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Airbus
A318/A319/A320/A321

ATA 24
Electrical Power

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Lufthansa Technical Training

Dept HAM US
Lufthansa Base Hamburg
Weg beim Jäger 193
22335 Hamburg
Germany

E-Mail: Info@LTT.DLH.de
Internet: www.LTT.aero

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ATA 24 ELECTRICAL POWER

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24–00 ELECTRICAL POWER GENERAL

AC/DC POWER SOURCES INTRODUCTION

Integrated Driven Generators

The electrical network of the A320 family is normally supplied by two engine driven AC generators (IDG 1/2).

The drive unit (for constant speed) and the generator are integrated in one unit designated as IDG (**I**ntegrated **D**rive **G**enerator).

- Nominal Power: 90 kVA
- Nominal Voltage: 115/200 V AC, 3–Phase
- Nominal Speed/Frequency: 12000 rpm/400 Hz

APU Generator

The APU drives a third, Auxiliary Generator (APU GEN) which can replace either main generator (GEN 1 and/or GEN 2). The APU generator also serves as an independent AC power supply on ground.

- Nominal Power: 90 kVA
- Nominal Voltage: 115/200 V AC, 3–Phase
- Nominal Speed/Frequency: 24000 rpm/400 Hz

Constant Speed Motor/Generator

In case of Emergency Configuration (loss of GEN 1,2 and APU Generator) in flight, an AC Generator driven by a Hydraulic Motor supplies the systems required for aircraft control.

The unit is designated as CSM/G (**C**onstant **S**peed **M**otor/**G**enerator).

- Nominal Power: 5 kVA
- Nominal Voltage: 115/200 V AC, 3–Phase
- Nominal Speed/Frequency: 12000 rpm/400 Hz

External Power

An external power receptacle located in front of the nose landing gear well enables power supply of the aircraft network. This is performed by means of the three–phase, 400 Hz, 115/200 V ground power unit.

DC POWER SOURCES

Transformer Rectifiers

The DC electrical system is normally supplied from the AC electrical system via TRUs (**T**ransformer **R**ectifier **U**nits).

- Nominal Current Output: 200 A DC
- Nominal Voltage In: 115/200 V AC, 3–Phase
- Nominal Voltage Out: 28 V DC

Batteries

Two Airborne Nickel–Cadmium Batteries are installed.

The main function of the batteries is:

- APU Start (FLT/GND)
- Essential Network Supply (in different configurations)
- Nominal Capacity: 23 Ah
  Nominal Voltage: 24 V DC

DC–AC Inverter

One Static Inverter of 1000 VA nominal power transforms the direct current voltage from battery 1 into a single phase 115 V/400 Hz alternating current.

The static inverter is automatically activated in the event of loss of all AC power sources and supplies the AC essential network.

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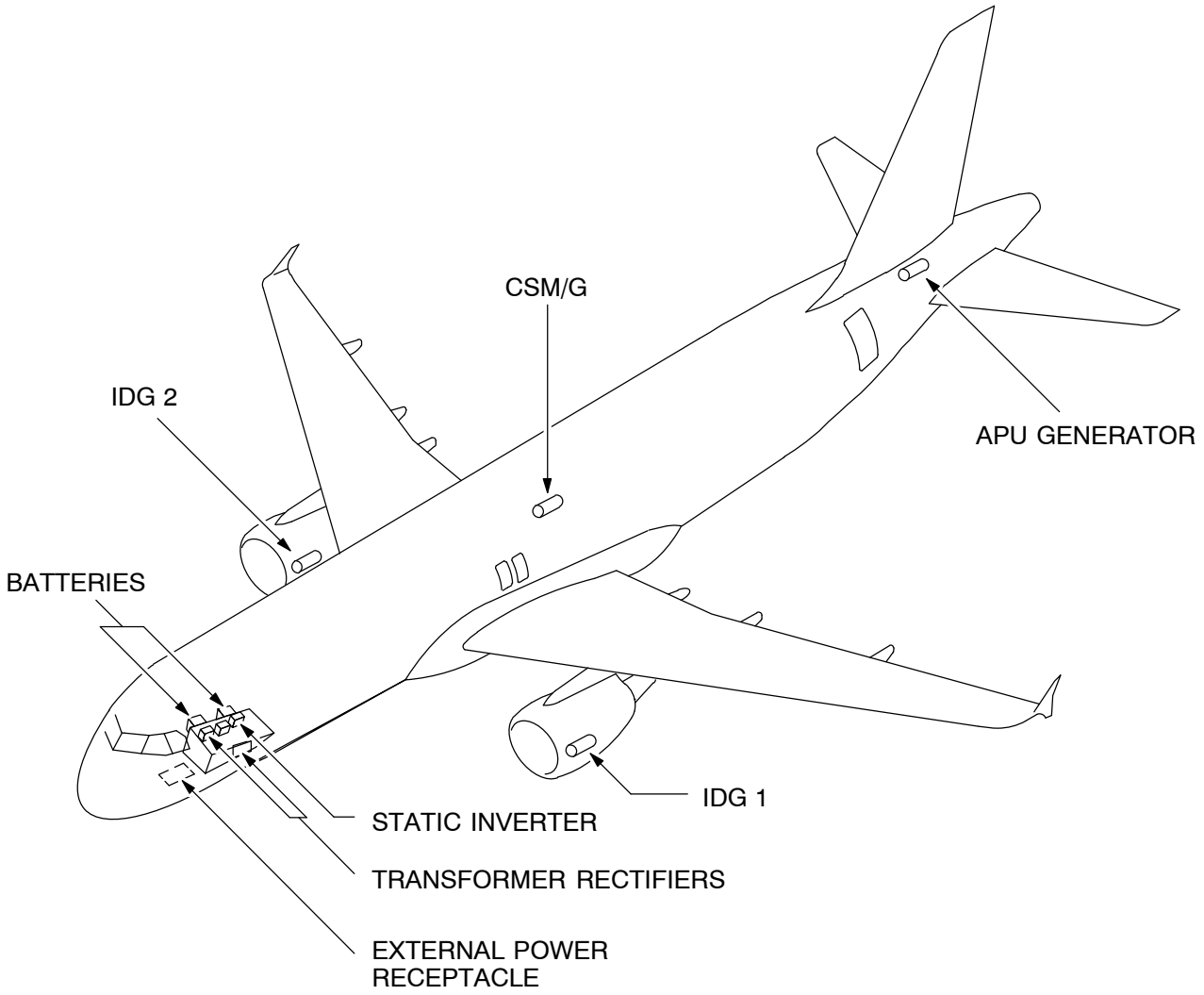

Figure 1 AC/DC Power Sources Location

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ELECTRICAL POWER SYSTEM INTRODUCTION

GENERAL

There are two identical engine driven generators called IDGs (**I**ntegrated **D**rive **G**enerators). They are used as the main power source to supply the A/C electrical network.

The IDG basically contains, in a common housing, a generator and a CSD (**C**onstant **S**peed **D**rive). The CSD gives a constant input speed to the generator, which is required for a constant output frequency.

Each generator supplies 115V 400Hz AC to its own bus:

- generator 1 supplies AC bus 1,
- generator 2 supplies AC bus 2.

This supply is known as split operation, which means that the AC power sources are never connected in parallel.

Each AC bus supplies a TR (Transformer Rectifier):

- AC bus 1 supplies TR 1,
- AC bus 2 supplies TR 2.

The TRs convert 115V AC into 28V DC to supply their associated DC buses, DC 1 and DC 2.

DC bus 1 then supplies the DC BAT bus.

The DC battery bus can charge the batteries or receive power from the batteries as a backup supply, if no other power sources are available.

The electrical system also includes two ESS (**ESS**ential) buses. One is the AC ESS bus fed by AC bus 1 and the other is the DC ESS bus fed by DC BAT BUS. These buses are used to supply the most critical A/C systems.

Other components which also supply the entire electrical network are the APU generator and on the ground, the aircraft electrical network can be supplied by an external power source.

Any one of the power sources can supply the entire electrical network. As no parallel connection is allowed on this A/C (split operation), there are priorities to the different power sources in supplying the bus bars. AC 1 and AC 2 buses are supplied in priority by their ownside generator, then the external power, then the APU generator and then by the opposite generator.

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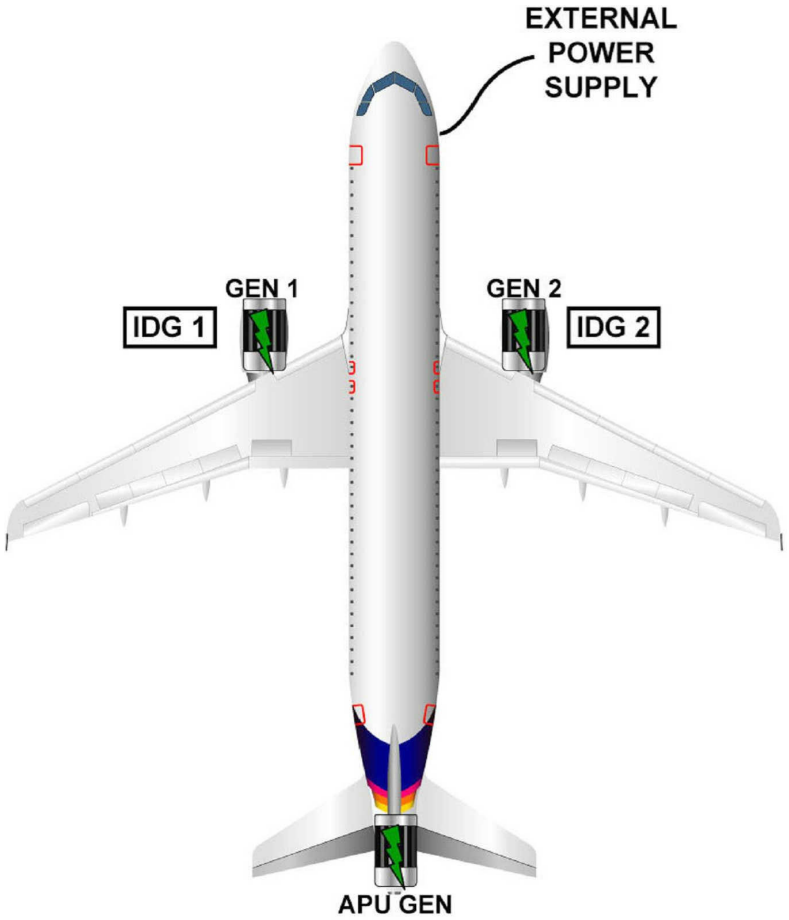

Integrated Drive Generator (IDG)
Constant Speed Drive (CSD)
Transformer Rectifier (TR)
Battery (BAT)
Essential (ESS)
Generator (GEN)

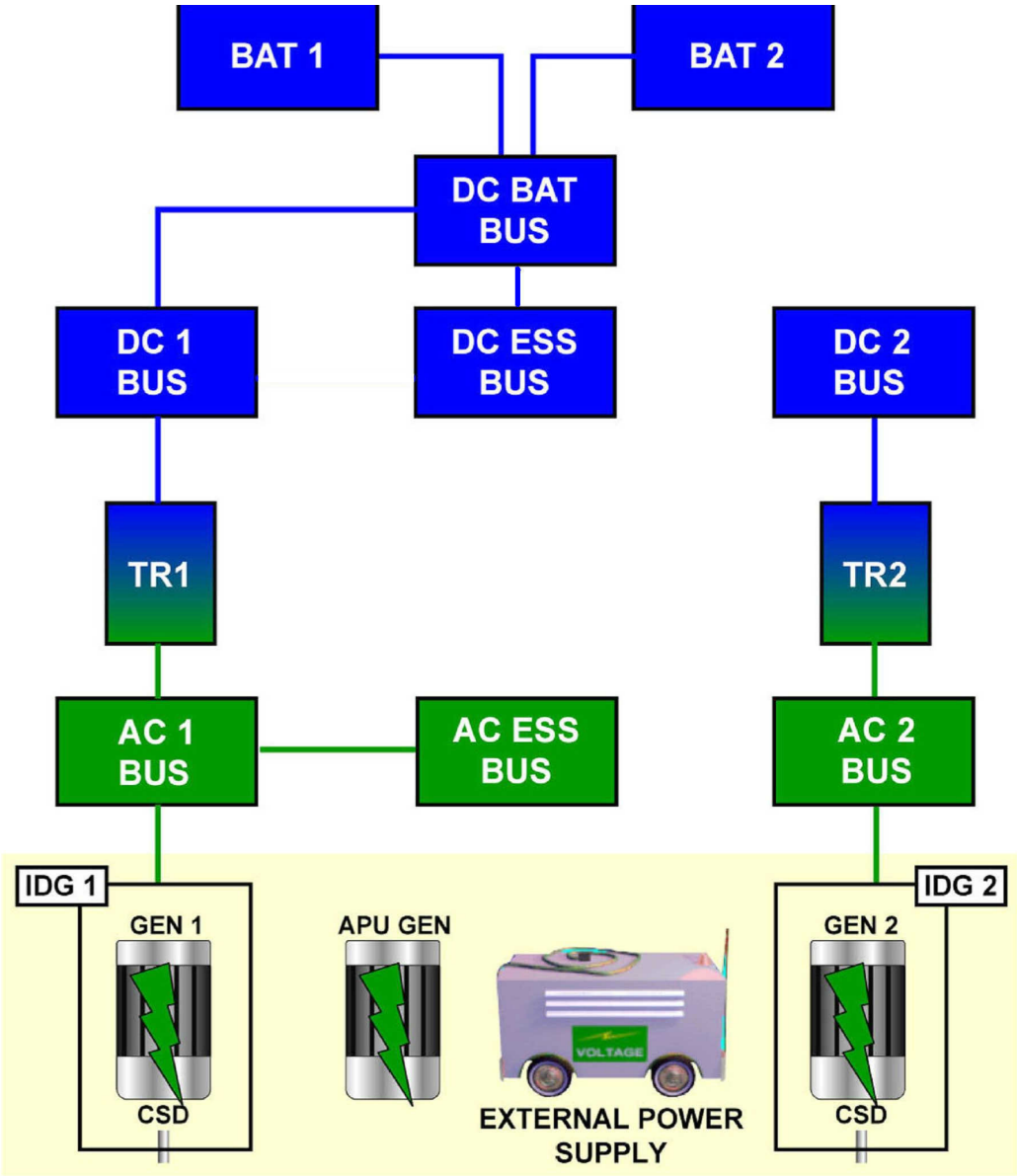

Figure 2 Normal Operation

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ABNORMAL CONFIGURATION

The electrical system has an ESS TR, which supplies the DC ESS Bus in abnormal or emergency configuration.

In abnormal configuration (loss of TR1 or TR2) the ESS TR is supplied by the AC ESS Bus.

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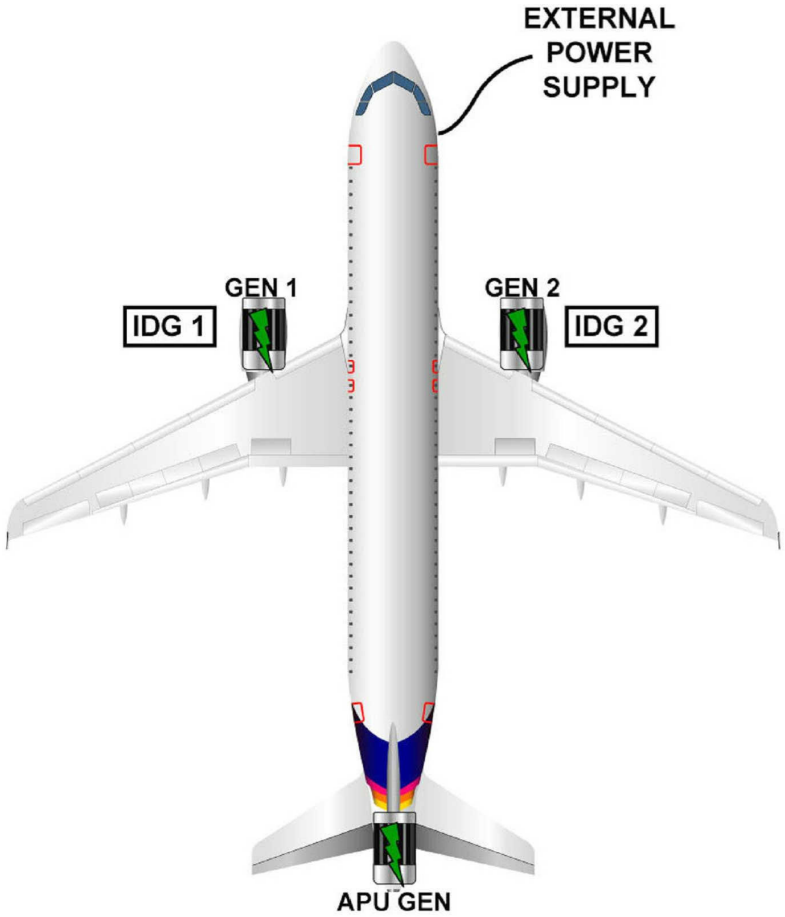

Integrated Drive Generator (IDG)
Constant Speed Drive (CSD)
Transformer Rectifier (TR)
Battery (BAT)
Essential (ESS)
Generator (GEN)

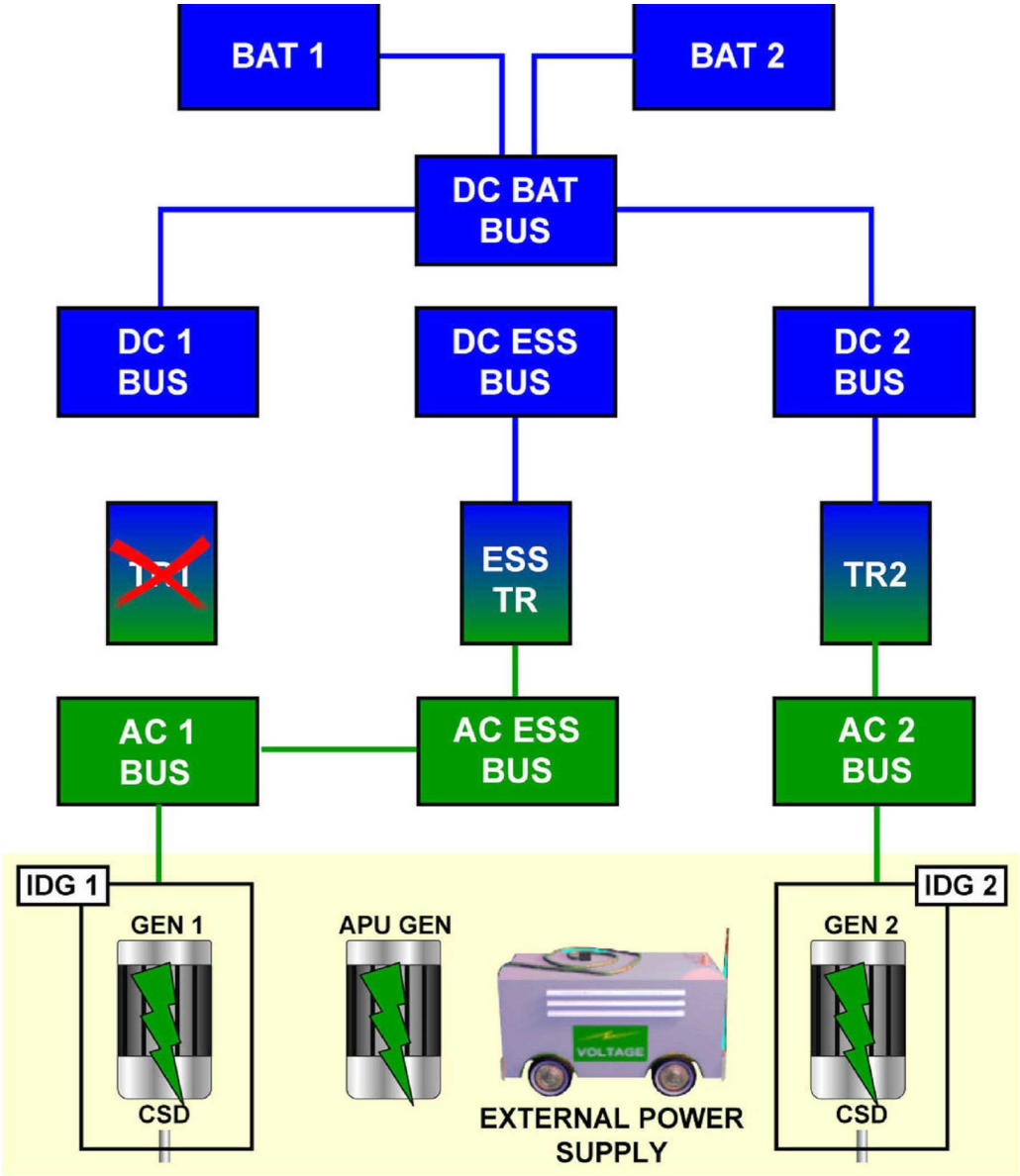

Figure 3 Abnormal Operation

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EMERGENCY CONFIGURATION

The hydraulic power to drive the EMER GEN (**EMER**gency **GEN**erator) is given by a RAT (**R**am **A**ir **T**urbine) via the blue hydraulic system.

The RAT located in the belly fairing extends automatically in case of loss of AC BUS 1 and 2. Then, the EMER GEN supplies the DC ESS BUS via ESS TR.

In emergency configuration (loss of AC BUS 1 and AC BUS 2), the ESS TR is supplied by the EMER GEN.

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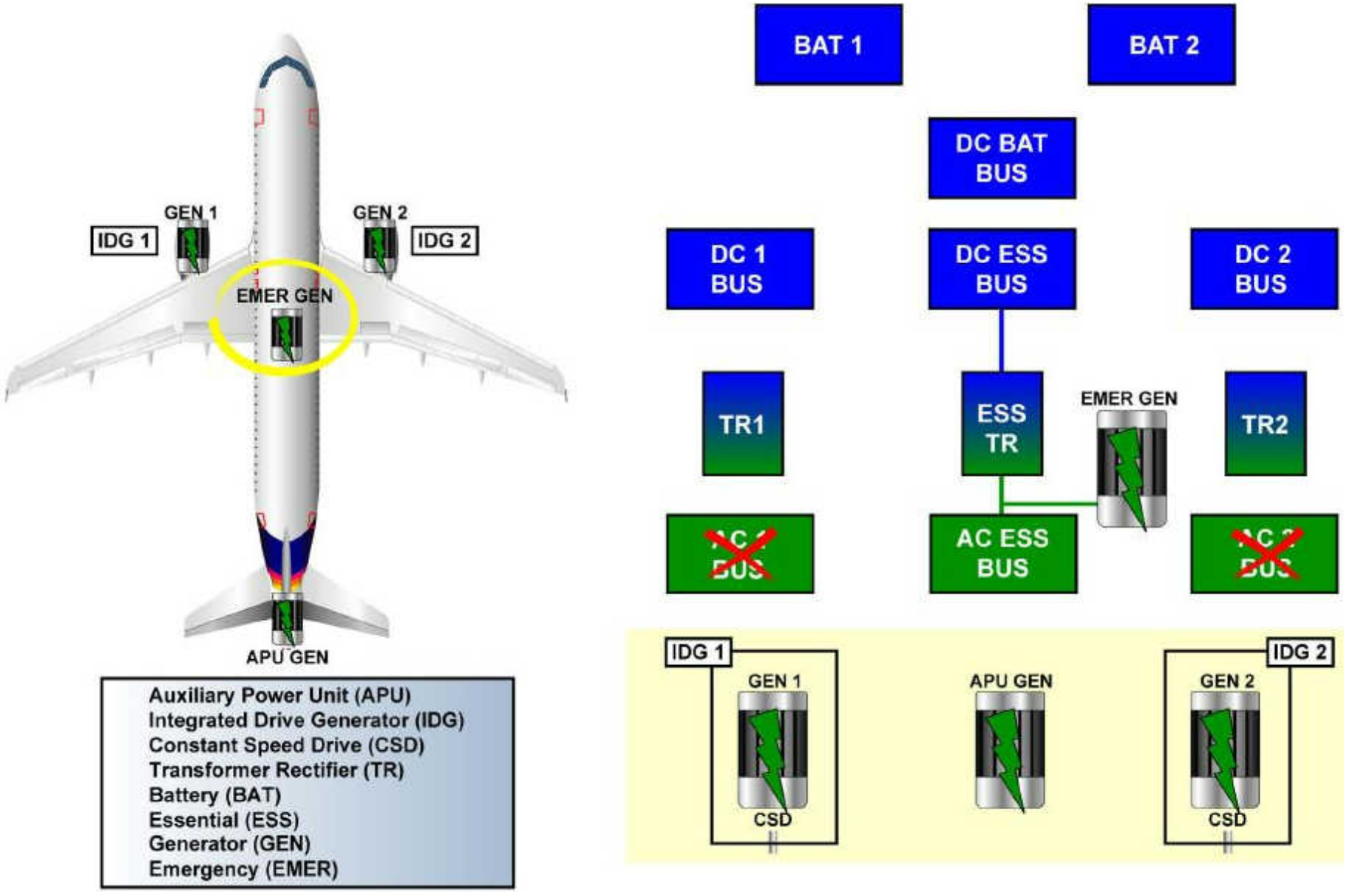

Figure 4 Emergency Configuration

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BATTERY ONLY CONFIGURATION

In emergency configuration with emergency generator not available,

BAT 1 supplies the AC ESS BUS via the static inverter and BAT 2 supplies the DC ESS BUS.

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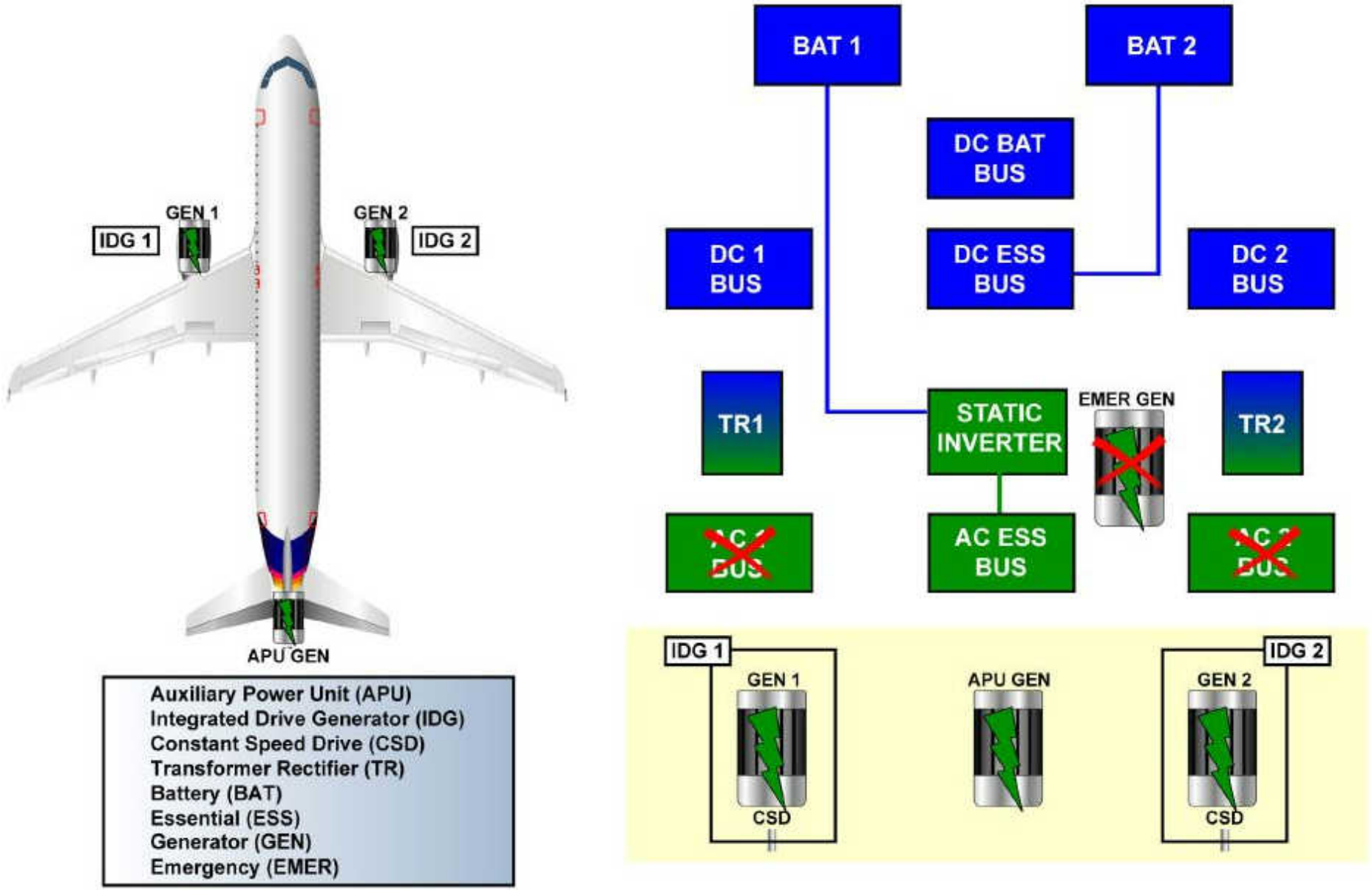

Figure 5 Battery only Configuration

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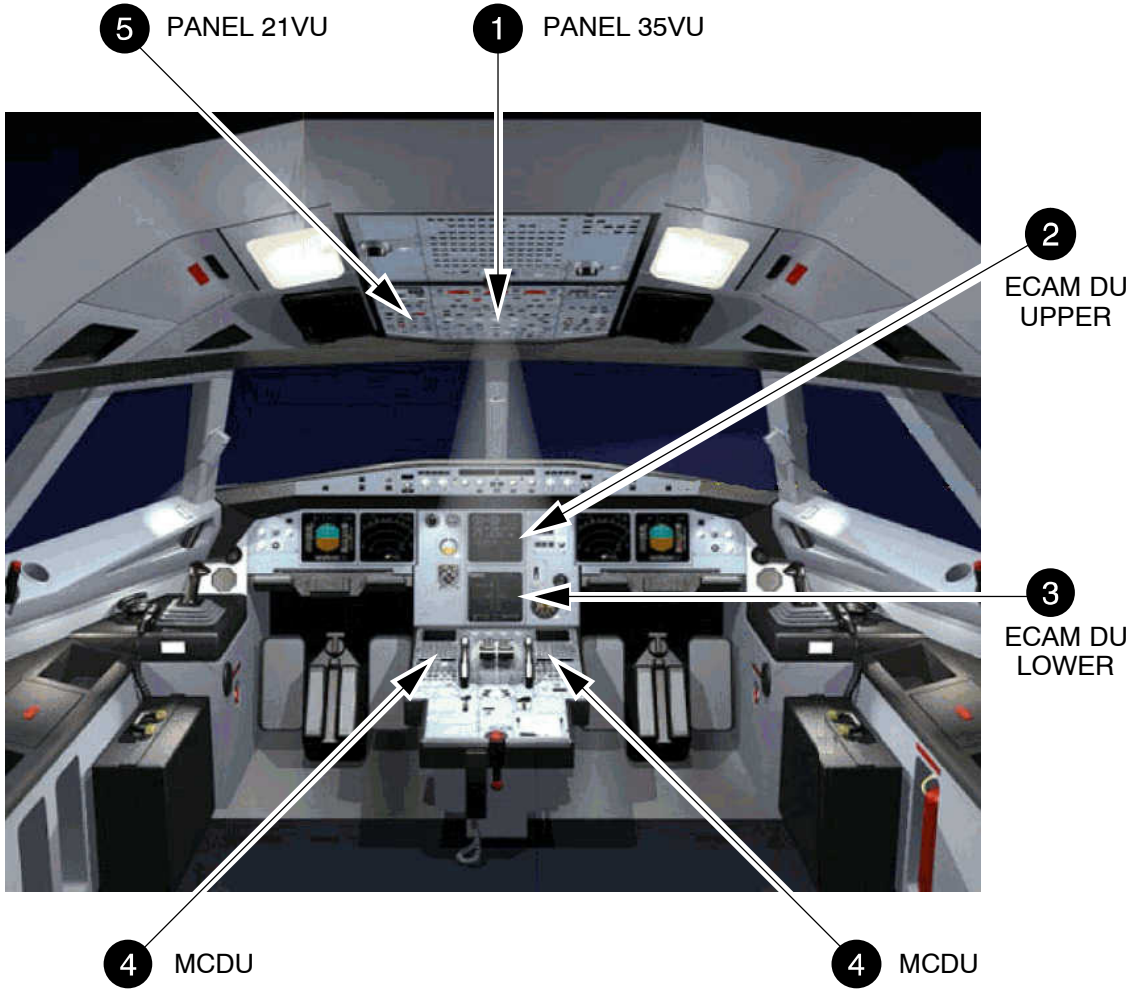
CONTROLS LOCATION COCKPIT



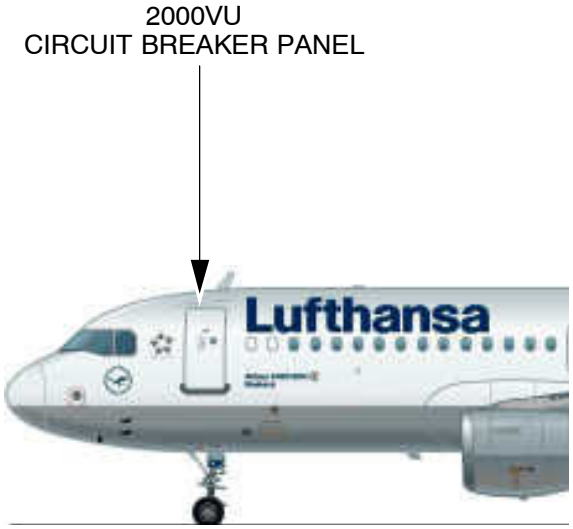


Figure 6 Cockpit Panels General Location

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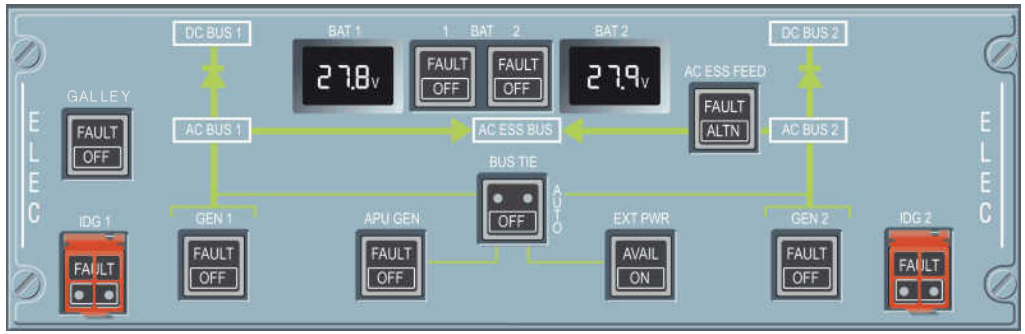
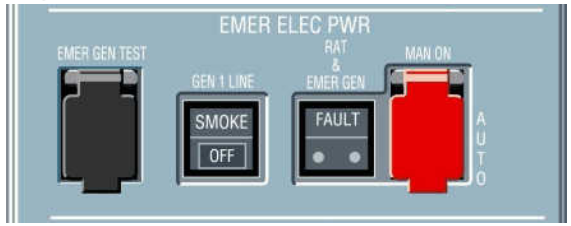
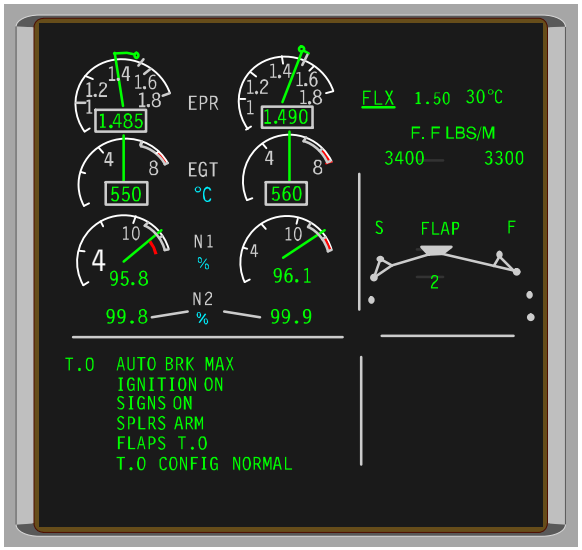


1 PANEL 35VU

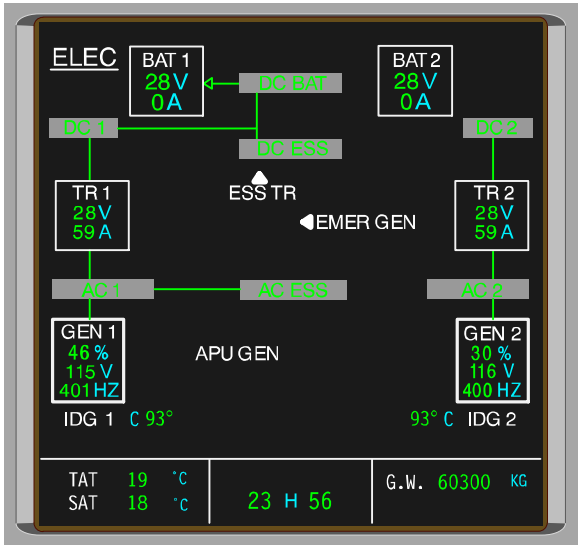


5 PANEL 21VU

4 MCDU



2 ECAM UPPER DU



3 ECAM LOWER DU

Figure 7 Panel Presentation

02|Panels|L1

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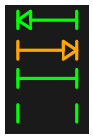
INDICATION

1 Battery indications

BAT P/BSW at OFF:
white
BAT P/BSW in AUTO:
Amber when voltage and current indications change to amber or in case of BAT FAULT warning.
Green if Voltage < 31V or > 25V
Battery current (green)
Becomes amber in case of discharge current > 5A.

2 Battery charge/discharge indication



Green: Battery contactor closed and charging current > 1A
Amber: Battery contactor closed and discharging current > 1A
Green: Battery contactor closed and charging current < 1A
Contactor open

3 DC BAT indication

Normally green.
Becomes amber if DC BAT Voltage ≤ 25V.

4 Bus indication

Normally green. Becomes amber when the corresponding bus is off. “SHED“ appears in amber when AC or DC SHED ESS BUS is off.

5 TR 1/2 indication

Becomes amber as hereunder

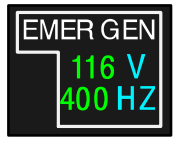
Voltage becomes amber if > 31V or < 25V.
Current becomes amber when ≤ 5A.

6 ESS TR indication

Same logic as TR1/TR2 indication above.
Voltage and current indications are not displayed when the essential TR contactor is open.

7 EMER GEN indication

Normally white. Becomes amber as hereunder:



EMER GEN voltage becomes amber if V > 120V or if V < 110V.
EMER GEN frequency becomes amber if F > 410Hz or if F < 390Hz.

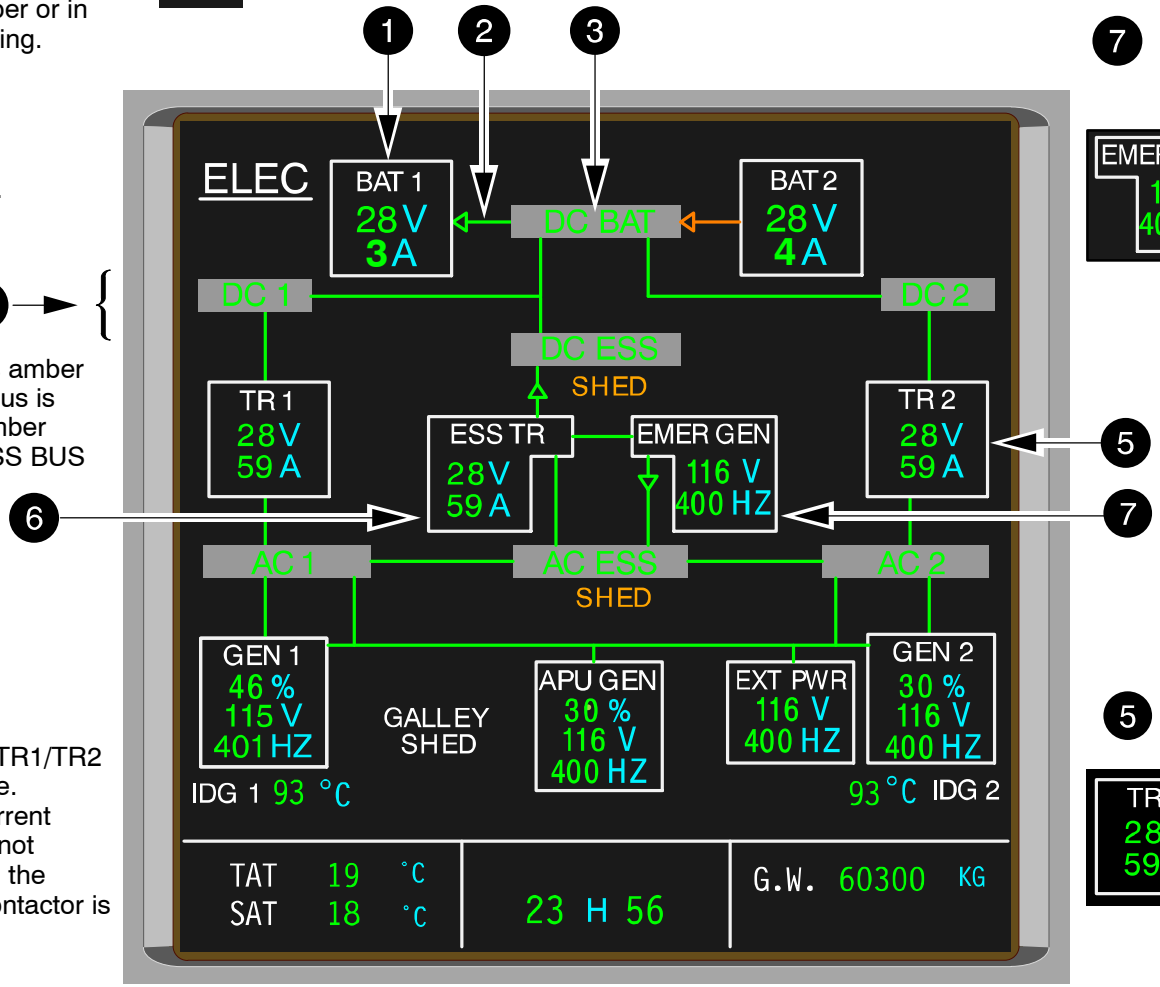


Figure 8 ECAM ELEC Page Presentation (1)

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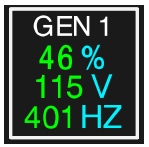
8 GEN 1/2 indications

GEN P/BSW at OFF:

1 or 2 indication white, when associated engine is running.
Amber if stopped.

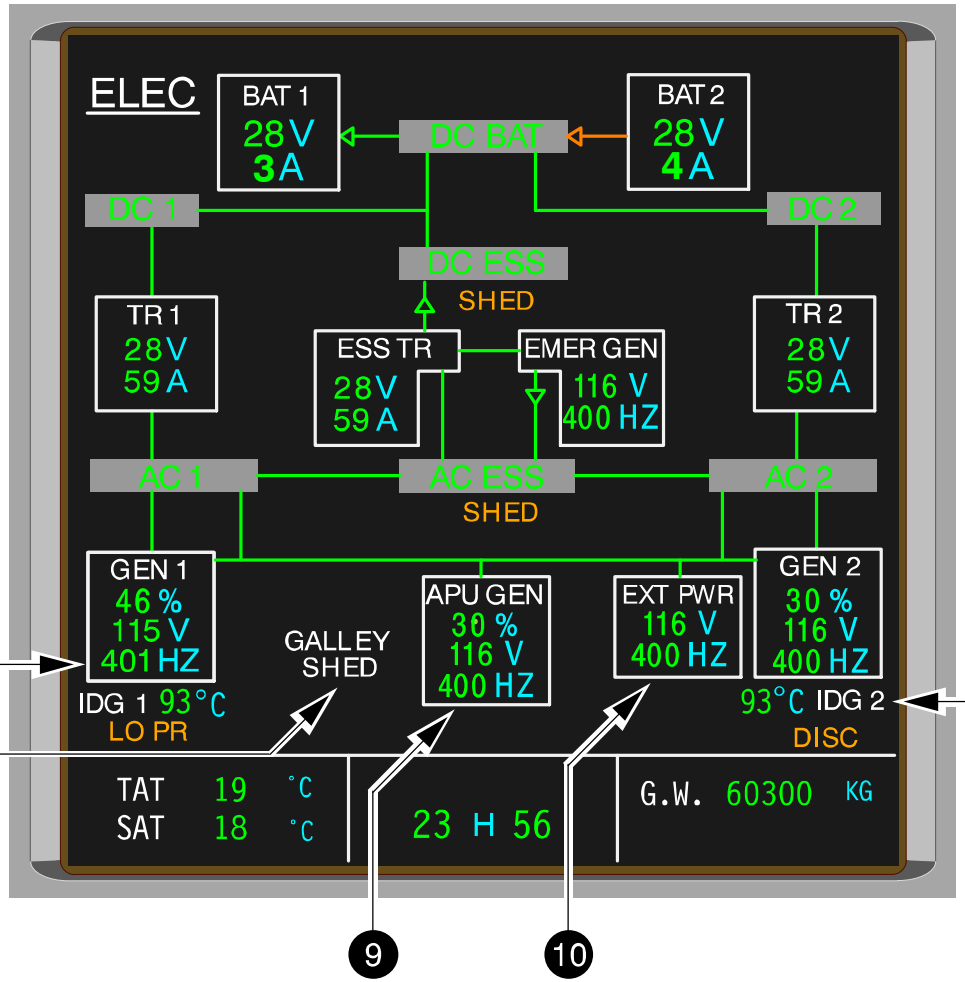
GEN P/BSW in ON:



GEN load indication green.
Becomes amber if load > 110%.

GEN voltage indication green.
Becomes amber if V > 120V or V < 110.

GEN frequency indication green.
Becomes amber if F > 410Hz or <. 390Hz.



11 IDG 1 (2) indication

"IDG" indication
Normally white.
Amber in case of:
- Oil outlet temp > 180° C
- Oil low press
- IDG disconnected

"1" or "2" indication
- white if associated engine running
- amber if stopped

DISC/LO PR indication
- DISC indication appears amber when IDG is disconnected.
- LO PR indication appears amber when IDG low pressure is detected and associated engine is running

Oil outlet temperature
- Normally green
- Advisory if 147° C < T < 180° C
- Amber if T > 180° C

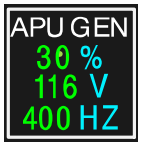
12 GALLEY SHED indication

Appears when galley P/BSW is at OFF, or main galleys are shed either in FLT if one generator is operating or on GND if A/C is supplied by one engine generator only.

9 APU GEN indications

White APU indication irrespective of the APU GEN P/BSW position.

APU P/BSW in OFF

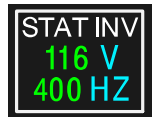


APU P/BSW at ON indications as for GEN 1/2.

10 EXT PWR indications

Shown if external power is available.
EXT PWR is normally white, becomes amber as hereunder:
EXT PWR voltage (green). Becomes amber if V > 120V or if V< 110V

10



Appears during static inverter test or if all normal AC Power loss
Normally green.
Amber if:
V < 110V or V< 120V
F < 390Hz or F > 410Hz

Figure 9 ECAM ELEC Page Presentation (2)

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ELECTRICAL POWER SUPPLY INTRODUCTION

AC BUSES SUPPLY

AC Buses 1 and 2

The supply of the AC buses 1 and 2 and associated sub-buses can be done by one or separated by two of the AC power sources, except external power and APU generator. They cannot supply the buses simultaneous.

If there are several power supplies able to deliver correct voltage simultaneous, **the AC BUS 1(2) are supplied in priority order as follows:**

- By the corresponding Generator [GEN 1(2)]
- By External Power [EXT PWR]
- By the APU Generator [APU GEN]
- Or by the other Generator [GEN 2(1)]

AC Essential Buses

Supply of important loads is provided by the AC ESS and AC ESS SHED buses.

They are normally supplied by AC BUS 1 (AC ESS FEED CNTR1 closed).

In the event of AC BUS1 loss, AC ESS BUS and AC ESS SHED BUS can be manually restored by the transfer of power supply directly from AC BUS2.

In the event of AC BUS1 and AC BUS2 loss (emergency configuration), the AC ESS BUS and AC ESS SHED BUS are restored automatically by the emergency generator (CSM/G) when the RAT (**R**am **A**ir **T**urbine) hydraulic power is available.

In emergency configuration without CSM/G operation (it depends on the aircraft configuration such as speed, landing gear, RAT deployment time), the AC ESS BUS is supplied by the STAT INV (**STAT**ic **INV**erter), which is supplied by BAT1 (**BAT**tery). The AC ESS SHED BUS is no longer supplied.

AC Static Inverter Bus

The AC STAT INV Bus is directly supplied by the STAT INV, if it is in operation. This is the alternate supply for APU fuel pump, engine ignition and some important annunciator lights.

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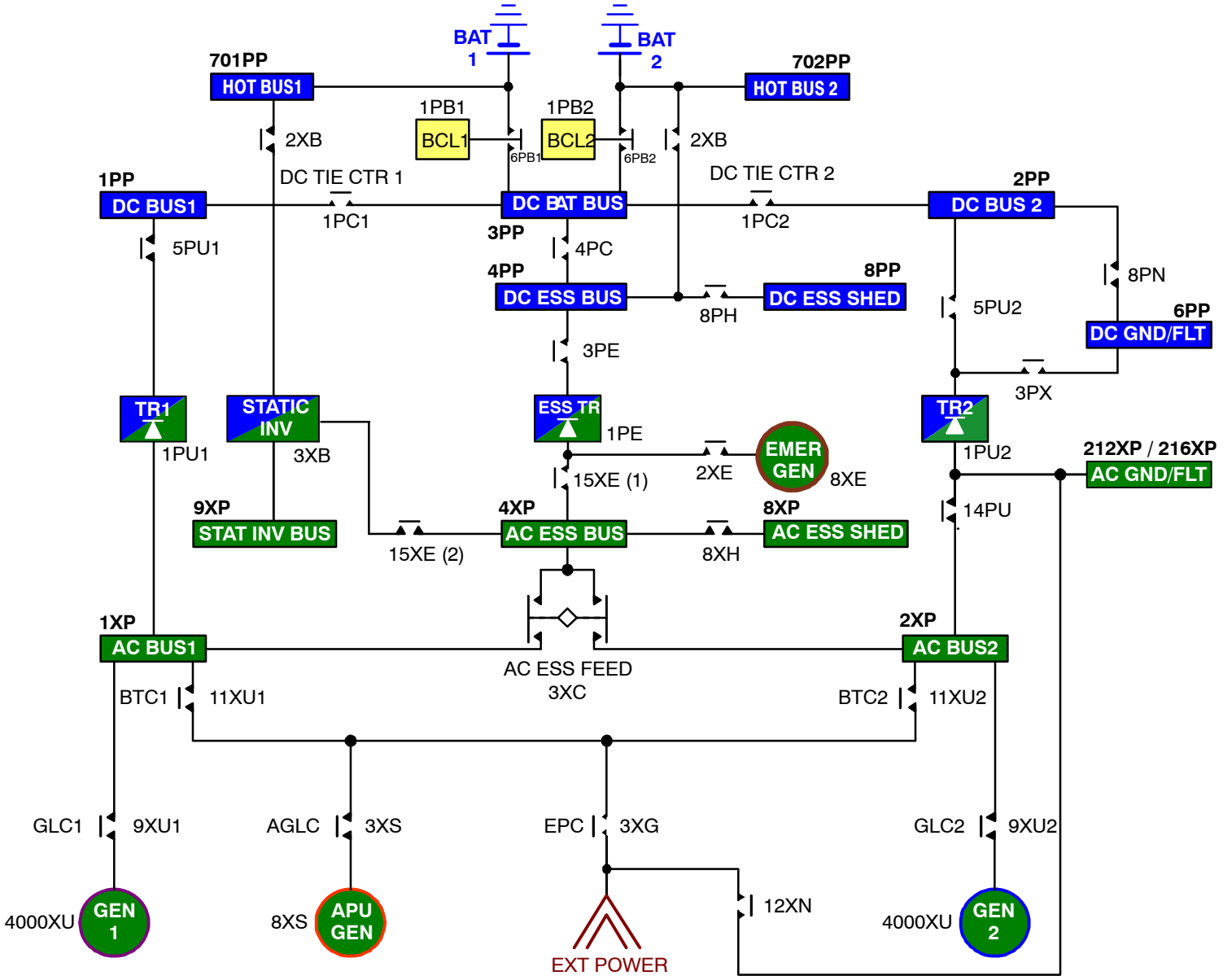

Figure 10 ELEC PWR Supply Basic Schematic

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DC BUSES SUPPLY

DC Bus 1 and 2

The main DC loads are supplied by DC BUS1 and DC BUS2.

Each bus is supplied by one TR (Transformer Rectifier):

- DC BUS1 by TR1
- DC BUS2 by TR2

There is no connection between the two TRs

(DC TIE CNTR 2 is normally open).

If there is a loss of one TR the other takes over automatically the supply of both DC buses (DC TIE CNTR 1 and 2 are closed).

DC Essential Buses

Essential DC loads are supplied by DC ESS BUS and DC ESS SHED BUS.

They are normally supplied by TR1 via DC BUS1 and DC BAT BUS

(ESS DC TIE CNTR is closed). For that the TR2 must also be in operation.

If there is a loss of TR1 and/or TR2 the ESS TR takes over automatically the supply of the DC ESS BUS and DC ESS SHED BUS.

For that the ESS TR is supplied by the AC ESS BUS

(AC ESS EMER CNTR1 is closed).

In emergency configuration or smoke configuration, when the EMER GEN is in operation, the ESS TR is supplied by this generator. Without operation of the EMER GEN, BAT2 automatically takes over the supply of the DC ESS BUS (STAT INV CNTR is closed). In the last case the DC ESS SHED BUS is no longer supplied.

DC Battery Bus

The DC Battery Bus (DC BAT BUS) is normally supplied by TR1 via DC BUS1 (DC TIE CNTR1 is closed).

If TR1 is loss TR2 automatically takes over the supply of the DC BAT BUS

(DC TIE CNTR1 and 2 are closed).

If there is a loss of both TRs (1 and 2) the DC BAT BUS also is power loss.

If BAT1 and BAT2 are the only power sources, the DC BAT BUS is supplied by them, but only on ground.

GROUND SERVICE SUPPLY

A ground service circuit enables the supply of AC and DC equipment by external power for maintenance purposes, without the necessity of supplying the whole network (AC SVCE BUS and DC SVCE BUS).

The control takes place through a switch outside the cockpit.

The service buses are also supplied during normal network configuration which is in priority.

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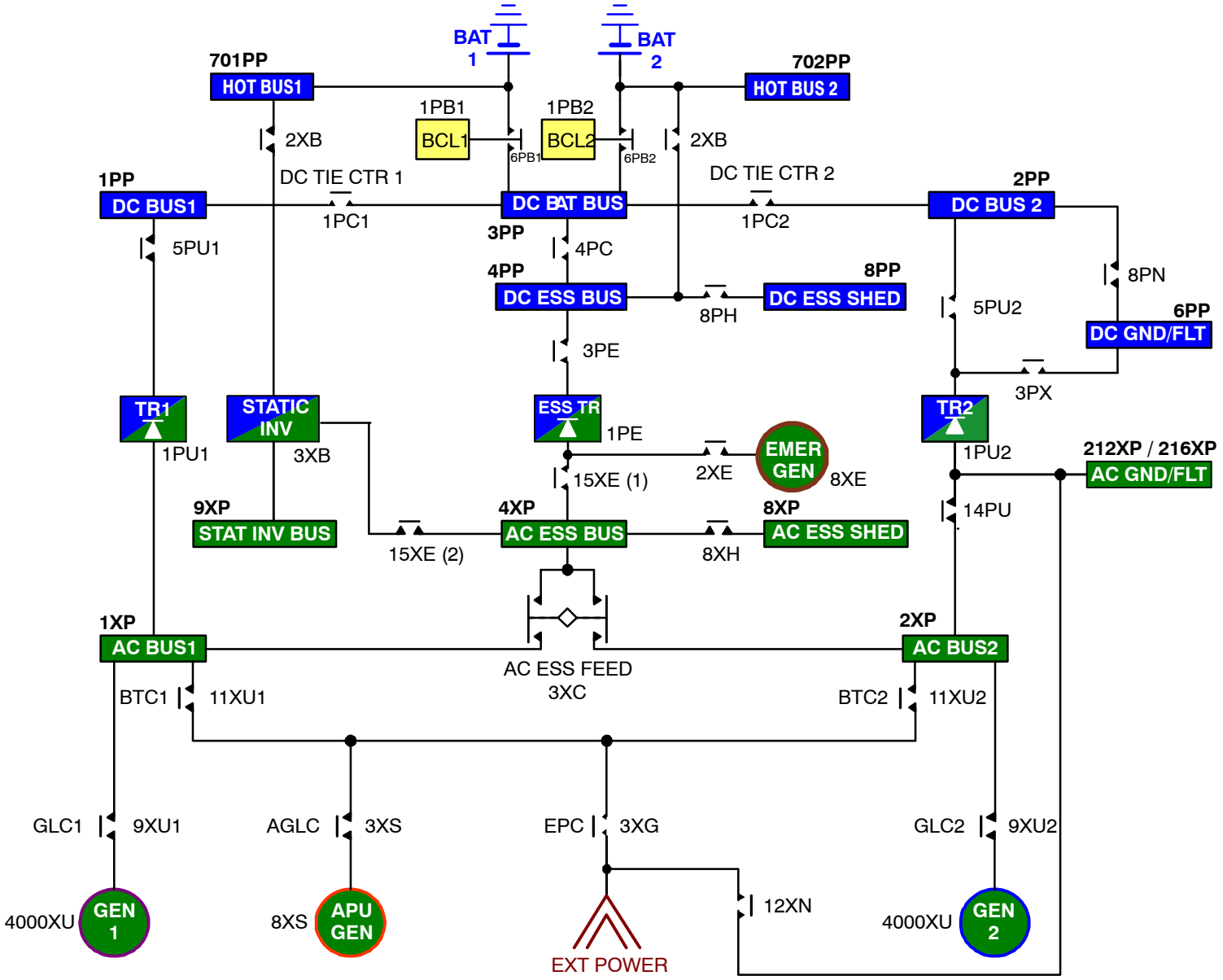

Figure 11 ELEC PWR Supply Basic Schematic

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AC CONTROL DESCRIPTION

Generator Control Units

Three identical GCUs (**G**enerator **C**ontrol **U**nits) are installed for the three generator systems (GEN1, 2 and APU).

The main functions of the GCUs are:

- generator voltage regulation by providing the field current,
- network and generator protection:
  By control of the associated GLC and the generator field current,
- providing of BITE information to the GPCU,
- control of warnings associated with the corresponding channel.

Emergency Generator Control Unit

For the CSM/G (**C**onstant **S**peed **M**otor/**G**enerator) system an EMER GCU (**EMER**gency **G**enerator **C**ontrol **U**nit) enables full control.

The main functions of the EMER GCU are:

- Servo–Valve Excitation Control for speed regulation,
- Generator Voltage Regulation by the field current,
- network and the generator protection:
  By control of the associated GLC and the generator field current.

Ground Power Control Unit

For the external power system a GPCU (**G**round **P**ower **C**ontrol **U**nit) serves:

- protection for the network by control of the EPC (**E**xternal **P**ower **C**ontactor)
- providing BITE information from external power and the three generator systems (1, 2 and APU) to the CFDS.

Cockpit Controls

Mechanical locked respectively spring–loaded pushbutton–switches on the cockpit overhead panel serve to transmit ON and OFF signals to the GCUs, GPCU, ESS BUS, BTCs and GLC1–switching.

For the emergency generator system one switch serve to manual control the system in emergency configuration if necessary, and one switch to initialize an operational test on ground (EMER GEN TEST).

Two spring–loaded switches are available to control the disconnect device of the IDGs.

Annunciator‘s integrated in the pushbutton switches show the condition of the IDGs (drive part and generator), external power, essential supply, BTCs and GLC1.

In accordance with the philosophy of the A 320, the pushbutton–switches have to be in such a position, that all annunciator lights are extinguished when the network is normal supplied.

BTC Control

The control of the two BTCs (**B**us **T**ie **C**ontactors 1 and 2) happens automatically. It depends on the position of the other contactors (GLC1, 2, APU and EPC). The BTCs can be switched off by one common pushbutton–switch (BUS TIE OFF).

AC Essential Bus Supply

The supply of the AC ESS BUS takes place as follows:

- Normally by the AC BUS 1 (automatic)
- Alternative by the AC BUS 2 (manually controlled by the AC ESS FEED P/BSW or automatically after modification related to SB)
- In Emergency or Smoke Configuration by the EMER GEN or STAT INV in flight (automatically or manually)

Monitoring

The centralized monitoring of the AC network happens via the ECAM (**E**lectronic **C**entralized **A**ircraft **M**onitoring) System.

Failure informations in detail are given via the CFDS (**C**entralized **F**ault **D**isplay **S**ystem).

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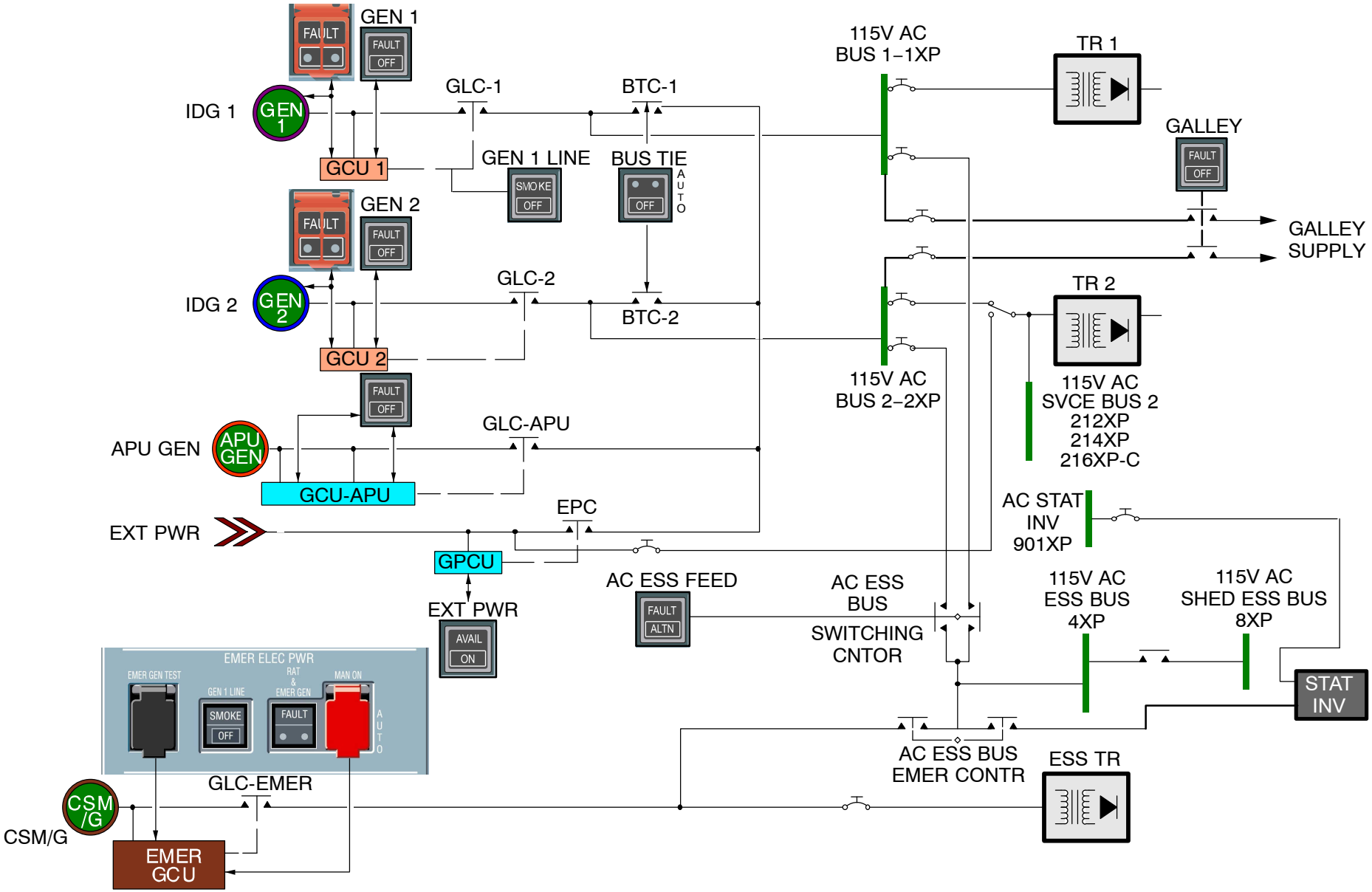

Figure 12 AC Generation & Distribution Schematic

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DC CONTROL DESCRIPTION

Transformer Rectifier

The TR1, TR2 and ESS TR supply their corresponding DC buses (1, 2, ESS) through contactors, which are automatically controlled by the respective TR.

In case of a faulty TR the TR–contactor opens automatically and remains open locked. A reset is possible either through the CFDIU (**C**entralized **F**ault **D**isplay **I**nterface **U**nit) via a MCDU (**M**ultipurpose **C**ontrol **D**isplay **U**nit), or through a Reset P/BSW on the relay–panel 103VU in the right lateral avionics compartment.

DC Tie Contactors

The contactors (DC TIE CNTR) between the DC buses (1, 2, ESS, BAT) are controlled automatically through relays logics.

Battery Charge Limiters

Two identical BCLs (**B**attery **C**harge **L**imiters) serve to control each battery contactor when the corresponding BAT P/BSW is in the AUTO position. The battery contactors connect the batteries with the BAT BUS.

The batteries are loaded via the BAT BUS normally through the TR1, or supply the BAT BUS if they are the only power supply.

Each BCL includes a BITE and self monitoring system which analyzes the faults of the internal or peripheral information. Initiation of the test is possible via the CFDS or at each power up on ground.

Each BCL delivers electrical parameters and warning concerning each battery to the lower ECAM display unit.

In order to monitor the battery voltage without ECAM available there are two digital DC volt–meters on the overhead panel. They are directly connected to each battery via the DC HOT BUS and through a control C/B.

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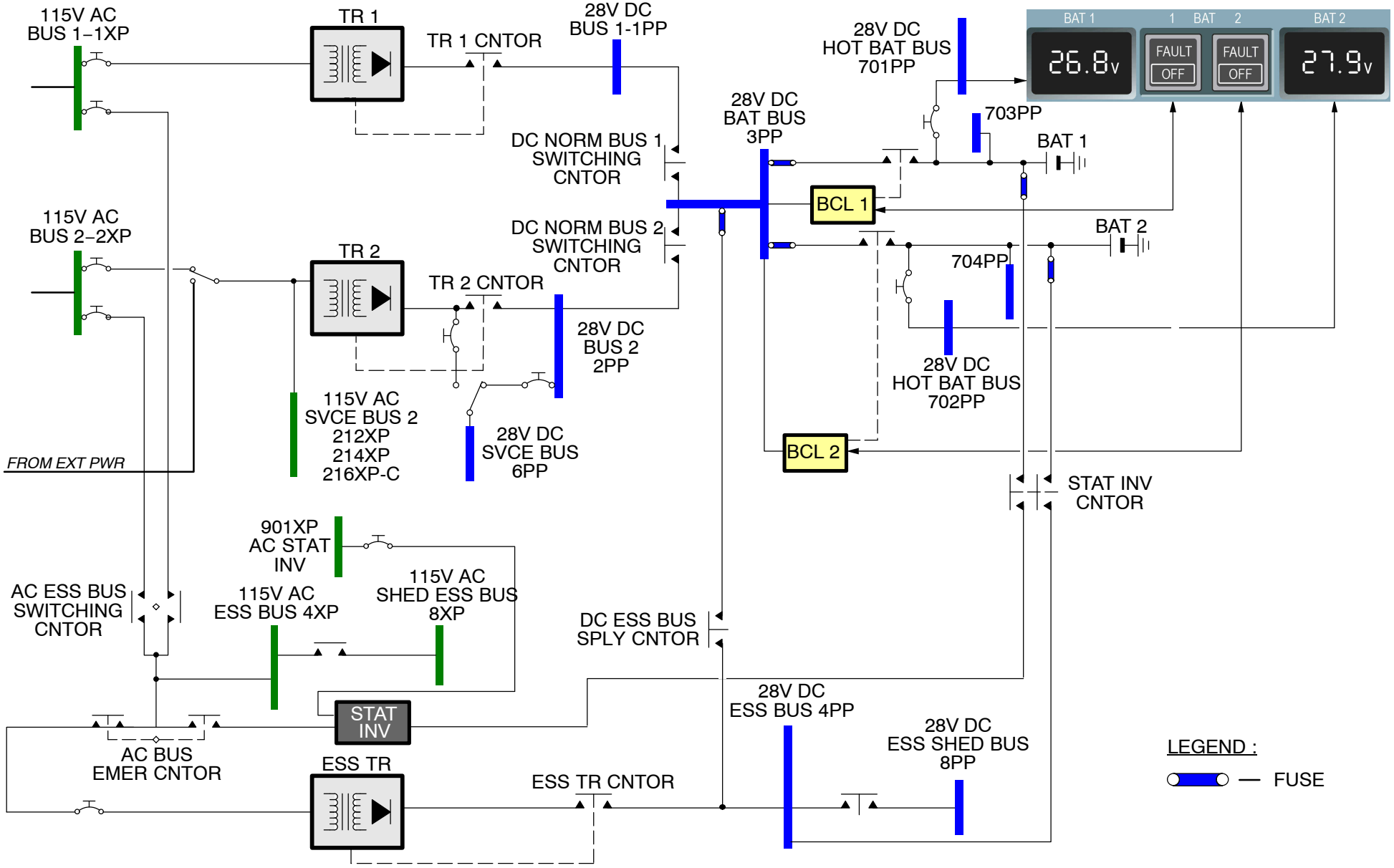

Figure 13 DC Generation & Distribution Schematic

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ELEC–ECAM/CFDS COMMUNICATION FUNCTION

ELEC–CFDS

The line and hangar maintenance of the electronic systems on the A320 family is based on the use of the CFDS (**C**entralized **F**ault **D**isplay **S**ystem).

The purpose of the CFDS is to give the maintenance personal a central maintenance aid for trouble shooting.

From the MCDUs it is possible

- to read the maintenance information and
- to initiate various tests.

The electrical power components connected to the CFDS are as follows:

- GPCU
- BCL 1, 2
- EMER GCU
- TR 1, 2, ESS

The GPCU and BCLs can memorize fault codes and communicate with the CFDIU (**C**entralized **F**ault **D**ata **I**nterface **U**nit) via ARINC 429 buses.

The EMER GCU and the three TRs are connected to the CFDIU by a discrete link. For these units it is only possible to know the systems status (ok or faulty) during SYSTEM REPORT/TEST sequence.

NOTE: The GCU 1, 2 and APU are continuously monitored by the GPCU.

The GPCU stores in the memory the failure codes acquired by the GCUs.

The GPCU then transmits to the CFDIU all the failure codes thus acquired together with the failure codes from the GPCU and the external power system.

ELEC–ECAM

A synoptic of the electrical network and STATUS informations are displayed on the ECAM system/status display (lower display).

Warnings or cautions appear on the engine/warning display (upper display).

For that some parameters are given directly by the AC and DC systems to the SDACs 1 and 2.

The parameters from the AC generation systems (1, 2, APU, EXT PWR) are transmitted to the SDACs in digital via two EGIU (**E**lectrical **G**eneration **I**nterface **U**nits).

The main functions of the EGIU is to process the parameters from the GCU and associated generator. The EGIU then transmits the information to the cockpit (ECAM) via the SDACs.

Two EGIUs are installed on the aircraft.

One EGIU is associated with the GCU 1 and GPCU.

This EGIU receives parameters in analog and discrete form from:

- GEN 1 on channel 1 and
- external power on channel 2.

Each channel sends its own parameters to SDAC 1 and SDAC 2 through two own isolated ARINC 429 data links.

The second EGIU is connected in the same manner to generator 2 and to the APU generator.

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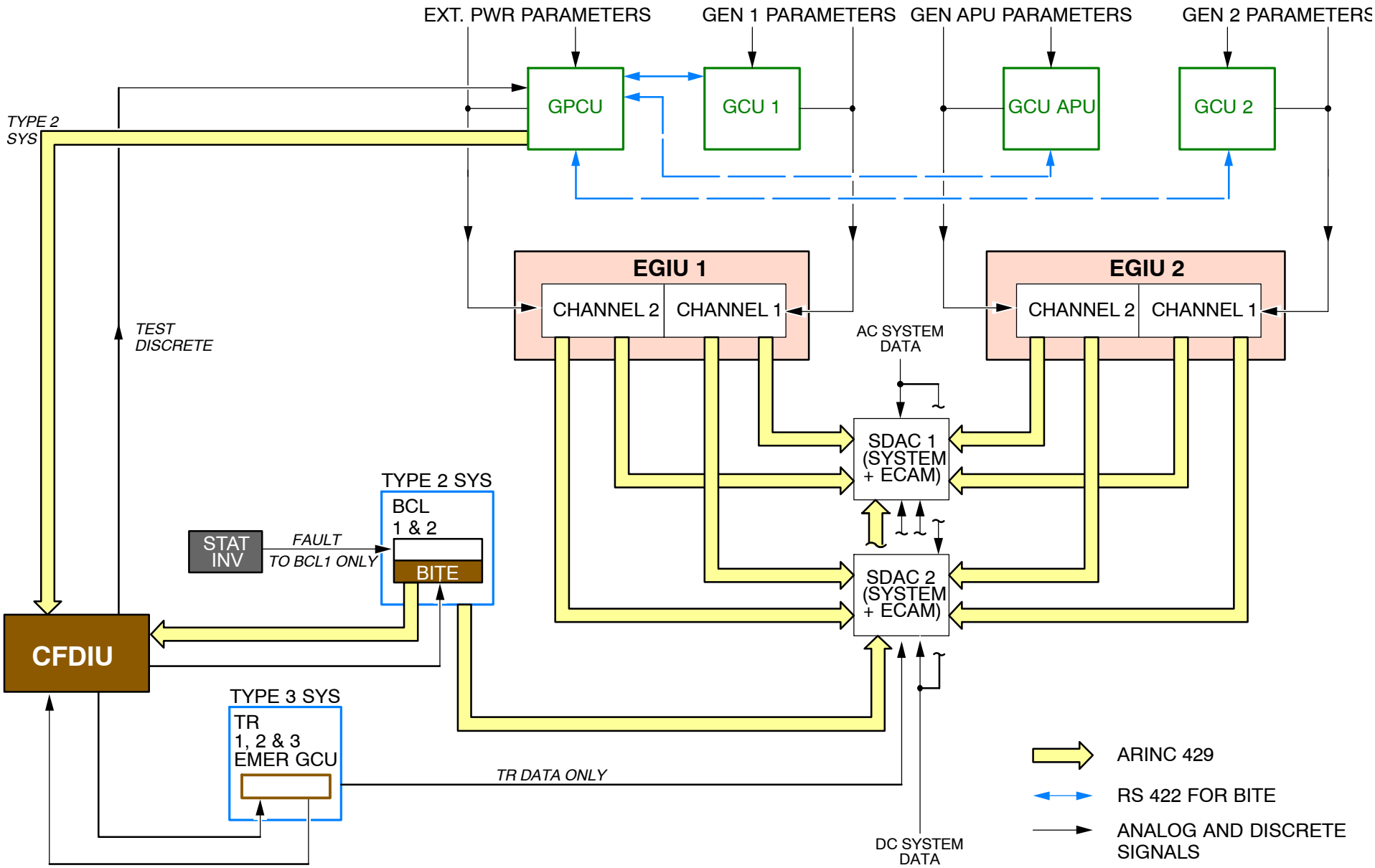

Figure 14 ELEC–ECAM/CFDS Communication

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24–21 INTEGRATED DRIVE GENERATOR SYSTEM (IDG, GCU)

IDG–SYSTEM PRESENTATION

Each engine (HP rotor) drives its associated main generator through the accessory gearbox and via an integrated hydromechanical speed regulator which transforms the engine variable speed into constant speed for the generator.

Thus the IDG provides a 400 Hz constant supply.

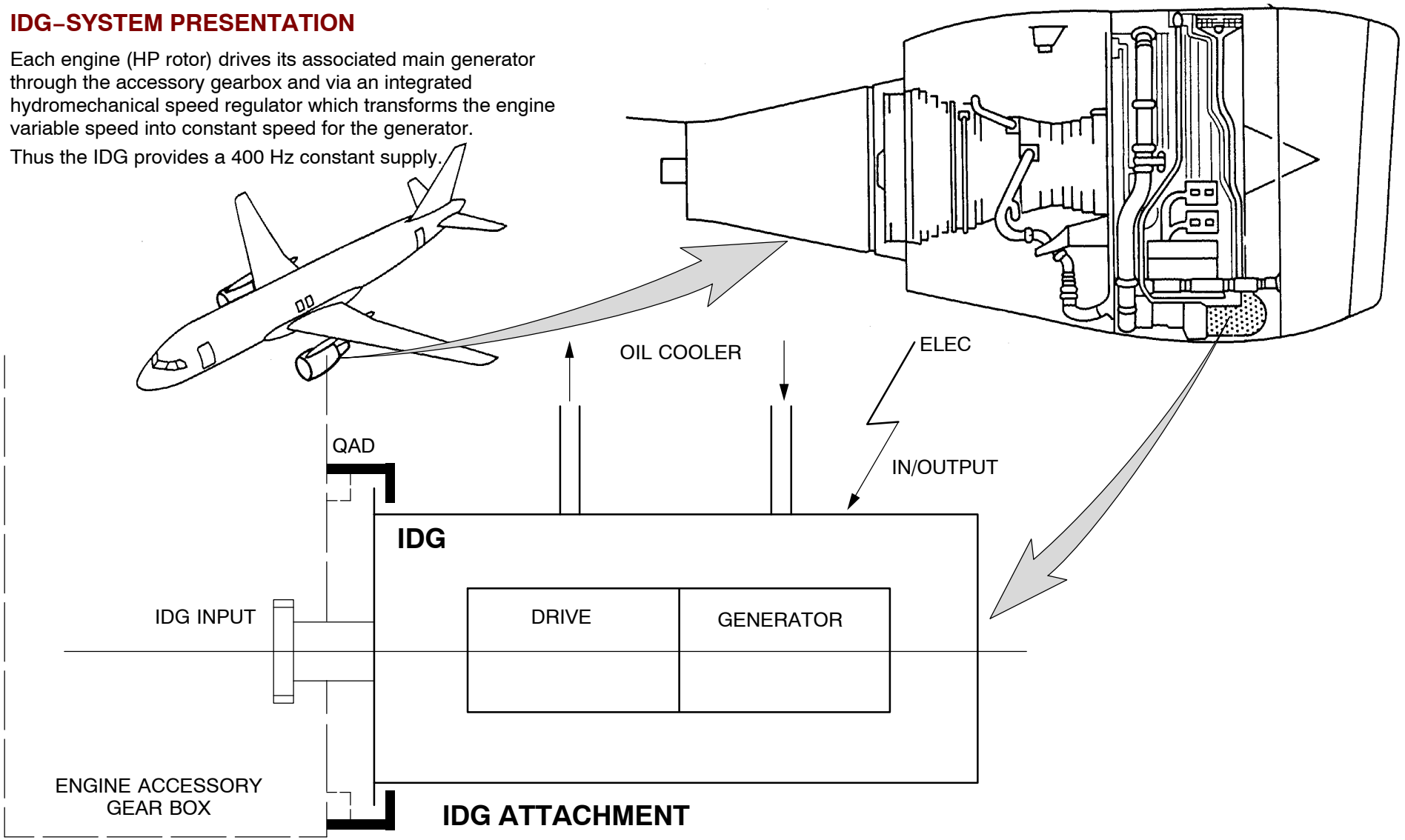

Figure 15 IDG Location - CFM Engine

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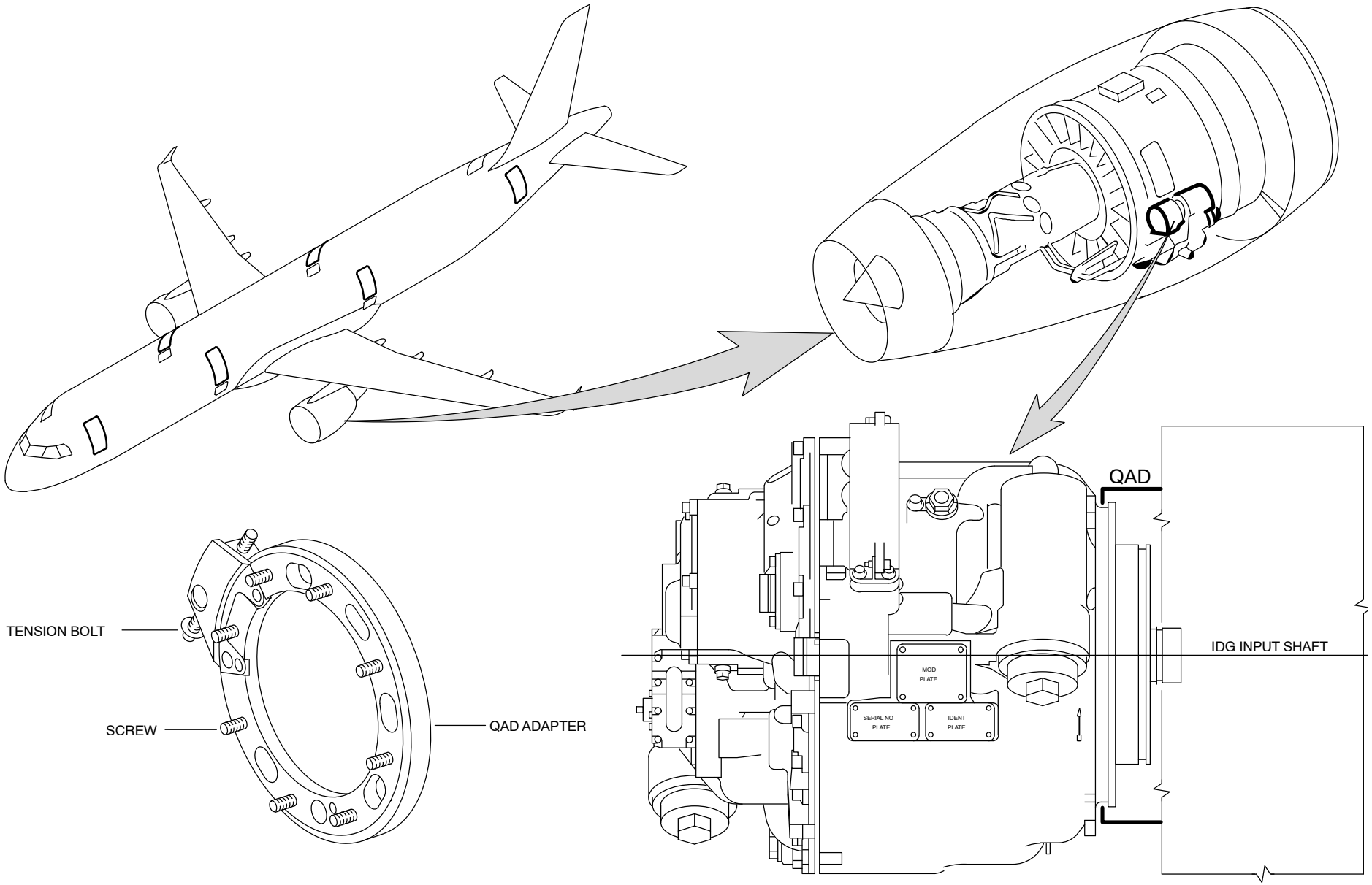

Figure 16 IDG Location - IAE Engine

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IDG DRIVE SPEED/CONVERSION OPERATION

GENERAL

Each engine (HP rotor) drives its associated IDG through the accessory gearbox.

The IDG can be split into two parts:

- The AC generator which has to be driven at constant speed to supply the loads with constant frequency and
- the drive which transforms the engine variable speed into constant speed for the generator.

The unit is lubricated and cooled by an own oil system.

DRIVE OPERATION

A mechanical epicyclic differential gear transmits power to the generator portion of the IDG.

- input speed:

  between 4500 and 9150 rpm;
- output speed:

  12000 rpm constant

The speed of mechanically coupled twin hydraulic sub–assemblies modify the differential output speed.

Each sub–assemblies consists of a hydraulic swashplate pump/motor:

- One with a fixed swash angle and
- the other with a variable swash angle.

The input shaft has a shear neck. Its primary duty is to protect the engine gearbox. But it also serves to safeguard the IDG against further damage.

In case of abnormal function of the IDG drive part it is possible to disconnect the IDG manually.

Disconnection is irreversible in flight.

The system can only be reconnected on the ground with engines shut down.

GENERATOR

The generator is a three stage machine with the three component machines connected in cascade.

Pilot Exciter

The first machine (pilot exciter) is a twelve pole PMG (**P**ermanent **M**agnet **G**enerator).

The output from the PMG stator winding:

- Has a generator excitation function and
- provides power for other components of the electrical system of which the generator forms part (supply of the GCU, EGIU and the external relays and contactors). The generator is thus ”self–flashing” and ”self–sufficient”.

Main Exciter

The second machine (main exciter) receives its fields excitation from the pilot exciter via the voltage regulator in the GCU to a 10 poles stator. This creates a stationary field. Rotating diodes rectify the three phase output of the main exciter rotor.

This output feeds the main rotor winding.

Main Alternator

The third machine (main alternator) receives excitation for the rotating salient four pole field from the rectified output of the main exciter.

The main alternator has a three phase star connected stator winding. The three phases and star point are taken to the generator output terminations.

The generator is designed for use with an external voltage regulator forming part of the GCU.

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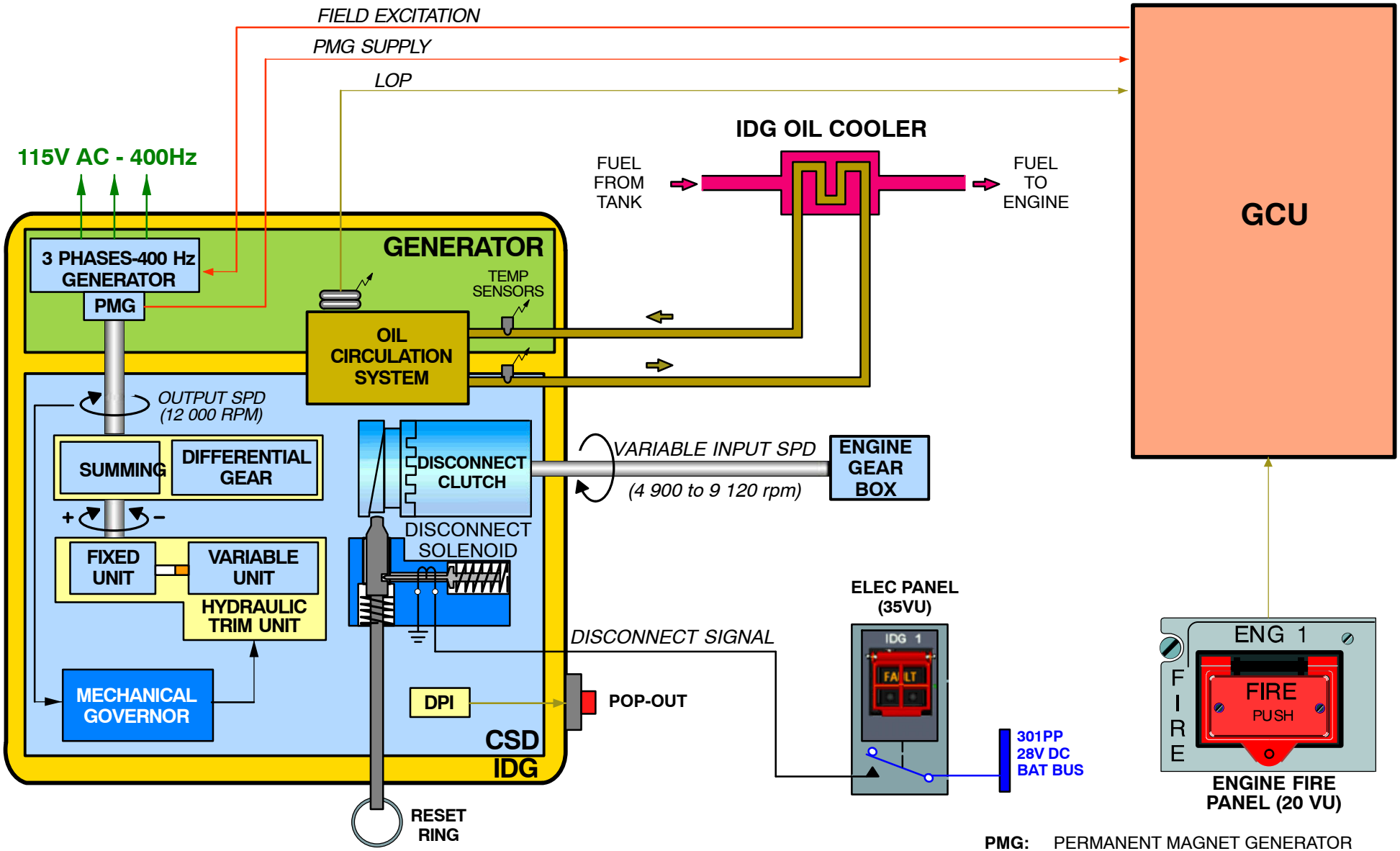

PMG: PERMANENT MAGNET GENERATOR
DPI: DIFFERENTIAL PRESSURE INDICATOR

Figure 17 IDG Drive/Speed Conversion

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IDG OIL SYSTEM PRESENTATION

The IDG has a self contained oil system except for the heat–exchanger.

Positive displacement scavenge pump pumps the oil (via the IDG filter) to the aircraft heat exchanger and return it to the IDG.

The charge oil supply of cleaned, cooled deaerated oil is provided as a bus.

This oil supply feeds:

- The differential hydraulic units,
- the generator,
- the governor,
- the control piston.

The lubrication jets are individually supplied.

The deaerator supercharges the inlet of the charge pump with solid oil.

The charge pump pressurizes the oil against the charge relief valve.

It provides thus regulated supply pressures to:

- The hydraulics,
- the controls,
- the differential,
- the generator,
- the various lubrication and cooling nozzles.

A differential pressure indicator is provided to show when the filter element is clogged. The sensing device for the differential pressure is automatically suppressed during cold oil running conditions. This avoids spurious operation due to high oil viscosity.

Similarly, a cooler by–pass valve is fitted within the IDG. The valve opens on a rising pressure to short circuit the cooler during cold oil operation.

A scavenge pump relief valve limits the supply pressure of the scavenge system.

A vent valve releases internal case pressure if necessary.

A quick fill coupling situated on the transmission casing enables pressure filling or topping up the unit with oil.

The oil thus introduced flows to the transmission via the scavenge filter and external cooler circuit.

This ensures:

- The priming of the external circuit and
- the filtration of any oil introduced.

An internal standpipe connected to an overflow drain ensures a correct quantity of oil.

You can read the oil level through two sight glasses located on the IDG. One for the CFM 56 engine, the other one for the V 2500 engine.

Oil temperature sensors monitor the temperature of both the input and output oil and therefore allow overheat detection.

A pressure switch operates in the event of a loss of the charge oil pressure.

In both cases (overheat and loss of pressure) a warning is provided to the cockpit.

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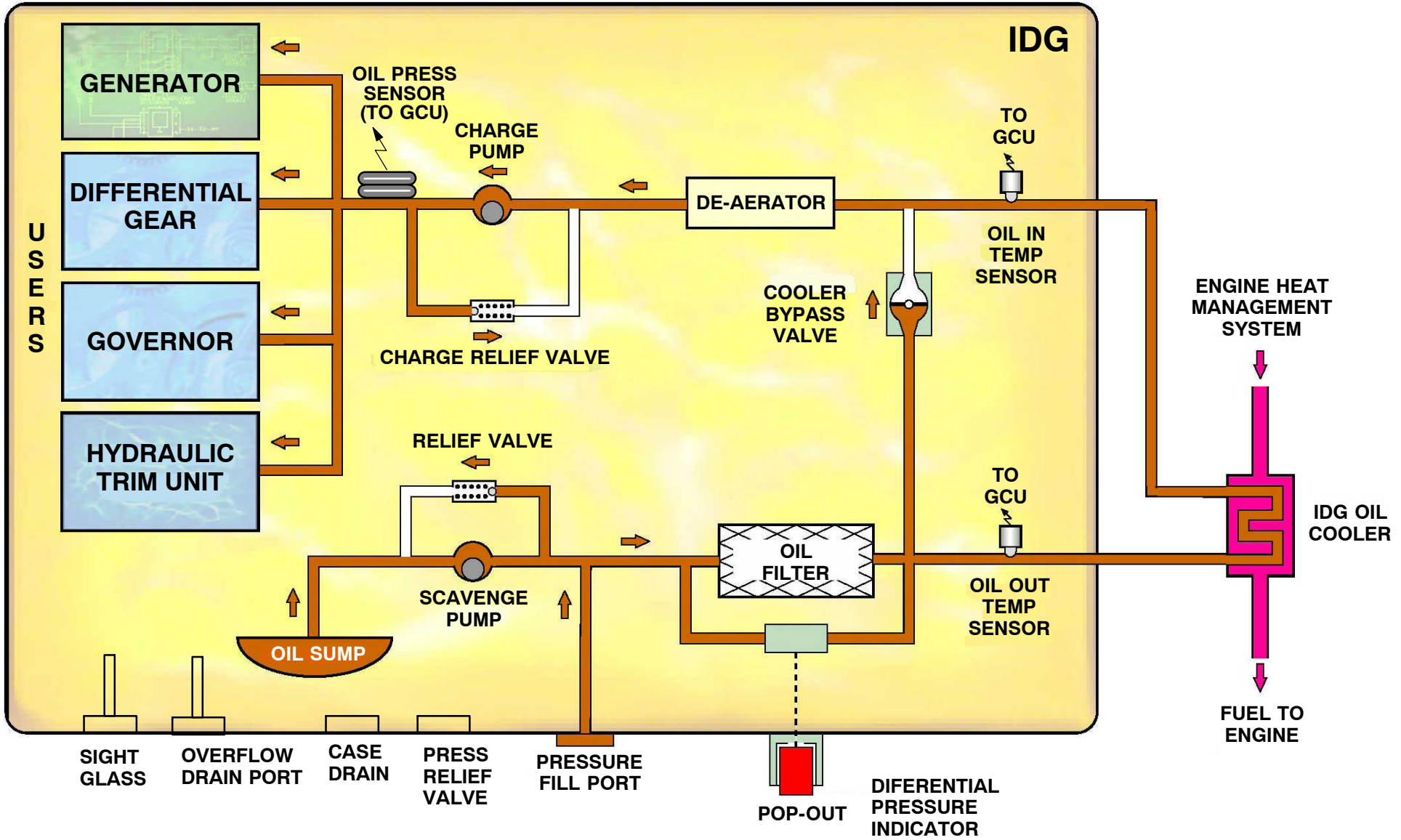

Figure 18 IDG Oil System Schematic

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IDG CONTROL/INDICATION OPERATION

Control and Indicating Circuits

The main parameters of the drive part of the IDG such as

- oil in and oil out temperature,
- system pressure and
- drive speed

are continuously monitored by the GCU.

All information (normal and abnormal) which are necessary for the ECAM system are acquired by the respective EGIU (**E**lectrical **G**eneration **I**nterface **U**nit).

Controls and Indications

An oil temperature sensor monitors the oil inlet temperature and the other one the outlet temperature.

The second enables oil temperature ADVISORY and OIL OVERHEAT detections.

A pressure switch operates in the event of a low charge oil pressure.

In case of:

- low oil pressure or
- IDG oil overheat (outlet temperature > or = 185 °C),

the warnings are provided to the cockpit:

- FAULT legend on the corresponding IDG P/BSW.
- MASTER CAUTION lights
- single chime and
- messages on the E/WD and SD.

The oil outlet temperature is displayed on the SD ELEC page.

When the oil temperature reaches a predetermined value (142 °C), an advisory mode is available on the SD.

The low pressure warning is inhibited, for IDG input speed below 2000 rpm (normal input speed range: between 4500 and 9120 rpm).

IDG DPI Reset

When the DPI pops out and there is no CFDS message generated:

- replace the IDG (4000XU),
- or do the alternate procedure (IDG DPI reset).

The alternate procedure lets you do a reset of the DPI as an alternative to the replacement of the IDG.

There are conditions related to this procedure:

- A maximum of three resets is permitted
- After a DPI reset, the DPI check interval becomes:
  - For normal operations: weekly or 100 FH (the one that comes first).
  - For Extended Range Twin–Engined Aircraft Operations (ETOPS): before each flight.

If, after a DPI reset, the DPI does not extend again between two scheduled oil/filter changes, you can cancel the conditions related to this procedure:

- The DPI reset status goes back to zero (a maximum of three more resets is permitted).
- The DPI check interval goes back to the interval specified in the MPD.

If this is the first reset:

- Do a check of the IDG1 oil filter(s) and the cover(s) for metal particles
- If you find metal particles replace the IDG (4000XU)
- If you do not find metal particles drain the oil, replace the oil filter(s) and fill the IDG1 with oil and do a reset of the DPI.
- Use a sticker, tag or other method to write on the IDG that you did the first reset of the DPI.

If this is NOT the first reset:

- Do a check of the number of reset and if three resets were done replace the IDG (4000XU)

If there were less than three resets:

- Do a check of the IDG1 oil filter(s) and the cover(s) for metal particles
- If you find metal particles replace the IDG (4000XU)
- If you do not find metal particles drain the oil, replace the oil filter(s) and fill the IDG1 with oil and do a reset of the DPI.
- Use a sticker, tag or other method to write on the IDG that you did the second or third reset of the DPI.

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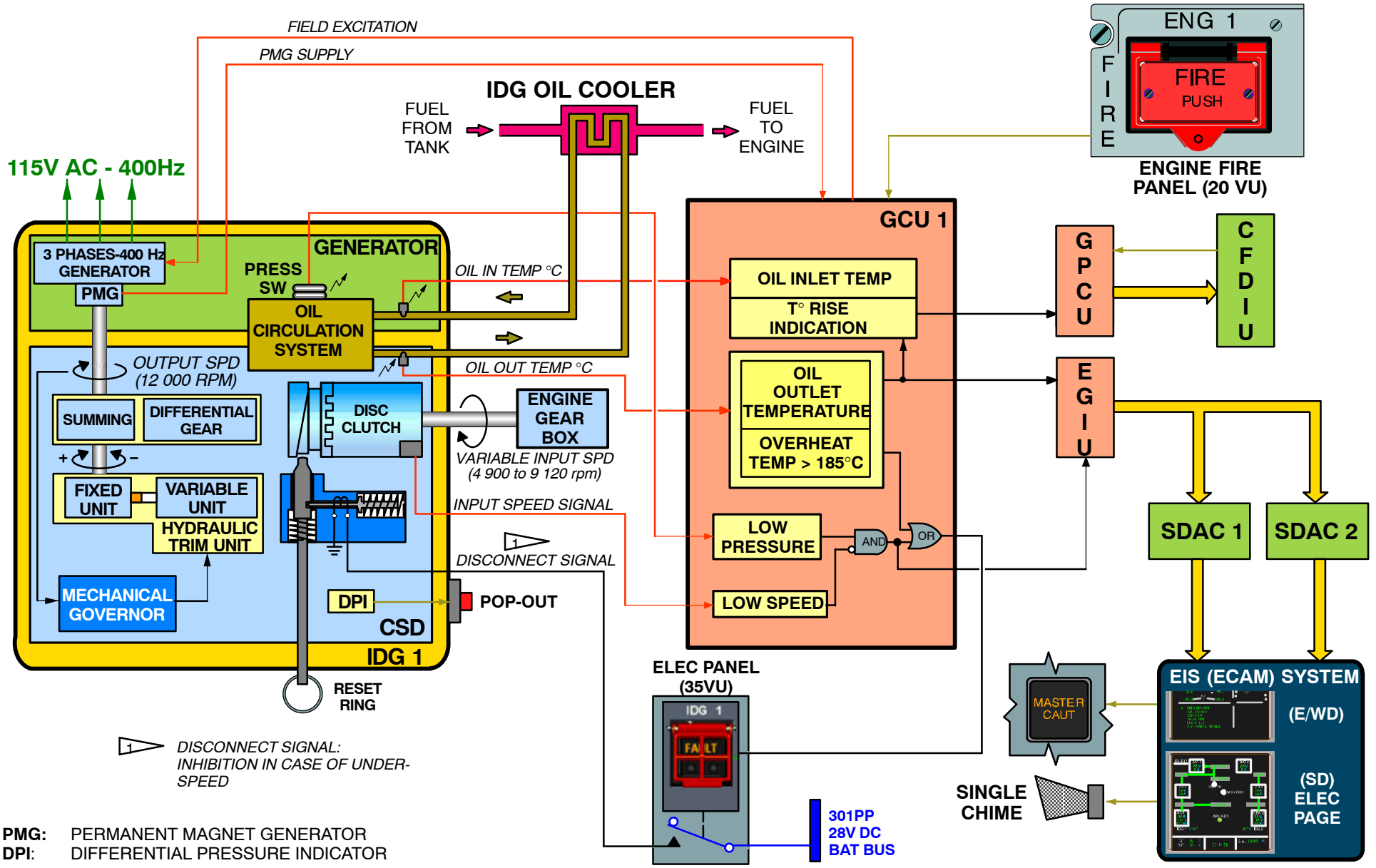

PMG: PERMANENT MAGNET GENERATOR
DPI: DIFFERENTIAL PRESSURE INDICATOR

Figure 19 IDG Control/Indication

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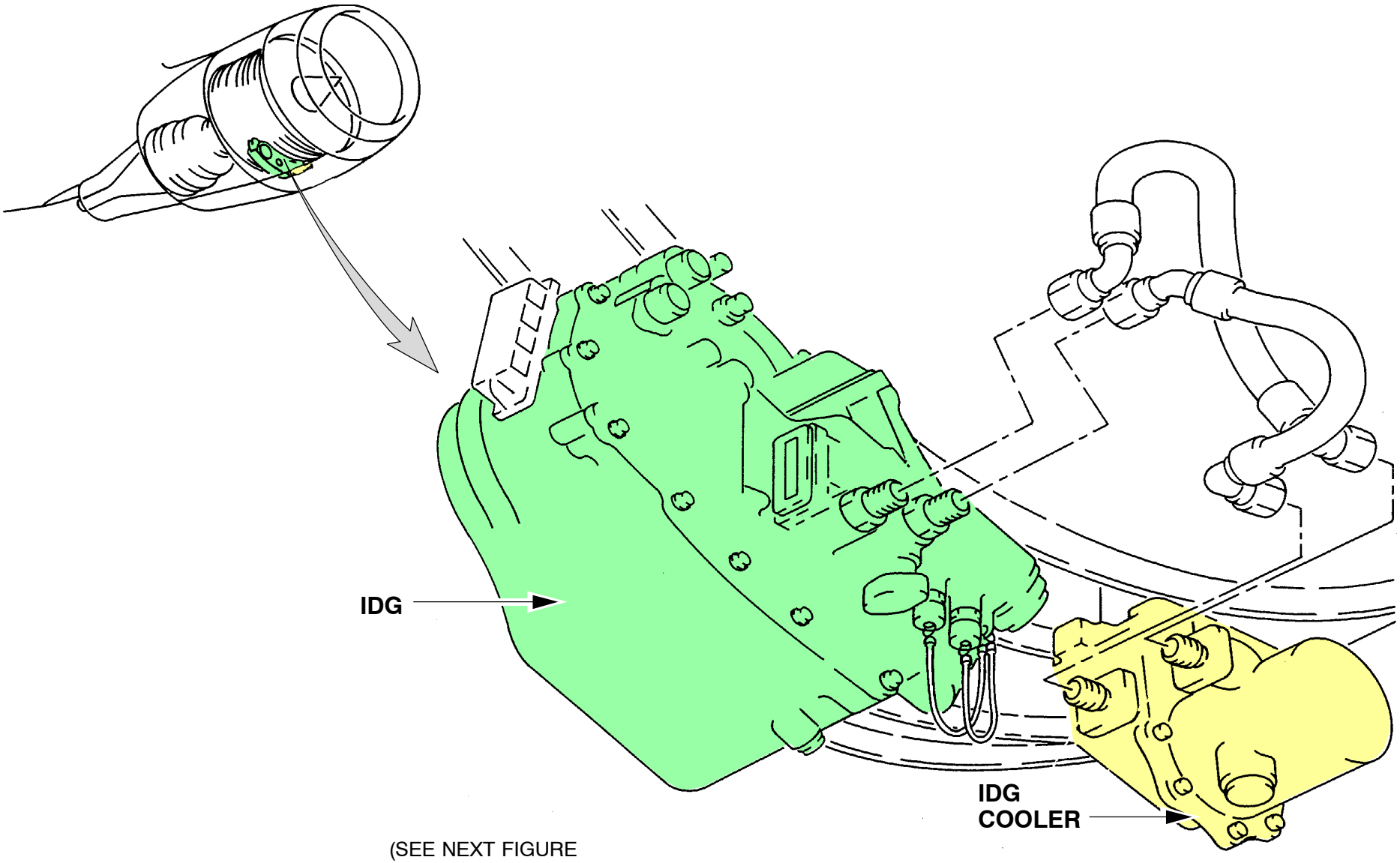

Figure 20 IDG Oil Cooler Location

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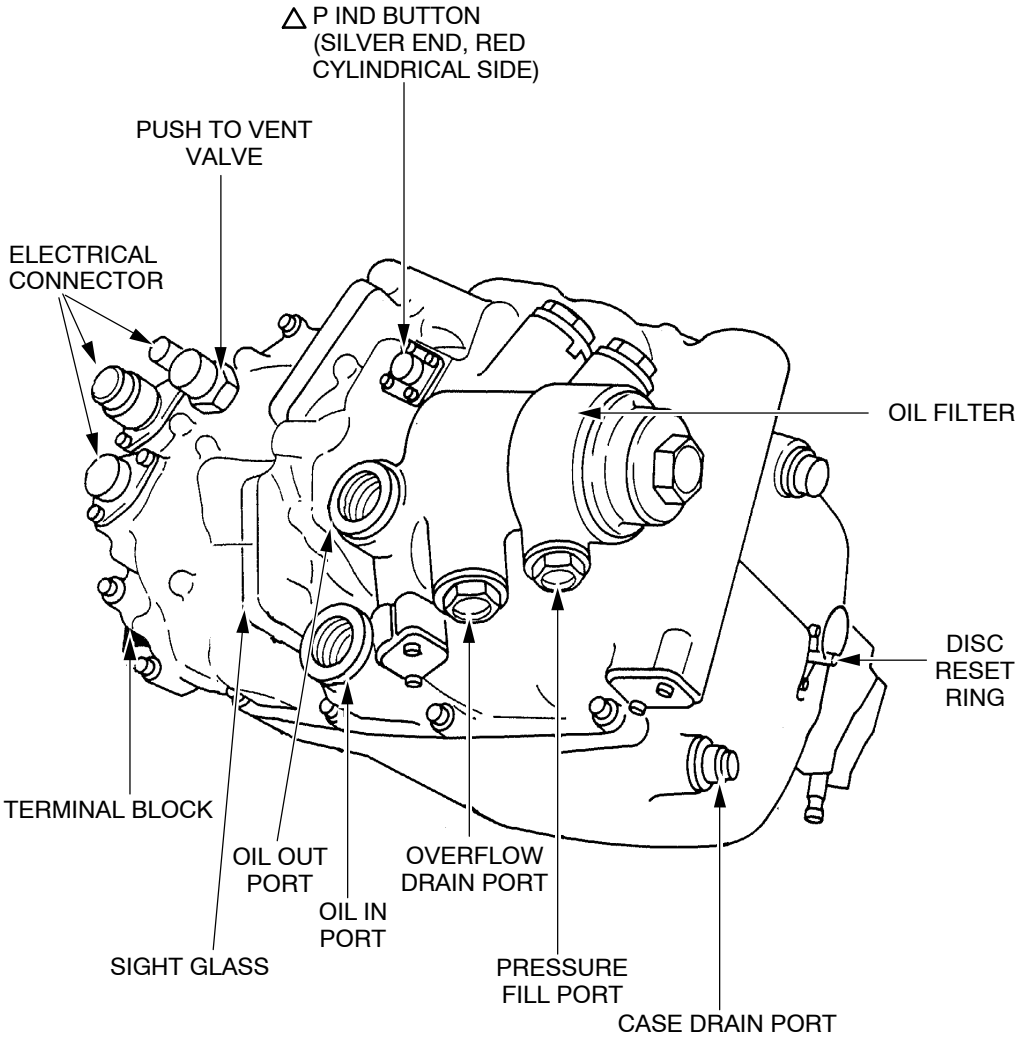

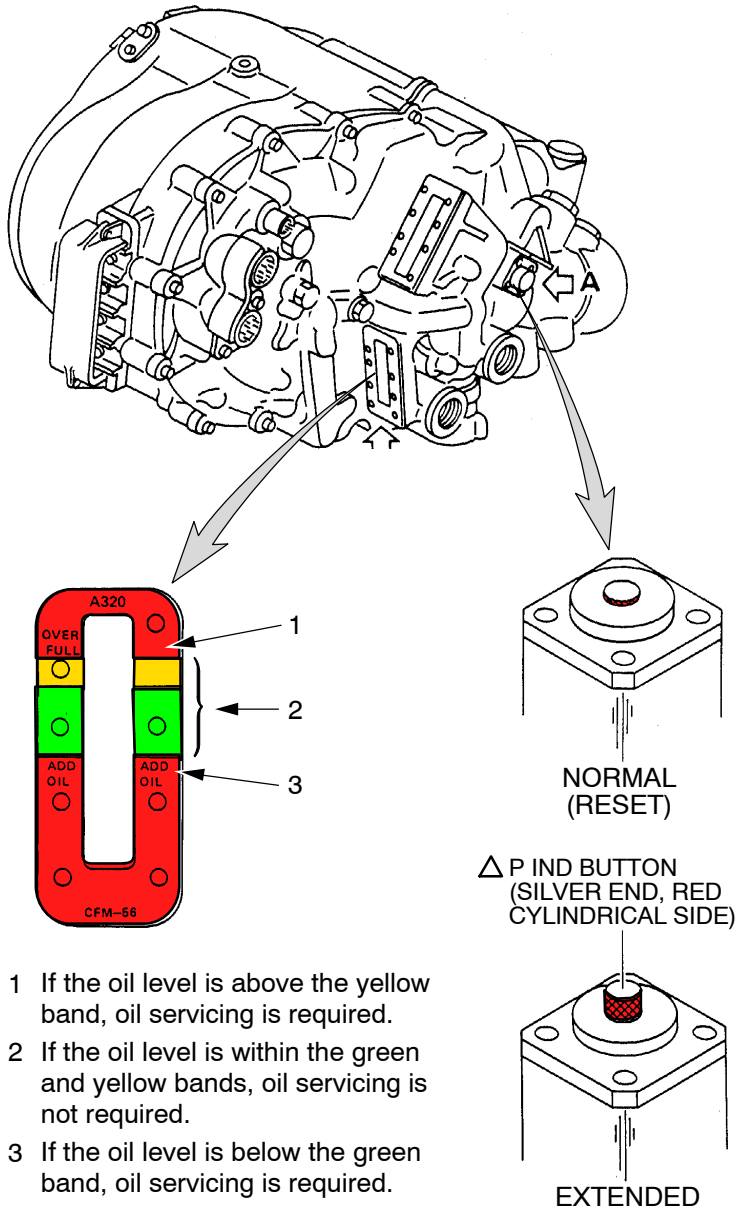

NOTE:

1 If the oil level is above the yellow band, oil servicing is required.

2 If the oil level is within the green and yellow bands, oil servicing is not required.

3 If the oil level is below the green band, oil servicing is required.

Figure 21 IDG Components Location

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IDG SYSTEM OPERATION

General

Two identical GCUs (**G**enerator **C**ontrol **U**nits) serve for controlling and monitoring of the engine driven generator–systems.

Their functions are as follows:

- regulation of the generator voltage,
- control and protection of the generator–system and network,
- control of various warnings and indications,
- self–monitoring and test of the system (BITE).

Voltage Regulation

The voltage regulation is performed by regulating the generator excitation current: the voltage is kept at the nominal POR (**P**oint **O**f **R**egulation).

The POR is located in the electrical power center at the end of the generator feeder, upstream of the line contactor.

Analog circuits achieve the regulation.

The PMG provides directly the excitation supply via the GCR (**G**enerator **C**ontrol **R**elay). The excitation supply is rectified. Then a chopper amplifier (pulse width modulation) controls the excitation supply.

The regulation is achieved using a signal proportional to the average of the three line to neutral voltages at the input.

Protection and Generator Control

These functions mainly consists of generator excitation, GLC (**G**enerator **L**ine **C**ontactor) control and BTC (**B**us **T**ie **C**ontactor) lockout (DP lockout).

The excitation is controlled via the GCR. The generator line contactor is controlled via the PRR (**P**ower **R**eady **R**elay) which is energized when:

- the speed is greater than 4320 rpm and
- the GCR is closed.

Signals received or generated by the GCU control both these relays.

GCU Detection Table (Trips which contactor or relay):

1. Overvoltage (GCR + PRR),
2. Undervoltage (GCR + PRR),
3. Overfrequency (GCR + PRR),
4. Underfrequency (GCR + PRR),
5. Underspeed (PRR),
6. Overload (FAULT light in GALLEY P/BSW),
7. Incorrect Phase Sequence (GLC),
8. IDG Disconnect (GCR + PRR),
9. FIRE P/BSW pressed (GCR + PRR),
10. Differential Protection (GCR + PRR),
11. Shorted Permanent Magnet Generator (GCR + PRR),
12. Open Cable (GCR + PRR),
13. GLC Failure (Lock Out BTC),
14. Oil Overtemperature (FAULT light in IDG Disconnect P/BSW),
15. Open Circuit (GCR, PRR & BTC),
16. Rotor diode short circuit (GCR + PRR),
17. Generator P/BSW OFF (GCR + PRR).

Except for some particular cases the system may be resetted by setting GEN P/BSW to OFF than back to “On“.

After a differential protection or GLC failure activation the system resetting can only be performed two times via the GEN P/BSW. A further reset is possible via the GCU (DP/BTC RESET).

Warnings, Signalizations and Indications

The GCU delivers the following outputs for warnings, signalizations and indications:

- FAULT light in the IDG disconnect P/BSW when a failure in the IDG drive part is detected,
- FAULT light in the GALLEY P/BSW and signal to ECAM via EGIU when there is an overload condition with one generator,
- FAULT light in the GEN P/BSW and signal to ECAM via EGIU when a failure in the generator system is detected,
- DISC indication on the ECAM SD when IDG DISC STATUS signal and IDG DISC PB switch POS signal are both available,
- IDG OIL OUT temperature on the ECAM SD,
- GEN AC LOAD on the ECAM SD.

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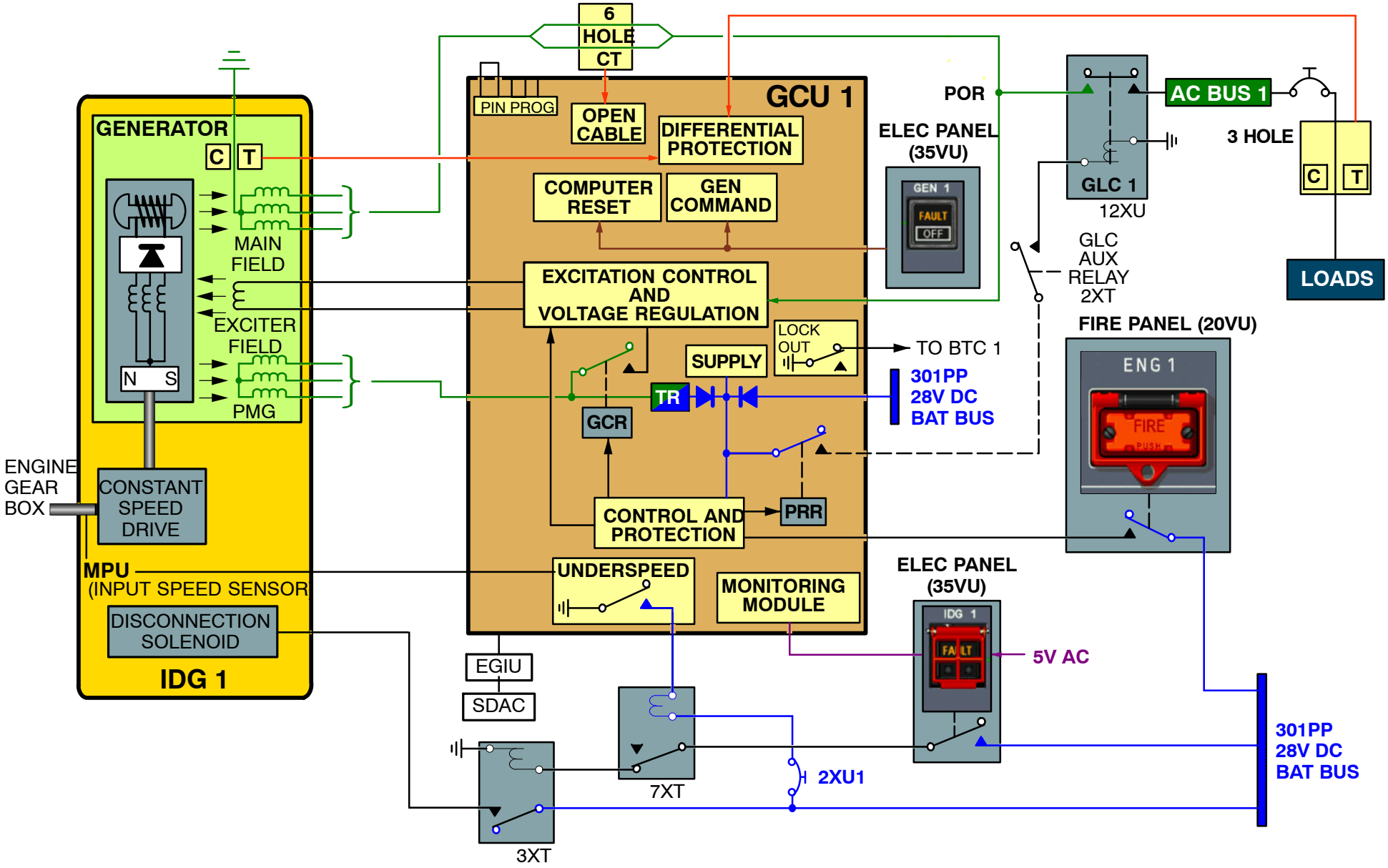

Figure 22 IDG System Control

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24–22 AC MAIN GENERATION

CONTROL AND PROTECTION OPERATION

CONTROL AND PROTECTION

Generator

The generator control and protection functions are mainly provided by means of the GCR and the PRR (**P**ower **R**eady **R**elay). The GCR controls the generator excitation. The PRR controls the GLC and activates the corresponding warnings.

Engine Fire and open Feeder Cable

The feeder cable is duplicated from the engine pylon to the forward cargo compartment. Each cable is monitored by a CT (**C**urrent **T**ransformer) and a sensor. If an open parallel condition exists, or if the ENGine FIRE P/B is released out, the GCU trips the GCR and the GLC and turns off the voltage regulation. The GPCU (**G**round **P**ower **C**ontrol **U**nit) determines whether a fire trip or an open cable trip has occurred.

DIFFERENTIAL PROTECTION

The differential protection prevents the electrical wiring between the two detection CTs from being damaged.

The protected area is divided into two parts: ZONE 1 and ZONE 2.

The ZONE 1 protected area comprises the generator coils and feeders between the IDG (**I**ntegrated **D**rive **G**enerator) CT and the GLC.

The ZONE 2 protected area comprises the wiring between the GLC and the CT.

Zone 1

In the event of a short circuit between phases or to the ground, a noticeable difference between transformer currents activates the protection system. When activated the protection system opens GLC and BTC (**B**us **T**ie **C**ontactor) (generator FAULT light comes on) and the generator is still excited. If the fault persists, the GCR is tripped thus the generator is de–excited. The BTC closes automatically, therefore allowing the network to be supplied by another generation source.

In that configuration, the short circuit is located in ZONE 1.

When the generator is cut off, the protection system of ZONE 2 remains operational. The IDG senses a null current. If there is no short circuit in ZONE 2, the sum of currents sensed by the line CTs is null (opposite current direction). If a short circuit occurs in ZONE 2, an unbalanced current is detected by the GCU which activates the protection system.

Zone 2

If a short circuit occurs, the protection system opens the GLC and confirms the BTC opening. The generator is still excited. The GEN 1 FAULT light comes on. If the fault does not persist, the short circuit has been isolated and the GCR is tripped thus the GEN is de–excited.

In this case, the BTC remains open and is locked out, and the AC BUS 1 supply cannot be recovered. The AC ESSential BUS supply is recovered through the AC ESS FEED control. The system is recovered by resetting the protection system from the associated GEN P/B. Two reset actions maximum can be performed. The GCR closes enabling generator excitation. The PRR is re–energized to control the GLC closing. The BTC lockout function is removed. The differential protection counter is reset either by pressing the differential protection RESET P/B on the front face of the GCU or at each power–up.

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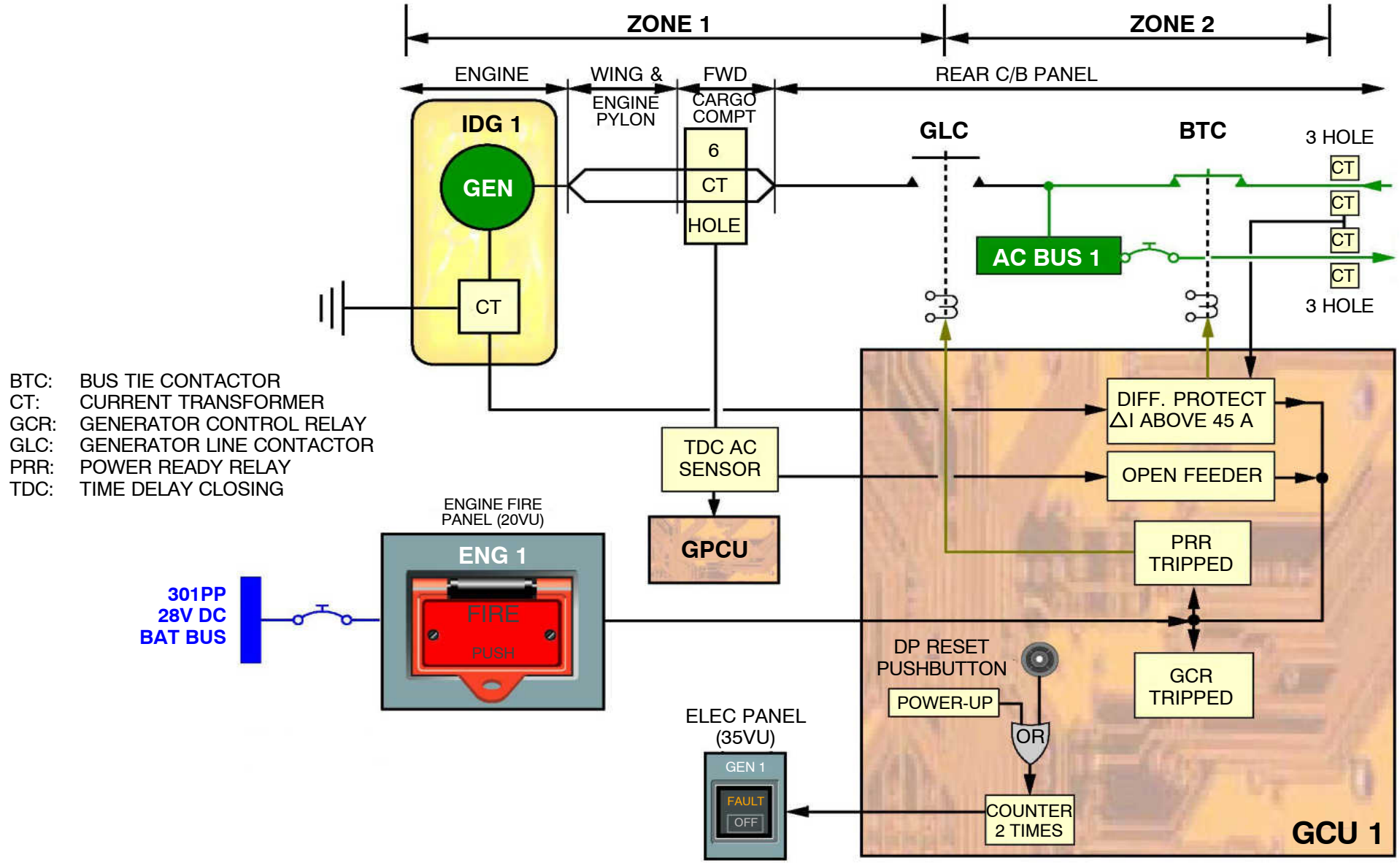

Figure 23 Control and Protection & Differential Protection

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OTHER PROTECTIONS

The GCR and PRR are de–energized by the protection module which processes various electrical parameters necessary for the protection functions.

ATTENTION: Note that the overload protection is only processed to give warning on the ECAM. In under speed conditions the under frequency and the under voltage protections are inhibited.

If the GLC remains closed (welded contact) after tripping of the PRR, the BTC lockout function is activated.

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BTC: BUS TIE CONTACTOR
CT: CURRENT TRANSFORMER
EGIU: ELECTRICAL GENERATION INTERFACE UNIT
GLC: GENERATOR LINE CONTACTOR
IDG: INTEGRATED DRIVE GENERATOR
POR: POINT OF REGULATION
SDAC: SYSTEM DATA ACQUISITION CONCENTRATOR

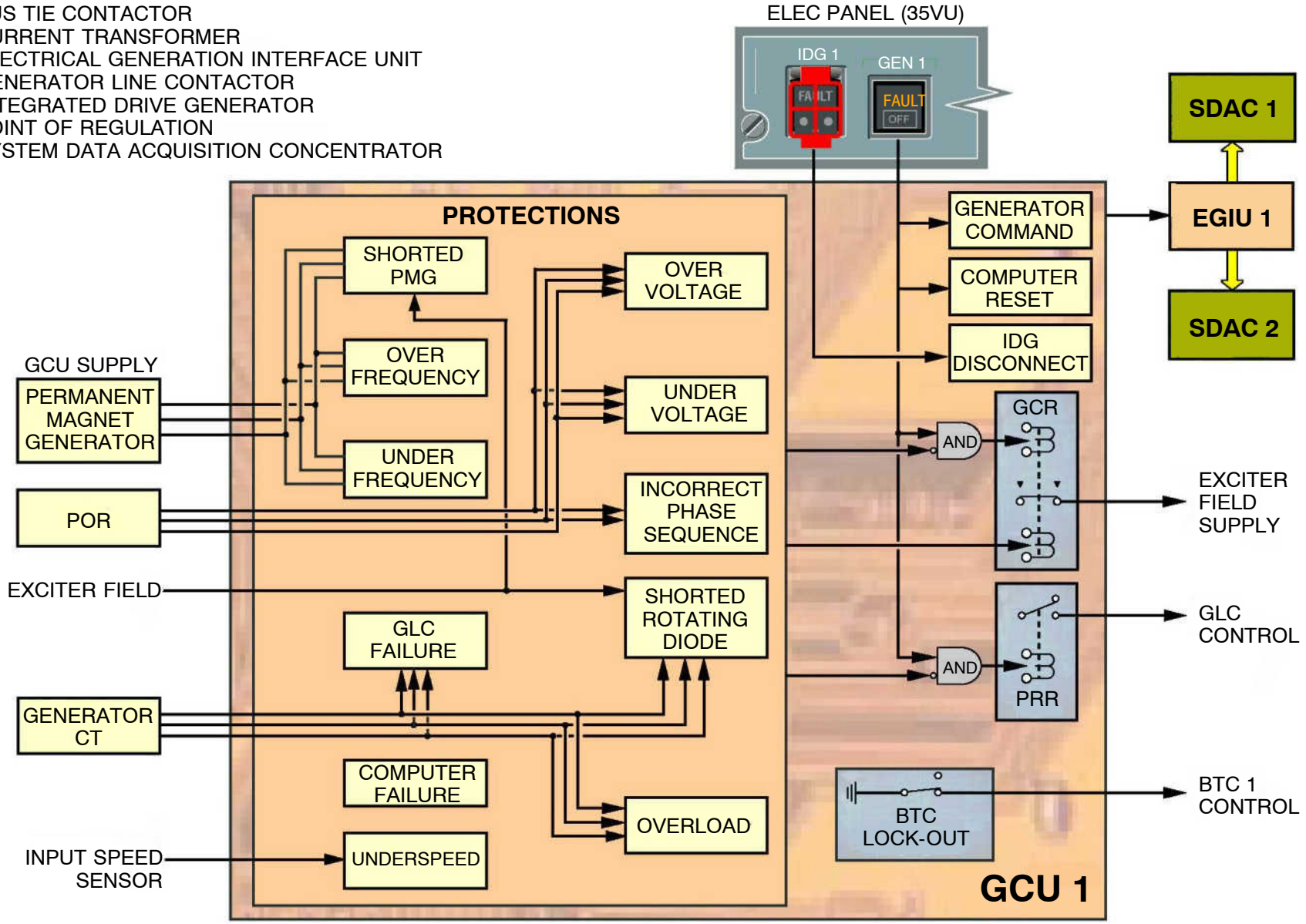

Figure 24 Other System Protections

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AUTOMONITORING AND TEST (BITE)

This function can be divided into three different parts.

Test and Analysis due to Generator Trip

During a generator tripping (active failure), the GCU

- identifies the protection which has caused the tripping (overfrequency, differential protection, etc.),
- analyses the conditions in which the tripping has occured and
- then, after analysis, determines the origin of the fault (GCU, wiring, or peripherals).

All these data are stored in a NVM (**N**on **V**olatile **M**emory), and are transmitted via the GPCU, as a data concentrator, to the CFDIU.

On the ground, they can be displayed via the MCDU.

Passive failure detection

Certain passive failures, that is those which do not cause generator tripping, can affect the system operation (sensors out of limit, CT failures etc.).

The GCU permanently monitors the majority of the circuits concerned.

When detecting a fault, the GCU determines the origin and stores the data in a non volatile memory.

As previously, these data can be displayed on the ground, via the MCDU.

Maintenance test

It can only be performed on the ground, with the IDGs shut down.

It completes to a certain extent, the monitoring already described:

- The test is performed by exciting (stimuli) the circuits concerned and analyzing the response.
- It is controlled
  - either automatically during the power up or
  - manually via the MCDU.
- The result of the test is stored in a NVM and can also be displayed on the ground, on the MCDU.

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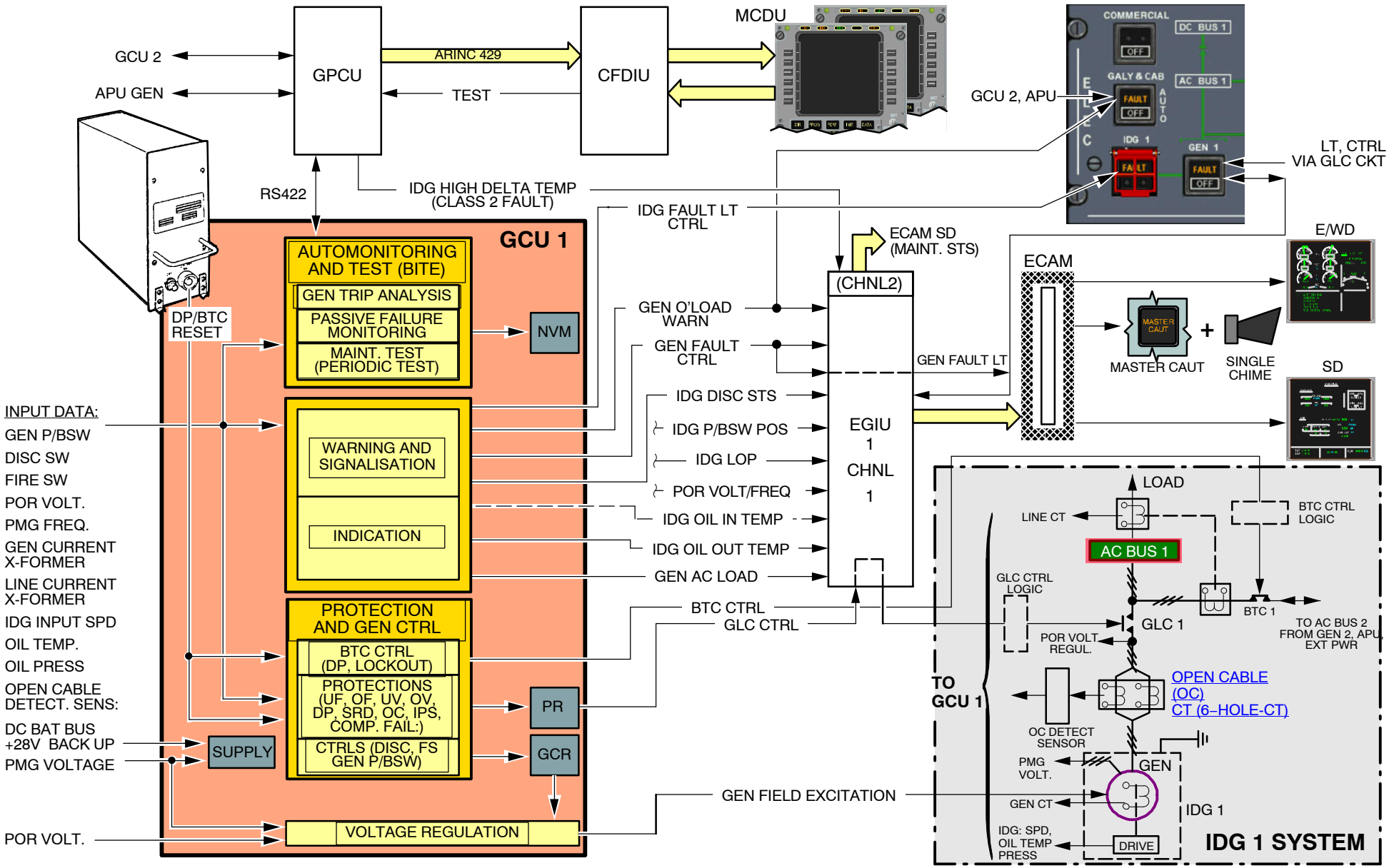

Figure 25 IDG System Control

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ELECTRICAL GENERATION INTERFACE UNIT OPERATION

Component Description

The main function of the EGIU is to process the parameters from the GCU and the associated generator (normal system parameters and failure signals).

The EGIU than transmits the information to the cockpit (ECAM) via the SDACs. Two EGIUs are installed on the aircraft.

One EGIU is associated with the GCU 1 and the GPCU.

This EGIU receives parameters in analog and discrete form from:

- GEN 1 on channel 1 and
- external power on channel 2.

Each channel sends its own parameters to SDAC 1 and SDAC 2 through two own isolated ARINC 429 data links.

The second EGIU is connected in the same manner to generator 2 and to the APU generator.

There is no connection between the EGIUs and the CFDIU.

Also no failure information are sent to ECAM in case of failures of the EGIUs.

When there is a failure of one EGIU channel, all corresponding parameters, normally seen on the system display, are replaced by amber crosses.

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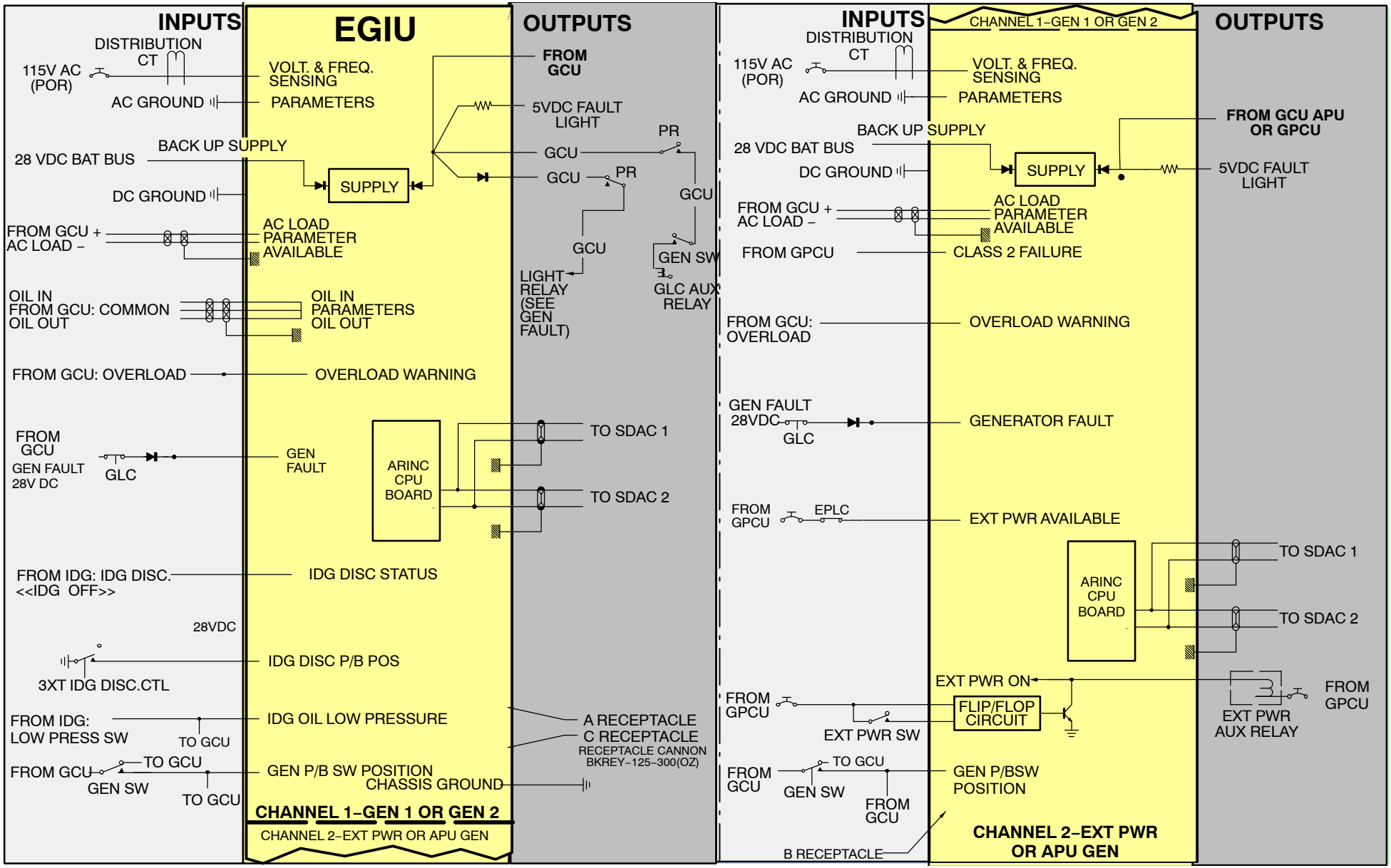

Figure 26 EGIU Schematic

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24–23 AC AUXILIARY GENERATION

AUXILIARY GENERATION SYSTEM PRESENTATION

APU Generator

The APU generator is not interchangeable with the IDGs (**I**ntegrated **D**rive **G**enerators). It is driven at a constant speed by the APU and can be connected to the electrical network in flight in case of any generator failure. It can supply the entire electrical network if no other power sources are available.

APU Generator Control

The main functions of the APU GCU (**G**enerator **C**ontrol **U**nit) are:

- voltage regulation
- network control and protection,
- interface with SDACs (**S**ystem **D**ata **A**cquisition **C**oncentrators),
- BITE function.

The BITE messages are sent to the CFDIU (**C**entralized **F**ault **D**isplay **I**nterface **U**nit).

Control, Indication and Distribution

The APU generator is controlled by a P/B located on the ELECtrical panel and has two lights: white OFF and amber FAULT.

The APU generator is connected to the network via the APU GLC (**G**enerator **L**ine **C**ontactor) and the BTCs (**B**us **T**ie **C**ontactors).

APU Generator Oil Temperature Sensor

A temperature sensor is located on the APU generator oil outlet. A high oil temperature leads to an immediate automatic shut down of the APU via the ECB (**E**lectronic **C**ontrol **B**ox).

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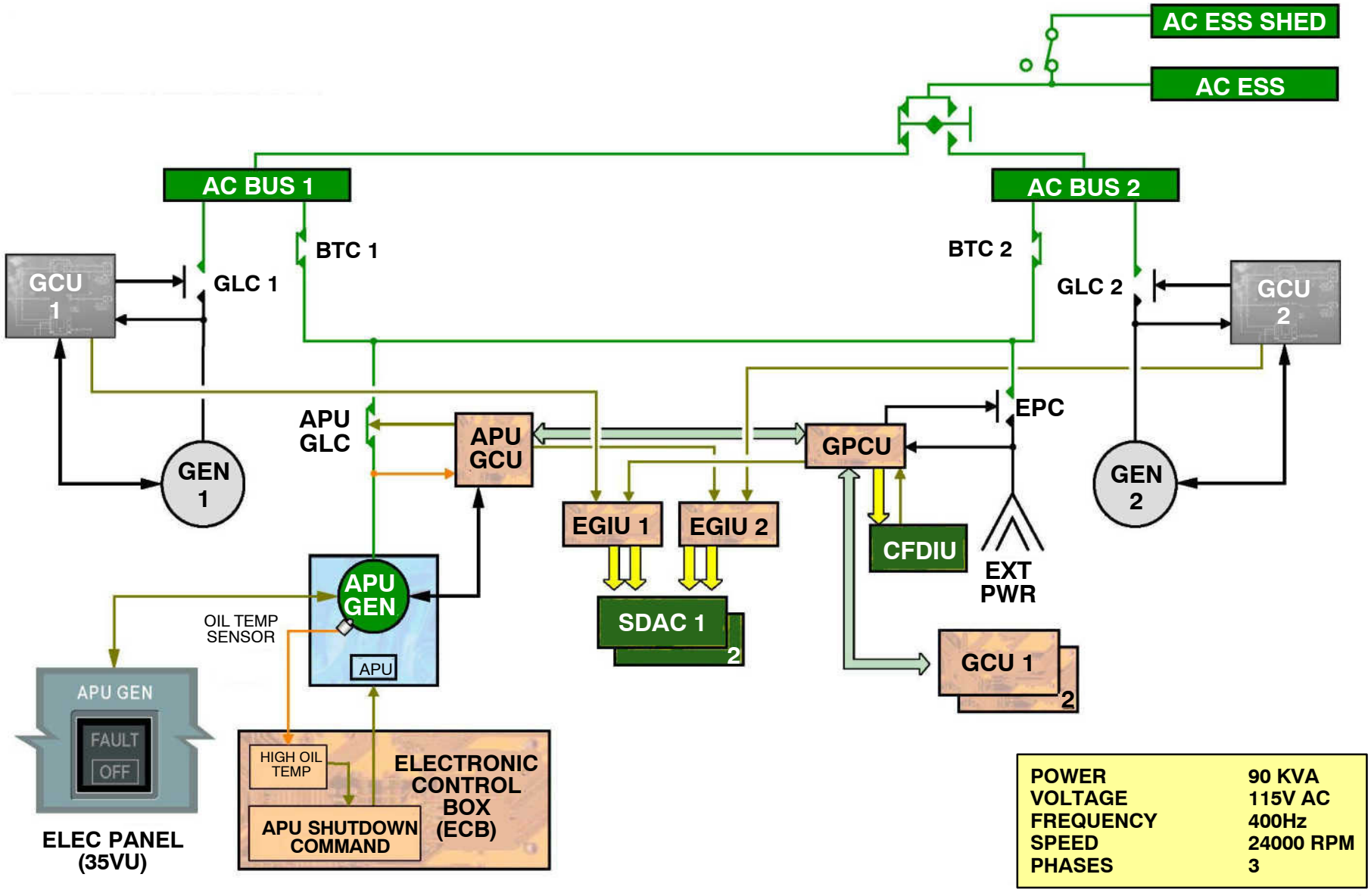

Figure 27 AC Auxiliary Generation

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APU GENERATION SYSTEM CONTROL OPERATION

General

One GCU (**G**enerator **C**ontrol **U**nit) serves for controlling and monitoring of the APU driven generator–system.

Its functions are as follows:

- regulation of the generator voltage
- control and protection of the generator–system and network
- control of various warnings and indications
- self–monitoring and test of the system (BITE).

Voltage Regulation

The voltage regulation is performed by regulating the generator excitation current: the voltage is kept at the nominal POR (**P**oint **O**f **R**egulation).

The POR is located in the electrical power center at the end of the generator feeder, upstream of the line contactor.

Analog circuits achieve the regulation.

The PMG provides directly the excitation supply via the GCR (**G**enerator **C**ontrol **R**elay). The excitation supply is rectified. Then a chopper amplifier (pulse width modulation) controls the excitation supply.

The regulation is achieved using a signal proportional to the average of the three line to neutral voltages at the input.

Protection and Generator Control

These functions mainly consists of generator excitation and APU GLC (**G**enerator **L**ine **C**ontactor) control.

The excitation is controlled via the GCR. The generator line contactor is controlled via the PRR (**P**ower **R**eady **R**elay) which is energized when:

- the speed is greater than 4320 rpm and,
- the GCR is closed.

Signals received or generated by the GCU control both these relays.

GCR and/or PRR are switched off by the following protection or control functions:

- GEN P/BSW in OFF,
- under–/overfrequency (UF/OF),
- under–/overvoltage (UV/OV),
- differential protection (DP),
- shorted rotating diodes (SRD),
- shorted PMG (SPMG),
- APU underspeed (US),
- incorrect phase sequence (IPS),
- computer failure

Except for some particular cases the system may be resetted by setting GEN P/BSW to OFF than back to ON.

After a differential protection or GLC failure activation the system resetting can only be performed two times via the GEN P/BSW. A further reset is possible via the GCU (DP/BTC RESET).

Warnings, Signalizations and Indications

The GCU delivers the following outputs for warnings, signalizations and indications:

- FAULT light in the GALLEY P/BSW and signal to ECAM via EGIU when there is an overload condition with one generator,
- FAULT light in the GEN P/BSW and signal to ECAM via EGIU when a failure in the generator system is detected,
- GEN AC LOAD on the ECAM SD.

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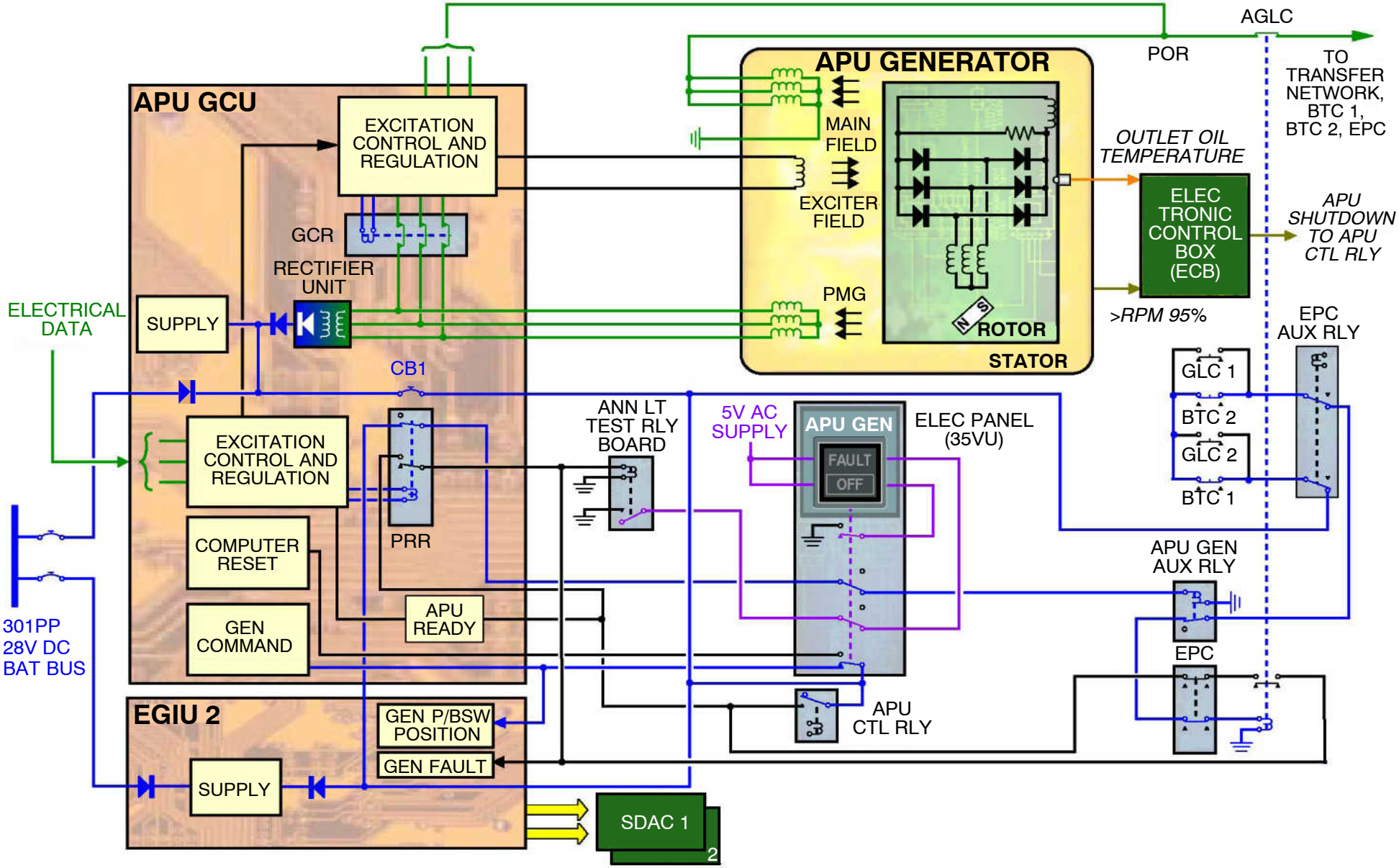

Figure 28 APU Generator System Control

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Automonitoring and Test (BITE)

This function can be divided into three different parts:

- **Test and analysis due to generator tripping.**

  During a generator tripping (active failure), the GCU:

  – identifies the protection which has caused the tripping (overfrequency, differential protection, etc.)
  – analyses the conditions in which the tripping has occured
  – then, after analysis, determines the origin of the fault (GCU, wiring, or peripherals).

  All these data are stored in a NVM (**N**on **V**olatile **M**emory), and are transmitted via the GPCU, as a data concentrator, to the CFDIU. On the ground, they can be displayed via the MCDU.

- **Passive failure detection**

  Certain passive failures, that is those which do not cause generator tripping, can affect the system operation (sensors out of limit, CT failures etc.).

  The GCU permanently monitors the majority of the circuits concerned.

  When detecting a fault, the GCU determines the origin and stores the data in a non volatile memory.

  As previously, these data can be displayed on the ground, via the MCDU.

- **Maintenance test**

  It can only be performed on the ground, with the GEN shut down.

  It is part of a certain extent, the monitoring already describes that the test is performed by exciting (stimuli) the circuits concerned and analyzing the response.

  It is controlled:

  – either automatically during the power up
  – or manually via the MCDU.

    The result of the test is stored in a NVM and can also be displayed on the ground, on the MCDU.

NOTE: APU shutdown at high oil Temperature and as well as low oil pressure is contolled via ECB.

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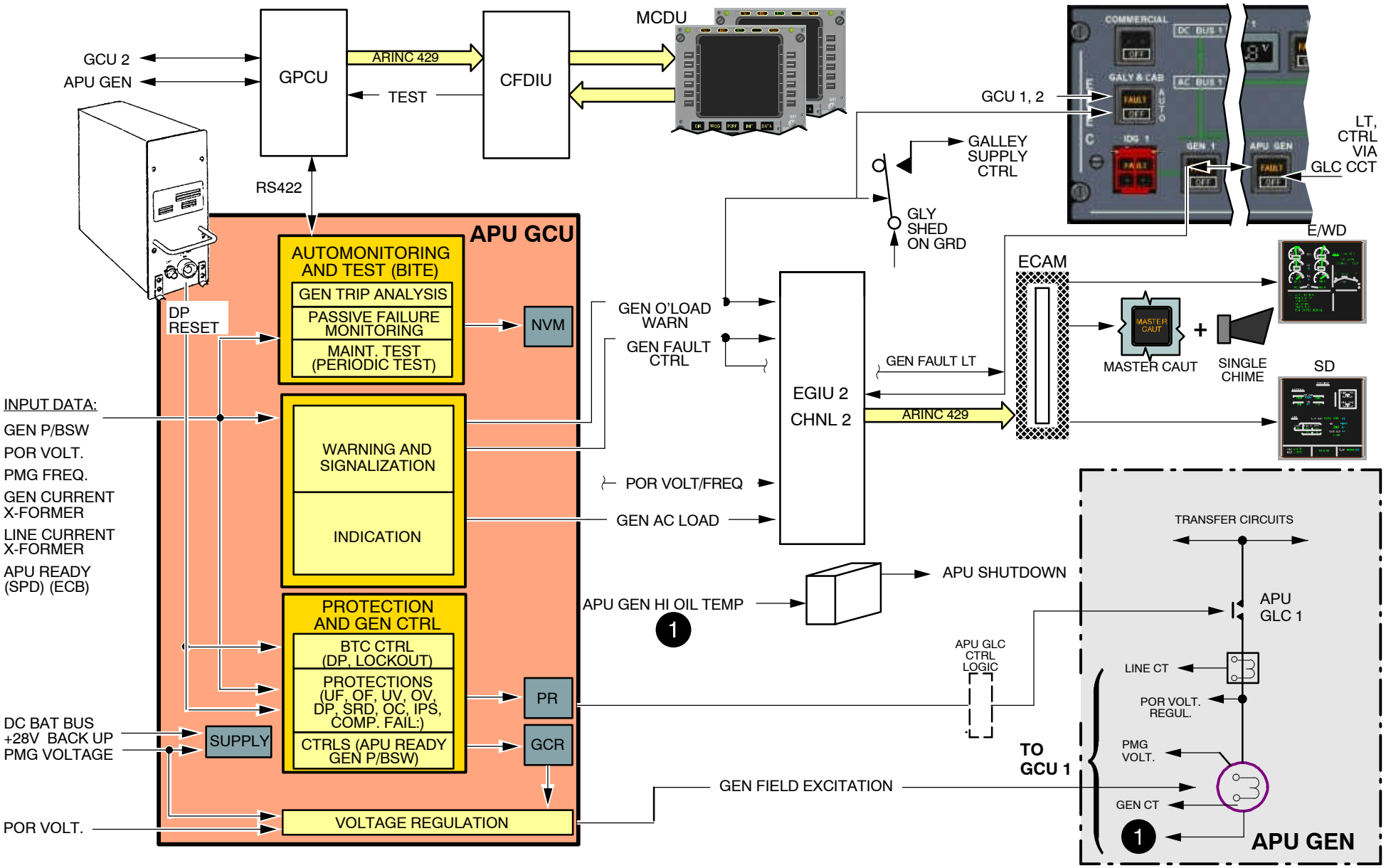

Figure 29 APU Generator System Control

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BUS TIE LOGIC FUNCTIONAL OPERATION

General

The transfer circuit enables to supply both or either AC electrical network from one of the four power sources via the BTC (**B**us **T**ie **C**ontactor).

The bus tie logic is responsible for the following tasks:

- no parallel operation of two power sources on the transfer line or busbars,
- automatic power transfer in case of a supply failure,
- the priority of power sources to supply the AC buses.

The order of these priorities is:

- onside IDG (**I**ntegrated **D**rive **G**enerator) to own bus:
  - the IDG 1 to AC BUS 1 and the IDG 2 to AC BUS 2,
- external power,
- APU generator,
- opposite IDG:
  - IDG 1 to AC BUS 2 or IDG 2 to AC BUS 1.

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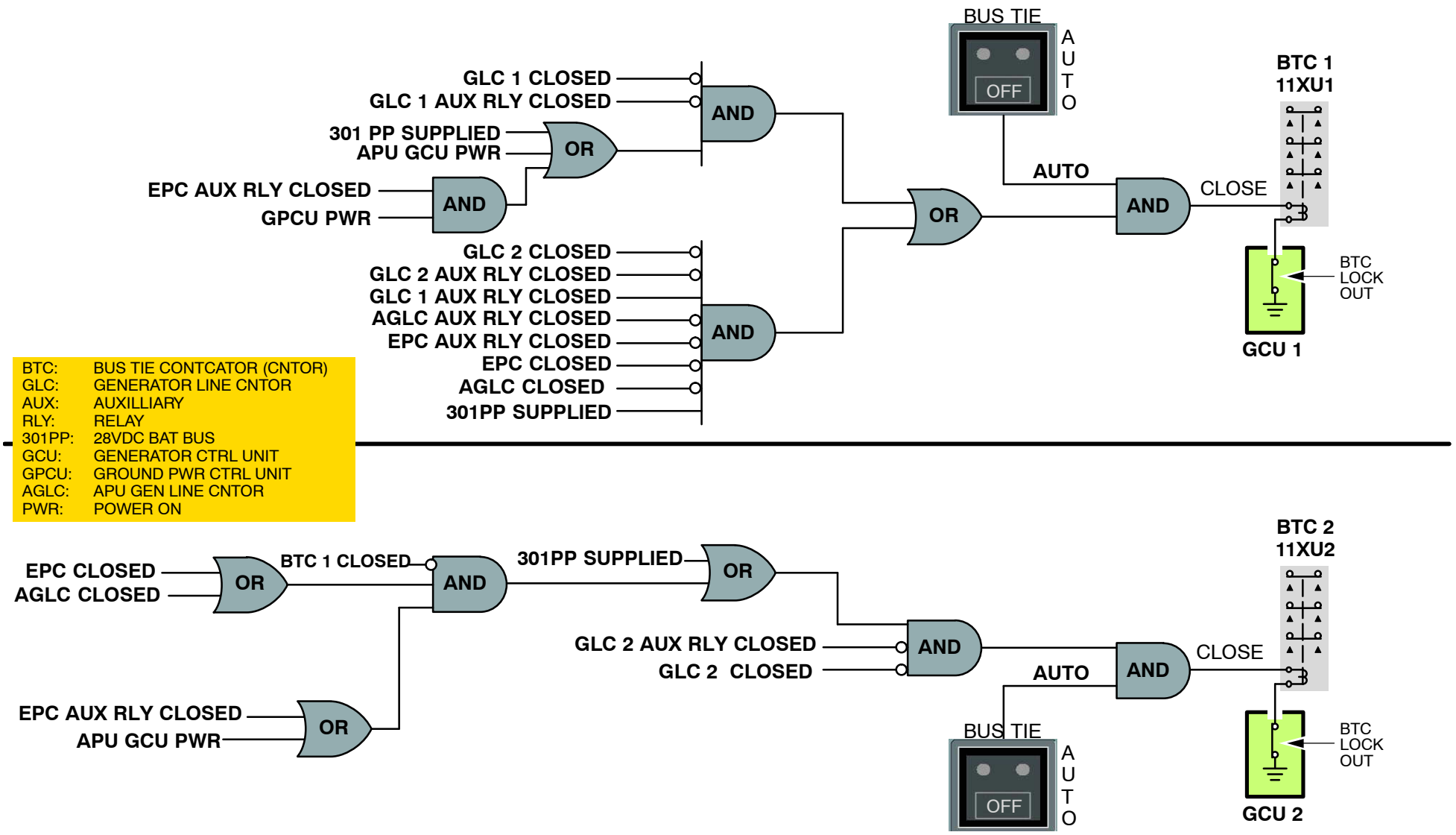

Figure 30 Bus Tie Logic

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TRANSFER CIRCUIT

The transfer circuit enables supply of both or either AC electrical network(s) from one of the four power sources (GEN 1, GEN 2, APU GEN, EXT PWR).

This is via the transfer contactors (BTC). The BTC control is entirely automatic. It depends on the availability of these sources and the correct condition of each network.

The BTC 1 closes if no interlock condition exists on GCU 1:

- when generator 1 is not available, in order to supply network 1 from another power source (generator 2, auxiliary generator or ground power unit),
- to supply network 2 from generator 1 in case of non–availability of:
  - generator 2,
  - auxiliary generator,
  - and electrical ground power unit.

In case of single generator configuration, the sheddable busbars 218XP, 220XP, 210PP and 212PP are no longer available.

GCU1 or GCU2 enables closure of BTC1 or BTC2 if:

- no DP zone 2 condition,
- no GLC welded failure occurred.

Networks 1 and 2 are supplied in priority order:

- by the corresponding generator,
- by the electrical ground power unit,
- by the auxiliary generator,
- or by the other generator.

BTC’s 1 and 2 can be locked out by pressing BUS TIE pushbutton switch located on ELEC overhead panel (Ref. 24–00–00). This causes both channels to be isolated.

EXAMPLE: External Power ON

With the BATtery P/BSW in the OFF position, as soon as the external power is AVAILable and selected ON, the GPCU (**G**round **P**ower **C**ontrol **U**nit) supplies BTC 1.

BTC 1 being closed, the BAT BUS 3PP is supplied allowing BTC 2 to be energized via BAT sub–busbar 301PP. The external power supplies the whole aircraft electrical network.

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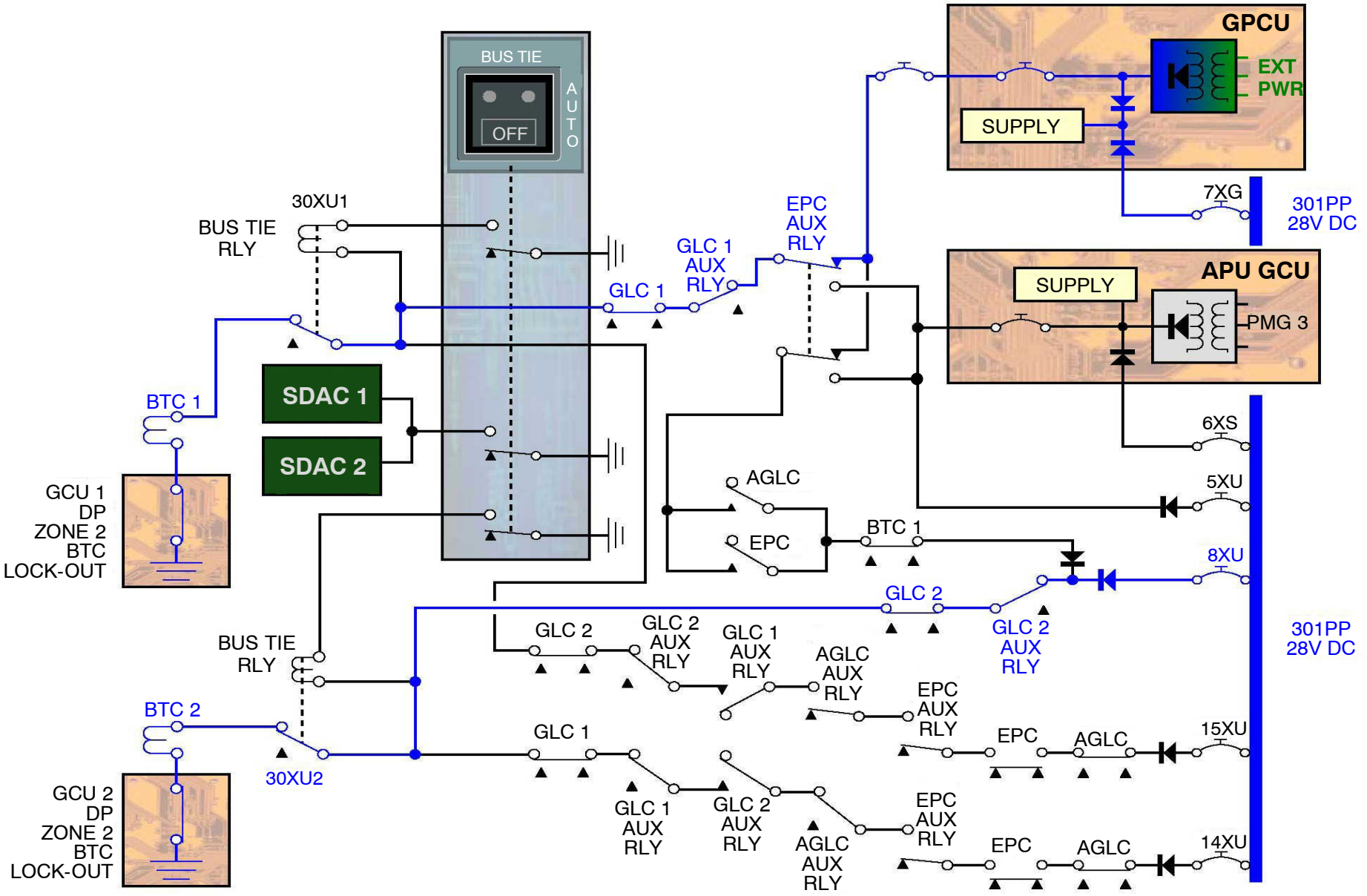

Figure 31 Bus Tie Schematic (External Power ON)

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24–25 AC ESSENTIAL GENERATION SWITCHING

AC ESS BUS SUPPLY OPERATION

Normal Supply

The AC ESS BUS is normally supplied by the AC BUS1 (AC ESS BUS CONTACTOR 3XC–1 energized).

Condition:

- AC BUS 1 supplied
- AC ESS FEED P/BSW in NORM
- All Contactors, necessary to supply the AC ESS BUS by other Buses or Power Sources must be deenergized.

Alternate Supply

In the event of AC BUS1 loss, the AC ESS BUS can be manually restored by the transfer of power supply directly from the AC BUS 2 (AC ESS BUS CONTACTOR 3XC–2 energized).

Condition:

- AC BUS 2 supplied
- AC ESS FEED P/BSW in ALTN
- All Contactors, necessary to supply the AC ESS BUS by other Buses or Power Sources must be deenergized.

Alternate Supply with relay 17XC

Several occurrences of loss of the AC BUS 1 have been reported which led in some instances to the loss of the AC ESS BUS and DC ESS BUS and connected systems. The affected systems include multiple flight deck Display Units (Primary Flight Display, Navigation Display and Upper Electronic Centralised Aircraft Monitoring display).

The reasons for these events have been investigated but have not been fully established for all cases.

Due to the range of system losses some crews reported difficulty in establishing the failure cause during the events and, consequently, the appropriate actions to be taken may not be completed in a timely manner.

The loss of multiple display units, if not corrected expediently during a high workload period, potentially affects the capability of the flight crew and could contribute to a loss of situational awareness and consequent control of the aeroplane, which would constitute an unsafe condition.

Therefore a modification of the electrical network configuration management logic is mandated consisting in adding an automatic switching of the AC and DC ESS BUS power supply such that upon the loss of the AC BUS 1, the AC BUS 2 will automatically take over the power supply. On pre–MOD aeroplanes, this power supply switching can only be accomplished manually from the cockpit and is covered by an Electronic Centralized Aircraft Monitoring (ECAM) procedure.

This lead to the installation of the **ESS**ential **N**e**TW**or**K AUTO**matic **ALT**er**N**ate switching relay 17XC.

ATTENTION: According to EASA AD Note 2009–0235 all Airbus A320 family aeroplanes must be equipped with the ESS NTWK AUTO ALTN relay modification (Airbus SB A320–24–1120) until November 2011.

Emergency Generator Supply

In the event of AC BUS1 and AC BUS2 loss (Emergency Configuration), the AC ESS BUS is restored on the CSM/G, when the RAT hydraulic power is available.

As soon as there is control power available from the EMER GCU, the relay 12XE is energized. Possibly still energized contactor (3XC–1 or 3XC–2) is deenergized. There upon the EMER GLC (2XE) can be energized.

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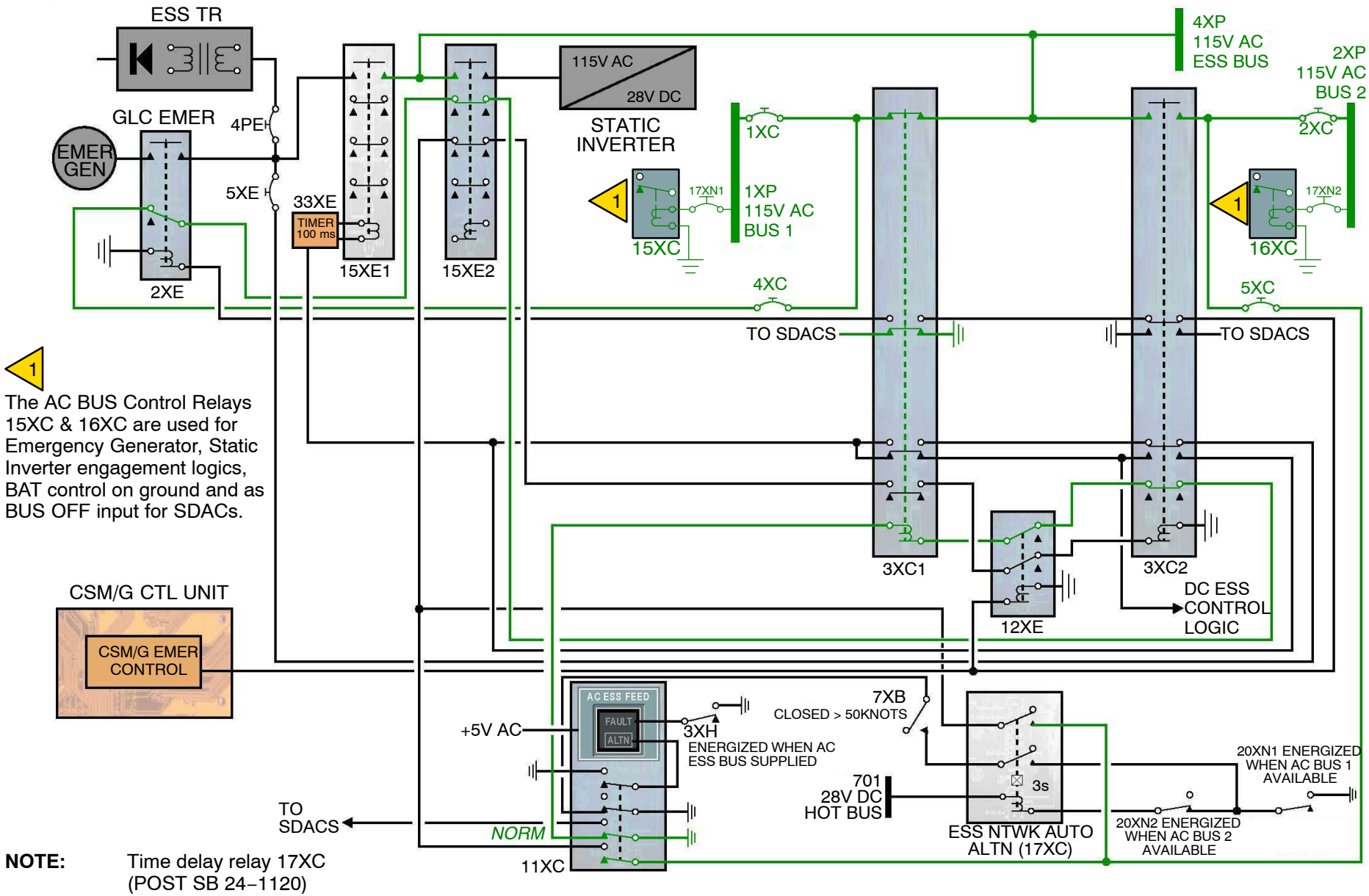

NOTE: Time delay relay 17XC (POST SB 24–1120)

Figure 32 AC Essential Bus Supply Schematic

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AC/DC SHEDDABLE BUS SUPPLY

Normal Configuration

The AC and DC ESSential BUSes supply the AC and DC ESS SHEDdable BUS via the control relays 8XH and 8PH. The open or closed position of the relays 8XH and 8PH depends on the network supply status.

Emergency Configuration

If there is an electrical emergency configuration and the Constant Speed Motor Generator (CSM/G) fails, the essential network operates with battery power only.

Battery 2 supplies the DC ESS BUS and battery 1 supplies the Static Inverter (STAT INV), which supplies the AC ESS BUS. In this condition, the AC and DC SHED BUS are not supplied because relays 8XH and 8PH are open due to the fact that BATtery ONLY relays 2XB and 6XB are energized.

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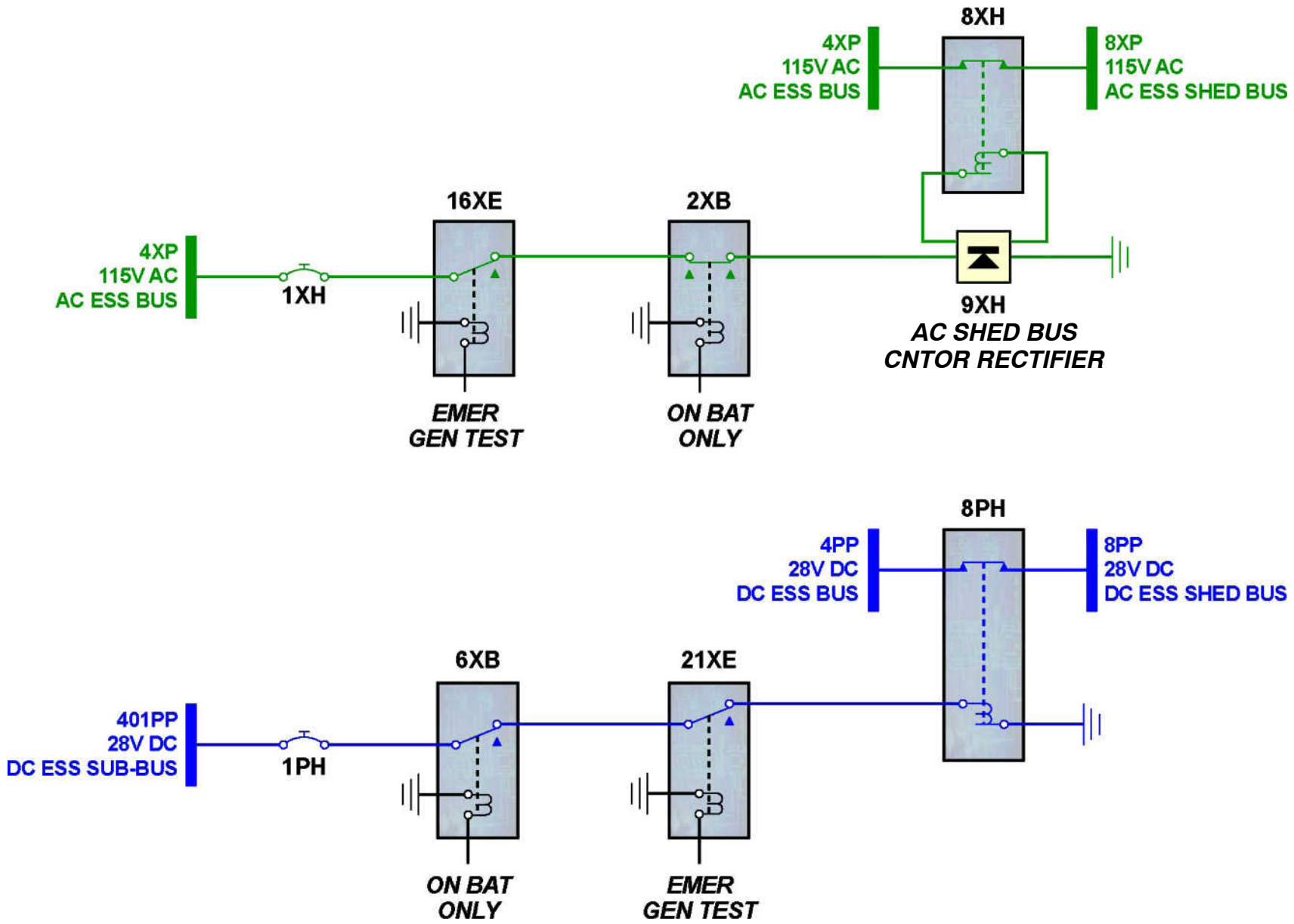

Figure 33 AC/DC Sheddable Bus Supply

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24–24 AC EMERGENCY GENERATION

AC EMERGENCY GENERATION DESCRIPTION

General

The AC emergency generation enables part of the distribution network to be recovered in case of:

- loss of the two main generation sources and,
- unavailability of the auxiliary generation.

Operation

The emergency generator has priority over its network and supplies the essential busbars (4XP, 8XP, 4PP, 8PP). Supply to the line contactor (EMER GLC) only depends on the availability of the emergency generator.

The emergency generation system is mainly composed of:

- a Constant Speed Motor/Generator (CSM/G) including a hydraulic motor and an AC generator,
- a Generator Control Unit (GCU).

A hydraulic motor drives the emergency generator.

A servo valve speed regulator controls the speed: it transforms the oil flow of the Blue hydraulic system into constant speed for the generator.

When emergency conditions are met, this Blue system is supplied by a Ram Air Turbine (RAT).

RAT Extension Logic

3 different logics control RAT extension:

- **the automatic electrical logic:** this energizes solenoid N .1 when there is loss of voltage at busbars 1XP and 2XP and speed V > 100 kts,
- **the manual electrical logic:** this energizes solenoid No. 2 directly, via OVRD ELEC pushbutton switch,
- **the manual hydraulic logic:** this energizes solenoid No. 1 directly, via OVRD HYD pushbutton switch.

CSM/G Control Logic (RAT Version1)

3 different logics control energization of the emergency generation:

- **the automatic electrical logic:** this is identical to that of the RAT extension, in the landing gear retracted configuration,
- **the manual electrical logic:** this is identical to that of the RAT extension, in the landing gear retracted configuration,
- **the electrical test logic:** this simulates the automatic electrical logic because it allows the emergency generator to be coupled to the Blue hydraulic system (supplied by the hydraulic electric pump) while inhibiting RAT extension.

CSM/G Control Logic (RAT Version2)

3 different logics control energization of the emergency generation:

- the automatic electrical logic: this is identical to that of the RAT extension, in the landing gear not compressed configuration,
- the manual electrical logic: this is identical to that of the RAT extension, in the landing gear not compressed configuration,
- the electrical test logic: this simulates the automatic electrical logic because it allows the emergency generator to be coupled to the Blue hydraulic system (supplied by the hydraulic electric pump) while inhibiting RAT extension.

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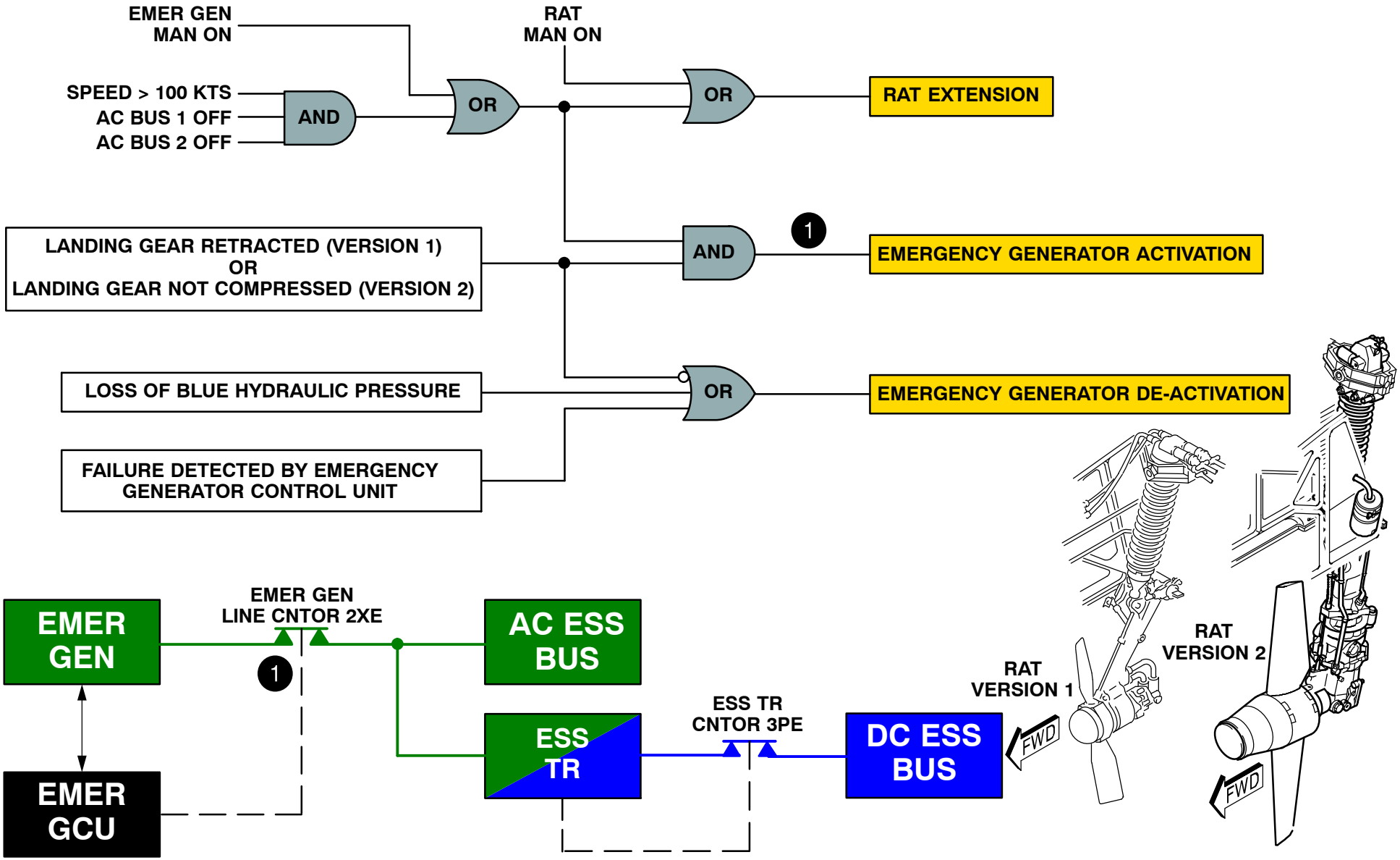

Figure 34 Emergency Generation Activation Logic

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CSM/G FUNCTIONAL OPERATION

Description

The extension of the RAT (**R**am **A**ir **T**urbine), for supplying the blue hydraulic system in electrical emergency configuration, can be done via two solenoids.

Control of the solenoids

Solenoid 1:

- automatically dependent on the configuration of the electrical network and aircraft
- manually by operating of the HYD RAT MAN ON P/BSW on the hydraulic panel 40VU.

Solenoid 2:

- manually by operating of the RAT & EMER GEN MAN ON P/BSW on the EMER ELEC PWR panel 21VU.

The automatic control of solenoid 1 happens, when:

- AC BUS 1 and 2 are not supplied
- A/C speed >100 kts (ADIRU 1) and
- battery 1 installed (Bus 703 PP supplied).

During the operational test of the CSM/G the above described control logic is simulated by operating of the EMER GEN TEST P/BSW, without extension of the RAT.

RAT & EMER GEN FAULT Control

The RAT & EMER GEN FAULT light (red) on the panel 21VU illuminates, when:

- AC BUS 1 and 2 not supplied,
- ESS TR not supplied and
- nose landing gear up and locked.

The control signal is delivered by both BCL (**B**attery **C**harge **L**imiters).

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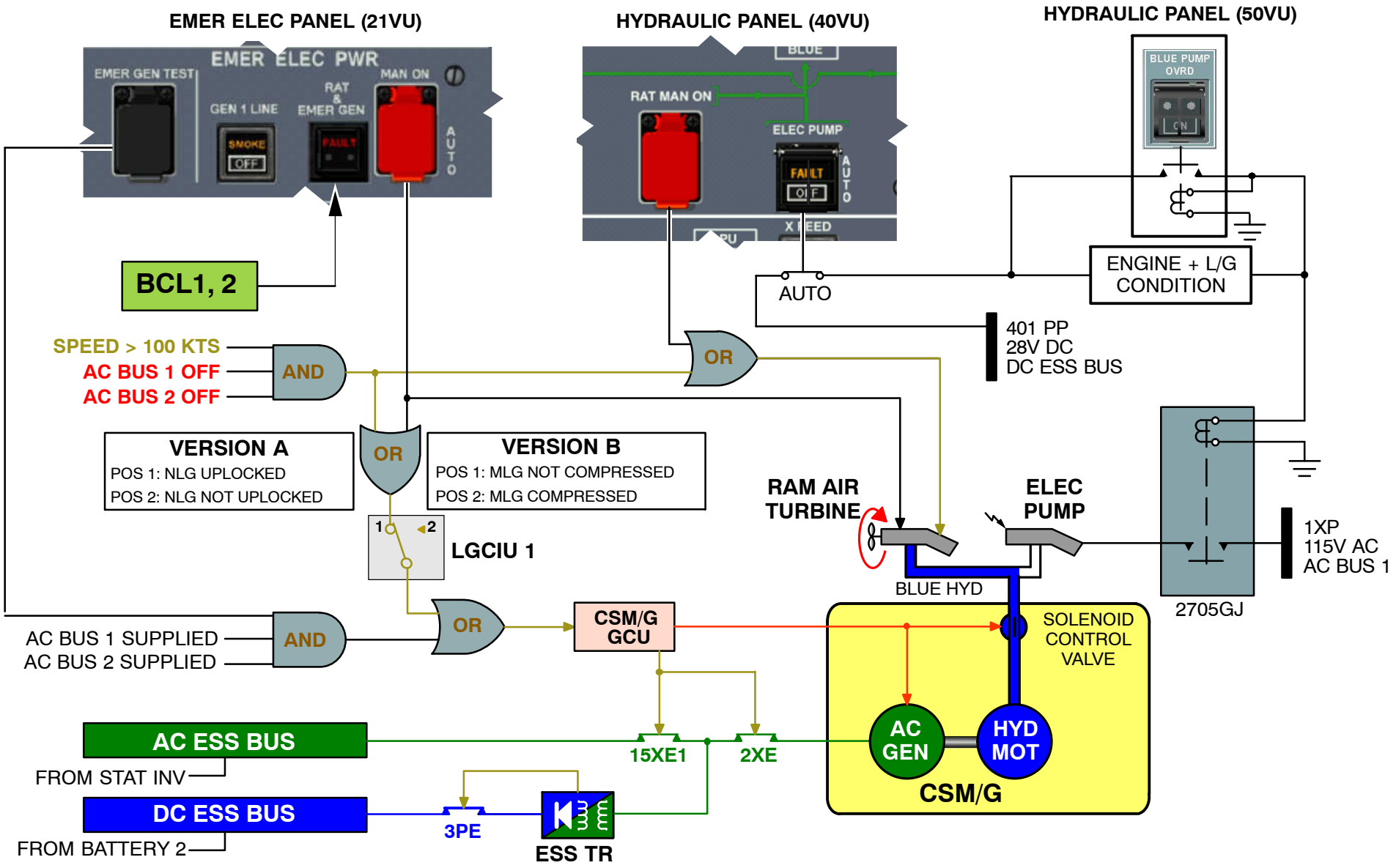

Figure 35 CSM/G Engagement Logic

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CONTROLS AND INDICATIONS IN THE COCKPIT

The RAT and CSM/G are:

- automatically controlled by AC BUS 1 and AC BUS 2 loss and V > 100 kts,
- or manually by means of the EMER ELEC PWR/MAN ON guarded pushbutton switch on the EMER ELEC PWR section of the overhead panel 21VU.

When a failure of the AC BUS 1 and 2 occurs, simultaneously:

- the RAT is automatically extended,
- the emergency generator is automatically coupled to AC and DC ESS busbars,
- the red FAULT legend comes on on RAT & EMER GEN annunciator until the emergency generator is available.

In all cases, the pilot has to press EMER ELEC PWR/MAN ON pushbutton switch in order to confirm the automatic logic. The red FAULT legend disappears if the emergency generator supplies the ESS network.

NOTE: The red **FAULT** legend on the RAT & EMER GEN annunciator is triggered by the BCL 1 or 2 (Battery Charge Limiter).

It illuminates, when the conditions for emergency generator operation are fulfilled, but the emergency generator does not supply the ESS network.

The BCLs recognize this by observing the ESS TR contactor, because it should be closed when the EMER GEN supplies the essential network correctly.

Emergency Generator Test

A test of the emergency generator can be initiated on the ground. The procedure is controlled by the EMER GEN TEST pushbutton switch located on the EMER ELEC PWR section of overhead panel 21VU. To do the test the blue hydraulic system must be pressurized.

When EMER GEN TEST pushbutton switch is pressed and held:

- ELEC page is automatically displayed on the ECAM system (on ground only),
- the emergency generator is coupled to its network,
- DC ESS BUS SPLY and AC ESS BUS switching line contactors (4PC/3XC) open, isolating AC and DC essential buses,
- on the ECAM system: green lines between normal busbars and essential busbar disappear.
- The white EMER GEN, ESS TR and the green indications of the corresponding parameters appear, green lines between EMER GEN and AC ESS and DC ESS appear.

NOTE: The ELEC page must disappear when the EMER GEN TEST pushbutton switch is released.

NOTE: The deployment of the RAT is inhibited during the test, because the EMER GEN TEST P/BSW disconnects the RAT solenoid #1 from the HOT BAT BUS 1.

A test of the emergency GCU can be initiated on the ground from the CFDS.

ELECTRICAL EMERGENCY CONFIGURATION

Electrical emergency configuration during RAT extension (<10 sec) and in landing gear extended configuration

This configuration is the result either of the RAT extension phase or of the activation of the CSM/G interlock logic when the landing gear is extended during an emergency configuration. In this case the CSM/G is switched off through a logic controlled by LGCIU–1.

No power source (GEN 1, GEN 2, APU GEN, EXT PWR, EMER GEN) being available, static inverter, AC busbars 4XP and 901XP are supplied by battery 1 via the static inverter and DC busbar 4PP by battery 2 via static inverter contactor 2XB.

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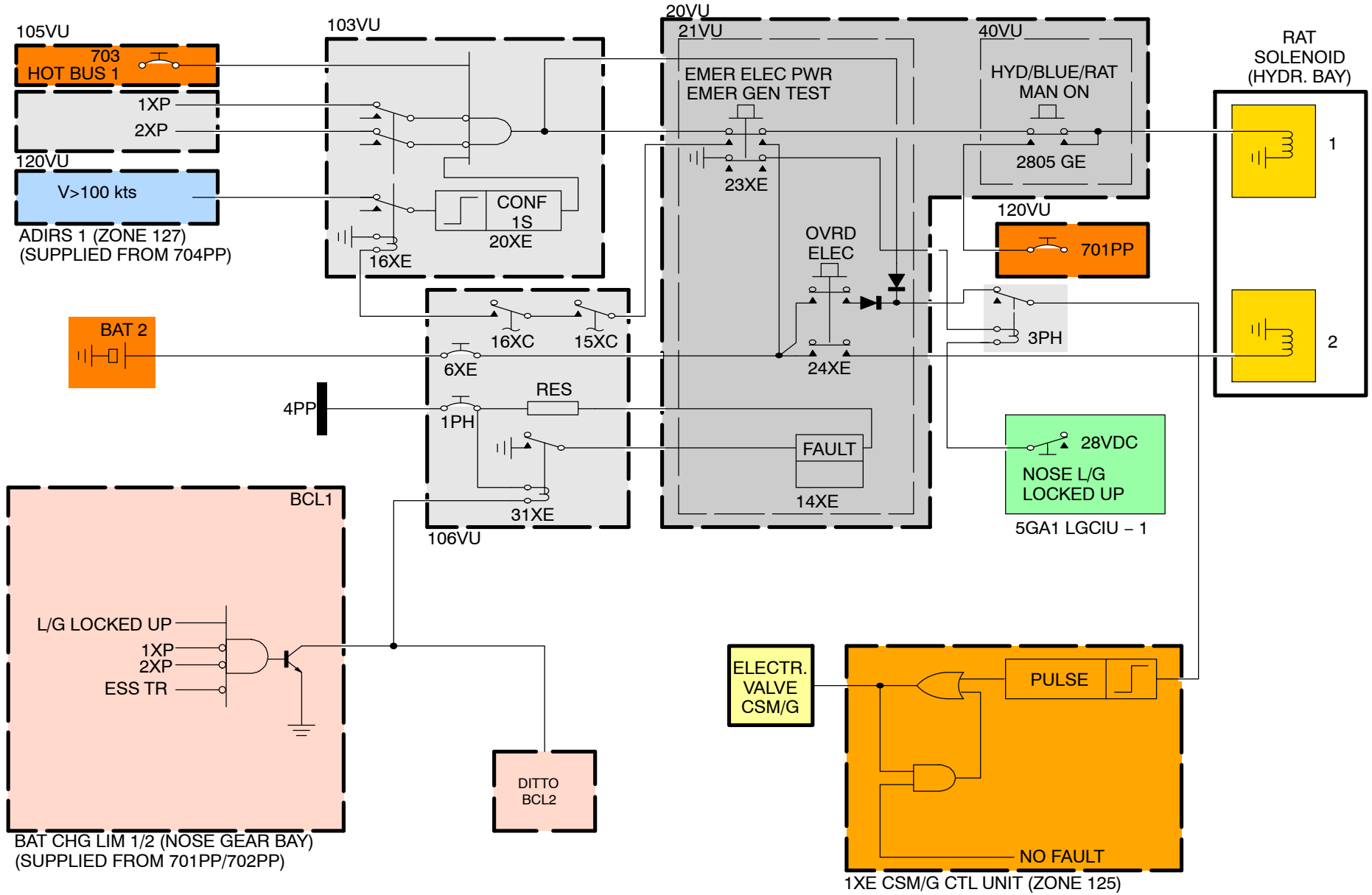

Figure 36 RAT Extension and CSM/G Control Logic

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CSM/G CONTROL FUNCTIONAL OPERATION

System Components and Functions

The emergency generation system mainly consists of:

- the CSM/G (**C**onstant **S**peed **M**otor/**G**enerator)
- an EMER GCU (**EMER**gency **G**enerator **C**ontrol **U**nit).

The CSM/G contains a hydraulic motor and an AC generator (emergency generator).

The hydraulic motor drives the generator. A servo valve speed regulator controls the speed of the hydraulic motor.

It transforms the oil flow of the blue hydraulic system into a constant speed for the emergency generator.

In emergency configuration the blue hydraulic system is pressurized by a RAT (**R**am **A**ir **T**urbine).

NOTE: Normally the blue hydraulic system is supplied by an electrical pump (normal electrical power configuration and during the CSM/G test).

The functions of the EMER GCU are:

- to control the servovalve excitation for speed regulation,
- to regulate the generator voltage by the field current,
- to protect the network and the generator by controlling the associated line contactor and generator field current.

Operational Modes

There are three modes to get the EMER GEN into operation:

- automatically dependent on the configuration of the electrical network and aircraft (AUTO CSM/G CONTROL LOGIC)
- manually by operating of the RAT & EMER GEN MAN ON P/BSW.
- manually by operating of the EMER GEN TEST P/BSW (push and hold).

In the first two cases the starting of the CSM/G is only possible with nose landing gear up and locked (relay 3PH deenergized).

As soon as the generator system is power ready, control power for the corresponding contactors is available from the GLC CONTROL CCT.

The EMER GCU (type 3 system) can be tested through the CFDIU via the MCDU.

CSM/G GCU Protections

The GCU protections are:

- Over/under voltage (OV/UV, Time Delay = 3–5s)
- Over/under frequency (OF/UF, TD = 3–5s)
- Shorted PMG (TD = 3–5s)
- Fast overspeed shutdown (TD = 150ms)

In all cases the line contactor 2XE opens, generator de–energization and control valve close (FAULT warning on RAT & EMER GEN warning light triggered by BCL 1 and/or 2).

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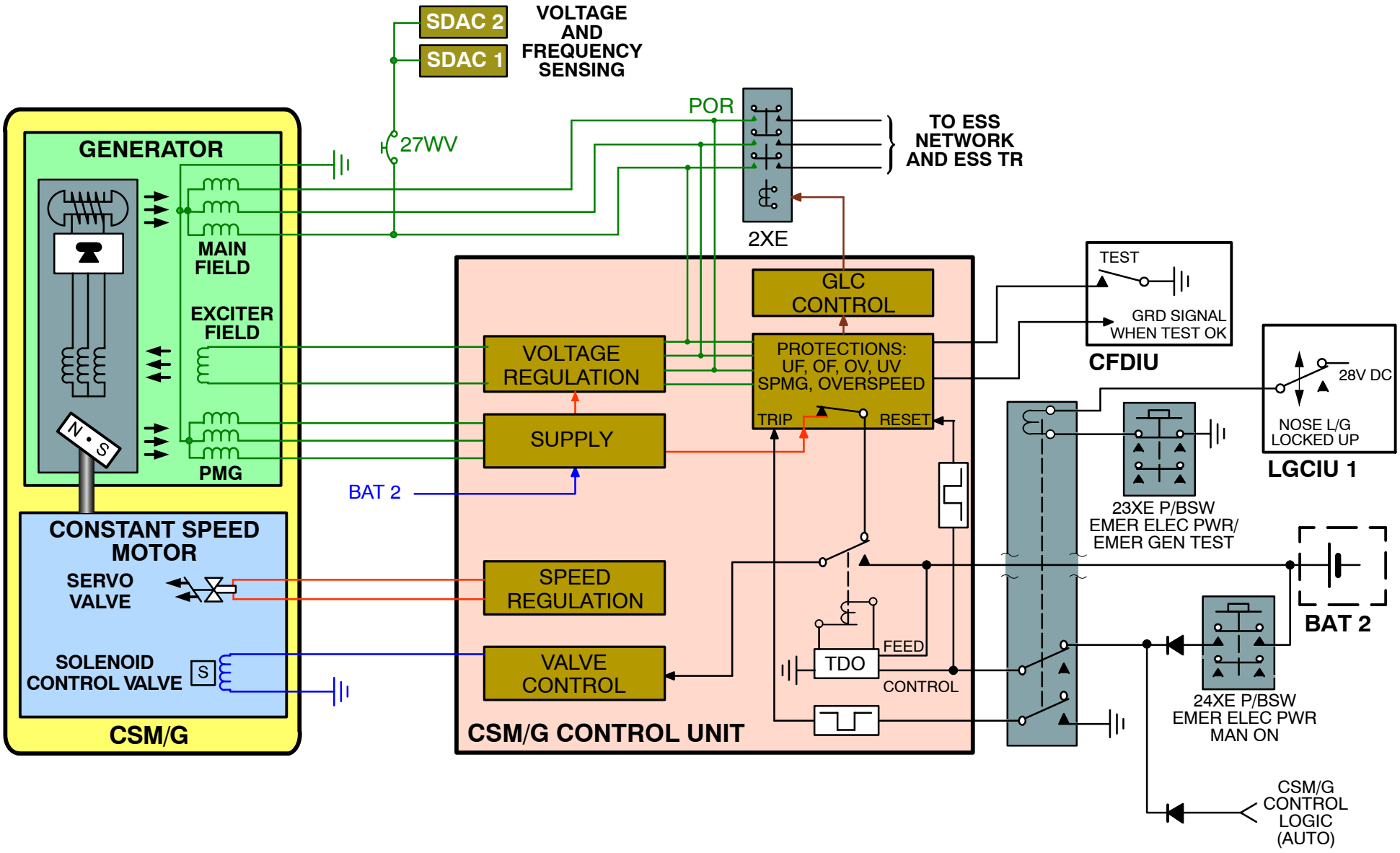

Figure 37 CSM/G Control Schematic

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24–28 STATIC INVERTER

STATIC INVERTER DESCRIPTION

GENERAL

The 1000 VA nominal–power static inverter transforms the direct current voltage from battery 1 into a single–phase 115 VAC/400 Hz alternating current.

The static inverter is used in these cases:

- APU start (supply of fuel pump),
- engine start on batteries (ignition),
- Ram Air Turbine (RAT) deployment (< 10s) (supply of ECAM display units),
- on ground, on batteries only (pushbutton switch supply),
- in emergency configuration with landing gear extended (RAT Version 1), or
- in emergency configuration after landing, when the CSM/G is switched off (RAT Version 2).

Operation/Control and Indicating

The static inverter starts automatically if:

- the AC BUS 1 and 2 are lost,
- the CSM/G is not available, and
- speed is more than 50 Kts.

When the static inverter is faulty, it generates a permanent ground signal to the BCL1. The presence of the ground signal means:

- overheat,
- output overvoltage,
- input undervoltage,
- input overvoltage.

The static inverter defect is sent to the battery charge limiter 1 which stores it in a memory as a class I failure. When the network is supplied, STATIC INV FAULT message appears on the upper ECAM display unit.

The fault indication will be available during BCL BITE reading from the Centralized Fault Display System (CFDS).

Test

On the ground, the static inverter can be checked applying the following procedure (aircraft supplied by EXT POWER or APU GEN):

- EMER GEN TEST P/BSW ON,
- BUS TIE P/BSW OFF,
- On the ECAM ELEC page, check voltage and frequency of static inverter, by pressing and holding the ELEC key on the Ecam Control Panel (Single ECAM DU operation).

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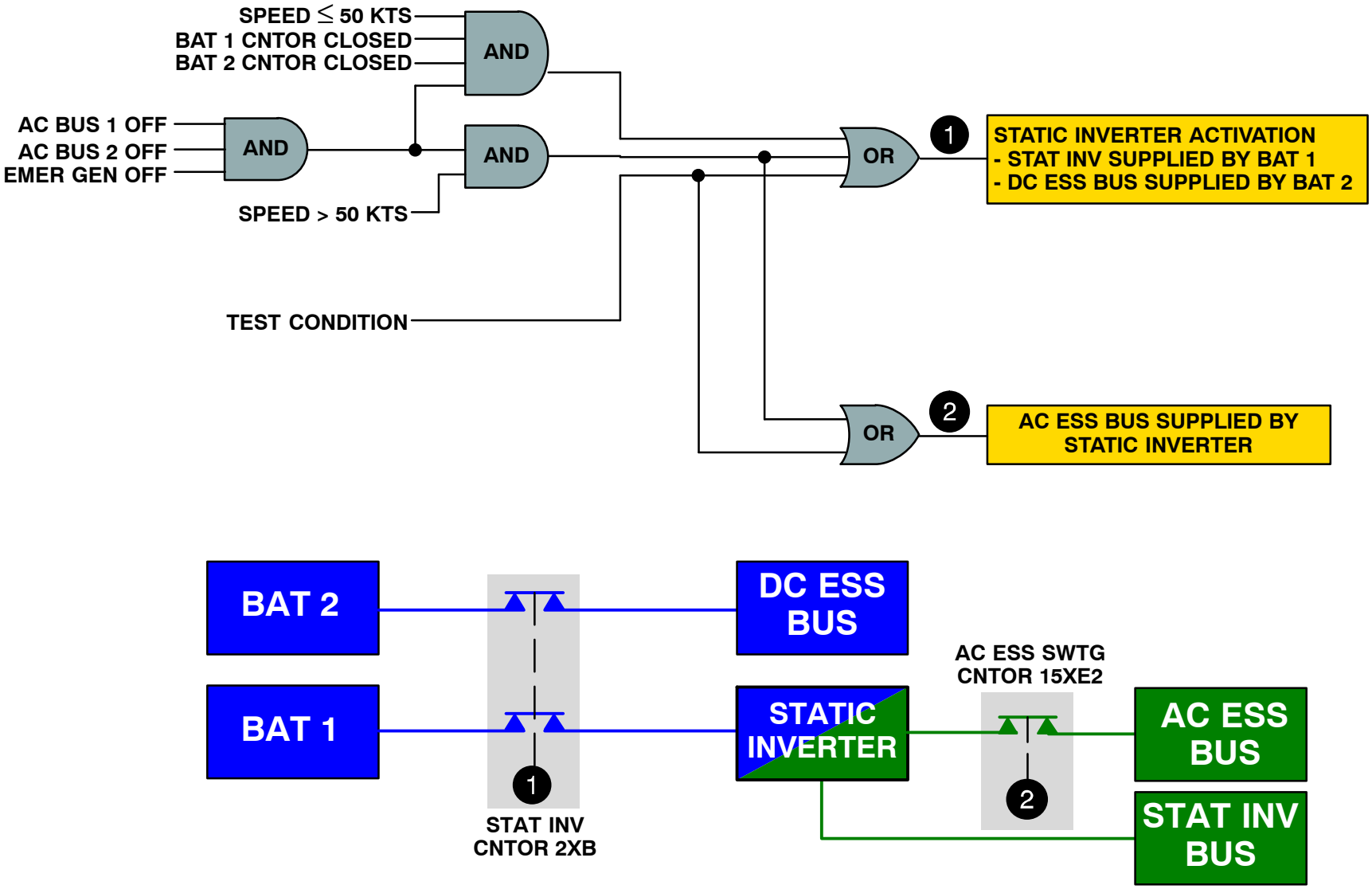

NOTE: The activation of the Static Inverter automatically leads to a de-energization of the DC and AC ESS SHED BUS.

Figure 38 Static Inverter Activation Logic

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STATIC INVERTER CONTROL DESCRIPTION

The static inverter serves to supply:

- the APU fuel pump (alternate supply)
- engine ignition (alternate supply)
- one annunciator light transformer (alternate supply) and
- the AC ESS BUS (in flight only), if there is no other power source available except the batteries.

The static inverter transforms 28 V DC into 115 V AC (single phase), 400 Hz.

Nominal power is 1000 VA.

On the ground (speed < 50 kts), to get the static inverter into operation (e.g. for an APU start), both batteries must be switched on (contactors 6PB1 and 6PB2 energized).

To check the static inverter on ground, the electrical network is switched off, included the batteries. After that, when the EMER GEN TEST pb–sw. on the EMER ELEC PWR panel is pushed and hold, a condition is simulated (A/C speed >50 kts), in which the static inverter goes into operation automatically and supplies the AC ESS BUS.

Thereby a part of the ECAM system goes into operation and the electrical parameters of the static inverter (voltage and frequency) can be checked via the E/WD (single display operation).

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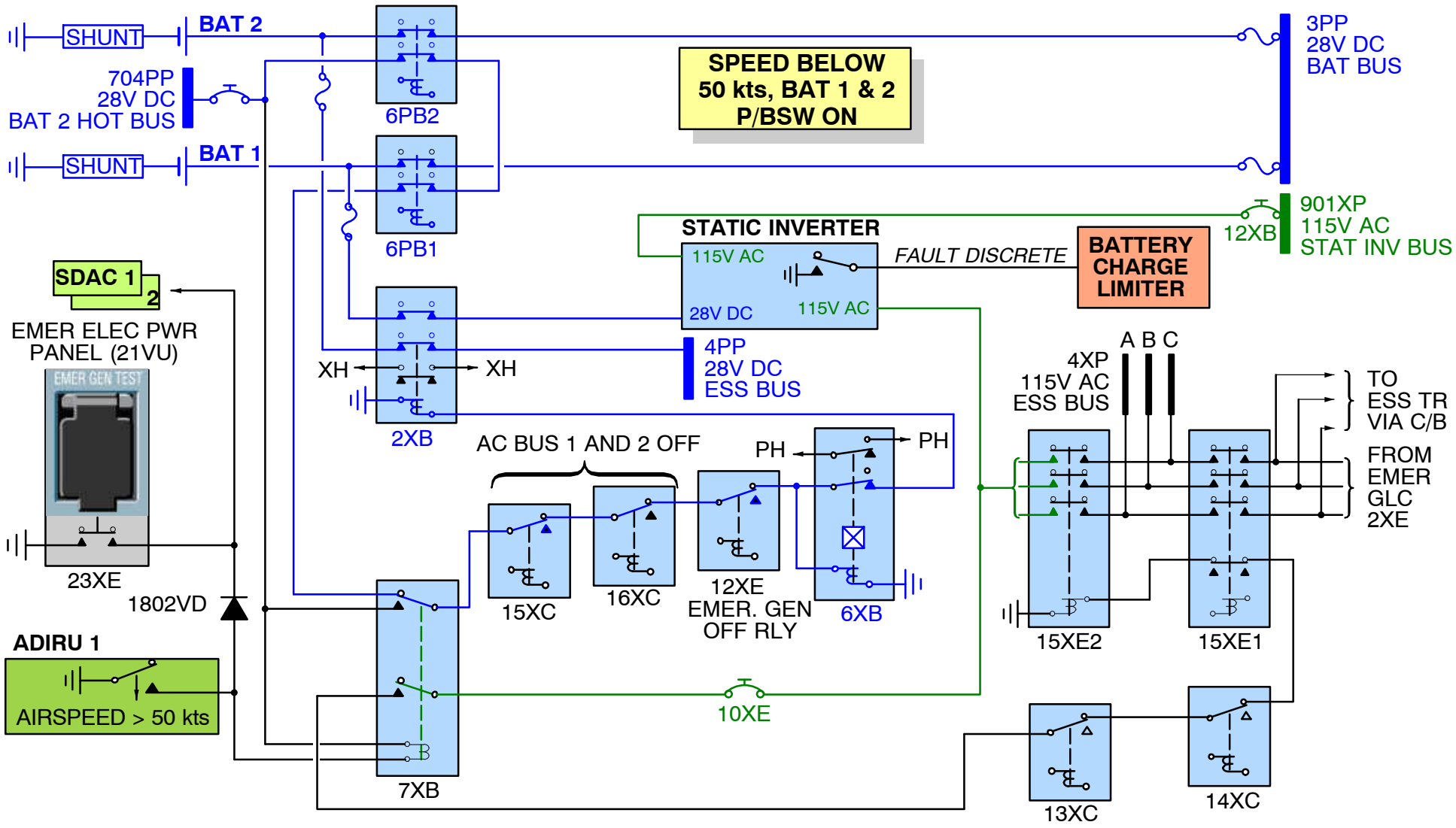

Figure 39 Static Inverter Control Schematic

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24–26 GALLEY SUPPLY CONTROL

GALLEY SUPPLY CONTROL OPERATION

GENERAL

The galley assembly is divided into several parts:

- Aft galley,
- Forward galley,
- Mid galley (A321 Only).

The galley general supply is controlled from flight compartment overhead panel 35VU by means of GALLEY or GALY & CAB pushbutton switch (normal operation when the pushbutton is pressed in).

If the OFF legend of the enhanced COMMERCIAL pushbutton switch (commercial load shed) is off (pushbutton switch pressed in), galley general supply can be controlled from flight compartment overhead panel 35VU by means of GALLEY pushbutton switch (normal operation when the pushbutton is pressed in).

Description

The supply of the galley loads is divided into two groups:

- Main Galley supply,
- Secondary Galley supply.

The power supply provides the galleys with 115 VAC and 50KVA to 70KVA electric power depending on A/C type.

The on and off switching and monitoring of the system takes place via a common pushbutton switch on cockpit overhead panel.

The supply of the galley loads depends on the supply of the electrical network in flight or on ground.

All galley loads are supplied, when the following power sources are in operation:

- external power
- two generators
- APU generator on ground.

Only the secondary galley loads are supplied, when the following power sources are in operation:

- one engine generator (ground or flight)
- APU generator in flight.

The FAULT light in the GALLEY P/BSW illuminates, when one of the three generator systems (IDG 1,2 or APU) signals an overload condition (discrete from the GCU).

When there is an overload condition with the APU generator system during ground operation, the complete galley loads are automatically switched off (relay 4XA is energized and locked via the GALLEY P/BSW).

A reset of the galley loads is possible via the GALLEY P/BSW (first OFF than on again).

Overload Detected by a GCU

If an overload is detected:

- amber FAULT legend illuminates on GALLEY pushbutton switch,
- auto display of the ELEC page on the lower ECAM display unit,
- MASTER CAUT light + single chime + amber message on the upper ECAM display unit confirm the overload.

The crew has to release GALLEY pushbutton switch. On the ECAM SD white OFF legend illuminates. This action results in shedding of all galleys. GALLEY indication is displayed on the lower ECAM DU, STATUS page.

On ground, it is possible to supply all galleys:

- either with the APU GEN: If I > 277 A, galleys automatic shedding,
- or with the EXT PWR: without galleys automatic shedding.

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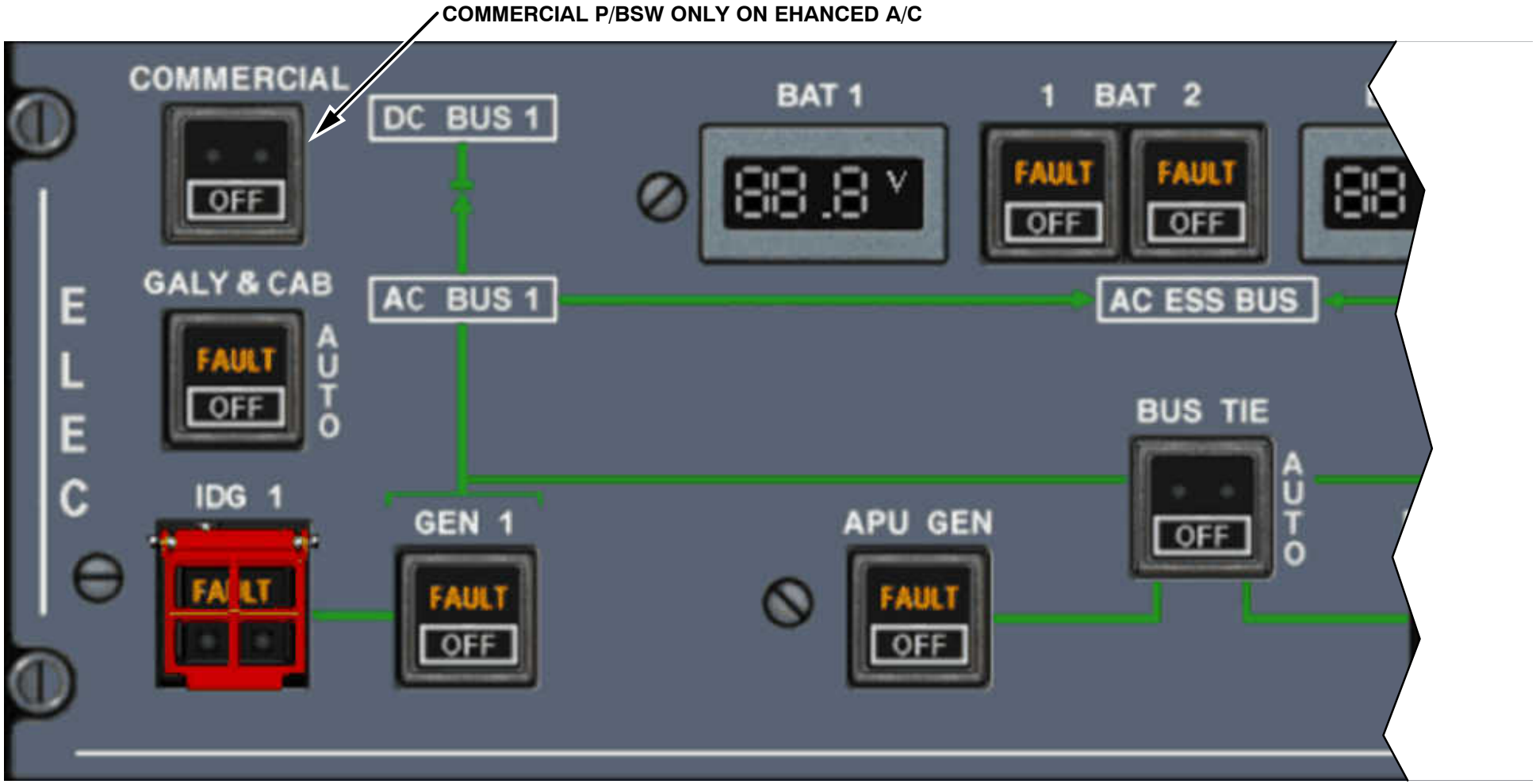

Figure 40 Galley and Commercial P/BSW

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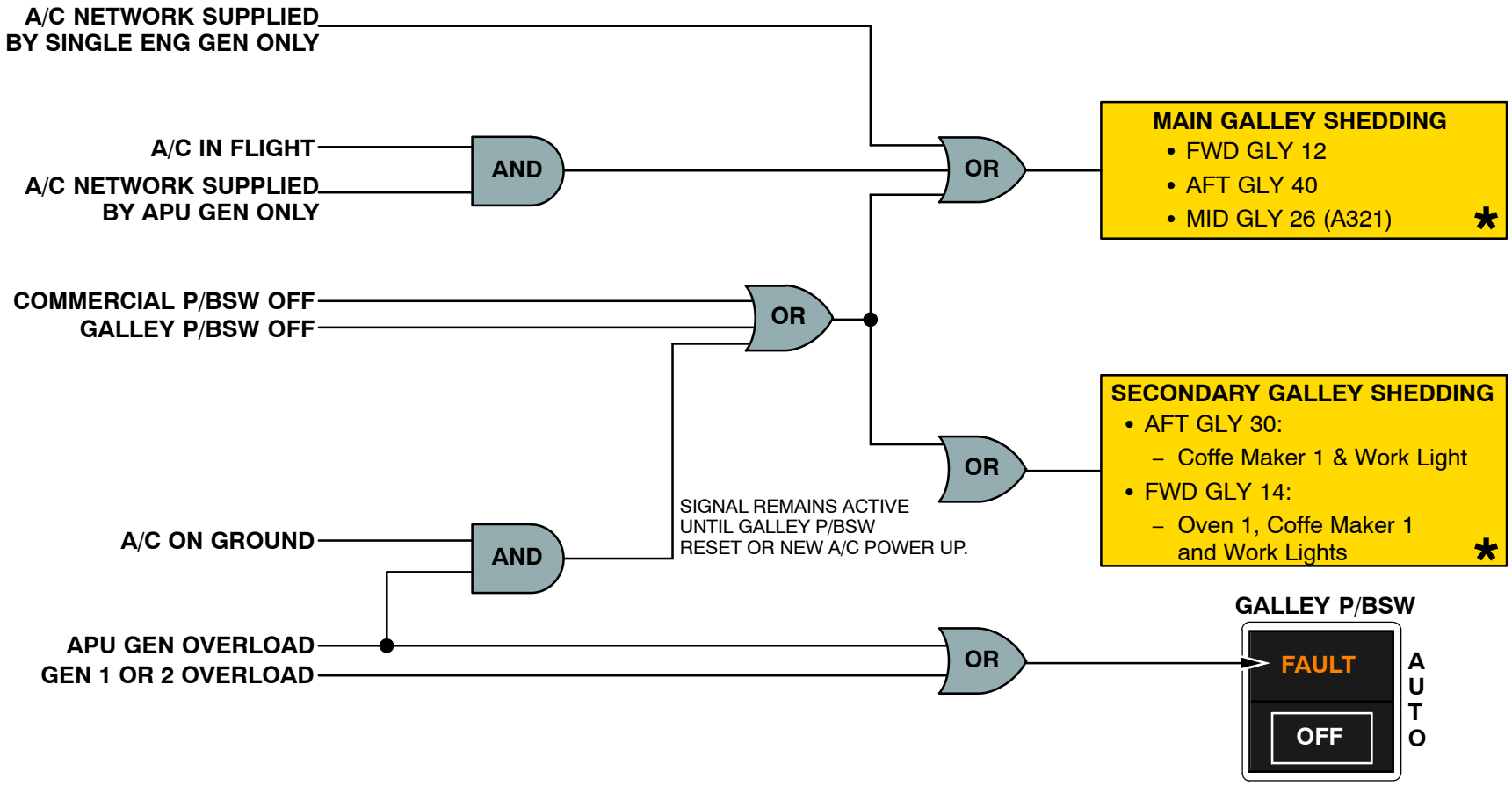

*EXAMPLES TAKEN FROM DLH FLEET. FOR OTHER AIRLINES REFER TO ASM 24–26 & 24–56.

Figure 41 Main & Secondary Galley Shedding Logic

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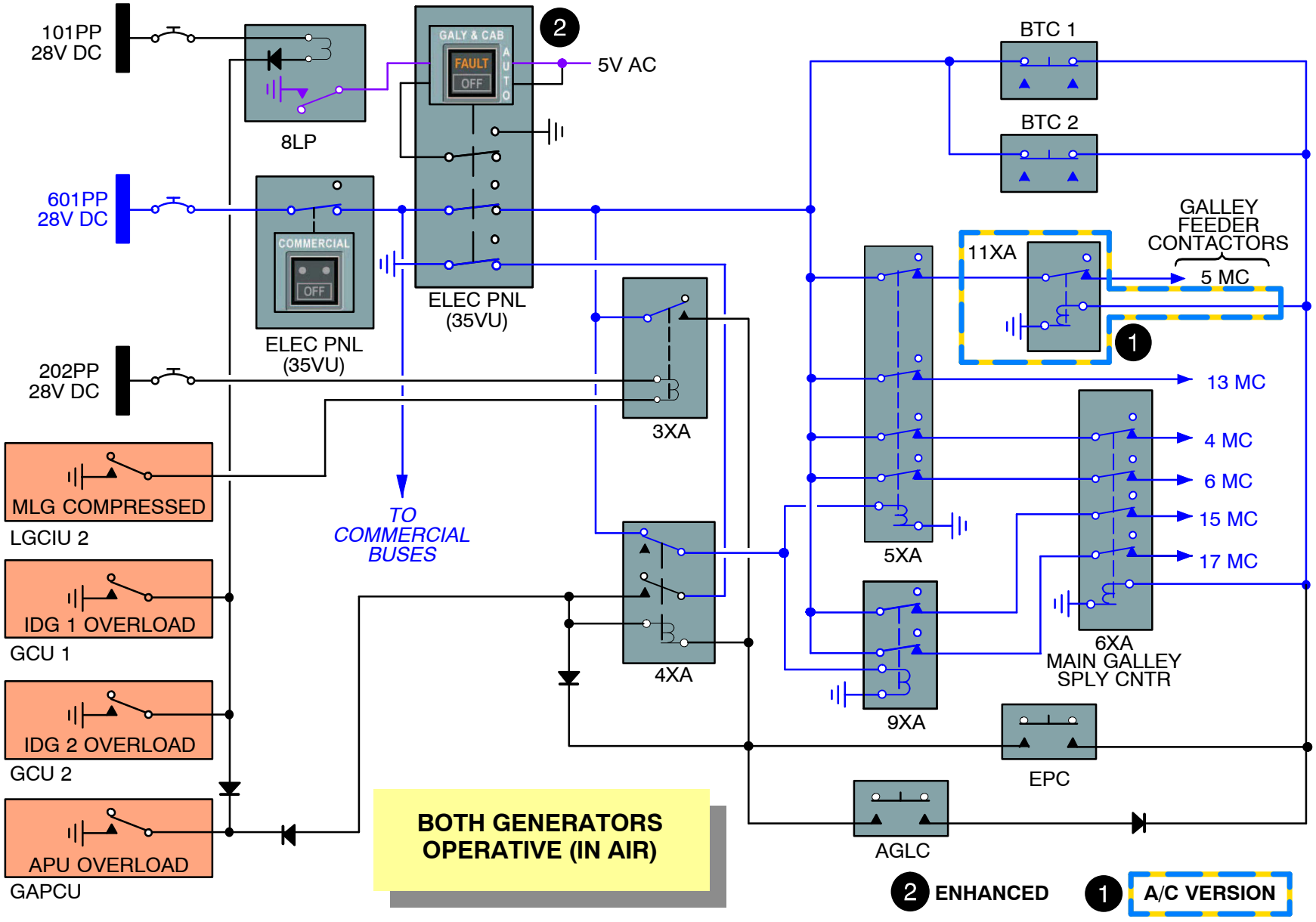

Figure 42 Galley Supply Control

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24–40 EXTERNAL POWER

EXTERNAL POWER SUPPLY PRESENTATION

GENERAL

The aircraft network can be supplied by a GPU (**G**round **P**ower **U**nit) connected to the external power receptacle located forward of the nose landing gear well.

EXTERNAL POWER CONTROL

Normal Parameters

If the external power parameters are correct, the indicator lights on the external power receptacle and the EXTernal PoWeR AVAILable light on the cockpit overhead panel come on. The ground power parameters are monitored by the GPCU (**G**round **P**ower **C**ontrol **U**nit) which activates the indicator lights. With such indications the ground cart can supply the aircraft network. As soon as the EXT PWR P/B is pressed–in, the GPCU closes the EPC (**E**xternal **P**ower **C**ontactor) to supply the aircraft electrical network.

Abnormal Parameters

If any external power parameter is not correct, the indicator lights stay off.

The external power cannot be connected to the aircraft network. The detection of a GPCU fault causes the EPC to open.

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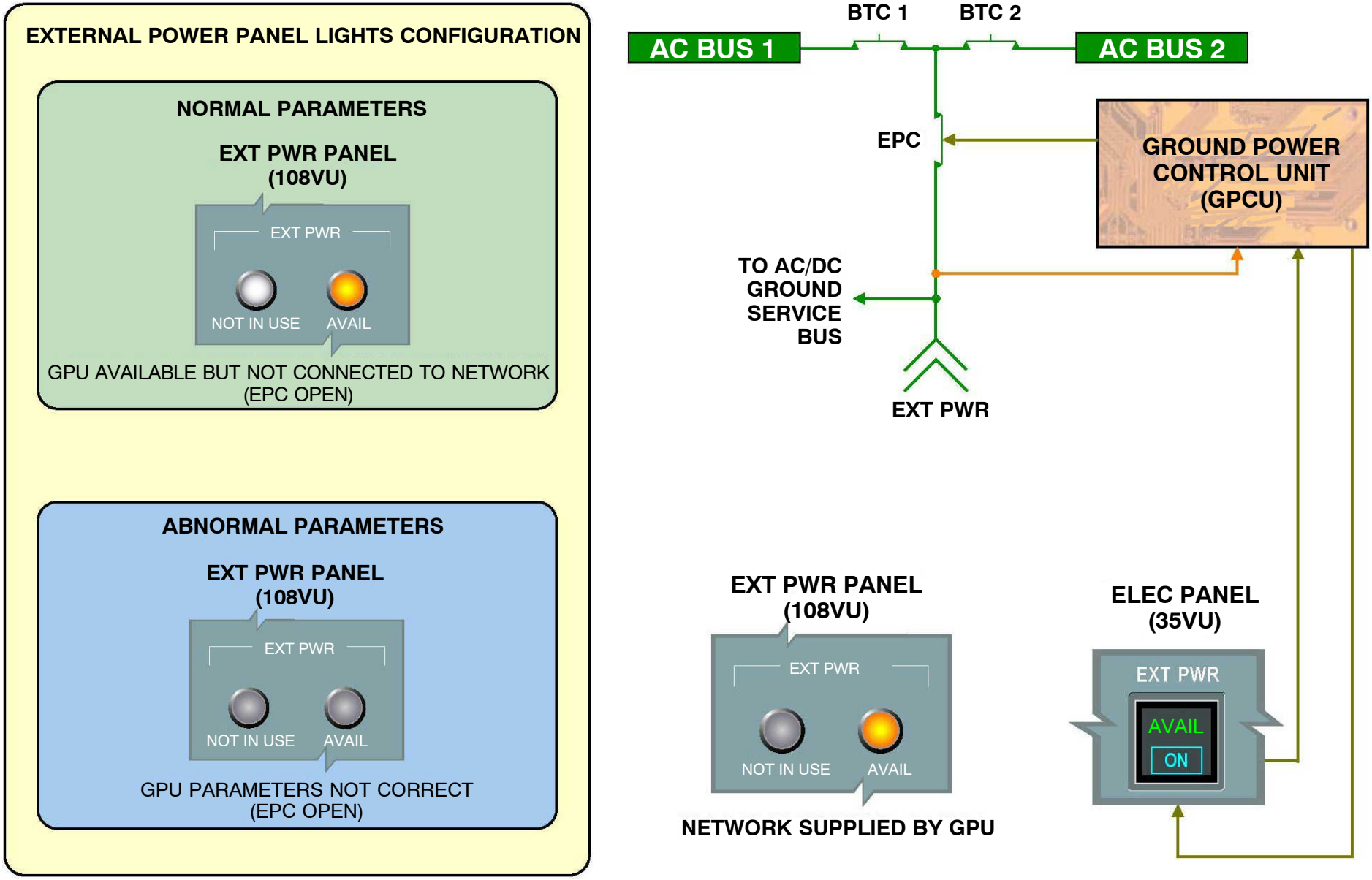

Figure 43 External Power Control

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EXTERNAL POWER FUNCTIONAL OPERATION

GENERAL

- The GPCU has three different functions:
- aircraft power supply control and network protection,
- system test and self–monitoring relating to these functions,
- provide BITE and messages for the AC generation (GCU's and GPCU).

Controls for the external power system are in the cockpit on the overhead panel and on the ground control panel.

CONTROL AND PROTECTION FUNCTIONS

Control Unit Supply

The control unit is supplied with 115 VAC/400 Hz, directly from the external power receptacle, by the voltage it has to analyse.

The GPCU generates 28VDC from this voltage.

It is used:

- for its own needs (internal plus or minus 15 V, plus or minus 5 V and + 28 V supply),
- to supply the aircraft power supply control and indicating circuits (EPC, EXT PWR pushbutton switch, EXT PWR NOT IN USE indicator light and EXT PWR AVAIL caution light, flight/ground network contactors),
- with 28 VDC from the normal aircraft electrical network and on the ground only.

This dual supply constitutes the 28 V internal supply, peculiar to the control unit.

Indicating Circuits

The GPCU (in association with the EXT PWR pushbutton switch) controls the connection/disconnection of the external power to/from the aircraft electrical system.

The necessary controls are achieved by means of relays:

- The Pin Monitoring Relay (PMR)

  This relay when energized, connects a holding supply to the GPU line contactor. It is energized when the DC input voltage (Pin E and F) is within acceptable limits (less than 42 VDC).

- The External Power Available Power Ready Relay (PR)

The PR when excited enables the connection of the ground power unit to the aircraft network provided none of the following protections is activ:

- over/undervoltage,
- over/underfrequency,
- incorrect phase order,
- GPCU internal fault.

Any fault detection:

- prevents the ground power unit from being connected to the aircraft network,
- or causes it to trip if already in line.

NOTE: When a fault is detected, the PR is no longer excited and/or inhibits illumination of the ON legend of the EXT PWR pushbutton switch.

NOTE: The PR also controls the illumination of the AVAIL legend of the EXT PWR pushbutton switch in the cockpit and the EXT PWR AVAIL caution light in the external power receptacle housing.

Protections

- **Over/underfrequency (OF, UF)**

  The control unit permanently monitors the frequency of phase A voltage of the external power receptacle. The over/underfrequencies protection are triggered when the frequency becomes higher/lower than a certain threshold.

- **Over/undervoltage (OV, UV)**

  The control unit permanently monitors the voltage of the three phases of the external power receptacle. The undervoltage protection is triggered when the voltage of the lower phase becomes lower than a certain threshold.

- **Incorrect phase order (IPS)**

  This detection is performed from voltage information of phases A and B of the external power receptacle.

  After excitation of the ground power unit generator, the control unit analyzes the phase order of the voltage supply. When the voltage is incorrect, the GPCU prevents the closure of the PR relay (protection of the three phase consumers).This protection is effective in case of cross connection between any two phases, and also if a phase and the neutral are crossed.

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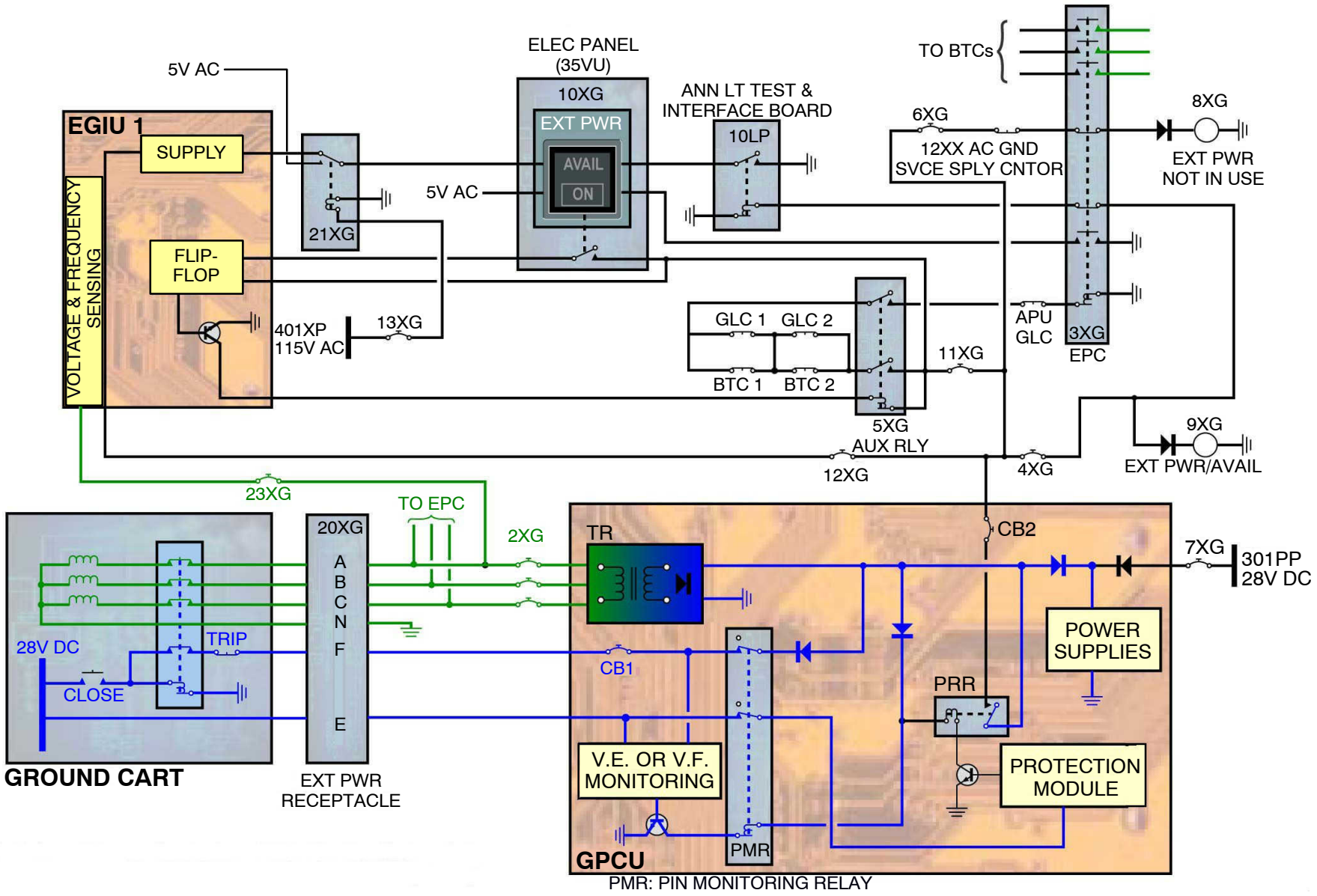

Figure 44 External Power Control

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GROUND SERVICE SYSTEM OPERATION

Ground Service Control

An AC and DC ground/flight distribution network can be supplied:

- either normally from the aircraft network or
- directly by the external power unit and TR 2 upstream of the EPC, in ground service configuration.

In ground service configuration this network can be supplied without energizing the whole aircraft network.

Supply selection for ground service network is controlled from panel 2000VU, MAINT BUS switch.

In ON position the switch is electromagnetically latched, if the GPCU delivers correct control voltage (power ready, PR).

The normal supply configuration has a priority on the ground service configuration (relay 7XX energized by AC BUS 202XP–C), but the switch remains in ON, until there is no longer power ready.

An overheat of TR 2 results in the automatic unlatching of MAINT BUS ON switch. This entails the cut–off of ground distribution network.

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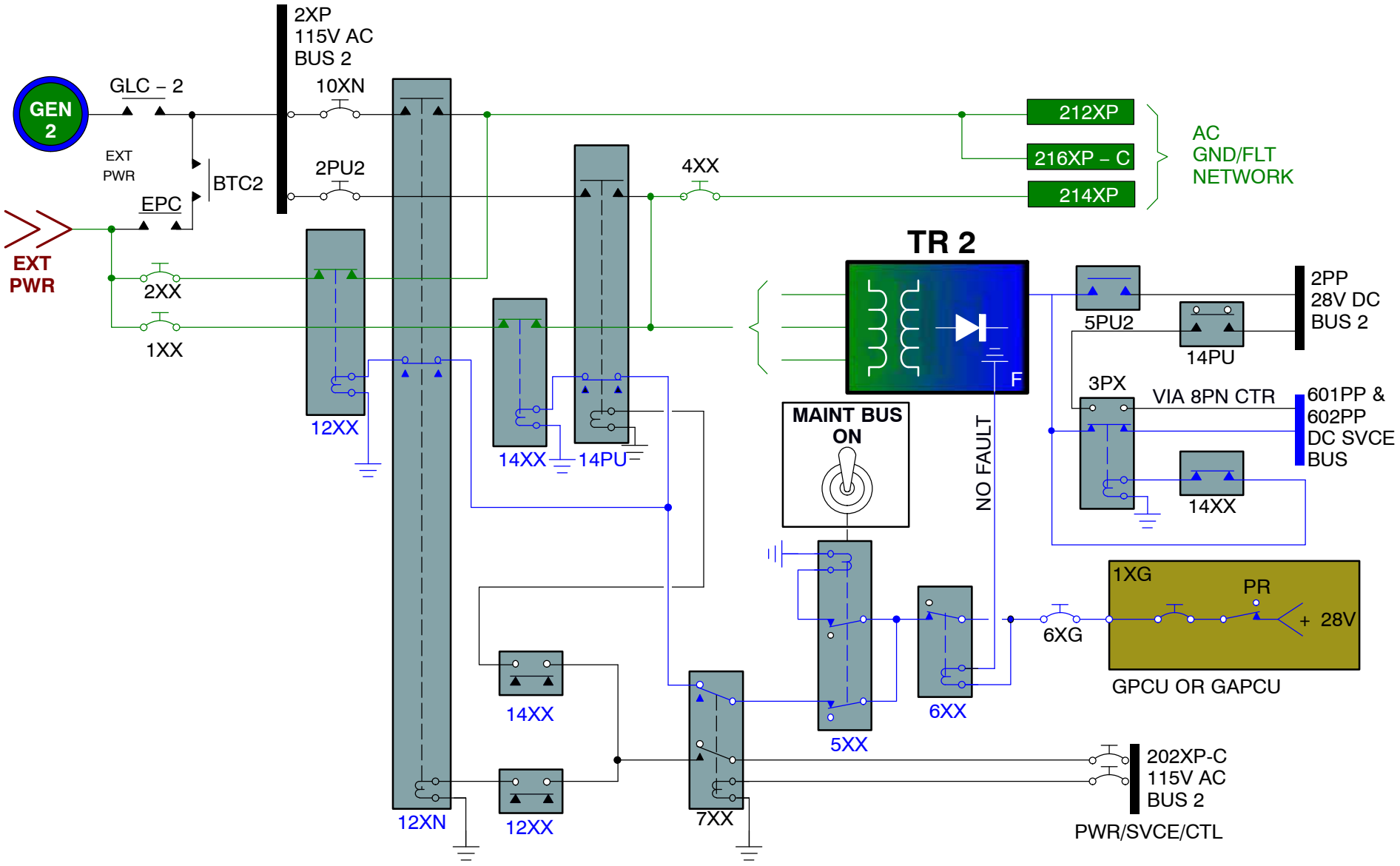

Figure 45 Ground Service Distribution

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24–30 DC GENERATION

TR–UNIT COMPONENT DESCRIPTION

Each TR (**T**ransformer **R**ectifier **U**nit) is supplied with 115 V AC/ 400 Hz, three phases.

Its nominal current output is 200 A at a voltage of 28 V DC.

The TRs are switched to the corresponding DC buses via contactors, which are controlled by the TRs itself.

In case of overheat (>171 °C) or minimum current detection (< 1 A), the TR contactor is switched off and locked open via the latching relay K1.

For TR 2 an open latching of the contactor after minimum current detection is inhibited during ground service operation (contactor 3PX energized).

RESET of a TR is possible either via the CFDS or a common RESET P/BSW (15PU) on the relay panel 103VU in the middle right avionics compartment.

Parameters of voltage and current of a TR are delivered to the ECAM system by the TR and are displayed on the SD (**S**ystem **D**isplay).

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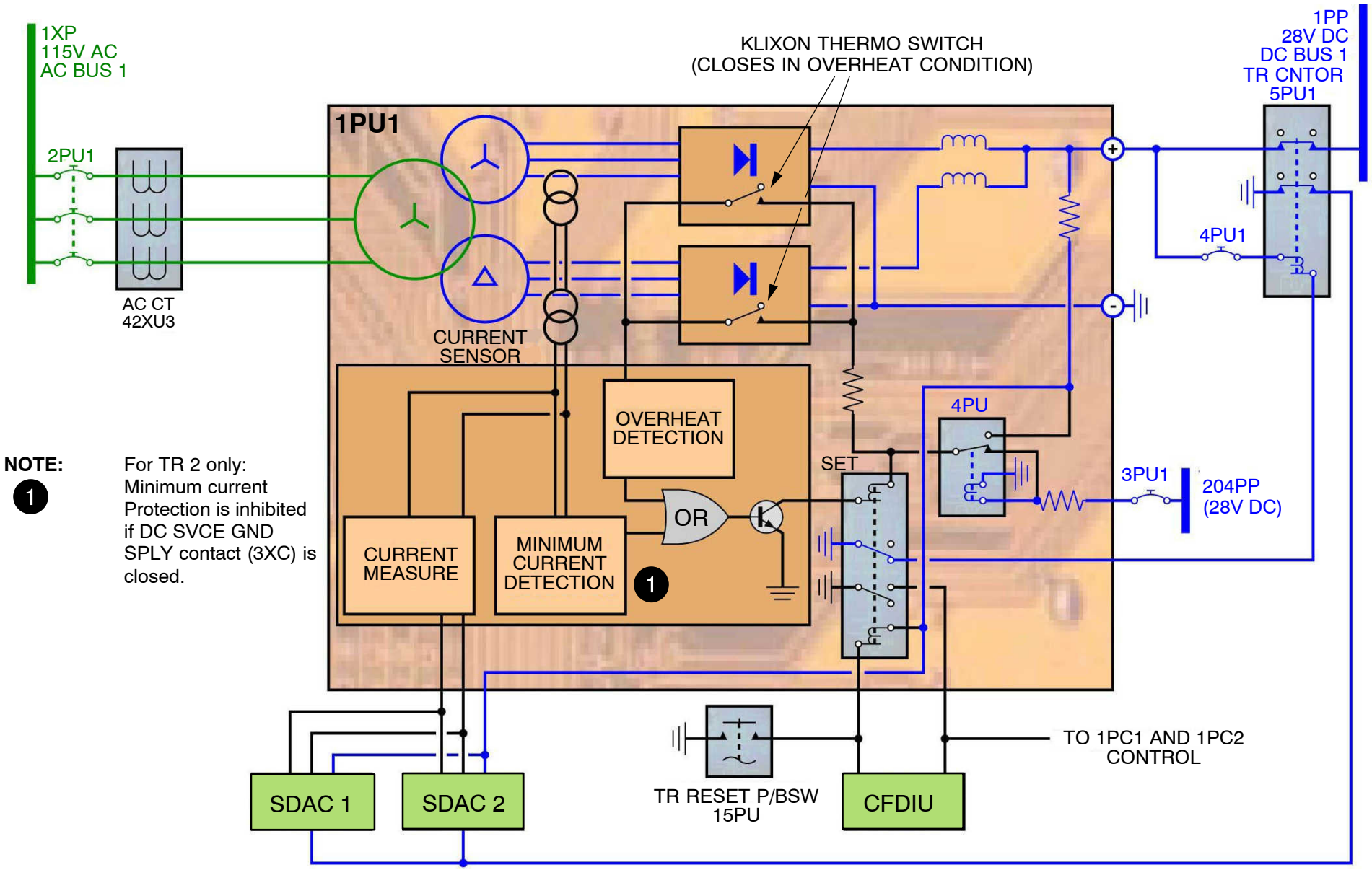

Figure 46 TR Unit Schematic

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TR–CONTACTOR SYSTEM OPERATION

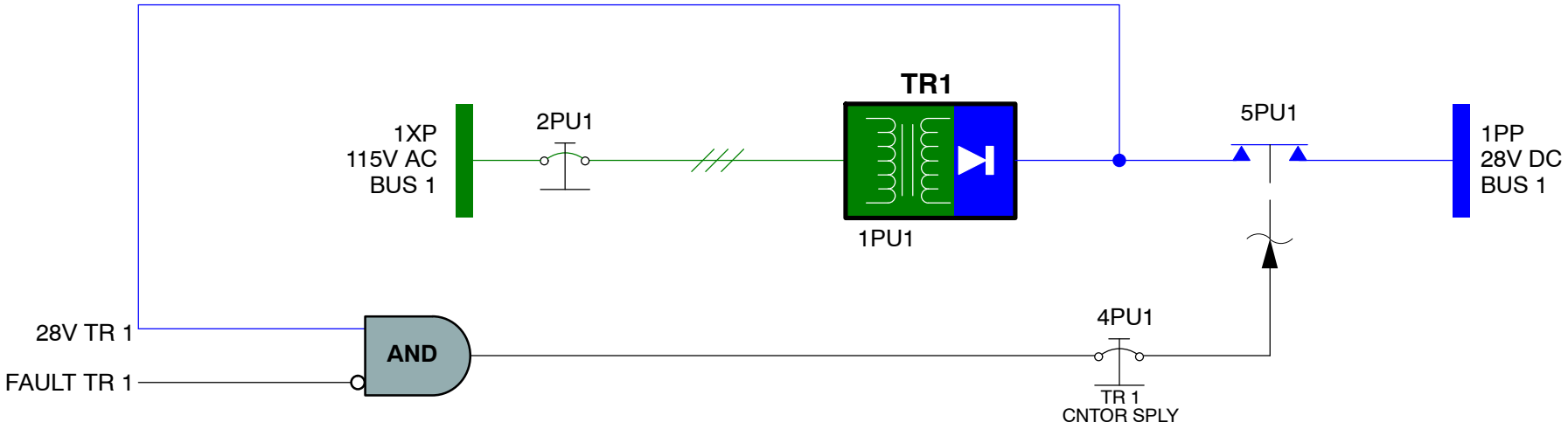
The TR CNTRs 5PU1, 2 and 3PE serve for connecting the DC BUSES 1, 2 and ESS with their corresponding TR.

The ON switching conditions are:

- no TR fault and
- 28V DC TR output

For the switching logic of TR 2 contactor a third condition is necessary:

5PU2 is only switched on, when the AC supply for TR 2 comes from AC BUS 2 (contactor 14PU energized) and not from ground service.



NOTE: For TR1, TR2:
"FAULT TR"=No output current or overheat.

Figure 47 TR 1 Contactor Control

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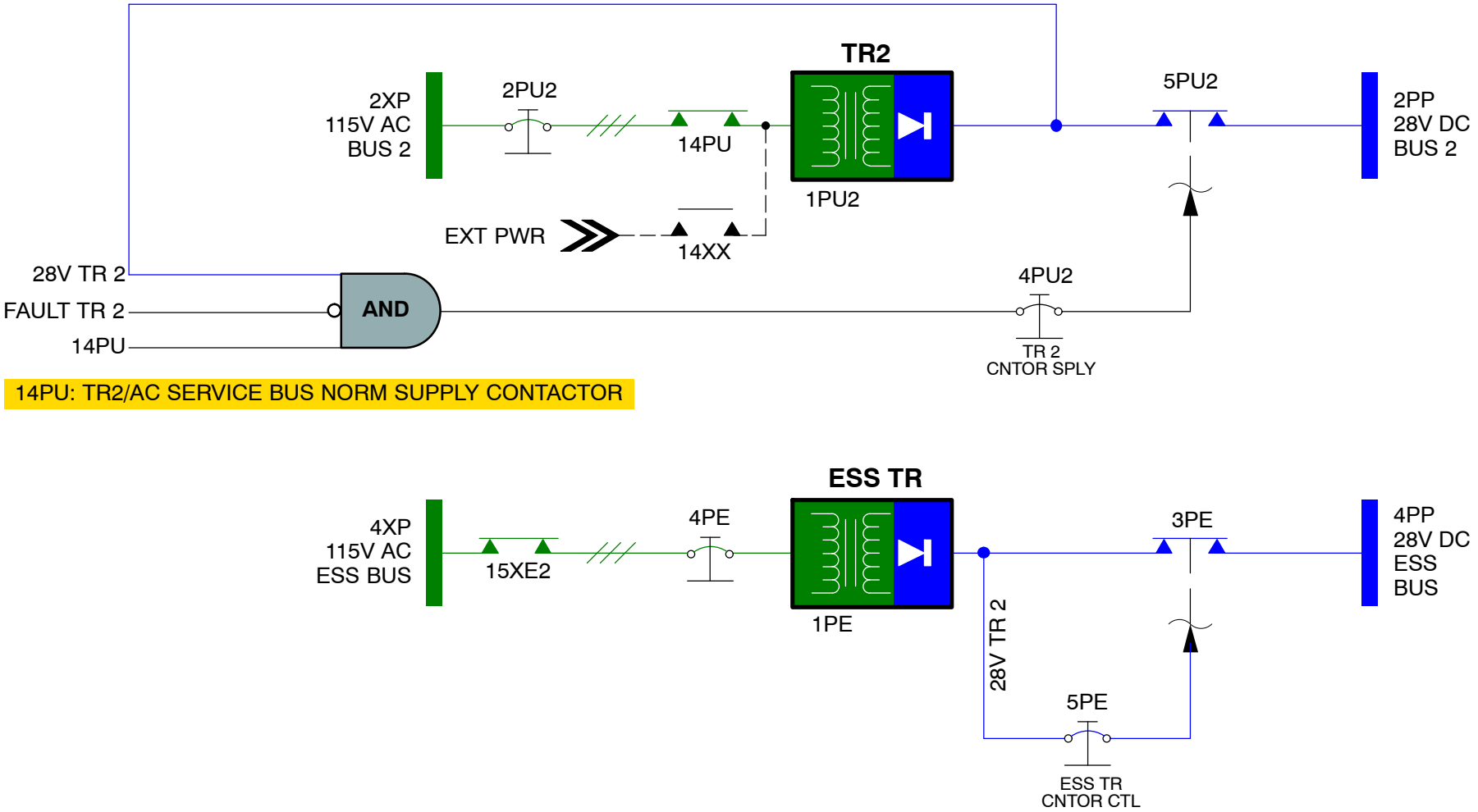

Figure 48 TR 2 & ESS TR Contactor Control

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24–35 DC ESSENTIAL & NORMAL GENERATION SWITCHING

DC TIE CONTROL OPERATION

DC TIE CNTR 1 (1PC1) Control

The contactor is normally energized and serves for connecting the DC BAT BUS to the DC BUS 1.

DC TIE CNTR 2 (1PC2) Control

The contactor is normally deenergized and energized if TR 1 or TR 2 is lost or contactor 1PC1 is faulty.

The FIN's in the logic in detail stand for the following components:

- 1PC1 = DC TIE CNTR 1
- 1PC2 = DC TIE CNTR 2
- 4PC = ESS DC TIE CNTR
- 1PP = DC BUS 1
- 2PP = DC BUS 2
- 5PU1 = TR 1 CNTR
- 5PU2 = TR 2 CNTR
- 1XP = AC BUS 1
- 2XP = AC BUS 2

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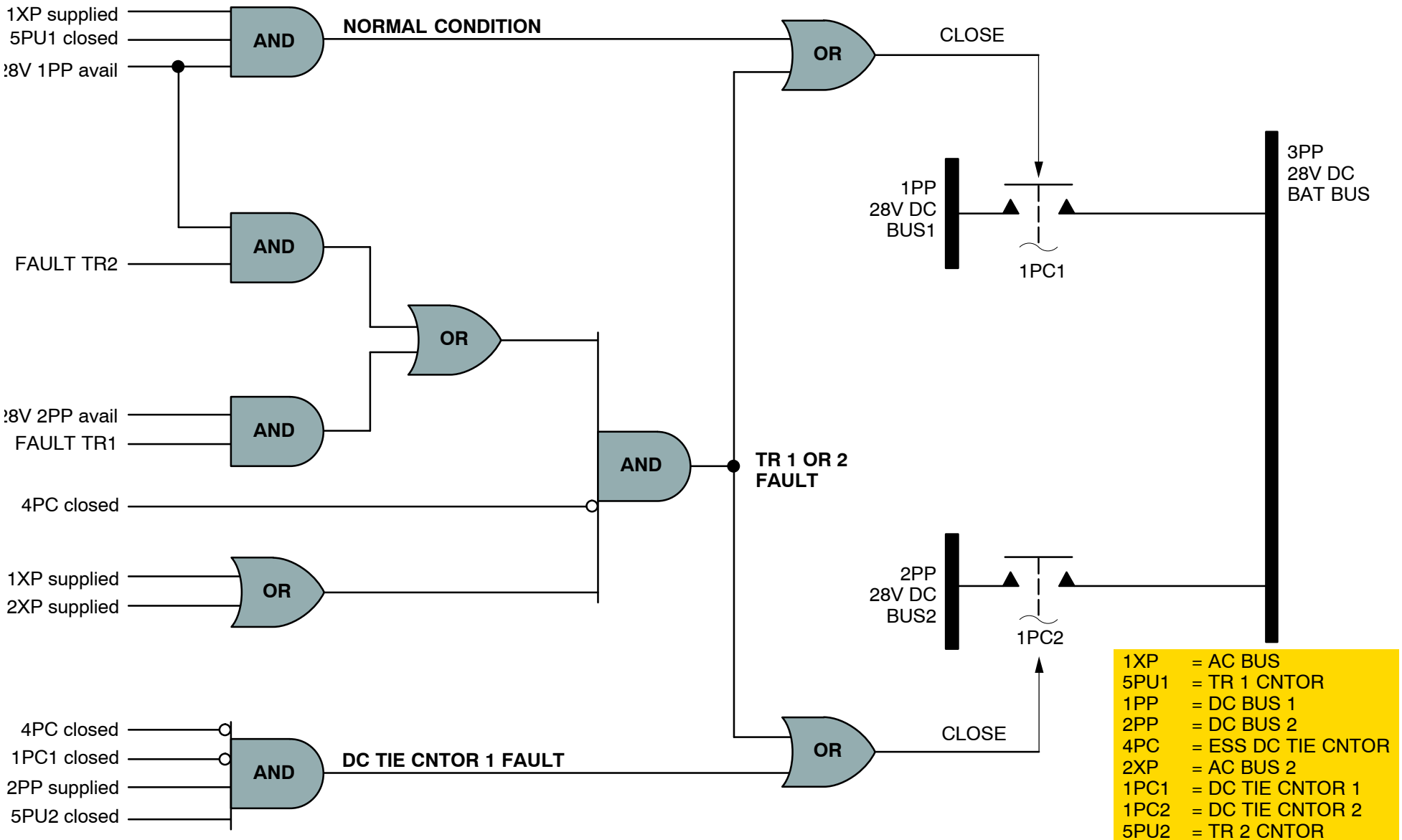

Figure 49 DC Tie Control

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DC ESS BUS NORMAL SUPPLY

The DC ESS BUS is normally supplied by the DC BUS 1 via the DC BAT BUS (ESS DC TIE CNTR 4PC energized).

The conditions therefore are:

- TR 1 supplies DC BUS 1 (contactor 5PU1 energized)
- DC TIE CNTR 1 energized, DC TIE CNTR 2 deenergized
- DC BUS 1 supplied (28 V DC)
- ESS TR not in operation (contactor 3PE deenergized).

The ESS DC TIE CNTR (4PC) is deenergized, if:

- TR 1 and/or 2 are/is lost (contactors 1PC1 and 1PC2 energized), or
- in emergency configuration (contactor 3PE energized), or
- DC TIE CNTR 1 (1PC1) faulty.

The FIN's in the logic in detail stand for the following components:

- 1PC1 = DC TIE CNTR 1
- 1PC2 = DC TIE CNTR 2
- 4PC = ESS DC TIE CNTR
- 3PE = ESS TR CNTR
- 1PP = DC BUS 1
- 5PU1 = TR 1 CNTR

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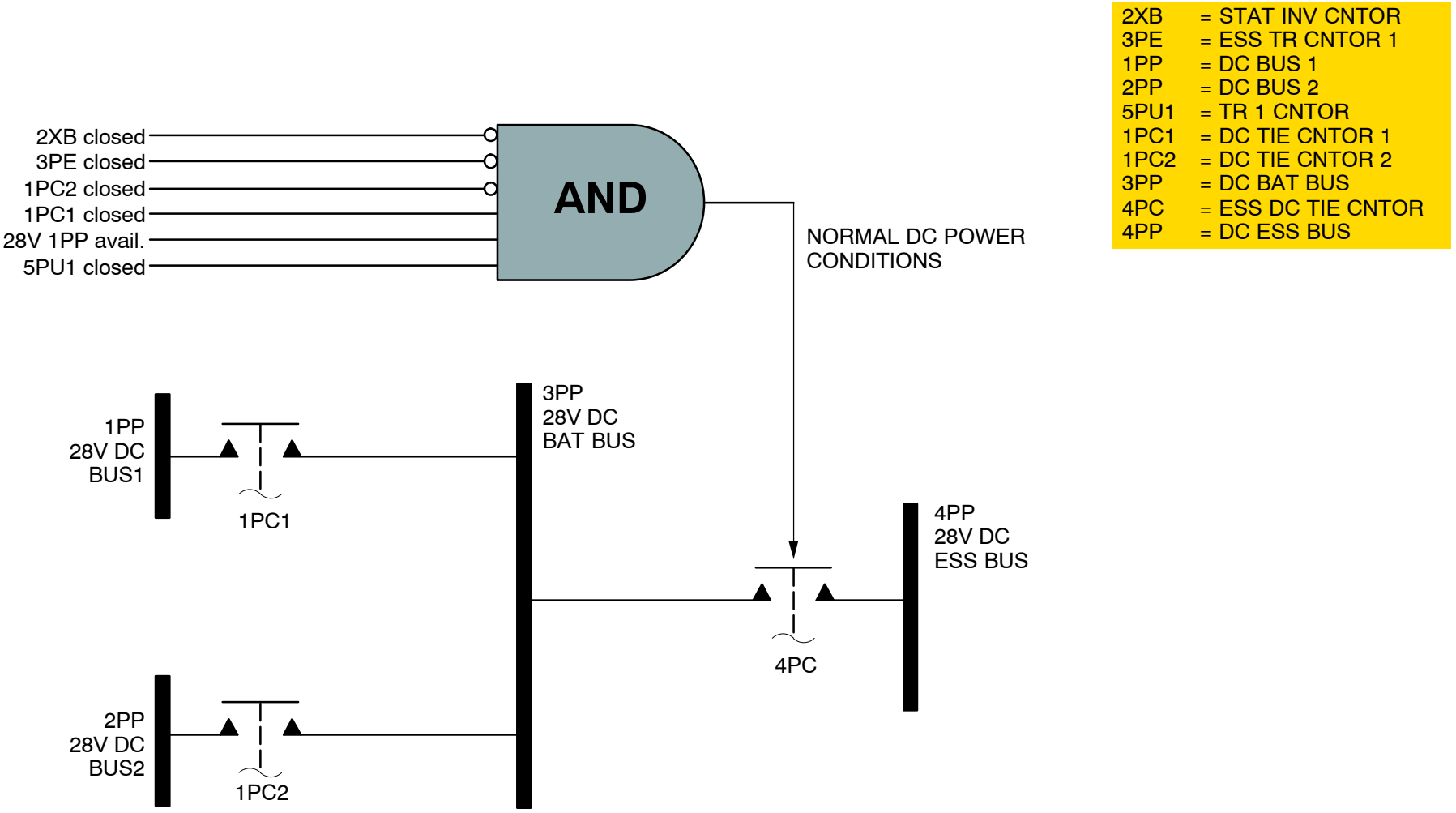

Figure 50 DC ESS Bus Normal Supply

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24–38 DC GENERATION BATTERIES

BATTERY CONTROL FUNCTIONAL OPERATION

GENERAL

Each battery of the nickel–cadmium type is composed of twenty elements housed in a stainless steel case.

They have the following characteristics:

- nominal voltage: 24 V,
- nominal capacity: 23 Ah,
- high instantaneous power,
- electrolyte reserve: 60 cubic centimeters,
- two ventilation ducts.

They are used for:

- start of the APU on ground and in flight, or
- supplying parts of the AC/DC network in emergency configuration, during RAT (**R**am **A**ir **T**urbine) deployment and when the emergency generator is not in operation (configuration with landing gear down).

CONTROL

Each battery system contains a BCL (**B**attery **C**harge **L**imiter), which controls the corresponding BC (**B**attery **C**ontactor). Therefore the BAT P/BSW (cockpit overhead panel) must be in position AUTO (pressed in):

BATTERY SHUNT

A 400 A/75mV shunt is installed on a base. It is used to read the charging and the discharging currents of a 24 V, 23 Ah battery.

It has the following characteristics:

- Rating: the shunt supplies a voltage of 75 mV when a 400 A current goes through it.
- Accuracy: 1% at 20 deg.C in the 0 – 400A range.
- Overload capacity: 600 A during 30 seconds, 1000 A during 5 seconds.
- Max. weight: 300 g.

Battery Contactor 1 or 2 closes:

- when the BAT P/B is set from OFF to AUTO (BCL reset),
- battery voltage < 26,5 V and BAT BUS voltage > 27 V, or
- during APU start (APU master switch ON and APU speed < 95%), or
- when no AC power available (AC BUS 1 and 2 power loss) and A/C on ground (LGCIU) or A/C speed < 100 kts (ADIRU 1).

BC 1 (2) open, when:

- charge current < 4A for 10 seconds on ground (BAT SHUNT),or
- charge current < 4A for 30 minutes in flight, or
- charge current > 10A and charge rate > 0,375 A/min (thermal runaway) (BAT SHUNT), or
- charge current > 150 A for > 90 sec. (BAT SHUNT), or
- discharge current > 150 A (BAT SHUNT), or
- BCL failure (e.g. internal short), or
- battery voltage < 23 V for 15 seconds to prevent complete discharge of the battery on ground.

  The battery contactor opens and remain latched open. A reset may be possible by pushing the appropriate BAT pb–sw. to OFF and back to AUTO.
- In flight, when the electrical emergency configuration is initiated, the APU start sequence is inhibited during 45 seconds (CNTR 5KA inhibited).

  If the CSM/G comes on line before 45 sec., the APU start sequence is available as soon as the CSM/G is coupled to the network.

  The APU start sequence is also inhibited in emergency configuration, when the landing gear is extended.
- The EMER GEN FAULT light on the EMER ELEC PWR panel is controlled by BCL 1 and 2.

  It illuminates, when:
  - AC BUS 1 and 2 power loss
  - nose landing gear up and locked
  - ESS TR CNTR (3PE) not energized.
- All parameters of the batteries for ECAM (indications and failure messages) are delivered by the BCLs in digital form.
- All failure messages from the BITEs, including static inverter fault, are delivered to the CFDIU in digital form.

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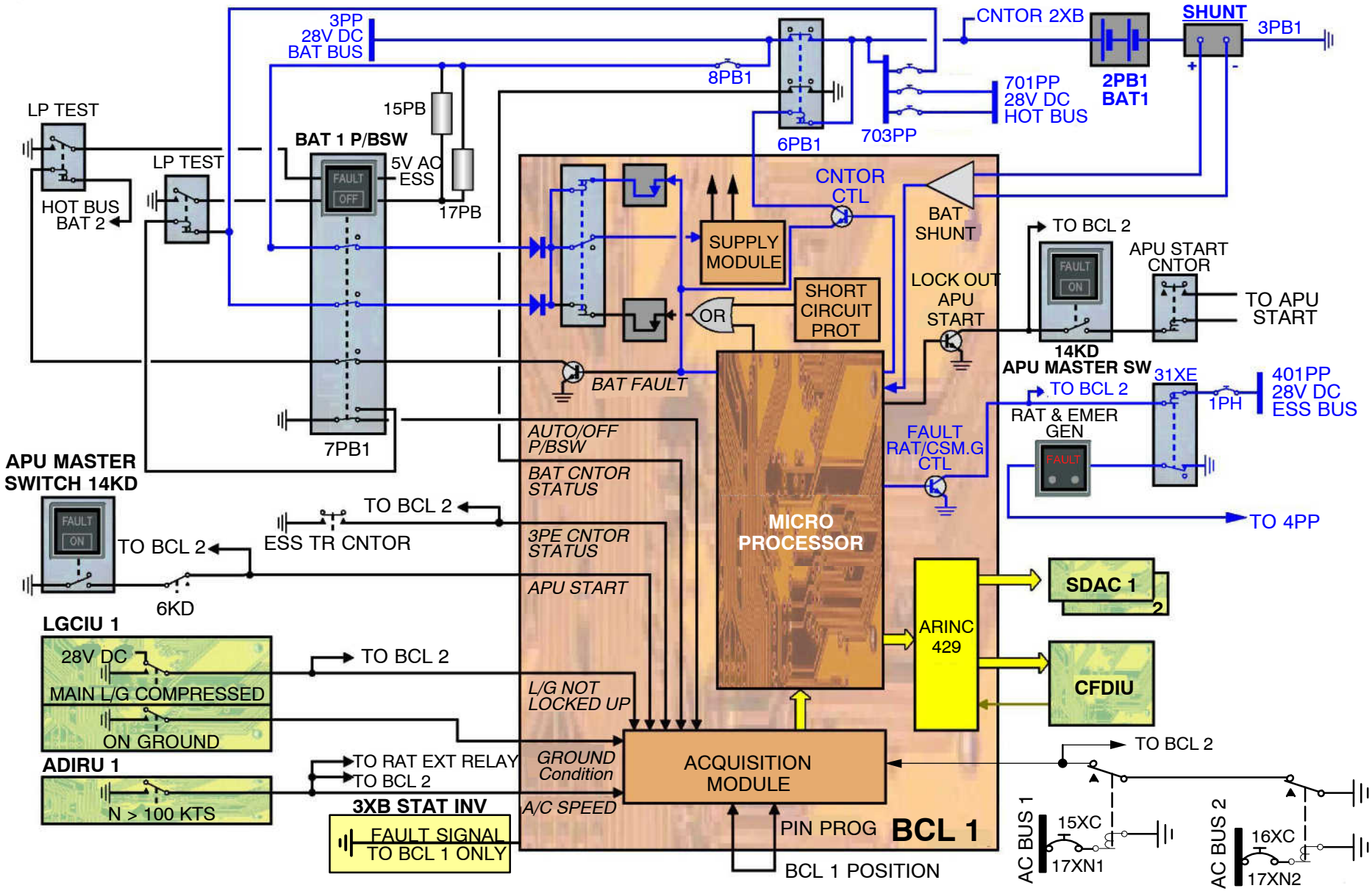

Figure 51 Battery Control

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24–00 GENERAL

ELECTRICAL POWER BITE (CFDS HANDLING)

CFDS UTILIZATION GENERAL

Access to the CFDS (**C**entralized **F**ault **D**etection **S**ystem) for testing the different electrical power systems is available via a MCDU from the cockpit.

The maintenance engineer has the choice between the tests of the:

- Emergency GCU (**G**enerator **C**ontrol **U**nit)
- All AC generation computers (GCU1, GCU 2, APU GCU, GPCU)
- The BCL (**B**attery **C**harge **L**imiters)
- A reset of one of the TRUs (**T**ransformer **R**ectifier **U**nits)

NOTE: The tests are only possible on ground with engines shut down.

For testing the AC generation computers the APU must also be shutdown.

The main menu of the electrical power system is shown in the next figure.

It represents the items which lead to the specific tests of the components.

EMER GCU

The GCU of the emergency generator system can be tested by only one menu item: ”TEST”.

If the protection circuits work correct during the test, the message ”TEST OK” appears on the MCDU.

In the case of a negative test result the message ”GCU EMER” with the associated ATA chapter is displayed.

TR–UNIT

When a TR has been switched off automatically due to a failure, its contactor keeps open latched.

A reset is possible via the CFDS, by only one menu item: ”RESET”.

AC GEN

All AC GENeration computers (GCU 1, 2, APU GCU and GPCU) include a BITE system type 2, which enable them to store failure messages in a memory.

Also they can be checked via the CFDS.

The GPCU is the interface between the GCUs and the CFDIU. The GCUs are continuously monitored by the GPCU.

The GPCU stores in the memory the failure codes acquired by the GCUs.

The GPCU transmits all the failure codes thus acquired together with the failure codes from the GPCU and the external power system to the CFDIU.

BCL

The BCL (**B**attery **C**harge **L**imiter) includes a BITE system type 2 which enables it to store failure messages in a memory.

The messages can be read out via the CFDS.

Also the BCL can be checked via the CFDS.

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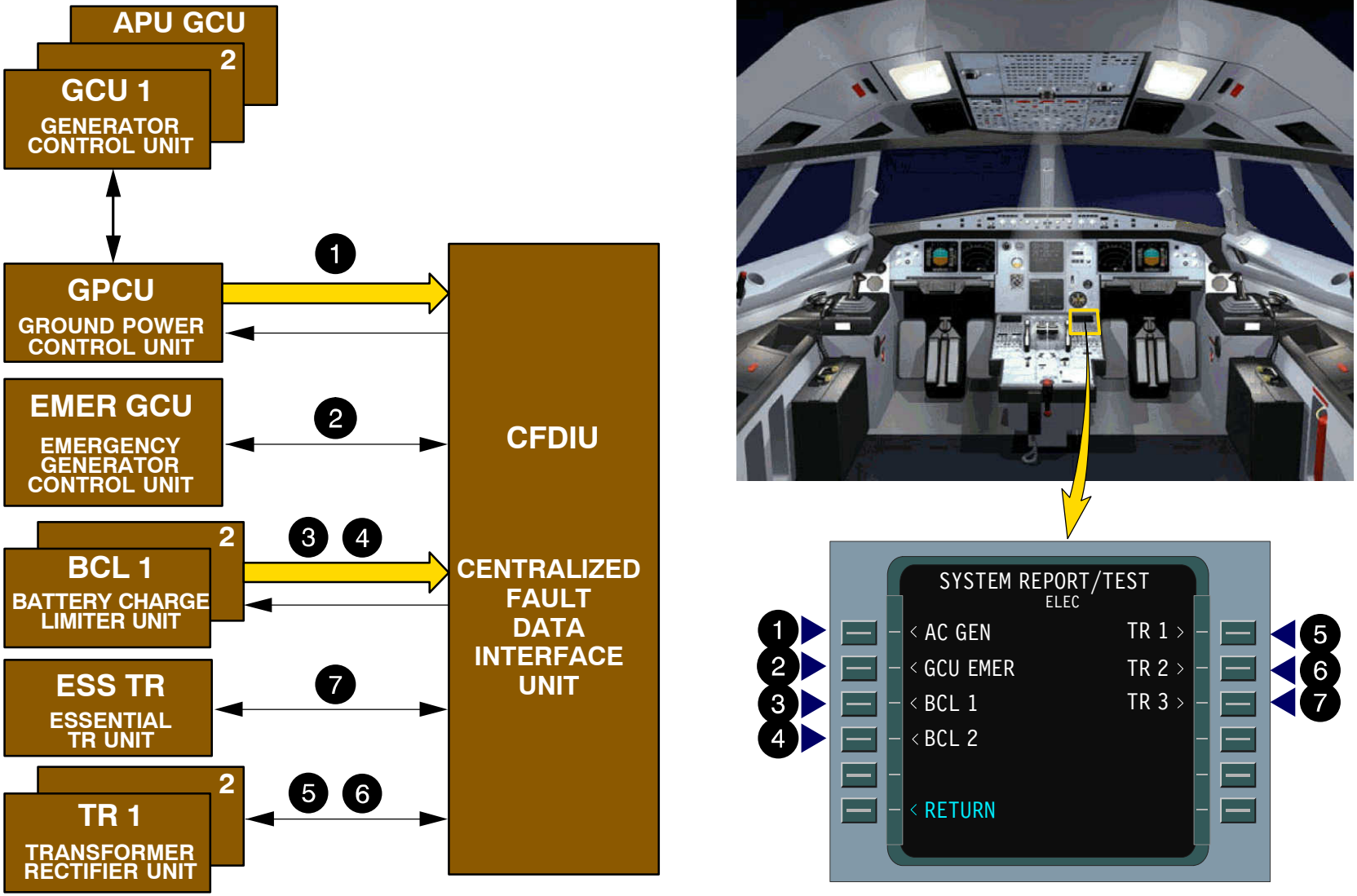

Figure 52 CFDS Tests Electrical Generation System

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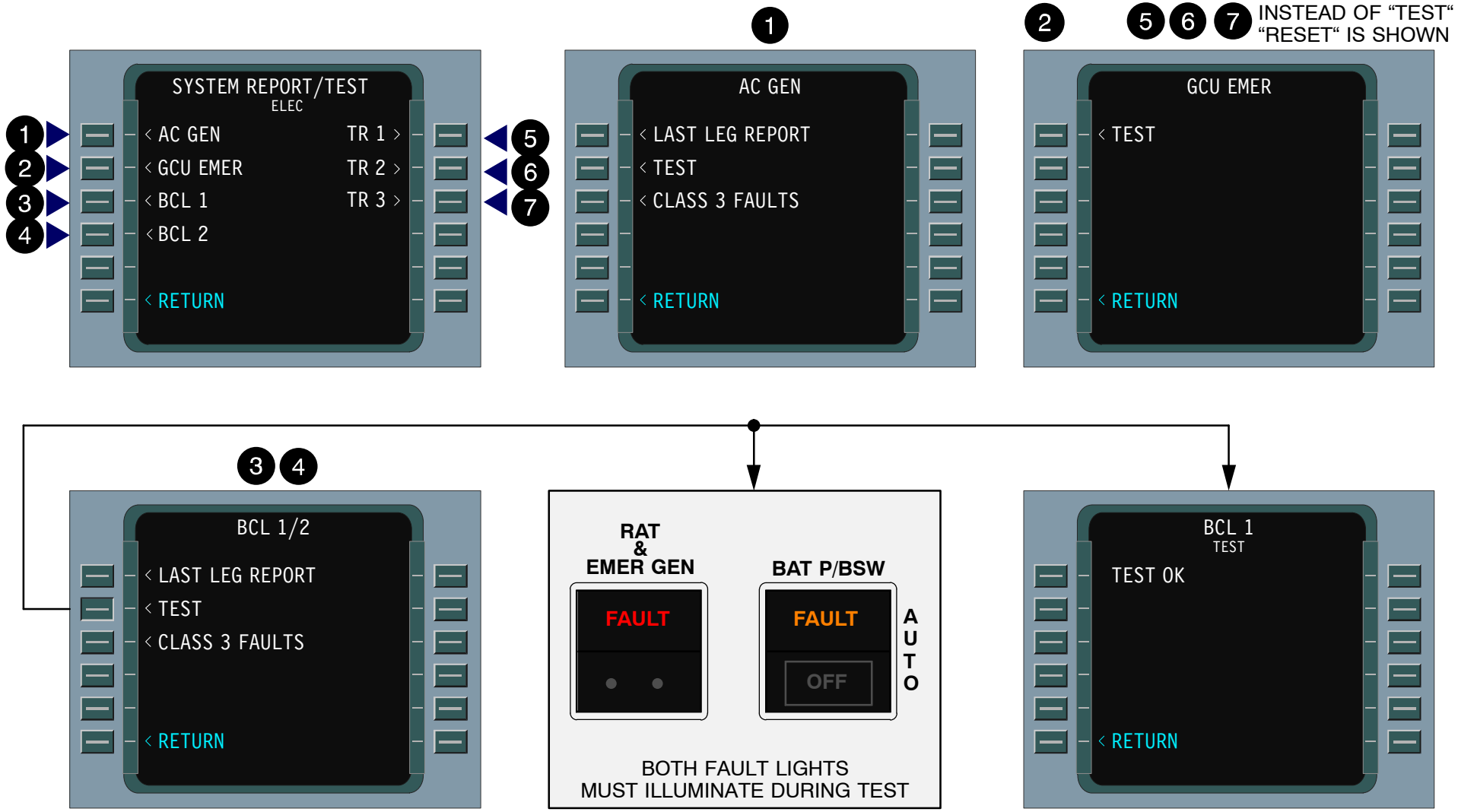

Figure 53 BITE Menues (CLASSIC)

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24–00 GENERAL

AC AND DC LOAD DISTRIBUTION PRESENTATION

The following Load Distribution Schematic shows the whole architecture of the electrical network of the A320/A321.

Most of the electrical loads are supplied by main buses or power sources via sub-buses.

All the switching elements (relays, contactors) are shown in deenergized condition; that means:

- aircraft on ground and
- no electrical power supply available.

26 VAC TRANSFORMER / BUS

The Rotary Variable Differential Transformers (RVDT) and the Linear Variable Differential Transformers (LVDT) are supplied with 26V/400 Hz

Transformer 15XN-1, Bus 131XP-A

One transformer 115VAC to 26VAC is supplied from BUS 1XP is installed to supply BUS 131XP-A

As a example BUS 131XP-A can supply:

- Hydraulic Qty. Indication
- ADIRU 3 and AOA
- EIS/SDAC/1/BUS 1 sync AC
- EIS/SDAC/2/BUS 1 sync AC

Transformer 15XN-2, Bus 231XP-A

One transformer 115VAC to 26VAC is supplied from BUS 2XP is installed to supply BUS 231XP-A

As a example BUS 231XP-A can supply:

- Auto Flt/FAC 2
- ADIRU 2 and AOA
- Flight Controls Slat-Flap 2 position indication
- EIS/SDAC/1/BUS 2 sync AC
- EIS/SDAC/2/BUS 2 sync AC

Transformer 5XH, Bus 431XP-A

One transformer 115VAC to 26VAC is supplied from BUS 4XP is installed to supply BUS 431XP-A

As a example BUS 431XP-A can supply:

- SDAC 1 / 26VAC sync/AC ESS BUS
- SDAC 2 / 26VAC sync/AC ESS BUS
- NAV Probes / ADIRU 1 and AOA
- Auto Flt/FAC 1
- Flight Controls Slat-Flap 2 position indication

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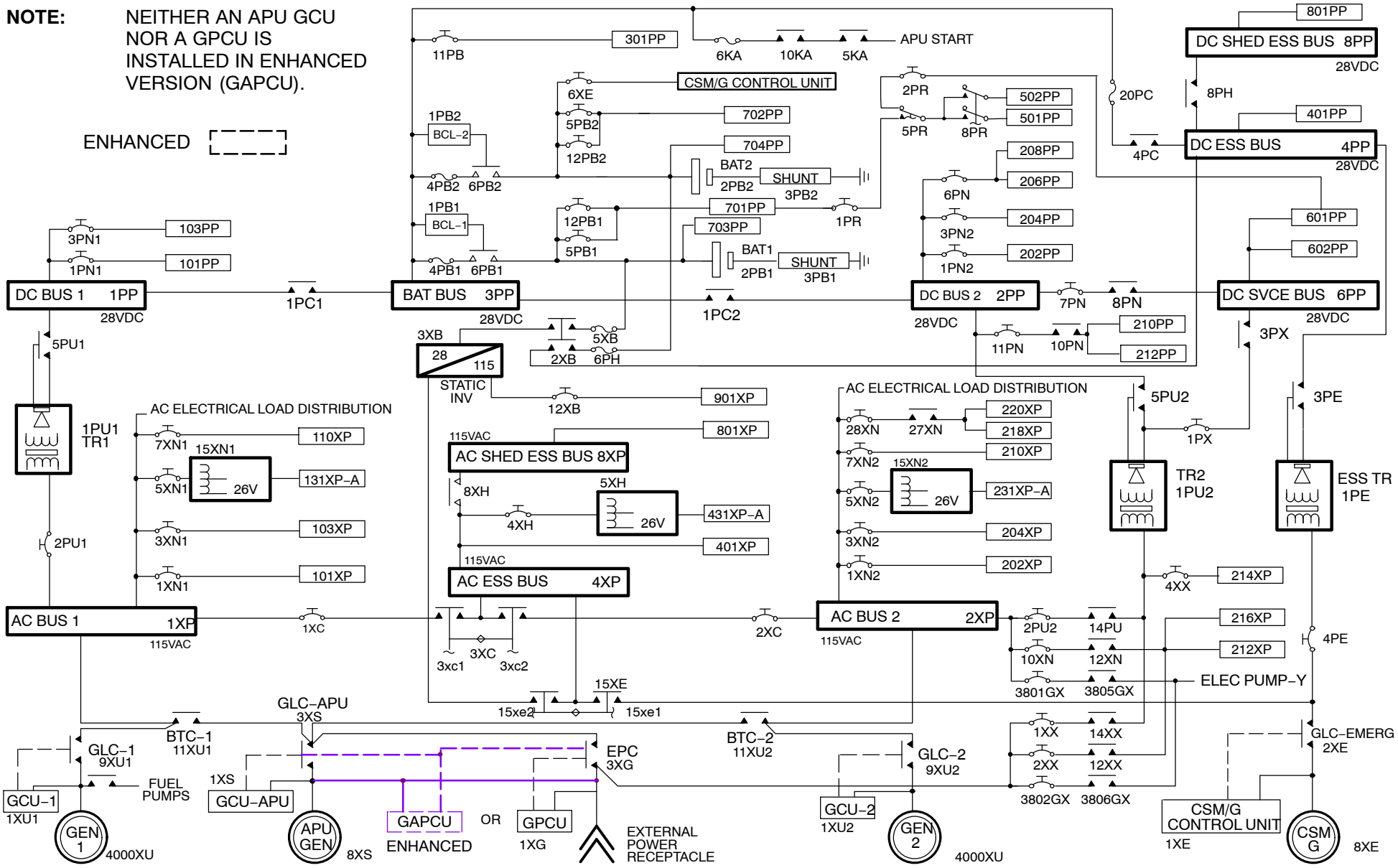

Figure 54 Load Distribution Schematic

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ELECTRICAL POWER-COMPONENTS LOCATION

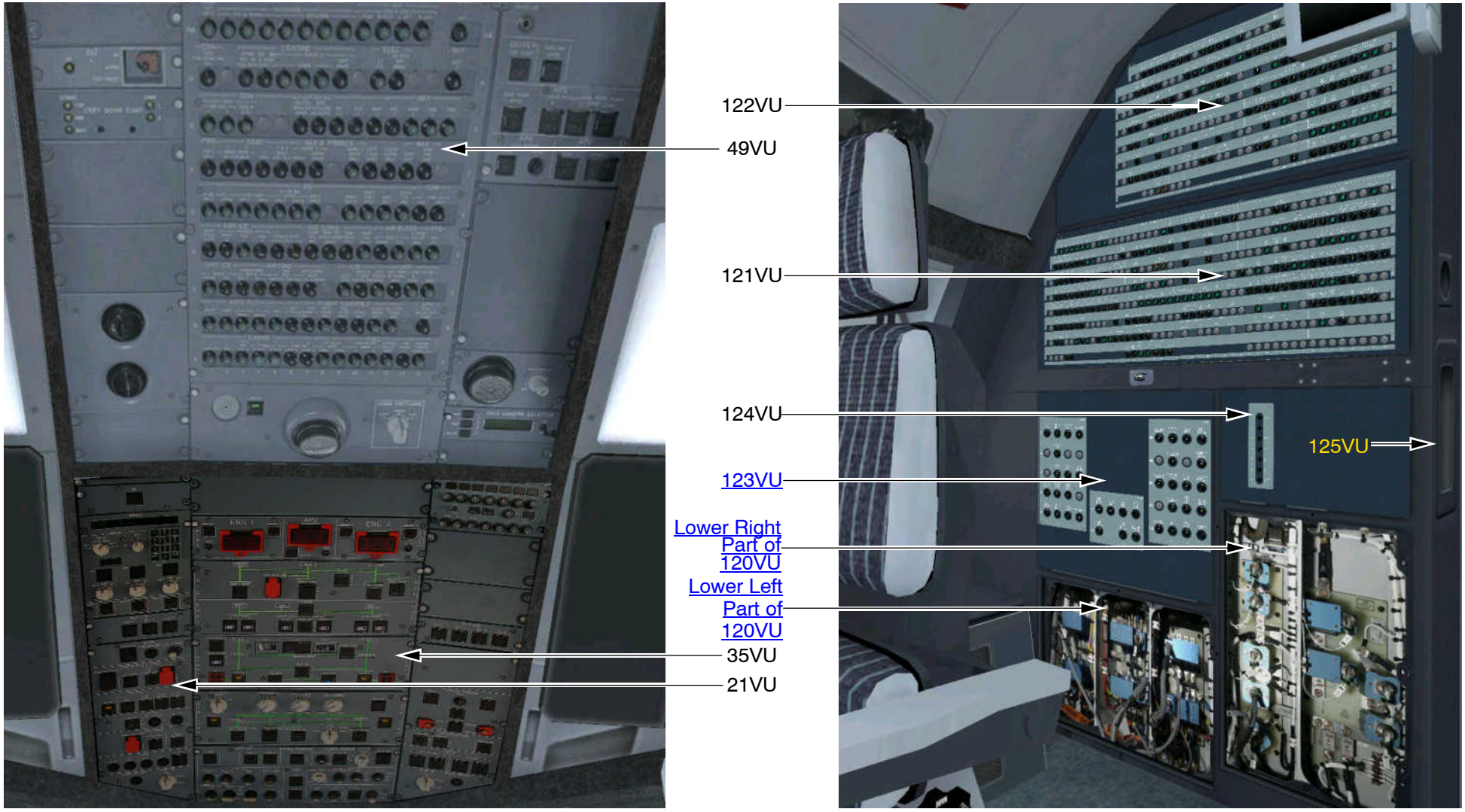

Figure 55 Components Location - Cockpit

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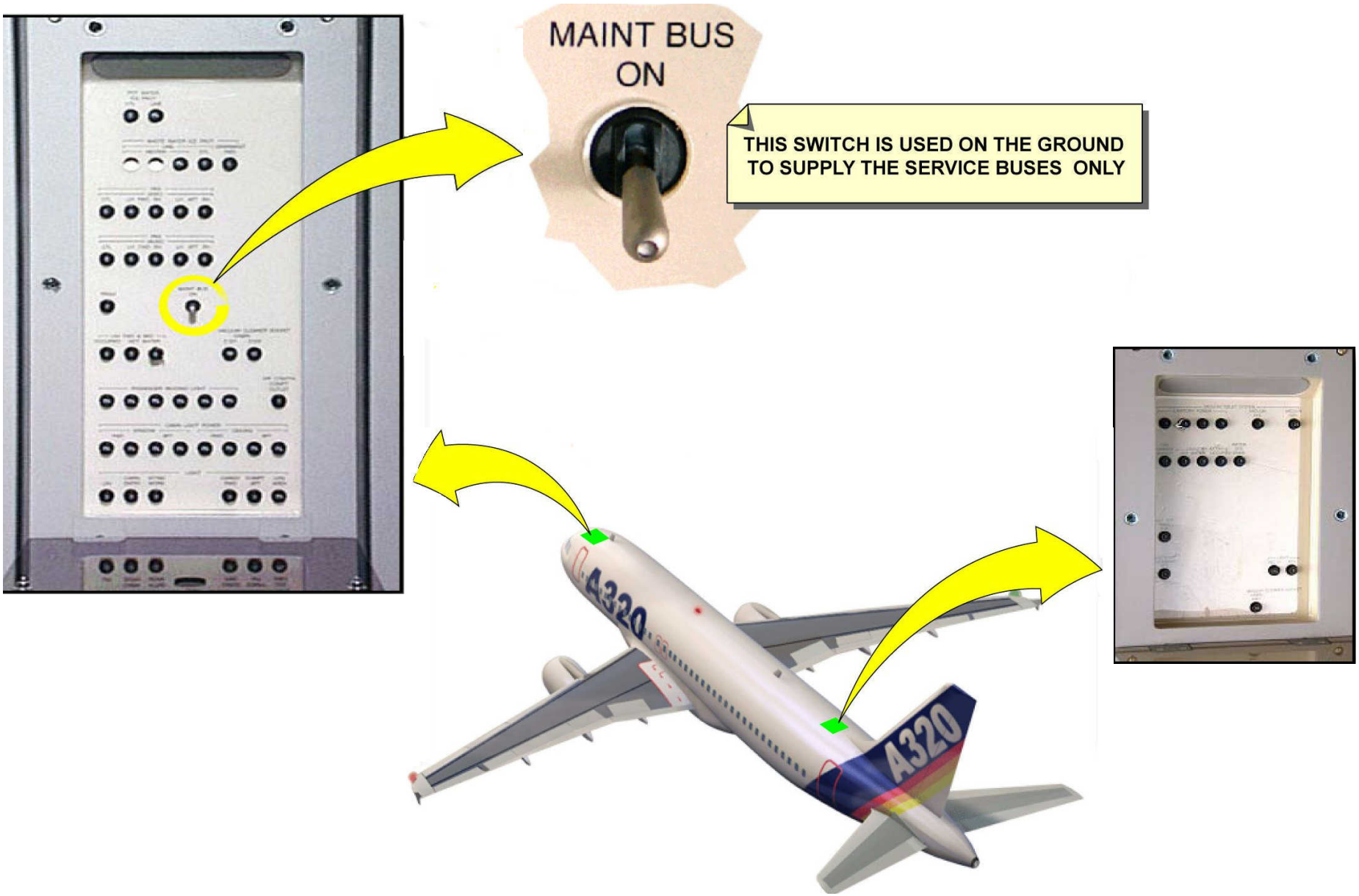

Figure 56 Component Location - Cabin

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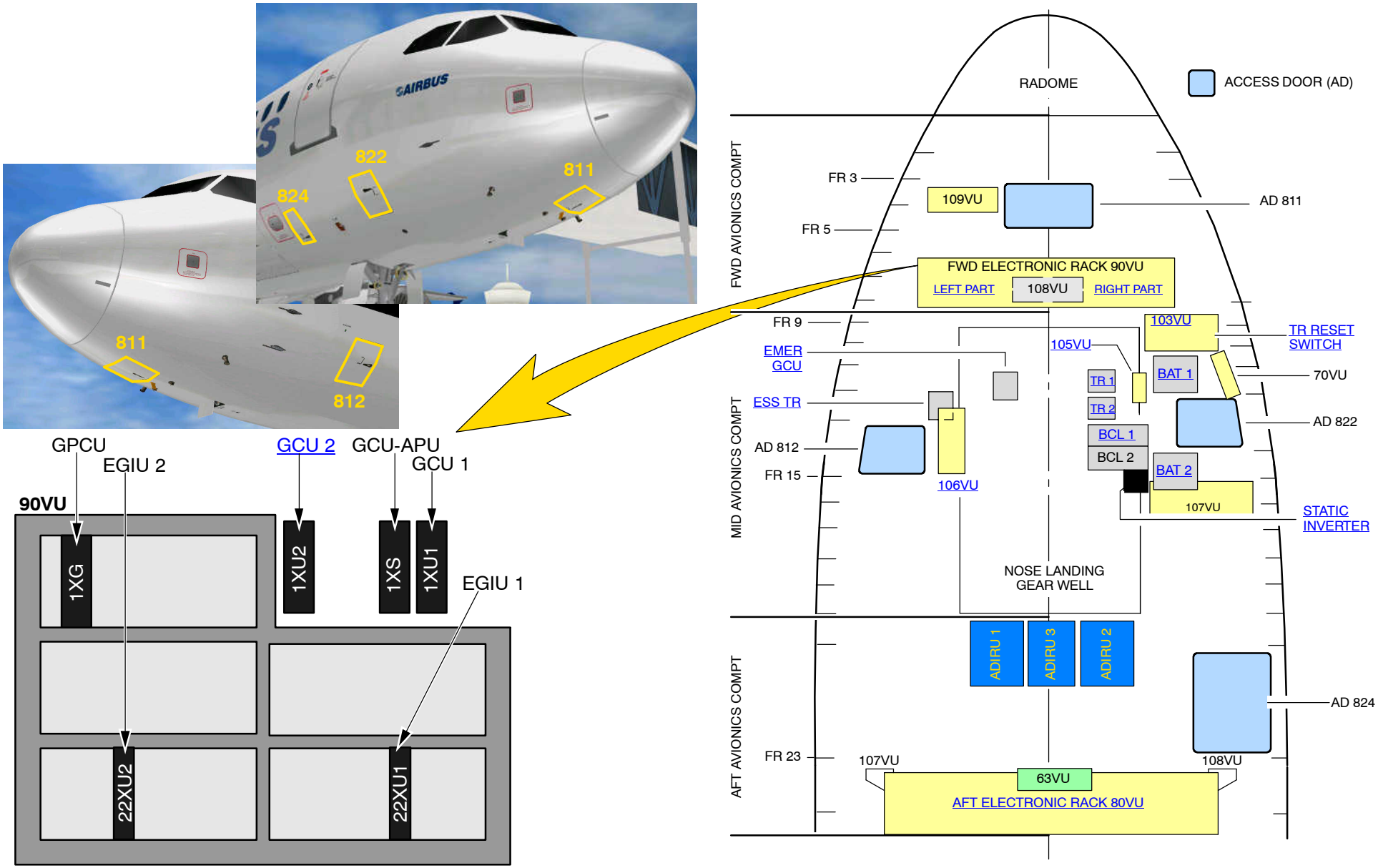

Figure 57 Components Location - Avionics

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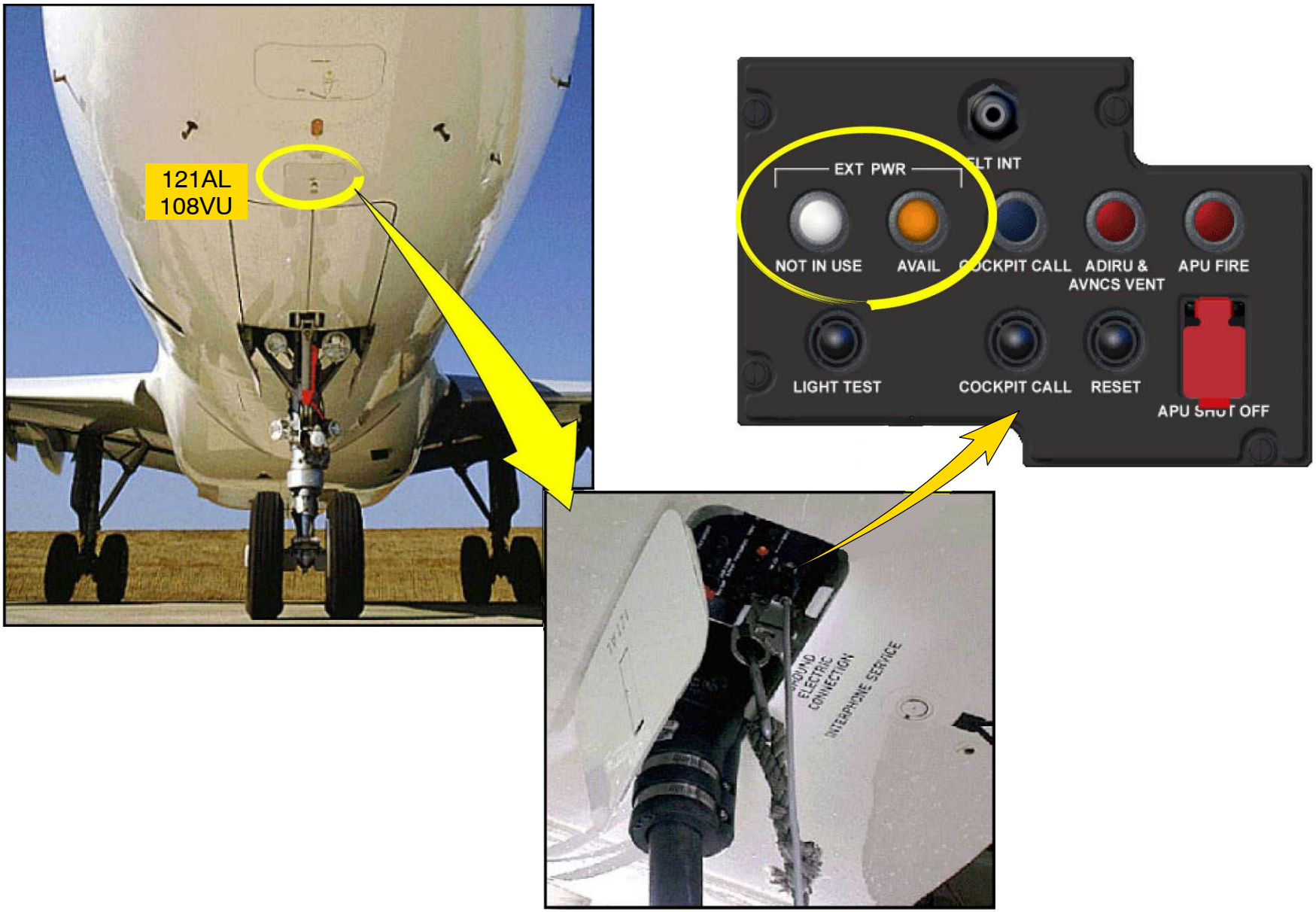

Figure 58 Component Location - External Power

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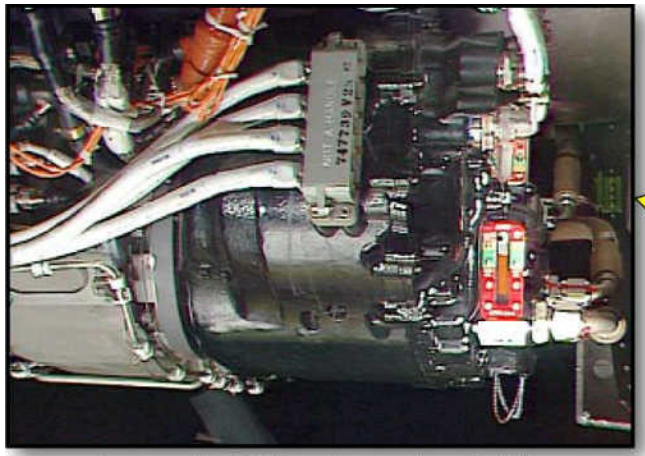
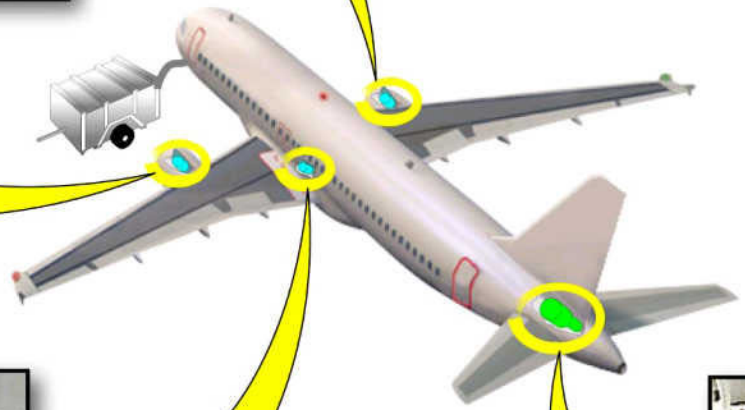
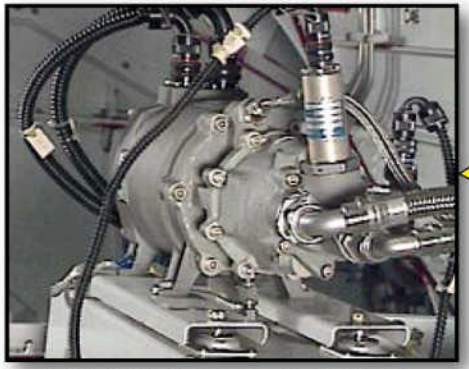


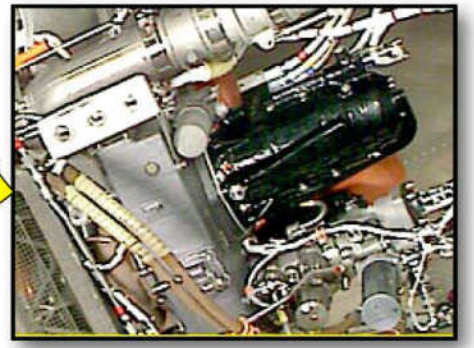
Integrated Drive Generator (IDG)

	VOLTAGE	FREQUENCY	PHASES	POWER
IDG 1/2	115 VAC	400 Hz	3 phases	90 kVA
APU GEN	115 VAC	400 Hz	3 phases	90 kVA
EMER GEN	115 VAC	400 Hz	3 phases	5 kVA





EMERGENCY GENERATOR



APU GENERATOR

Figure 59 Component Location - Genrators

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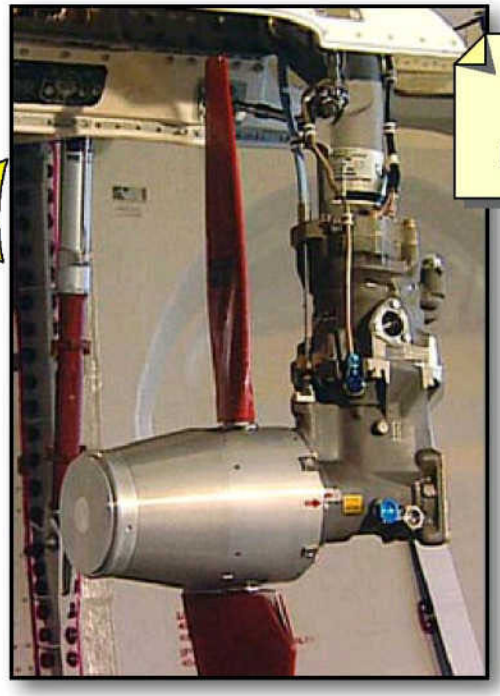
(21VU)



Ram Air Turbine (RAT)

Ram Air Turbine (RAT) DEPLOYMENT
+
EMERGENCY GENERATOR ACTIVATION

WARNING

ACTIVATION OF THE RED GUARDED MAN ON PUSHBUTTON ON THE GROUND OR IN FLIGHT WILL EXTEND THE Ram Air Turbine (RAT), EVEN ON COLD AIRCRAFT

Figure 60 Component Location - Ram Air Turbine

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24–00 ELECTRICAL POWER GENERAL

INTRODUCTION (ENHANCED)

AC BUSES SUPPLY

AC Bus 1/2:

The supply of the AC BUSES 1 and 2 and associated sub-buses can be done by one or separated by two of the AC power sources (exception: external power and APU generator can not supply the buses simultaneous.)

If there are several power sources able to feed correct power (parameters), the AC BUS 1 (2) are supplied in priority order as follows:

- by the corresponding generator, GEN 1 (2)
- by external power (EXT PWR)
- by the APU generator (APU GEN)
- or by the other generator, GEN 2 (1).

AC ESS BUSES

Supply of important loads is provided by the AC ESS and AC ESS SHED bus.

They are normally supplied by AC BUS 1 (AC ESS BUS CNTR 1 closed).

In the event of AC BUS 1 loss, AC ESS BUS and AC ESS SHED BUS can be manually restored by the transfer of power supply directly from AC BUS 2.

In the event of AC BUS 1 and AC BUS 2 loss (emergency configuration), the AC ESS BUS and AC ESS SHED BUS are restored automatically on the CSM/G when the RAT hydraulic power is available.

In emergency configuration without CSM/G operation (it depends on the aircraft configuration: speed, landing gear, RAT deployment time), the AC ESS BUS is supplied by the STAT INV (**STAT**ic **INV**erter), which is supplied by battery 1 (BAT 1). The AC ESS SHED BUS is no longer supplied.

AC STAT INV BUS

The static inverter bus (AC STAT INV) is directly supplied by the STAT INV when it is in operation.

This is the alternate supply for APU fuel pump, engine ignition and some important annunciator lights.

DC BUSES SUPPLY

DC BUS 1/2

The main DC loads are supplied by DC BUS 1 and DC BUS 2.

Each bus is supplied by one TR (**T**ransformer **R**ectifier):

- DC BUS 1 by TR 1
- DC BUS 2 by TR 2.

There is no connection between the two TRs (DC TIE CNTR 2 is normally open).

If there is a loss of one TR the other takes over automatically the supply of both DC buses (DC TIE CNTR 1 and 2 are closed).

DC ESS BUSES

Essential DC loads are supplied by DC ESS BUS and DC ESS SHED BUS.

They are normally supplied by TR 1 via DC BUS 1 and DC BAT BUS (ESS DC TIE CNTR is closed). For this the TR 2 must also be in operation.

If there is a loss of TR 1 and/or TR 2 the ESS TR takes over automatically the supply of the DC ESS BUS and DC ESS SHED BUS.

For this the ESS TR is supplied by the AC ESS BUS (AC ESS EMER CNTR 1 is closed).

In emergency configuration or in smoke configuration, when the EMER GEN is in operation, the ESS TR is supplied by this generator. Without operation of the EMER GEN, BAT 2 automatically takes over the supply of the DC ESS BUS (STAT INV CNTR is closed). In the last case the DC ESS SHED BUS is no longer supplied.

DC BAT BUS

The DC battery bus (DC BAT BUS) is normally supplied by TR 1 via DC BUS 1 (DC TIE CNTR 1 is closed).

If TR 1 is loss TR 2 automatically takes over the supply of the DC BAT BUS (DC TIE CNTR 1 and 2 are closed).

If there is a loss of both TR‘s (1 and 2) the DC BAT BUS also is power loss.

If BAT 1 and 2 are the only power sources, the DC BAT BUS is supplied by them, but only on ground.

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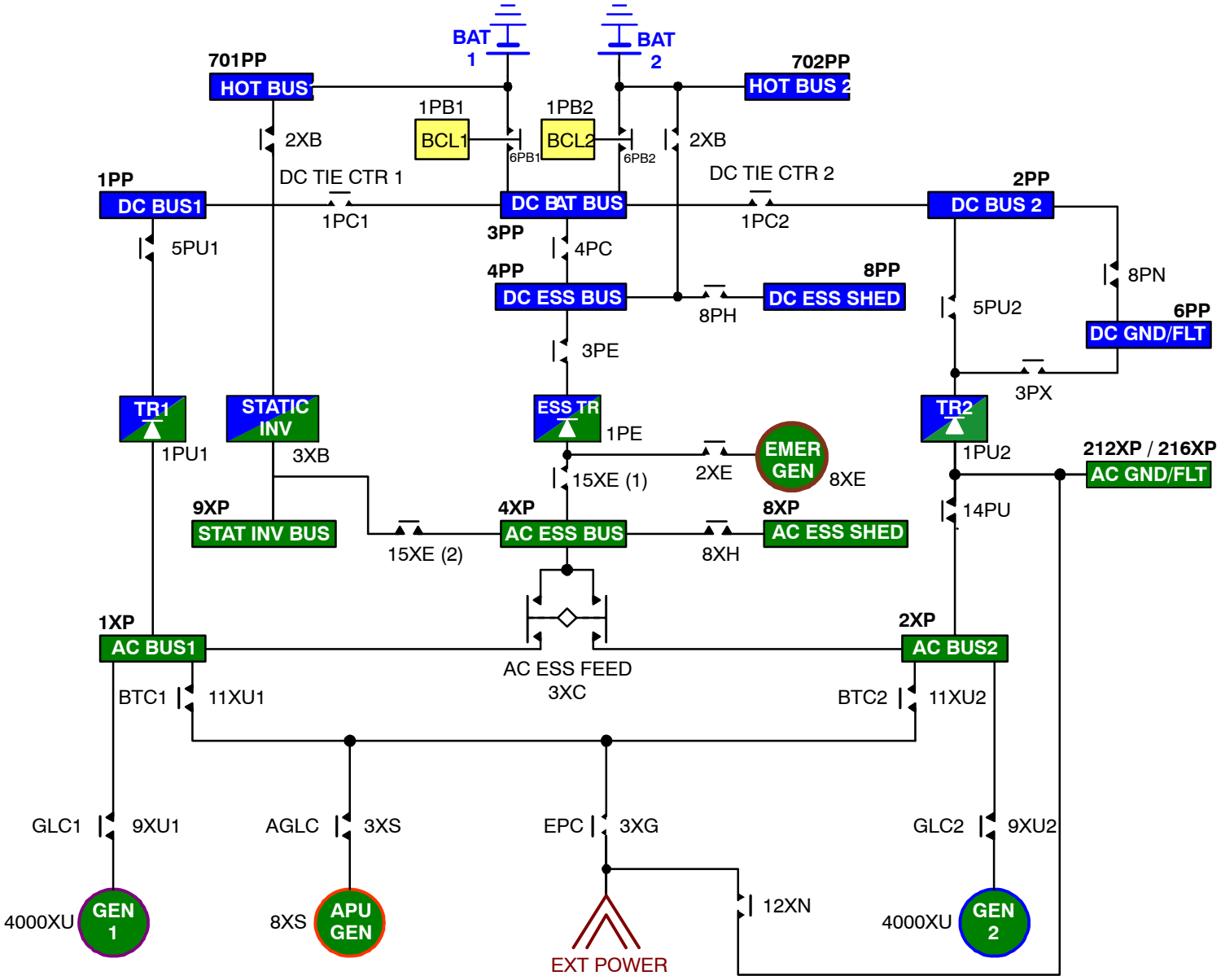

Figure 61 ELEC PWR Supply Basic Schematic

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GCUS AND EGIUS INTRODUCTION (ENHANCED)

GCUs

Tree identical GCU (**G**enerator **C**ontrol **U**nits) serve for controlling and monitoring of the two engine driven generator–systems and the APU generator.

Their functions are as follows:

- regulation of the generator voltage
- control and protection of the generator–system and network
- control of various warnings and indications
- self–monitoring and test of the system (BITE).

One GPCU (**G**round **P**ower **C**ontrol **U**nit) is controlling and monitoring the ground power and auxiliary electric power.

Its functions are as follows:

- control and protection of the generator–system and network,
- control and protection of external power supply,
- control of various warnings and indications,
- self–monitoring and test of the system (BITE).

Voltage Regulation

The voltage regulation is performed by regulating the generator excitation current: the voltage is kept at the nominal POR (**P**oint **O**f **R**egulation).

Protection and Generator Control

These functions mainly consists of generator excitation, GLC (**G**enerator **L**ine **C**ontactor) control and BTC (**B**us **T**ie **C**ontactor) lockout (DP lockout).

Enhanced Improvements

The new installed GAPCU (**G**round and **A**uxillary **P**ower **C**ontrol **U**nit) monitors and controls the APU generator and the external power operation. The APU GCU and GPCU are removed.

The GCU (**G**enerator **C**ontrol **U**nits) are changed.

Now they are able to send directly information to the SDACs. Therefore the EGIUs are no longer installed.

The regulation of the generator speed is accomplished by means of a servo valve located in the IDG. The GCU controls the servo valve position.

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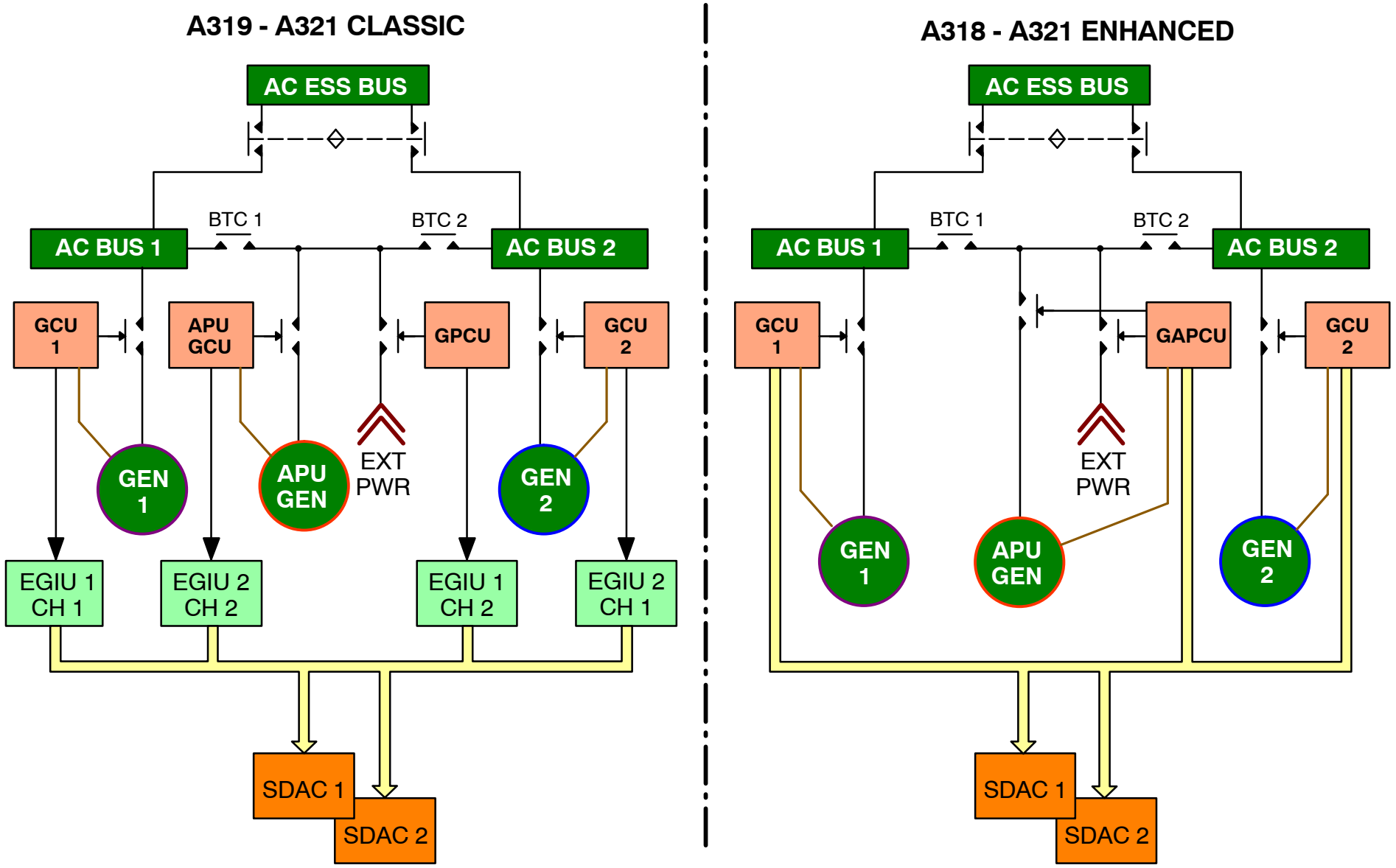

Figure 62 Differences of AC Generation System (All)

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CONTROLS (ENHANCED)

CONTROL PANEL (NEW PUSHBUTTONS)

1 Commercial P/BSW (1)

ON:

When the commercial pushbutton switch is pressed in ("OFF" legend off) the galley general supply can be controlled from the overhead panel 35VU by means of GALY & CAB pushbutton switch.

The window and ceiling lights can be switched on.

OFF:

The COMMERCIAL P/BSW allows loads to be shed (galleys, cabin and commercial related loads) when it is released out.

The OFF legend comes on white. On the ECAM ELEC Page „GALLEY SHED" is shown. No galley is powered. The window and ceiling lights are off.

2 Galy & Cab (2)

In automatic mode, switch pressed in, the galleys and some SUB–Buses are automatically supplied or shed according to the electrical configuration.

AUTO:

Main galley and secondary galley are supplied.

The main galley is automatically shed in the following cases:

- In flight:

  Only one generator is operating.
- On ground:

  Single engine generator operation (All galleys are available when APU GEN or EXT PWR is supplying).

OFF:

The main galley and secondary galley are not supplied.

FAULT LIGHT:

Comes on amber accompanied by ECAM activation when the load of any generator is above 100 % of rated output.

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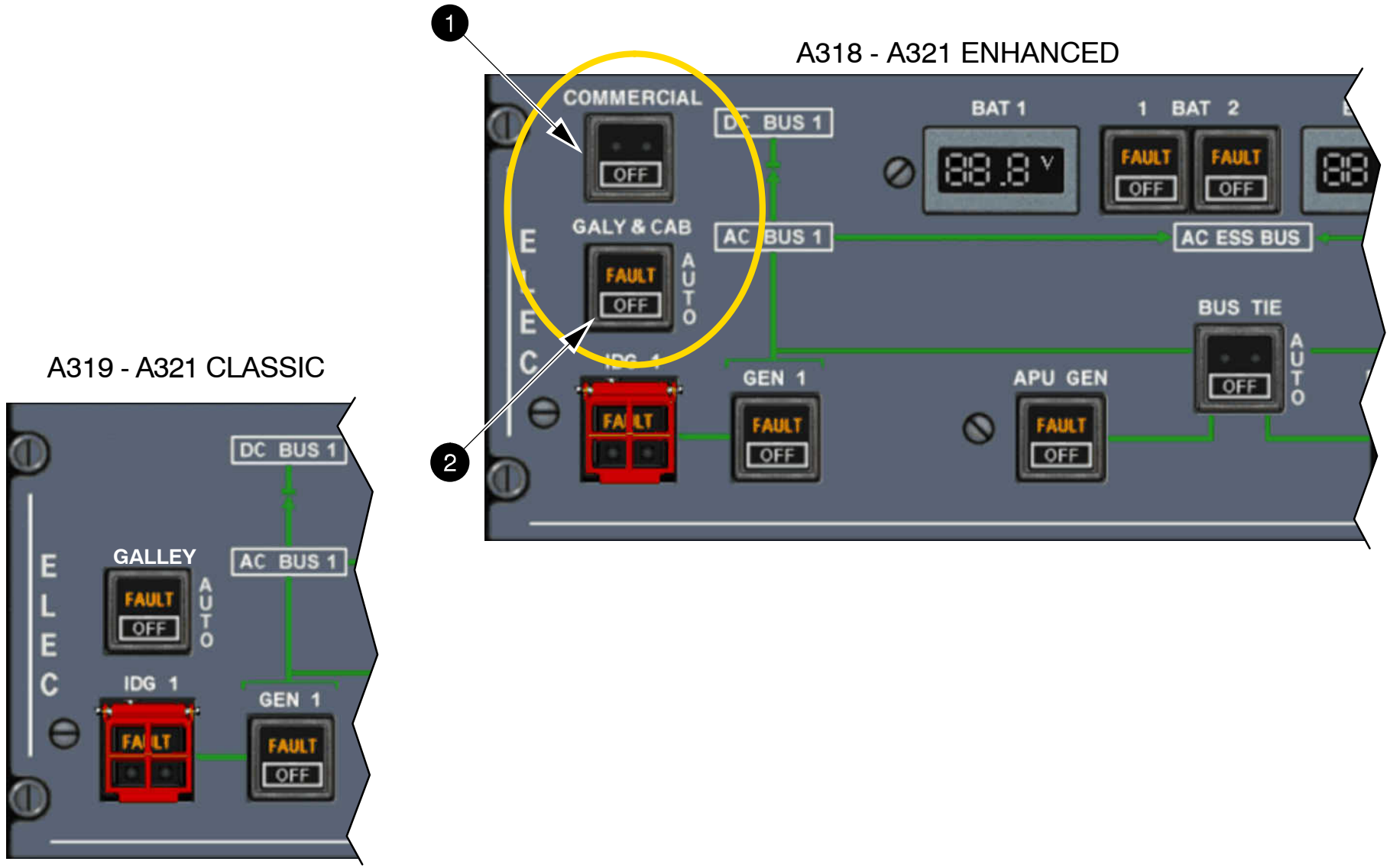

Figure 63 ELEC Control Panel Cockpit (enhanced)

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24–21 INTEGRATED DRIVE GENERATOR SYSTEM (IDG, GCU)

IDG PRESENTATION (ENHANCED)

Oil Temperature Monitoring

The IDG (**I**ntegrated **D**rive **G**enerator) oil temperature sensors monitor the input and the output oil temperature. If a high difference between the input and the output temperature is detected, a status message is sent to the ECAM.

This difference is called a temperature rise.

The normal IDG oil inlet temperature is between 40 °C to 105 °C. When the oil outlet temperature reaches 142 °C, an advisory mode is available on the lower ECAM.

If the oil outlet temperature is equal to or more than 185 °C the master caution is triggered, and a manual disconnection is written on the ECAM.

If the oil outlet temperature is more than 200 °C the IDG is automatically disconnected.

Oil Pressure Monitoring

A pressure switch operates in case of oil low pressure (lower than 140 psi) not caused by underspeed.

Temperature and Pressure Indication

The oil outlet temperature is displayed on the ECAM System Display.

In case of high oil outlet temperature or oil low pressure, the following warnings are triggered:

- MASTER CAUTION light,
- Single chime,
- the message ”ELEC IDG 1(2) OIL OVHT or ELEC IDG 1(2) OIL LO PR” is displayed on the EWD,
- the FAULT legend on the corresponding IDG P/BSW comes on amber.

The IDG must be disconnected immediately by pushing the IDG P/BSW for a maximum of 3 seconds.

ATTENTION: Do not push the disconnect switch if the engine speed is less than idle. The engine must be stopped for IDG reconnection.

NOTE: Disconnection is only possible if the related engine is running above underspeed.

Thermal IDG Disconnection

If the IDG disconnection is not performed at 185 °C, the temperature will increase and at 200 °C an automatic thermal disconnection should occur to protect the IDG.

A warning message is sent to the ECAM system and a BITE message (THERMAL DISCONNECT) is sent to the CFDS.

If this thermal disconnection fails, the message ”THERMAL DISC FAILED” is sent to the CFDS and a warning message is sent to the ECAM system.

NOTE: After a thermal disconnection, the IDG has to be replaced, a reconnect is not possible.

The class 2 message ”IDG OIL DELTA TEMP” is generated by the system BITE. If there is no difference between the input and the output temperature, the class 2 message ”IDG COOLER” is generated by the system BITE.

In both cases, the ”AC GEN MAINTENANCE STATUS” is displayed on the ECAM STATUS page.

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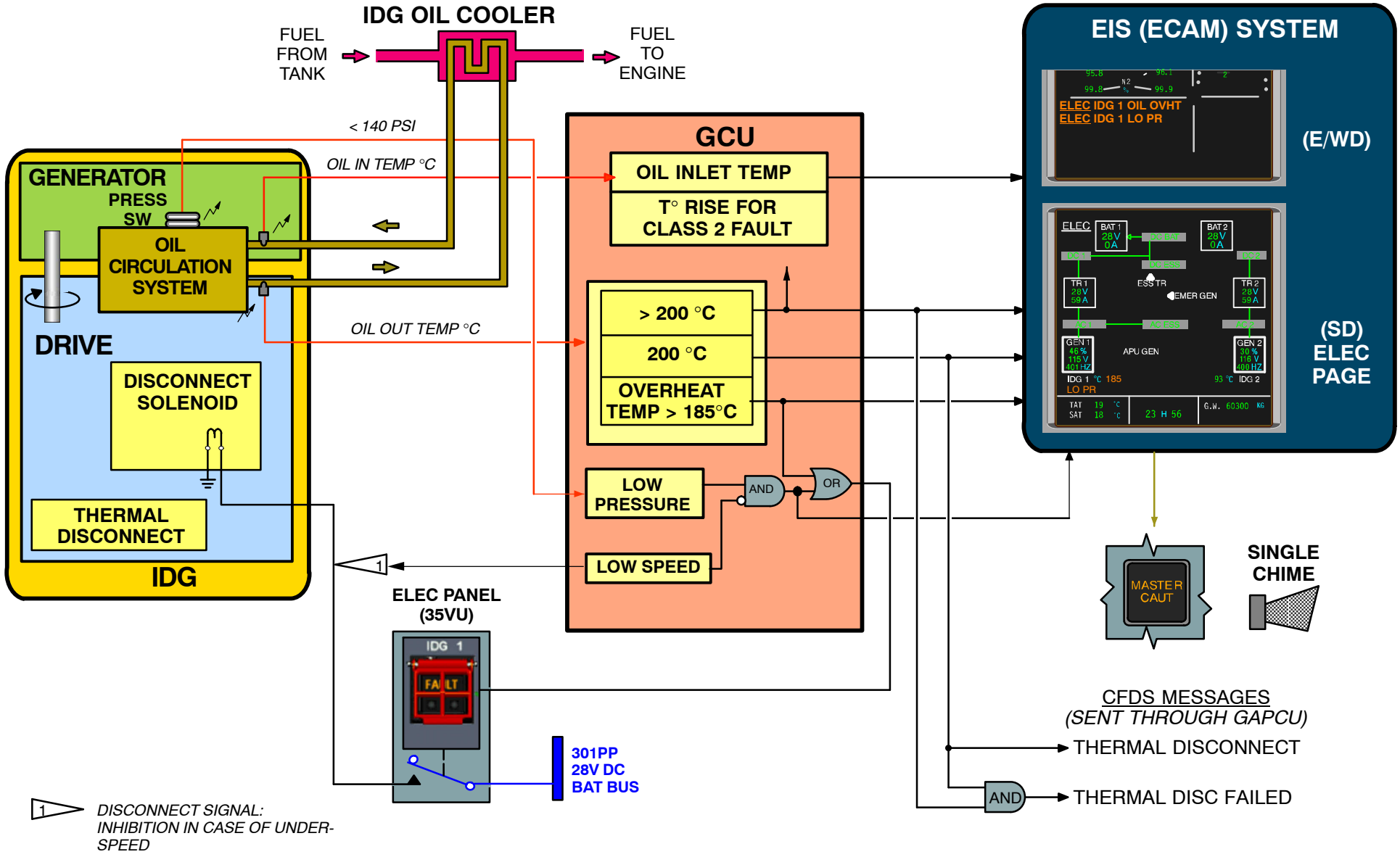

Figure 64 IDG Oil Monitoring & Disconnection (enhanced)

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IDG CONTROL PRESENTATION (ENHANCED)

General

Each IDG is a two pole high speed (24000 rpm) brushless spray oil cooled unit.

The IDG (**I**ntegrated **D**rive **G**enerator) consists of a CSD (**C**onstant **S**peed **D**rive) and an AC generator mounted side by side in a single housing.

The CSD components convert a variable input speed to a constant output speed. The CSD portion of the IDG is a hydromechanical device that adds to or subtracts from the variable input speed of the engine gearbox.

The CSD performs this operation by controlled differential action to maintain the constant output speed required to drive the AC generator.

The IDG is cooled and lubricated by the oil circulation system. The oil is cooled by an external mounted IDG oil cooler.

Each IDG is controlled and monitored by its own GCU (**G**enerator **C**ontrol **U**nit).

IDG Drive Control

The Constant Speed Drive converts the variable input speed provided by the engine gearbox to the constant output speed through the CSD hydromechanical components.

IDG Speed Control

The GCU performs the output speed control for the IDG via the servovalve control loop whenever several conditions are met:

- The GCU is powered–up,
- Engine input speed to the IDG is sufficient for speed control to begin,
- No failure is present in the channel to trip the servovalve control circuit.

Servovalve Control Loop

The servovalve control loop is composed of a hydraulic servovalve in the IDG and control circuitry in the GCU which includes the SVR (**S**ervo **V**alve **R**elay). The output speed control is performed as follows: the GCU control circuit monitors the PMG (**P**ermanent **M**agnet Generator) frequency to determine the generator frequency.

Note that the PMG is mounted on the IDG differential output gear.

The PMG frequency signal is compared with a GCU internal frequency reference. The difference, between the actual PMG frequency and the frequency reference, creates an error signal in the servovalve control loop circuitry. The frequency error signal is then used to control the servovalve current flow via the SVR.

The servovalve works by porting oil to an hydraulic control cylinder which determines the position of a variable displacement hydraulic unit. Depending on the error signal, the servovalve ports more or less oil to the cylinder to maintain the desired generator frequency (IDG output speed).

As IDG speed (thus PMG frequency) decreases below the reference frequency setpoint, the servovalve supplies current increases, resulting in an IDG output speed increase.

During normal operation, the SVR is closed to allow current flow in the servovalve control loop. Under certain channel failure conditions, the SVR is opened to make sure that the servovalve drive current from the GCU is completely removed.

Engine Speed Sensing

The FADEC provides the GCU with the corresponding engine speed information, which is also used for the underspeed protections.

IDG FAULT

The IDG P/B FAULT legend comes on if the IDG oil pressure is less than 140 psi or if the IDG oil outlet temperature is above 185 °C. In both conditions, the IDG must immediately be disconnected!

IDG disconnection is achieved by a solenoid activated clutch. It must be performed, via the IDG switch if the IDG pushbutton FAULT legend is on. If the temperature reaches 200 °C, a solder fuse melts and automatically releases the disconnect mechanism to open the IDG disconnect clutch.

When the IDG pushbutton is depressed and no underspeed is detected, a 28V DC signal is sent to the disconnection solenoid which will open the clutch.

In case of low oil pressure due to underspeed, the FAULT legend remains off. In underspeed condition, it is not possible to disconnect the IDG.

After a thermal disconnection, the IDG must be changed.

IDG reset must be performed on the ground after manual disconnection with the engine shutdown, by pulling the reset ring mounted on the IDG casing.

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PMG: PERMANENT MAGNET GENERATOR
DPI: DIFFERENTIAL PRESSURE INDICATOR
SVR: SERVO VALVE RELAY

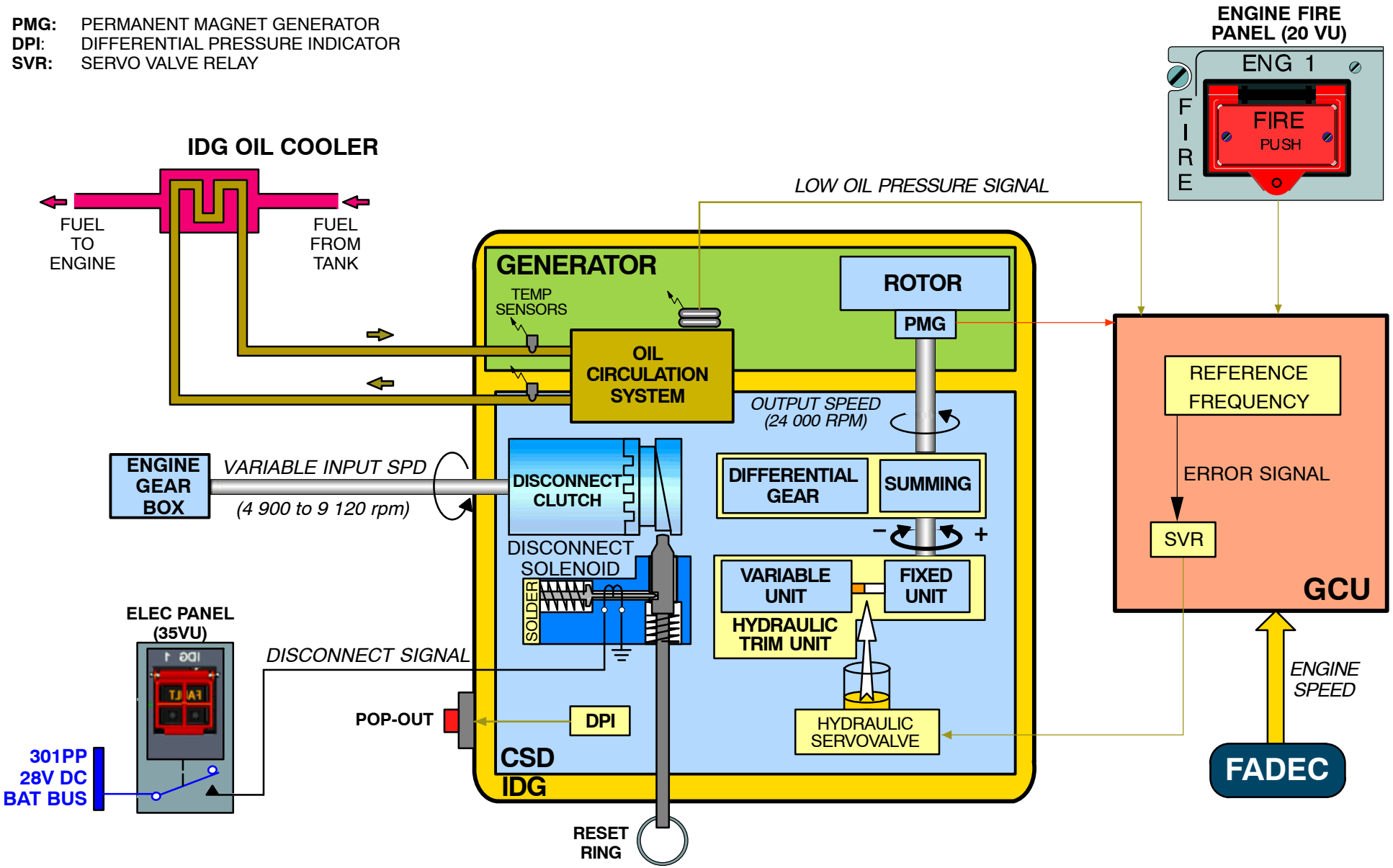

Figure 65 IDG Drive Part (enhanced)

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GCU CTL. & PROTECT. OPERATION (ENHANCED)

Main Functions for GCU/IDG Control

The 2 GCUs are identical and interchangeable. The GCU functions (GCU 1 and GCU 2) are selected by Pin Programming.

The GCU has four different functions:

- voltage regulation,
- frequency regulation,
- control and protection of the network and the generator,
- control of the various indications,
- system test and self–monitoring.

All these functions are performed in the digital form.

The GCUs are supplied:

- directly from the PMG, for generator excitation and 28V DC internal and external supply,
- from the aircraft normal network (28V DC) for the internal and external supply.
- This dual supply constitutes a back up supply.

BITE Type

The GCU is a type 1 computer. Its BITE detects and isolates active and passive failures. The BITE is connected to the GAPCU.

Control and Protective Functions

The GCU controls the connection and disconnection of the power provided by the generator to and from the aircraft electrical system.

This control is provided by means of 3 relais:

- the GCR (**G**enerator **C**ontrol **R**elay) which controls the generator excitation,
- the PRR (**P**ower **R**eady **R**elay) which controls the generator line contactor and the FAULT warning light in the cockpit,
- the SVR (**S**ervo **V**alve **R**elay) which controls the generator speed by means of the servo valve.
- Additionally the GCU is able to isolate its AC BUS in case of an short circuit via a BTC lock out signal.

Generator Control and Protection functions

The following control or fault signals cause generator shutdown (The tripped Relais are mentioned in the parentheses):

1. No controlled Shutdown recognized upon power–up of the control unit (GCR/PRR),
2. *Over*-/Undervoltage (GCR/PRR),
3. *Over*-/Underfrequency (GCR/PRR/SVR),
4. Underspeed (PRR),
5. Shorted Rotating Diode Fault (PMG to chassis short) (GCR/PRR/SVR),
6. Open Cable (GCR/PRR),
7. *Differential Protection* (**No Zone 1+2!**) (GCR/PRR),
8. ***Overcurrent*** (GCR/PRR/BTC Lockout),
9. **Delta Overcurrent** (GCR/PRR/BTC Lockout),
10. Phase Sequence Fault with PRR absent (GCR),
11. ***Servo Valve Deterioration Fault*** (GCR/PRR/SVR),
12. Manual Disconnect (GCR/PRR/SVR),
13. Fire P/B switch (GCR/PRR/SVR),
14. *Welded GLC Fault* (GCR/PRR/BTC Lockout),
15. ***GLC Control Circuit Fault*** (GCR/PRR),
16. Shorted/Open PMG Fault with the Power Ready Relay absent (GCR/SVR),
17. **Pin Programming Error** detected on GCU power–up (PRR/SVR/GCR on Coldstart).

NOTE: Deviations between the classic & the enhanced EPGS are written in **bold type text**.

The cursive protections shall be limited to a total of 2 resets after which a cold start will be required for reset.

The generator shall be reset when the protective faults (identified above) are still not present and one of the following occurs:

- GCS (Generator Control Switch) is toggled from „OFF“ to „ON“ (defined as COLD RESET).
- Cold Start (which is defined as POWER–UP RESET or the application of 28 volts to the control unit) occurs.

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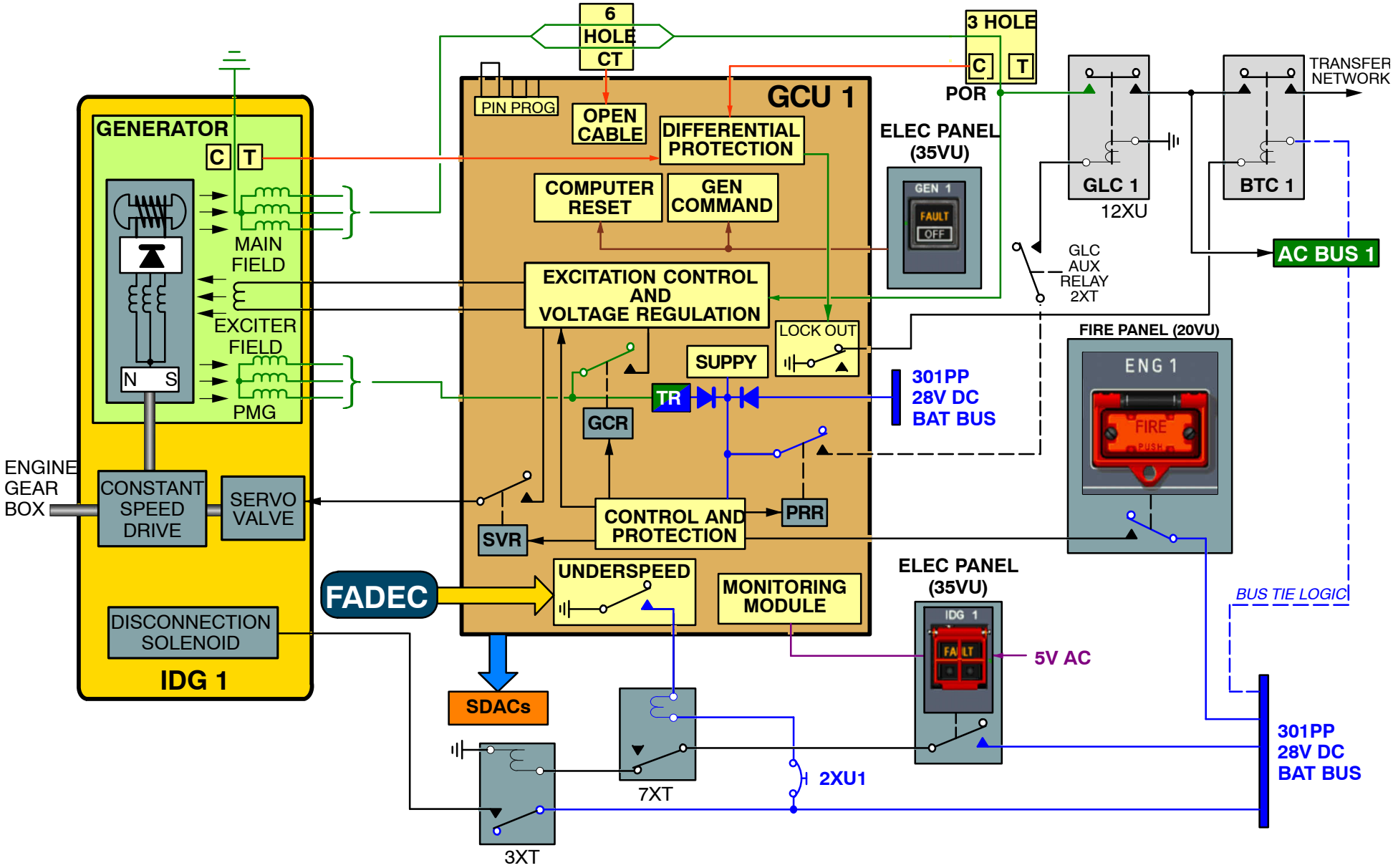

Figure 66 GCU Control and Protection (enhanced)

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24–41 AC EXTERNAL POWER CONTROL

GAPCU PRESENTATION (ENHANCED)

GAPCU Functions

The GAPCU controls both APU generator and external powers channels.

In addition to the APU generator functions, the GAPCU (**G**round and **A**uxiliary **P**ower **C**ontrol **U**nit) has three different functions:

- aircraft power supply control and network protection,
- system test and self–monitoring relating to these functions
- provide BITE and messages for the AC generation (GCU).

The GAPCU transmits command data to the GCUs, and receives BITE data from the two GCUs (GCU 1, 2).

EXTERNAL POWER CONTROL

Normal Parameters

If the external power parameters are correct, the indicator lights on the external power panel and the AVAILable light on the EXT PWR P/BSW come on.

The power parameters are monitored by the GAPCU which activates the indicator lights. With such indications the ground cart can supply the aircraft network.

When the EXT PWR P/BSW is pushed,the GAPCU closes the EPC (**E**xternal **P**ower **C**ontactor) to supply the aircraft electrical network then the ON blue legend illuminates.

The BTCs (**B**us **T**ie **C**ontactors) 1 and 2 close if no engine driven generator is on line and the BUS TIE P/B in the cockpit set to AUTO.

The blue ON light, in the EXT PWR P/BSW, indicates that the EPC is closed.

Abnormal Parameters

If any external power parameter is not correct, the indicator lights stay off. The external power cannot be connected to the aircraft network.

APU GENERATOR CONTROL

The APU Generator control module is part of the GAPCU.

The main functions of the module are:

- Voltage and frequency regulation,
- APU GLC (**G**enerator **L**ine **C**ontactor) control in accordance with the bus tie logic,
- Control and Protection,
- Interface with SDACs (**S**ystem **D**ata **A**cquisition **C**oncentrators),
- BITE (**B**uilt–**I**n **T**est **E**quipment) function. The BITE messages are sent to the CFDIU.

Control, Indication and Distribution

The APU generator is controlled by a P/BSW located on the overhead ELEC panel and has two lights: white OFF and amber FAULT.

The APU GEN is connected to the network via the APU GLC and the BTCs.

APU GEN Oil Temperature Sensor

A temperature sensor is located on the APU generator oil outlet port.

A high oil temperature leads to an immediate automatic shut down of the APU via the ECB (**E**lectronic **C**ontrol **B**ox).

BITE

The GAPCU is able to read fault data from its own BITE and from the NVMs (**N**on–**V**olatile **M**emories) in each GCU on the ground or in flight.

The GAPCU is able to initiate its own and each GCUs maintenance BITE when requested by the CFDS (**C**entralized **F**ault **D**isplay **S**ystem).

If the GAPCU has lost the communication with a GCU, it generates a message to the CFDS indicating the failed GCU communication.

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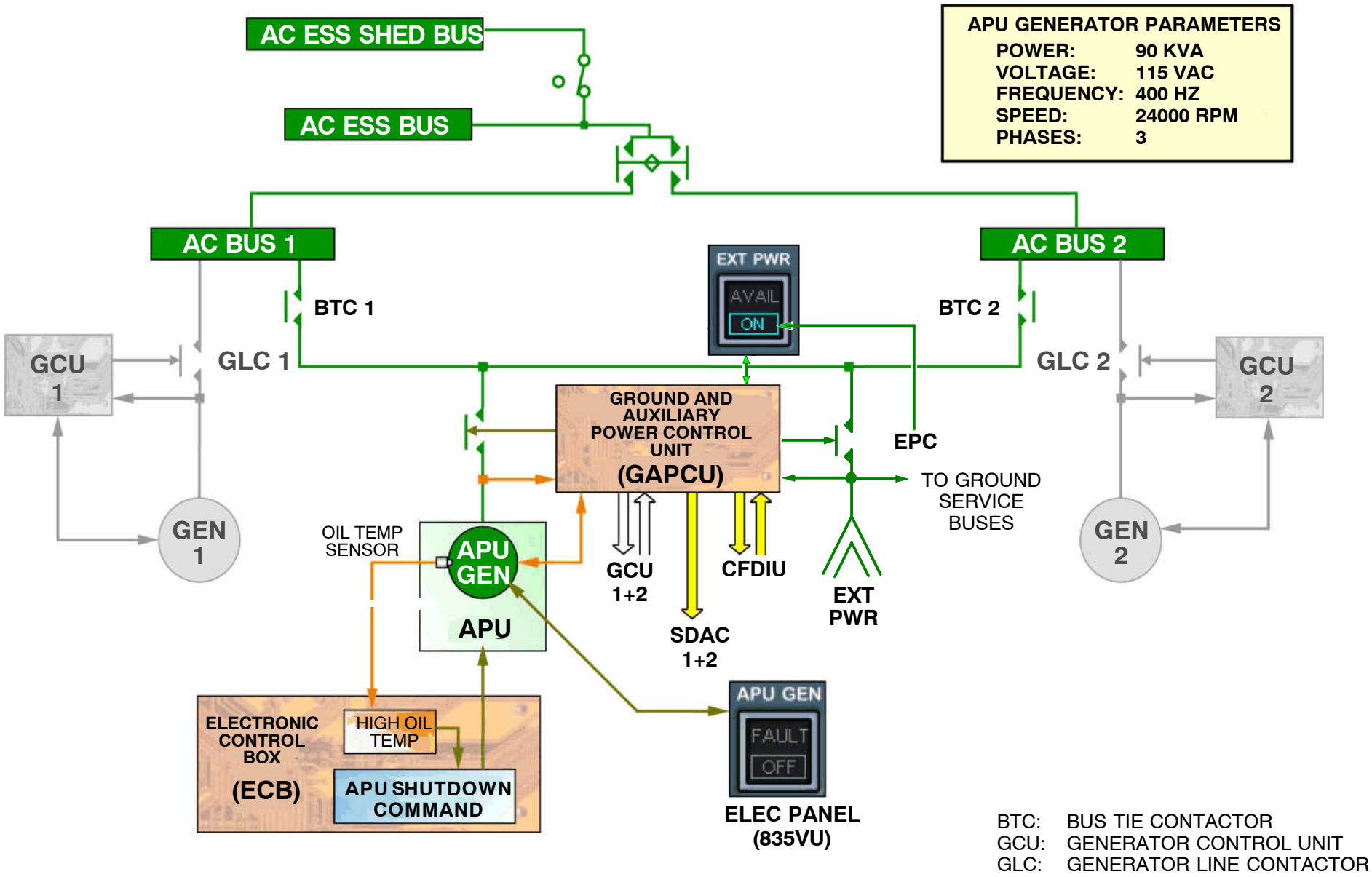

Figure 67 Ground & Auxiliary Control Unit Schematic (enhanced)

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GAPCU COMPONENT DESCRIPTION (ENHANCED)

The GAPCU (**G**round and **A**uxiliary **P**ower **C**ontrol **U**nit) controls the APU GEN (**Gen**erator) and the EXT PWR (**Ext**ernal **P**ow**r**) System. The AGLC (**A**PU **G**enerator **L**ine **C**ontactor), the EPC (**E**xternal **P**ower **C**ontactor) and their related Auxiliary Relays can only close when the correct conditions exist. They are opened manually or automatically, by the control and protection circuits. The GAPCU also performs BITE analysis and communication and interface with other systems:

- GCUs (**G**enerator **C**ontrol **U**nits),
- APU ECB (**E**lectronic **C**ontrol **B**ox),
- CFDIU (**C**entralized **F**ault **D**isplay **I**nterface **U**nit),
- SDACs (**S**ystem **D**ata **A**cquisition **C**oncentrators),
- LGCIU (**L**anding **G**ear **C**ontrol and **I**nterface **U**nit).

Power Supply

The GAPCU internal power supply module can be supplied by the external power or the APU GEN via internal TRs (**T**ransformer/**R**ectifiers). The supply module also has a back up supply from the BAT BUS.

EXT PWR CONTROL

The GAPCU performs the following functions for the external power control and BITE:

- monitoring,
- interlock function,
- EPC (**E**xternal **P**ower **C**ontactor) control,
- protection,
- BITE function,
- communication and interface.

Monitoring

The GAPCU permanently monitors the quality of the external power supply. A faulty parameter automatically disconnects the external power from the transfer line opening the PRR (**P**ower **R**eady **R**elay) hence the EPC. In some GAPCU failure conditions the back up card can control the PRR, so that the external power can still be connected to the aircraft. In these cases, after a ”cold reset” the PRR closes and the external power is supplied to the aircraft with limited protection.

Interlock

The IMR (**I**nterlock **M**onitoring **R**elay) closes when:

- The 28V DC control voltage from the GPU (**G**round **P**ower **U**nit) to the GAPCU, is within limits (< 45V DC and < 60V AC).
- The phase voltage (115V AC) at the POR (**P**oint **O**f **R**egulation), is accepted by the Control and Protection Module. The closed IMR connects 28V DC to the GPU.

This interlock voltage is a ”hold on’’ supply for the GPU contactor and is one of the PRR close logics (AND gate). If the POR voltage is also good, the AND gate is qualified and the PRR and the EPC close. If the IMR opens, the AND gate is disqualified, the PRR trips and the EPC opens.

EPC Control

The closed PRR provides power to the EPC AUX relay. The AUX relay is responsible for opening and closing the main contactor (EPC). The EPC AUX relay is also responsible for the priority switching, i.e. the External Power over the APU GEN. Depending on the network supply status (sensed by the GLC (**G**enerator **L**ine **C**ontactor)/BTC (**B**us **T**ie **C**ontactor) logic) the EPC AUX relay connects power via the open AGLC to the EPC. The EPC then connects the GPU to the transfer line. When the EXT PWR P/BSW is pressed again, the FLIP/FLOP removes the ground so that the AUX relay and EPC open.

Protection

The GAPCU performs the following protection functions for the external power:

- over and under voltage,
- over and under frequency,
- EXT PWR interlock,
- IPS (**I**ncorrect **P**hase **S**equence),

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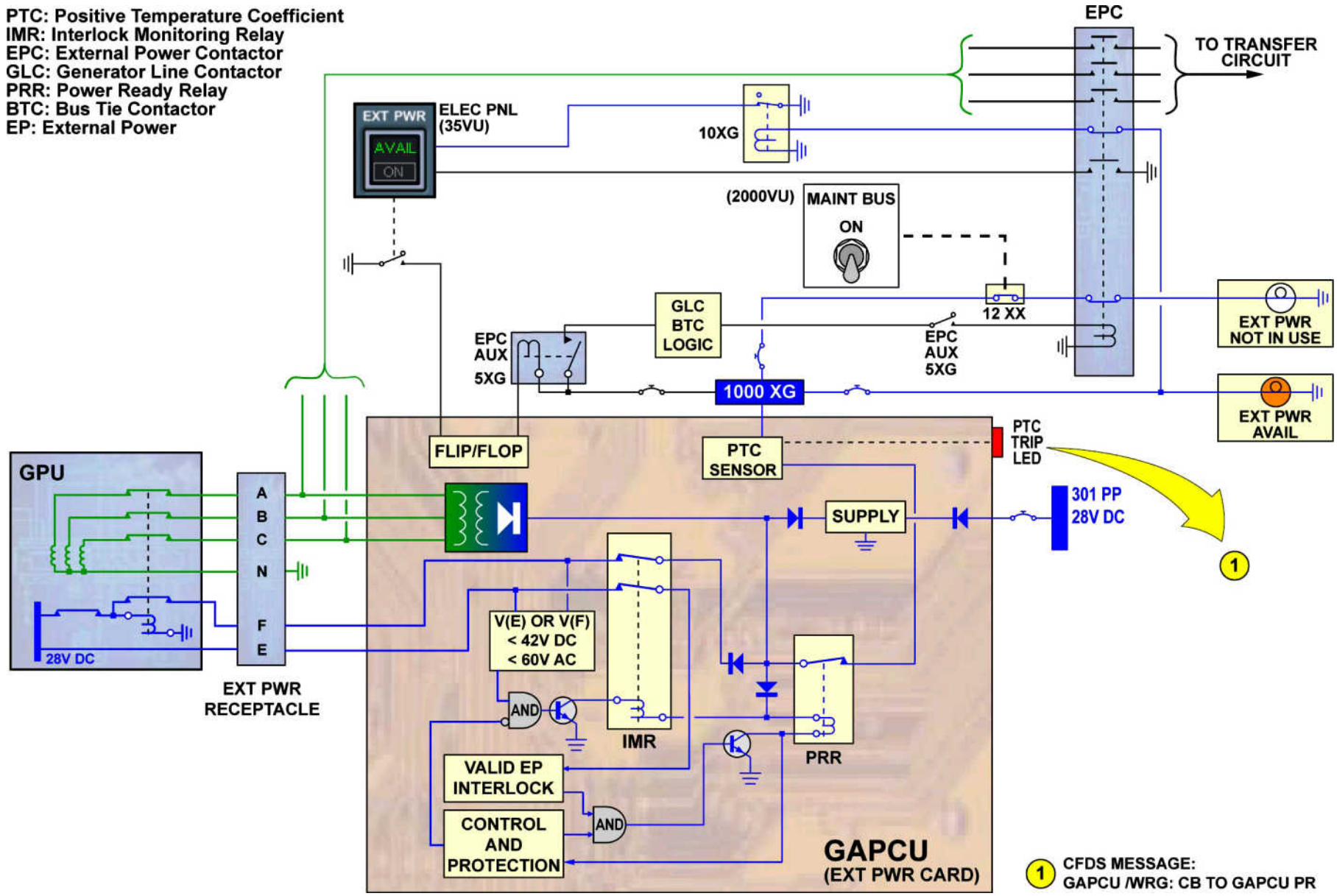

Figure 68 External Power Control - Enhanced

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APU GENERATOR CONTROL

APU Generator

The APU directly drives the APU generator at a nominal 24000 rpm constant speed. The APU gearbox supplies the oil for cooling and lubrication of the generator. The cooling circuit is common to the APU and the generator.

The APU supplies, scavenges, drains the oil.

The generator is a brushless oil–cooled generator with a nominal 115/200 volt, 90 KVA, 3 phase 400 Hz output.

A temperature bulb is included in the auxiliary generator. This sensor is connected to the Electronic Control Box (ECB) of the APU. Any high oil temperature causes the automatic shutdown of the APU (by the ECB).

Ground and Auxiliary Power Unit (GAPCU)

The GAPCU controls the APU generator and the external Power channels. For the APU generator channel control, the GAPCU has different functions:

- voltage regulation,
- control and protection of the network and the generator,
- control of the various indications,
- system test and self–monitoring.

The GAPCU is supplied:

- directly from the PMG, for generator excitation and 28VDC internal and external supply,
- from the aircraft normal network (28VDC) for the internal and external supply.

  This dual supply constitutes a back up supply.

Voltage Regulation

The voltage regulation is achieved by controlling the current through the exciter field. The voltage is kept at nominal value (115 VAC) at the Point of Regulation (POR).The POR is located in the electrical power centre (120VU) at the end of the generator feeder, upstream of the line contactor.

The principle of operation of the voltage regulator is by constant frequency variable pulse width modulation of the voltage through the exciter field.

Control and protective Functions

The GAPCU controls the connection and disconnection of the power provided by the generator to and from the aircraft electrical system.

This control is provided by means of 2 relays. The Generator Control Relay (**GCR**) which controls the generator excitation and the Power Ready Relay (**PRR**) which controls the generator line contactor and the FAULT warning light in the cockpit.

The following control or fault signals cause generator shutdown or de–energization:

1. No controlled Shutdown recognized upon power–up of the control unit
2. Overvoltage Fault
3. Undervoltage 1 or 2 Fault
4. Overfrequency 1 or 2 Fault
5. Underfrequency 1 or 2 Fault
6. SRD/PMG to Chassis Short Fault
7. Differential Protection Fault
8. Overcurrent Fault
9. Phase Sequence Fault with the Power Ready Relay ”absent”
10. APU GLC Control Circuit Fault
11. APU GLC welded Fault
12. Shorted/Open PMG Fault with the Power Ready Relay ”absent”
13. Pin Programming Error

The generator shall be ”reset” when the protective faults (identified above) are still not present and one of the following occurs:

- Cold Start (which is defined as POWER–UP RESET or the application of 28 volts to the control unit) occurs,
- Generator Control Switch (GCS) is toggled (OFF to ON).

The following functions shall be limited to a total of 2 resets after which a cold start will be required for reset:

- Overvoltage Fault
- Overfrequency 2 Fault
- Differential Protection TD Fault
- Overcurrent Fault
- APU GLC Welded Fault

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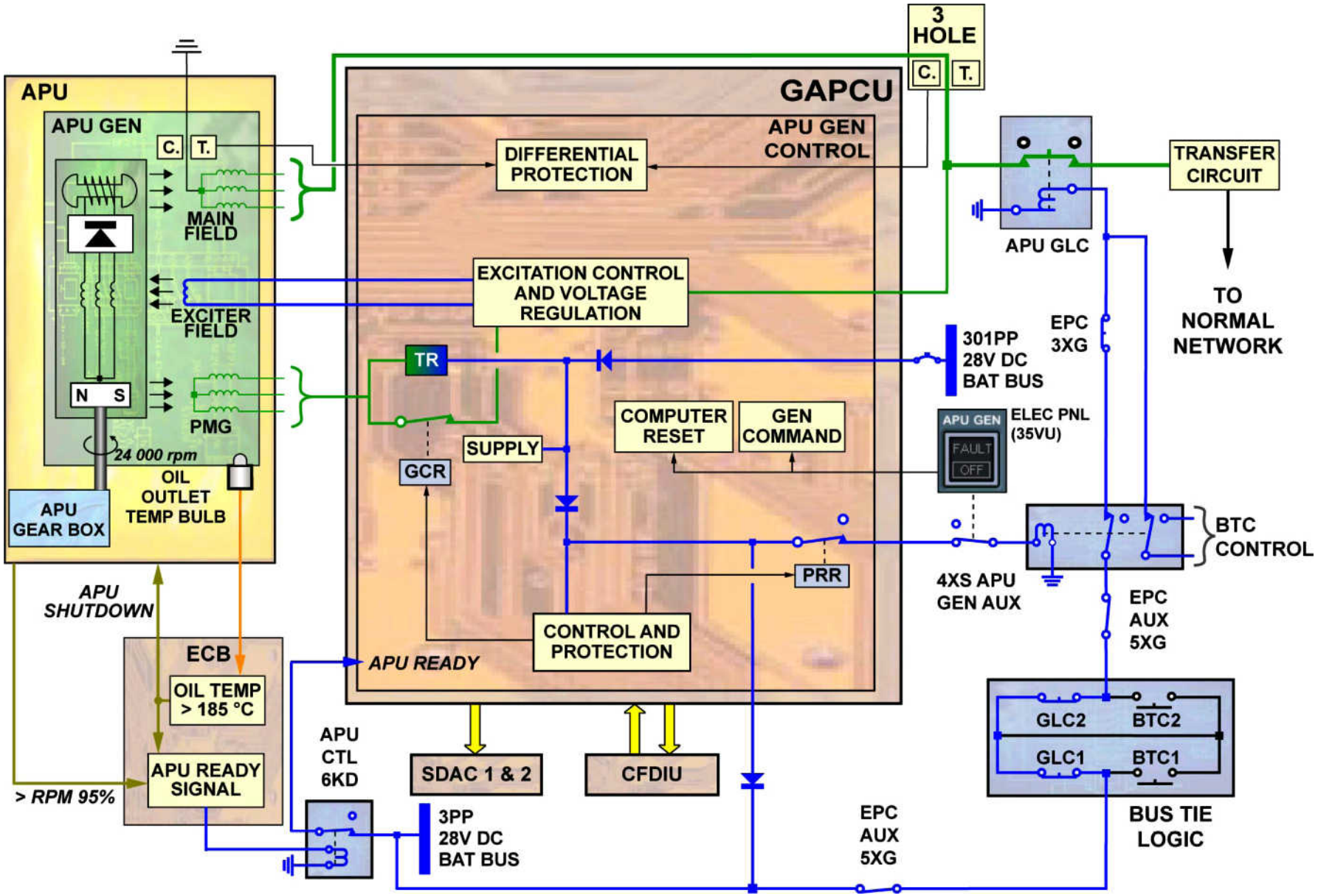

Figure 69 APU Generator Control - Enhanced

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EPGS BITE (ENHANCED)

General

The GAPCU is the interface between the GCU 1 and 2 and the CFDIU.

The GAPCU receives the fault information from GCU 1 and 2, and compiles them with its own failures and transmits them to the CFDIU.

The GAPCU receives fault information through MIL–STD 1553 data links from the GCUs and transmits a failure list to the CFDIU (ARINC 429).

The GAPCU transmits the fault message in clear english language to the CFDIU by ARINC 429 input/output buses (Type 1).

The maintenance test can be performed only on ground with engine shut down It is initiated either:

- Automatically at each GAPCU power–up.
- Or manually from the MCDU.

The AC GEN system in the classic EPGS (**E**lectrical **P**ower **G**eneration **S**ystem) is a type 2 system.

The AC GEN system in the Enhanced EPGS is now a type 1 system, so the EPGS menu has additional sub menus related to type 1 systems.

PTC Protection

If a short circuit occurs on the PRR output line sensed by the PTC (**P**ositive **T**emperature **C**oefficient) sensor, the red PTC TRIP LED on the front face of the GAPCU comes on and a BITE message is sent to the CFDS (**C**entralized **F**ault **D**isplay **S**ystem).

The PTC and the PTC LED are only supplied if the ground power unit remains connected to the receptacle (i.e. PRR is still closed). The LED is not a ”latched” status signal. Thus, if a short circuit does exist, and the LED is illuminated, it will go off as soon as the external power is removed from the receptacle.

Back up card

An internal Back up Card allows reduced functions of the GAPCU. In case of trouble with the external power control part of the GAPCU this Back up Card can be activated by recycle the External power plug. By that action it is possible to activate Ground power with limited functions to start trouble shooting.

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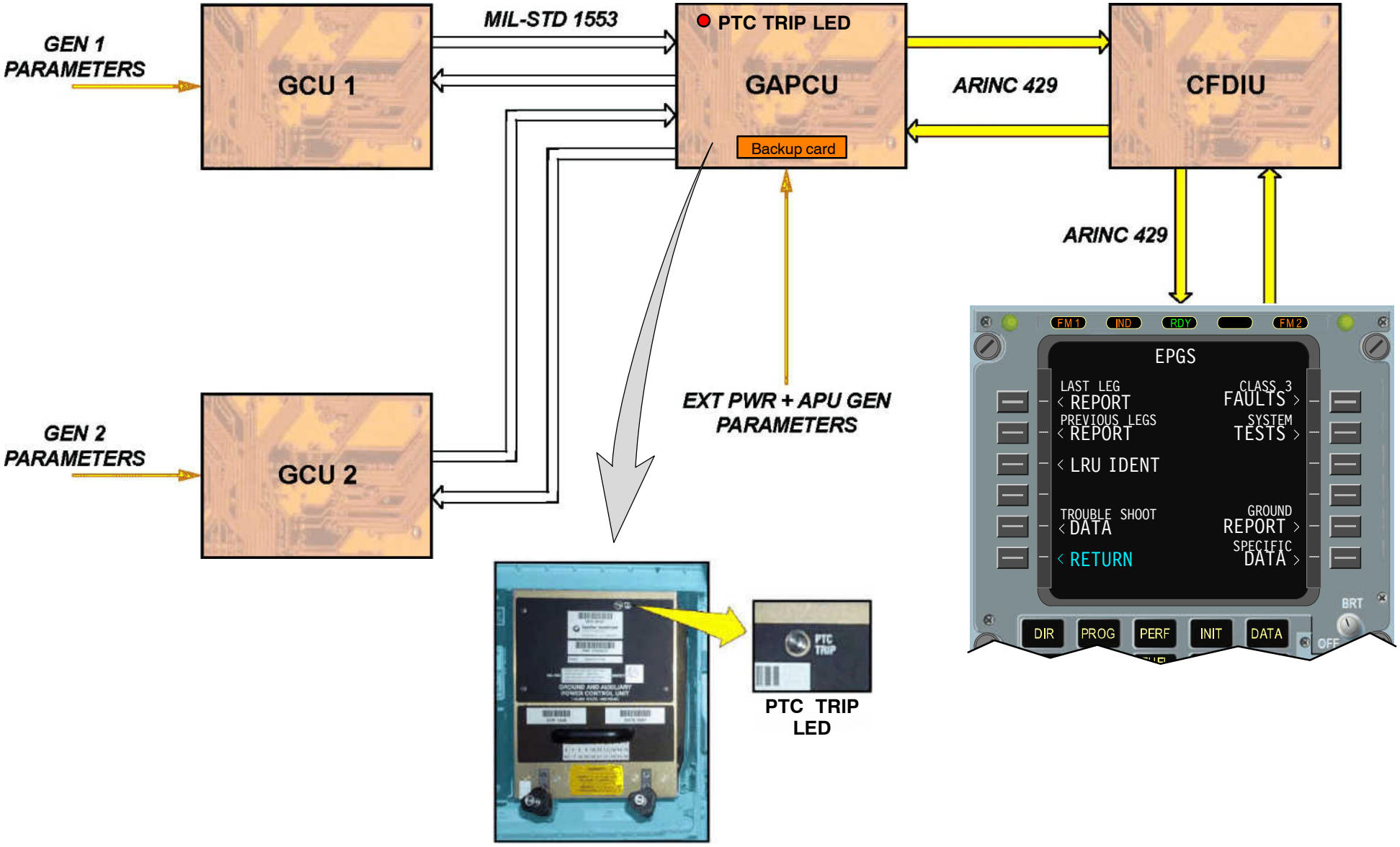

Figure 70 EPGS BITE Overview (enhanced)

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GAPCU MCDU PAGES-DESCRIPTION

The AC GEN system in the standard EPGS is a type 2 system.

The AC GEN system in the Enhanced EPGS is a type 1 system, so the EPGS menu has additional sub menus related to type 1 systems.

EPGS SUB–MENU

In the EPGS menu, the LAST LEG REPORT line key allows access to GCU 1, GCU 2 and the GAPCU last flight leg report data.

The same sub–menu is available to get access to the:

- PREVIOUS LEGS REPORT,
- TROUBLE SHOOTING DATA,
- CLASS 3 FAULTS,
- GROUND REPORT and
- SPECIFIC DATA.

SYSTEM TEST

The SYSTEM TEST pages enable the ground engineer to perform tests and to retrieve data associated to the system. Furthermore the pages show the result of the EPGS tests.

The system test is done on the ground, with the GAPCU in the interactive mode. Only internal GAPCU and GCU tests are done.

The first test page asks for confirmation that engines and APU are not running. The test displays the GAPCU and each GCU test results.

The test will not run if the related engine or APU is running.

More information about the failed test (GCU 2) is available by selecting the line keys.

Selecting the CLASS 3 line select key gives snapshot troubleshooting data.

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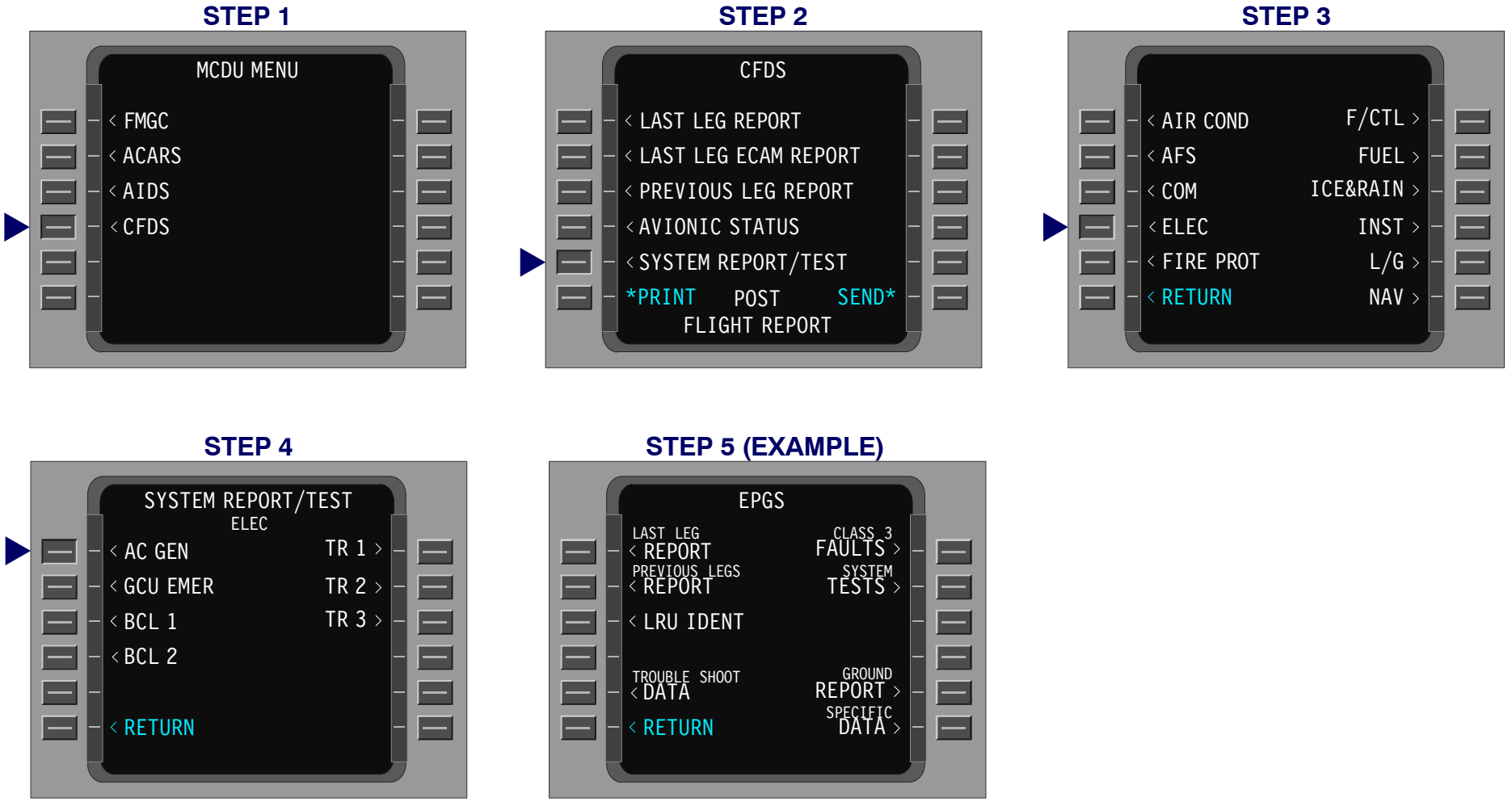

Figure 71 MCDU EPGS Menu Selection (enhanced)

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24–26 GALLEY SUPPLY CONTROL

GALLEY AND COMMERCIAL OPERATION (ENHANCED)

In normal supply configuration (GALY & CAB and COMMERCIAL P/BSWs pushed in) all the galleys, the cabin and commercial sub–busbars are supplied.

When the GALY & CAB P/BSW is set to OFF (OFF legend on) all the galleys and the cabin systems sub–busbars are OFF.

When the COMMERCIAL P/BSW is set to OFF (OFF legend on) all the galleys and all the sub–busbars are off. The GALLEY SHED indication comes into view on the ELEC system page.

The galley power is off and the ceiling and window lights in the cabin extinguish.

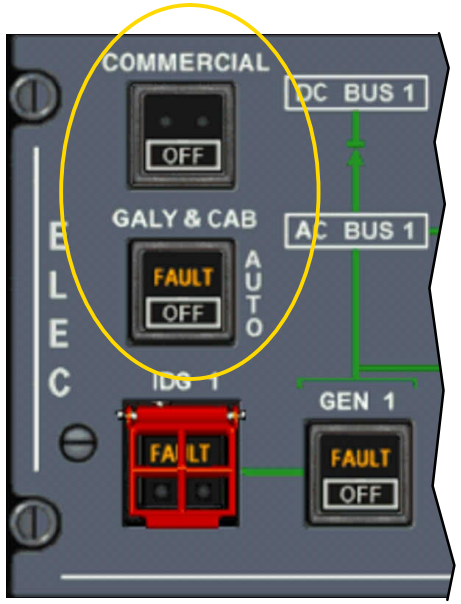
TR1 or 2 loss

GALY & CAB and COMMERCIAL P/BSWs are in normal supply configuration. When TR1 or TR2 is lost the relay 1PC2 is energized whereas the DC sub–busbars 210PP and 212PP are not supplied.

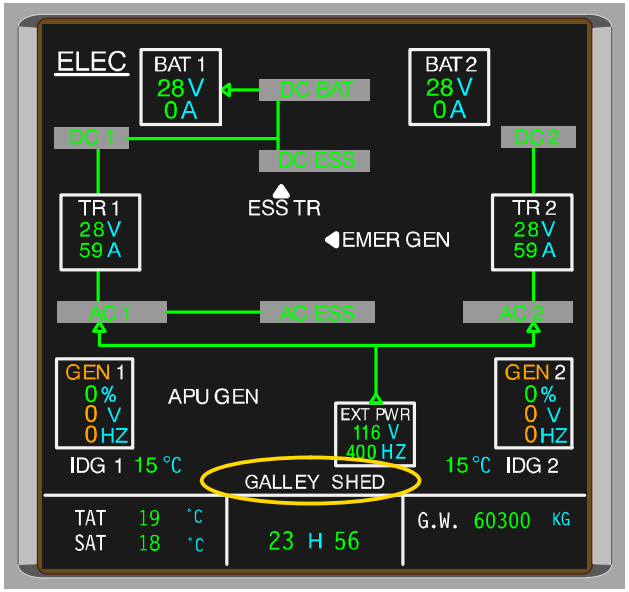
IDG1 or 2 loss

When IDG1 or IDG2 is lost, BTC1 and 2 are closed and the relay 10XA is de–energized, this sheds the cabin–related sub–buses.

If the APU generator is lost due to a current overload (I > 277 A) on the ground, all Galleys & Cabin related sub–buses are off.



ELEC CONTROL PANEL (35VU)



SYSTEM DISPLAY (SD)

Figure 72 Galley & CAB and Commercial Control

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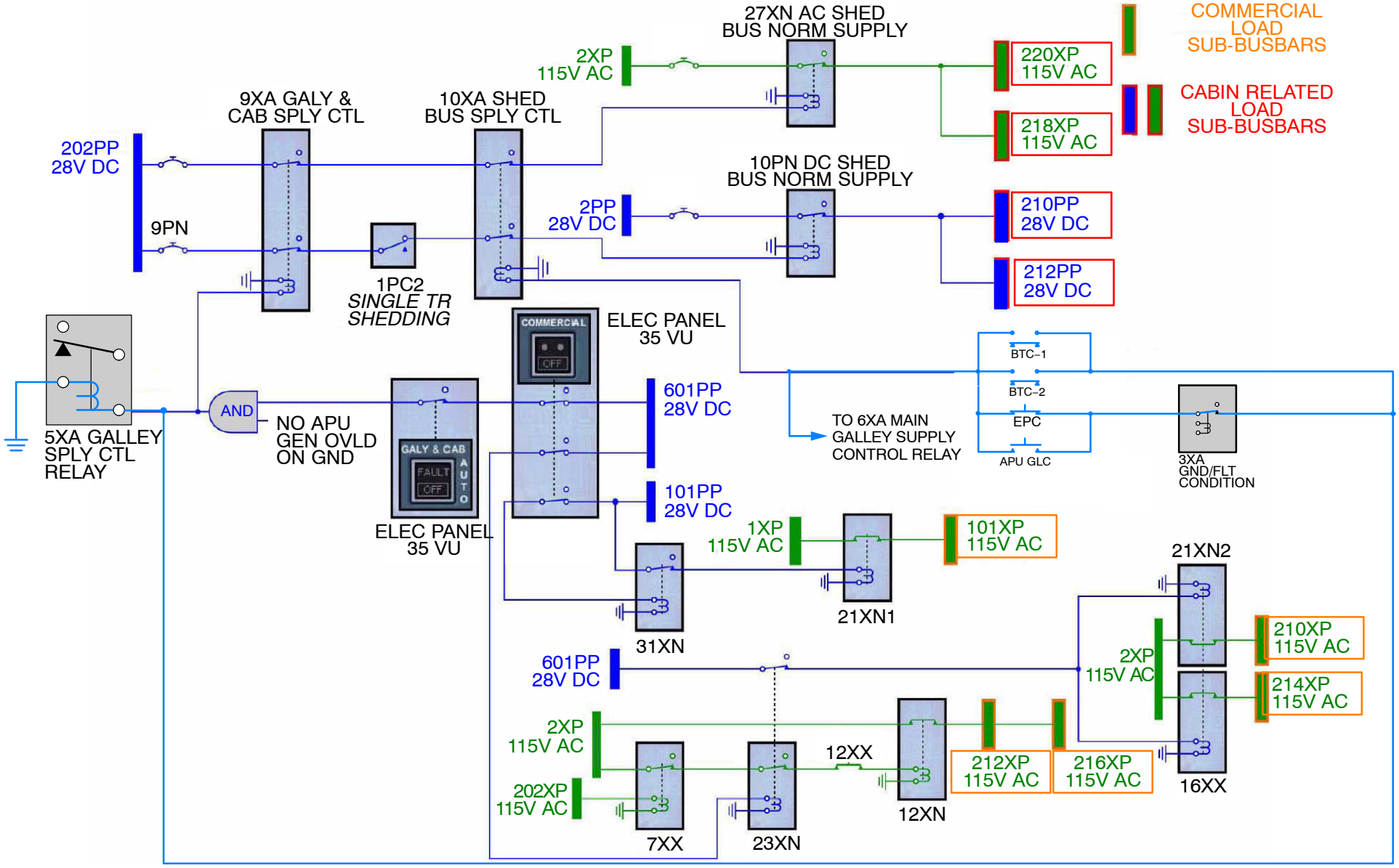

Figure 73 GLY/CAB and Commercial P/B Schematic (EXT PWR ON)

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24–00 ELECTRICAL POWER GENERAL

ELECTRICAL POWER SYSTEM WARNINGS

EMER CONFIG

In case of dual generator failure, the MASTER WARNing comes on associated with a Continuous Repetitive Chime (CRC). The lower ECAM Display Unit (DU) is lost. In this case, the ELECtrical SYStem page can be displayed on the upper DU by maintaining the P/B pressed–in on the ECAM Control Panel (ECP). The emergency generator has taken over the essential network.

GEN FAULT

In case of a generator fault, the MASTER CAUTion comes on associated with a Single Chime (SC). The GENerator FAULT light on the electrical control panel comes on. This failure occurs when GEN 1(2) parameters are not correct. The failure is shown amber on the ECAM page.

NOTE: In case of GEN fault, the related AC BUS is supplied by the opposite GEN and galley loads are partially shed.

IDG OIL LO PR/OVHT

In case of an Integrated Drive Generator (IDG) unit oil low pressure or overheat, the MASTER CAUT comes on associated with a SC. The IDG FAULT light on the electrical control panel comes on. The failure is shown amber on the ECAM page. IDG 1(2) OIL OVHT warning message appears when the IDG oil outlet temperature is above 180 DEG C.

GEN OVERLOAD

In case of generator overload, the MASTER CAUT comes on associated with a SC. The GALleY & CABin FAULT light on the electrical control panel come on. The failure is shown amber on the ECAM page.

NOTE: The generator load can be reduced by switching the GALY & CAB or COMMERCIAL P/Bs off. On ground, in case of APU generator overload, the whole galley network is automatically shed.

AC BUS 2 FAULT

In case of an AC BUS 2 failure, the MASTER CAUT comes on associated with a SC. The aural warning sounds and the lower ECAM DU is lost. The failure is shown amber on the ECAM page. The ELEC SYS page can be displayed on the upper DU by maintaining the ELEC P/B pressed in on the ECP. In this case, DC ESSential BUS is supplied by ESS Transformer Rectifier (TR) and DC BUS 2 is supplied by DC BUS 1 through DC BATtery BUS.

AC ESS BUS FAULT

Associated with a SC the AC ESS FEED FAULT light on the electrical control panel comes on. The failure is shown amber on the ECAM page.

NOTE: In case of AC ESS BUS power loss, the upper ECAM DU is no longer supplied, and the EWD is automatically transferred to the lower DU. System Display (SD) is still available on request by holding the ELEC P/B pressed in on the ECP.

AC ESS BUS SHED

In case of an AC ESS BUS SHED warning, the MASTER CAUT comes on associated with a SC. The failure is shown amber on the ECAM page.

DC BUS 1 FAULT

In case of a DC BUS 1 FAULT, the MASTER CAUT comes on associated with a SC. VENTILATION BLOWER FAULT and EXTRACT FAULT lights on the overhead control & indicating panel come on. The failure is shown amber on the ECAM page. In this case, the DC ESS BUS is supplied by the ESS TR and DC BAT BUS is supplied by DC BUS 2.

DC ESS BUS FAULT

In case of a DC ESS BUS FAULT warning, the MASTER CAUT comes on associated with a SC. The failure is shown amber on the ECAM page.

DC ESS BUS SHED

In case of a DC ESS BUS SHED warning, the MASTER CAUT comes on associated with a SC. The failure is shown amber on the ECAM page.

BAT 1(2) FAULT

In case of excessive battery charge current, the MASTER CAUT comes on associated with a SC.The BAT 1(2) FAULT light comes on. The failure is shown amber on the ECAM page.

DC BAT BUS FAULT

In case of a DC BAT BUS FAULT warning, the MASTER CAUT comes on associated with a SC. The failure is shown amber on the ECAM page.

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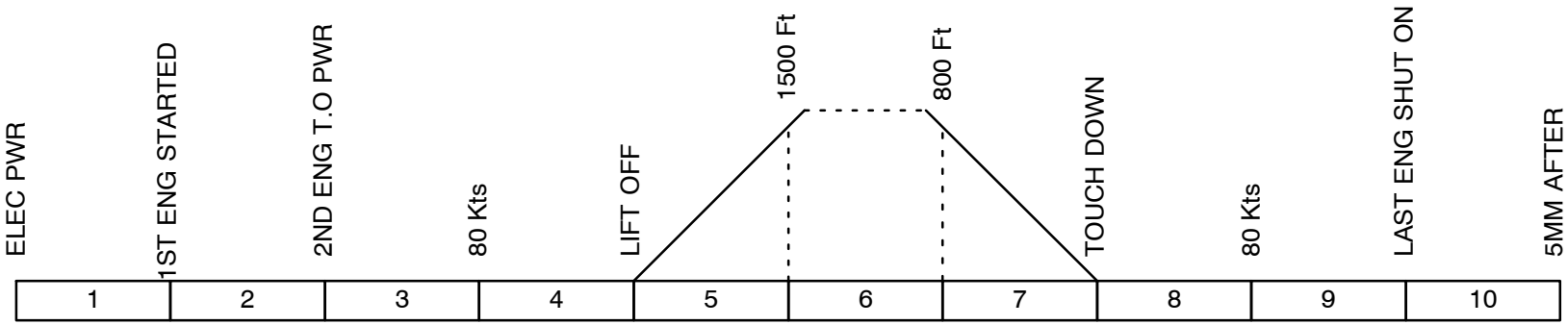

E/WD FAILURE MESAGE	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS	FLIGHT PHASE INHIBIT
ELEC EMER CONFIG LOSS OF ALL MAIN GENERATORS	CRC	MASTER WARN	NIL * (SD POWERLESS)	RAT & EMER GEN FAULT LIGHT	4,8
ELEC ESS BUSES ON BAT DC & AC ES BUSES ARE SUPPLIED BY BATTERIES			ELEC	NIL	1,2,3,4, 8,9,10
ELEC AC BUS 1 FAULT	SC	MASTER CAUT	ELEC	AC ESS FEED FAULT LT	4,8
ELEC DC BUS 1 FAULT			ELEC	VENTILATION BLOWER & EXTRACT FAULT LT	
ELEC AC BUS 2 FAULT			NIL * (SD POWERLESS)	NIL	
ELEC AC ESS BUS FAULT				AC ESS FEED FAULT LT	

* ELEC PAGE SHALL BE CALLED ON REMAINING ECAM SCREEN BY PRESSING & HOLDING THE ELEC KEY ON THE ECP

Figure 74 Electrical Power System - ECAM Messages (1)

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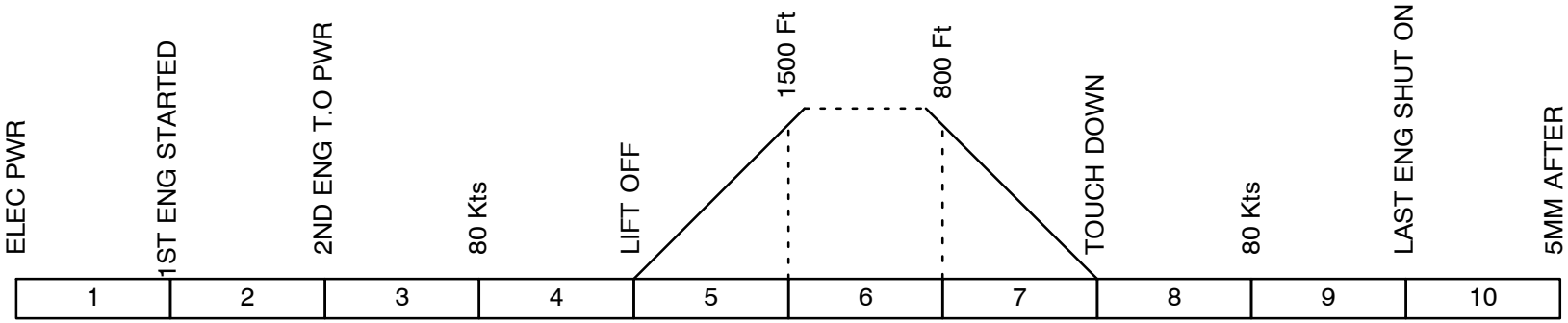

E/WD FAILURE MESAGE	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS	FLIGHT PHASE INHIBIT
ELEC AC ESS BUS SHED ELEC DC BUS 2 FAULT ELEC DC BUS 1 + 2 FAULT ELEC DC ESS BUS FAULT ELEC DC ESS BUS SHED	SC	MASTER CAUT	ELEC	NIL	4,8
ELEC DC BAT BUS FAULT					4,5,7,8
ELEC GEN 1 (2) FAULT				GEN 1 (2) FAULT LIGHT	1,4,5,7, 8,9,10
ELEC APU GEN FAULT				APU GEN FAULT LIGHT	4,5,7,8
ELEC GEN 1 (2) OR APU GEN OVERLOAD				GALY & CAB FAULT LIGHT	3,4,5,7,8
ELEC IDG 1 (2) OIL LO PR				IDG 1 (2) FAULT LIGHT	1,4,5, 7,8,10
ELEC IDG 1 (2) OIL OVHT					
ELEC BAT 1 (2) FAULT				BAT 1 (2) FAULT LIGHT	3,4,5,7,8
ELEC ESS TR FAULT					

Figure 75 Electrical Power System - ECAM Messages (2)

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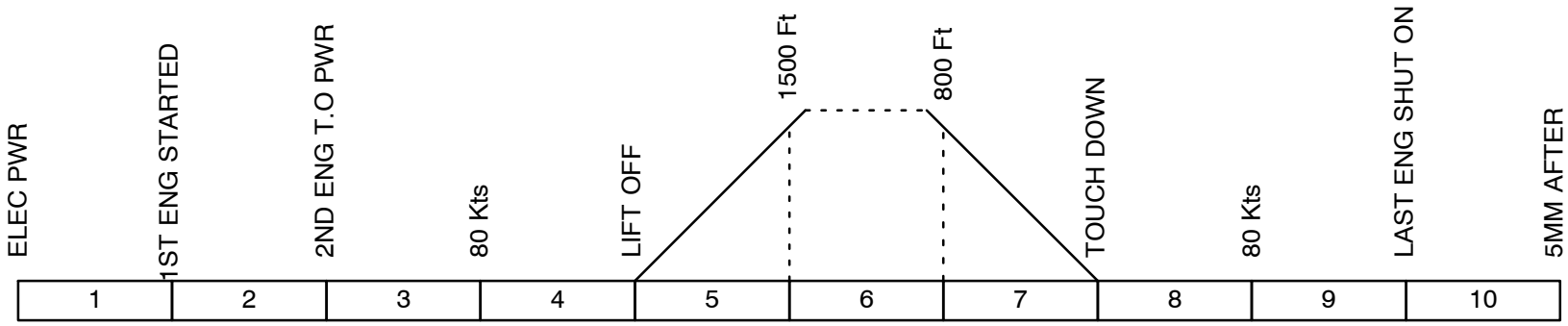

E/WD FAILURE MESAGE	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS	FLIGHT PHASE INHIBIT
ELEC C/B TRIPPED ON OVHD PANEL ELEC C/B TRIPPED ON L (R) ELEC BAY ELEC C/B TRIPPED REAR PANEL J-M (N-R), (S-V), (W-Z)	SC	MASTER CAUT	ELEC	NIL	3,4,5,7, 8,9,10
ELEC BAT 1 (2) OFF BAT P/BSW AT OFF WITHOUT FAULT	NIL				1,3,4,5,7, 8,9,10
ELEC TR 1 (2) FAULT					3,4,5, 7,8,
ELEC BCL 1 (2) FAULT					
ELEC STAT INV FAULT			NIL		
ELEC GEN 1 LINE OFF GEN 1 LINE P/B AT OFF POSITION WITHOUT A SMOKE WARNING					1,3,4,5, 7,8,9,10
ELEC GEN 1 (2) OFF GEN 1 (2) P/B AT OFF POSITION WITHOUT A GEN FAULT WARNING	SC	MASTER CAUT	ELEC		

Figure 76 Electrical Power System - ECAM Messages (3)

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