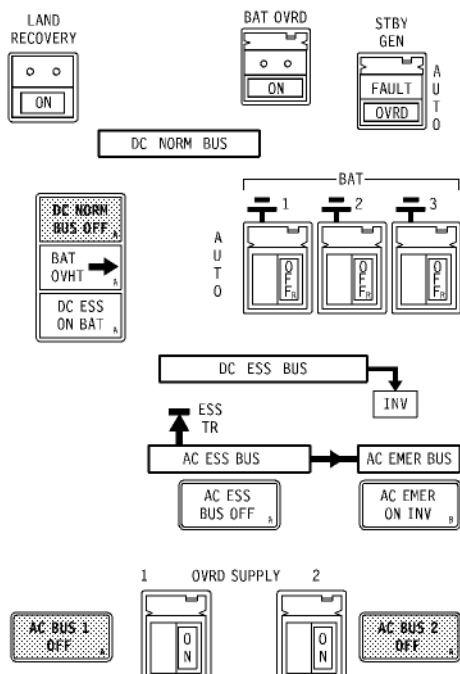
- AC/DC stand-by generation is achieved by a constant speed-hydraulically driven STBY GEN powered by the green hydraulic system.
- The generator is rated at :
 - AC output : 5 kVA, 115 V, 400 Hz.
 - DC output : 50 A, 28 V (24 to 30 V).

GENERATOR CONTROL UNIT (GCU)

- The STDBY GEN is associated with a dedicated generator Control Unit (GCU) which provides AC voltage and frequency regulation and protection against the following faults :

FAULTS	EFFECTS
Under voltage (AC + DC)	AC and DC stand-by line contactors open
Under frequency (AC)	Generator is de-energized

DISTRIBUTION



- When the starting and feeding conditions (described on page 2) are met, the STBY GEN supplies :
 - a part of the AC ESS BUS (AC ESS BUS 2),
 - the AC EMER BUS,
 - the DC ESS BUS.

AC ESS BUS 2

- The AC ESS BUS 2 is a part of the AC ESS BUS and is normally supplied by the AC BUS 1, through the Essential Transfer Contactor and a two-direction contactor.
- Should STBY AC power feeding conditions be met, the two-direction contactor automatic switching :
 - will split the connection between AC ESS BUS 1 and AC ESS BUS 2, and AC BUS 1, and
 - will establish the connection between the AC output of the STBY GEN and AC ESS BUS2 provided the BAT OVRD guarded pushbutton switch is not selected ON.

AC EMER BUS

(Refer to section - EMERGENCY AC AND DC POWER SUPPLY).

DC ESS BUS

- The DC ESS BUS is normally supplied by :
 - the DC NORM BUS through a DC Bus Tie contactor,
 - and the AC ESS BUS 2 through the ESS TR.
- When STBY DC power feeding conditions are met (see DC power feeding conditions paragraph further), the DC ESS BUS is supplied :
 - either by the DC output of the STBY GEN, provided the BAT OVRD pushbutton switch or the LAND RECOVERY pushbutton switch is not selected ON,
 - or by the batteries, if the BAT OVRD pushbutton switch is selected ON, (the STBY GEN is then deactivated).

Electrical System**AC and DC Stand-by Power,
Operational Description****STBY GEN STARTING AND FEEDING
CONDITIONS**

- The STBY GEN operation is confirmed by :
 - AC EMER ON INV light extinguished,
 - DC ESS ON BAT light extinguished,
 - FUEL X-FEED in-line.

STARTING WITHOUT FEEDING

- The STBY GEN starts to run provided the following conditions are met :
 - DC NORM BUS is OFF, and
 - the Generator Line Contactor 2 is opened, and
 - BAT OVRD pushbutton switch is not selected ON, and
 - DC ESS ON BAT light illuminated, and
 - green hydraulic power is available, and
 - aircraft is in flight.

AC POWER FEEDING

- When feeding conditions are met :
 - no FAULT detected by the STBY GEN generator control unit, and
 - AC STBY power available,the AC STBY contactor closes, and STBY GEN AC power supplies the AC ESS BUS (AC ESS BUS 2) and the AC EMER BUS.

DC POWER FEEDING

- When feeding conditions are met :
 - no FAULT detected by the STBY GEN generator control unit, and
 - DC STBY power available, and
 - no APU start attempt, and
 - LAND RECOVERY pushbutton switch is not selected ON,the DC STBY contactor closes, and STBY GEN DC power supplies the DC ESS BUS.

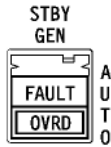
- After an automatic starting of the STBY GEN in flight (for example in case of LOSS OF BOTH ENGINE GENERATORS), the two starting conditions DC ESS ON BAT and aircraft in flight are replaced by a STBY GEN operating condition (in order to maintain STBY GEN operation for the remainder of the flight).

This maintains the STBY GEN operation although the DC ESS BUS is no longer supplied by the batteries.

- APU GEN has priority over STBY GEN to supply the electrical network, when GEN 1 and GEN 2 are lost.
- DC ESS BUS is momentarily disconnected from the STBY GEN during APU start to enable APU starting on batteries and prevent tripping of STBY GEN during APU start.

STBY GEN OVRD MODE

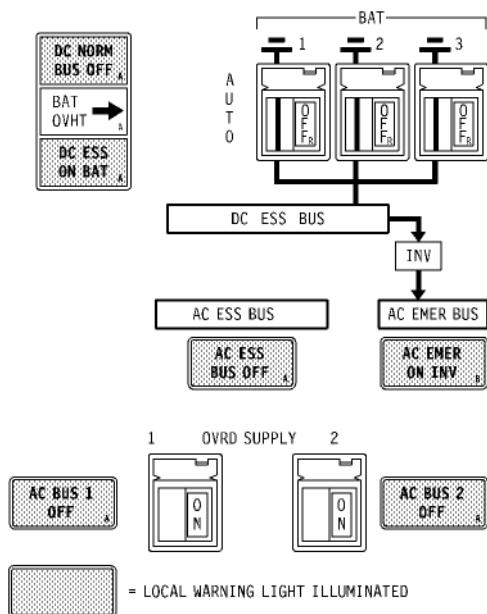
- The OVRD procedure is used if the STBY GEN fails to start automatically.
- Either in flight or on ground, the STBY GEN can be forced to run as soon as the following conditions are met:
 - BAT OVRD pushbutton switch is not selected ON, and
 - green hydraulic power is available.
- AC ESS BUS 2, AC EMER BUS, and DC ESS BUS electrical supply by the STBY GEN is achieved in the same way as with the STBY GEN pushbutton switch selected AUTO.
- If a the forced starting has been initiated :
 - in flight, the STBY GEN operation will continue after landing,
 - on ground, the STBY GEN operation will be limited to two minutes (ground test).

STBY GEN PUSHBUTTON SWITCH


- The STBY GEN pushbutton switch enables the STBY GEN to be started as soon as starting conditions are met.
- Automatic operation of the STBY GEN is not controlled by the STBY GEN pushbutton switch.
- **AUTO (pushbutton switch released out-normal position)**
 - Automatic starting of the STBY GEN is performed provided the automatic starting conditions are met. Refer to section - STBY GEN STARTING AND FEEDING CONDITIONS
 - Automatic starting is inhibited on ground.
- **OVRD (pushbutton switch pressed-in)**
 - The OVRD light illuminates white to indicate that the pushbutton switch is pressed-in.
 - The STBY GEN is forced to connect :
 - in flight : permanently,
 - on ground : for a 2-minute test period.
- **FAULT**
 - The FAULT light illuminates amber when :
 - an undervoltage or underfrequency is detected by the GCU, or
 - an defect is detected in the AC stand-by line contactor logic.

EMERGENCY AC and DC POWER SUPPLY

- Emergency power is provided either by :
 - an AC/DC STBY GEN(See AC AND DC STAND-BY POWER section) which supplies power to :
 - . the DC ESS BUS,
 - a part of the AC ESS BUS,
 - the AC EMER BUS,
- or
- three batteries which supply power to :
 - . the DC ESS BUS,
 - the AC EMER BUS (via the emergency inverter) :



- The emergency electrical system is designed to cover cases when no aircraft generator is available (i.e. loss of both engine generators, APU or APU GEN not available and failure of the STBY GEN to come on line).

The aircraft is in the FLIGHT ON BAT ONLY configuration.