TB40 Small Turbojet Engine Technical Specification

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1. Engine Overview

The Model- 40 micro turbojet engine serves as a power unit for small-size aircraft. Under international standard atmospheric conditions at sea level with Mach 0, its maximum thrust is approximately 41 kgf. The engine assembly consists of an inlet duct, compressor, combustion chamber, turbine and exhaust nozzle. Ambient air is drawn in through the inlet duct and compressed by the compressor before entering the combustion chamber, where it mixes with fuel for combustion. The resulting high- temperature, high- pressure gas drives the turbine. The turbine delivers shaft power to rotate the compressor. Hot gas expands and accelerates through the exhaust nozzle to produce thrust.

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The Electronic Control Unit (ECU) executes engine start - up, acceleration, deceleration, steady - state operation and shutdown in response to control inputs. Under real - world flight altitude, flight - speed and climatic conditions during steady - state operation, the ECU modifies fuel - pump delivery to maintain stable engine rotational speed. Key technical parameters for the Model - 40 micro turbojet engine are listed in Table 1.

Parameter	Value	Unit
Main - body Diameter	152	mm
Length	375	mm
Installed Weight	4.7	kg
Idle Rotational Speed	25 000	RPM
Idle Thrust	1.8	kgf
Maximum Rotational Speed	90 000	RPM
Maximum Thrust	40	kgf
Maximum - Regime Fuel Consumption	1.4	L/min
Maximum Exhaust - Gas Temperature	750	° C
Battery Type	25.2 V DC, 6S Lithium - ion Battery	—
Fuel Type	Aviation Kerosene No. 3	—

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Performance data measured at sea - level altitude

H=0 km

, Mach 0, ambient temperature 288.15 K (15 ° C), atmospheric pressure

101 325 Pa; measurement accuracy ±2 %.

2. Engine System Introduction

Besides the engine core assembly, the full system comprises a control system, fuel system and starting system. These assemblies are mandatory for reliable engine performance. Users must also supply the traction battery and fuel.

Precision-machined mechanical components form the engine core, which also carries the ECU circuit board, ceramic igniter, temperature sensor and other functional parts.

2.1 Control System

The Model-40 engine control system includes the ECU, temperature sensor, rotational-speed sensor, wiring harness, fuel pump, solenoid valves and battery pack. The ECU provides the following capabilities during engine operation:

Infinitely variable adjustment of engine rotational speed and thrust.

Regulation of engine acceleration, deceleration and throttle-mode transitions within the flight envelope.

Acquisition and processing of engine rotational speed

N

and exhaust-gas temperature

T

signals.

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RS232 communication capability; cold cranking of the engine via the electric- start subsystem.

Emergency shutdown, over - current and overload - protection functions.

On - board self - test for the engine and its components. Self - test routines verify the igniter, ignition- circuit solenoid valve, main- fuel- circuit solenoid valve, starter motor and fuel pump.

2.2 Fuel System

Fuel: Aviation kerosene.

Lubricant: Mobil Pegasus II lubricant mixed with fuel at a volumetric ratio of 4 %. If blended fuel sits unused for an extended period, thoroughly agitate the mixture before deployment.

Fuel Pump and Solenoid Valves: A gear- type pump is used. The pump and solenoid valves are integrated within the engine for high compactness. A fuel filter is fitted upstream of the pump. Clean the filter screen periodically to prevent blockages by contaminants.

2.3 Starting System

The Model- 40 micro turbojet starting system includes a starter- motor assembly, ignition subsystem and ignition - fuel supply subsystem. A brushless motor performs engine cranking; ignition is achieved with a ceramic thermal - resistance igniter. The ignition - fuel circuit uses aviation kerosene, enabling one- button kerosene- fueled start- up.

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Prior to start- up, verify the ECU supply voltage is no lower than 25.2 V. Confirm secure seating of the engine ' s aviation- grade plug and all accessory connectors.

3. Safety Notes

Each engine undergoes factory functional inspection and testing. Read this manual thoroughly before operating the unit.

During operation, the engine spins its rotor at high speed, sustains elevated internal pressure, produces hot exhaust and generates intense aerodynamic noise. Test personnel and observers must be in good physical condition before entering the test area.

Personnel with cardiovascular conditions or high noise sensitivity shall not conduct tests or stand near the test site.

3.1 Safe Engine Operation

Before mounting the engine onto an aerial vehicle such as a model aircraft or UAV, complete at least one full start- up and full- speed run on a ground test stand. This familiarizes technicians with start - up workflows and maintenance procedures.

Assign at least one dedicated test assistant for each engine start - up. The assistant must understand micro- turbojet fundamentals as well as the specific start- up and control workflows for this engine, and must be ready to respond to aborted starts or other incidents.

Exhaust - gas temperatures reach very high values during engine

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operation. When installing the engine on an airframe, implement adequate thermal insulation and cooling for nearby equipment and structural elements around the exhaust nozzle.

3.2 Engine Hazard Zones

The running engine draws large air volumes through its inlet and expels high- velocity hot gas through the exhaust nozzle. Do not place light-weight objects near the inlet (risk of ingestion) or flammable/explosive articles near the exhaust (risk of ignition or detonation). Foreign- object ingestion can cause severe personal injury and property loss.

Securely fasten the ECU, fuel tank, fuel lines and all associated accessories. Never enter the fan- shaped exhaust hazard zone shown in Figure 1 while the engine is running. Operators shall stand forward of the engine inlet, maintaining a minimum separation of 5 m from the inlet for personal safety.

Figure 1 Engine Hazard- Zone Diagram

- Ingestion hazard zone (2 m radius at inlet)
- High- temperature hazard sector: 60- degree fan extending 30 m aft of nozzle
- General hazard zone: 30- m maximum radial coverage aft of engine

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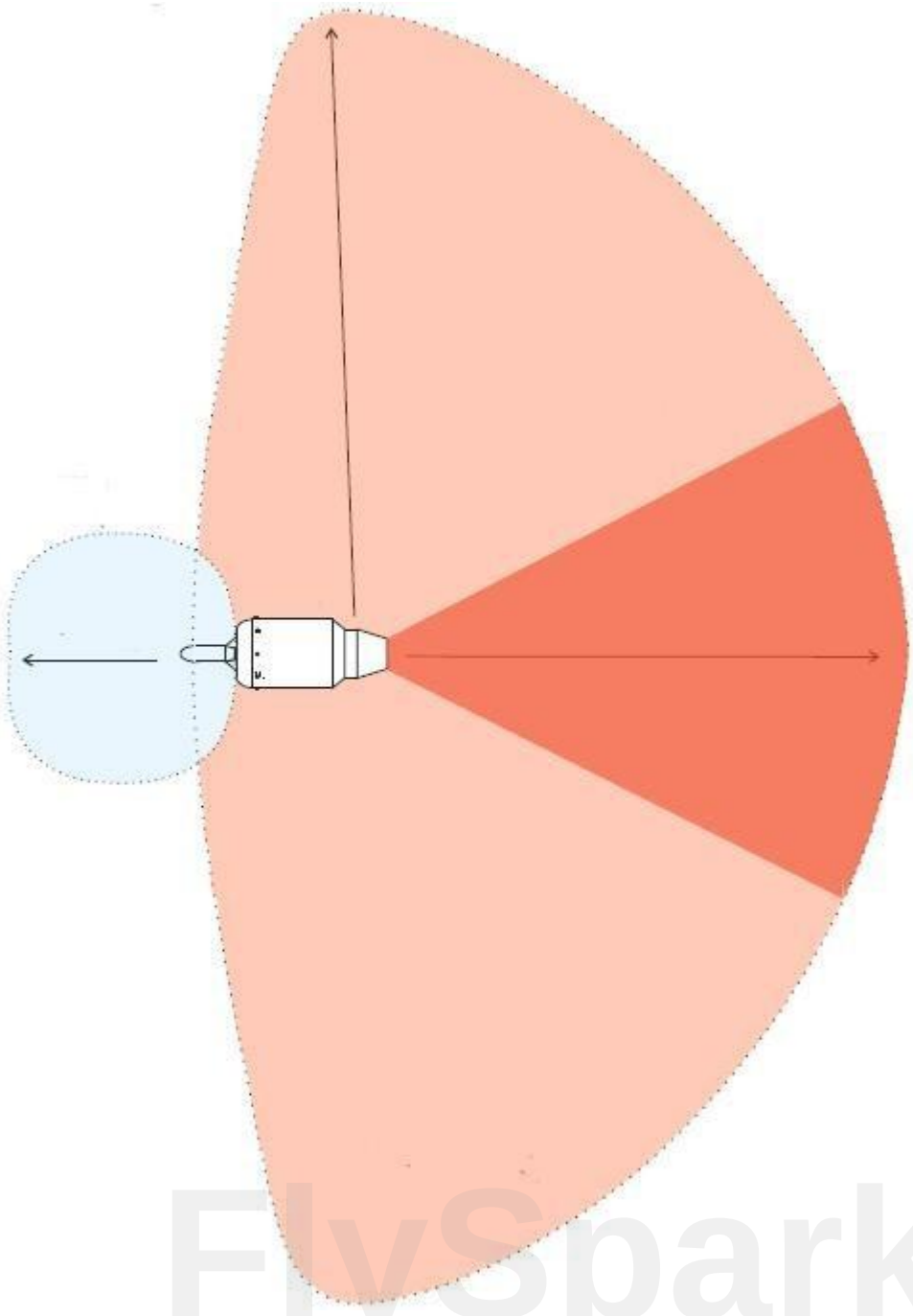
3.3 Fire Extinguisher Preparation

Have sufficient carbon- dioxide fire extinguishers on- site before any engine start- up to mitigate fire risks. Do not use dry- powder or water

- based extinguishers for this micro turbojet. Foam or powder extinguishing agents will damage ECU electronics and precision rotating components.



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3.4 Engine- Generated Noise

High- decibel aerodynamic noise occurs during engine operation and poses risks to hearing and general well- being. All personnel present

must wear high- attenuation earplugs or earmuffs.

If any onsite person develops adverse symptoms including tinnitus, dizziness, nausea, appetite loss, breathing difficulty or arrhythmia, seek prompt medical attention.

4. Engine Installation and Connection

4.1 Engine System Connection

Connect the engine power cable, DB15 communication cable (pin definitions in Table 2 and Figure 3) and fuel- system tubing to the power - supply unit, host - computer control terminal and fuel tank respectively, following Figure 2.

Figure 2 Engine System Connection Schematic

- Micro- turbojet controller unit connected to engine core, power- supply unit, fuel tank and laptop host- computer.

Notice: Keep total fuel - line length within 2 m. Contact technical - support staff if longer tubing is required.

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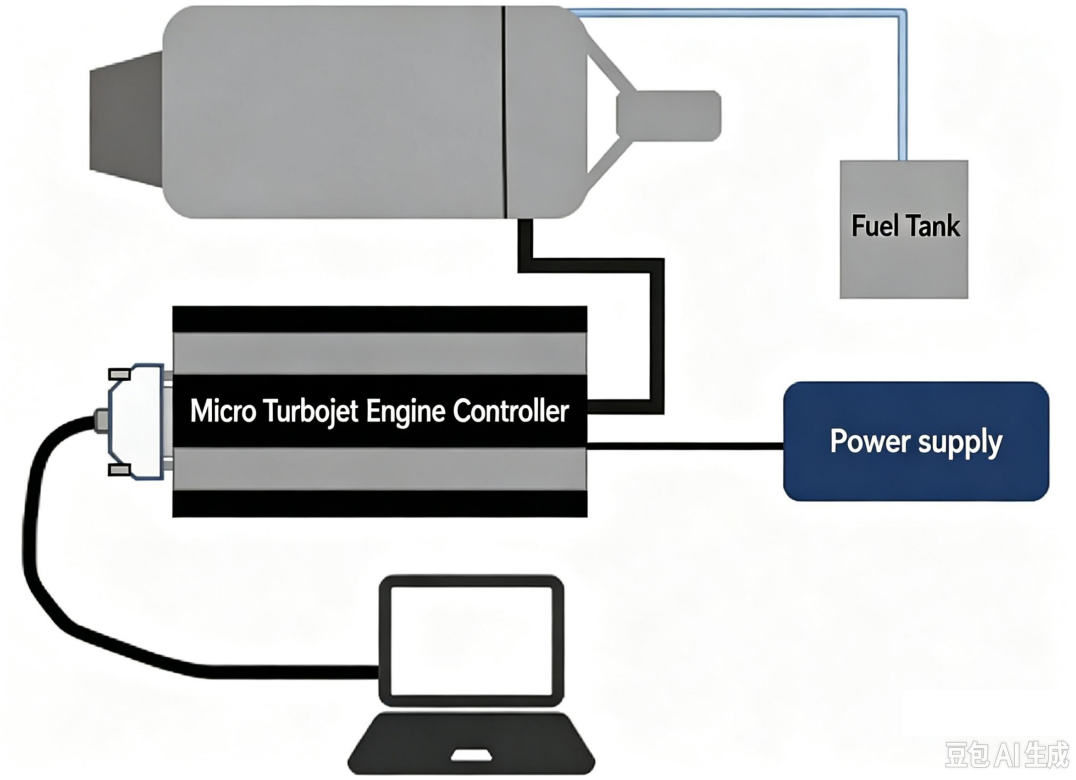


Table 2 DB15 Pin Definitions

Pin No.	Definition	Pin No.	Definition
1	Throttle Signal- / RS232 GND	9	Throttle / Switch Channel+
2	Throttle Signal+	10	N/A
3	N/A	11	Ground- Station- Unit (GSU) Input
4	GSU-	12	RS232 RXD
5	RS232 TXD	13	GSU+
6	N/A	14	N/A
7	Switch Signal+	15	N/A
8	Switch Signal-	—	—

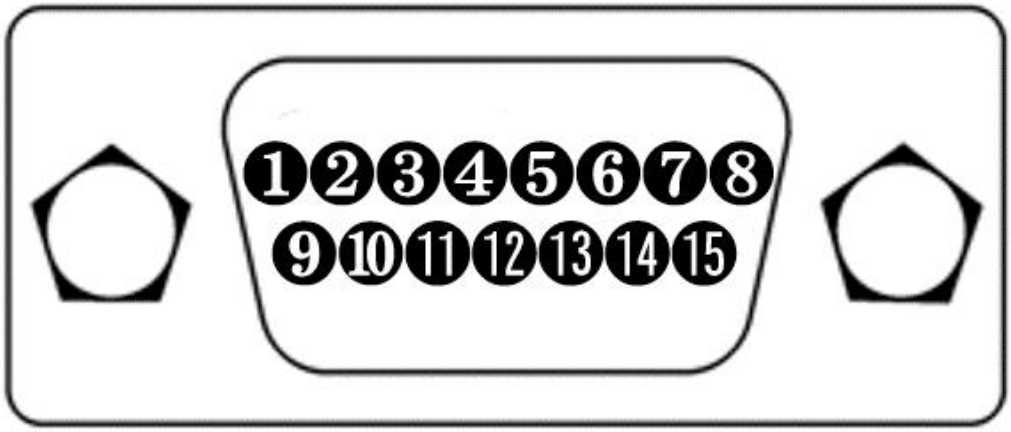


Figure 3 DB15 Connector Pin- Layout Diagram

4.2 Battery Specifications

All system operating power originates from the DC power- supply unit. A 6S lithium - ion battery delivering 25.2 V is standard. The power source must sustain an instantaneous output current of no less than 30 A. Insufficient peak current can trigger start - up failure, power - source overload or fire.

Factory calibration and performance validation are performed at 25.2 V DC supply voltage.

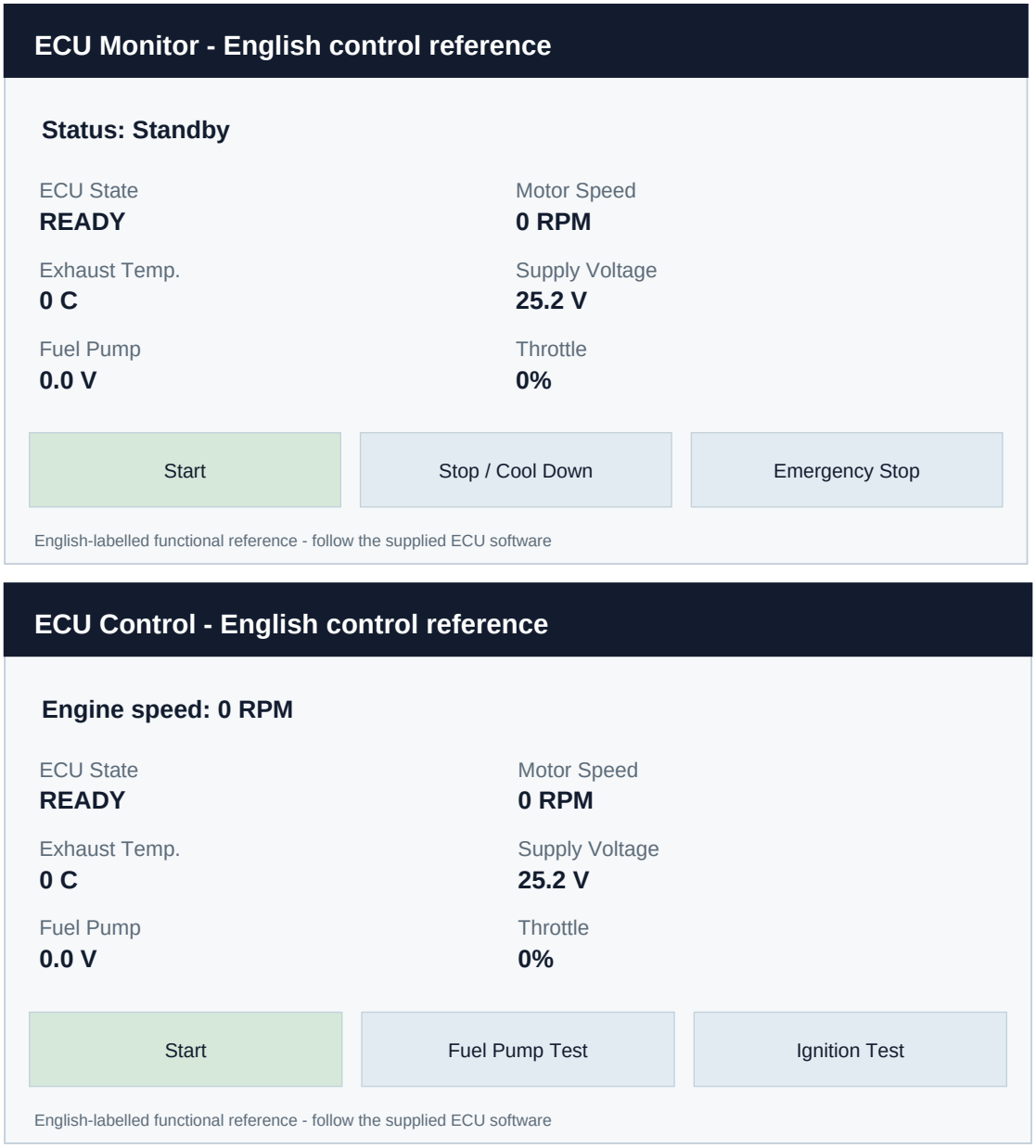
5. Engine Operation and Ground- Test Software

All state transitions including start- up, ignition, pre- heating, running, acceleration, deceleration, shutdown and post - run cooling are commanded via the ground - test - software graphical interface. Software operating procedures are described below.

Install and launch the ground- control software

Install the engine control software on a laptop PC and launch the

executable. The main software interface is shown in Figure 5- 1.



Configure communication parameters after launch: select the correct COM port matching the physical connection, set baud rate 19 200, stop - bit 1, and choose throttle- control operating mode (see Figure 5- 2).

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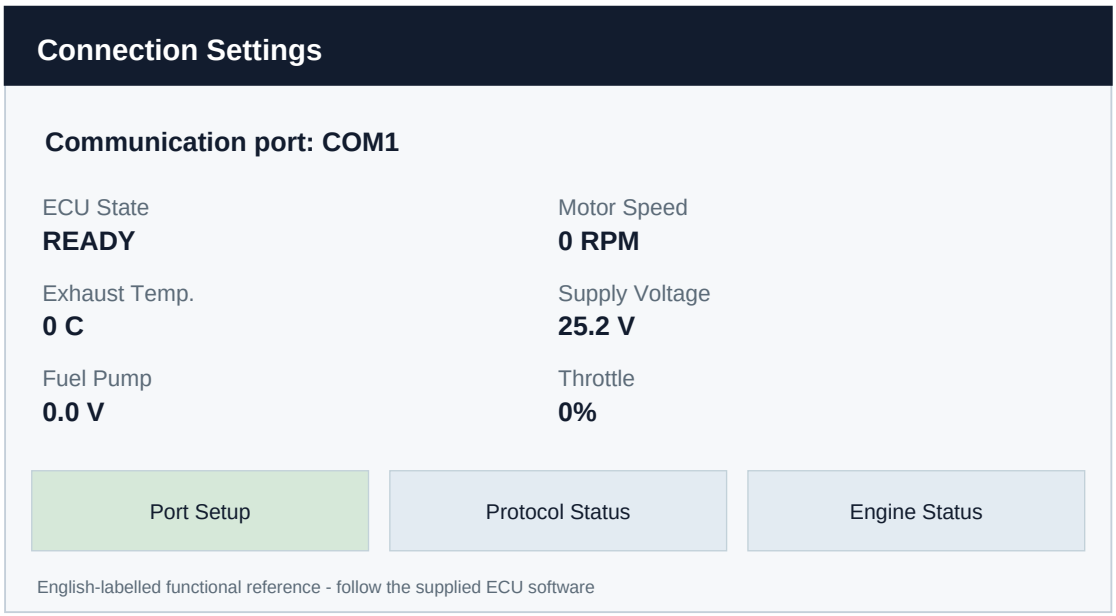

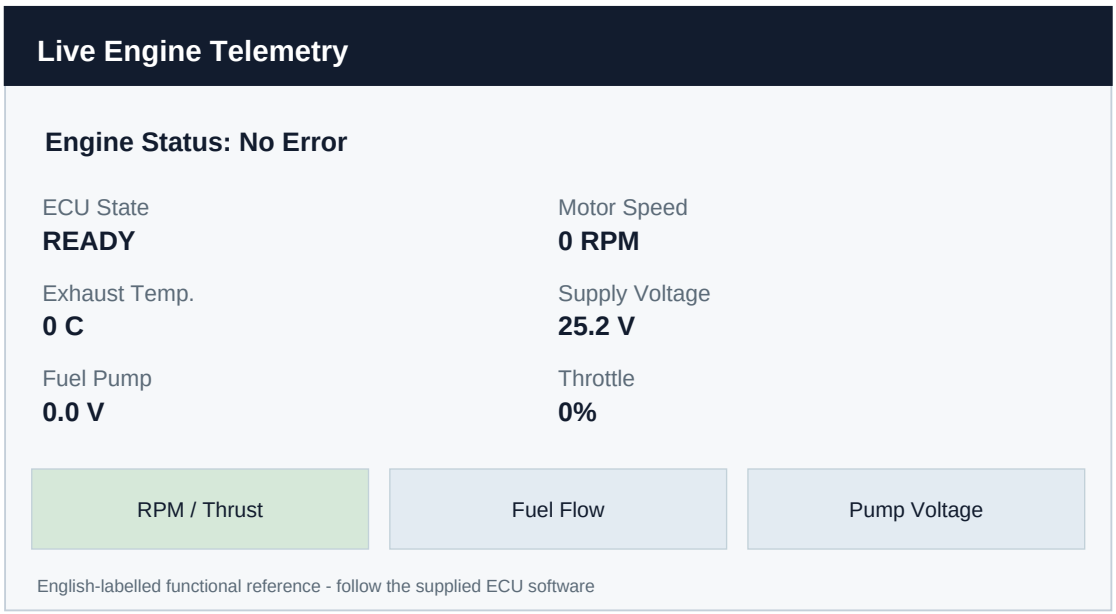

When communication is established successfully, the status bar reports “No Error”, and real- time parameters such as supply voltage, idle speed and maximum speed populate the display (Figure 5- 3). If error messages appear, power- cycle the ECU and re- establish the link.

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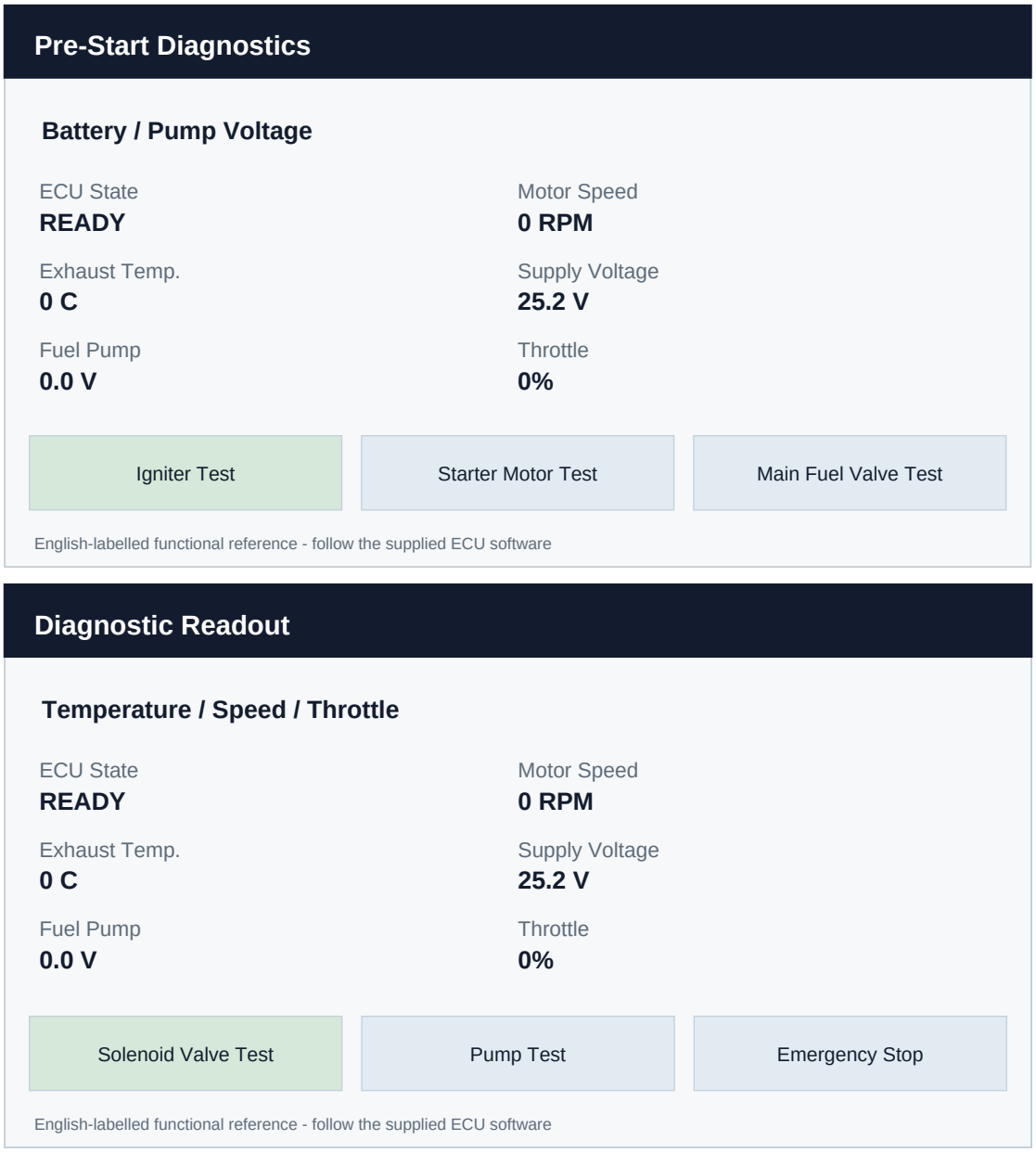

Pre- start hardware- installation and functional checks

Evaluate component health by inspecting parameter read- outs in the software GUI (Figure 5- 4). Complete the following pre- start checklist:

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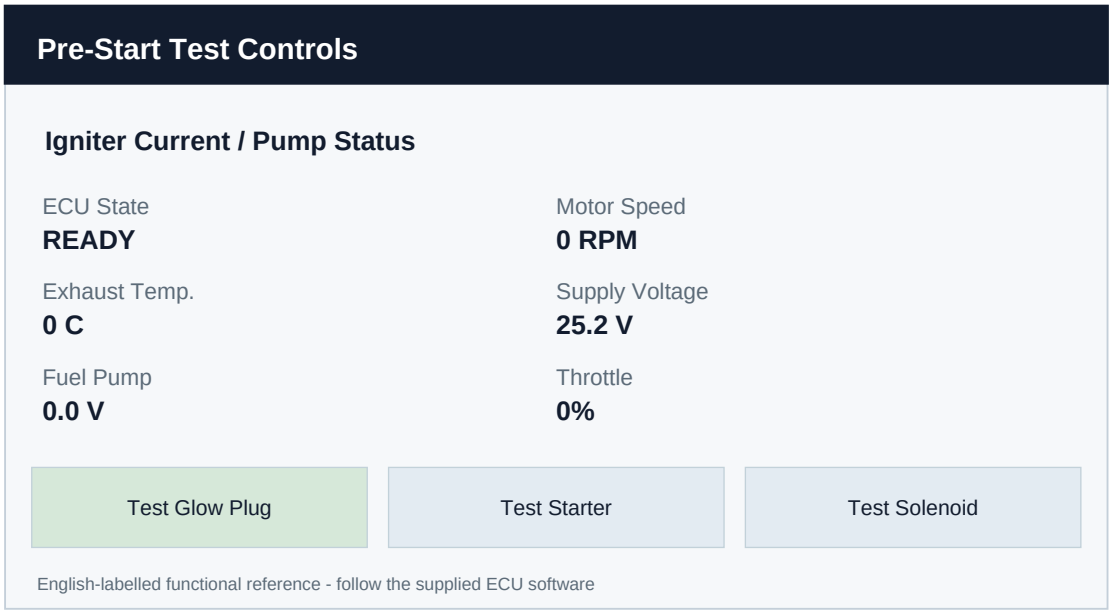

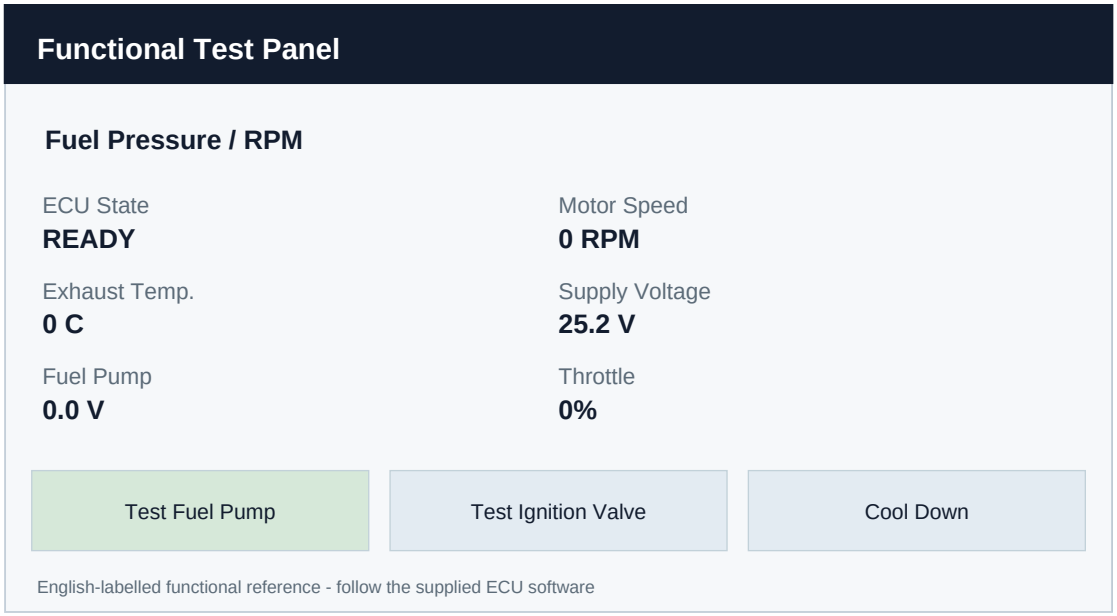

① Mount the fuel tank such that the tank, ECU and related accessories lie at approximately the same elevation as the engine.

② Click Test Glow- Plug. A momentary current reading near 20 A confirms proper igniter- circuit function.

③ Click Test Starter Motor. A transient rotational- speed reading of 2 000- 3 000 RPM indicates correct starter- motor behaviour.

④ Verify fuel- pump performance via dedicated test controls.

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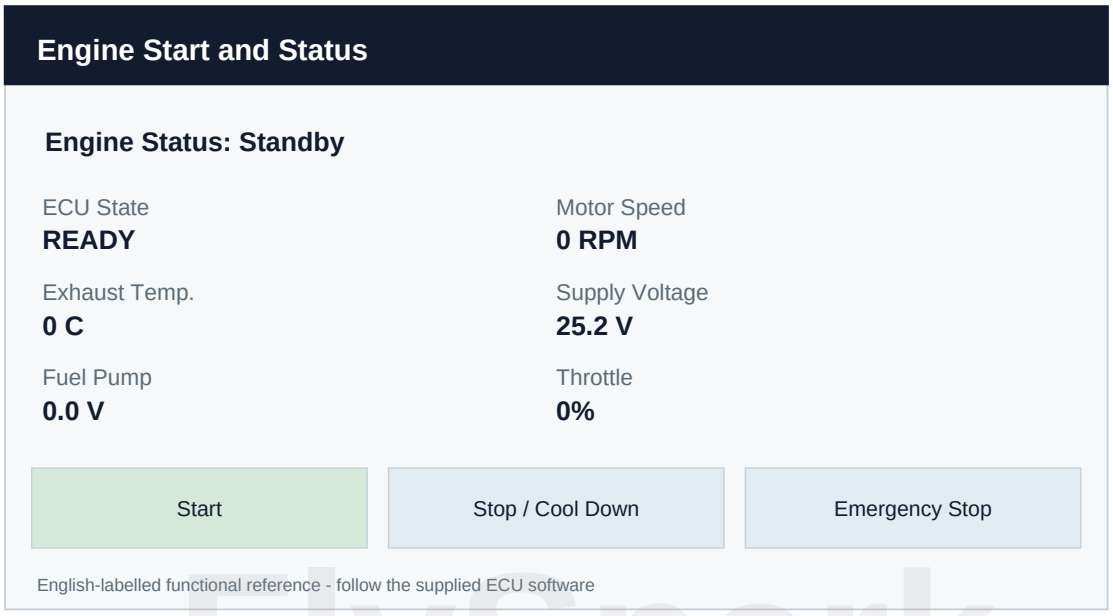
⑤ Click Test Main Solenoid Valve. Audible clicking or tactile vibration confirms main- fuel- solenoid actuation.

⑥ Click Test Ignition Solenoid Valve. Audible clicking or tactile vibration confirms ignition- fuel- solenoid actuation.

Purge residual air and prime fuel lines by repeatedly pressing Pump Air - Purge until fuel fully fills tubing and reaches the engine inlet.

Engine Start- up and Operation

Press the Start button shown in Figure 5- 5. The starter motor engages and engine speed rises. The current reading falls from approximately 12.6 A toward 0.1 A. The ECU executes the fully- automatic start- up sequence and brings the engine to idle.



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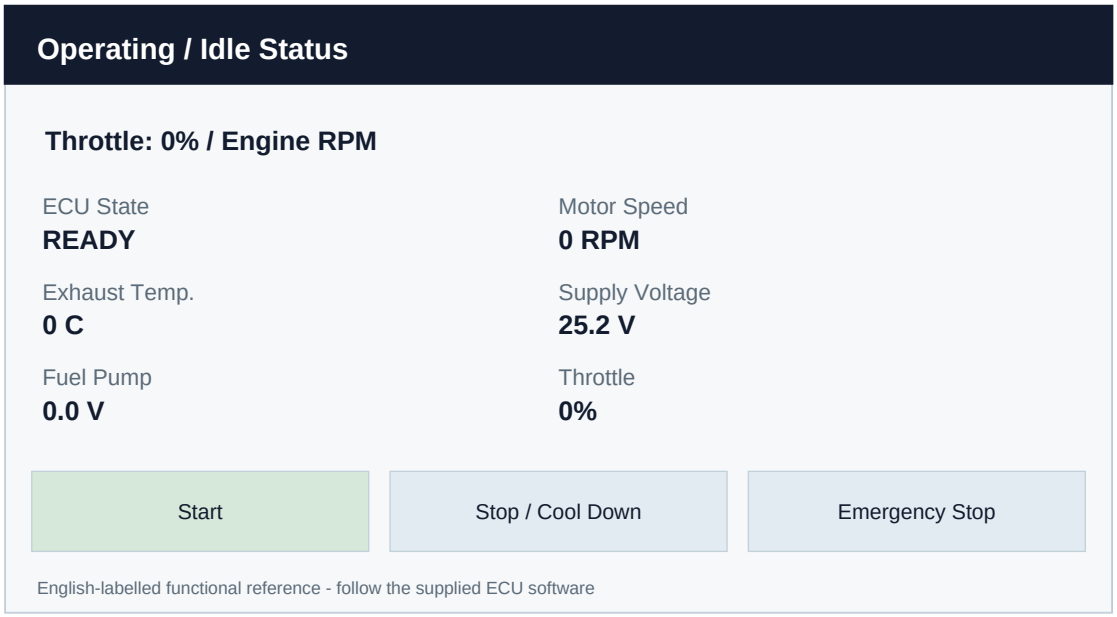

English ECU operating panel

When idle speed is attained, the software status updates to “Running”. Automatic start-up finishes, and manual operator control becomes active. Adjust rotational speed and thrust either by dragging the on-screen throttle slider or by entering numerical target values for throttle percentage or rotational speed.

Notice: Confirm stable idle operation without persistent over-temperature or abnormal acoustic signatures before adjusting throttle setting.

Normal shutdown procedure: Reduce engine speed to idle and maintain idle for at least 10 seconds before clicking Shutdown / Cool-Down. The ECU cuts fuel delivery; rotational speed decays and automatic cooling runs until exhaust-gas temperature drops below 80 ° C.

Caution 1: Press the Emergency Stop button immediately upon detecting any anomaly during start-up or operation. This forcibly cuts fuel and

initiates shutdown.

Caution 2: If successive restarts are required within a short interval, ensure exhaust- gas temperature falls below 80 ° C. Hot restarts cause start- up failure or permanent engine damage.

6. Engine Storage

Store unused engines in the original dedicated shipping container within a cool, dry and well- ventilated environment. Periodically perform test - run inspections to verify engine health.

For previously - run or installed engines, maintain cool, dry, well - ventilated storage. Avoid prolonged vertical storage orientations. Inspect engine condition on a regular schedule.

7. Warranty Provisions

Observe maximum - regime operating - time limits. Time - to - first overhaul is 25 operating- hours. Total service life is 40 operating- hours or 50 start- stop cycles, whichever occurs first.

Warranty coverage lasts for one calendar year or 20 operating - hours from purchase. Repair costs apply for engines returned to the factory for service outside warranty terms.

8. Disclaimer

Keep unauthorized personnel away while the engine runs. Operators must remain inside designated safe operating zones.

The manufacturer accepts no liability for accidents arising from disregard

of safety instructions or entry into hazard zones (refer to hazard- zone definitions in this manual).

Engine components are precision- machined, and the rotor assembly undergoes factory dynamic balancing. Unauthorized disassembly destroys rotor balance, leading to excessive vibration, shortened service life and potential catastrophic failure. The manufacturer disclaims responsibility for injury or damage resulting from customer- initiated disassembly.

The engine inlet constitutes a severe hazard during operation. Loose objects risk ingestion; never place hands or articles near a spinning engine inlet. All consequences stemming from non - compliant operating procedures are the responsibility of the end- user.

Do not operate the engine above its maximum rated rotational speed. Overspeed can cause structural failure and serious accidents. The manufacturer bears no liability for loss or injury caused by over- speed operation.

9. Fault Information and Troubleshooting

Start - up and runtime faults may arise from ambient - atmosphere conditions, ECU parameter settings or degraded component performance. The table below lists typical symptoms, root causes and corrective actions.

Fault Symptom	Probable Cause	Remedial Action

Fault Symptom	Probable Cause	Remedial Action
Ignition Failure	No fuel in supply line / air bubbles in tubing	Use software *Pump Air- Purge* or pump- test functions to prime lines and eliminate trapped air
	Insufficient ECU battery voltage	Recharge the ECU battery pack
	Defective igniter (may be flagged by self- diagnostics)	Contact factory technical- support personnel
Start- up Abort	Incomplete cooling; exhaust- gas temperature remains high	Await exhaust- gas temperature < 80 ° C before attempting restart
	Low battery voltage / faulty wiring connections	Recharge battery; inspect ECU wiring and connectors
	Disconnected wiring for starter motor or igniter	Inspect cable terminations and ECU- to- engine interconnects
Ignition Followed by Start- Sequence Abort	Air intrusion into fuel lines	Inspect all Festo- style fittings and fuel- filter assemblies; check filter for clogging
	Fuel pump inoperative	Run pump- diagnostic tests to verify pump functionality
Starter- Motor Abnormal Noise	Dust or deposits adhering to compressor- impeller lock- nut and clutch O- ring	Clean clutch O- ring and compressor- impeller lock- nut top face with swabs and cleaning solvent

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Fault Symptom	Probable Cause	Remedial Action
Erroneous Temperature Readings / Jittering Rotational- Speed Readings	Radio- frequency interference from nearby RC- receiver antenna	Relocate RC- receiver antenna away from the engine assembly

Supplementary Common- Fault Descriptions

Fault 1: Ignition does not succeed

Possible contributing factors:

① Ignition- pump supply voltage too low; ② Insufficient glow- plug voltage; ③ Low ignition- solenoid duty cycle; ④ Cross- wired main - fuel and ignition- fuel solenoid valves; ⑤ Excessively high ignition rotational- speed set- point.

Fault 2: Severe afterburning during start - up, protracted start - up sequence, sustained exhaust- gas over- temperature

Possible contributing factors:

① Excess ignition - fuel pressure; ② Excess ignition - solenoid duty cycle; ③ Over- elevated pump- slope setting; ④ Insufficient starter - motor slope parameter; ⑤ Liquid - fuel pooling inside engine. If substantial liquid - fuel accumulation occurs, tilt the engine tail - upwards to fully drain pooled fuel out through the inlet duct before retrying start- up.

Fault 3: Slow rotational - speed rise during start - up - acceleration phase; high starter- motor current draw

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Possible contributing factors:

① Restricted or insufficient main- fuel delivery; ② Low main- fuel-pump slope setting yielding low combustion - chamber flame temperature.

Fault 4: Persistent exhaust- nozzle afterburning during transition from idle toward maximum rotational- speed

Possible contributing factor: Excess acceleration - coefficient setting causing overly - rapid pump - voltage ramping and excessive fuel delivery.

Fault 5: Uncommanded engine flame- out during normal running

Possible contributing factors:

① Depleted fuel- tank supply; ② Clogged fuel filter interrupting fuel flow; ③ Large foreign objects inside fuel tank blocking tank outlet port; ④ Improper fuel - tank installation geometry (relevant for airborne flight- condition flame- outs at take- off).

Fault 6: Visible blade damage while engine still spins

Recommended action: Cease operation immediately and return the engine to the factory for inspection and repair.

10. Engine Status Descriptions

From receipt of a Start command through acceleration to maximum speed and subsequent shutdown, the engine progresses through multiple distinct operating states. The ECU transmits real - time state

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information to ground - test software or airborne flight - control hardware. Current engine status appears in the ECU- status field of the software GUI. State transitions are governed automatically by ECU logic according to preset parameters and user- input signals. See Table 3 for state- code definitions.

Table 3 Engine Operating- State Codes

State Code	State Name	State Description
0	Stop	Engine shutdown
1	Ready	Stand- by mode
2	Ign(StickDown)	Ignition- prepare: set throttle stick to minimum/idle position
3	Ignition	Ignition in progress
4	Preheat	Combustion- chamber pre- heating
5	Fuelramp	Acceleration phase
6	Learn StickMax	Calibrate maximum- throttle stick position
7	Learn StickMin	Calibrate minimum- throttle / shutdown stick position
8	Learn Rc…	Calibrate idle- throttle stick position
9	Run(StickMin)	Running; maintain throttle stick at minimum/idle
10	Run(PumpLimit)	Running; fuel pump operating at maximum preset power limit
11	Running	Normal engine running state
12	Cooling	Post- shutdown cooling sequence active
13	Restart	Automatic restart sequence in progress

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State Code	State Name	State Description
14	Test GlowPlug	Glow- plug / igniter self- test
15	Test FuelValve	Main- fuel- circuit solenoid- valve self- test
16	Test GasValve	Ignition- fuel- circuit solenoid- valve self- test
17	Test Pump	Fuel- pump self- test
18	Test Starter	Starter- motor self- test
19	Exhaust Air	Fuel- draining / air- purging routine active

11. Engine Error- Code Explanations

Built- in ECU diagnostics detect foreseeable faults during start- up and runtime, reporting fault location and root cause via text error- code messages displayed in the control- software status bar. Table 4 lists defined ECU error codes and explanations.

Table 4 ECU Error- Code Definitions

Serial No.	Error Name	Error- Code Explanation
0	No Error	No active fault
1	Time Out	1. Ignition phase: exhaust- gas temperature unchanged for 20 s2. Forced cooling: cooling duration exceeds 60 s
2	Low Battery	1. Traction- battery voltage falls below minimum threshold2. RC- receiver supply voltage drops below 4 V
3	GlowPlug Bad	No igniter current detected; glow- plug malfunction
4	Starter	During ignition: rotational speed cannot reach

Serial No.	Error Name	Error- Code Explanation
	failure	ignition- speed threshold
5	RPM Low	1. Ignition: rotational speed drops below 50 % of ignition- speed set- point2. Pre- heat: rotational speed falls below ignition- speed threshold3. Acceleration: rotational speed drops below pre- heat- speed threshold4. Running: rotational speed falls below configured minimum operating speed
6	RPM Instability	1. Acceleration: large rotational- speed oscillations2. Acceleration: severe rotational- speed decay
7	HighTemp	1. Ignition: temperature exceeds maximum limit2. Pre- heat: temperature exceeds maximum limit3. Acceleration: temperature exceeds maximum limit for ≥ 4 s
8	LowTemp	1. Pre- heat: sharp temperature drop2. Acceleration: sharp temperature drop
9	Lost Signal	RC- control- signal loss persists beyond configurable timeout (default 2.5 s)
10	Current Overload	ECU supply- current exceeds design limit; most frequently caused by motor stall

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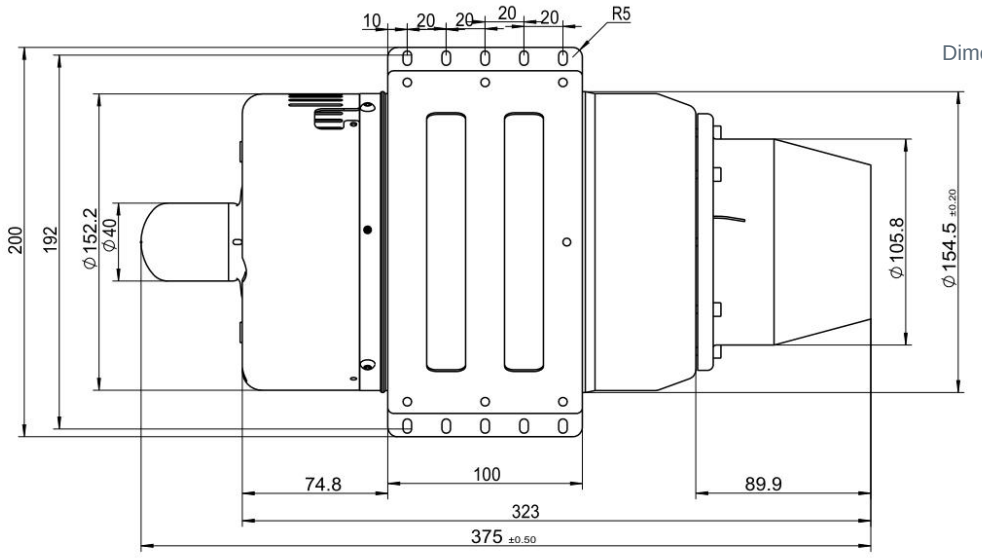
Dimensions in mm



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