G650 POWERPLANT

Diagram showing the powerplant system with components such as the throttle resolver, electronic engine controller (EEC), modular avionics units (MAU), fuel metering unit (FMU), high pressure shutoff valve (HPSOV), and fuel spary nozzles.
Two (2) Rolls-Royce BR700-725A1-12

- 16,900 lbs of Thrust at ISA + 15°C
- High bypass Turbopfan – 4.18:1

- FADEC - controlled
- Engine Pressure Ratio (EPR)

\[ EPR = \frac{\text{output}}{\text{input}} \]

- Titanium inlet cowling
- High Thrust-to-Weight Ratio \( \rightarrow \) Fuel Efficiency, Noise Reduction
- Left engine is designated as the Critical Engine (AFM - Performance, Section 5.01.10)
• HP and LP compressor sections are driven by their own coaxial shafts (shaft within a shaft)
  - Twin-spool

  • Low pressure rotor
    Single-stage fan driven by three (3) stage turbine

  ![Diagram of LP Fan and Turbine]

• High pressure rotor
  Ten (10) stage compressor driven by a two (2) stage turbine

  ![Diagram of HP Compressor and Turbine]
Accessory Gear Box (AGB)

Uses power extracted from the HP compressor shaft to drive the following accessories:

- Integrated Drive Generator (IDG)
- Fuel Metering Unit (FMU)
- Fuel pump
- Oil pump and breather
- Permanent Magnet Alternator (PMA)
- Hydraulic pump
- **Full Authority Digital Electronic Control (FADEC):**
  Mounted on outside, upper portion of the engine.
  Consists of three (3) major components:

![FADEC Diagram]

- **FADEC provides engine start protection:**
  1. **On the Ground only**
  2. **ON switch only**

- **Controls and responds to EPR requirements**

- **The FADEC provides:**
  - Engine protection
  - Improved handling
  - Better fuel efficiency
  - Prolonged engine life
- FADEC automatically performs a rotor bow (uneven heating of the engine's core) avoidance procedure during start if engine has been shutdown within:

  > 20 minutes  < 5 hours

  The crew is notified via the following CAS message:

  ![Engine Start Protect]

- If FADEC were to fail the engine would flame out
• **Brains of the FADEC**
• **Dual channels** - one active and one standby
• **Fuel control switch**: changes channels
• **ECC controls engine idle speed**

Idle Speed Control is based on EPR with thrust levers at idle. There are **three (3) modes**:

1. **Flight Idle**
2. **Approach Idle**
3. **Ground Idle**
1. **Flight Idle:**
   - Flaps < 22°

2. **Approach Idle:**
   - Flaps > 22°
   - WOW – Air
   - Wheel speed < 53 knots

3. **Ground Idle:**
   - Aircraft WOW (GROUND)
   - Touchdown + five (5) seconds
   - Delay allows for full and rapid spool up

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The diagram illustrates the transition from **Flight Idle** to **Approach Idle** to **Ground Idle**, highlighting key stages in aircraft operation.
Primary control mode
Alternate control mode
Reverse thrust control mode

Primary control mode
Alternate control mode
Reverse thrust control mode

- Independent Overspeed Protection (IOP)

* Both IOP channels must agree for EEC to command FMU to shut off fuel to the engine.
The DSU contains engine trim data. This trim data is utilized by the EEC to make all engines produce the same thrust.
PERMANENT MAGNET ALTERNATOR (PMA)

Primary source of EEC power once the engine accelerates > 35% HP RPM
Engine Ignition System

- Dual channel Ignition Exciter (A and B) on each engine
- Controlled by dual channel EEC and powered by 28 VDC
- Generates high voltage pulse transmitted through ignition leads to ignition plugs in combustor

- Ground starts → One ignition
- Airstarts → Two ignition (high sparking rate)
- Manual ignition → Two (2) igniters

- Igniters are turned off automatically at 42% RPM HP during engine start

- EECs alternate channels and igniters as follows:

  1. EEC Channel A/Igniter 1
  2. EEC Channel B/Igniter 1
  3. EEC Channel A/Igniter 2
  4. EEC Channel B/Igniter 2

- When a normal ground start is aborted due anomalies, FADEC automatically selects the other igniter

- There is no time limit on the use of continuous ignition
- Ignition modes:

1. Auto Start
2. Alternate Start
3. Inclement Weather Mode
4. Auto-Relight Mode
5. Quick Restart Mode

1. **Auto Start**

   - One (1) igniter only
   - EEC alternates channels
   - Fuel control switches change igniter plugs
② **Alternate Start**

- Two (2) igniters
- No FADEC protection

③ **Inclement Weather Mode**

- T30 probe senses moisture

④ **Auto-Relight Mode**

- HP, LP or TGT abnormality

⑤ **Quick-Restart Mode**

- Inadvertent engine shutdown in flight
- Return fuel control to run within 30 seconds
Engine Fuel System

- Metered fuel from tank's boost pumps to fuel nozzles
- Introduction of fuel is controlled by FADEC
- Low (LP) and High (HP) pressure pumps are driven by engines' accessory gearbox
- Extracts heat from hot engine oil
- LP pump can suction feed the engine ≤ 20,000'
- Each engine has its own **Fire Handle**

- Pulling a **Fire Handle** shuts off fuel at the tank

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Shutoff Valve
Open

Engine
OP

Shutoff Valve
Closed
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**Engine Oil System**

**Total Capacity:** 21 pints

One (1) Pressure Pump

Four (4) Scavenge Pumps

Max consumption allowed 0.42 pints/hour

Normal consumption is 0.1 pints/hour

Located and driven by engine's accessory gearbox.

Fuel cooled oil cooler.

Magnetic chip detector.

Engine oil servicing.
ENGINE LIMITATIONS

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**Engine Oil Temperature**
- +20°C: Taxi/Takeoff
- +160°C: Maximum
- -40°C: Start

**Engine Fuel Temperature**
- +140°C
- +165°C (15 minutes)
- -40°C

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**Cycle / Cooling Period**
- 3 minutes / 15 seconds
- 3 minutes / 15 seconds
- 3 minutes / 15 minutes

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**Engine TGT Temperature**
- 150°C: Introduce fuel
- 700°C: Start - Ground
- 850°C: Start - Inflight
- 900°C: Takeoff (5 minutes)
- 900°C: OEI (10 minutes)
- 885°C: Max Continuous

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**Engine Oil Level Check**
- 5 minutes to 24 hours from engine shutdown
Engine Limitations - Start

Minimum oil temperature -40°C

Minimum bleed air 40 psi

Maximum TGT < Fuel 150°C

Maximum TGT 700°C

Engine start cycles
3 minutes / 15 seconds
3 minutes / 15 seconds
3 minutes / 15 minutes

Engine Limitations - Static Ground Run

> idle RPM
Exhaust Danger Area

Idle Thrust

Takeoff Thrust

275'

750'
Engine Limitations - Takeoff

Takeoff in ALT mode (LP) is Prohibited

Minimum oil temperature for Takeoff: +20°C
Maximum TGT: 900°C

5 minutes to/0 GA 10 minutes
Engine Limitations - Inflight

Maximum Continuous Thrust (MCT) 885°C TGT
Start Envelope
≤ 30,000'
Starter Assist Windmilling
≤ 250 KCAS ≥ 251 KCAS
Maximum TGT 850°C
Note: No FADEC Protection

Engine Limitations - Landing
Thrust Reverse

78.1% LP - 30 Seconds
Idle Reverse by 60 KCAS

Note: It is recommended to operate engines at idle for 3 minutes before shutdown

Static = 30% LP Maximum
**Do not attempt restart:**

- Fire
- FOD
- Frozen

**Restart - Yes or No?**

**Yes:**
- Airstart - Automatic ✓ list ⭐⭐
- Airstart - Windmilling ✓ list ⭐⭐

⭐ No FADEC protection during start
⭐ Icing conditions

**No:**
- Engine shutdown in flight ✓ list
Questions, comments or errors... please send me an email: ivan.luciani@gmail.com

Thank you!