G650 Electrical System
**G650 Electrical System**

- The Electrical Power System produces:
  
  
  
  
  AC and DC power

- 115 Volts AC is generated in order to produce 28 Volts DC via Transformer Rectifier Units (TRU)
  
  
  
  
  115 VAC \rightarrow TRU \rightarrow 28 VDC

- AC Motors
  
  
  
  
  Heaters
  
  
  
  
  DC Chargers


  
  
  
  
  Everything else

- Two (2) separate systems/networks
  
  
  
  
  L \rightarrow R

  
  
  
  
  AC

  
  
  
  
  DC

- A split bus system prevents a short on one side from affecting the other side
- Operative side can power inoperative side

- Power Distribution Buses (PDBs):

- The Electrical System is controlled by two (2) Bus Power Control Units (BPCUs)

- Six (6) Computers (2 BPCUs and 4 GCU)

(RAT deployed) only
AC System

115 VAC is generated by:

NORMAL

OPEN BUS TIE RELAY

EMERGENCY
DC System

28 VDC is produced by:

NORMAL

ESS TRU

L MAIN TRU

AUX TRU

R MAIN TRU

R ESS TRU

L MAIN DC

R MAIN DC

EXT DC

GSB

L ESS DC

R ESS DC

L MAIN BATT

R MAIN BATT

EBHA BATT

UPS BATT

EMERGENCY
- **Bus Power Control Units (BPCU)**

- The electrical power system is **controlled** by two **identical and interchangeable microprocessors** called BPCUs

- in charge of power distribution and protection
- traffic cops and protectors of the buses
- control and make all logical decisions associated with the electrical power system
- BPCU logic: ESS before MAIN / L before R

- located in LEER and REER
Fault detected by \( L \) BPCU

Bus contactor opened and locked out to protect the bus

\( L \) BPCU notifies the crew via CAS

\( L \) AC Power Fail

\( L \) AC reset

\( L \) IDG

Can be reset by the crew via the AC\( \text{DC} \) switch if the fault is no longer present

\( AC\text{DC} = \text{CTRL} + \text{ALT} + \text{DEL} \)

Resets BPCU
Control the bus tie relays which allow operative side to power the inoperative side in the event of a short/fault on one side.
- **No Break Power Transfer (NBPT)**
  
  - Controlled by L BPCU
  - Power Transfer without a Momentary Interruption
  - Matches the phases of the IDGs and/or APU GEN

- No Break
  - IDG
  - AND
  - No failure

- Break
  - No IDG
  - AND/OR
  - Failure

- EXT AC
- APU GEN
- GEN
- R IDG
- Failure
- Eng
- Fire
- Handle pulled
Auxiliary Power Unit (APU) Generator

- The APU provides an auxiliary source of:
  1. Electrical AC power - Ground
  2. Backup Electrical AC power - Air

- The APU can be started with main power.
- When the APU reaches 99% RPM + two (2) seconds, the APU generator comes online and can power all AC and DC buses.

- APU GEN is rated at 40 kVA, produces 115 VAC, 400 Hertz, 3-phase.
- Refer to AFM OIS G650ER-2016-03 APU sealant for APU inflight operation limitations.

45,000 feet
Integrated Drive Generators (IDG)

- Two (2) Engine-driven IDGs

- Located on the engine's accessory gearbox

- IDG < Constant Speed Drive (CSD)
  - Oil-cooled generator (oil is cooled by fan air)

- IDG < Rated at 40 kVA
  - Produces: 115 VAC, 400 Hertz, 3-phase

- CSD converts variable engine speed to constant speed at the generator (12,000 RPM)
- Dispatch with an IDG u/s not permitted due to AFM OIS G650ER-2016-03 APU SEALANT

- GENERATOR SWITCHES:

  
  ![Diagram of generator switches]

  ON
  L GEN
  L IDG
  L MAIN AC

  ON
  R GEN
  R IDG
  R MAIN AC

  OFF
  L GEN

  OFF
  R GEN

  Pressed in and IDGs power respective AC bus

  Pressed in and failed/isolated from respective AC bus

  Pushed out and unpowered
- Backup AC Generator

- The RAT, once deployed by the crew, converts airstream energy to electrical energy:

180 kts - VMO/MMO - Up to 51,000
- RAT GEN Rated at 15 kVA
  Produces: 115 VAC, 400 Hertz, 3-phase

- Minimum 180 KCAS. < 180 KCAS the RAT GEN drops offline and the L MAIN BATT, R MAIN BATT power the L ESS DC, R ESS DC buses.

- Land w/Flaps 20° (as per the QRH) so that in the event of a go-around the L MAIN BATT, R MAIN BATT are not used to power the \( \bigodot \) pump to retract the flaps from 39° to 20° (save the batteries).

- Rotates counter clockwise

- 6% fuel penalty

- RAT TEST = maintenance function only

- Cannot be stowed inflight

- FG: no vertical modes/altitude capture (ADS 4)
**GENERATOR CONTROL UNITS (GCU)**

- GCUs control GEN output (Quality Assurance) and provide fault protection.

- There are **4** GCUs:
  - **Identical**
  - **Independent**
  - **Interchangeable**
  - **Non-Interchangeable**

- If GEN:
  - Voltage
  - Frequency
  - Amperage

- **GCU** takes GEN offline
- **GCU** notifies **L BPCU**
- **L BPCU** notifies the crew via CAS
  - **L AC Power Fail**
  - **L Generator Fail**

- **GCU** can be reset by cycling associated GEN switch.
A Static Inverter converts DC to AC power in order to power Channel 1 of the Cabin Pressure Controller (CPC).
In the unlikely event that normal (IDG) or back up AC power (APU GEN) is not available the RAT GEN can continue to power CPC.

- The Static Inverter is located in the REER.
Transformer Rectifier Units (TRU)

- TRUs are powered by the main AC buses.
- A TRU converts 115 VAC to 28 VDC.

- TRUs are located underneath the floor.
- L ESS TRU | L MAIN TRU | R MAIN TRU | R ESS TRU | power their own buses

- AUX TRU | powers the L AUX DC | R AUX DC | buses and will take over the duties of a failed ESS or MAIN TRU using the following priority process:

ESS before MAIN

L before R

1. Sheds L AUX DC | R AUX DC | buses
2. L ESS DC
3. R ESS DC
4. L MAIN DC
5. R MAIN DC
TRU switches allow opposite bus to power a that lost power due to the failure of its own main ac.

- TRUs are rated at 250 amps

-Ground ops - TRU load limits:

\[
\begin{align*}
\text{LESS TRU} & \quad \text{MAIN TRU} & \quad \text{MAIN TRU} & \quad \text{ESS TRU} \\
80\% & \quad 40\% & \quad & \\
\text{AUX TRU} &
\end{align*}
\]
Ground Service Bus

- When you don't want to wake up the beast

- Ground Operations (APU shutdown)
  - Refueling
  - Engine oil
  - Potable water servicing
  - Hydraulic fluid servicing
  - Wheelwell lights

- Three (3) GSB Switches
  - Security/Ground Service Panel
  - REER Maintenance Panel
  - Tail compartment

- Power Sources (Priority)
- Rotating beacon light is powered by the **GSB** when the **R Main Batt** is the source of power.

- At least one of the following must be open when using one of the **GSB** switches:

  ![Diagram of electrical power control]

  - **L Bus Tie**
  - **R Bus Tie**
  - **L Gen**
  - **APU Gen**
  - **Ext Pwr**
  - **R Gen**
  - **Gnd Sync Bus**
  - **Main Batteries**
  - **ON**
  - **Reset**
Main Batteries

- Two (2) Main Batteries:
  
  ![L MAIN BATT] ![R MAIN BATT]

  - Located in the tail compartment
  - Nicad, 21 cells, 95 pounds
  - 28 VDC, 53 amp/hour

- Purpose:

  1. Start the APU - uses only but both switches must be selected on

     **NOTE:** Minimum 22 volts on both batteries to start the APU

  2. Operate aux hyd pump -

  3. Power ESS DC buses - (if no other source of power)

Main Batteries

![ON] ![ON]

LEFT RIGHT

Switchlights illuminate (Discharging)
- **16 minutes with two (2) APU start attempts**

- **Must be removed from aircraft in cold soaked conditions** \( \leq -20^\circ C \) and stored in a location warmer \( > -20^\circ C \) and cooler than \( +40^\circ C \)

- **If \( \leq 22 \) volts but not less than \( 7 \) volts** the batteries can be recharged as follows:
  - Ext AC power connected
  - Batt switches **ON**

- **The **L** MAIN BATT** and **R MAIN BATT** are normally recharged by the **MAIN AC** buses
Flight Control Batteries

- Two (2) flight control batteries:
  - Power the flight controls for 30 minutes
  - Illuminated ON if no AC power is being produced and batteries power their own buses (discharging)

- FTL CTRL Batteries
  - EBHA ON
  - UPS ON

System Power ON Self Test (SPOST)
- EBHA BATT selected ON first then UPS BATT
- Forty five (45) second test
- No electrical interruptions during SPOST or a complete power down required
Uninterruptible Power Supply (UPS)

- Lead acid
- Located in the REER

- Powers Flight Control Computers channels 1A and 2B

- Can be charged by RAT GEN via the Emergency AC Bus
• **Electrical Backup Hydraulic Actuator**

- Nicad
- Located in the tail compartment

- Powers seven (7) EBHA actuators

- Can be charged by RAT GEN via the Emergency AC Bus

- Must be removed from aircraft in cold soaked conditions \( \leq -20^\circ C \) and stored in a location warmer \( > -20^\circ C \) and cooler than \( +40^\circ C \)
- FCS Batteries - Charger/Transformer Rectifier

* Dual Function: Charger and TR
EMERGENCY BATTERIES

- Two (2) E-BATTs:
  - FWD E-BATT
  - AFT E-BATT

EMERGENCY POWER

<table>
<thead>
<tr>
<th></th>
<th>ON</th>
<th>ARM</th>
<th>OFF</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>LIGHTSAY POWER</td>
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- Sealed Lead Acid, 45 minutes
- 24 VDC, 10.5 amp/hour
- Located in the:
  - FWD E-BATT = LEER
  - AFT E-BATT = AEER

- Powers the following buses:
  - FWD E-BATT
  - AFT E-BATT
  - L Emergency
  - R Emergency
  - Flight Instrument

- On when LESS DC and/or RESS DC buses < 20 Volts, even momentarily
• After a break power transfer the e-batts will come on and must be re-armed to avoid depletion

**EMERGENCY POWER**

<table>
<thead>
<tr>
<th>On</th>
<th>Arm</th>
<th>Off</th>
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<tbody>
<tr>
<td>Lights</td>
<td>Ac Power</td>
<td>Ac Power</td>
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• When **Lights** **Ac Power** the following equipment is powered:

- Emergency Lighting
  - Cabin Emergency lights
  - Exterior Emergency lights
- Three (3) Audio Control Panels (ACPs)
- MCDU 1 - STBY Engine Instruments
- MCDU 3 - Backup Radios (VHF1/NAV1)
- Two (2) Clocks
- Two (2) Standby Flight Displays (No ADS)
- Three (3) IRUs
- An integrated charger/transformer rectifier recharges the E-Battis.

- The FWD E-Batt can be used in an emergency to open the electric main entrance door (EMED).

Diagram showing the main entrance door switch and its action.
ELECTRICAL POWER CONTROL

L Bus Tie

AUTO

ON

L GEN

APU GEN

EXT PWR

ON

R BUS Tie

AUTO

ON

R GEN

GND SYC BUS

MAIN BATTERIES

Two (2) Green

Two (2) Blue

Six (6) Black

Five (5) switchlights Pressed IN

Four (4) switchlights Pushed OUT
**Normal - Emergency**

- **Normal**
  - L IDG and R IDG → All AC/DC buses
  - L IDG or R IDG → All AC/DC buses

- **APU GEN**
- **RAT GEN** (> 180 KTs)

**Emergency AC Bus**
- L ESS TRU
- L ESS DC
- R ESS TRU
- R ESS DC

- **L MAIN BATT**
- **R MAIN BATT**

- **EBHA BATT**
- **UPS BATT**

- **FWD E-BATT**
- **AFT E-BATT**

**Standby Flight Instruments**
- IRUs
- Comm Radio
- Ener. lights

- **00:16 minutes**
- **00:30 minutes**
- **00:45 minutes** (approximately)

2 APU START ATTEMPTS

(< 180 KTs)
Questions, comments or errors?
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Thank you!