UTC Aerospace Systems

Airbus A350 XWB
Electrical Power System

System Description and Operation Training Manual

A350 XWB EPGS
For Training Use Only (Level III)

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A350 XWB Electrical Power System

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Disclaimer

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Airbus A350 XWB Electric Power Generation System

Acronyms

Acronyms & Abbreviations

AC	Alternating Current
ADE	Anti-Drive End
AGB	Accessory Gear Box
AMP	Ampere(s)
APU	Auxiliary Power Unit
Assy	Assembly
ATA	Air Transport Association
C	Celsius (Temperature)
cm	centimeter
CMM	Component Maintenance Manual
CMP	Component Maintenance P
CPRV	Case Pressure Relief Valve
CSD	Constant Speed Drive
CT	Current Transformer
CTA	Current Transformer Assembly
DC	Direct Current
DE	Drive End
EGB	Engine Gear Box
EPDC	Electrical power distribution centers
EPGS	Electric Power Generation System
F	Fahrenheit (Temperature)
Ft-lb	Pound-Foot
GCU	Generator Control Unit
GLC	Generator Line Contactor
GND	Ground
Hz	Hertz
IPL	Illustrated Parts List
Kg	Kilogram
kPa	Kilopascal
kVA	Kilo Volt-Ampere(s)
kW	Kilo Watt
L-L	Line-to-line
L-N	Line-to-neutral
lbs	Pounds
LOP	Low Oil Pressure
mA	MilliAmpere
Min	Minute
N-M	Newton Meters
Ω	Ohm
PMG	Permanent Magnet Generator

Acronyms & Abbreviations

POR	Point Of Regulation
psi	Pounds per square inch
PWM	Pulse-Width-Modulated
QAD	Quick Attach-Detach
RBA	Rotor Balance Assembly
ROLS	Remote Oil Level Sensor
RPM	Revolutions Per Minute
RRA	Rotating Rectifier Assembly
SB	Service Bulletin
Sec	Second
SIL	Service Information Letter
SPM	Standard Practice Manual
V	Volts
VAC	Volt, Alternating Current
VF	Variable Frequency (AC)
VFG	Variable Frequency Generator
Vrms	Volts root-mean-square
W	Watt

Acronyms & Abbreviations

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Airbus A350 XWB Electric Power Generation System

Module 1 - System Overview and EPGS Components

System Components

UTC Aerospace Systems Components

- One A350 XWB ship set includes the following from UTC Aerospace Systems:
  - 4 Variable Frequency Generators (VFG)
  - 4 V-Band Clamps
  - 4 Generator Control Units (GCU)
  - 4 Over-voltage Protection Units (OPU)

- These items will be described in this manual.

Components Supplied by Others

- A ship set would also include the following equipment that are not supplied by UTC Aerospace Systems:
  - Contactors to open/close electrical contact
  - Line Current Transformers -- A line current transformer assembly (CTA) is required for each channel and will be contained within the electrical power distribution center (EPDC). This assembly monitors the current in each of the six generator feeder cables. The CTA interfaces with the GCU.
  - Transformer Rectifiers to convert AC to DC
  - Batteries
  - Electrical power distribution centers (EPDC)

- These items are described in manuals provided by their respective manufacturers.

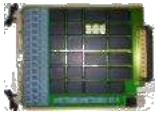
A350 XWB EPGS System Components (UTAS)

VFG

V-Band

Zodiac

ZEPS



UTAS

GCU

OPU

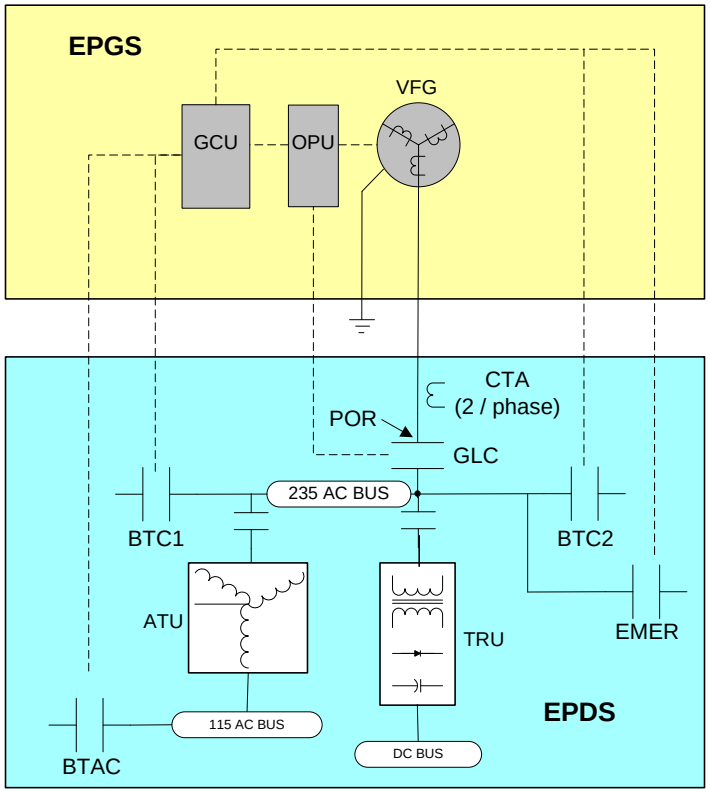
EPGS Overview

- The Airbus A350XWB aircraft has an electrical power **generation** system (EPGS) and a **distribution** system (EPDS).

- The figure provides a simplified electrical system schematic for the A350 XWB electrical aircraft system.
  - The EPGS portion of the electrical power single line may be represented by functional interfaces of a single channel as shown at right (in yellow).

  - The electrical power distribution centers are equipment items that form part of the distribution system (EPDS) which is not part of UTC Aerospace Systems provided equipment (seen at right in blue).

- The whole aircraft system integrate four channels together with emergency equipment.



EPGS Overview

- The functions of the EPGS are provided in the following list:
  1. Generate electrical power required by the aircraft loads
  2. Maintain electrical power quality within the detailed functional specification requirements
  3. Provide generator contactor control power, and protection in conjunction electrical power distribution centers (EPDC) logic
  4. Provide bus tie inhibit/trip protection in conjunction with the electrical power distribution centers (EPDC) logic
  5. Protect the EPGS equipment, installation, and main ac buses per the detailed functional specification requirements
  6. Provide operational/coordination data to the electrical power distribution centers (EPDC)
  7. Provide system indication and control data for the flight deck
  8. Provide system maintenance data
  9. (Power transfers between VFG and any other source are break power transfers)

EPGS Overview

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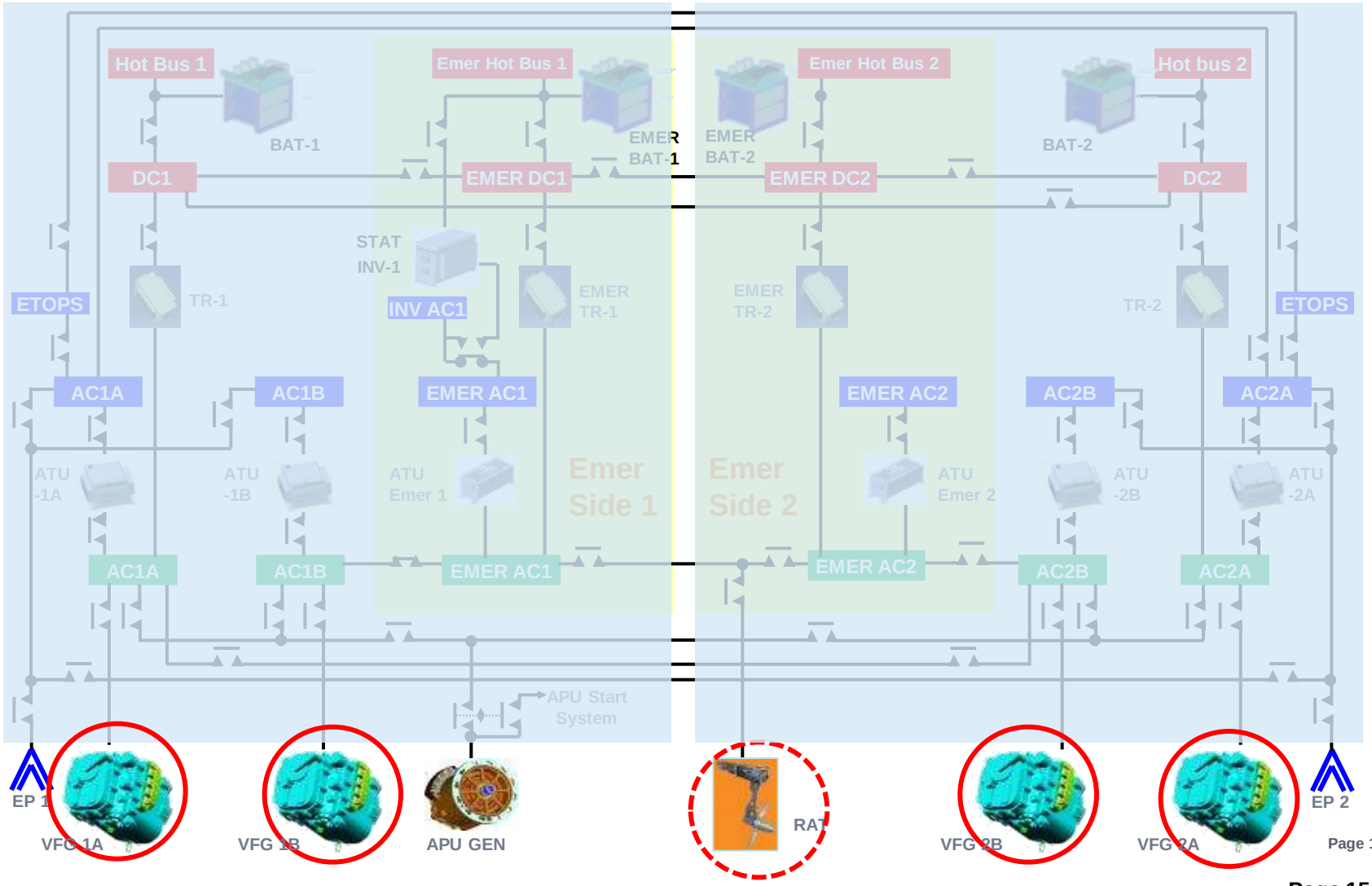
EPGS Overview



EPGS Overview

VFG Description

- The Variable Frequency Generator (VFG) provides 230 Vac variable frequency at the Point of Regulation (POR).
- All aspects of EPGS performance, ratings, power quality characteristics, and protections are based on POR voltages unless otherwise specifically stated.
- The normal operating frequency range of the EPGS is 360Hz to 800 Hz.
- Each generator supplies **100** kVA **continuous** power over the entire frequency range with a Steady State Power Factor of 0.95 leading to 0.80 lagging.
- Each generator supplies **1.2** Per Unit (PU) nominal power (**120** kVA) for **5 minutes** over the entire frequency range with a Power Factor of 0.95 leading to 0.80 lagging.
- Each generator supplies **1.6** PU nominal current (**227A**) for **5 seconds** over the normal speed range with a Power Factor of 0.95 leading to 0.80 lagging.

Variable Frequency Generator (VFG)

Aluminium Housing
needs no paint

V-Band Clamp and Adapter Plate

Generator Control Unit

Overvoltage Protection Unit

Controls

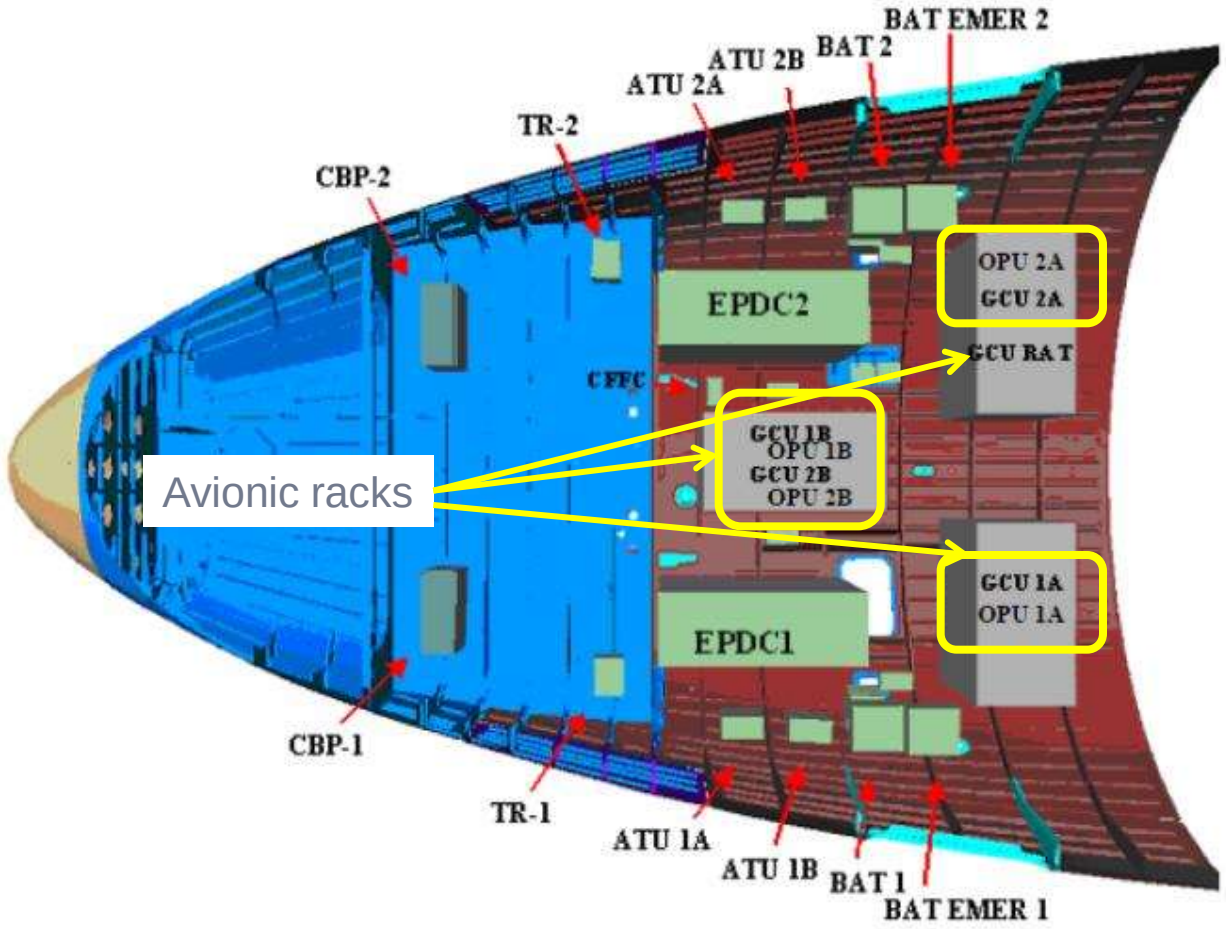
- The A350 EPGS uses two separate control units
  - Generator Control Unit (GCU)
  - Overvoltage Protection Unit (OPU)

- Generator Control Unit (GCU) provides overall control of the electrical generation while the Overvoltage Protection Unit (OPU) provide redundant protection against overvoltage.

- There is one GCU and OPU for each generating channel, for a total of four of each.

- All GCUs and OPUs are located in the electronics bay.

Controls Located in Avionics Bay



System Components & Overview

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Airbus A350 XWB Electric Power Generation System

Module 2 - Electric Power Generation & Variable Frequency Generator (VFG)

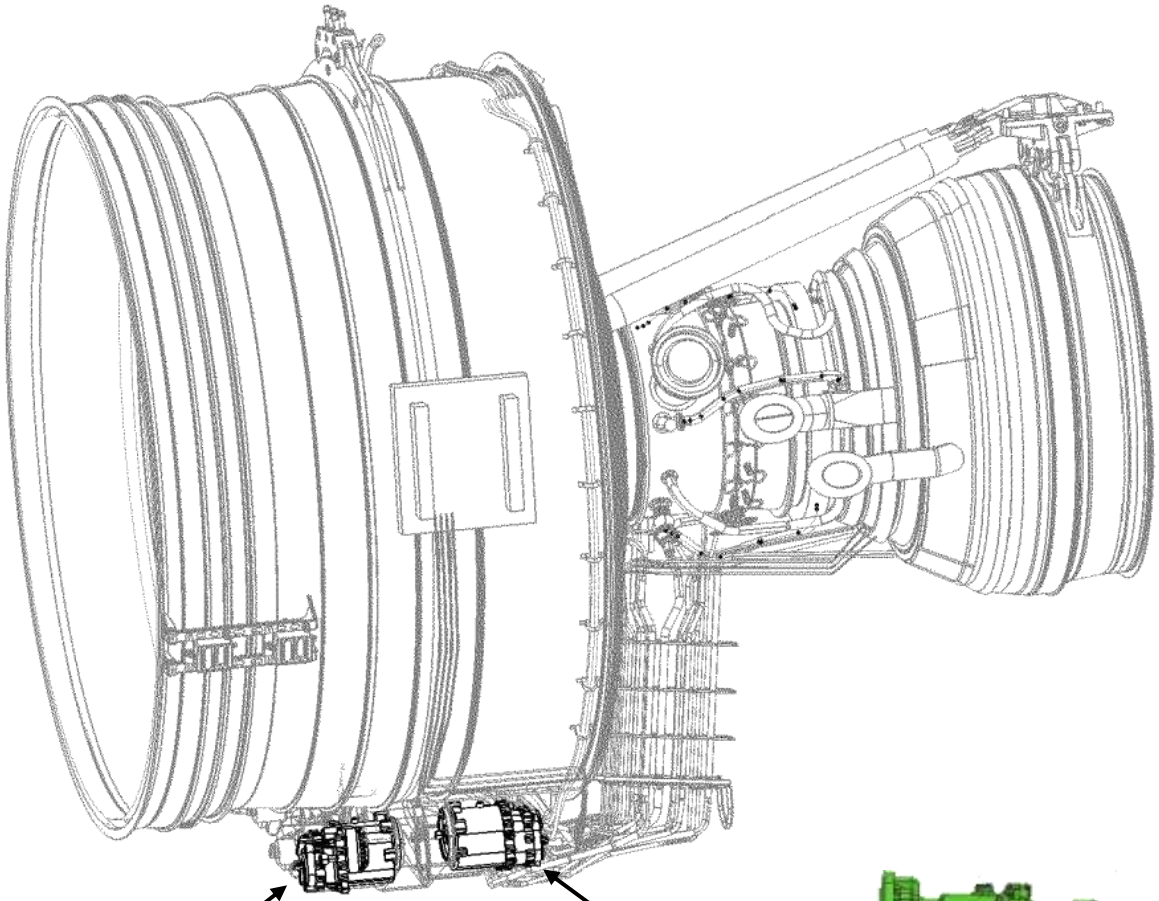
Variable Frequency Generator (VFG)

- The engine gearbox VFG pad gear that drives the two VFGs are offset by one tooth in order to maximize gear life and minimize possible harmonic effects between the two VFGs. As a consequence, the two VFGs operate over two slightly different speed/frequency ranges within the overall operating speed range envelope. The faster VFG defines the top speed and the slower VFG defines the bottom speed of the VFG speed range.

- The VFG input shaft rotates clockwise when viewing the VFG input pad (counterclockwise when viewing the engine gearbox VFG pad).

- **Abnormal Input Speed Range**
  - The VFG can sustain an overspeed condition at 26,000 RPM for 5 seconds.

Variable Frequency Generator (VFG)



Forward VFG B

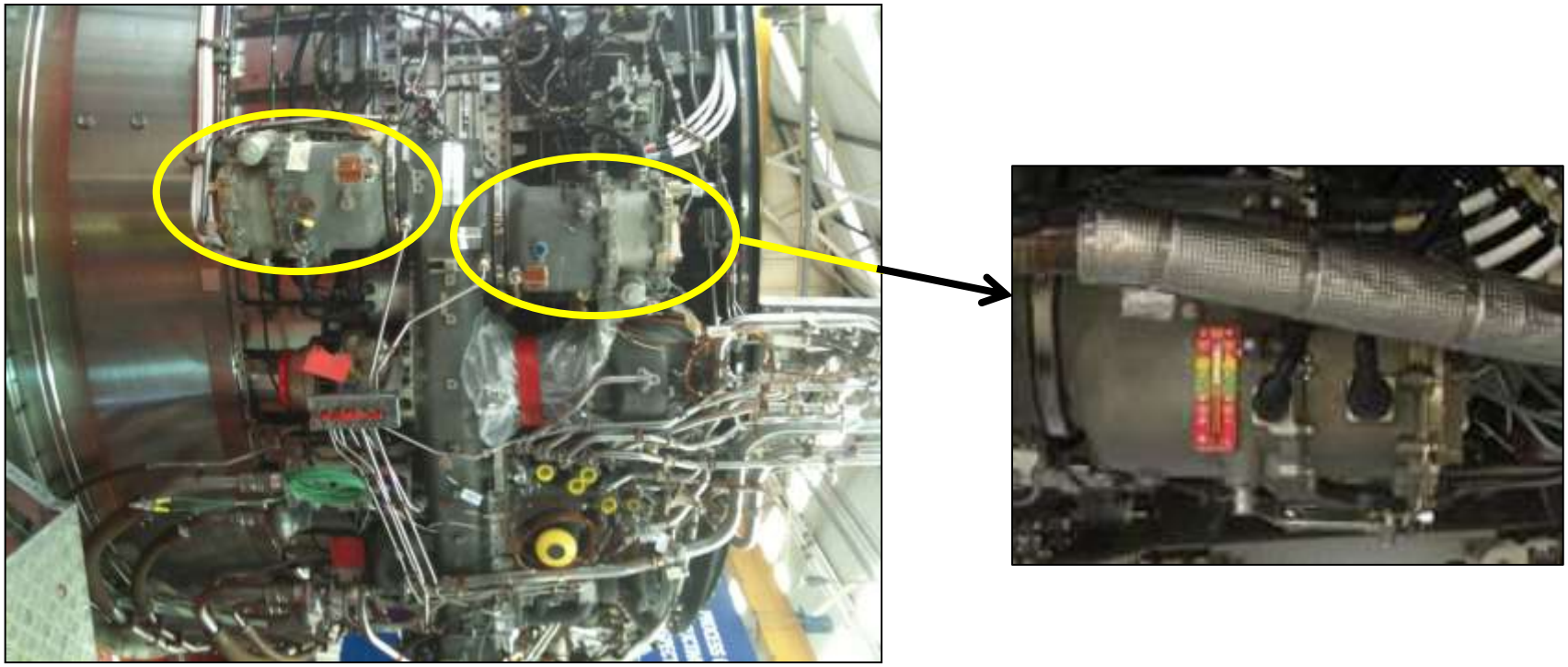
Rear VFG A

Up

Fwd

VFG Nameplates

Rolls Royce Mounted VFG



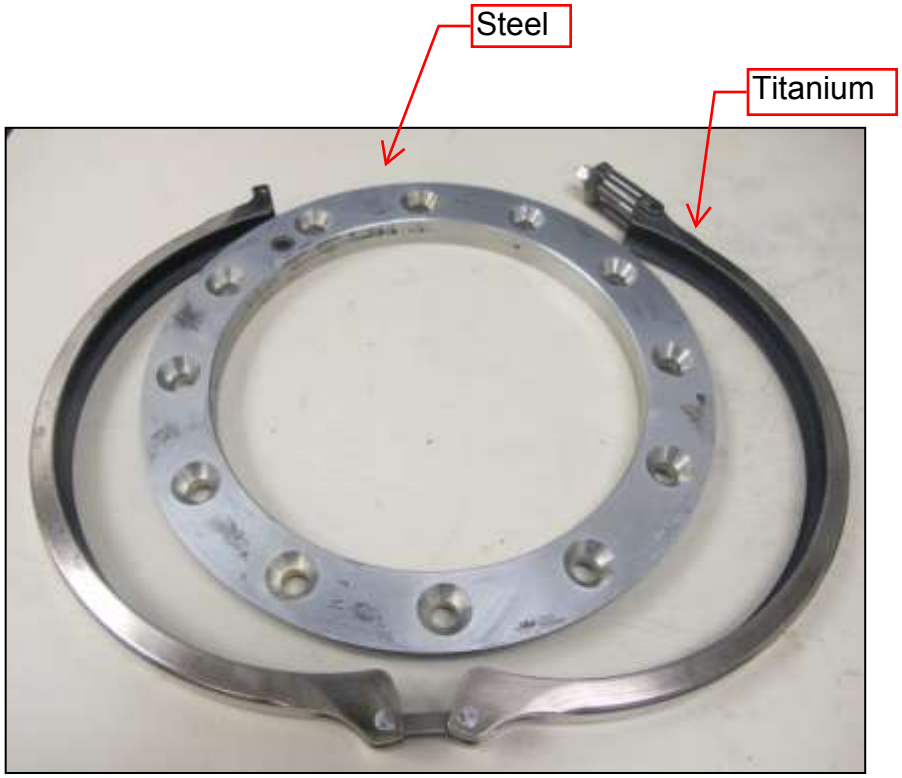
V-Band Clamp

- The V-band clamp serves to efficiently secure the VFG to the engine gearbox.
  - VFG input housing features a half-v shaped rim which mates to the adapter plate.
  - The adapter plate, which also features a half-V shape, is mounted to the engine accessory gear box.
  - A V-shaped band clamp secures the two V-featured surfaces of the VFG and the mounting flange together to mount the VFG to the engine gear box.

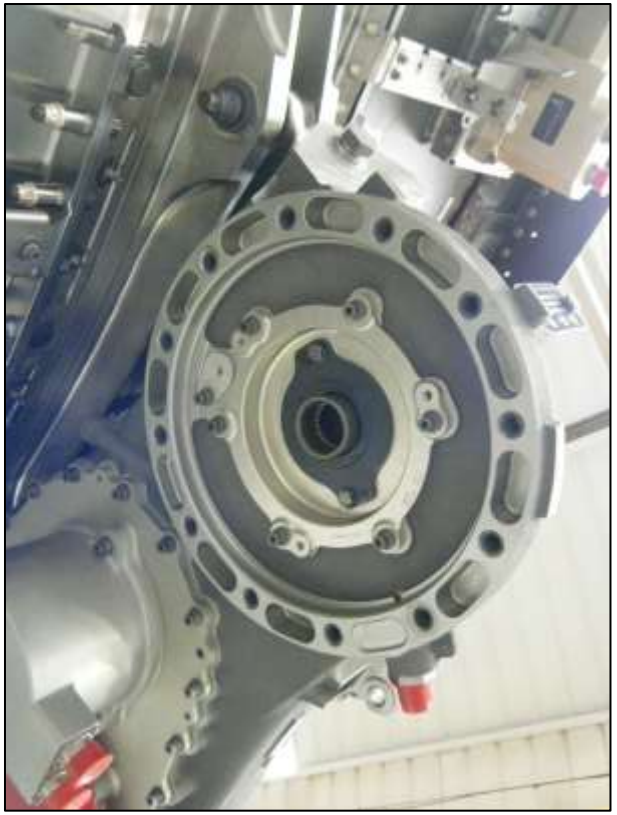
V-Band Clamp

Rolls Royce Gearbox Mounting Pad

- The VFG mounting flange is mounted to the engine gear box with 12 screws.



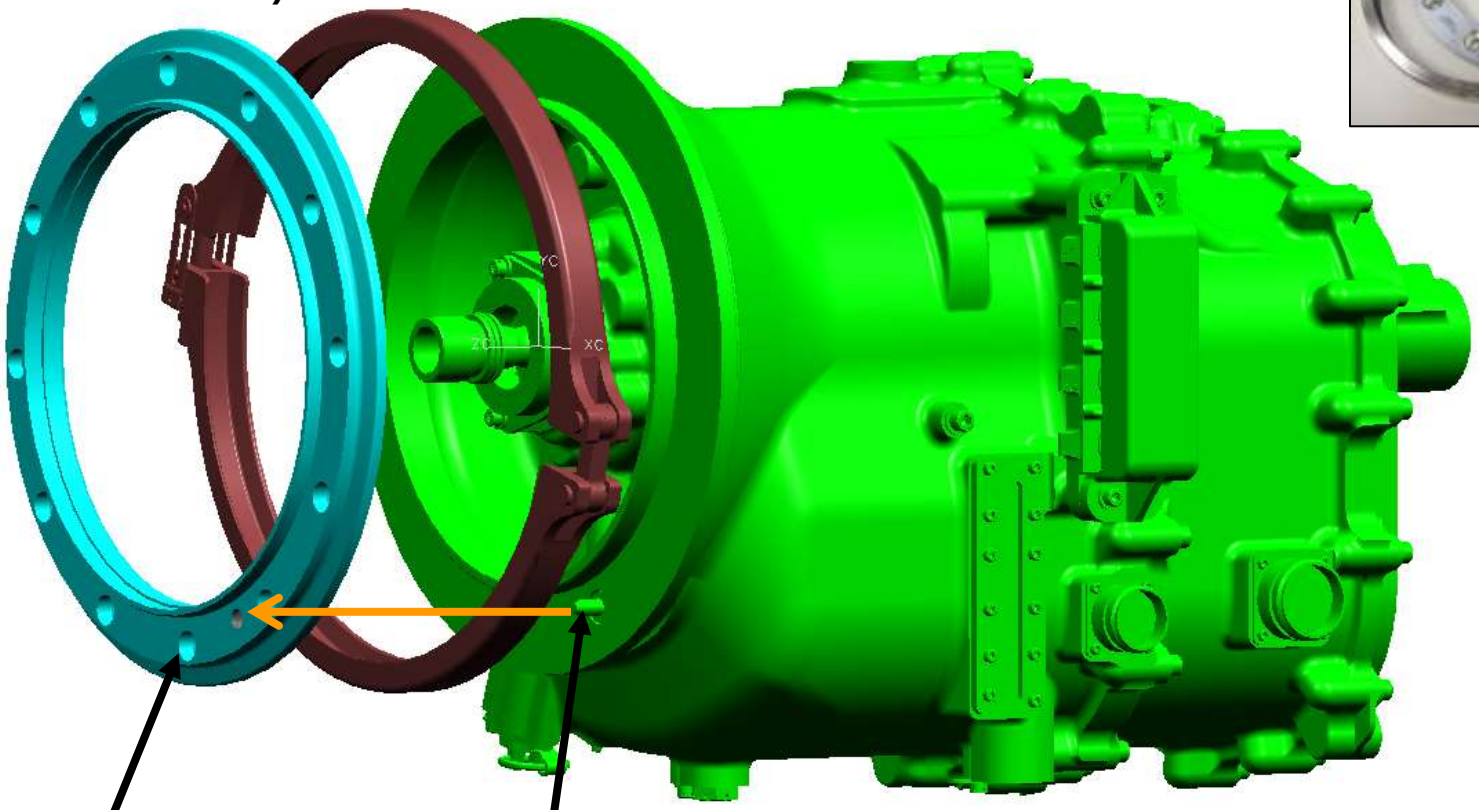
V-Band with Mounting Flange



Engine Gear Box Mounting Pad

V-Band-to-VFG Interface Expanded View

(Qty 12 fasteners to AGB not shown)



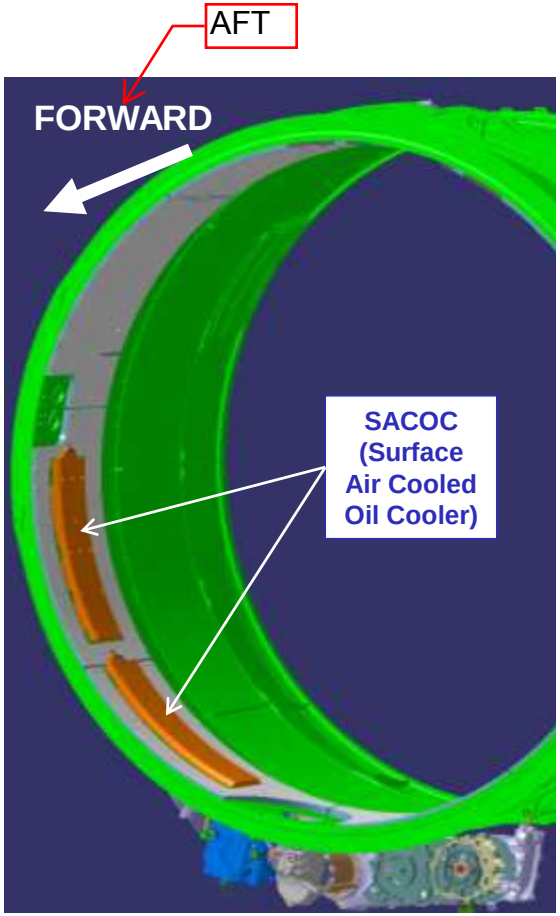
V-band Flange Alignment hole

VFG Alignment Pin

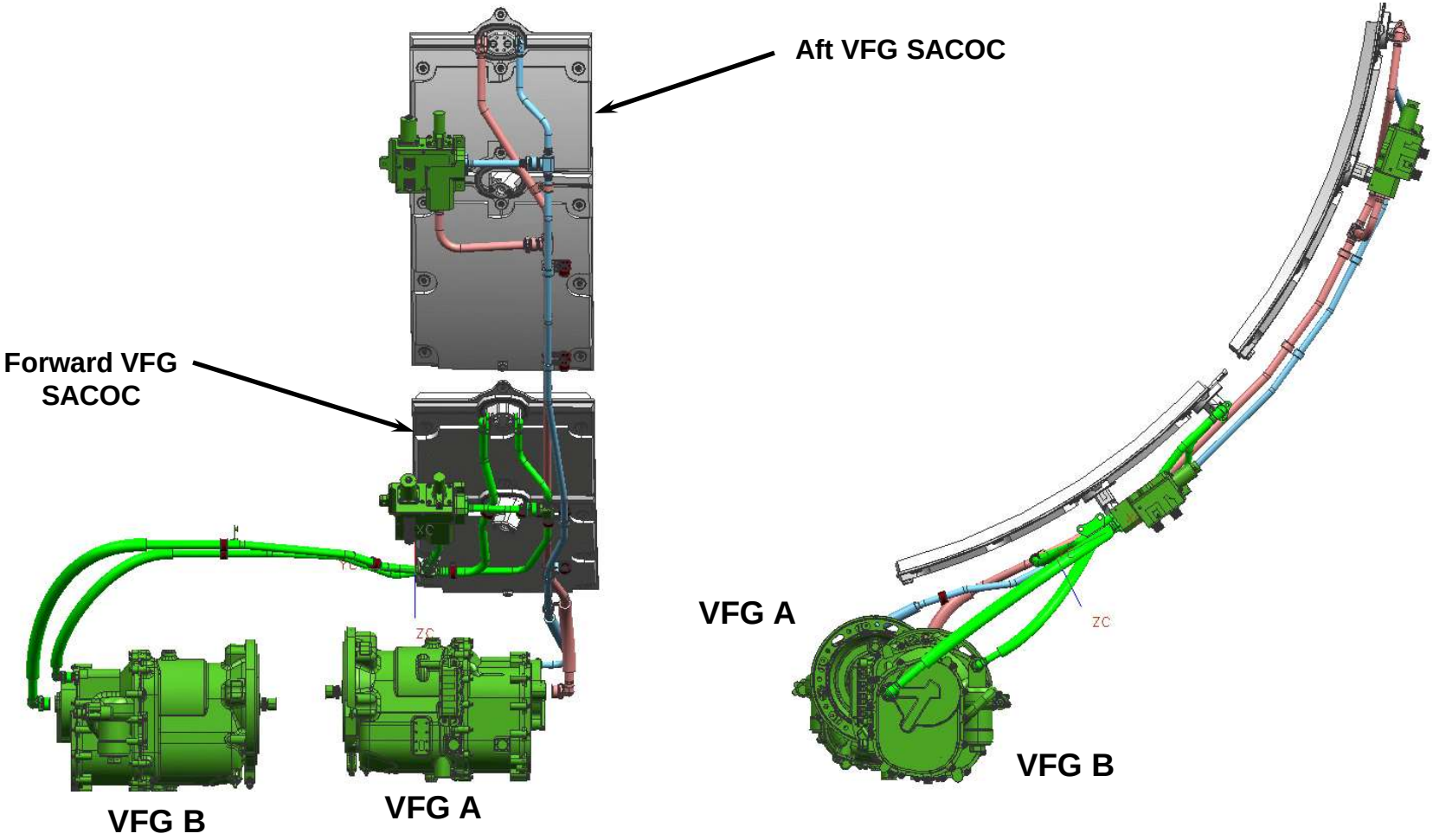
VFG External Oil Cooling Circuit

- The VFG is cooled by a Surface Air Cooled Oil Cooler (SACOC) which is mounted in the engine air stream. The SACOC is connected to the VFG via an external circuit of piping. Oil flows from the VFG to the SACOC where the air flowing over the SACOC serves to cool the VFG oil.

- Each engine has a separate SACOC and external circuit for each VFG.

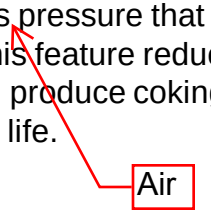


VFG External Oil Cooling Circuit

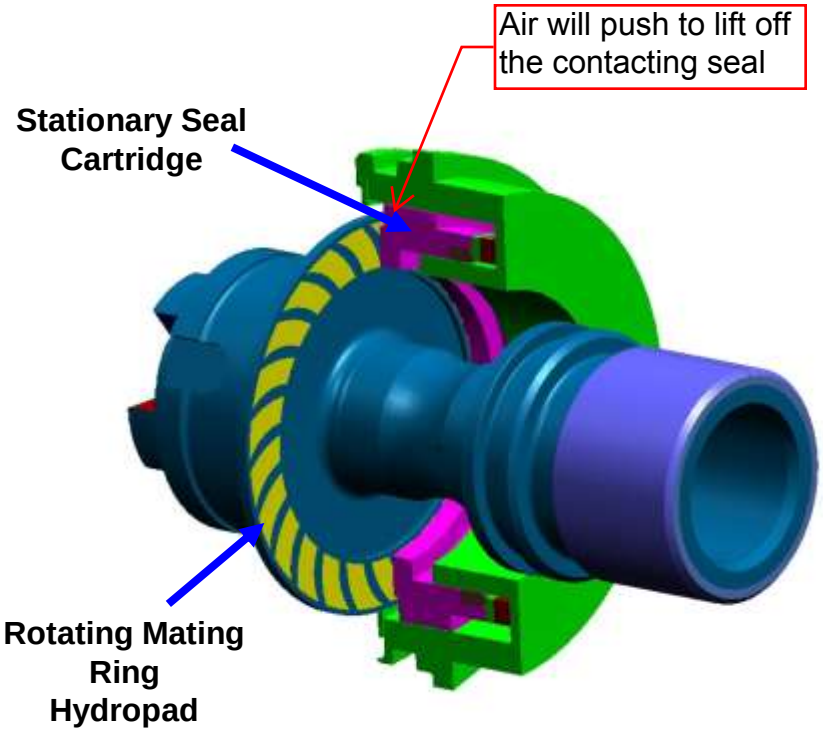


Hydropad Seal

- The VFG mechanical input uses a dynamic seal that has a stationary carbon seal mating with a dynamic input shaft seal that features proprietary machining that produces pressure that lifts the carbon seal off the shaft. This feature reduces the friction-induced heat that can produce coking leading to oil leaks and reduced seal life.



Hydropad Seal



Variable Frequency Generator (VFG)

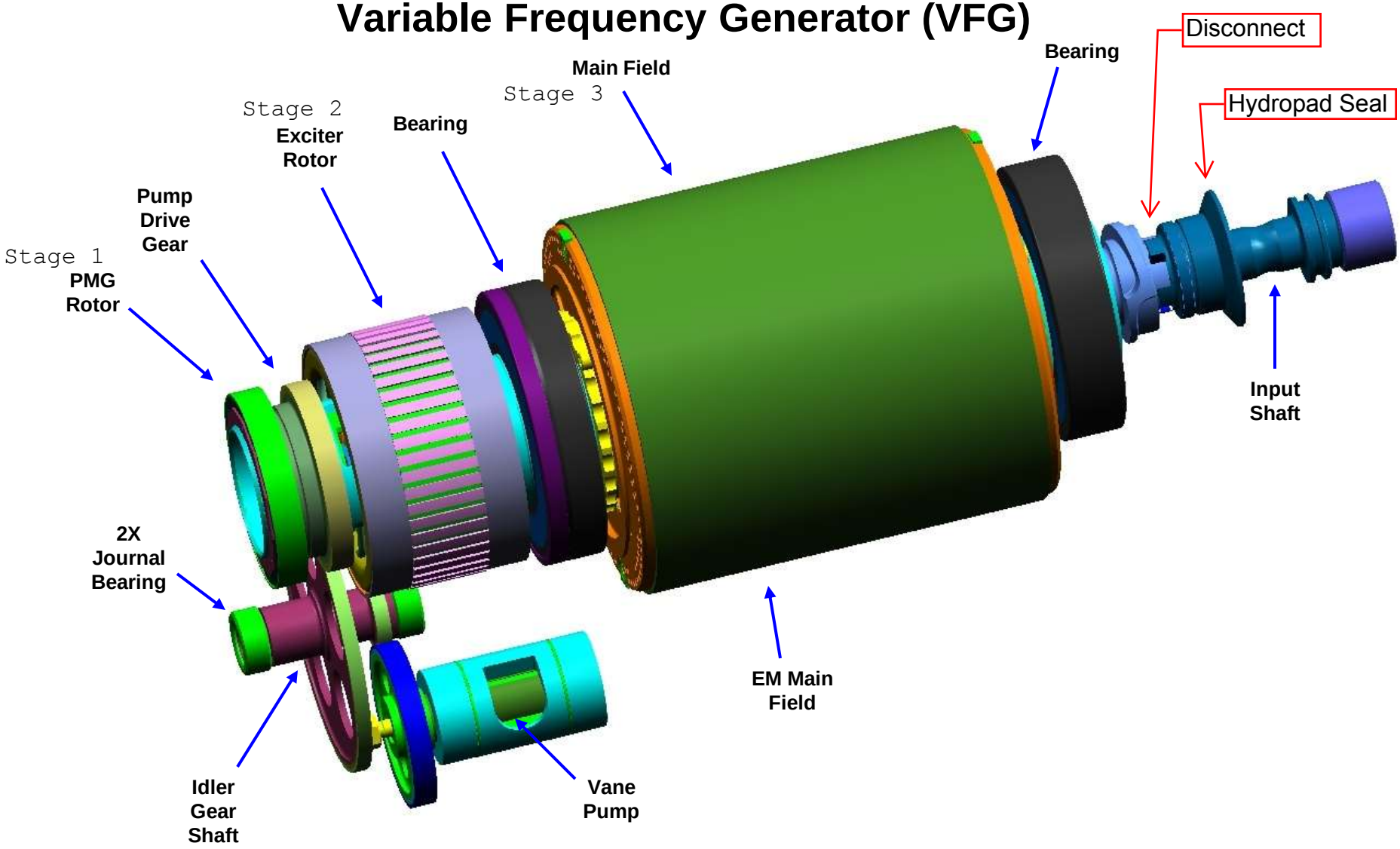
- The generators in the EPGS are ac brushless synchronous variable frequency design. The architecture of each VFG is typical of aircraft generators and consists of 3 stages:
  - 12-pole permanent magnet generator (PMG)
  - 8-pole exciter generator
  - 4-pole main generator

- VFG is driven by the Engine Accessory Gear Box (AGB).
  - When the input shaft is turning, it simultaneously rotates the PMG, exciter and main rotors.
  - The PMG provides raw electric power for internal GCU processing and initiating electric power to the exciter.
  - The exciter provides controlled excitation for the main generator.
  - The main generator produces 3-phase 230 Vac for the aircraft main buses.

- VFG is oil cooled and lubricated, with a closed-loop, internally driven, dedicated oil circuit.

- In addition to creating variable frequency AC power, the VFG contains the following sensors to assist the EPGS control and protection functions:
  - Current Transformers (CT) for Differential Current Protection
  - Disconnect Solenoid
  - Oil Temperature Sensor
  - Low Oil Level Sensor
  - Low Oil Pressure (LOP) Switch
  - Filter Delta Pressure Switch

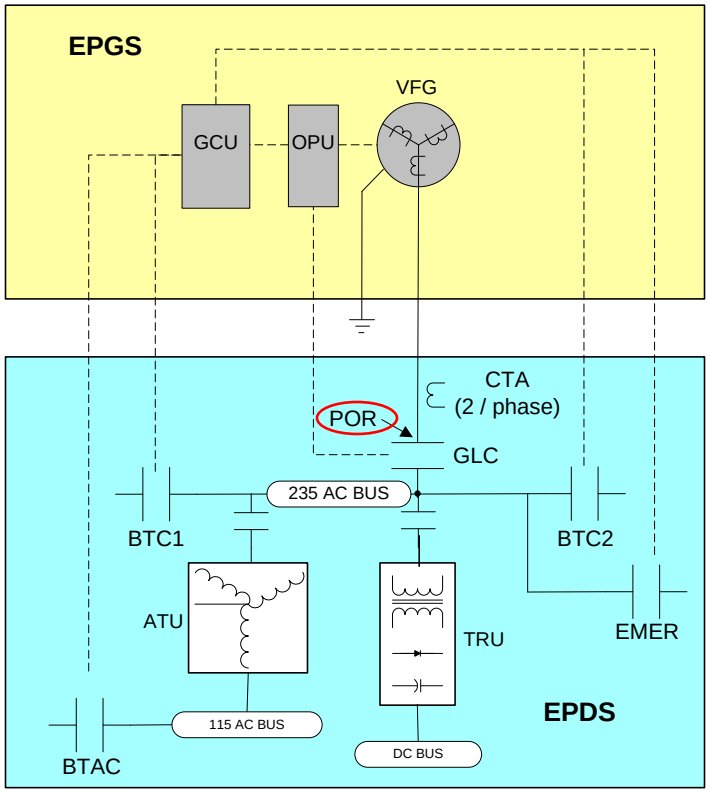
Variable Frequency Generator (VFG)



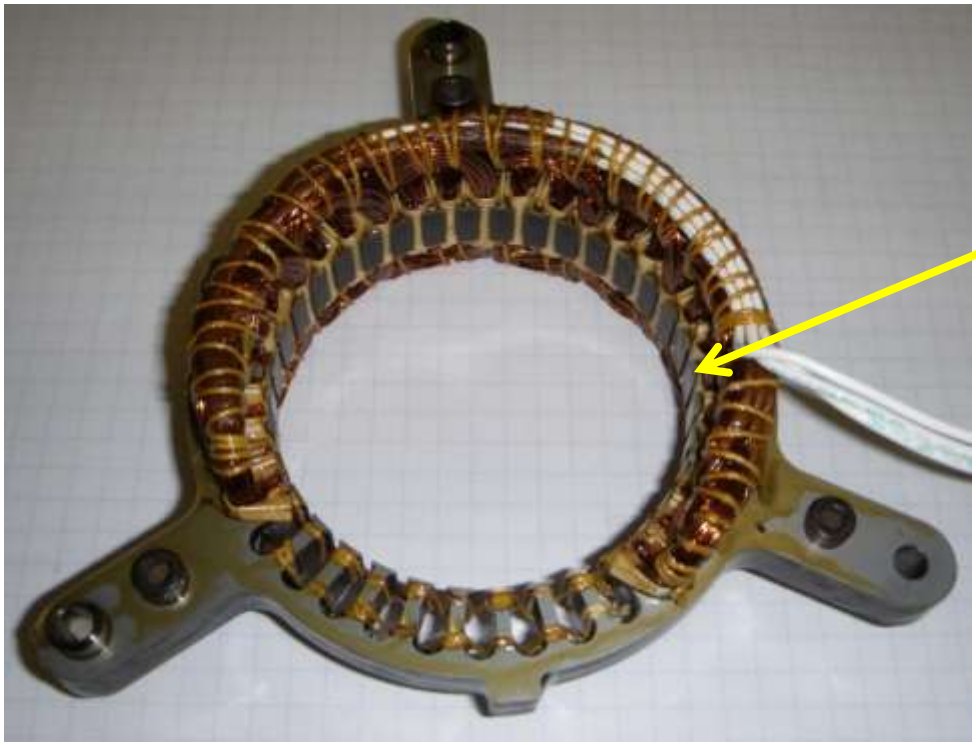
Variable Frequency Generator (VFG)

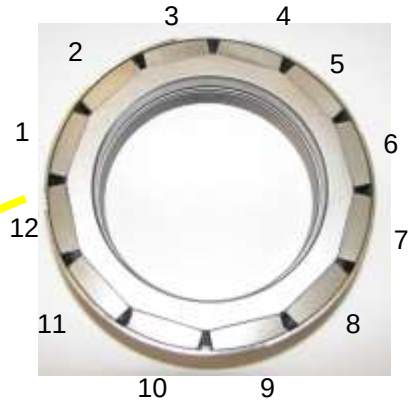
- The Variable Frequency Generator (VFG) provides 3-phase 230 Vac rms L-N variable frequency power at the Point of Regulation (POR) which is located at the power input side of the Generator Line Contactor (GLC).

- Generator uses three stages of generation.
  - First stage is the Permanent Magnet Generator (PMG) which produced power for the GCU and excitation power for the main generator.
  - Second stage is the Exciter Generator which uses regulated power from the PMG to feed the main generator.
  - Main generator uses rectified power from the exciter generator to produce 230 Vac variable frequency power for the aircraft networks.

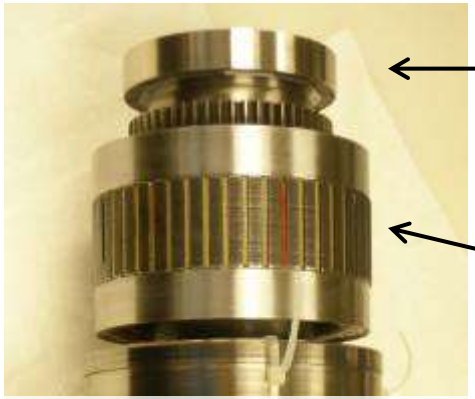


Variable Frequency Generator (VFG)





12-Pole Samarium Cobalt
Permanent Magnet Rotor



PMG

Exciter Rotor

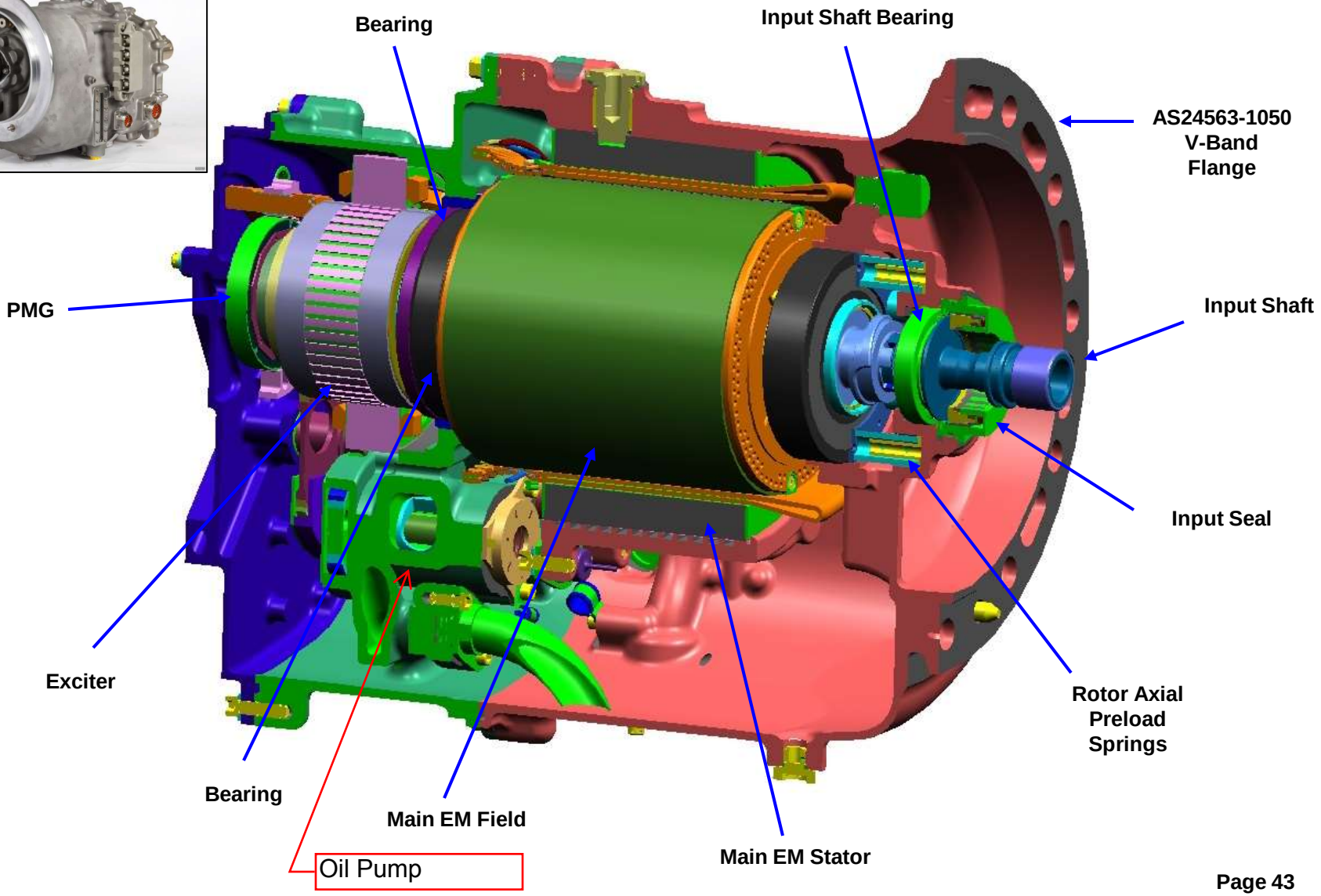
Exciter Stator

Main Rotor

Variable Frequency Generator (VFG)

- The VFG rotor is directly driven from the engine accessory gear box producing a fix ratio of speed to frequency. The higher the input speed from the engine, the higher the frequency the VFG will produce.

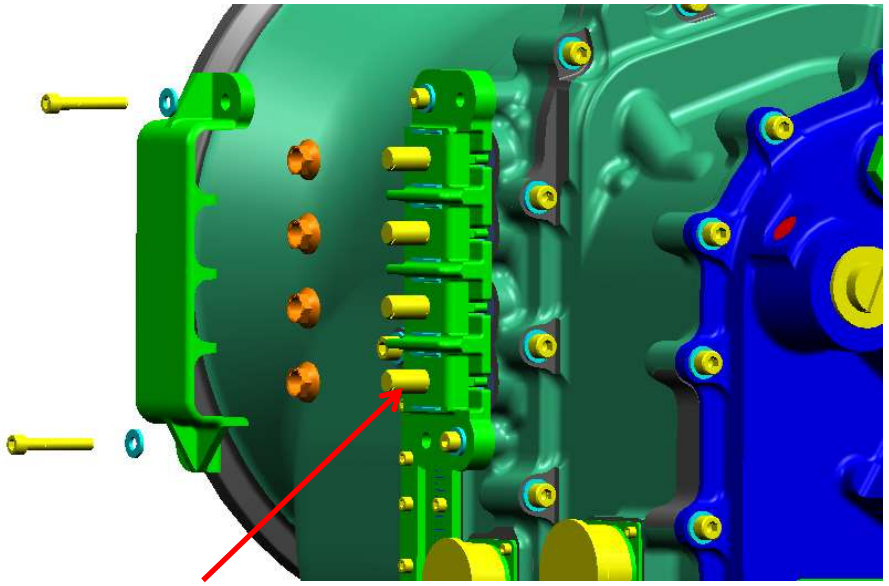
Frequency POR Equivalent	Input Shaft speed, RPM
867	26,000
800	24,000
360	10,800
330	9,900



Terminal Block

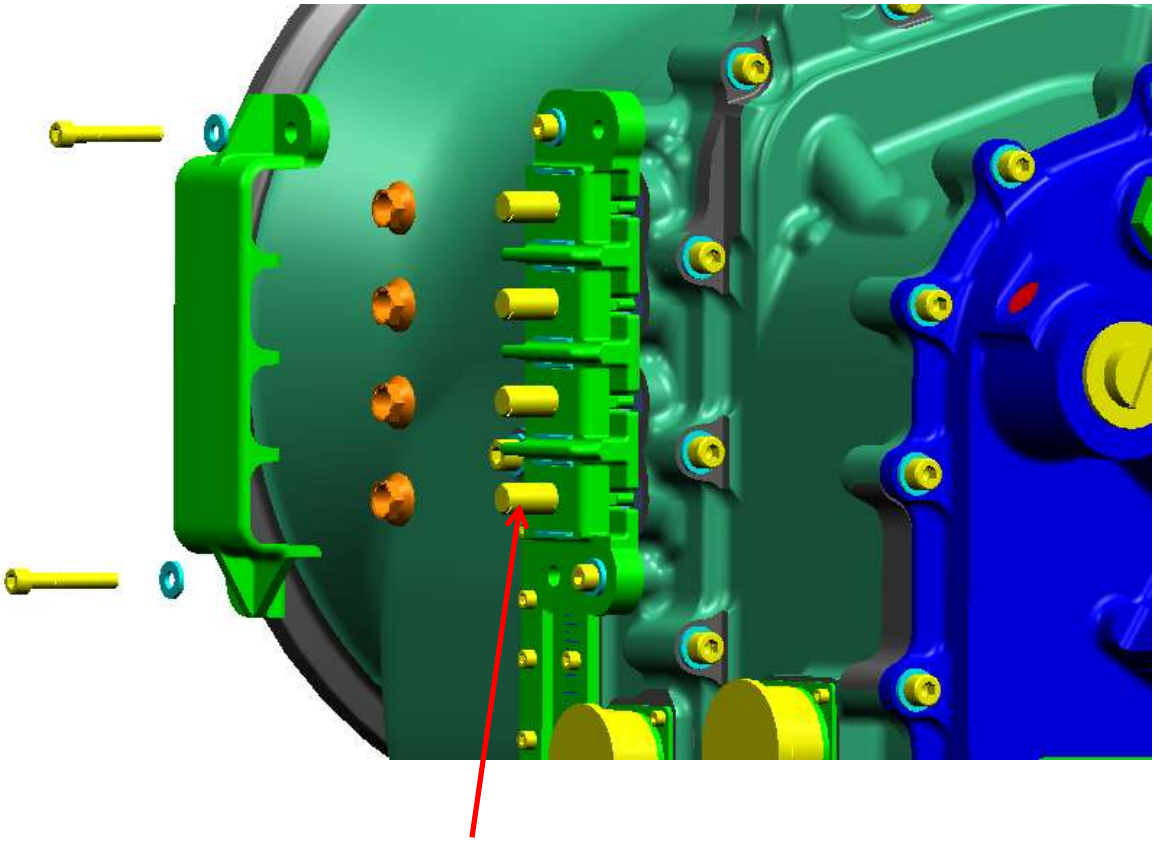
- Ultimately, the 230 Vac power is available at the terminal block studs. There are four studs, one for each of three phases (A, B, C) and neutral.

- Aircraft feeders connect to the studs to carry power from the VFG to the electrical buses.



Terminal Block Studs

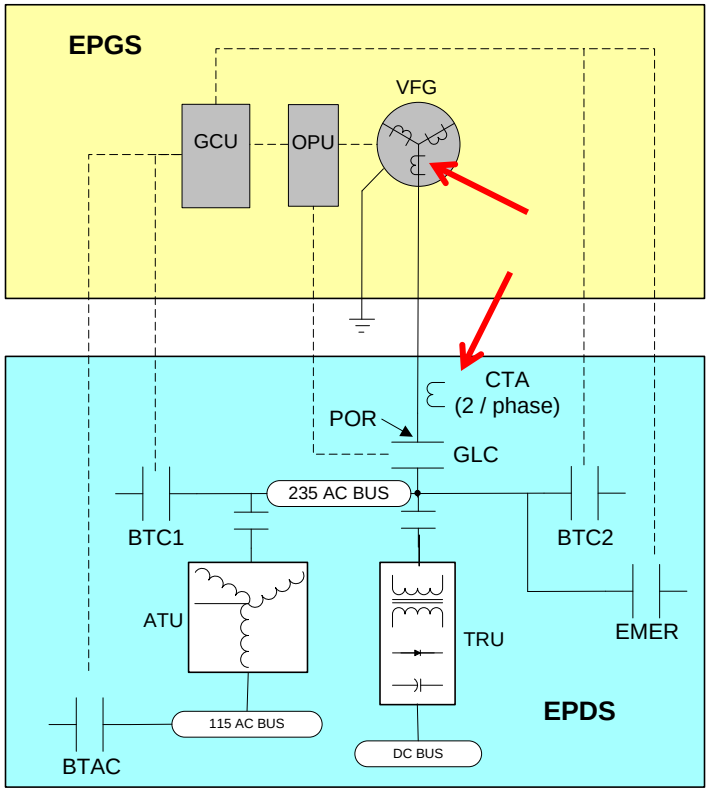
Terminal Block



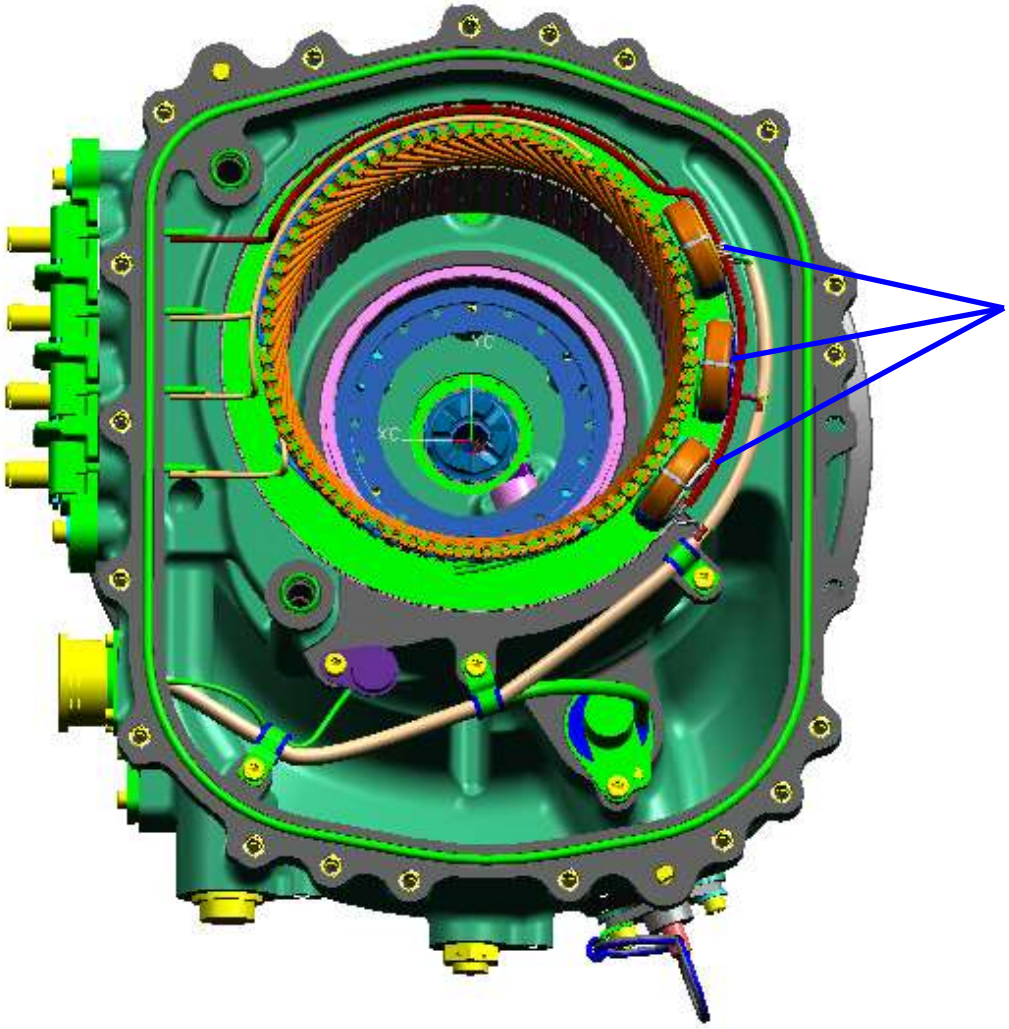
Current Transformers

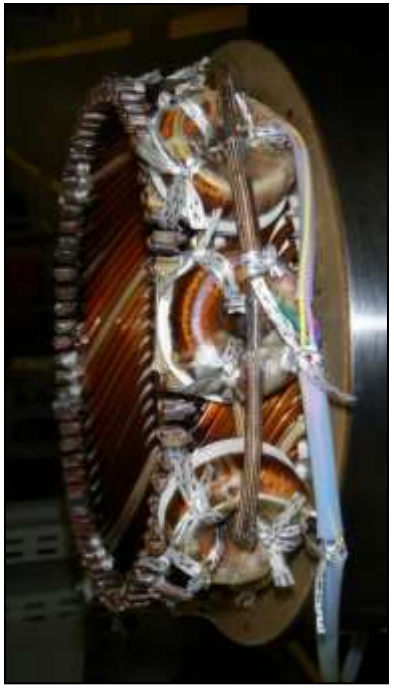
- Current transformers (CT) are passive electronic devices that are use to monitor current or load levels on each power phase from the VFG.

- The aircraft uses a second set of current transformers (line CTs). The output of these two measurements is compared to provide protection against feeder faults.



Current Transformers



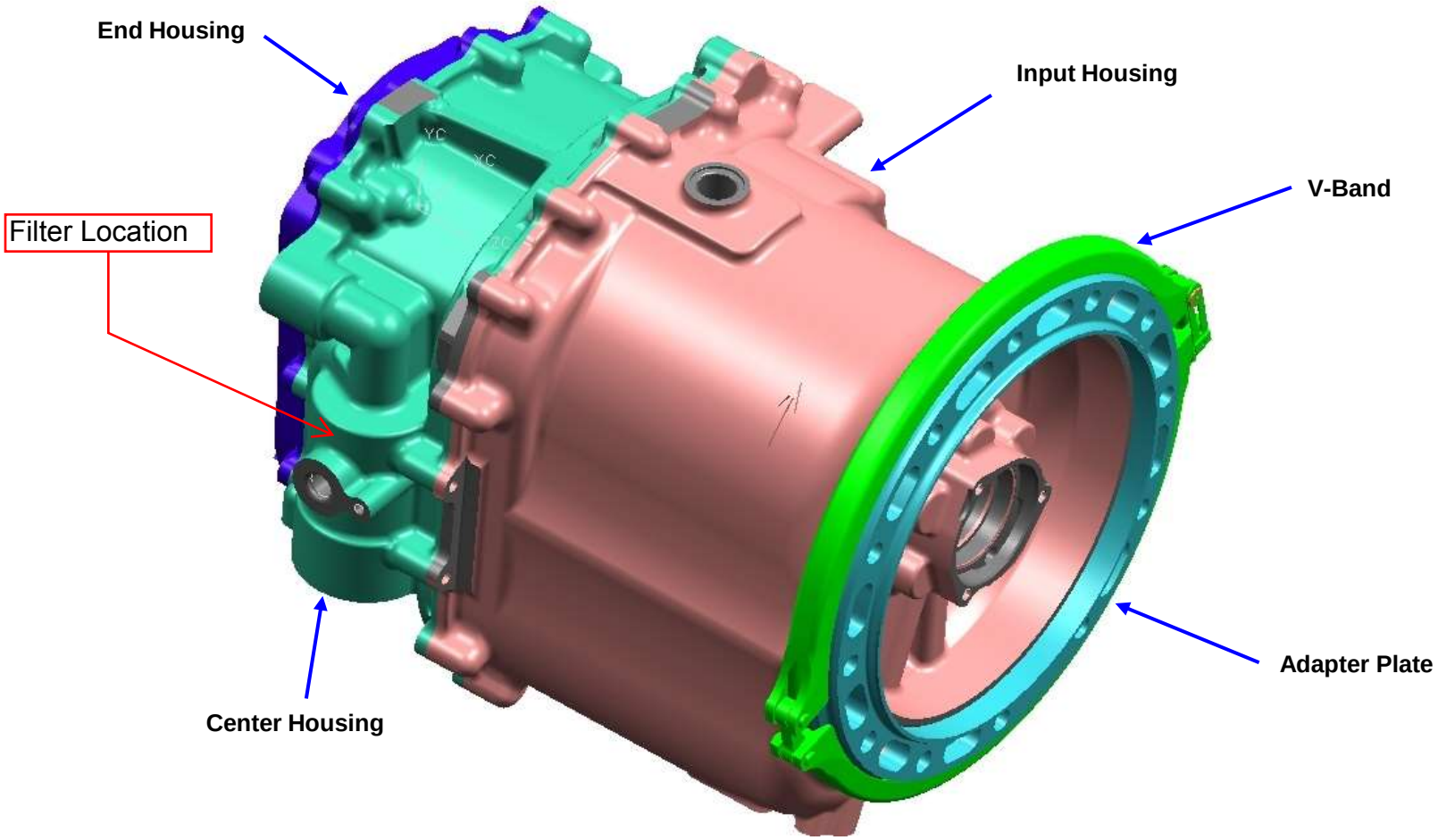


Variable Frequency Generator (VFG)

- The VFG is constructed with three housings:
  - End Housing
  - Center Housing
  - Input housing

- Mounting
  - VFG input housing features a v-shaped rim which mates to the adapter plate.
  - The adapter plate is mounted to the engine accessory gear box.
  - A V-band clamp secures the to V-featured surfaces together to mount the VFG to the engine gear box.

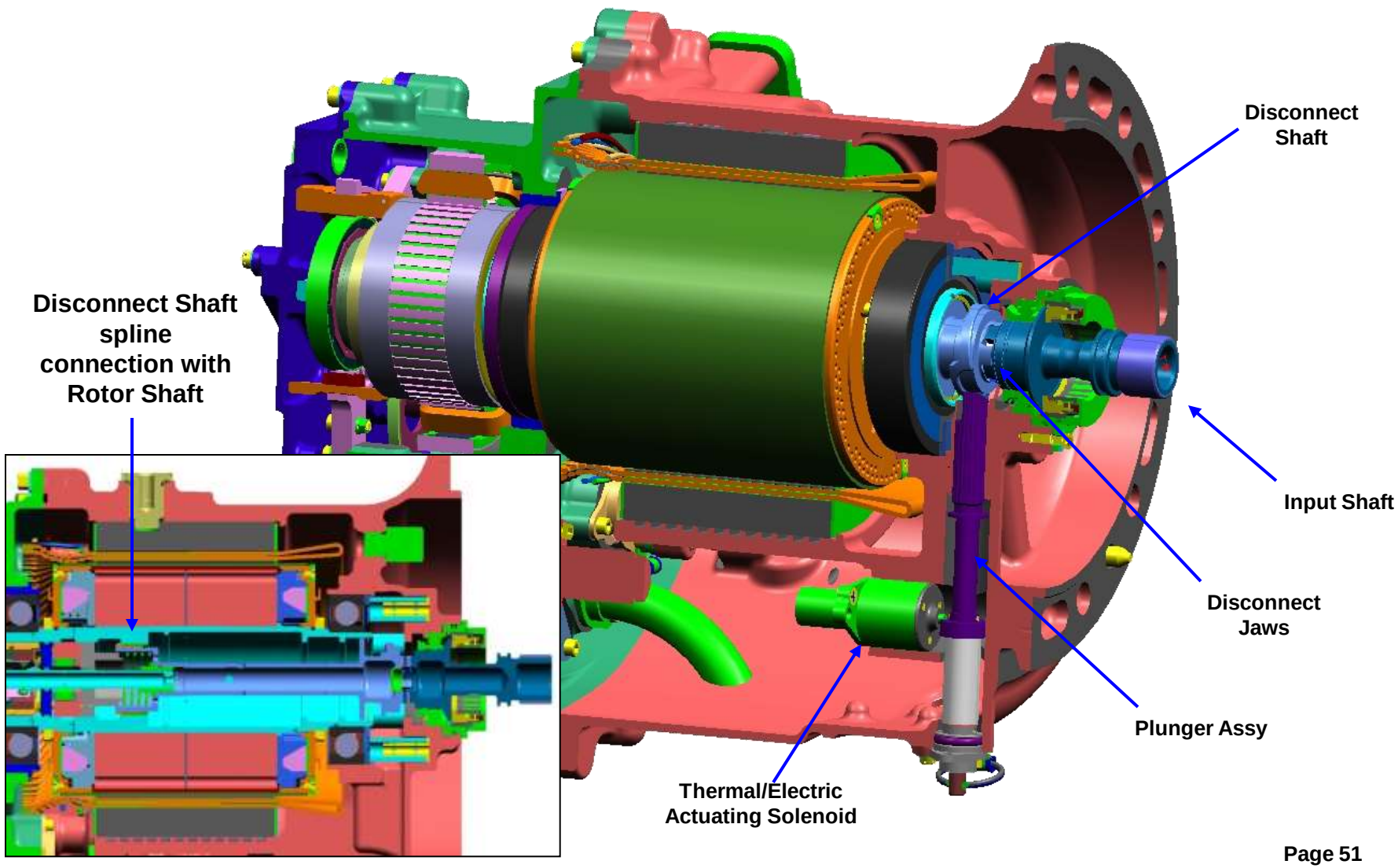
VFG Housings



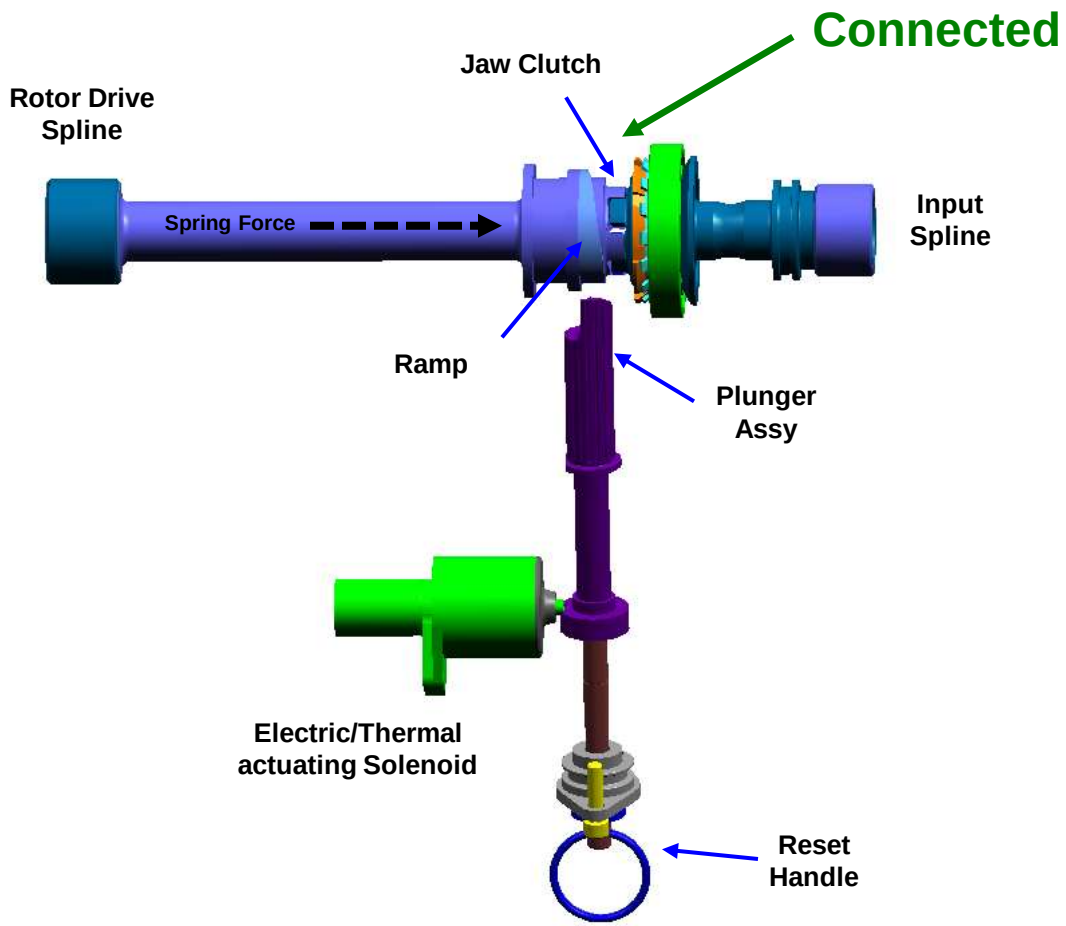
VFG Disconnect Spline Shaft

- In order to facilitate a mechanical disconnection capability, the VFG incorporates an internal intermediate shaft that turns the rotor. On one end, this shaft has dog teeth that mate with the input shaft. These teeth become separated (no longer interface) when the VFG is disconnected. On the opposite end, deep in the VFG rotor, there is a spline connection that permits axial movement to allow the dog teeth to separate during disconnection.

VFG Disconnect Hardware

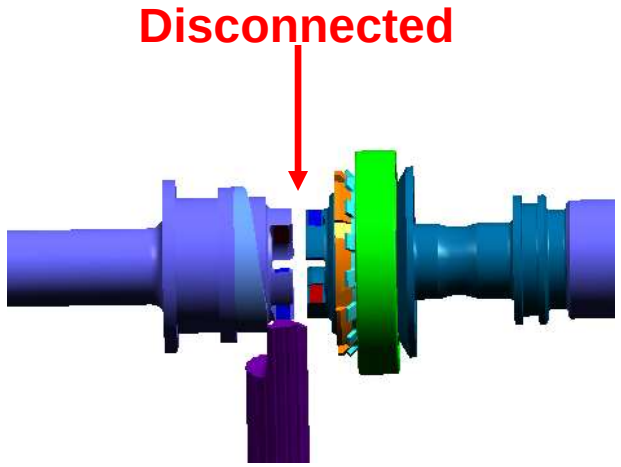


VFG Disconnect Spline Shaft



When connected, the rotational energy from the gear box is transmitted to the VFG to produce power.

When Disconnected, the input shaft only rotates, the generators does not rotate. The VFG is offline for the remainder of the flight. There is a 50FH limit in this condition.

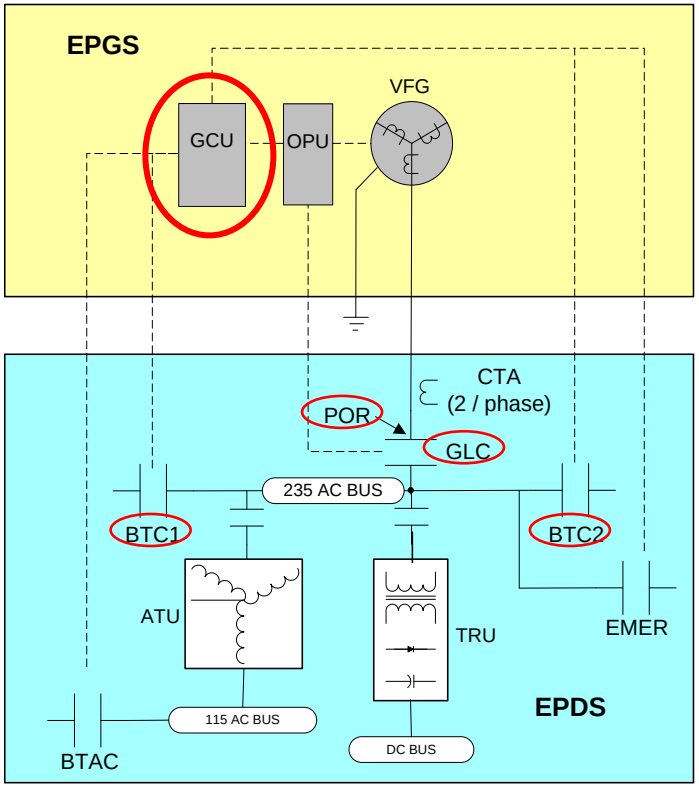


Airbus A350 XWB Electric Power Generation System

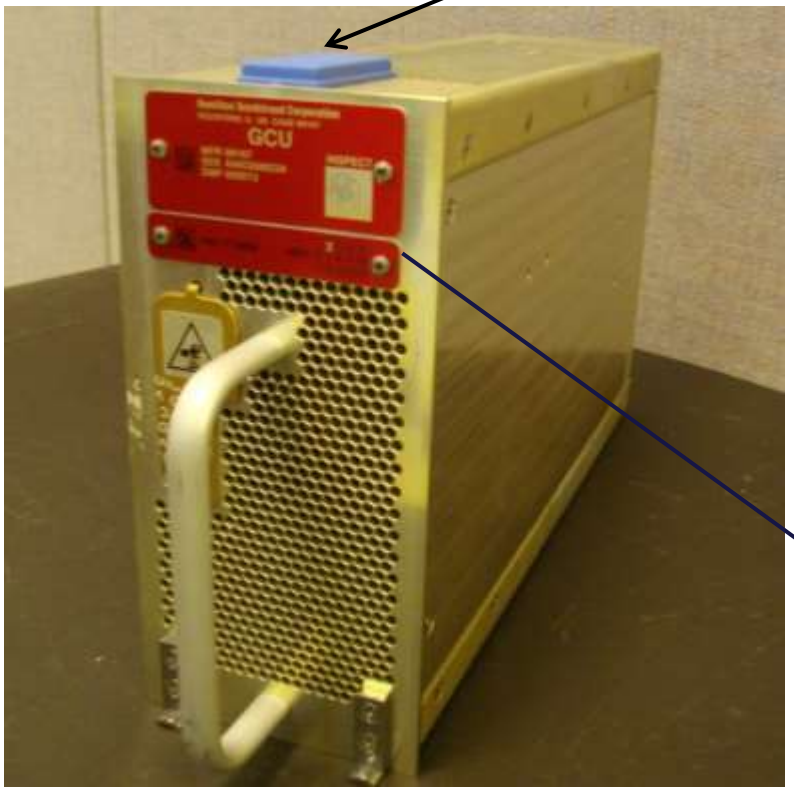
Module 3 - Electric Power Control & Generator Control Unit (GCU)

Generator Control Unit (GCU)

- Each GCU provides the following:
  1. Microcontroller-based control, protection, communication, and BITE
  2. DSP voltage regulation and fault current limiting for the generator
  3. The GCU controls the VFG to provide nominal 3-phase 230 Vac rms L-N voltage at the Point of Regulation (POR) located at the power input side of the Generator line contactor (GLC)
  4. Protection for the generator, associated power feeders, and associated bus
  5. Control of the associated GLC
  6. Control of the adjacent bus tie contactors (BTC)
  7. Support of airplane health management functions

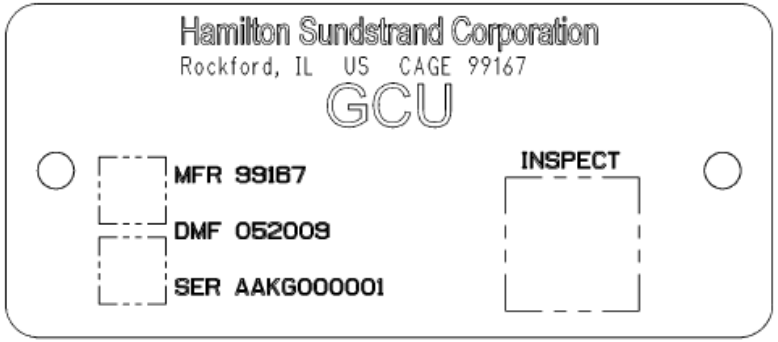


GCU Identification



The GCU includes an RFID (radio frequency identification) tag that enables RFID technology to interrogate essential data such as the part number and serial number information of the GCU remotely.

Nameplate



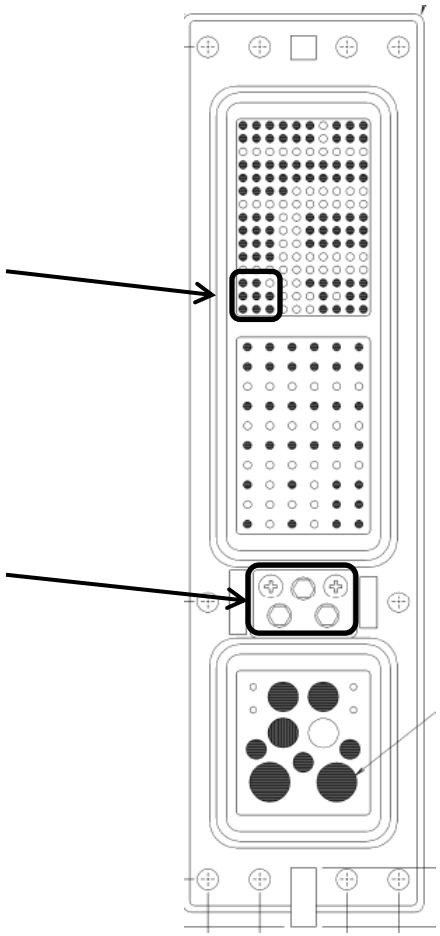
Amendment (mod) plate

GCU Installation Keying & Pin Programming

- The Pin Programming feature and connector keying prevent the GCU from being operated in an incorrect rack position on the aircraft.

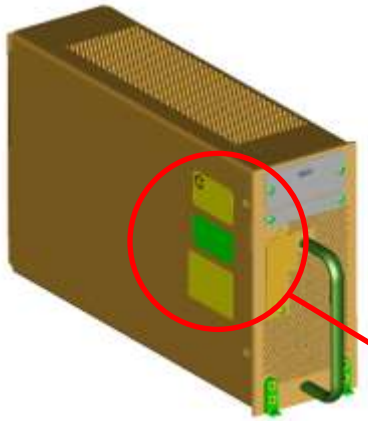
- **Pin Programming**
  - The GCU senses aircraft pin programming to define
    - Aircraft type
    - Engine type
    - EPGS channel number (1 through 4)

- **GCU Keying**
  - The GCU back connector incorporates keying that prevents installing an incorrect device in the GCU mounting rack.



Keyed for installation

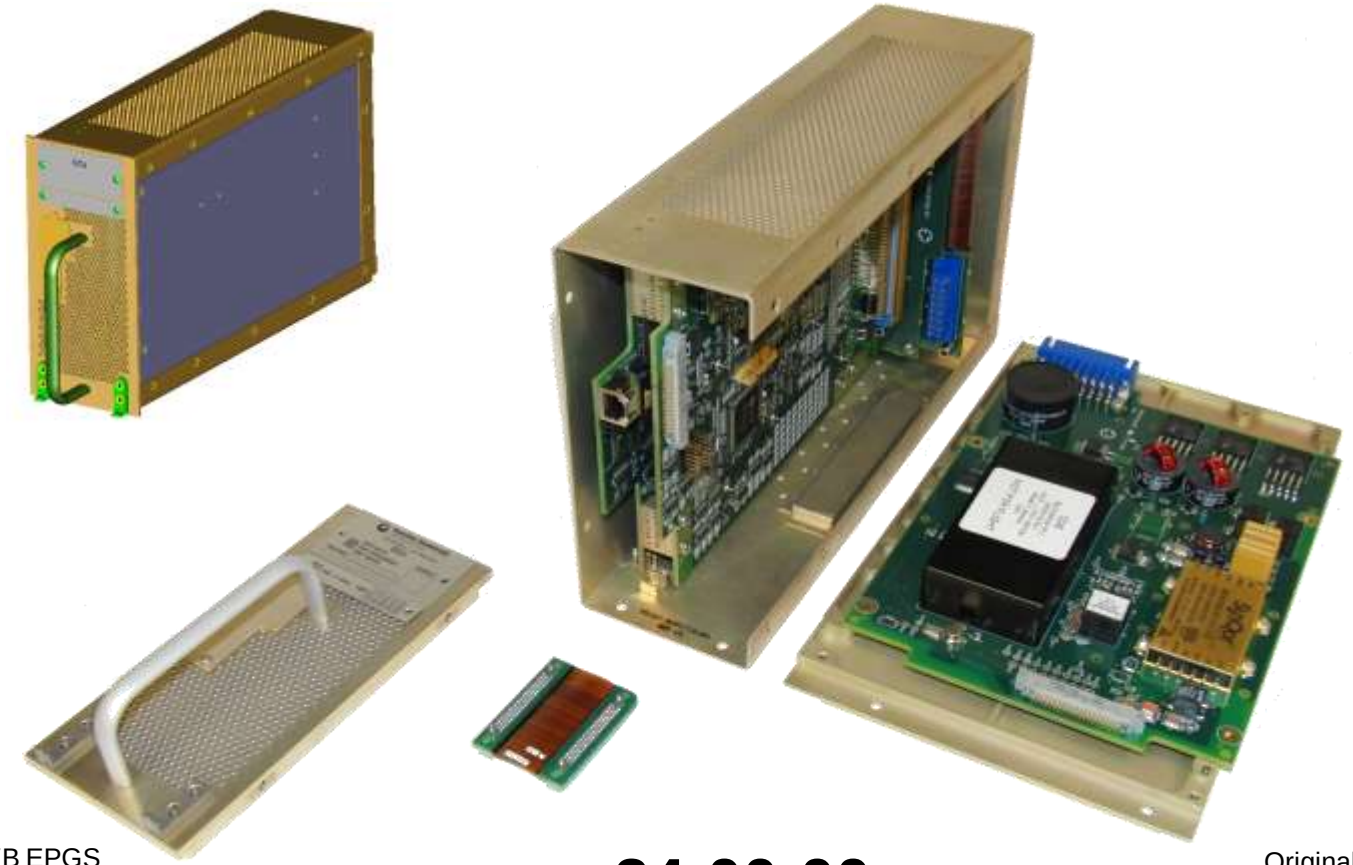
Warning Labels



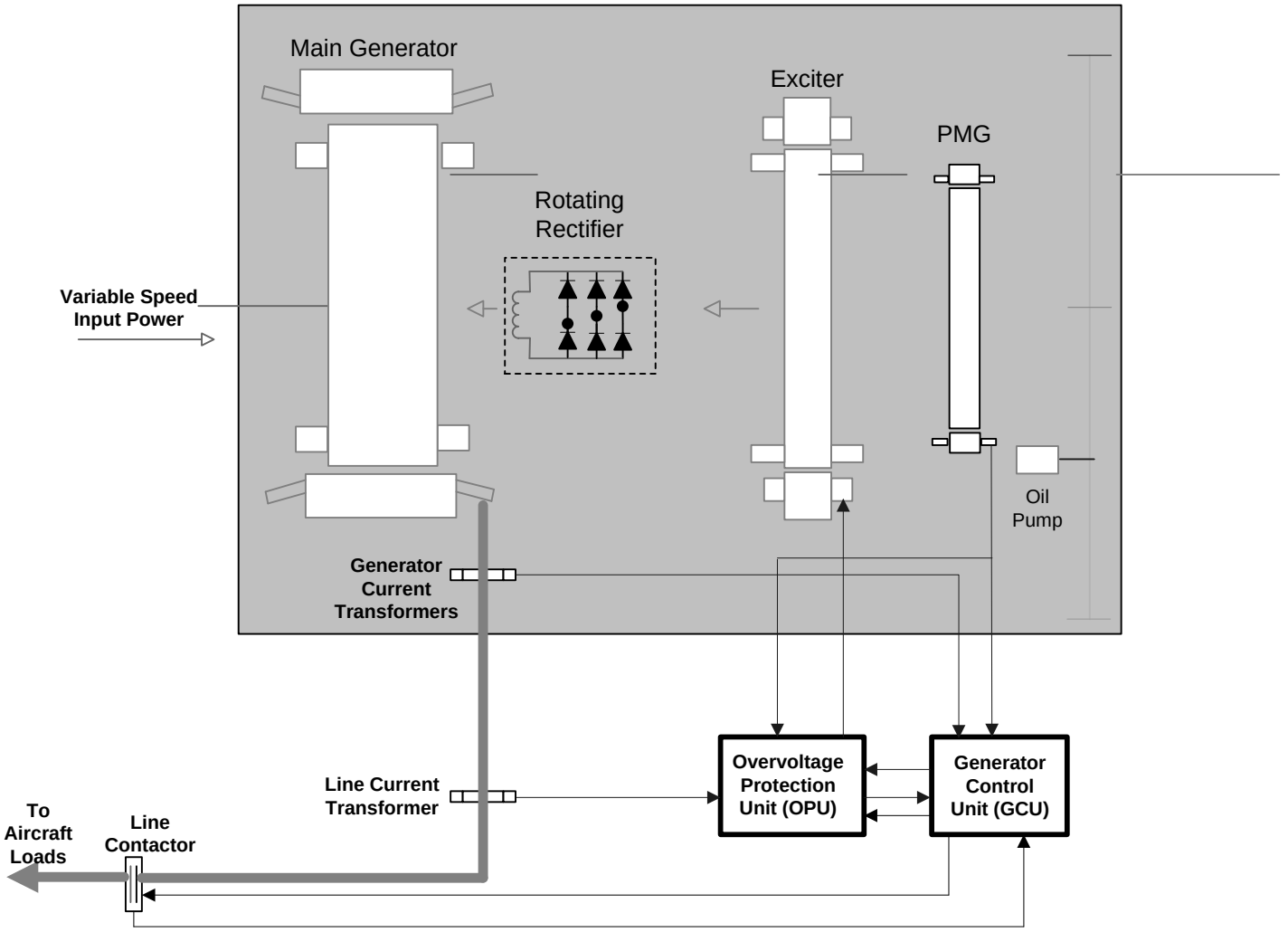
- The GCU contains warning labels for three hazards
  - Electrostatic sensitivity
  - Hot surfaces
  - Electric shock
- For protection of oneself and the equipment, always follow the cautions listed in the Aircraft Maintenance Manual

GCU Construction & Cooling

- The GCU is efficiently constructed.
  - It features a side wall that also serves as a heat sink.
- GCU Cooling
  - Heat sink panel
  - Forced air flow direction will be from the bottom to the top of the GCU ARINC 600 enclosure.



EPGS Single Channel VFG Block Diagram



Electric Power Control & Generator Control Unit (GCU)

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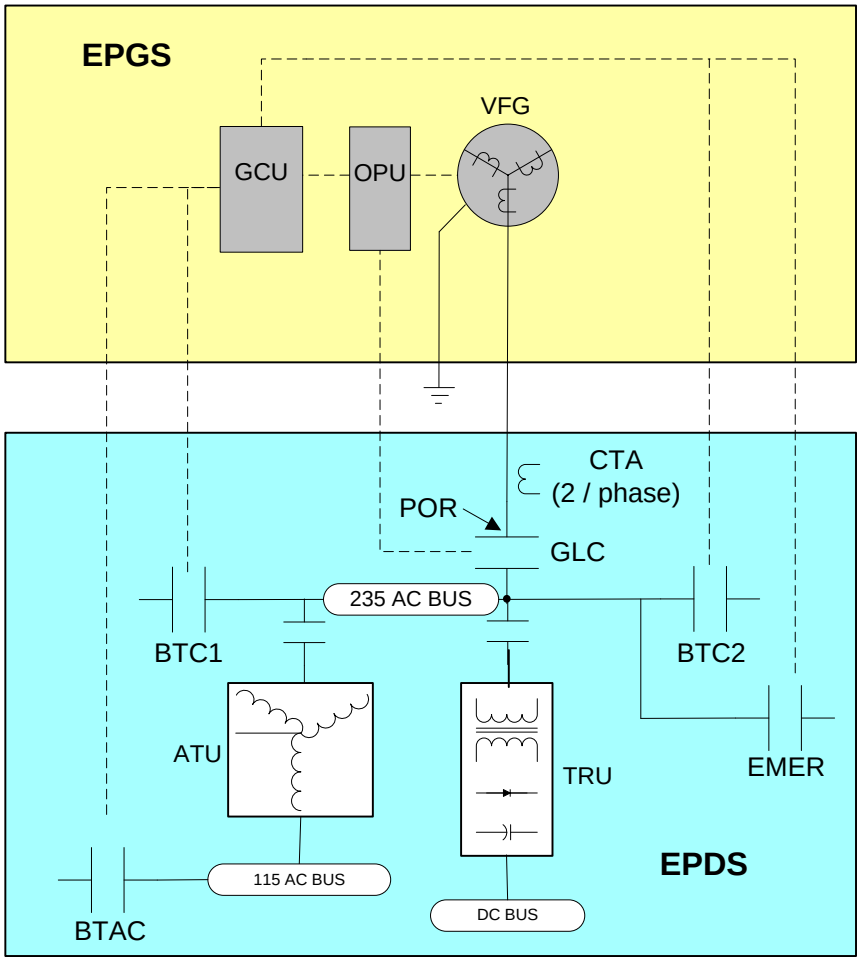
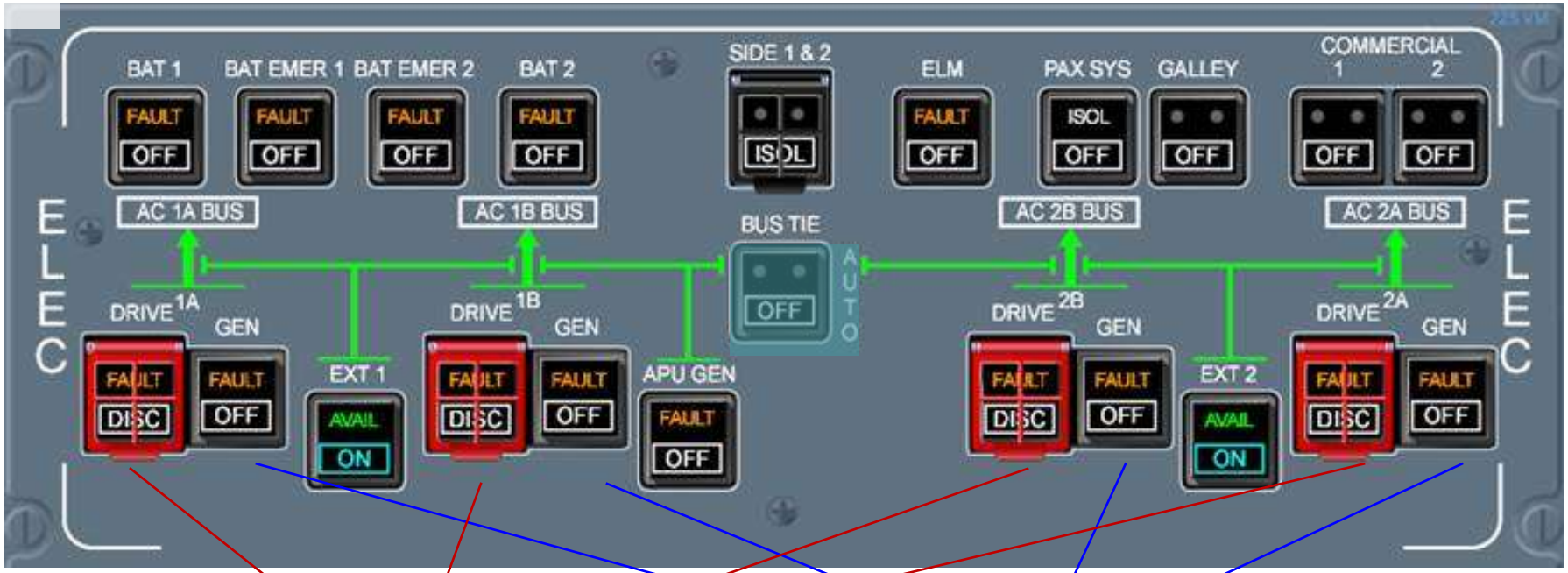
Airbus A350 XWB Electric Power Generation System

Module 4 - Normal Operations

EPGS Single Channel Architecture



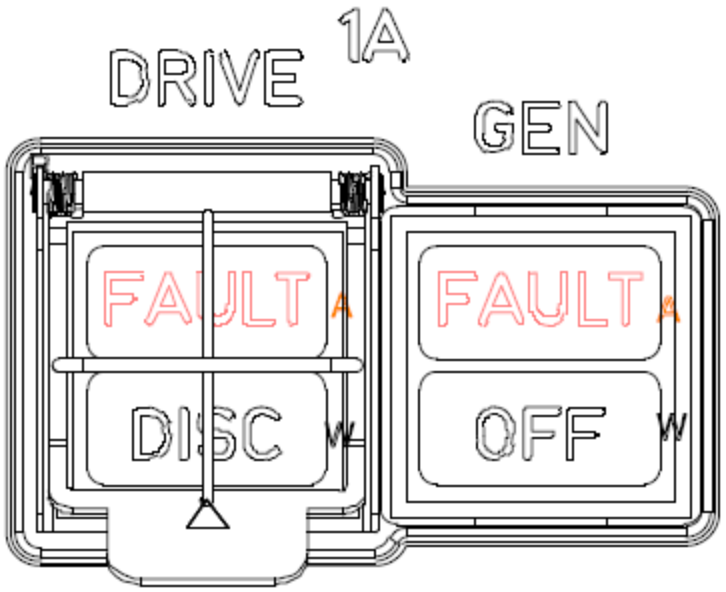
Overhead Electrical Panel



Guarded VFG "DRIVE" (Disconnect) Switches **"GEN" Control Switches ("GCS")**

Generator Control Switch

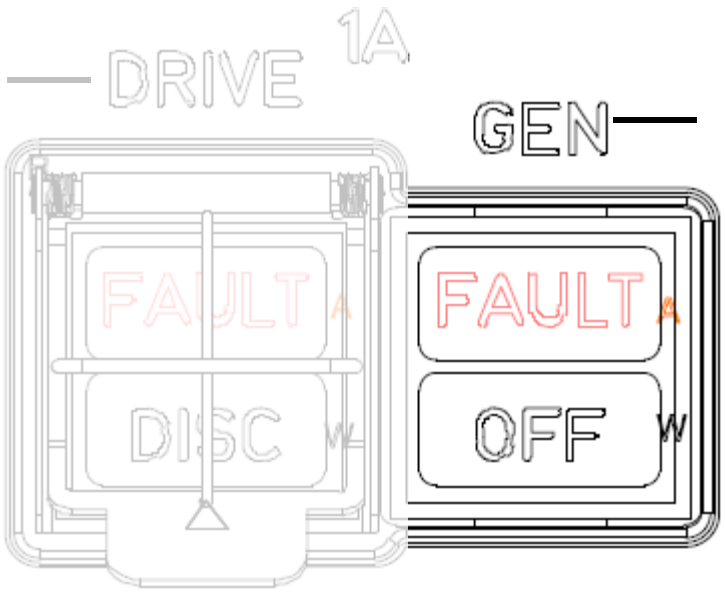
- The generator (GEN) control switch (GCS) controls the generator control relay which connects excitation power to the exciter stator.
- The amount of exciter power depends on the channel loading at any given time. If the GCS is placed in the out/off position, the GCR is opened and generator excitation stops. The electrical channel is no “offline.”
- When the GCS is in an "**ON**" (or indeterminate) state and the EPGS channel is **NOT** supplying power to the aircraft, the GCU turns on the amber “FAULT” lamp in the GEN pushbutton switch (by setting the "GEN_FAULT_LT" GND/Open discrete output to true).



Generator Control Switch

MECHANICAL DISCONNECT VFG SHAFT

(may require VFG removal)



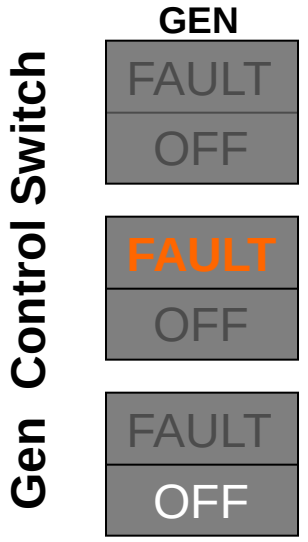
ELECTRICAL-DE-ENERGIZE GENERATOR

(no effect on mechanical rotation)

NORMAL "CONNECTED" INDICATION

VFG LOW OIL PRESSURE OR HIGH OIL TEMP
(Lift guard and press to disconnect VFG)

CONFIRMED VFG DISCONNECT
(Cannot be reconnected in flight)

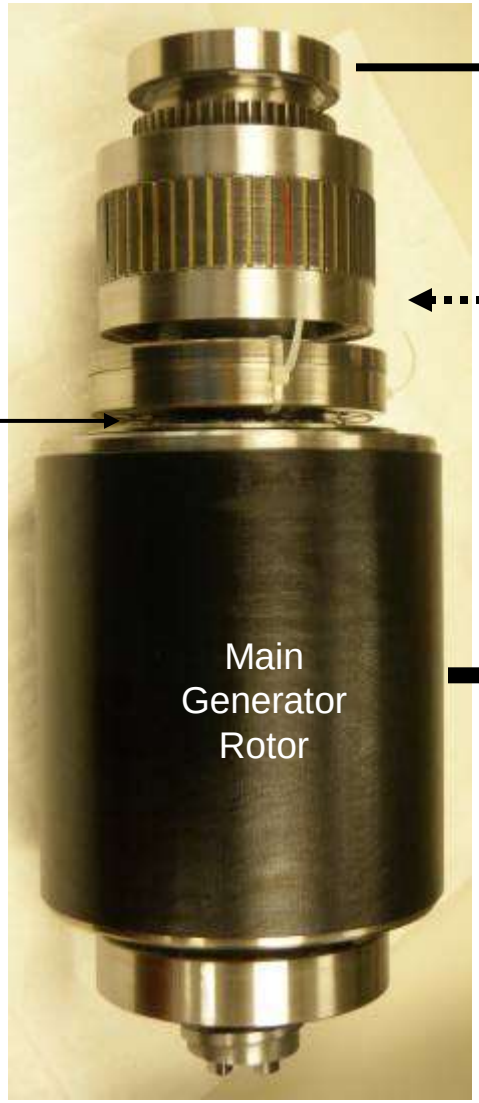


NORMAL INDICATION (Latched-in position)

GENERATOR PROTECTION TRIP (Push twice to reset)

GENERATOR OFF (Push once to turn on)

Voltage Regulation



Rectifier (Diode Package Assembly--Internal)

OPU

GCU

PMG

Rectifier

HVPS

Exciter Generator

OPU GCR

GCR

Rectifier

HVPS

PWM

28Vdc

Internal 28Vdc

Generator Control Relay

28V Backup

GEN

FAULT

OFF

FAULT

OFF

FAULT

OFF

POR SENSE

230Vac Aircraft Power

GLC

BTC

TIE BUS

AC BUS

Normal Operations

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Airbus A350 XWB Electric Power Generation System

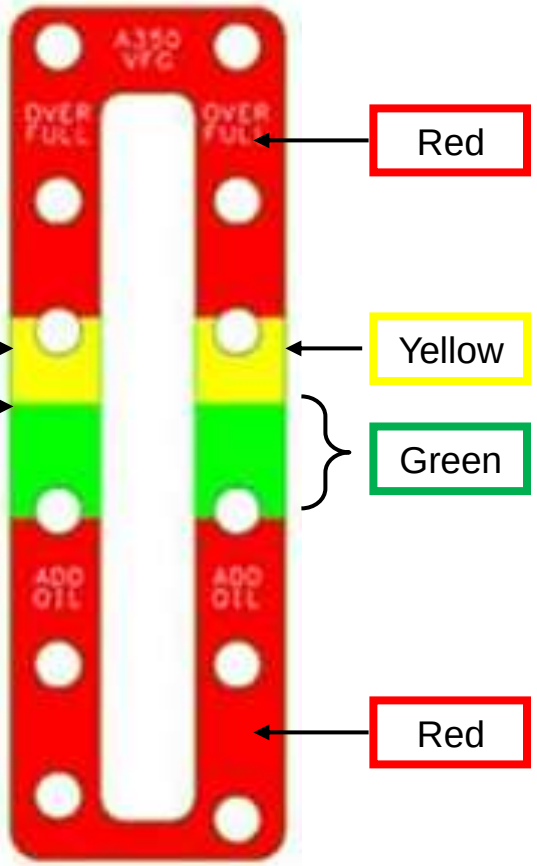
Module 5 - Abnormal Operations & Overfrequency Protection Unit (OPU)

VFG Sight Glass Configuration

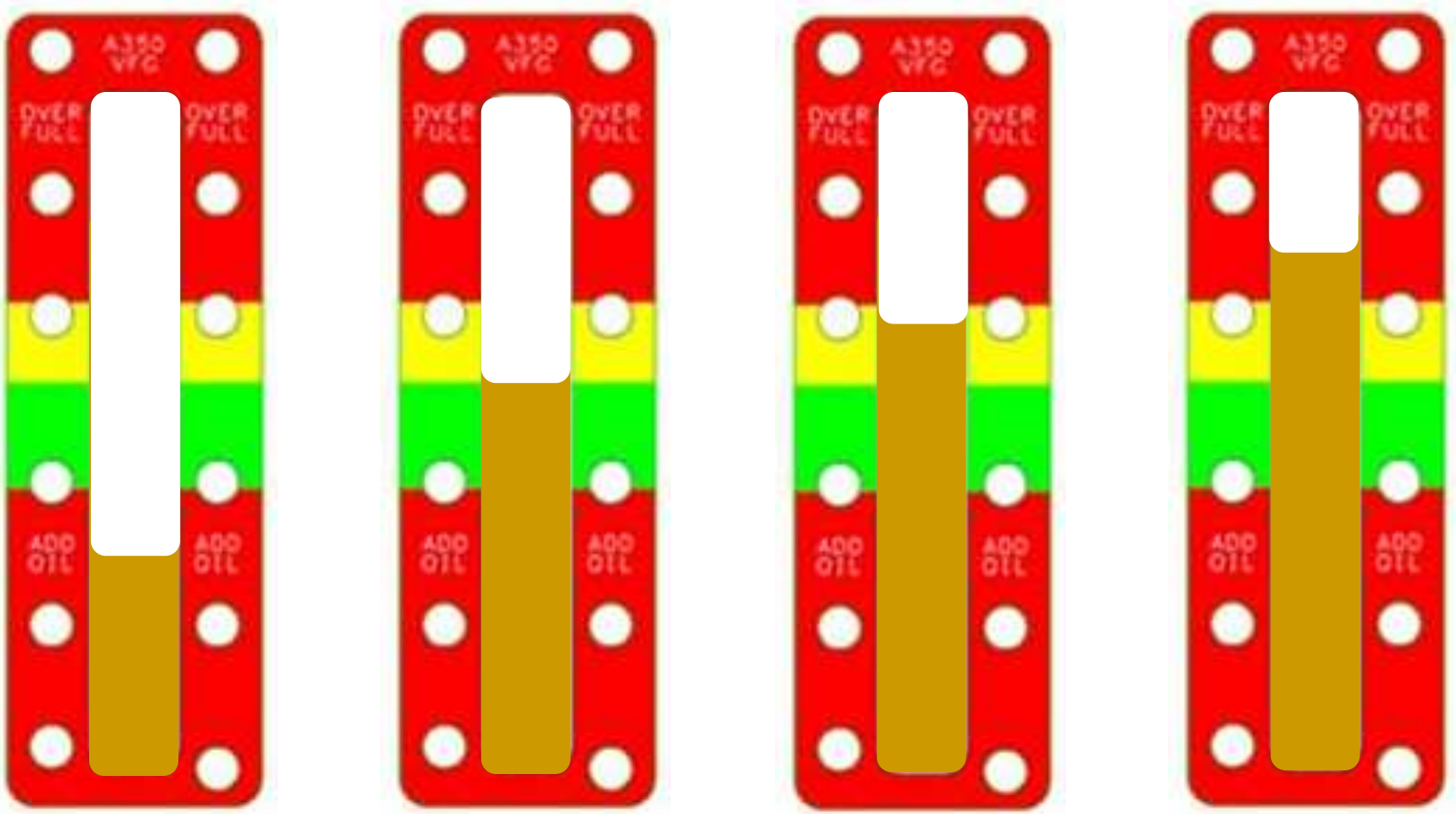
- A sight glass is provided to indicate the VFG oil level.
- Allow at least 10 minutes after engine shutdown for the oil to settle (to prevent an artificially low reading as the oil settles in the VFG housing).
- The aircraft should be within the ground normal attitude.
  - Pitch ± 1.9°
  - Roll ± 0.5°
- Follow AMM Task.

If **hot**, oil level may increase to the yellow band.

Proper VFG servicing brings oil level to the top of the green band.



VFG Sight Glass Indications



ADD Oil

Good :-)

with warm Oil = OK

Over Full

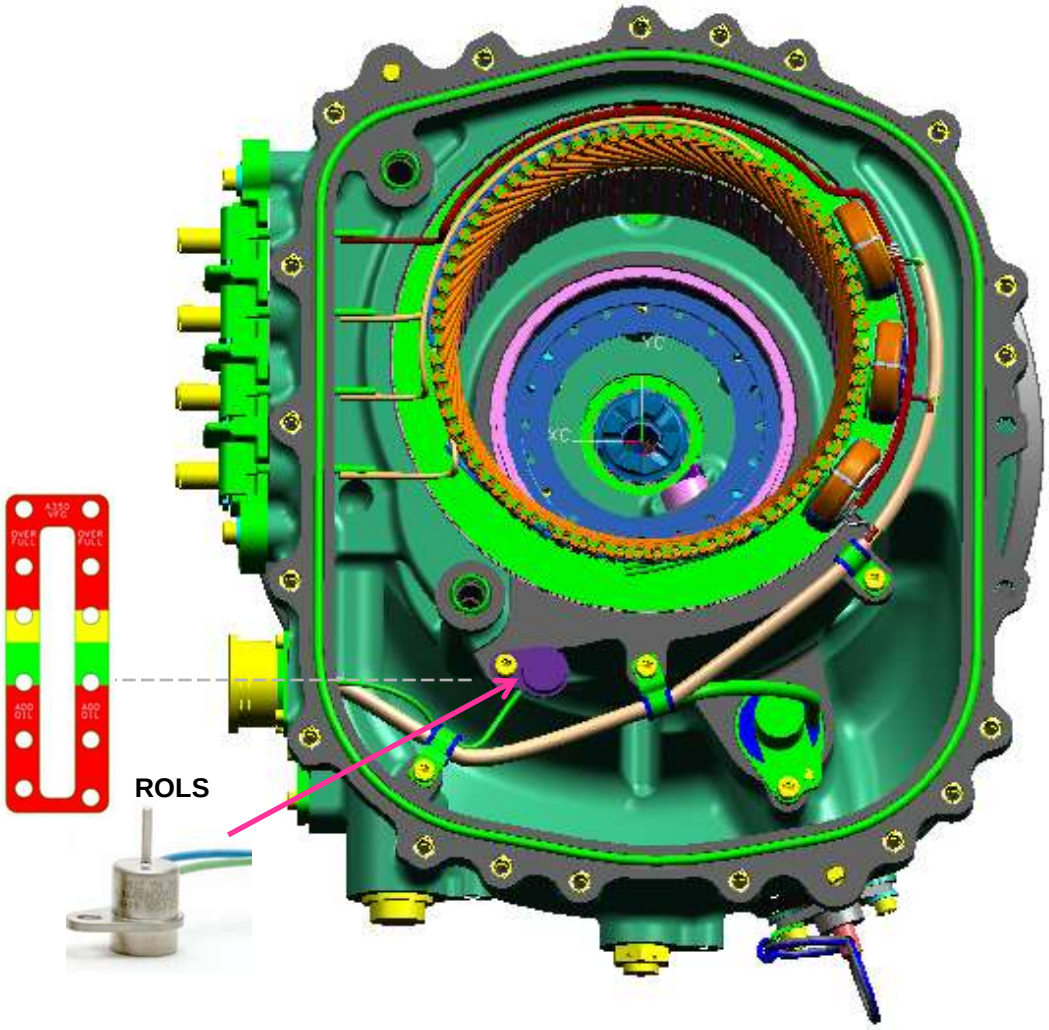
Remote Oil Level Sensing (ROLS)

- The GCU performs a remote oil level sense function after all the following conditions remain present for 6 +/- 0.5 minutes (ROLS measurement condition):
  - Valid engine speed indication in ARINC 429 message "Input Speed" is below equivalent VFG input shaft speed of 200 rpm OR Valid PMG frequency measurement is less than 900 +/- 6 Hz (300Hz POR equivalent)
  - Both ARINC 429 "TOW/NOT TOW" messages (side 1 and 2) indicate "NOT TOW" or invalid
  - Valid ARINC 429 "Engine Crank" message indicates "Not Active" OR ARINC 429 "Engine Crank" message is invalid
  - Discrete signal "Engine shutdown" indicates "Engine Shut down“
  - ROLS failure is not detected
  - No Low Oil Level status has been detected
  - 28V back-up supply voltage exceeds 21V.

- **NOTE**: ROLS measurement is performed when the GCU is supplied power *exclusively* from the 28V back-up supply.

- ROLS function:
  - The GCU applies current excitation to the VFG Remote Oil Level Sensor upon detection of the ROLS measurement condition.
  - The GCU reads 2 samples of the voltage across the sensor 1 +/- 0.1 seconds after applying the current excitation to the VFG Remote Oil Level Sensor, then calculates and stores the 2 sample average value.
  - The GCU reads 2 samples of the voltage across the sensor 30 +/- 0.1 seconds after applying the current excitation to the VFG Remote Oil Level Sensor, then calculates and stores the 2 sample average value.
  - The GCU removes current excitation to the VFG Remote Oil Level Sensor after completion of the paired readings.
  - The ROLS paired readings are taken at 6 +/- 0.5 minute intervals as long as the ROLS measurement condition is present.

Remote Oil Level Sensing (ROLS)



The GCU performs a remote oil level sense function after all the following conditions remain present for 6 +/- 0.5 minutes (ROLS measurement condition):

- ✓ Valid engine speed OR Valid PMG frequency measurement to confirm VFG not running
- ✓ Both side 1 and 2 indicate "NOT TOW" or invalid
- ✓ Valid "Engine Crank" message indicates "Not Active" or invalid
- ✓ Discrete signal "Engine shutdown" is TRUE
- ✓ 28V back-up supply voltage (only present) and exceeds 21V
- ✖ ROLS failure is not detected
- ✖ No Low Oil Level status has been detected

- ➢ The GCU compares voltage readings across the sensor before and after a 30-second stimulation to determine if the oil level is normal or low.
- ➢ The ROLS paired readings are taken at 6 +/- 0.5 minute intervals as long as the ROLS measurement condition is present.

VFG Low Oil Pressure

Subject to Change

- **Oil Pressure Sensor**
  - VFG incorporates a low oil pressure sensor, which will detect a low oil pressure condition.
  - Pressure sensor opens an electrical switch at oil-in pressures above 50 ± 10 psig. and closes at oil-in pressures below 30 ± 10 psig.

- **Time delay**
  - There is a 30 sec. time delay for the Low Oil Pressure fault, which starts only after the VFG input speed has exceeded 10,800 rpm.
  - The 30 sec. oil warm-up period is reset by the VFG input speed transitioning below 10,000 rpm.

- **The low oil pressure fault is inhibited when**
  - Manual Disconnect status is true.
  - The underfrequency condition is true.
  - The manually initiated Fire Trip Request is indicating engine fire.
  - The Engine Shutdown Switch is indicating an engine shutdown.

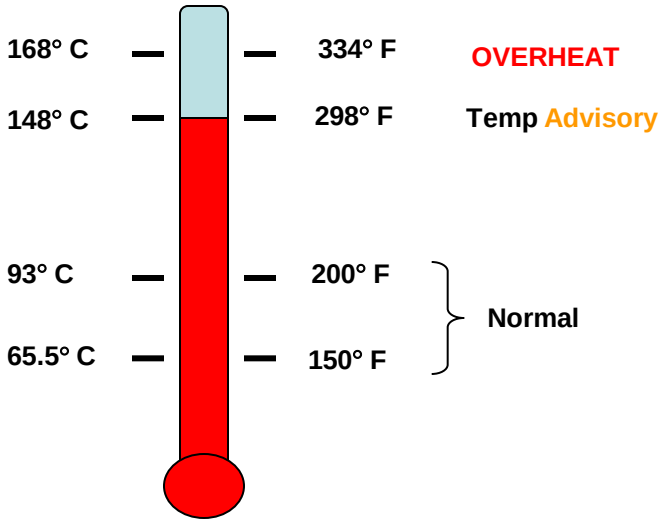
- **Flight deck effects**
  - When an LOP condition is TRUE, the FAULT lamp is illuminated in the **DRIVE** pushbutton switch.
  - This condition calls for the crew to disconnect the VFG to prevent further mechanical damage to the VFG.

- **Aircraft Messages**:
  - **ECAM**:
    - ELEC DRIVE 1A(1B)(2B)(2A) MECH FAULT
  - **DM**:
    - ELEC DRIVE 1A(1B)(2B)(2A) DISCONNECTED

      or
    - ELEC DRIVE 1A(1B)(2B)(2A) DISC STS UNKNOWN
      - (Procedure for ECAM requires DISC, hence DM)

Oil System Monitoring

- **Oil Temperature Sensing**
  - The generator incorporates an oil temperature bulb that monitors the VFG oil-out temperature for conditions that would be detrimental to the VFG.

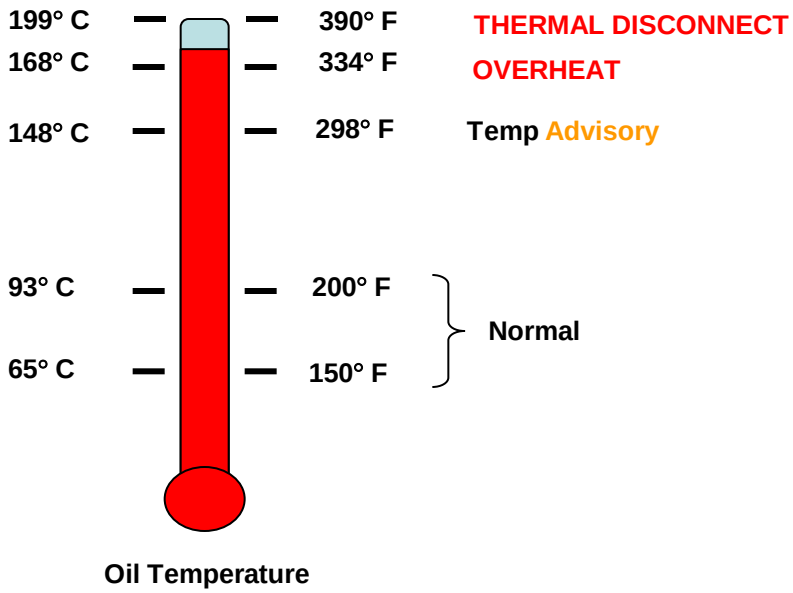


Oil Temperature

- **Oil Overtemperature *Advisory***
  - The overtemperature advisory information is obtained by monitoring the VFG temperature bulb.
  - The High Oil Outlet Temperature Advisory indication is **annunciated** when the Oil Outlet Temperature exceeds **148** -4/+26°C (291 to 345°F).
  - The High Oil Outlet Temperature Advisory indication is **cleared** when the Oil Outlet Temperature falls below **141** -4/+26°C (279 to 333°F).
  - The High Oil Outlet Temperature Advisory is inhibited/and reset by a Temperature Sensor Bulb Failure.

Oil System Monitoring

- **Oil Overtemperature *Warning***
  - When the oil-out temperature **exceeds 168** -4/+26°C (327 to 381°F) for 2 +0/-0.1 seconds, an Oil Overtemperature Warning is annunciated with the ECAM message "VFG Overheat."
  - The Oil Overtemperature condition is **inhibited** by a Temperature Sensor Bulb Failure.
  - The Oil Overtemperature Warning is **reset** by:
    - a Temperature Sensor Bulb Failure.
    - oil-out temperature is less than 141 -4/+26°C (279 to 333°F)
  - The **Temperature Sensor Bulb Failure** is established by the temperature measurements below -70ºC or above 250ºC.
  - If the temperature continues to rise reaching 199°C, a thermal disconnect will occur
  - **Messages**:
    - **ECAM**:
      ELEC DRIVE 1A (1B)(2B)(2A) OIL OVHT
  - **Messages**:
    - **DM**:
      ELEC DRIVE 1A(1B)(2B)(2A) DISCONNECTED
      or
    - ELEC DRIVE 1A(1B)(2B)(2A) DISC STS UNKNOWN
      - (Procedure for ECAM requires DISC, hence DM).



Oil System Monitoring

Filter Delta Pressure Switch P/N 5910157

- A Filter Delta Pressure switch, installed in the VFG cooling oil circuit, monitors filter pressure drop due to an abnormal quantity of particles accumulating in the filter, which may indicate a progressing failure condition.

- Filter Delta Pressure Switch conditions include:
  - PMG frequency is greater than 300 ± 1 Hz (POR equivalent)
  - VFG oil temperature is greater than 56 -4/+26°C (133 -7/+47°F)
  - No Fire Trip Request
  - No Filter Delta Pressure Switch fault
  - No Temperature Sensor Bulb Failure
  - Engine is not shutdown

- The Filter Delta Pressure Switch **closes** (to GND) an electrical switch at 78 psid maximum on increasing pressure in the 10 to 121°C (50 to 250°F) temperature range.
- The Filter Delta Pressure Switch **opens** at 56 ± 4 psid on decreasing pressure in the 60 to 70°C (140 to 158°F) temperature range.

- A Filter Blocked fault is **set** when a Filter Blocked condition is present for a period exceeding 10 ± 1 seconds.
- A Filter Delta Pressure Switch fault is **reset** by a Cold Start (It may also be reset from a maintenance access screen).

- Messages:
  - **ECAM**:
    - ELEC DRIVE 1A (1B)(2B)(2A) OIL FILTER CLOGGED
  - **DM**:
    - ELEC DRIVE x FILTER CLOGGED

Low Oil Pressure

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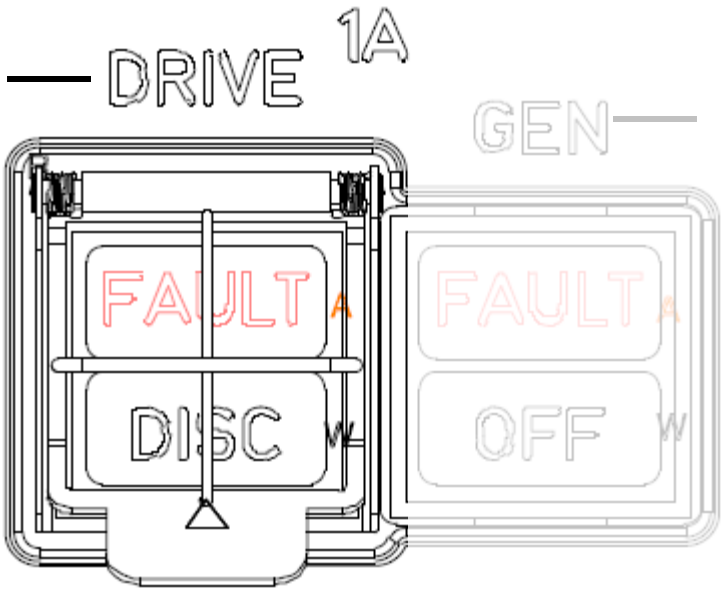
MECHANICAL DISCONNECT VFG SHAFT

(may require VFG removal)



ELECTRICAL-DE-ENERGIZE GENERATOR

(no effect on mechanical rotation)

Disconnect Function

- **VFG Disconnects**
  - The VFG is capable of mechanical disengagement from the gear box which stops the generator from rotating.
  - **All dynamic (rotating) mechanical disconnects require the VFG to be removed** from the aircraft and not reset until the hardware has been inspected by an approved repair facility.

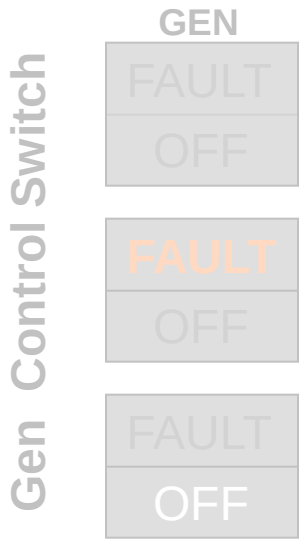
- **Disconnect Request**
  - A disconnect request is initiated by the pilot lifting the guard and pressing the DRIVE pushbutton switch.
  - Upon sensing the pilot pressing the DRIVE pushbutton switch, the GCU removes GLC coil power, VFG excitation while energizing the VFG disconnect solenoid.

- **Ground Disconnect checks**
  - Static disconnect checks of the VFG are used to verify the functionality of the disconnect system upon VFG installation.
  - During this process, the disconnect mechanism will be exercised, but the mated shafts that carry gear box rotation will not separate.
  - Following the static disconnect, the VFG reset ring must be pulled to reset the VFG prior to engine start in order to prevent VFG damage which may occur during an engine start with the VFG disconnected statically.

NORMAL "CONNECTED" INDICATION

VFG LOW OIL PRESSURE OR HIGH OIL TEMP
(Lift guard and press to disconnect VFG)

CONFIRMED VFG DISCONNECT
(Cannot be reconnected in flight)



NORMAL INDICATION (Latched-in position)

GENERATOR PROTECTION TRIP (Push twice to reset)

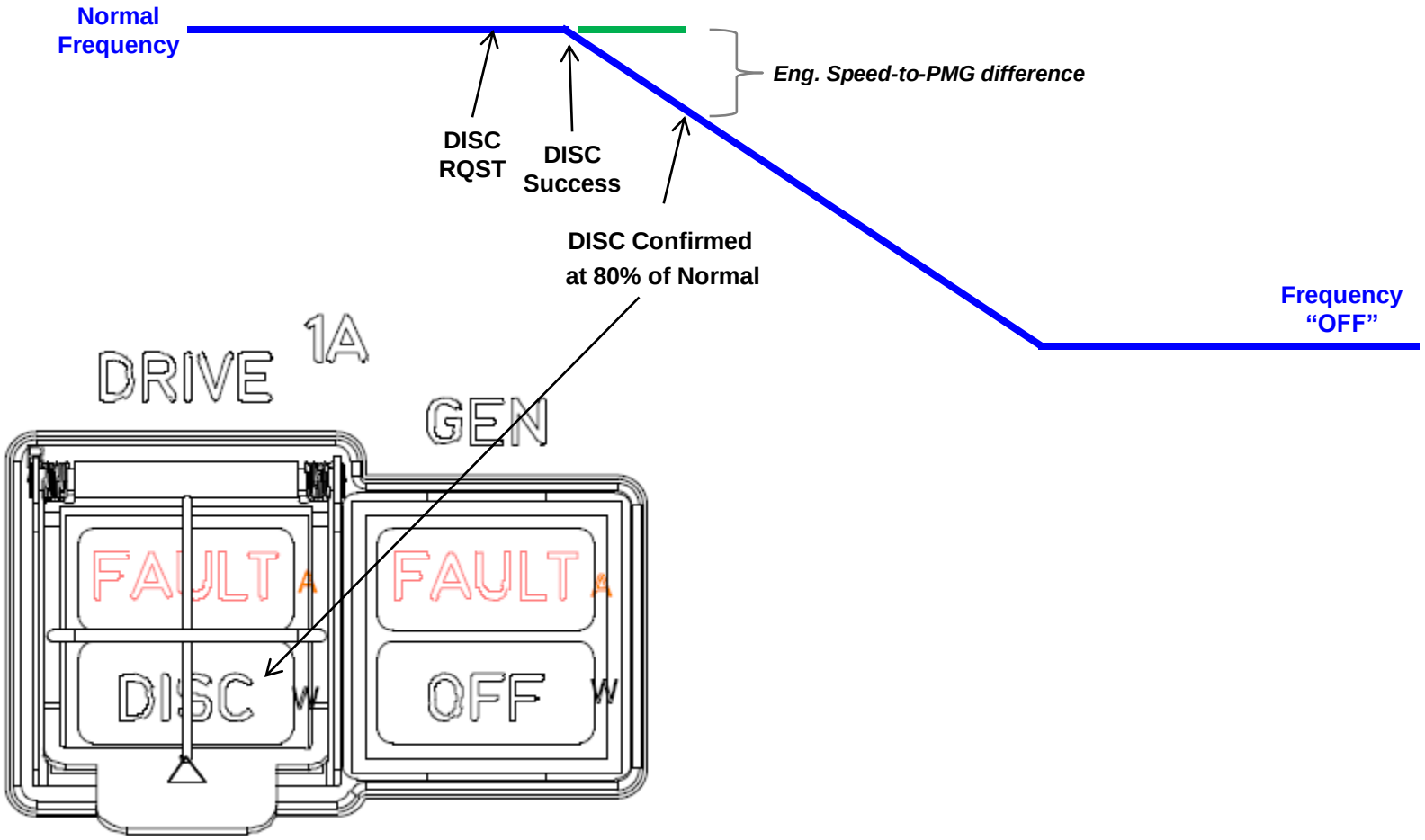
GENERATOR OFF (Push once to turn on)

Disconnect Function

- **Disconnect Confirmation**
  - A Disconnect condition is detected, when
    a) GCU senses the "DISC_REQUEST" momentary pulse **AND**
    b) PMG frequency is lower than 80% of the equivalent engine speed as delivered by ARINC 429 message ("Input speed").
  - A Manual Disconnect status is latched if the Manual Disconnect condition exists for 300 ms.
    - "VFG OFF" message annunciated

- **Reconnect Confirmation**
  - The Disconnect status is reset when:
    a) in Ground Mode and
    b) the GCU detects increasing PMG frequency for more than 1 second.
  - Reconnecting a disconnected VFG is a ground operation conducted with the engine is stopped.
    - The disconnect can be reset at an input speed between **0 and 100 rpm** to account for a windmilling engine.

Disconnect Confirmation (Valid PMG)



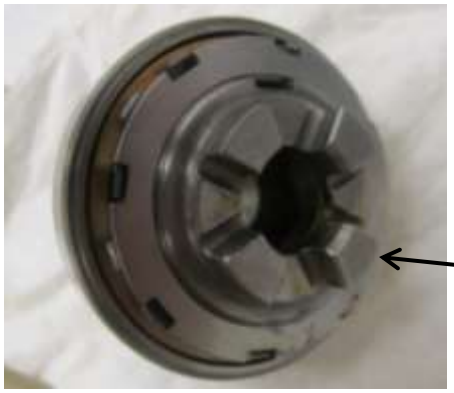
Disconnect Function

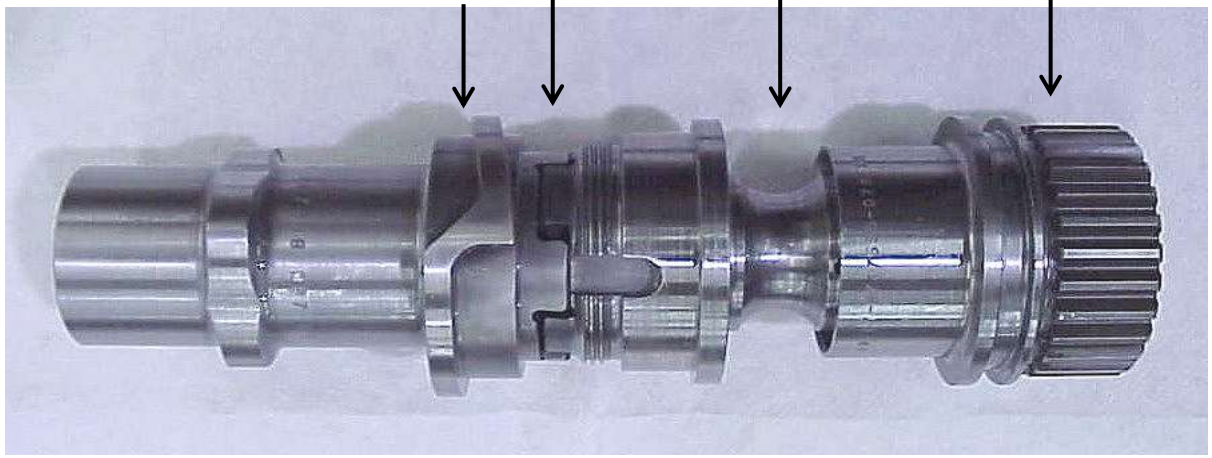
- **Thermal Disconnect**
  - The thermal disconnect operates to disconnect the VFG from the AGB when the oil out temperature exceeds 199 ± 5° C (390 ± 10° F).
  - A thermally disconnected VFG requires removal and repair in order to replace the melted eutectic solder feature.

- **Input Shaft Shear Section**
  - The VFG has a shear shaft section on the input shaft that will break thus disconnecting the VFG from the AGB when the designed maximum torque is exceeded.
  - Should this occur, the VFG is mechanically disconnected preventing further internal mechanical damage. This condition also requires removal and repair in order to replace the input shaft.

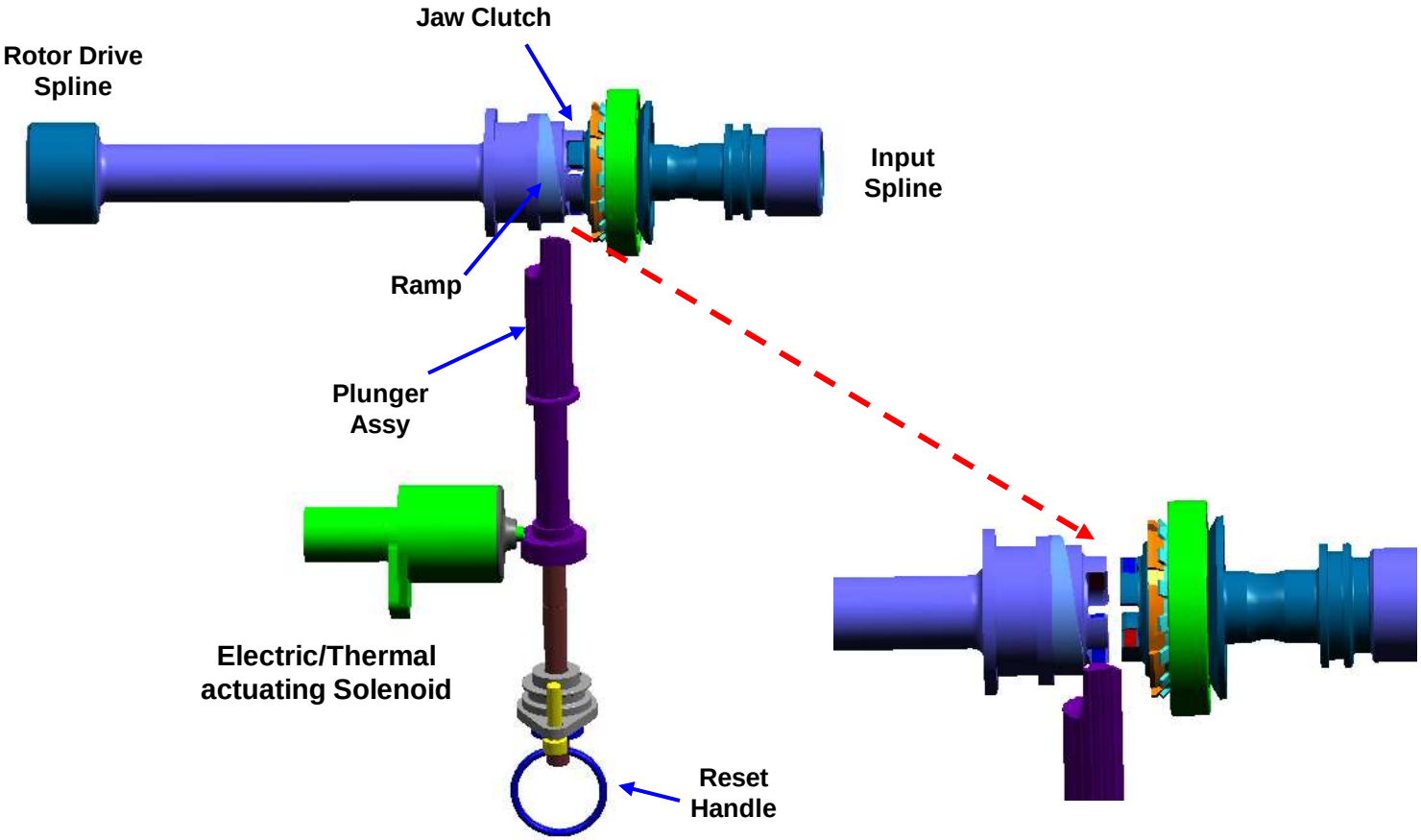
- **Nuisance Disconnect Message**
  - The disconnect pushbutton switch will operate on the ground (though it is guarded).
  - In the case where the disconnect pushbutton is pressed with power on the aircraft, the VFG disconnect solenoid will operate. There will be an ECAM message to warn the crew so that they take action to reconnect the VFG before starting the engine. Starting the engine in this configuration can cause damage to the VFG.

Input/Ramp Shaft Assembly

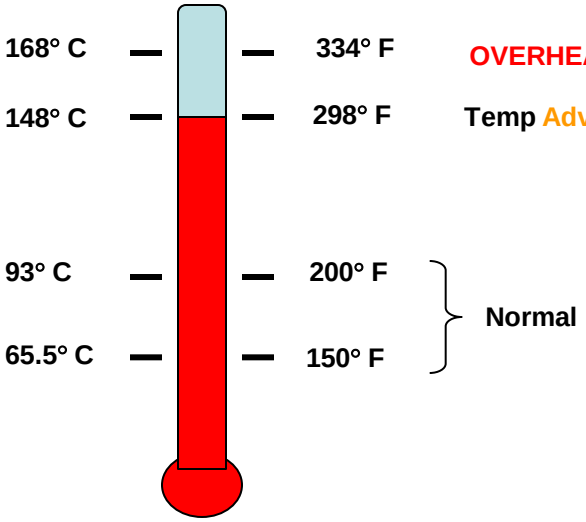




VFG Disconnect

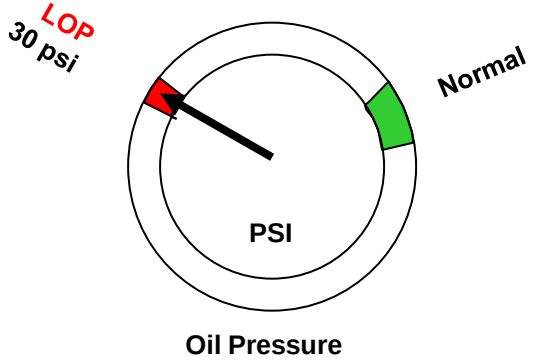


Two IDG Fault Causes



Flight Deck Indication

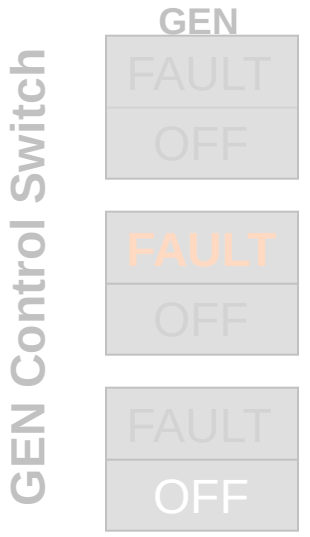
"FAULT" Light On



NORMAL INDICATION

VFG LOW OIL PRESSURE OR HIGH OIL TEMP
(Lift guard and press to disconnect VFG)

CONFIRMED VFG DISCONNECT
(Cannot be reconnected in flight)

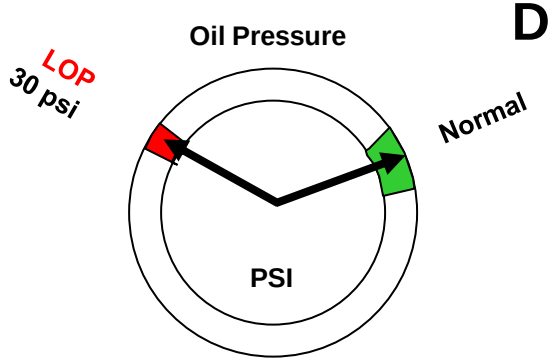


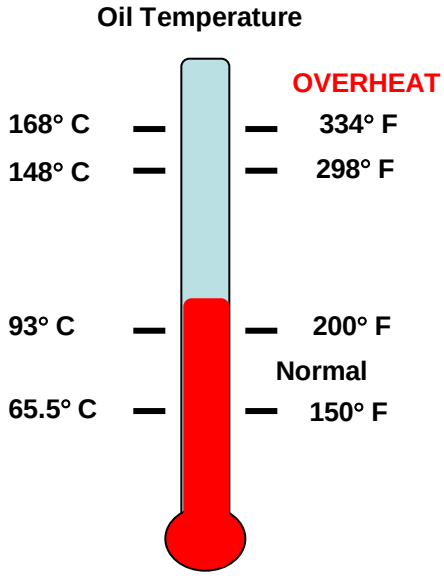
NORMAL "ON" INDICATION (Latched-in position)

GENERATOR PROTECTION TRIP (Push twice to reset)

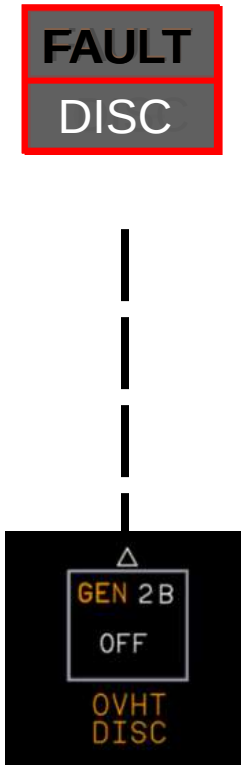
GENERATOR OFF (Push once to turn on)

Disconnect Function Animated





VFG Conditions

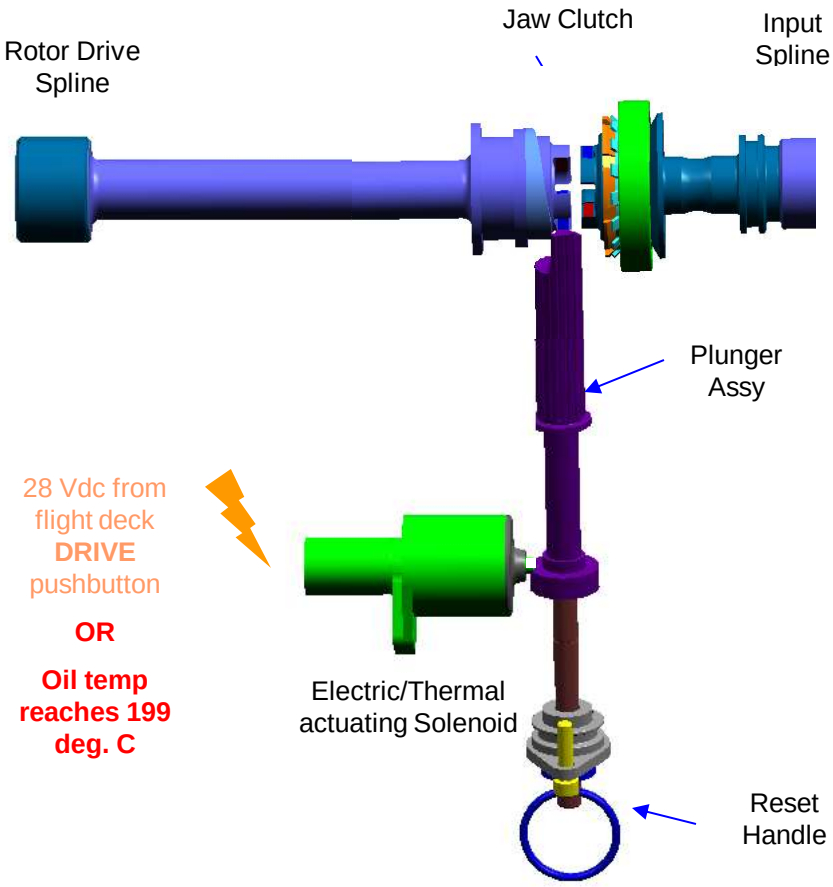


Flight Deck Indication

28 Vdc from flight deck **DRIVE** pushbutton

OR

Oil temp reaches 199 deg. C



VFG Reaction

Manual Disconnect Notifications

- **VFG Disconnect Inhibit Notification**
  - While operating on PMG power, if the GCU receives ARINC indication of either the "28Vdc Busbar" as "Not Available", or the "Disconnect C/B-7.5A" as "Trip", or "Sub-Busbar C/B - 50A" as "Trip", the GCU asserts the ARINC 429 message **"VFG Manual Disconnect" as "Not Available".**
  - While operating on 28Vdc only, if the GCU receives ARINC indication of the "Disconnect C/B-7.5A" as "Trip" the GCU asserts the ARINC 429 message **"VFG Manual Disconnect" as "Not Available".**
  - While operating from PMG power, if the GCU receives ARINC indication of either the "GCU Back-up C/B - 5A" as "Trip", or "Sub-Busbar C/B - 50A" as "Trip", or "28Vdc Busbar" as "Not available", the GCU asserts the ARINC 429 **message "VFG Disconnect Inhibition" as "Not Available"**.

Manual Disconnect Notifications

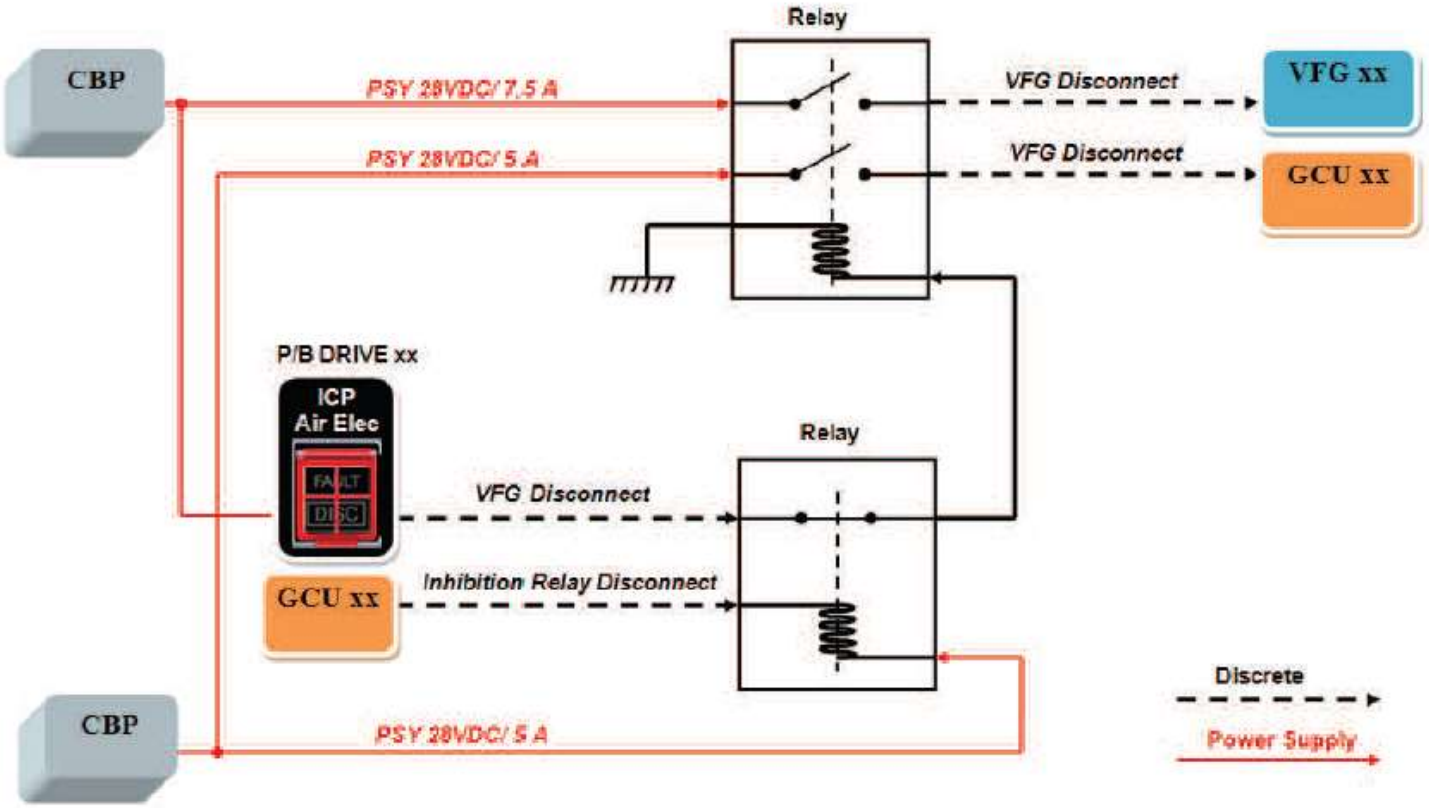


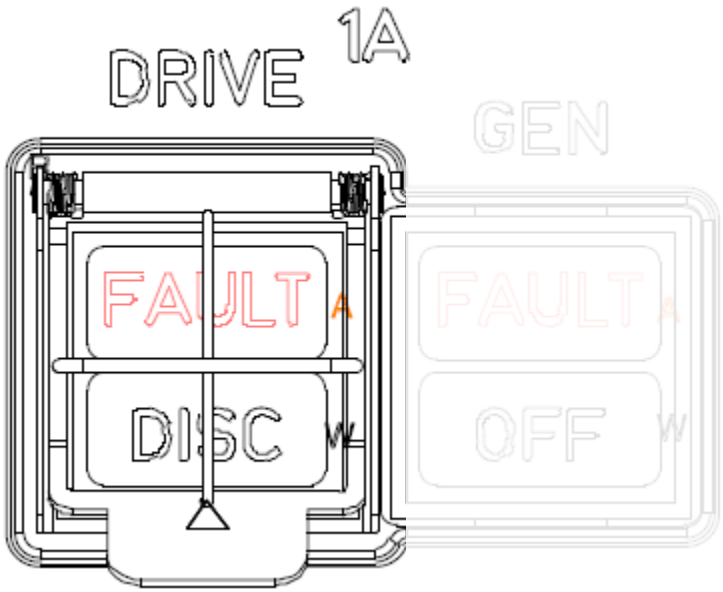
Figure 5-4: VFG Disconnect Wiring Diagram

Disconnect Placard

- There is currently a disconnect placard on the VFG. It is not used and may be disregarded.

Low-Speed Disconnect Placard

***NOTE**: Low-Speed Disconnect definition and tracking is not presently implemented. It is included in this version for reference only.*



Case Pressure Relief Valve

Gearbox Pad & Drain

CPRV

- Case Pressure Relief Valve (CPRV)
  - The VFG provides an overpressure valve to prevent certain scenarios of VFG housing rupture.
  - The valve drains excess pressure from the VFG into the gearbox pad which is vented to ambient pressure by way of the pad drain to the drain mast.

Drain Mast

GCU Protections

- The GCU will open the GLC and disable voltage regulation for the following conditions:
  1. A shorted VFG rotating diode
  2. An open PMG phase or phase-to-phase short
  3. The POR single-phase output voltage is 256 ±4 Vrms
  4. The POR single-phase voltage is 206 ±4 Vrms for 4.3 ±0.2 seconds
  5. The POR single-phase voltage is 160 ±3 Vrms for 130 ±30 milliseconds
  6. The overvoltage protection unit (OPU) signals an overvoltage condition
  7. The frequency of the rotor speed is 793 ±1 Hertz (Hz)
  8. An engine surge
  9. The POR single-phase current is greater than 170 ±6 Amperes (A) rms
  10. The current difference between two of the three phases is 77 ±11 Arms
  11. A greater than normal differential line current
  12. An open parallel feeder cable
  13. An open neutral
  14. An open phase feeder
  15. The phase sequence is not correct
  16. A welded GLC
  17. An open GLC coil
  18. The GLC coil current remains at the pull-in current
  19. The exciter field current is more than the rated value
  20. An engine fire
  21. An exciter field short circuit
  22. An even parity on power up (software verification)
  23. A generator control switch (GCS) fault
  24. An uncontrolled GLC coil power removal
  25. A VFG disconnect inhibit
  26. A PMG mechanical failure.

Overvoltage Protection Unit

Purpose of the Overvoltage Protection Unit (OPU)

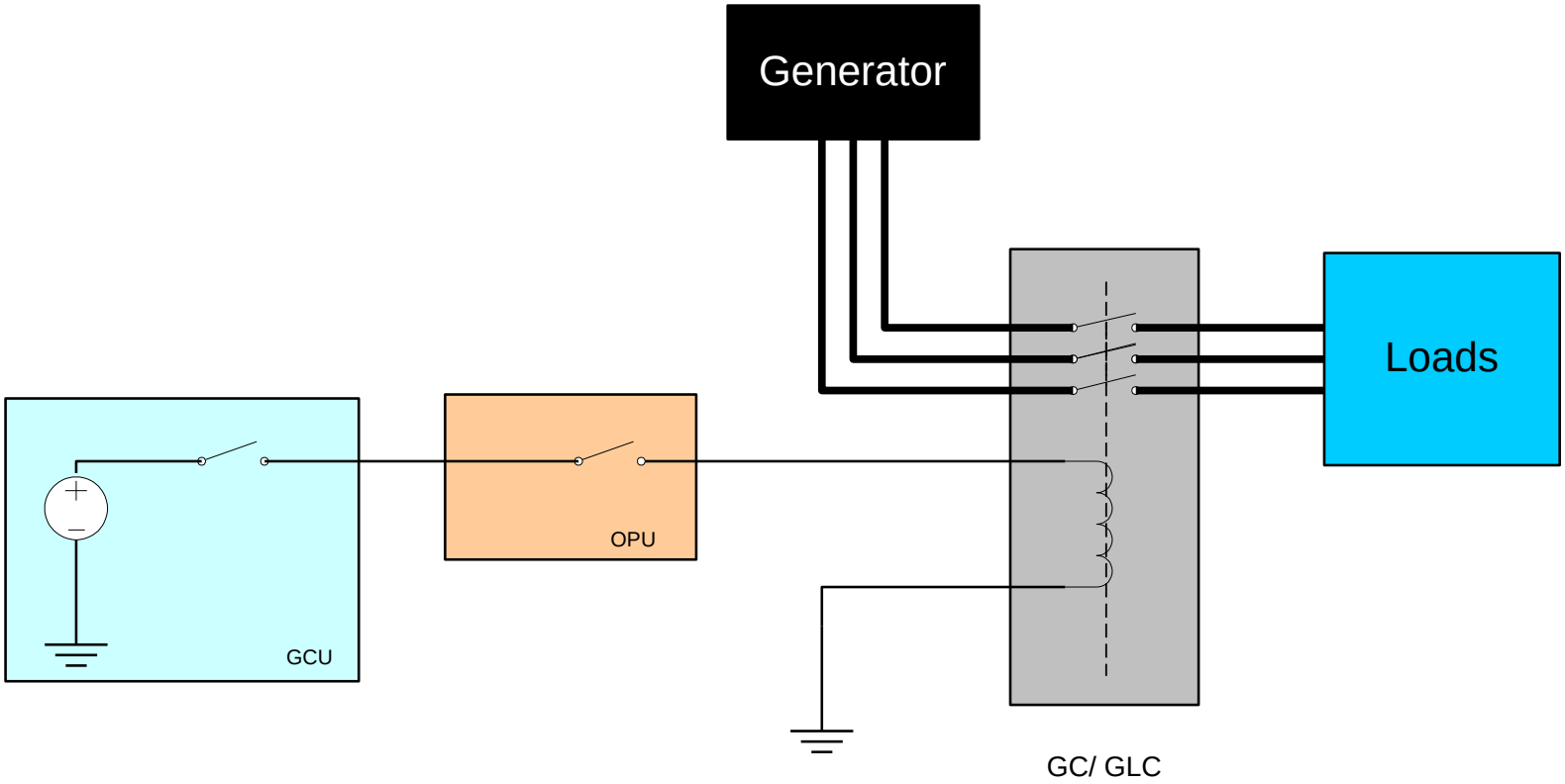
- Electrical bus voltage control is considered critical for the aircraft because of the potential effect on aircraft utilization equipment. This potential requires an independent and separate protection if such a fault can be caused by a single failure. The OPU and the Generator Control Unit (GCU) are separate LRUs. The OPU together with the associated GCU provide the necessary redundancy to ensure an overvoltage cannot result from a single event.

- During normal operations, the GCU regulates the generator output voltage to 230 Vac nominal at the POR. If the GCU voltage regulation fails, allowing the voltage to exceed a defined curve, a GCU voltage protection function is designed to (1) command the GCU to disable voltage regulation, (2) open the GCU exciter Generator Control Relay (GCR), and (3) command the GLC to open. The GCU voltage regulation and protection functions are independent of each other.

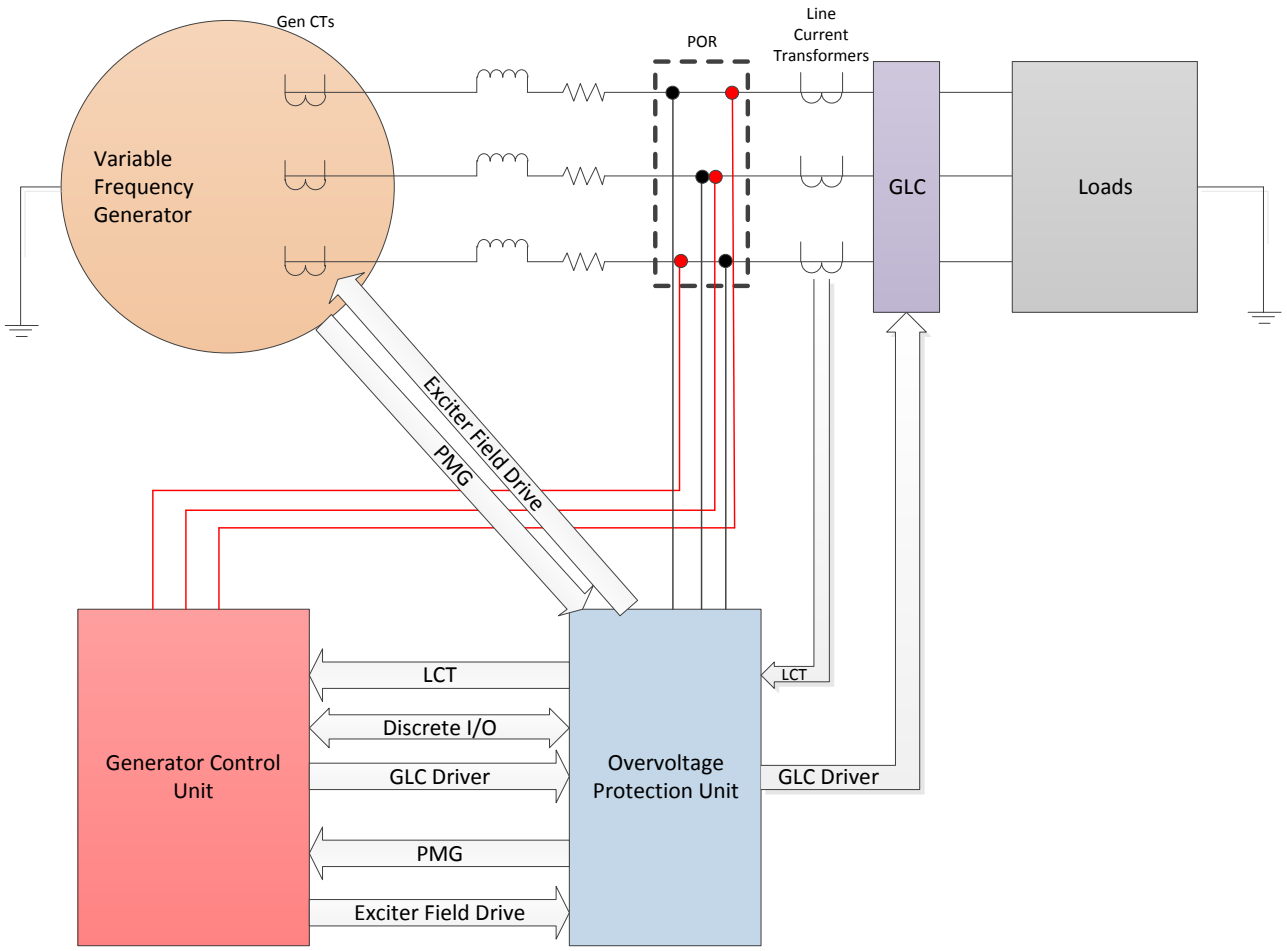
POR Voltage	Max Time to Trip (s)
355	0.01
355	0.1
347	0.2
291	1
252	5
252	10

Overvoltage Protection Unit

OPU Functional Location



Overvoltage Protection Unit



Redundant Overvoltage Protection

Redundant Overvoltage Protection Trip (ROV)

- The OPU provides a **redundant** OV protection function to isolate the generator if the POR voltage exceeds the envelope defined by the design inverse-time characteristics. When a trip threshold is reached, the OPU will open 1) the OPU-controlled GCR, 2) open the command signal to the GLC, and 3) send a signal to the GCU indicating the protection trip.
- In less severe conditions, the OPU provides an OV **limiter** function. When the voltage exceeds acceptable limits, but short of the upper limit, the OPU temporarily opens the OPU-controlled GCR (leaving the GLC closed and the VR active) until the voltage drops to an acceptable level at which point it re-closes the GCR. It will perform this regulating function for a limited time, after which it will perform the redundant overvoltage trip (ROV) by opening the GCR, GLC, and disabling voltage regulation.

Overload

Overload 1

- An **Overload condition** is set if the highest phase generator current exceeds **170**+/-6 A rms.

- If the Overload condition remains for the inverse time delay, an **Overload fault** is set.

- The overload inverse time delay value is not cleared until the Overload condition has been alleviated for **5 seconds**.

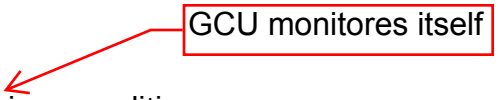
- An Overload fault and the Overload Inverse Time Delay state is reset with a **RESET CONDITION 2** event.

Overload 2

- The Overload 2 Condition is **set** if the three phase average generator current exceeds **147** +/- 5 A rms for greater than 250 +/- 10 seconds (**4 minutes** minimum).

- The Overload 2 Condition is **reset** if the three phase average generator current is less than **137**+/-5 Arms for 5 +/- 1 seconds, **or** if the VFG is de-excited.

Failsafe



Failsafe

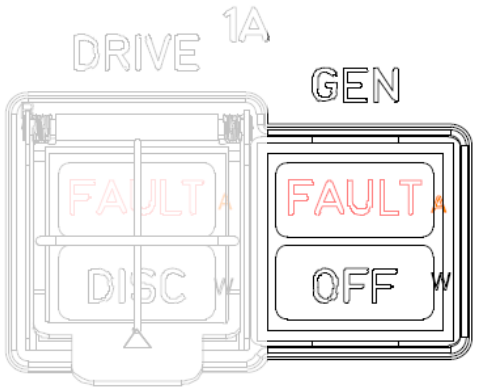
- The Failsafe mode places the GCU in a condition, which will have no adverse effect on the EPGS as a whole (i.e. output signals from the GCU are in a default state). This can result from a critical circuit or software failure.
  - Exciter Drive Control circuit is OFF.
  - Voltage Regulation is disabled.
  - While unpowered, the GCU will maintain "Ground" state on the NOT_LOCKOUT
  - Failsafe condition is reset by cycling the Generator Control Switch.

Clearing System Faults (1)

- **Reset Condition 1**
  - For a latched fault with a Reset Condition classified as RESET CONDITION 1, the fault is cleared by cycling the GCS status from OFF to ON.
  - Cycling of the GCS clears "Reset Condition 1" latched faults and reinitialize the voltage regulation function.

- **Reset Condition 2**
  - For a latched fault or control function with a Reset Condition classified as RESET CONDITION 2, the fault or control function is cleared by cycling the GCS status from OFF to ON **for up to two occurrences** of **ANY** fault or control function with a Reset Condition classified as RESET CONDITION 2 **since the last GCU Cold Start.**
  - If any latched fault or control function with a Reset Condition classified as RESET CONDITION 2 occurs a **third time** since the last Cold Start**, the fault or control function remains latched** even when the GCS is cycled from OFF to ON.

- For a latched fault or control function with a Reset Condition classified as RESET CONDITION 2, the count of the resets from cycling the GCS from OFF to ON **is cleared by a COLD START** of the GCU.
- There is no way to determine externally what the status of the Reset Condition 2 count is. This could be addressed by checking the last leg CMS report for any BITE faults related to Reset 2 trips.
  - **If it is suspected that the 'count' has been incremented, a Cold start would be in order.**



Clearing System Faults (2)

- **Cold Start**
  - For a latched fault or control function with a Reset Condition classified as RESET CONDITION 1, or RESET CONDITION 2, the fault or control function is cleared by a COLD START of the GCU.
  - A Cold Start is defined as removing all power from the GCU.
- It may also be possible to reset select faults from the maintenance terminals.

- **Reset Condition 2 faults include:**
  1. Over-voltage
  2. Over-current
  3. Delta Current
  4. Differential protection
  5. Open Phase
  6. Welded GLC
  7. GLC Coil Open Circuit
  8. GLC Control output Overload
  9. OV Prevention
  10. Preventive Overload

Protective Functions

Function	Sensing	Threshold	Time Delay	Trips
Shorted Rotating Diode (SRD Trip)			160 ms	GLC coil power & Excitation removed
PMG Failure (SOPMG trip)	(only during start-up)		2 seconds	Excitation removed
Overvoltage (OV trip)	Any POR phase	256 Vrms +/- 4	Inverse (400ms-10sec)	GLC coil power & Excitation removed
Undervoltage (UV1) (UV2)	Any POR phase	Less than: 206 +/- 4 Vrms 160 +/- 4 Vrms	4.3s +/- 0.2sec 130ms+/- 30ms	GLC coil power & Excitation removed
Overfrequency (OF)	POR Equivalent freq	>793 +/- 1 Hz 4 Hz hysteresis	30 +/- 10ms	GLC coil power & Excitation removed
Preventative Overload	Gen Frequency Generator load	Freq<397+/-1Hz Load>100kVA	40 +/-10ms	Transfer Contactor Lockout 2

Abnormal Operations & Overvoltage Protection Unit

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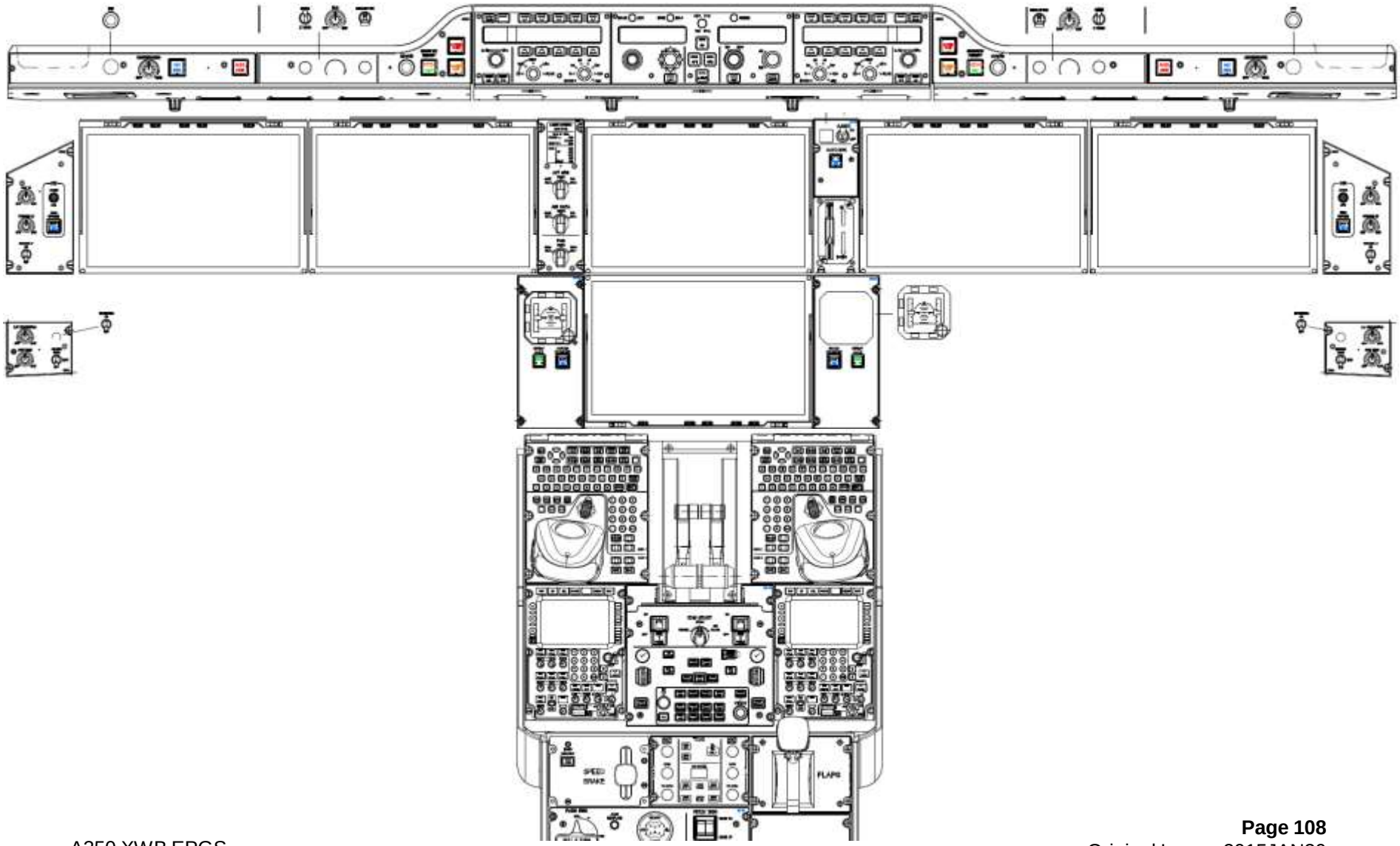
Airbus A350 XWB Electric Power Generation System

Module 6 -Troubleshooting

MFD (Multifunction Displays) Screens



Flight Deck Displays

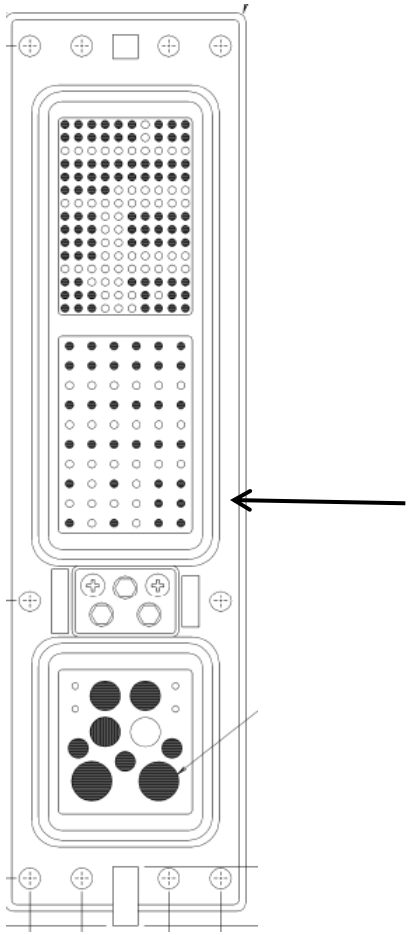
Troubleshooting

- Follow the Airbus Troubleshooting Manual (TSM)
  - *ARI Ref 10974: Unable to perform GCU System test*.
  - Until remedied in 4Q15, the mitigation action is to initiate the EPDS test and check for any dispatch messages related to the GCU.

- If after following the TSM procedure, the GCU, OPU, or VFG is determined to be faulted, send the unit for repair with substantiating data for the removal:
  - Removal reason
  - Fault code(s) from the NVM dump
  - Post Flight Report (PFR)
  - Pilot Report

GCU Installation Keying & Pin Programming

- **Pin Programming Fault**
  - A PIN PROG fault will prevent:
    - GLC closure
    - Generator excitation
  - A Pin Programming fault is reset only by a COLD START event.

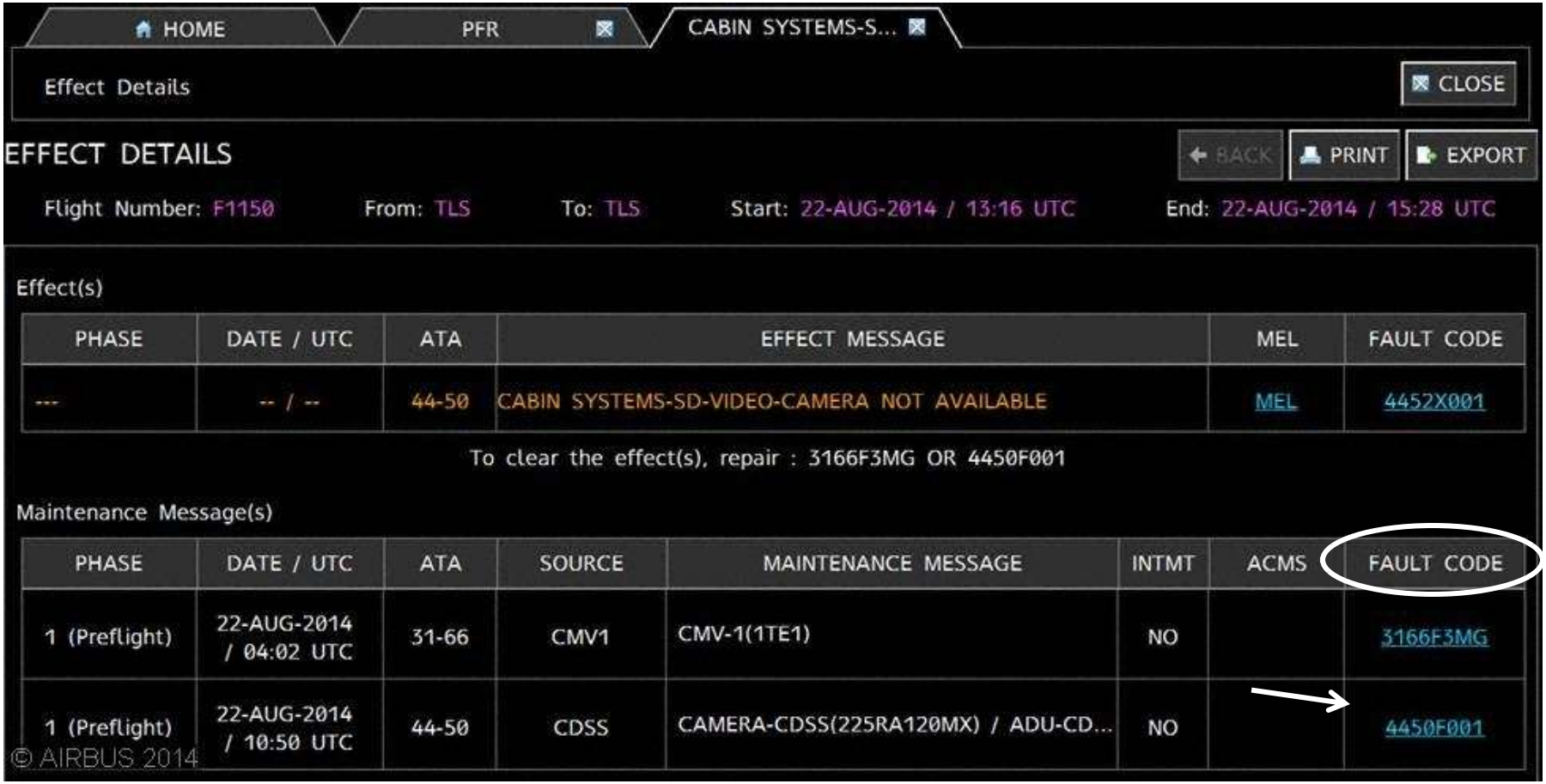


Troubleshooting

- Fault Code sample from downloaded aircraft data:

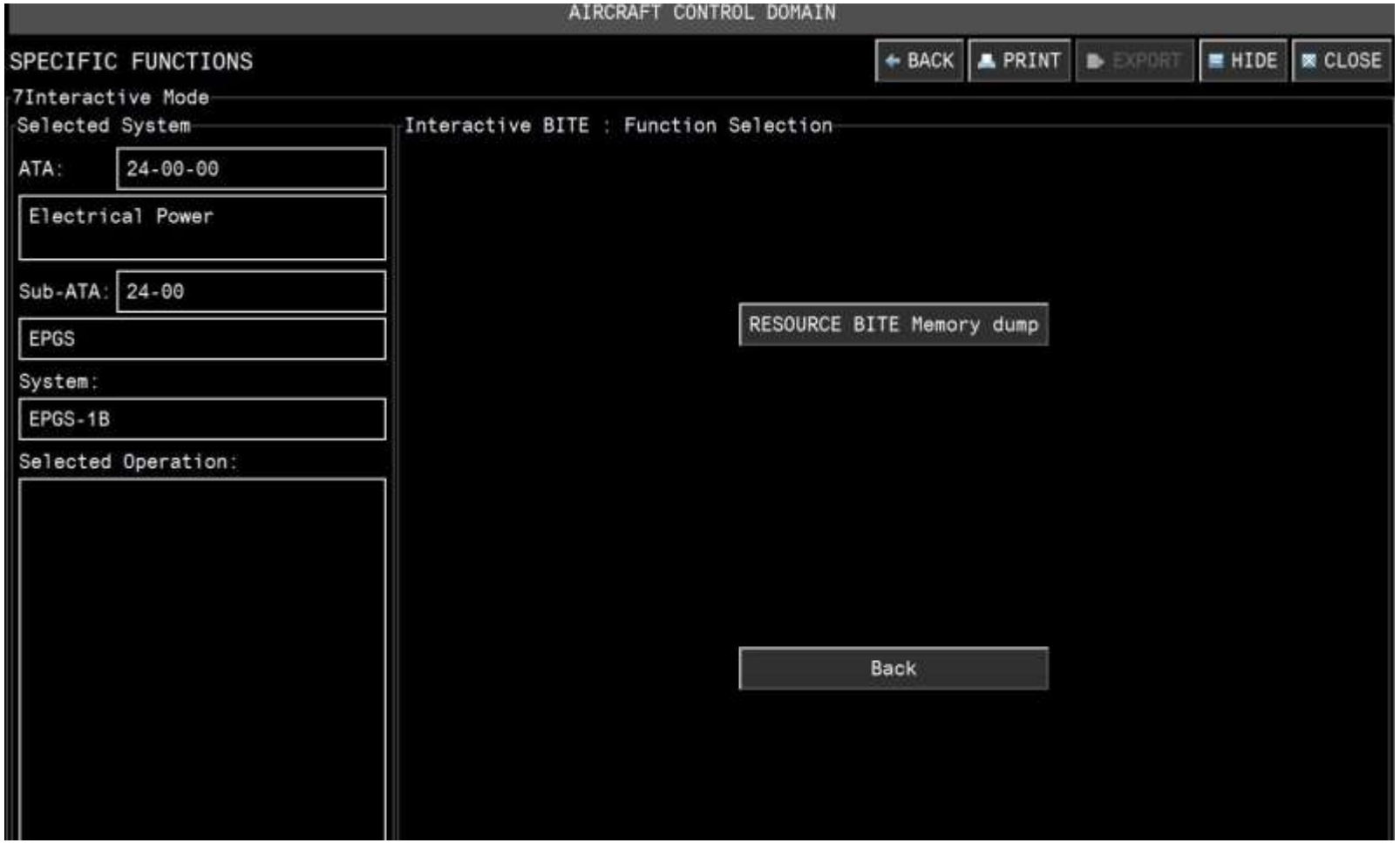
TAIL	Maintenance Side Name	Fault Class	**Fault Code**	FMC	Displayed Fault Message
F-WZGG	EPDS & EXT LT	0	**24X1F2SX**	3227	EDMU-EPDC2B(1402XZ2)

Fault Code from Online PFR

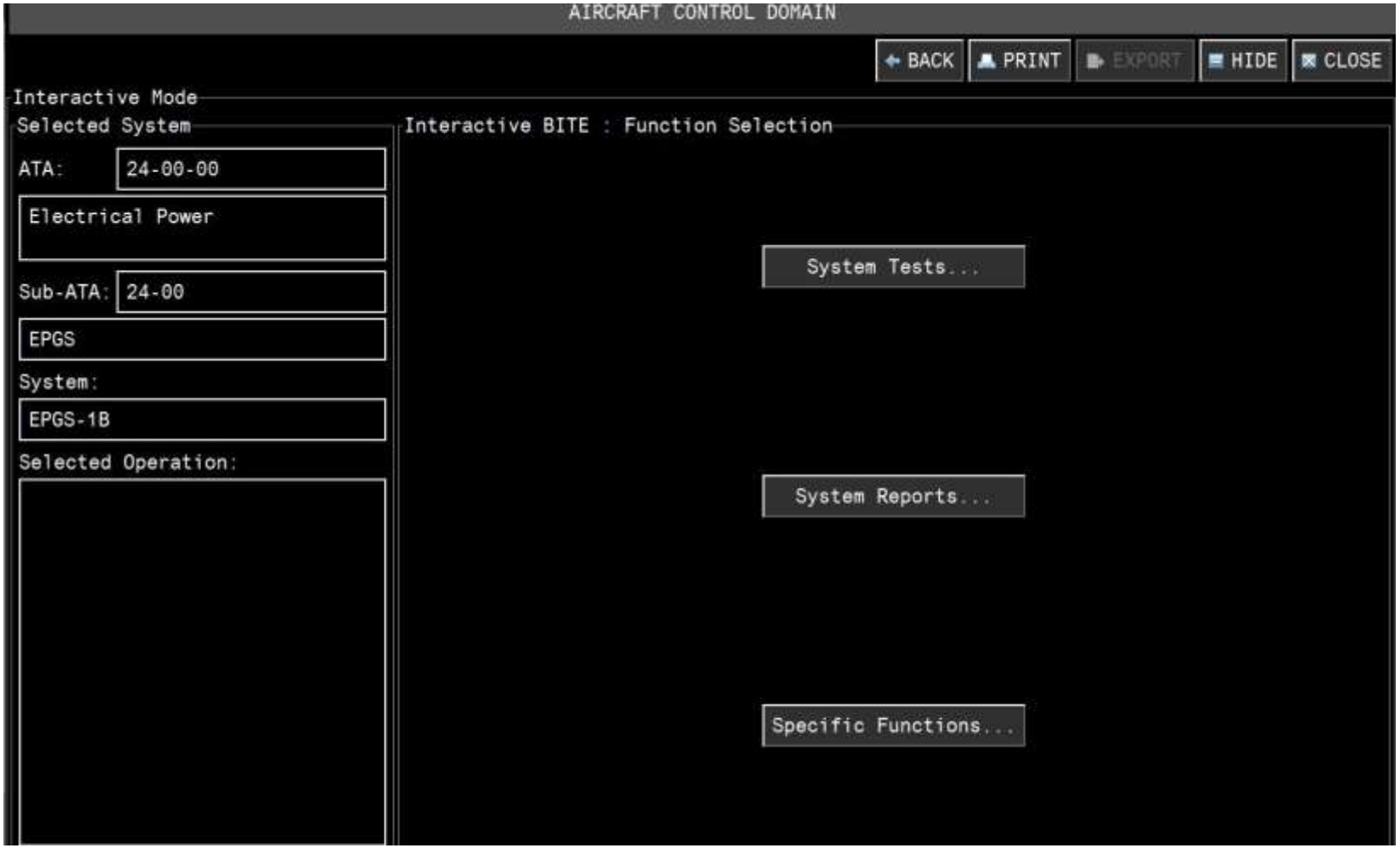


Maintenance Home Page

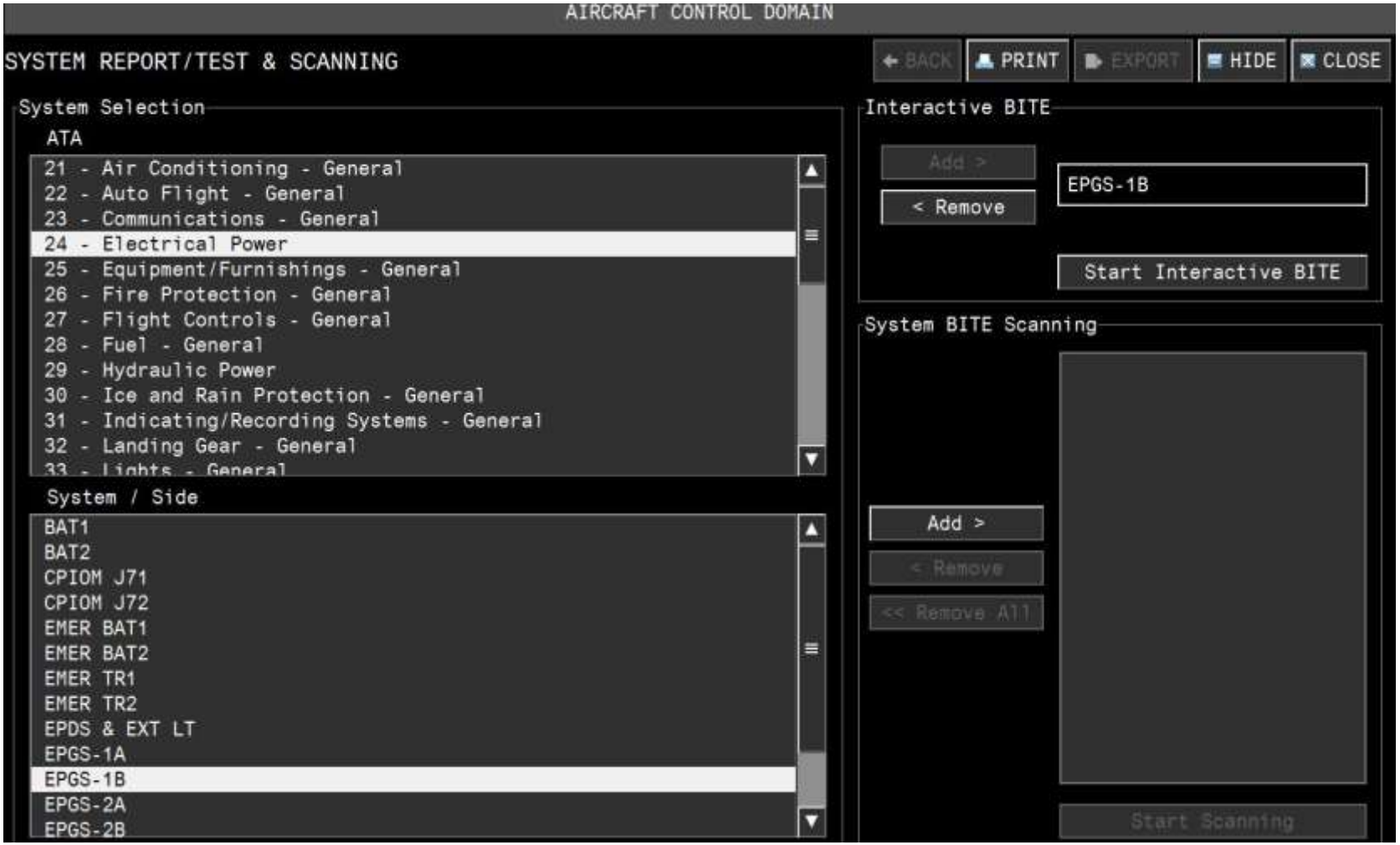
Specific Function



Interactive BITE



System Report / Test



Aircraft EPGS Fault Messages

Fault	ECAM Message	Dispatch Message
LOP	ELEC DRIVE 1A (1B)(2B)(2A) MECH FAULT	ELEC DRIVE 1A(1B)(2B)(2A) DISCONNECTED or ELEC DRIVE 1A(1B)(2B)(2A) DISC STS UNKNOWN (Procedure for ECAM requires DISC, hence DM)
Oil Temp Advisory & Overheat	ELEC DRIVE 1A (1B)(2B)(2A) OIL OVHT	ELEC DRIVE 1A(1B)(2B)(2A) DISCONNECTED or ELEC DRIVE 1A(1B)(2B)(2A) DISC STS UNKNOWN (Procedure for ECAM requires DISC, hence DM)
Disconnect success	ELEC DRIVE 1A (1B)(2B)(2A) DISCONNECTED	ELEC DRIVE 1A(1B)(2B)(2A) DISCONNECTED (NB: Manual, thermal or shear-neck type disconnections)
Disconnect failure	Varies depending on the cause of the failure. Ref above and below for ECAM associated with a given failure	ELEC DRIVE 1A(1B)(2B)(2A) DISC STS UNKNOWN
Disconnect available	Availability of DISC is assumed and is therefore not indicated	
Disconnect not available notifications	Nil	ELEC DRIVE 1A(1B)(2B)(2A) MAN DISC

Aircraft EPGS Fault Messages

Fault	ECAM Message	Dispatch Message
Overload 1/2	Nil	Nil (the overload would have cleared after landing) NB: There is a MEMO displayed on the FWS: “ELEC SHED” NB: By design, an overload of the VFG is unlikely due to the Elec Load Management Function (ELMF). If the ELMF fails, then the Elec Network Management Function will preventatively shed certain groups of loads when VFG lost or VFG near overload, regardless of actual load. Apart from that, the GCU will trip the VFG offline. “ELEC GEN 1A(1B)(2B)(2A) FAULT” Should there be an overload with the engine at low speed, the VFG will be tripped offline and the BTC will be locked out to prevent the load from burdening the other engine.
Overvoltage	ELEC GEN 1A (1B)(2B)(2A) FAULT	ELEC GEN 1A(1B)(2B)(2A)
A PMG mechanical failure	ELEC DRIVE 1A (1B)(2B)(2A) MECH FAULT	ELEC DRIVE 1A(1B)(2B)(2A) DISCONNECTED or ELEC DRIVE 1A(1B)(2B)(2A) DISC STS UNKNOWN (Procedure for ECAM requires DISC, hence DM)

ELEC GEN XX FAULT

The following faults will produce a generator trip with the messages:

- ECAM: ELEC GEN 1A(1B)(2B)(2A) FAULT
- DM: ELEC GEN 1A(1B)(2B)(2A)
  - A shorted VFG rotating diode
  - An open PMG phase or phase-to-phase short
  - The POR single-phase output voltage is 256 ±4 Vrms
  - The overvoltage protection unit (OPU) signals an overvoltage condition
  - The POR single-phase voltage is 206 ±4 Vrms for 4.3 ±0.2 seconds
  - The POR single-phase voltage is 160 ±3 Vrms for 130 ±30 milliseconds
  - The frequency of the rotor speed is 793 ±1 Hertz (Hz)
  - An even parity on power up
  - The current difference between two of the three phases is 77 ±11 Arms
  - A greater than normal differential line current
  - An open parallel feeder cable
  - An open neutral
  - An open phase feeder
  - The phase sequence is not correct
  - The POR single-phase current is greater than 170 ±6 Amperes (A) rms
  - The exciter field current is more than the rated value
  - An exciter field short circuit
  - A generator control switch (GCS) fault

Spurious DM "DRIVE XX OIL LEVEL MONITORING

A350 ATA24 – Spurious DM "DRIVE XX OIL LEVEL MONITORING"

Issue

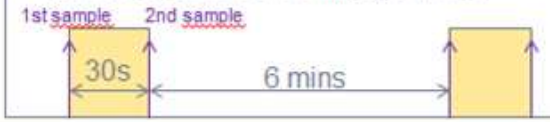
- Approx. 5 events in previous 12 months of: ELEC DRIVE XX OIL LEVEL MONITORING Dispatch Messages during turnaround (on ground, engines not running) on flight test aircraft

Operational Impact

- One per engine:
  - No oil check: Three flights
  - With oil check: MMEL "C"
  - *(24-22-04A/B)*
- Two per engine: No-Go

Root Cause / Investigation

- Oil levels measured every 6 minutes
- Consists of two measurements taken 30 sec. apart
- If first measurement ≠ second → Fault
  - Toggle GEN pushbutton during 30 sec. interval interrupts 2nd measurement *(Flight Test Procedure)*
- Root cause is GCU software issue



Mitigation / Interim Action

- Investigation to allow two DM per engine if visual oil level check performed every flight
- Cycle GEN Pushbutton again to clear fault + wait 7 mins for new level measurement

Applicability

- All MSN potentially affected

Terminating Action

- GCU Standard 4 (Q4 2015, currently planned MSN59)

AIRBUS

ELEC AC System Status

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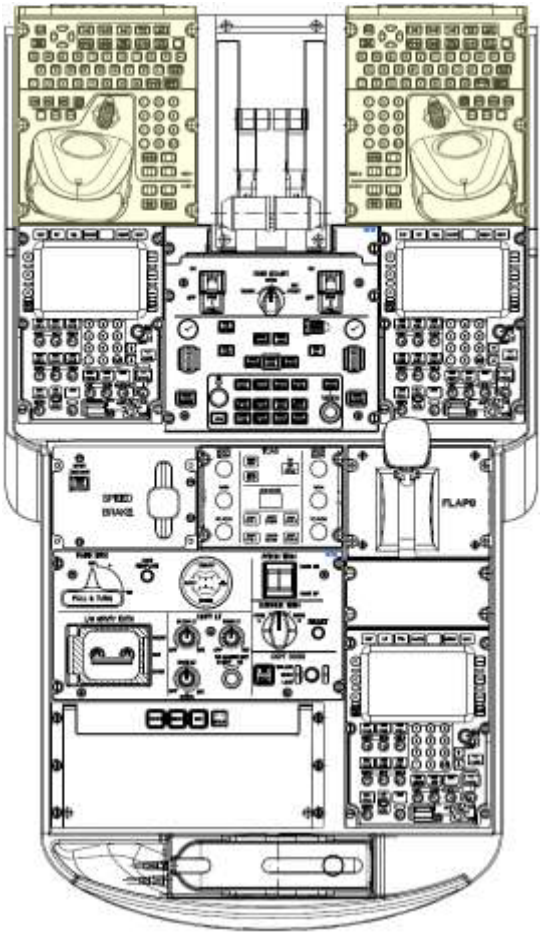
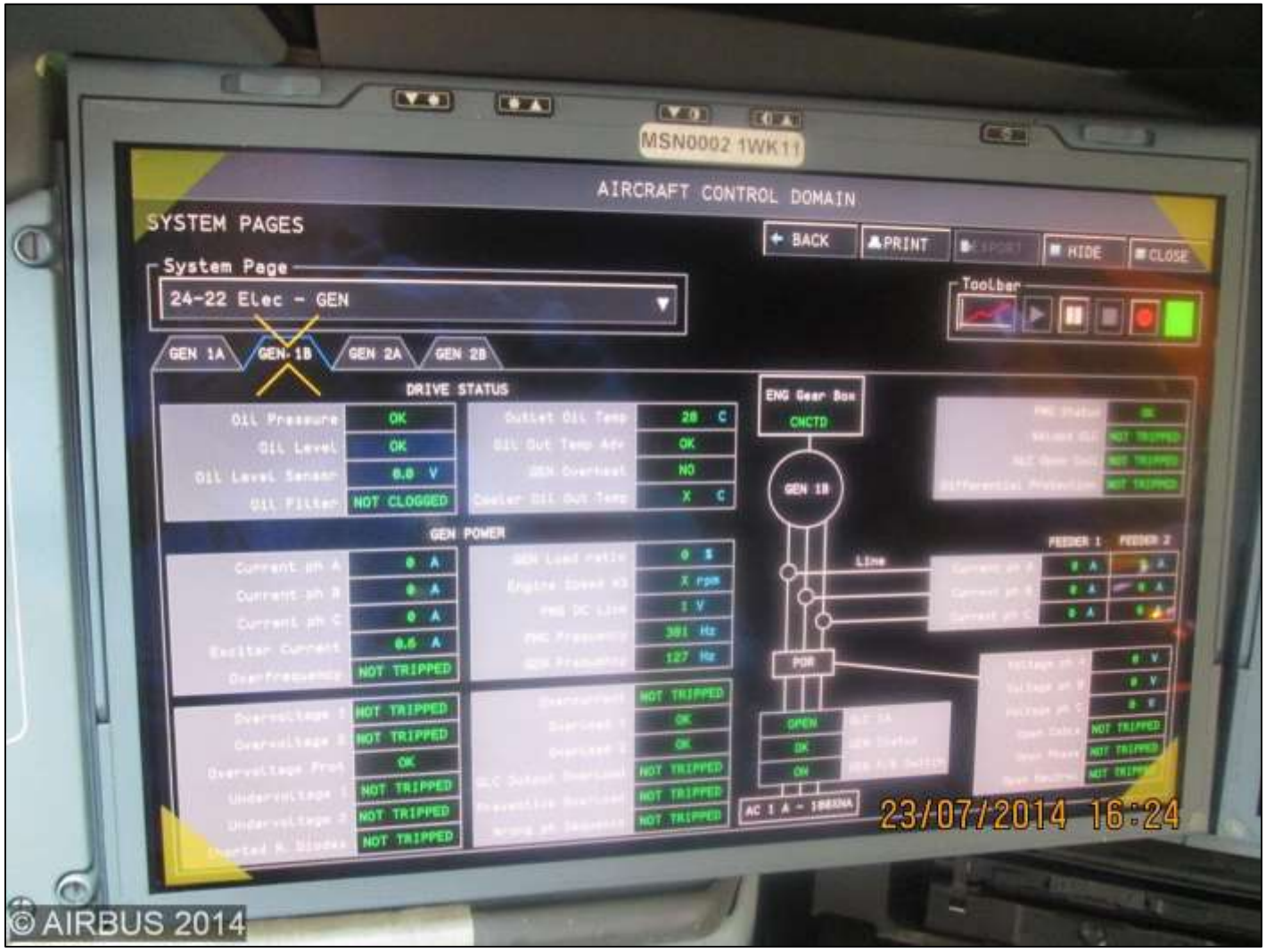
ELEC AC System Status

KCCUs (Keyboard and Cursor Control Units)



System Data Screen



Input Seal Leaks

Indicates possible oil loss from:

1. **VFG Input seal**
2. **VFG CPRV**
3. **Engine Gear Box**

Airbus A350 XWB Electric Power Generation System

Module 7 - EPGS Maintenance

Controls Maintenance

- A350 GCU and OPU require no maintenance.

V-Band Installation

Mount V-Band Flange to Engine Gearbox

- Mount the engine AGB adapter V-Band flange to engine gearbox using the twelve socket head cap screws provided by HS in the V-Band Kit. The V-Band kit is defined by the V-Band outline part number. The parts included in each of the V-Band kits are as follows:

Part Name	Quantity	V-Band Component Part Number	Comment
		V-BAND Outline 1714475A	
Engine AGB Adapter V-Band Flange	1	1714468	V-Band bolt-on flange
Gasket	1	1717290	Adhesive side attaches to Adapter V-band flange prior to installation to AGB
Countersunk Socket Head Cap Screws	12	0649P720-20	Attaches Adapter V-Band Flange to the gearbox
V-Band Clamp	1	5915758	Corrosion Resistant Steel

V-Band Flange Installation

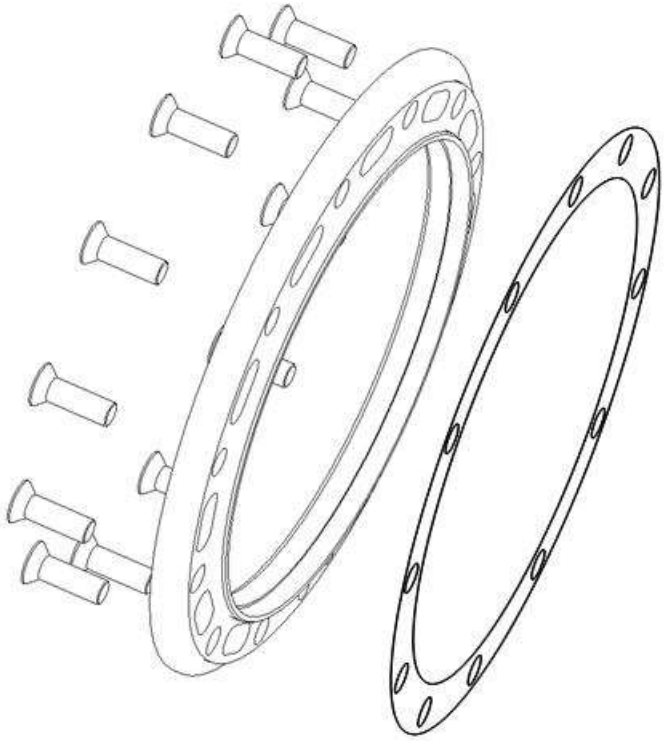
- Verify that the Adapter V-band Flange is clean and dry. Remove adhesive backing from gasket (part number 1717290). Install the gasket onto the “flat” side of Adapter V-band Flange (not the side with the countersunk holes for the 12 flat head screws). Align the ID (pilot diameter) of gasket to the pilot diameter of the Adapter V-band Flange. Also align the 12 screw holes in the gasket with the 12 holes in the Adapter V-band Flange. Attach the gasket to the Adapter V-band Flange and press firmly to remove air bubbles between the gasket and the Adapter V-band Flange.

- Position the engine gear box adapter V-Band flange on the engine gearbox VFG mounting boss with the word “TOP” oriented upwards.

- **NOTE:** DO NOT use washers under the engine gear box adapter V-Band flange mounting screw heads.

- Lubricate conical surfaces of screw head and screw threads with anti-seize lubricant (MIL-A-907E) prior to installation. Install the screws into the engine gear box adapter V-Band flange and into the engine gearbox threaded inserts. Torque screws per the torque table provided.

V-Band Flange Installation

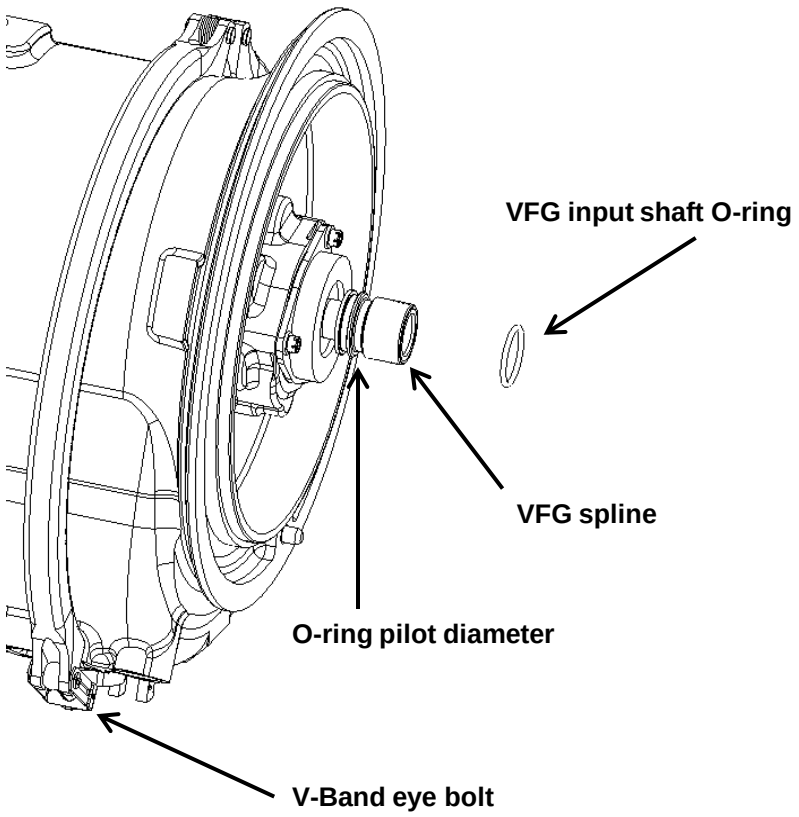


Installation of Engine AGB Adapter V-Band flange and gasket onto Accessory Gearbox

V-Band Outline Part Number	V-Band Component	Installation Torque
1714475A	Socket Head Cap Screws	39.3-43.4 Nm (29-32 ft-lb)
1714475A	V-Band Nut	16.3-17.5 Nm (145-155 in-lb)

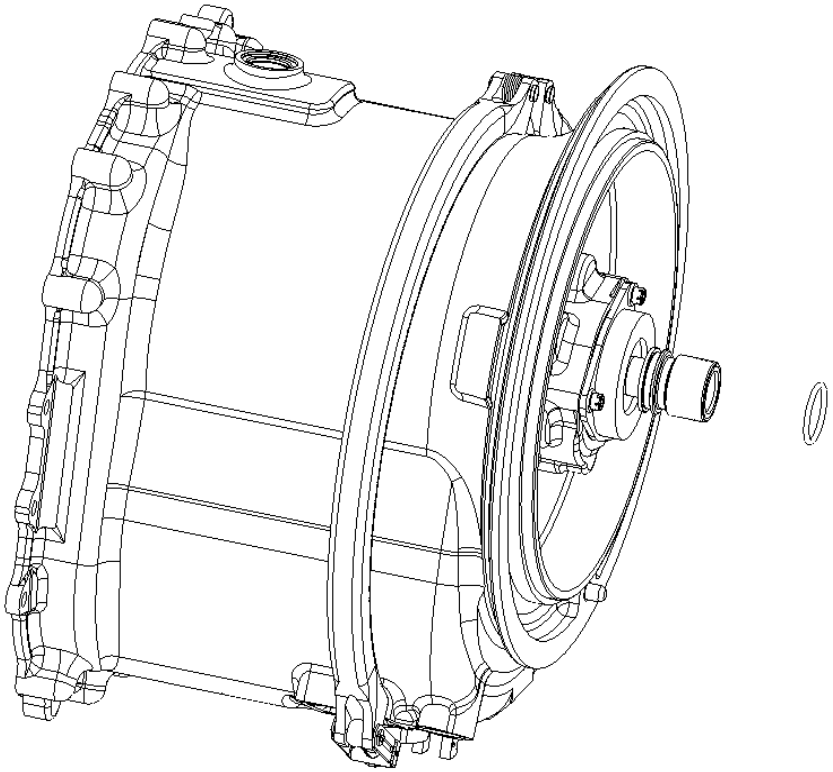
Input Shaft O-ring

- The VFG input shaft O-ring is shipped in a bag attached to the VFG input shaft. The O-ring (Part Number M83485/1-121) should be removed from the bag and installed on the input shaft. Lubricate the VFG spline, input shaft O-ring, gearbox spline, and O-ring pilot diameter with MIL-PRF-23699 or MIL-PRF-7808 oil. Apply MIL-PRF-23699 or MIL-PRF-7808 oil to the V-Band eye bolt.



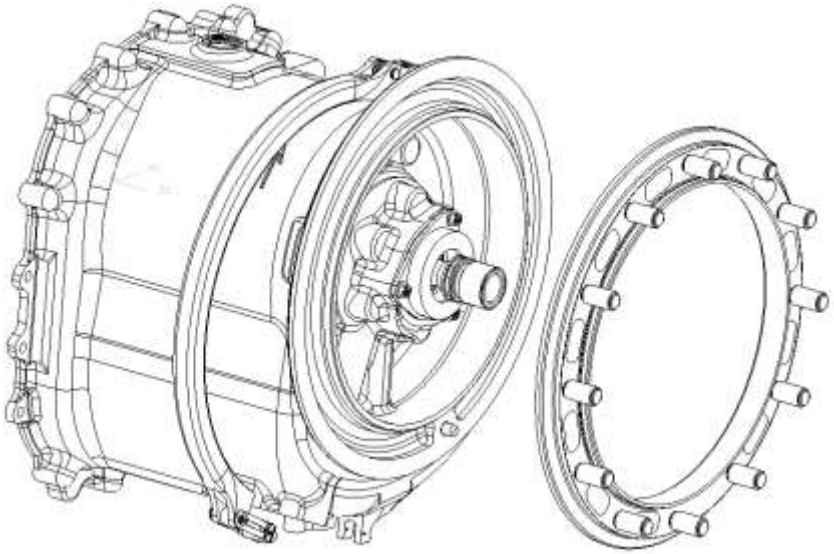
Mount the VFG to the Engine AGB Adapter V-Band Flange

- Pre-position V-Band clamp on the VFG Input Housing as shown.
- **NOTE:** The VFG input shaft is not to be used to support VFG weight. Load imparted to the input shaft during installation could damage the VFG input shaft, input shaft seal, and other internal components.
- A hoist device should be used to support the VFG during installation (the VFG weighs 52.6 kg without oil). Align the locating pin on the VFG with the mating hole in the engine AGB adapter V-Band flange, the VFG input spline with the engine gearbox output spline, and install the VFG on the V-Band flange previously installed on the engine gearbox.

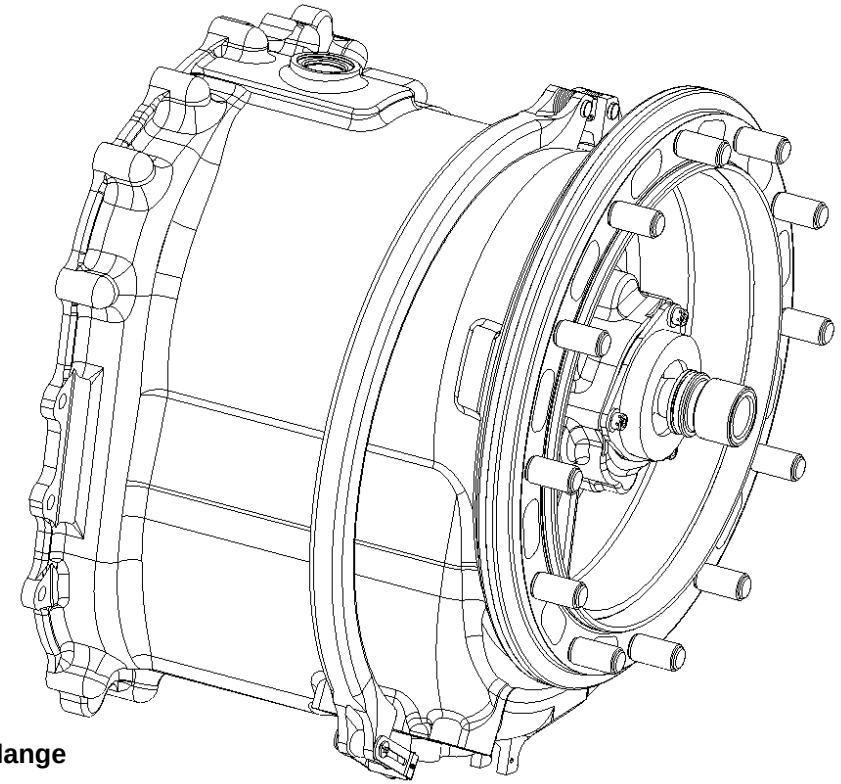


V-Band Clamp Pre-placement onto VFG Input Housing

VFG Mounting



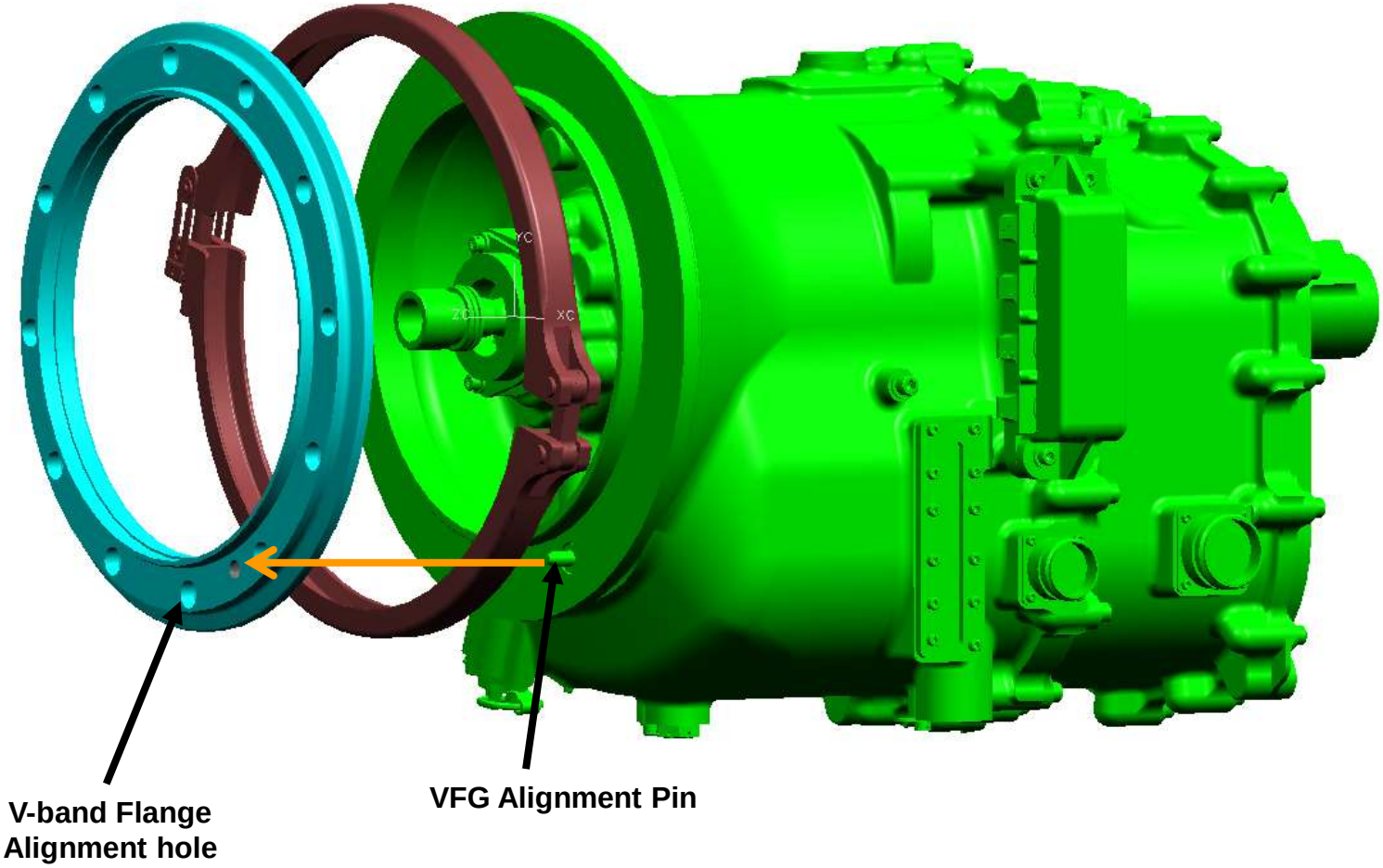
Alignment of VFG Locating Pin and Engine AGB Adapter V-Band flange



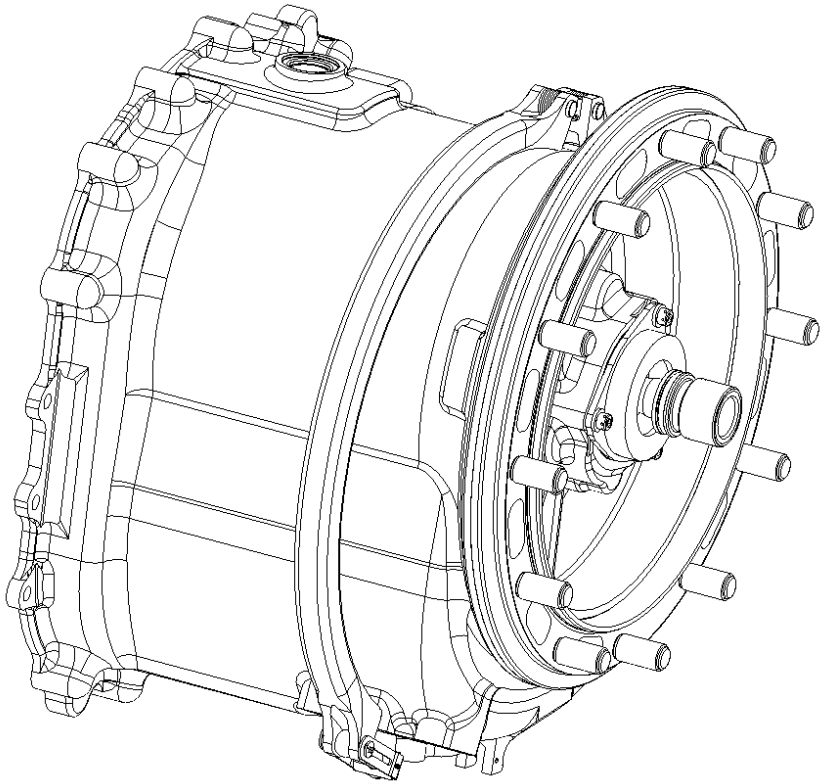
Mounted VFG and Engine AGB Adapter V-Band flange

V-Band-to-VFG Interface Expanded View

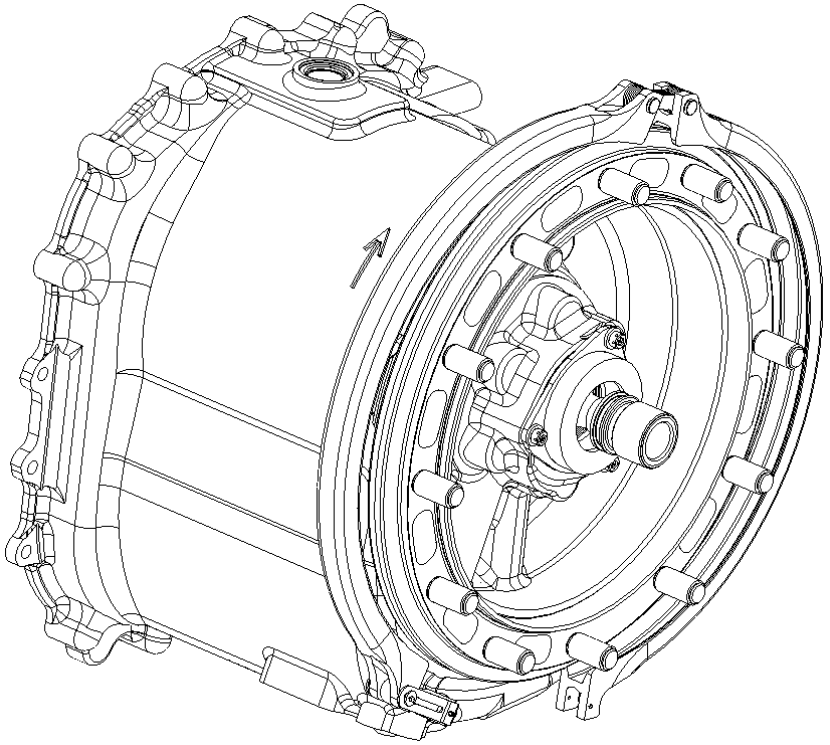
(fasteners to AGB not shown)



VFG Mounting



Mounted VFG and Engine AGB Adapter V-Band flange



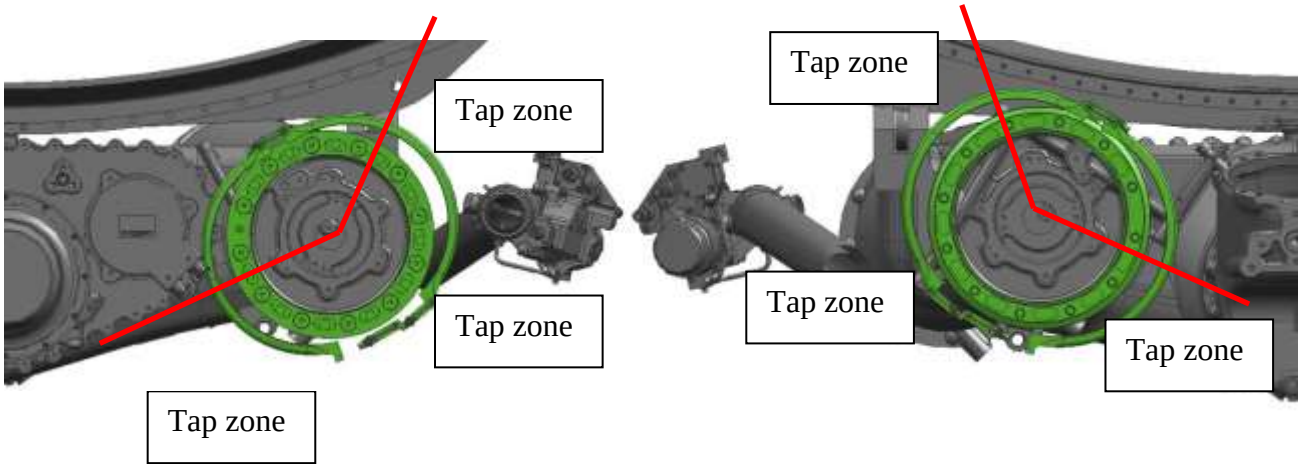
Installation of V-Band Clamp on Mated Flanges

Torqueing the V-Band Clamp

- Install the V-Band Clamp nut on the eyebolt.
- Orient the V-Band Clamp such that the eyebolt is in the approximate orientation shown on next slide.
- Tighten the nut on the V-Band Clamp to AMM specifications . Check to assure the V-Band has seated over the flanges equally around the periphery.
- **NOTE:** A torque wrench should be used to prevent excessive tightening and damage to the V-Band.
- **CAUTION: ALL SECTIONS OF THE V-BAND CLAMP MUST BE OVER FLANGE OF GEARBOX AND VFG TO PREVENT DAMAGE AND MISALIGNMENT.**
- **CAUTION: TO PREVENT POSSIBLE MISALIGNMENT, OBSERVE ACTION OF V-BAND CLAMP TO ENSURE IT DOES NOT SNAG OR BIND DURING INSTALLATION.**
- Lightly tap the open periphery of the V-Band Clamp, starting opposite or most distant from the latch, with a plastic or nonmetallic mallet to distribute the band tension.
- As nut torque is increased to **noted requirements**, lightly tap around the open periphery as necessary to prevent unequal loading.
- After the nut is torqued to noted requirements, retap around the band and retorque once more to the specified value.
- Repeat taping/torquing steps until the torque does not change by more than AMM specifications.
- Retorque the V-band Clamp to AMM specifications

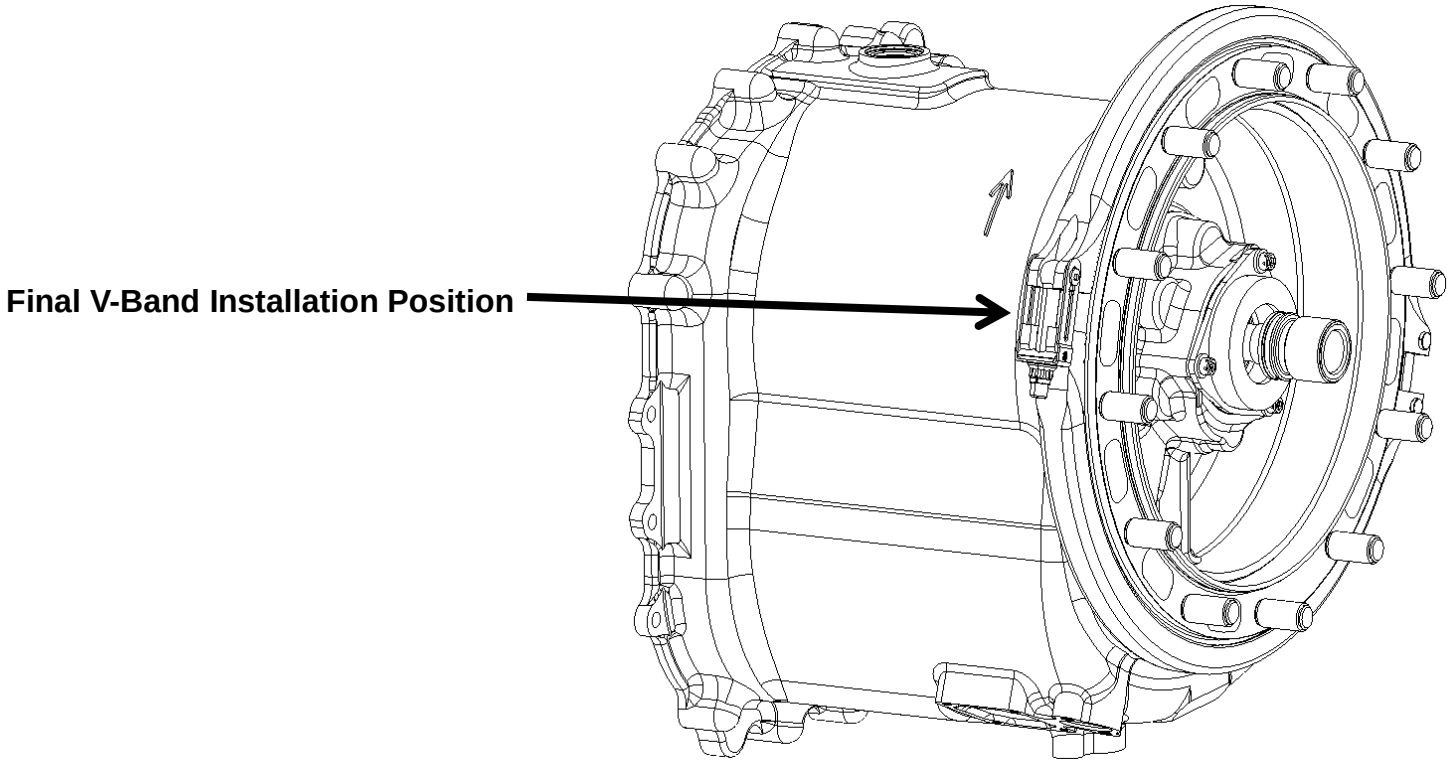
V-Band Clamp "Tap" Zones

- Lightly tap the open periphery of the V-Band Clamp, starting opposite or most distant from the latch, with a plastic or nonmetallic mallet to distribute the band tension.
- As nut torque is increased to **noted requirements**, lightly tap around the open periphery as necessary to prevent unequal loading.
- After the nut is torqued to noted requirements, retap around the band and retorque once more to the specified value.
- Repeat taping/torquing steps until the torque does not change by more than AMM specifications.
- Retorque the V-band Clamp to AMM specifications.

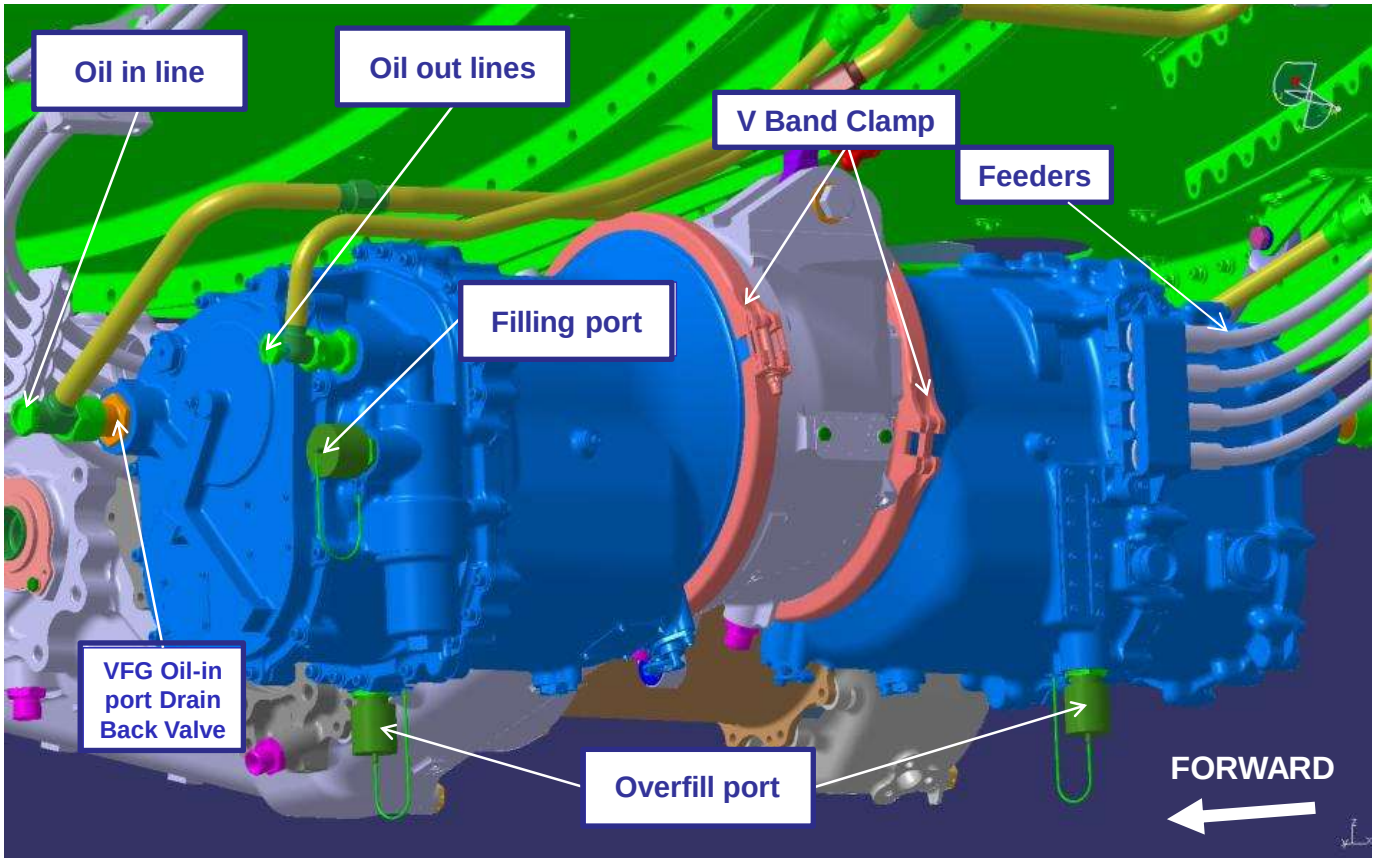


V-Band Tap Zones

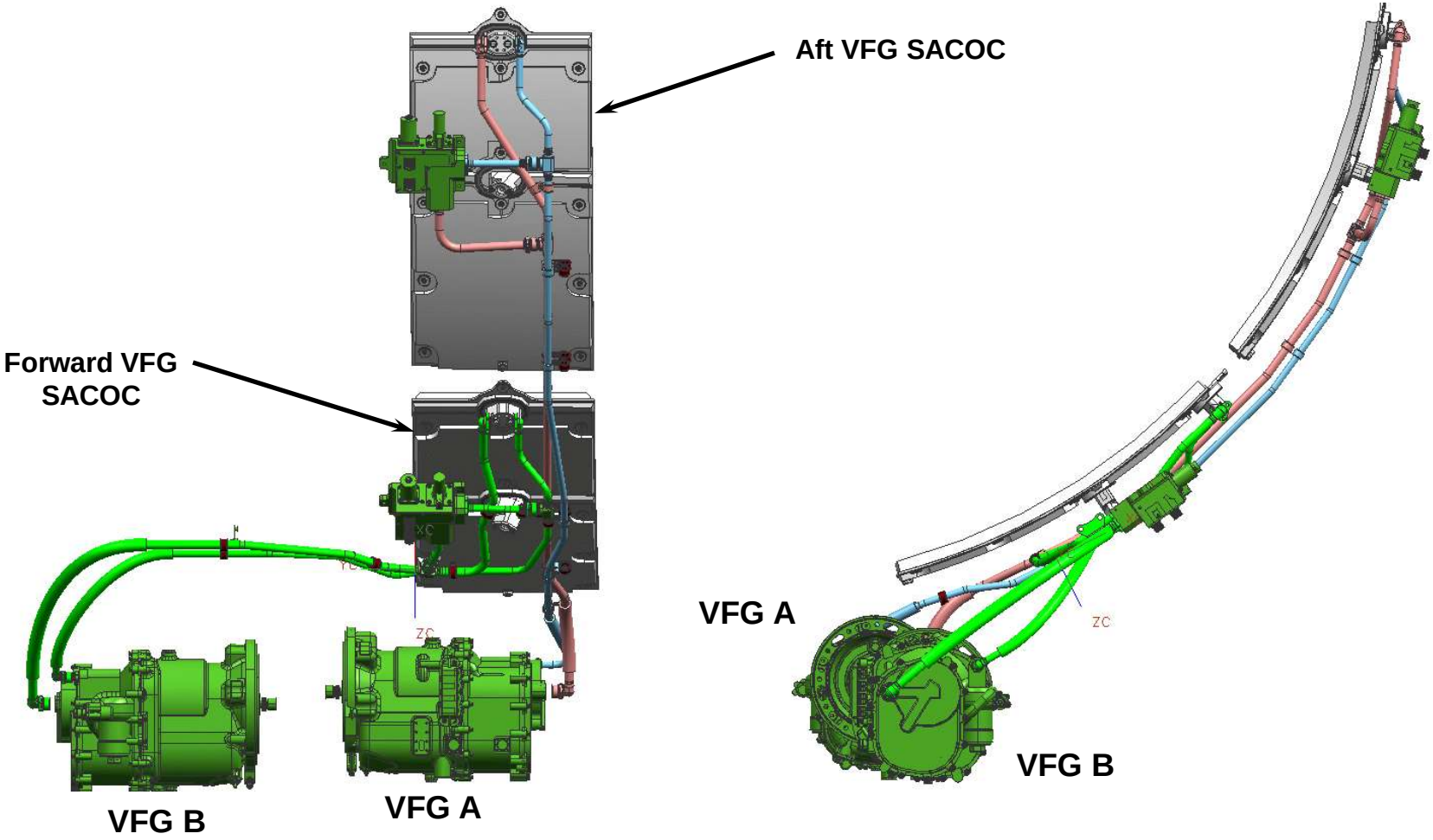
Final V-Band Installation Clock Position



VFG Installation Features



VFG External Oil Cooling Circuit



Oil Type and Leak Rate

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Oil Type and Leak Rate

- The VFG is oil cooled and lubricated, with a closed loop, internally driven, dedicated oil circuit.
- The VFG functions satisfactorily while using oil specified in HS approved oil list which conform to MIL-PRF-23699 or MIL-PRF-7808 including oil types defined in the AMM.
- The use of any additional oil brands to be approved for the aircraft engines will need to assessed for compatibility with the VFG.

Oil Leakage

- The VFG maximum oil leakage rate is 0.5 cc/FH or less during normal operation.
- Static seal oil wetting is normal, but no drops should form (including input shaft seal assembly when the input shaft is not rotating).

VFG/External Circuit Oil Fill Description

The following is a description of how oil is introduced into the VFG and external circuit:

1) Oil from the oil servicing cart/pump is introduced into the VFG via the pressure fill port on the high pressure/upstream side of the filter. This is also the discharge side of the positive displacement scavenge pump and prevents oil from flowing directly into the VFG sump during the fill process.
2) Oil flows through the filter and directly to the external circuit via the VFG oil-out port.
3) Oil exits the VFG oil-out port and fills the external circuit plumbing and heat exchangers returning into the VFG oil-in port.
4) Oil flows from the oil-in port into internal VFG coring and fills internal oil passages in the generator rotor and the main generator stator back iron cooling passages.
5) Oil exiting the rotor shaft orifices and scavenge pump inlet will fill the VFG sump until the oil reaches the top of the oil level standpipe located in the VFG sump.
6) Oil entering the top of the oil level standpipe will drain out of the VFG overflow drain port into the drain line to be captured in a container.
    - **NOTE**: VFG part numbers Pre-1712967E, the standpipe is higher than the operating oil level should be. Therefore, for those serial number VFGs, oil must be removed after servicing to standpipe to obtain the correct oil level. This should only affect test aircraft.

- **NOTE:** The end of the overflow hose must remain above the top of the oil in the container to permit air to enter the hose.

- The maximum oil supply pressure and flow to be provided by the oil servicing equipment is 15 gpm (56 liters/minute) at 30 psig (206 kPa). Quick connect couplings may be used on the pressure fill port and the standpipe overflow port if desired. **The fittings are not provided with the VFG nor are they supplied by UTAS.**

VFG Oil Servicing Precautions

The following considerations and precautions should be observed when performing any servicing procedures to the VFG:

- **WARNING**: HOT OIL CAN CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES, INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE OR SKIN CONTACT, SEEK MEDICAL ATTENTION.

- **WARNING**: POINT THE DRAIN HOSE INTO AN APPLICABLE CONTAINER WHEN YOU CONNECT THE OVERFLOW DRAIN HOSE TO THE OVERFLOW DRAIN VALVE. THIS WILL PREVENT BURNS FROM THE HOT OIL SPRAY. HOT OIL CAN CAUSE BURNS TO EYES AND SKIN.

- **CAUTION**: DO NOT OPERATE THE VFG WITHOUT SUFFICIENT OIL, OR WHEN IT IS OVERSERVICED WITH OIL. THIS CAN CAUSE DAMAGE TO THE VFG.

- **CAUTION**: DO NOT MIX OIL TYPES OR BRANDS WHEN YOU ADD OIL.

- **CAUTION**: DO NOT USE SOLVENTS THAT CONTAIN CHLORINE TO CLEAN THE EQUIPMENT (PUMP, HOSES, TANK, AND FUNNEL) USED TO FILL THE VFG WITH OIL. CHLORINE CONTAMINATION CAN CAUSE QUICK DETERIORATION OF THE OIL AND THE VFG.

- **CAUTION**: MAKE SURE THE DRAIN VALVE HOSE IS CONNECTED TO LET THE OVERFLOW OIL DRAIN TO THE CORRECT LEVEL IN THE VFG. THE VFG WILL OVERHEAT IF OVERSERVICED WITH OIL.

- **CAUTION**: USE ONLY NEW CANS OF OIL WHEN YOU SERVICE THE VFG. CONTAMINATION CAN CAUSE QUICK DETERIORATION OF THE OIL AND THE VFG.

VFG Normal Oil Servicing Procedure

The VFG oil servicing procedure is required only when a VFG is initially installed or when a hydraulic connection in the external circuit has been broken. Service the VFG by following these steps:

1) Place a drainage container capable of holding 1.5 gallons (5.7 liters) below the VFG.
2) Vent any residual pressure from the VFG per the following instructions: Put the end of the overflow drain hose over the drainage container and connect the overflow drain hose to the overflow drain Quick Disconnect fitting on the VFG. Some oil may come out from the overflow drain hose when it is connected.
3) Attach the oil filling device and line to the VFG pressure-fill Quick Disconnect fitting. Pump oil through the pressure-fill line until approximately 1 quart of oil drains from the overfill port.
4) Disconnect the oil filling device and line from the VFG pressure-fill Quick Disconnect fitting.
5) Install the dust cover securely on the pressure-fill Quick Disconnect fitting.
6) Wait until oil flow out the overfill port comes to a slow drip.
   NOTE: Flow may stop temporarily with the oil level above the top of the green band. In this case, more time is required to allow air to enter the VFG, or the overflow drain hose can be removed and reinstalled to accelerate the process.
7) Remove the overflow drain Quick Disconnect fitting.
8) Install the dust cover securely on the overflow drain Quick Disconnect fitting.
9) Good practice is to check for any VFG, fitting or line leakage after the first post servicing operation of the VFG. The oil level should also be checked after the first post servicing VFG operation.

VFG Oil Service Procedure With A Contaminated Oil System

This oil servicing approach is applicable when the cooling system external circuit is not disturbed and only the VFG is replaced but the external circuit is suspected to have been contaminated with failure debris.

This procedure assumes a new VFG has been installed.

1) After replacement of the VFG, **do not** connect the external circuit **oil-in** plumbing to the VFG. Connect the **oil-in** plumbing line from the external circuit to a hose that can drain into a 2-gallon (7.6 liters) minimum volume container.
2) Connect pressure fill hose to pressure-fill coupling/QD of the VFG.
   NOTE: This is similar to step 3 of the VFG Fill Description.
3) Pump approved oil into the VFG and allow oil to drain out of external circuit into container.
4) Stop pumping oil when at least 2 gallons (7.6 liters) of oil has drained from the overflow hose (approximately twice the external circuit volume).
5) Connect the oil-in plumbing line to the VFG.
6) Perform the oil servicing procedure per paragraph 4 above.

Procedure to flush the external circuit prior to VFG replacement

- Flushing of the external circuit could also be performed prior to removing the failed VFG. The oil filter in the failed VFG should be replaced with a new oil filter and the VFG oil-in plumbing line disconnected from the VFG. This will permit flushing clean filtered oil from the VFG through the external plumbing and into a separate container.

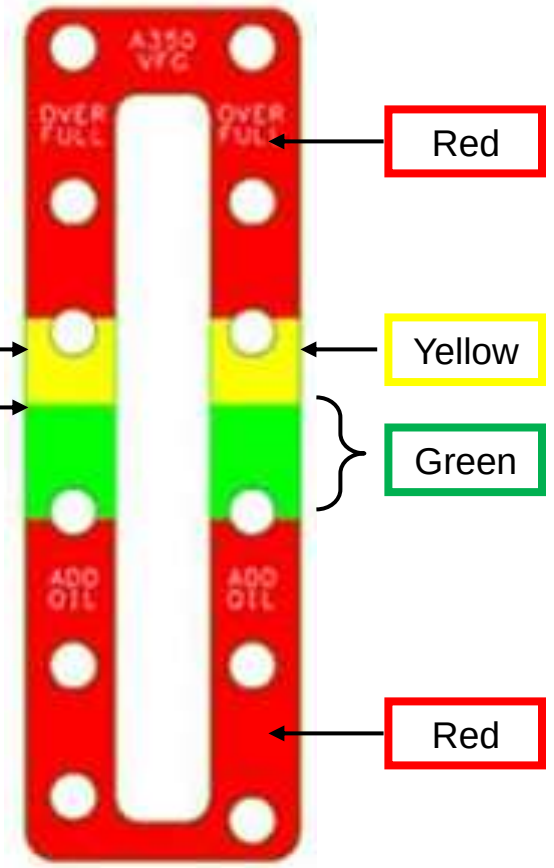
Visual Oil Level Indication

- A sight glass is provided to indicate the VFG oil level while the VFG is not operating for at least 5 minutes after engine shutdown (no rotation) and the airplane is within the ground normal attitude.
  - Pitch ± 1.9°
  - Roll ± 0.5°
  - **NOTE**: aircraft should not be on the towbarless truck when readings are made.

Visual Oil Level Indication – Sight Glass Indications

If **hot**, oil level may increase to the yellow band.

Proper IDG servicing brings oil level to the top of the green band.



VFG Static Installation Orientation with Reference to Ground

Engine	RR Trent XWB
Pitch	*+1.9° / -1.9°* *Push back (towbarless truck) +5.0°/-5.0°*
Roll	*Due to engine +0.5° / -0.5°*

VFG Oil/Filter Change Procedure

This procedure is very similar to the VFG standard oil servicing procedure with the exception that the filter must be changed and the drain plug removed to permit oil in the VFG sump and external circuit to be “flushed” out of the cooling plumbing. Typically the amount of oil used to flush the cooling plumbing is 1 gallon (3.8 liters) minimum, which is typically equal to or greater than the external circuit total volume.

The following considerations and precautions should be observed when performing any servicing procedures to the VFG:

- **WARNING**: HOT OIL CAN CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES, INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE OR SKIN CONTACT, SEEK MEDICAL ATTENTION.

- **WARNING**: POINT THE DRAIN HOSE INTO AN APPLICABLE CONTAINER WHEN YOU CONNECT THE OVERFLOW DRAIN HOSE TO THE OVERFLOW DRAIN VALVE. THIS WILL PREVENT BURNS FROM THE HOT OIL SPRAY. HOT OIL CAN CAUSE BURNS TO EYES AND SKIN.

- **CAUTION**: DO NOT OPERATE THE VFG WITHOUT SUFFICIENT OIL OR WHEN IT IS OVERSERVICED. THIS CAN CAUSE DAMAGE TO THE VFG.

- **CAUTION**: DO NOT MIX TYPES OR BRANDS WHEN YOU ADD OIL.

- **CAUTION**: DO NOT USE SOLVENTS THAT CONTAIN CHLORINE TO CLEAN THE EQUIPMENT (PUMP, HOSES, TANK, AND FUNNEL) USED TO FILL THE VFG WITH OIL. CHLORINE CONTAMINATION CAN CAUSE QUICK DETERIORATION OF THE OIL AND THE VFG.

- **CAUTION**: MAKE SURE THE DRAIN VALVE HOSE IS CONNECTED TO LET THE OVERFLOW OIL DRAIN TO THE CORRECT LEVEL IN THE VFG. THE VFG WILL OVERHEAT IF OVERSERVICED WITH OIL.

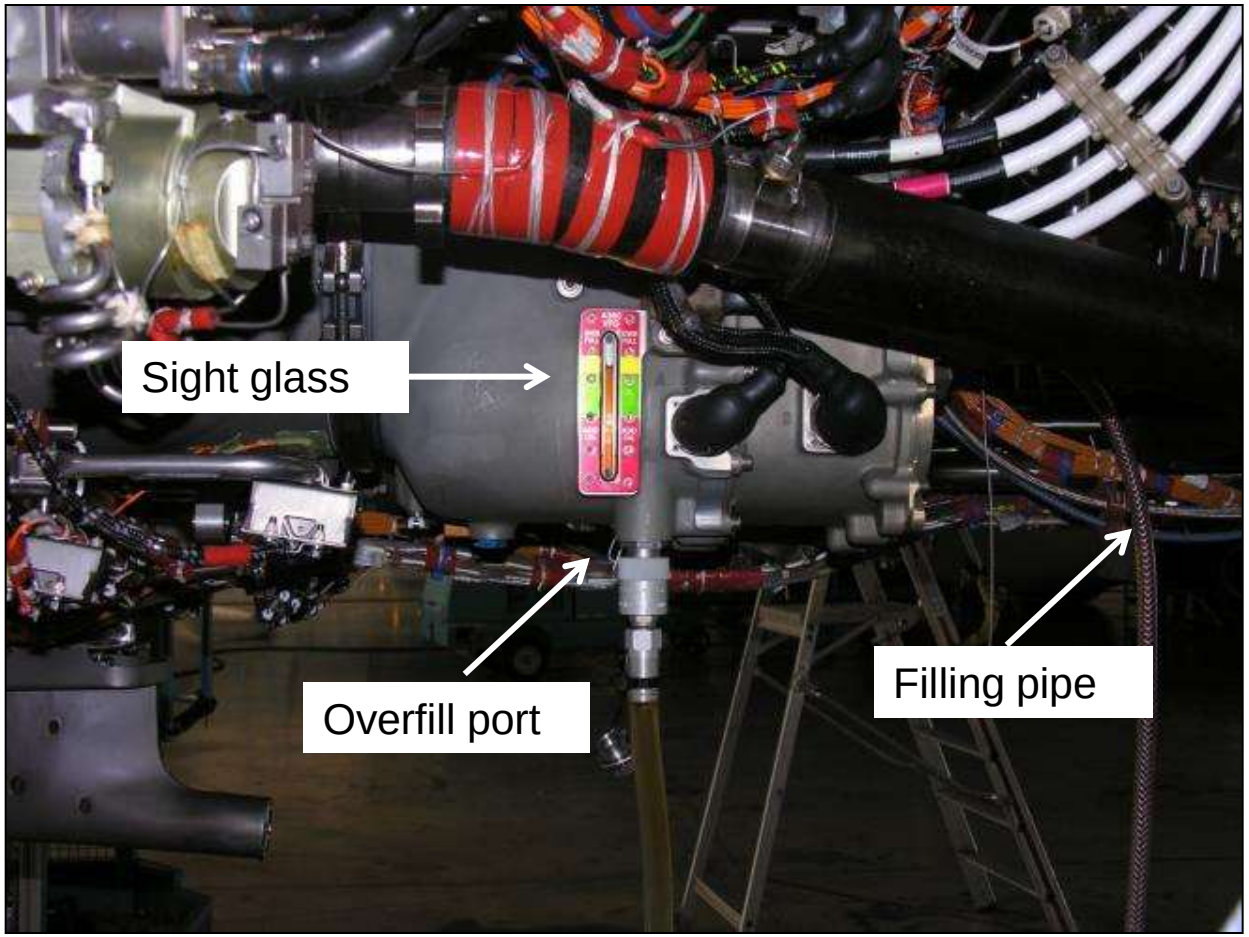
- **CAUTION**: USE ONLY NEW CANS OF OIL WHEN YOU SERVICE THE VFG. CONTAMINATION CAN CAUSE QUICK DETERIORATION OF THE OIL AND THE VFG.

VFG Oil/Filter Change Procedure

The oil/filter change procedure is as follows.

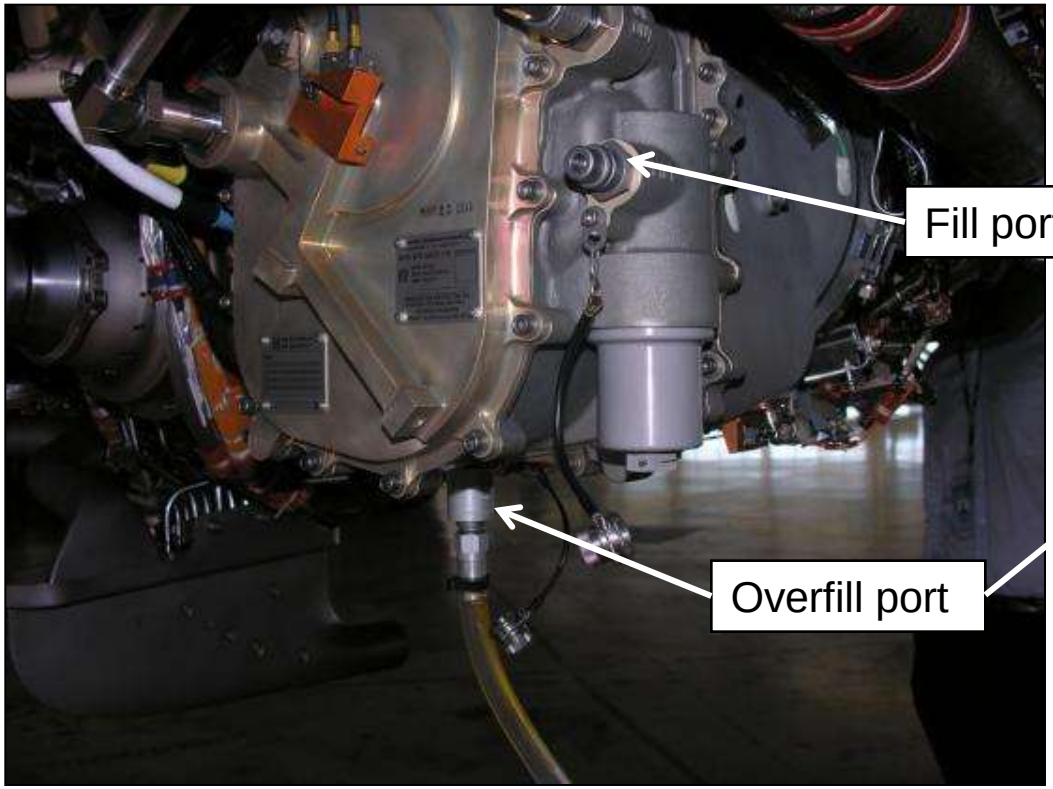
1) Place a drainage container capable of holding 2 gallons (7.6 liters) below the VFG.
2) Vent any residual pressure from the VFG per the following instructions: Put the end of the overflow drain hose over the drainage container and connect the overflow drain hose to the overflow drain Quick Disconnect fitting on the VFG. Some oil may come out from the overflow drain hose when it is connected.
3) With a 2-gallon (7.6 liters) minimum container located under the VFG drain plug, remove the oil drain plug to drain oil from the VFG.
4) Remove filter bowl cover and remove filter.
5) It is recommended that the VFG oil cooler be drained. The cooler drain cap must be replaced after the cooler is drained.
6) Install new filter in VFG and O-ring on filter bowl cover. Install filter bowl cover.
7) Attach the oil filling device and line to the VFG pressure-fill Quick Disconnect fitting.
8) Pump approved oil into the VFG. Stop pumping oil when at least 1 gallon (3.8 liters) of oil has pumped into the VFG and drained from the drain port into the container.
9) When oil from the oil drain port slows to a slow drip, install the oil drain plug with a new O-ring.
10) Service the VFG with oil using the detailed instructions in oil servicing procedures.

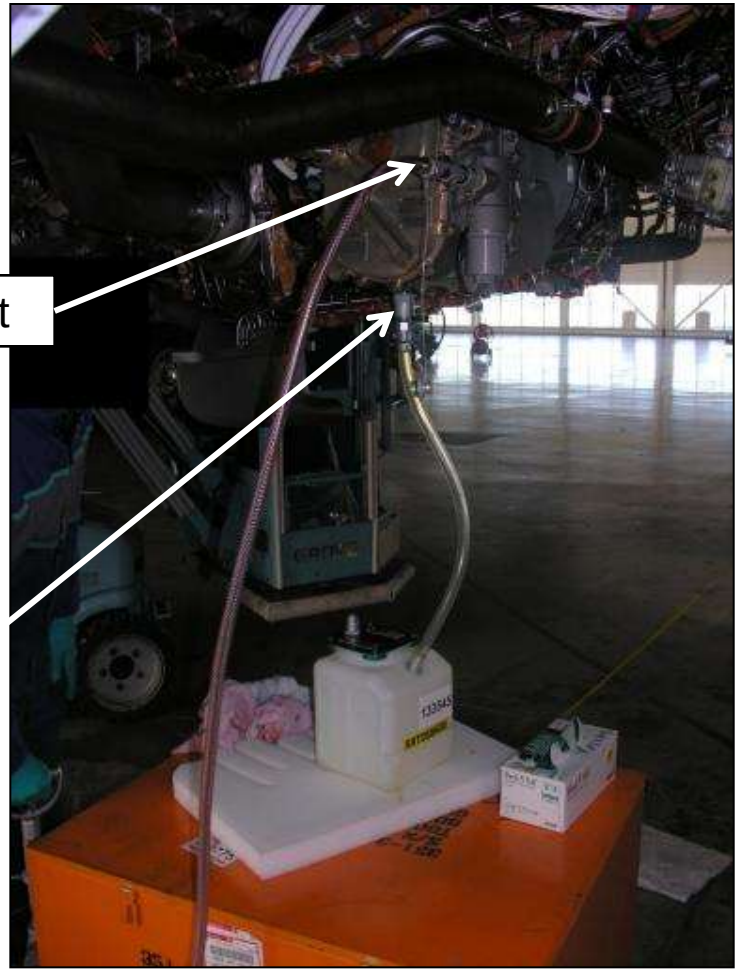
VFG Servicing

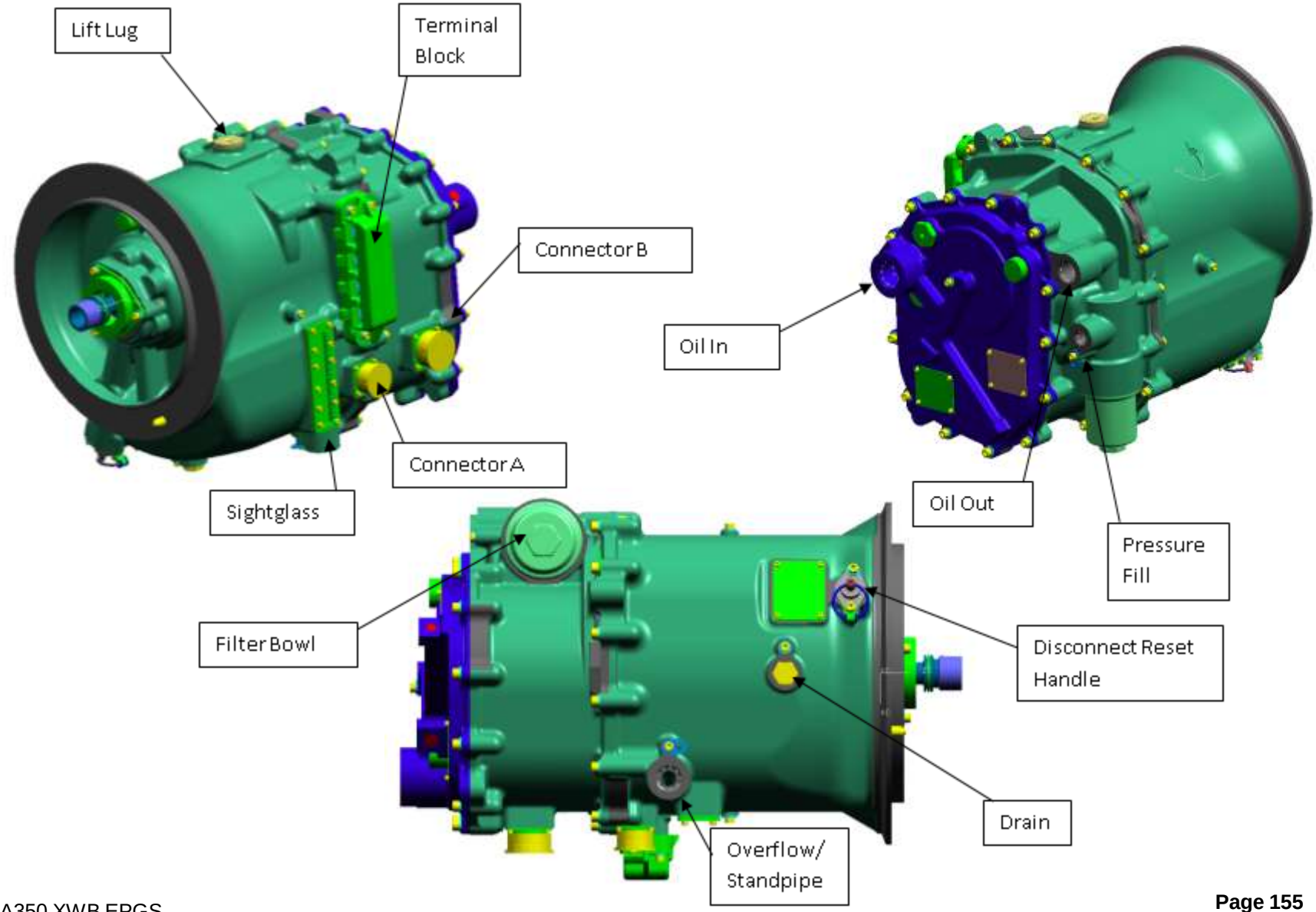


VFG Quick Disconnect Fittings (not supplied)

VFG Servicing







Parts Replacement

General Procedures

Follow the general procedures listed below when the VFG parts are replaced. Know the general procedures before you continue.

1) If possible, let the VFG become cool before the VFG has any parts replaced. This will make sure that the VFG is not dangerous to touch.
2) Open the VFG overflow fitting slowly to allow any residual internal pressure to be relieved. This will prevent oil from spraying when a part is removed or replaced.
3) The O-rings are used as oil seals on different components of the VFG. Discard all moved O-rings. Use new O-rings for assembly. Apply O-ring lubricant or an approved oil to the O-rings. Do not use grease. O-ring lubricant and oil prevent the O-ring from being cut when moved between metal surfaces. After assembly, remove the unwanted O-ring lubricant or oil so that the unwanted O-ring lubricant or oil is not mistaken for a leak.
4) Do not do unnecessary disassembly. Keep disassembly to the related replacement area. Keep the related parts together.
5) Never use a screwdriver to move a part or assembly apart from the housing. When resistance is found, it will usually be caused by the tight fit of the O-ring below.

Oil Filter Removal

WARNING: HOT OIL CAN CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES, INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE OR SKIN CONTACT, SEEK MEDICAL ATTENTION.

1) Remove the dust cap from the overflow fill fitting.

   WARNING: POINT THE DRAIN HOSE INTO AN APPLICABLE CONTAINER WHEN YOU CONNECT THE OVERFLOW DRAIN HOSE TO THE VERFLOW DRAIN VALVE. THIS WILL PREVENT BURNS FROM THE HOT OIL SPRAY. HOT OIL CAN CAUSE BURNS TO EYES AND SKIN.

2) Connect the overflow drain hose to the overflow drain valve to release the VFG case pressure. Some oil may come out from the overflow drain hose when it is connected.

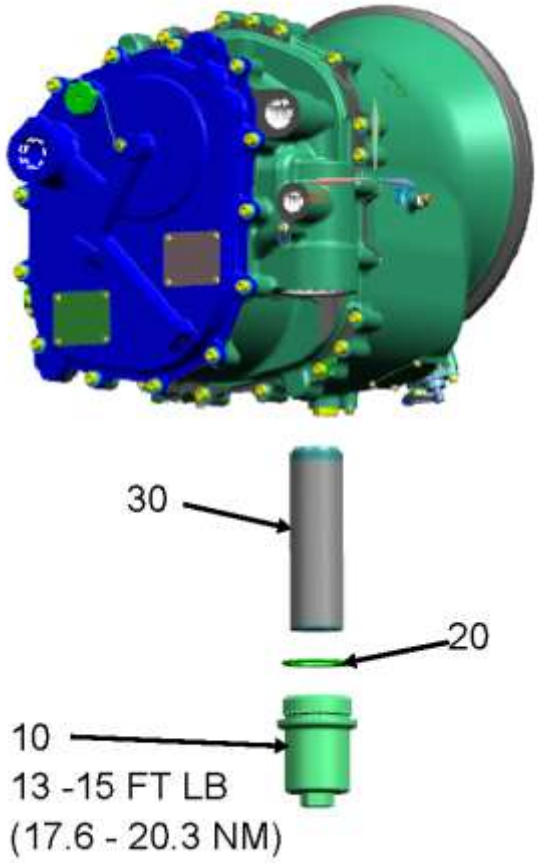
   WARNING: WEAR GOGGLES WHEN YOU REMOVE LOCKWIRE OR SAFETY CABLE.

3) Remove the lockwire or safety cable from the filter cap (10)
4) Remove the filter cap(10).
   NOTE: Be prepared to catch the oil in a separate container under the filter cavity.
5) Remove the O-ring (20) from the filter cap. Discard the O-ring.
6) Remove the filter element (30).
7) Examine the filter element.

Oil Filter Installation

1) Apply O-ring lubricant or oil to the O-ring (20) and install it on the filter cap (10)
2) Apply O-ring lubricant or oil to the O-ring on the inner diameter of the filter element (30).
3) Install the filter element (30) into the filter cavity in the VFG until the O-ring makes a seal.
   CAUTION: MAKE SURE THE COMPONENTS ARE SEATED IN THE FILTER CAVITY BEFORE YOU INSTALL THE FILTER CAP. DO NOT TIGHTEN THE FILTER CAP TO FORCE THE FILTER ELEMENT INTO THE HOUSING.
4) Apply a light coat of anti-seize lubricant (MIL-A-907E) to the filter cover threads prior to installing. (Recommended)
5) Install the filter cap (10). Torque the filter cap 13 to 15 ft-lb (17.6 to 20.3 Nm)
   WARNING: WEAR GOGGLES WHEN YOU REMOVE LOCKWIRE OR SAFETY CABLE.
6) Secure the filter cap (10) with lockwire for safety cable.
7) Service the VFG. Refer to OIL SERVICING.

Oil Filter Parts Replacement



Item	Nomenclature	Part Number	Quantity
10	Oil Filter housing cap	739482	1
20	Oil Filter housing cap O-ring seal	M83485/1-226	1
30	Oil Filter	5904761	1

Case Drain Plug Removal

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Case Drain Plug Removal

1) Remove the dust cap from the overflow drain valve.

   WARNING: HOT OIL CAN CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES, INSULATED GLOVES, AND OTHER PROTECTIVE EAR. IN CASE OF EYE OR SKIN CONTACT, SEEK MEDICAL ATTENTION.

2) To release the VFG case pressure, connect the overflow drain hose to the overflow drain valve. Some oil may come out from the overflow drain hose when it is connected.

   WARNING: POINT THE DRAIN HOSE INTO AN APPLICABLE CONTAINER WHEN YOU CONNECT THE OVERFLOW DRAIN HOSE TO THE VERFLOW DRAIN VALVE. THIS WILL PREVENT BURNS FROM THE HOT OIL SPRAY. HOT OIL CAN CAUSE BURNS TO EYES AND SKIN.

3) Point the drain hose into an applicable container.

WARNING: WEAR GOGGLES WHEN YOU REMOVE LOCKWIRE OR SAFETY CABLE.

4) Remove the lockwire from the case drain plug (10)

   NOTE: Be prepared to catch the oil in a separate container under the case drain.

5) Remove the drain plug (10) and drain the oil into a suitable container.

6) Remove the O-ring (20) from the plug (10). Discard the O-ring.

Case Drain Plug Installation

1) Apply O-ring lubricant or oil to the O-ring (20) and install it on the plug (10)

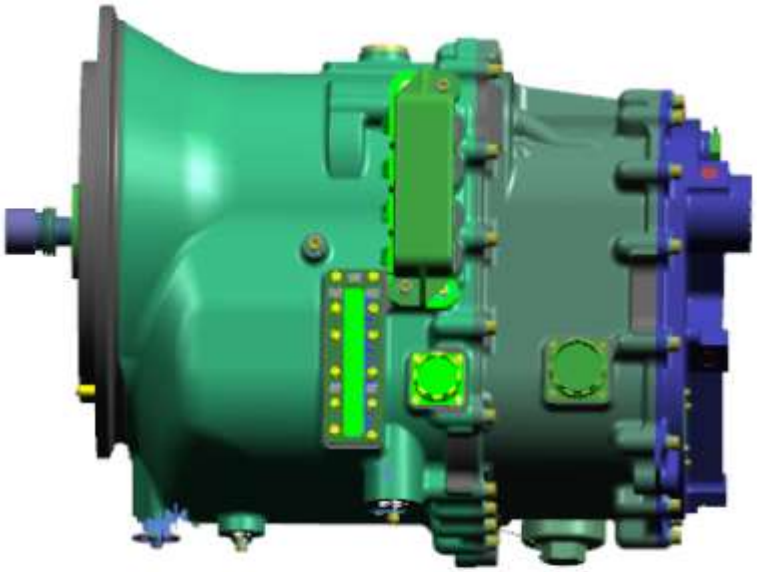
2) Install the drain plug (10) in the VFG. Torque the drain plug to AMM specifications.

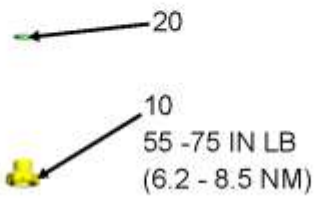
WARNING: WEAR GOGGLES WHEN YOU REMOVE LOCKWIRE OR SAFETY CABLE.

3) Secure the case drain plug (10) with lockwire or safety cable.

4) Service the VFG. Refer to OIL SERVICING

Drain Plug Parts Replacement





Item	Nomenclature	Part Number	Quantity
10	VFG drain plug	AS5169D05L	1
20	VFG drain plug O-ring seal	M83485/1-905	1

Terminal Block Removal/ Installation

Removal

1) Remove the screws (30), washers (40), and terminal block cover (10).

2) Remove the captive washer nuts (60). Discard the nuts only if they are damaged.

3) Remove the phase leads from the terminals.

4) Remove the screws (20) and washers (40) that attach the terminal block (50).

5) Slide the terminal block (50) toward the input end of the VFG from the through leads and remove it from the VFG.

6) Remove the square washers (70) from the terminal block.

Installation

1) Install the square washers (70) on the terminal block.

   CAUTION: MAKE SURE THE SQUARE WASHERS ARE PUT UNDER THE THROUGH LEAD STRAPS. WASHERS NOT IN THE CORRECT POSITION CAN CAUSE TOO MUCH HEAT AND DAMAGE THE VFG

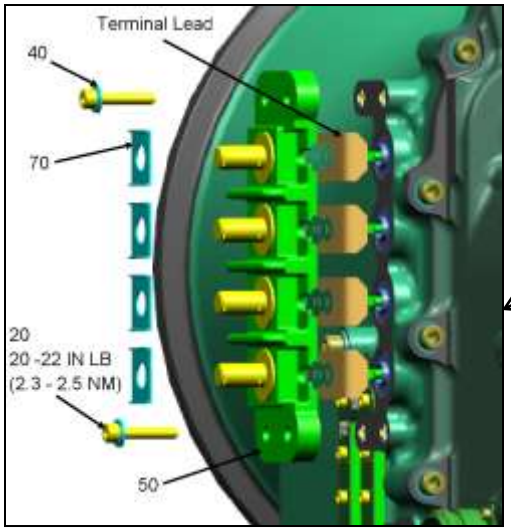
2) Slide the terminal block (50) under the through leads on the VFG. Make sure the square washers (70) are installed under the through lead straps (Refer to figure 16)

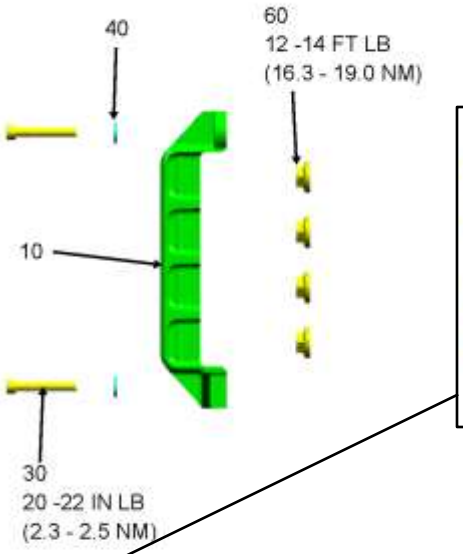
3) Attach the terminal block (50) with washers (40) and screws (20). Torque the screws to AMM specifications.

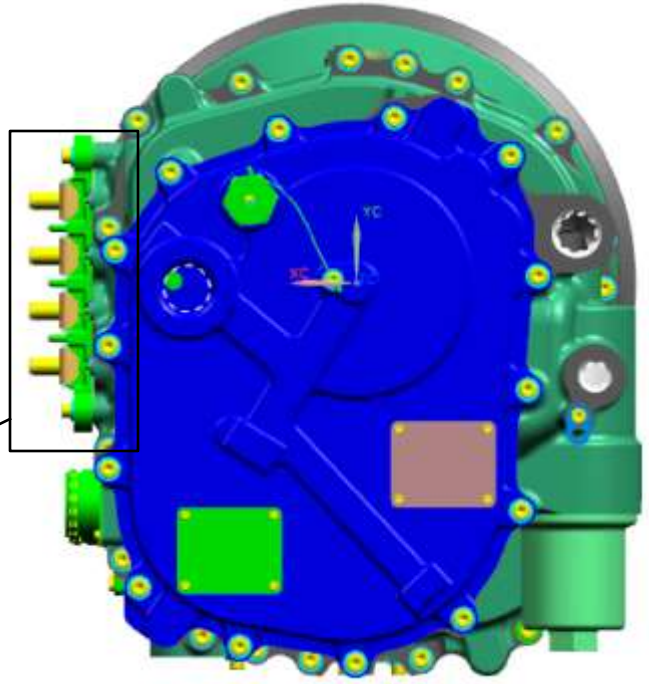
4) Install the phase leads and captive washer nuts (60). Tighten the nuts to AMM specifications.

5) Attach the terminal block cover (10) with the washers (40) and screws (30). Torque the screws to AMM specifications.

Terminal Block Parts Replacement



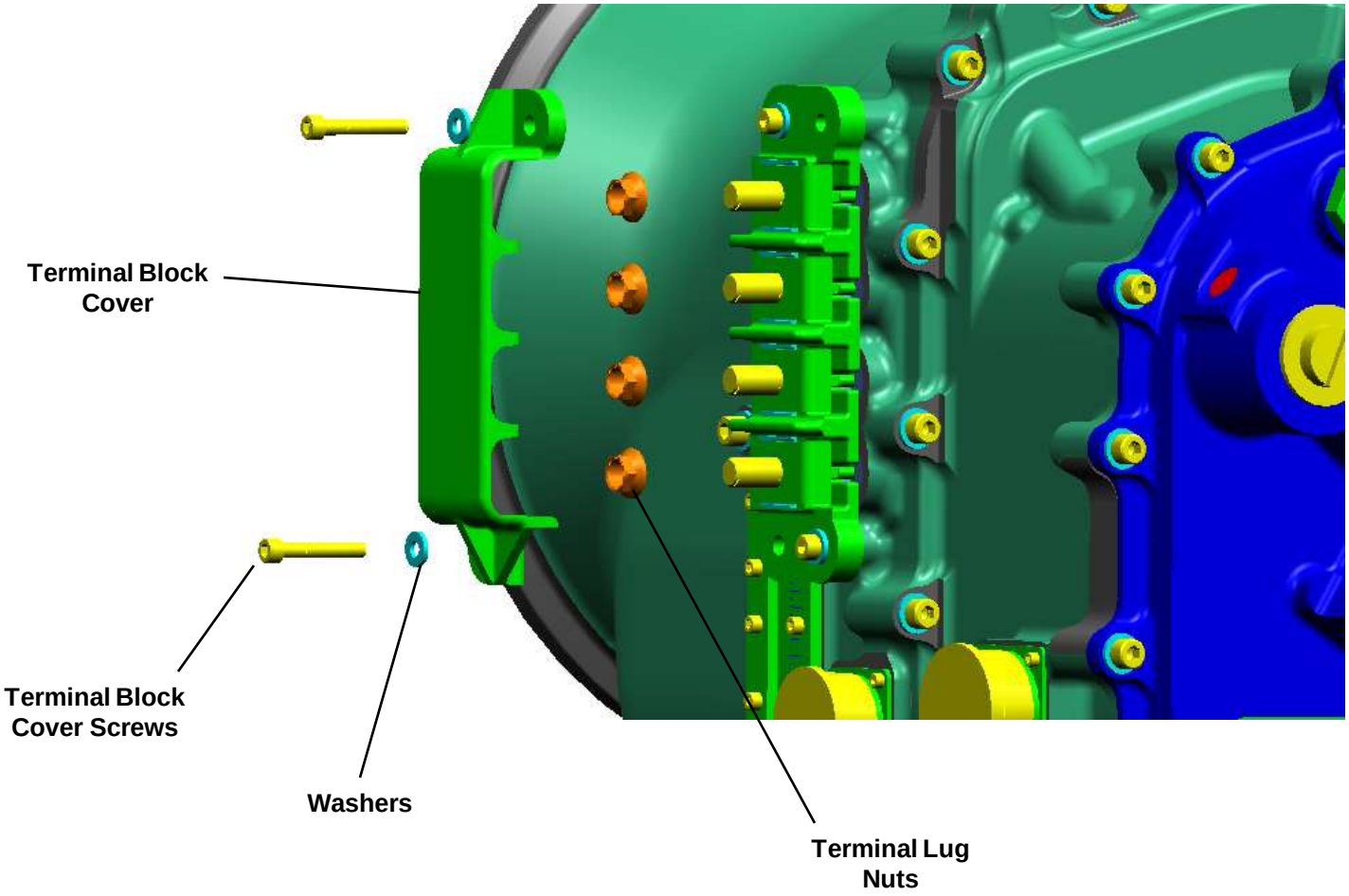




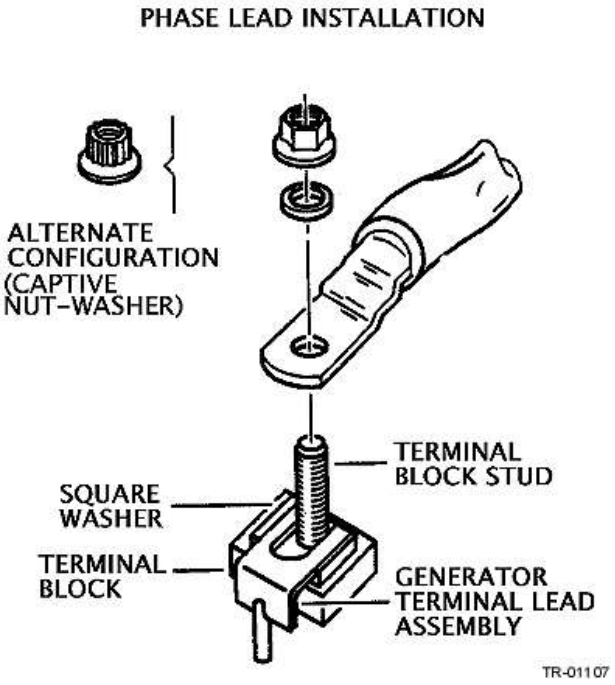
Item	Nomenclature	Part Number	Quantity
10	Terminal Block Cover	1716077-1	1
20	Terminal Block Mounting Screws	NAS1351N3-16S	2
30	Terminal Block Cover Screws	NAS1351N3-20S	2
40	Washers	NAS1149E0363R	4
50	Terminal Block	1714388	1
60*	Captive Washer Nuts	5914875-5	2
70	Square Washers	730807	4

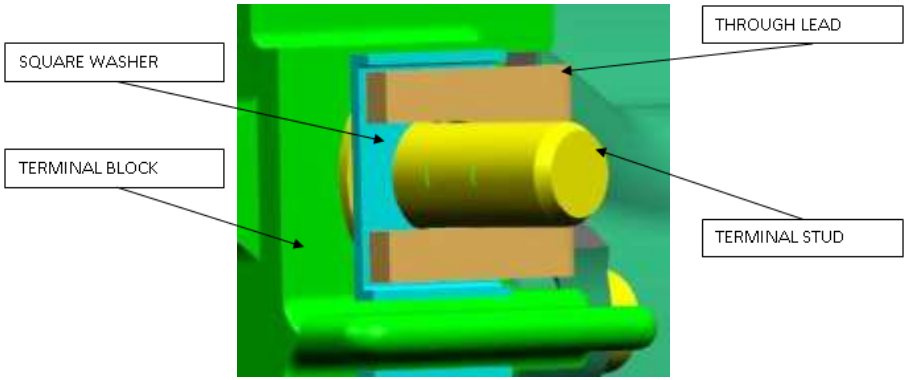
***Item 60 may be replaced with 5914876-5, but 5914875-5 is preferred**

Terminal Block Parts Replacement



Phase Lead Installation & Square Washer Positioning





Input Shaft O-ring Seal Replacement

Removal

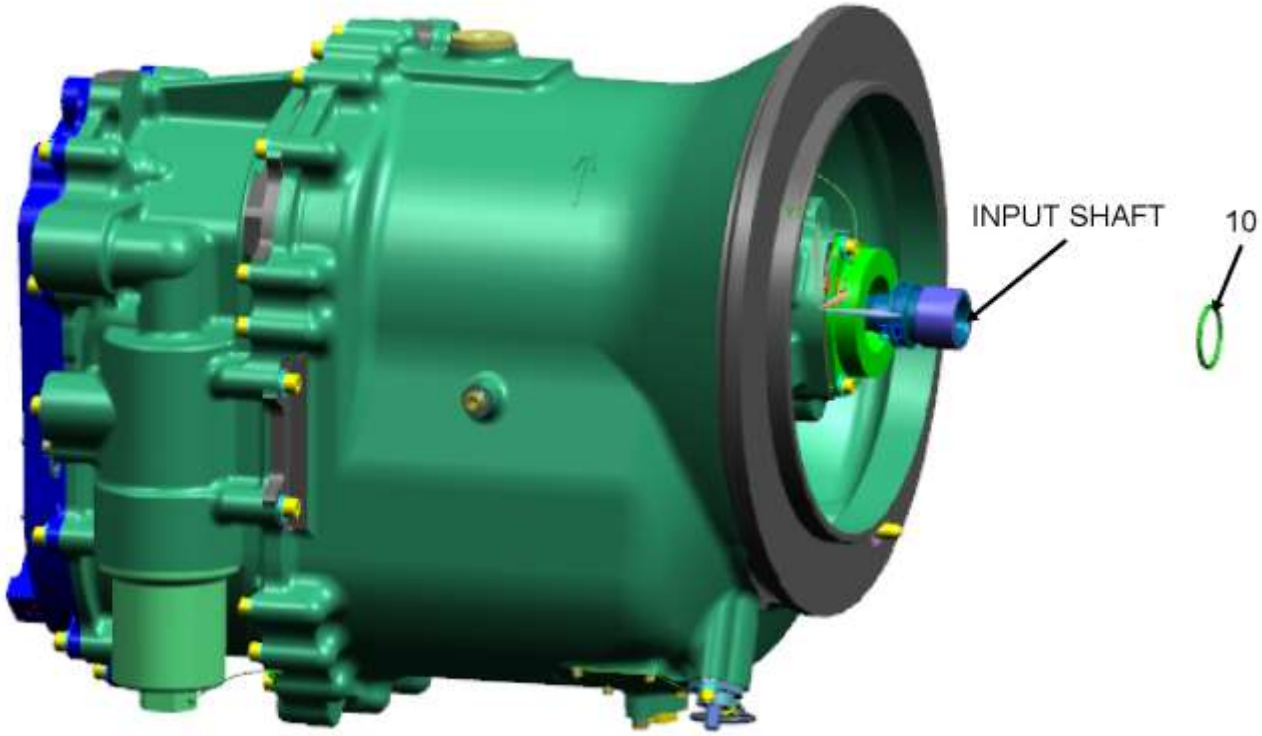
- **WARNING**: HOT OIL CAN CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES, INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE OR SKIN CONTACT, SEEK MEDICAL ATTENTION.

1) Remove the O-ring (10) from the Input shaft. Discard the O-ring.

Installation

1) Apply O-ring lubricant or oil to the O-ring (10) and install it on the input shaft.

Drive Shaft O-ring Seal Parts Replacement



Item	Nomenclature	Part Number	Quantity
10	Drive shaft O-ring seal	M83485/1-121	1

Oil Port Parts Replacement

Removal

WARNING: HOT OIL CAN CAUSE BURNS TO EYES AND SKIN. WEAR SPLASH GOGGLES, INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE OR SKIN CONTACT, SEEK MEDICAL ATTENTION.

NOTE: Be prepared to catch the oil in a separate container under the case drain.

1) Remove drain plug (Refer to 7.1 DRAIN PLUG REMOVAL).

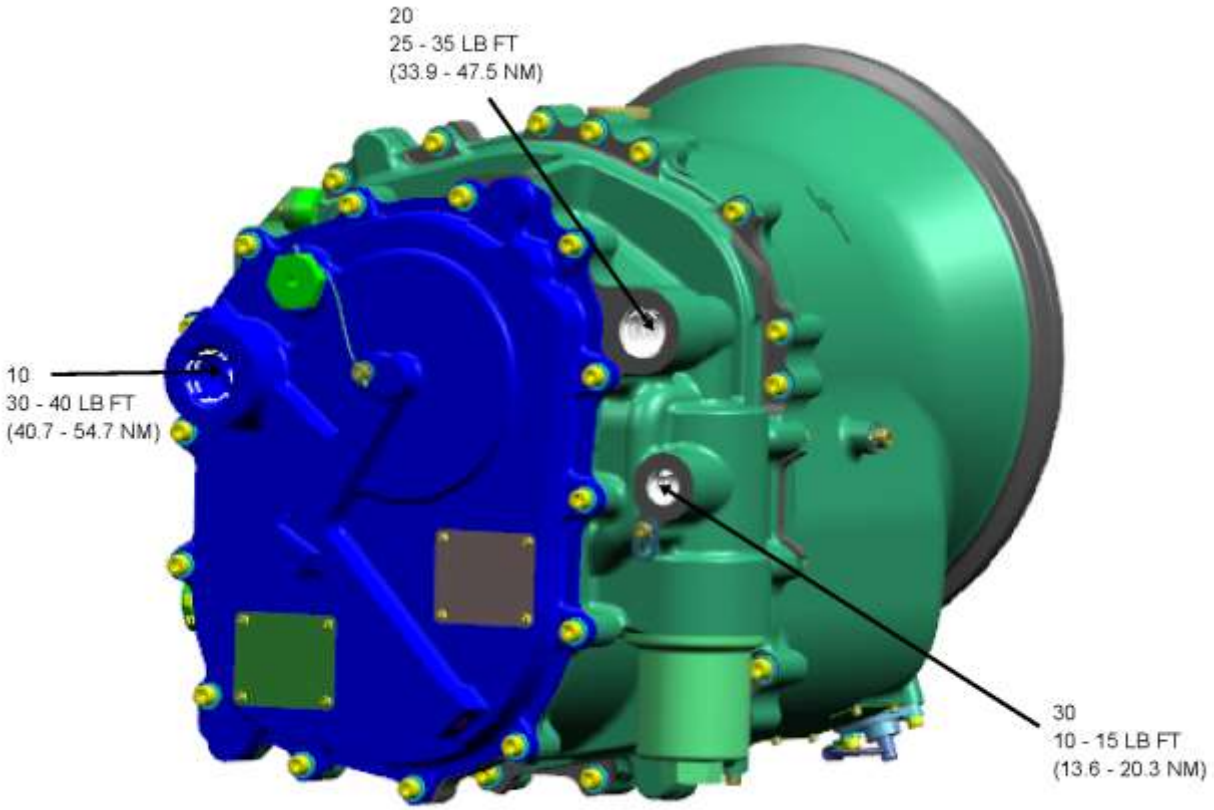
2) Remove the fittings (supplied by Airbus or Rolls Royce) from oil-in port (10), oil-out port (20), and pressure fill port (30).

Installation

1) Verify drain plug has been installed (Refer to 7.2 DRAIN PLUG INSTALLATION).

2) Install fittings (supplied by Airbus or Rolls Royce) in oil-in port (10), oil-out port (20), and pressure fill port (30). Refer to Figure 19 for torque values.

Oil Port Parts Replacement



Item	Nomenclature	Torque value
10	Oil-in port	per AMM Specifications
20	Oil-out port	per AMM Specifications
30	Pressure Fill Port	per AMM Specifications

Disconnect Reset Parts Replacement

Disassembly

1) Remove screw (10) and cushioned clamp (20).

2) If performing a disconnect pull disconnect handle fully to the extent of the handles travel, then slowly release (Refer to 2.2.2 INPUT SHAFT DISCONNECT MECHANISM).

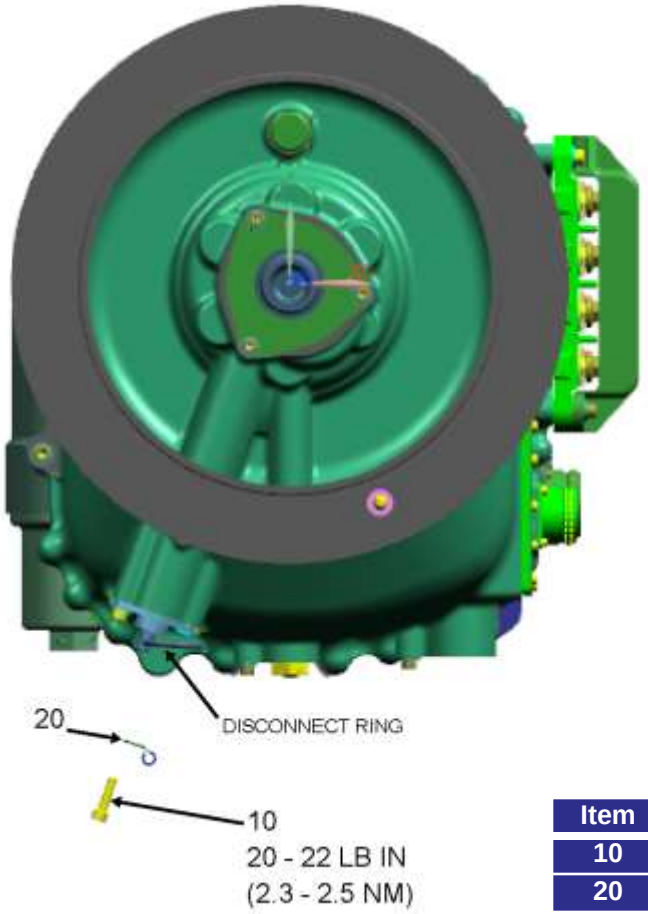
3) Note on placard that a disconnect has been performed.

Reassembly

1) Assemble disconnect ring into clamp.

2) Install cushioned clamp (20) and screw (10). Torque fastener to AMM specifications.

Disconnect Reset Parts Replacement



Item	Nomenclature	Part Number	Quantity
10	Screw	NAS1351N3-12S	1
20	Cushioned Clamp	59087-3	1

Servicing Activities

- Maintenance Schedule
  - After entering regular service, no scheduled maintenance will be required by the VFG other than oil and filter servicing.
  - All other maintenance is “On Condition”.
- Oil Filter
  - The VFG incorporates an oil filter to protect the external oil circuit from contamination in case of an internal failure.
- Servicing and Filter Change Interval
  - 2100FH (increase pending oil sampling results)
- Servicing fittings
  - The VFG pressure fill and drain fittings are supplied by the engine manufacturer.
  - Consider potential effects of reusing these parts over an extended period.
- Deactivated VFG
  - An on aircraft deactivated VFG can withstand 35FH cumulative time without damage, per Master Minimum Equipment List (MMEL) requirements. (35FH = 50FH - 15FH for conservative flight time of previous flight with disconnect.)
- Draining the VFG of Oil
  - The VFG can be drained of oil by removing VFG drain plug.
  - Residual oil is allowed to remain.

Torque Values

- Double-wrenching
  - Double wrenching will be applied when addressing the oil port connections to stabilize torque between connection elements.

- All Torque Values can be found in the AMM:
  - Servicing Torque Values
    - VFG Terminal Stud Resist Capability
    - Feeder Lug Retention Nuts
    - V-Band Flange Mounting Screws
    - V-Band Clamp Tension Nut
    - Oil Filter Cap
    - Terminal Block Mounting Screws
    - Terminal Block Cover Mounting Screws
  - Fastener Interface Torque Values:
    - VFG Terminal Stud Resist Capability
    - Feeder Lug Retention Nuts
    - V-Band Flange Mounting Screws
    - V-Band Clamp Tension Nut
    - Oil Filter Cap 17.6-20.3 N-m
    - Terminal Block Mounting Screws
    - Terminal Block Cover Mounting Screws
  - VFG Oil Interface Torque Values:
    - Oil-out Port
    - Oil-in Port
    - Pressure Fill Port
    - Case Drain Port
    - Standpipe Port

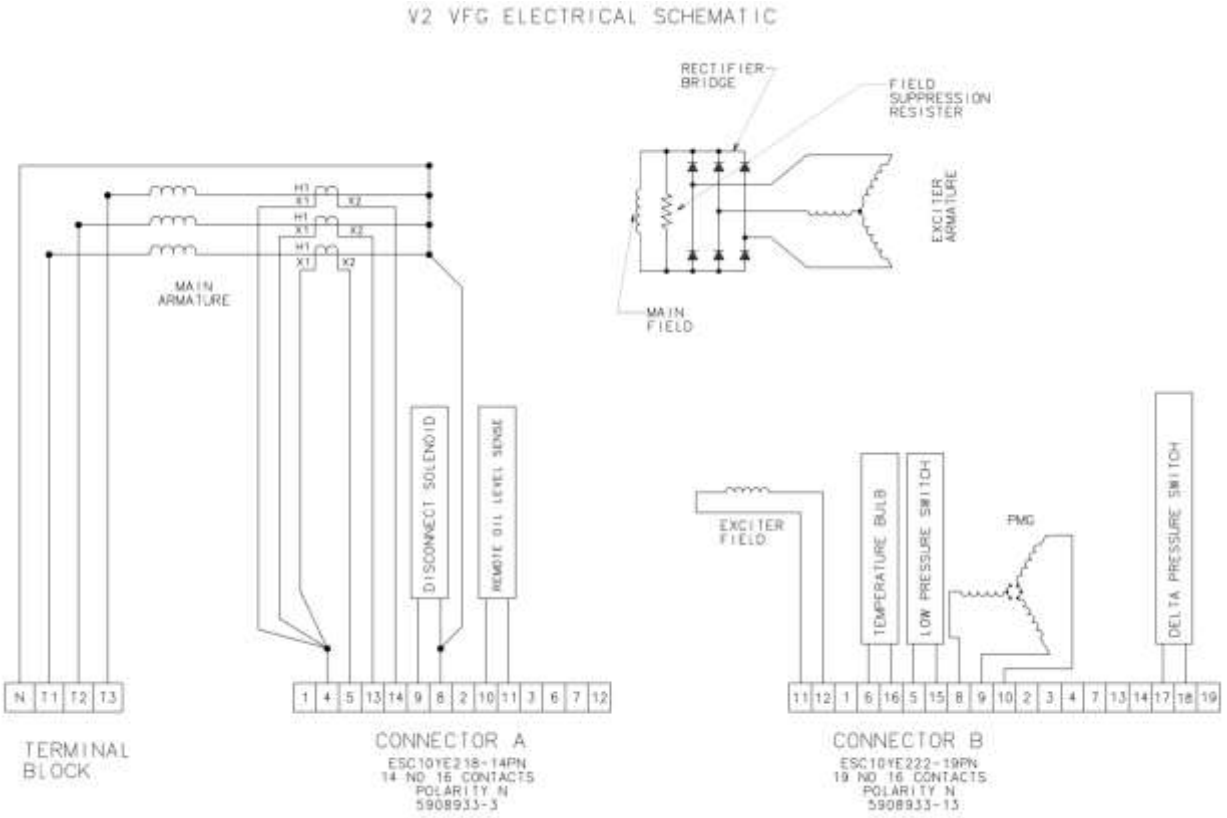
Lubricating Oils

Document	Title/Description
MIL-PRF-7808L	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-PRF-23699F	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-PRF-907F	Special Anti-Sieze Lubricant

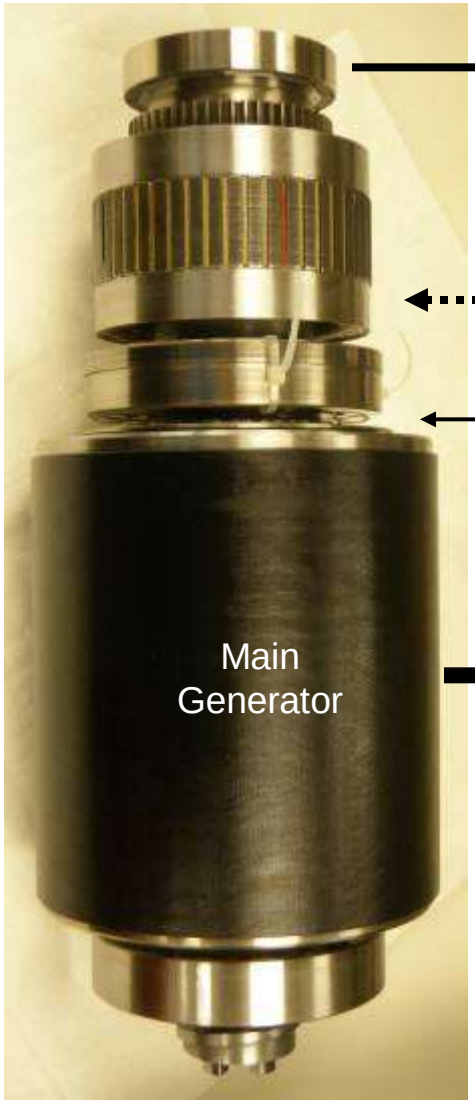
Oil Contamination Limits

ACID CONTENT (maximum) ASTM D974 or ASTM D664 (mg KOH/gram)	GRAVIMETRIC CONTAMINATION (maximum) (mg/100 ml)	WATER CONTENT (maximum) ASTM D1533 (percent by Weight)	CHLORINE CONTENT (maximum) (ppm)
2.0	5.0	0.10	100

VFG Electrical Schematic



Voltage Regulation



OPU

GCU

PMG

Rectifier

HVPS

Exciter
Generator

OPU
GCR

GCR

Rectifier

HVPS

PWM

28Vdc

Internal
28Vdc

28V
Backup

FAULT
OFF

FAULT
OFF

FAULT
OFF

Rectifier
(Diode Package
Assembly)

POR
SENSE

Main Generator

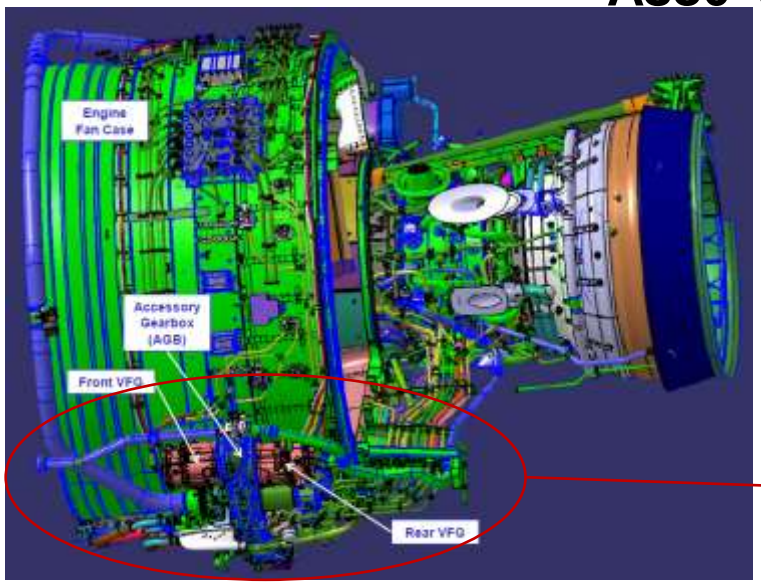
GLC

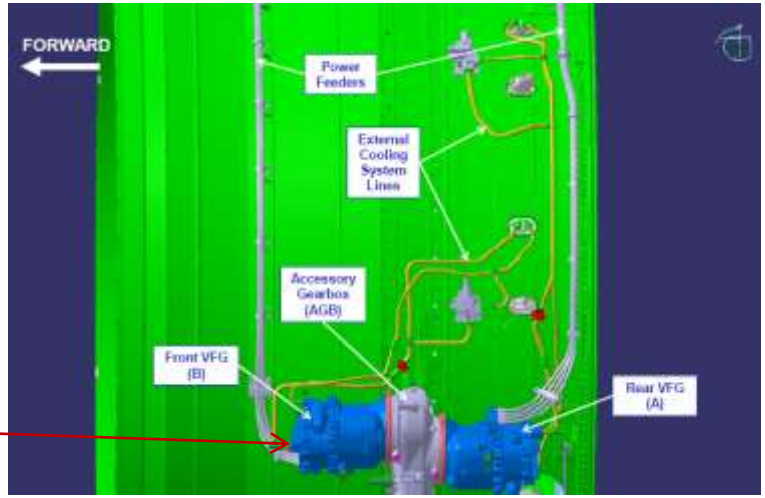
BTC

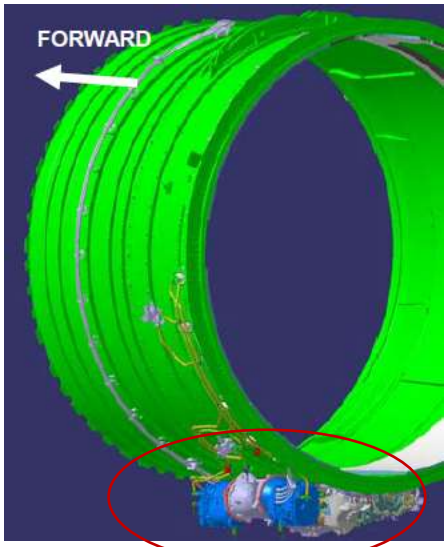
TIE BUS

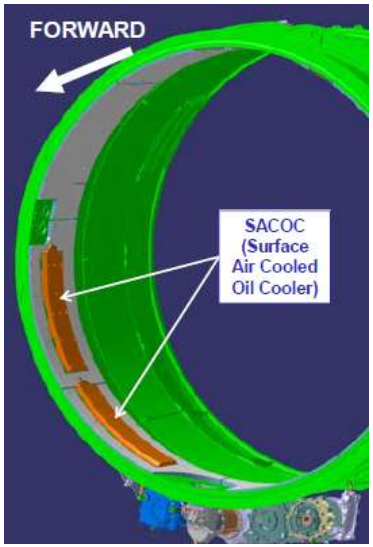
AC BUS

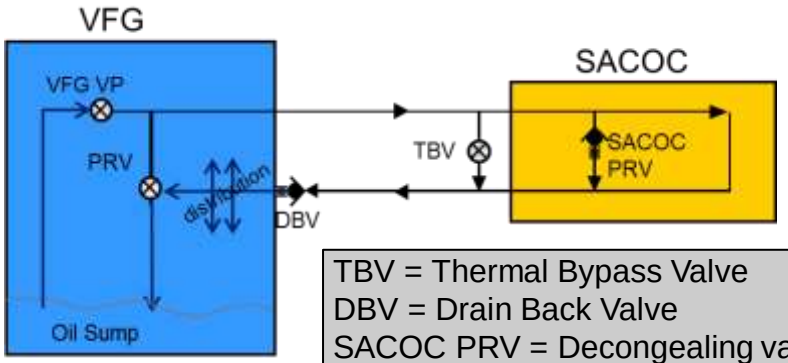
A350 VFG External circuit





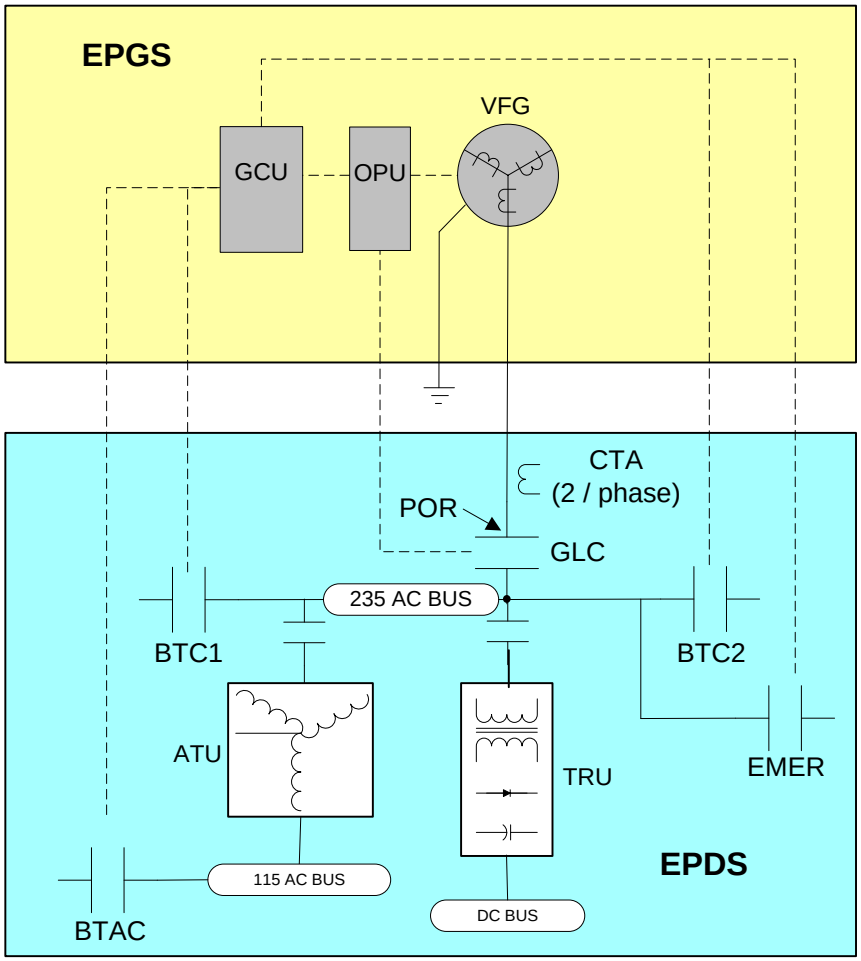




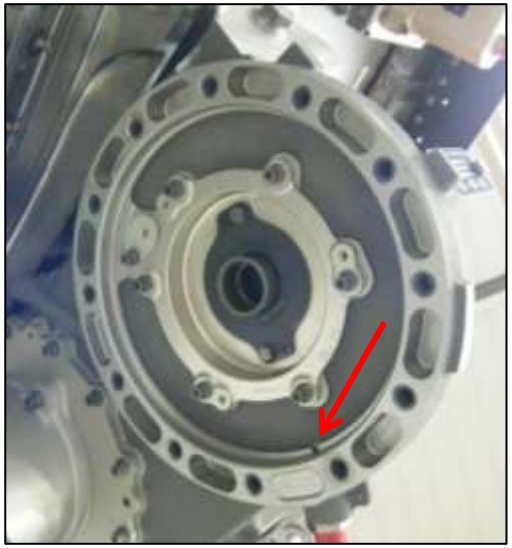


TBV = Thermal Bypass Valve
DBV = Drain Back Valve
SACOC PRV = Decongealing valve
VFG PRV = VFG Flow control valve
VFG VP = VFG Vane Pump
PRV = Pressure Regulation Valve

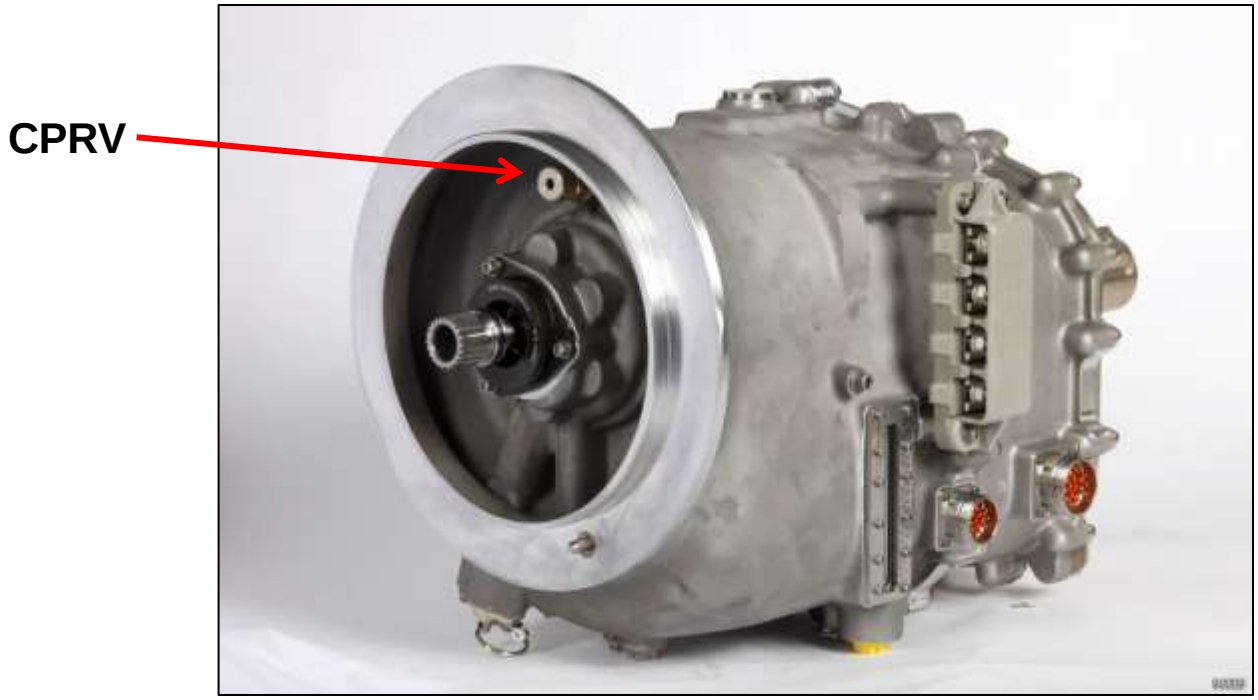
EPGS Single Channel Architecture



Case Pressure Relief Valve

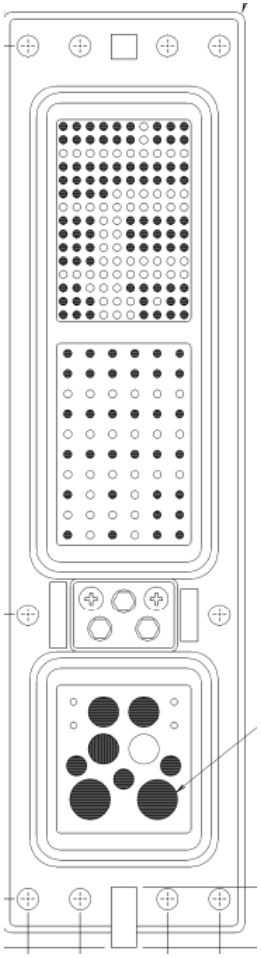


Gearbox Pad & Drain



Pin Programming

- **Pin Programming**
  - The GCU senses aircraft pin programming to define
    - Aircraft type
    - Engine type
    - EPGS channel number (1 through 4)



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