High-Pressure Oil Injection Disc Type Turbojet Engine

WP-GY120 Technical Manual

Prepared by:_____

Reviewed by: _____

Approved by:_____

D a t e:_____

1. Engine Overview

1.1 Introduction

The WP-GY120 turbojet engine is a small turbojet engine capable of rapid start (within **5 seconds**), operation in extreme low temperatures (**-40°C**), high-altitude starting (**6000m**), and stable operation at altitudes greater than **10,000m**.

The engine primarily consists of a 1-stage high-pressure ratio centrifugal compressor, an annular evaporator tube combustion chamber, a 1-stage axial flow turbine, a casing, and a fuel control system. The engine employs a unique high thrust-to-weight ratio compressor design and, through an embedded generator mounting structure, achieves self-powered electricity extraction of 1200W. Simultaneously, the application of a 0-2-0 bearing support structure combined with direct fuel lubrication effectively shortens the shaft span, simplifies the lubrication system, increases the thrust-to-weight ratio, and results in a simple overall engine structure with a compact layout.

1.2 Basic Working Principle

During operation, air is continuously drawn into the compressor, where it is compressed and pressurized before entering the combustion chamber. Fuel is injected and burned here, producing high-temperature, high-pressure gas. This gas then expands through the turbine to perform work, allowing the engine to run continuously and generate sustained thrust.

The engine's ECU features stepless speed regulation functionality. The ECU regulates the fuel supply by controlling the duty cycle of the fuel pump motor, thereby ensuring the engine rotor speed remains constant or increases according to a specific acceleration pattern. This

guarantees stable operation of the WP-GY120 turbojet engine within the aircraft's flight envelope.

2. Engine Technical Data

2.1 General Technical Data

a) Engine Model and Category
> Model: WP-GY120;
> Category: Micro Turbojet Engine.

b) Engine Rotor Rotation Direction
> The engine rotor rotates clockwise (viewed from the direction of flight).

c) Engine Outline Dimensions
> Maximum Diameter: 270mm (excluding external screws)
> Maximum Length: 556.5mm
> Inlet Inner Diameter: 146mm

d) Engine Weight
> Engine Dry Weight: 16kg
> Engine Delivery Weight (including accessories): 20kg

e) Engine Outline Drawing (See Figure 2)
120 Installation Dimensions

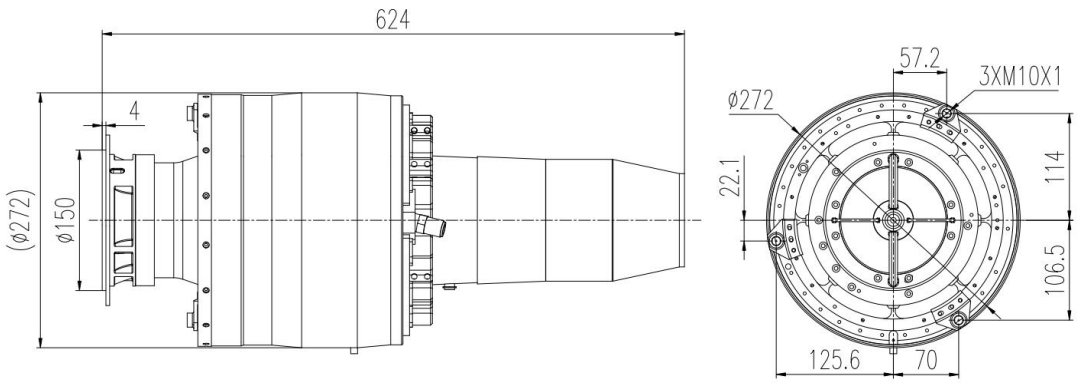


Figure 2 Engine Outline Drawing

f) Engine Thrust-to-Weight Ratio

> Thrust-to-Weight Ratio: 6.15.

g) Engine Air Flow

> Corrected Inlet Air Flow under Standard Atmospheric Conditions at Sea Level, Static: 1.8 kg/s

h) Engine Life

> Total Life of WP-GY120 Engine: 30 hours or 60 starts.

> Storage Life: 10 years.

> Warranty Period: 2 years (from the date of un-preserving).

i) Engine Operating Stability Margin at Maximum Condition

> Stable Operating Margin: 15%

j) Engine Overall Vibration Value

> Engine Vibration Value Requirement: Not greater than 10g (fundamental frequency). Vibration measurement point is located on the outer surface of the engine diffuser casing.

k) Compressor Parameters

> Compressor Type: Centrifugal Compressor;

> Number of Compressor Stages: Single Stage;

> Compressor Pressure Ratio: 4.8;

> Compressor Inlet Air Flow: 1.8 kg/s;

l) Combustion Chamber Parameters

> Combustion Chamber Type: Annular Reverse Flow Combustion Chamber;

> Number of Nozzles: 12;

> Number of Igniters: 1;

m) Turbine Parameters

> Turbine Type: Axial Flow Turbine;

> Number of Stages: Single Stage;

> Expansion Ratio: 2.5;

n) Exhaust System

> Type: Convergent Nozzle;

> Nozzle Exit Diameter: 96mm;

2.2 Main Performance Data

a) Engine Parameters under Standard Atmospheric Conditions at Sea Level, Static

Table 1 Engine Performance Parameters

Item	Value
Power Output (W)	500
Specific Fuel Consumption (kg/N/h)	1.4
Air Flow (kg/s)	1.8
Thrust-to-Weight Ratio	6.85
Maximum Speed (r/min)	59900
Minimum Speed (r/min)	24000

Maximum Exhaust Temperature (°C)	<780
Engine Outer Diameter (mm)	272
Engine Length (mm)	640
Engine Weight (kg)	17.5
Maximum Operating Altitude (m)	10000
Maximum Starting Altitude (m)	6000
Flight Speed Range	0-0.8M

b) Engine Start Time and Rapid Start Time

> Engine start time: 5 seconds to idle; capable of starting at altitudes of 6000m ~ 8000m.

c) Engine Acceleration

> Engine acceleration from idle to full throttle: 10 seconds.

d) Engine Deceleration

> Engine deceleration from full throttle to idle: 1 second.

e) Generator Operating Parameters

> Generator Rated Speed: 42000~60000 rpm

> Rated Power: 1200W

> Rated Voltage: 28V.

f) Engine Bleed Air Quality

> Engine bleed air mass flow to fuel tank < 0.5% of inlet flow.

g) Others

i. Speed Characteristics

The speed characteristics of the WP-GY120 engine (Figure 5 is for reference only; specific engine data shall be based on the performance data in the logbook upon delivery) indicate that when flight speed and altitude are constant, the relationship

between thrust, specific fuel consumption, and speed should ensure the engine provides stable and reliable power for aircraft flight, meeting the flight requirements under various design conditions, as shown in the figure below.

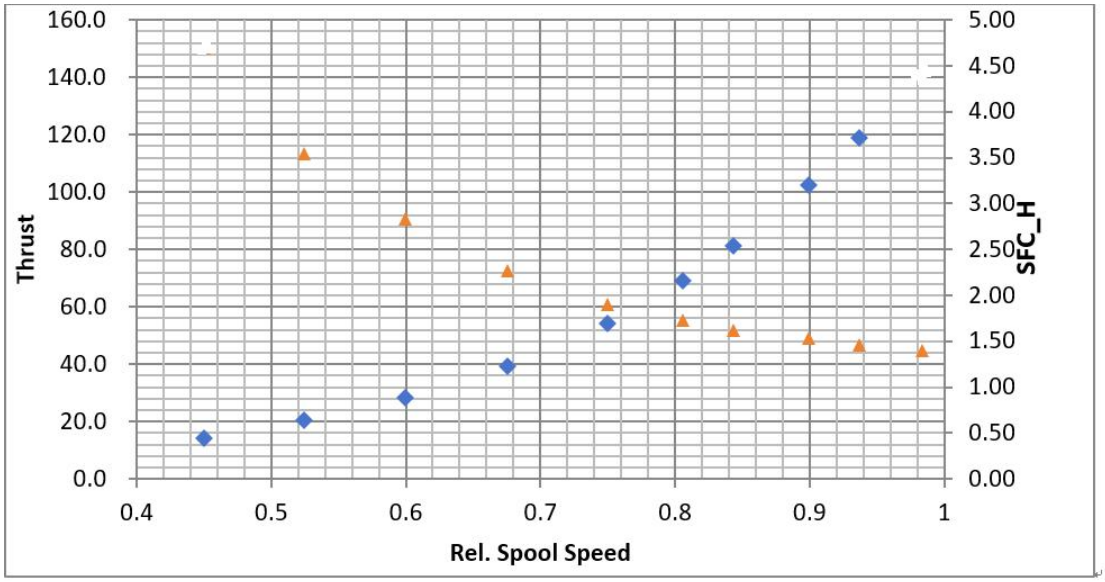


Figure 5 Engine Thrust and Specific Fuel Consumption Throttle Characteristics

ii. Operating Envelope (For Reference Only)
Maximum Flight Altitude: 12000m;
Maximum Flight Speed: 0.8Ma;
Minimum Operating Temperature: -45°C;
Maximum Operating Temperature: +60°C

2.3 System Technical Data

2.3.1 Fuel System

a) Fuel Type: No. 3 Jet Fuel (Jet A-1 equivalent)
b) Fuel Pump Model: ZP7852; Pump Type: Gear Pump; Pump Rotation Direction: Counterclockwise (viewed from above the motor); Inlet Pressure not less than 30kPa; Outlet Pressure not

less than 0.7MPa (at full throttle); Operating Temperature: -40°C to 55°C.

c) Number of Fuel Nozzles: 12; Fuel Supply Pressure: not less than 0.75MPa at full throttle.

d) One fuel filter, filtration rating: 20μ.

2.3.2 Lubrication System

a) Lubricant Type: Aeroshell 500 Turbine Oil; System Type: Fuel-Lube oil mixed lubrication, direct injection lubrication; Operating Pressure: not less than 0.75MPa at full throttle; Operating Temperature: not higher than 300°C; Lubricant Consumption: approximately 15% of total fuel flow.

2.3.3 Starting System

a) System Type: Electric Motor Start; Starting Time approximately 5s.

2.3.4 Control System

a) Engine Control Type:
> The control system consists of an Electronic Controller Unit (ECU), actuators, sensors, cables, and other electrical accessories working in coordination to complete control functions.

b) Controller Model:
> ECU-105; Operating Voltage: 26V~30V; Power Consumption: not higher than 200W.

c) Controller Hardware Interfaces:
Engine igniter cable tail length: 250mm, igniter equipped with XC158/12T2K1P13 socket.
Engine temperature sensor cable tail length: 250mm; ECU

mating cable tail length: 300mm.
Engine speed sensor cable tail length: 1000mm; ECU mating cable tail length: 200mm.
Fuel pump cable tail length: 400mm; ECU mating cable tail length: 300mm.
ECU to aircraft cable connection tail length: 500mm, equipped with JY27473T14F35SN-H socket.
Generator cable tail length after exiting engine intake hub: 1000mm, equipped with reliable terminals.

d) Engine gas inlet, fuel inlet, high-pressure air inlet, and accessory cables should have clear identification.

2.3.5 Monitoring, Diagnostics, and Measurement System
ECU-140 monitors the engine tailpipe exhaust temperature at a single point and simultaneously monitors the actual controlled engine speed value.

3. Engine Structure

The WP-GY120 is a micro turbojet engine adopting an overall structure of a single-stage centrifugal compressor + a short annular straight-through combustion chamber + a single-stage axial flow turbine, making it simple in form. It uses a 0-2-0 support structure, with one thrust ball bearing each at the front and rear to share the engine's radial loads, and the rear bearing 承受s the axial load. Damping or elastic ring structures are used on the front and rear bearings to adjust rotor dynamics. The engine is fixed within the aircraft nacelle via the front casing mounting flange and the tailpipe mounting flange. The engine rotor uses an internal load path structure; rotor forces are transmitted to the aircraft nacelle through the bearing housing, diffuser, mounting flange, and front mounting

attachment. Overall, the WP-GY120 engine features a simple and compact structural design, easy disassembly and assembly, efficient use of space while ensuring component strength requirements, meeting the design requirements of short life, low cost, and high thrust-to-weight ratio.

4. Engine Systems

4.1 Fuel-Lubrication System

The WP-GY120 integrates fuel and lubrication systems, primarily consisting of fuel tank, fuel filter, motor pump, fuel manifold, oil spray nozzle, etc.

Fuels: JET-A, JET-A1, JP4, JP8, TS-1, T2, RT, mixed 20:1 with aviation lubricating oil (Pegasus II). In emergency, Mobil 2-stroke motorcycle oil can be added. If the mixed fuel is not used for a long time, it must be stirred to remix before use.

4.2 Starting System

4.2.1 Overview

The starting system of the WP-GY120 engine uses an electric motor for starting, a high-voltage pack for ignition, and a high-pressure fuel injection disc for fuel delivery, ensuring engine start within 5 seconds.

4.2.2 Working Principle

The working process of the engine's starting system is as follows:

1) Check the battery charge level for ECU power supply; recommended supply voltage is not less than 28V (ECU minimum operating voltage is 21V). Ensure the ECU aviation plug is installed and locked as required, without looseness or detachment.

2) Before starting, ensure there are no obstructions within 1m in front of the engine intake. Ensure there are no light, hard, or small inhalable foreign objects. Ensure no personnel are within 15m to the side of the engine and 12m behind the exhaust direction of the tail nozzle.

3) As required, use ground starting equipment to check the fuel supply system, gas (propane) supply system, and ignition system. Confirm all circuits are clear, without breaks or leaks, and pressures meet starting requirements. Perform a fuel pump check to ensure the engine fuel lines are 尽可能 filled with fuel and free of air.

4) WP-GY120 engine starting logic: Upon receiving the ground start signal, the starter motor activates, the high-voltage pack ignites, the high-pressure fuel injection disc injects fuel, and the engine enters idle state within 5 seconds. When the engine speed rises to 30000 rpm, the engine enters idle state.

5) Parameters for starting with an external 24V-12Ah battery:

Parameter	Value
Peak Current Consumption (5s)	Approx. 70A
Operating Current	30A
Current after switching to Gen mode	Less than 10A, Voltage 28V
Average Power Consumption per Start	Approx. 0.3Ah
Note: After engine start, the starter/generator switches to generator mode, supplying its own oil pump and ECU, and can provide 500W of power externally.	

4.4 Control System

a) Overview

The engine control system can be regarded as the brain and nervous system of the engine. Based on flight commands, engine control status, engine speed signal, and tailpipe temperature signal, it completes control functions such as fuel supply, blade, and nozzle position adjustment. The WP-GY120 turbojet engine control system consists of an Electronic Controller Unit (ECU), actuators, sensors, cables, and other electrical accessories.

b) System Working Principle

The ECU regulates the fuel supply by controlling the duty cycle of the fuel pump motor, thereby ensuring the engine rotor speed remains constant or increases according to a specific acceleration pattern. Specific functions and purposes include:

1) Ensuring stable operation of the WP-GY120 turbojet engine within the aircraft's flight envelope;
2) Having stepless regulation functionality;
3) Ensuring engine acceleration, deceleration, and steady-state speed regulation for various conditions within the flight envelope;
4) Capable of acquiring and processing speed (n) and exhaust temperature (T_5) signals, and having RS422 communication capability;
5) Having an emergency shutdown function (for ground testing);
6) Having alarm and protection functions for T_5^* overtemperature and n overspeed;
7) Having the function to control the fuel pump motor;
8) Reserved function for external power supply from the generator (500W).

c) System Composition

i. ECU

The WP-GY120 engine uses a digital electronic fuel regulator, powered by battery or DC power supply, voltage 28V.
The control device (ECU) receives communication commands from the flight control computer, drives the fuel pump, measures the engine's exhaust temperature and speed in real time, completes functions such as starting, acceleration/deceleration regulation, steady-state regulation, overtemperature/overspeed alarm, and sends status parameters to the flight control computer in real time via RS422 communication.

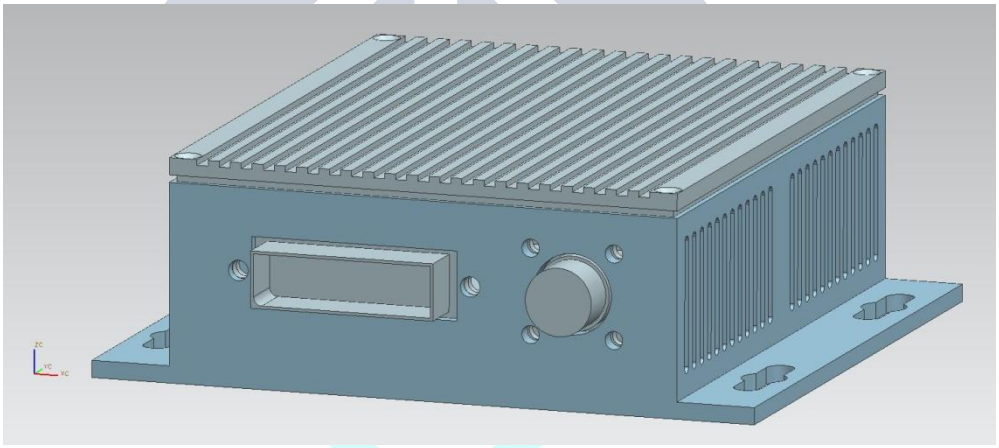


Figure 10 ECU Controller

ii. Sensors

Sensor signals acquired by the ECU include speed n (two-wire) and T5 (two-wire).

1. Speed Measurement

Engine speed is determined by measuring the period of the generator output voltage; the generator outputs a sine wave signal. The relationship between generator voltage

frequency and engine speed is: ; Voltage peak not greater than 30V (at 52500 rpm), peak not less than 0.5V (at 800 rpm);

2. Temperature Sensor

Table 3 Sensor Parameters

Purpose	Measure Turbine Exhaust Temperature
Type	K-Type Thermocouple
Measurement Range	0°C ~ +1300°C
Measurement Accuracy	0.5% Class A, Linearity ±0.15%
Quantity	1
Output	To ECU

4.5 Monitoring, Diagnostics, and Measurement System

a) Overview

Engine condition monitoring, fault diagnosis, and measurement are all performed by the engine ECU, which monitors the entire system operation by measuring key engine status parameters. The system mainly consists of the engine Electronic Controller (ECU), engine T5 temperature sensor, and engine speed sensor.

b) System Working Principle

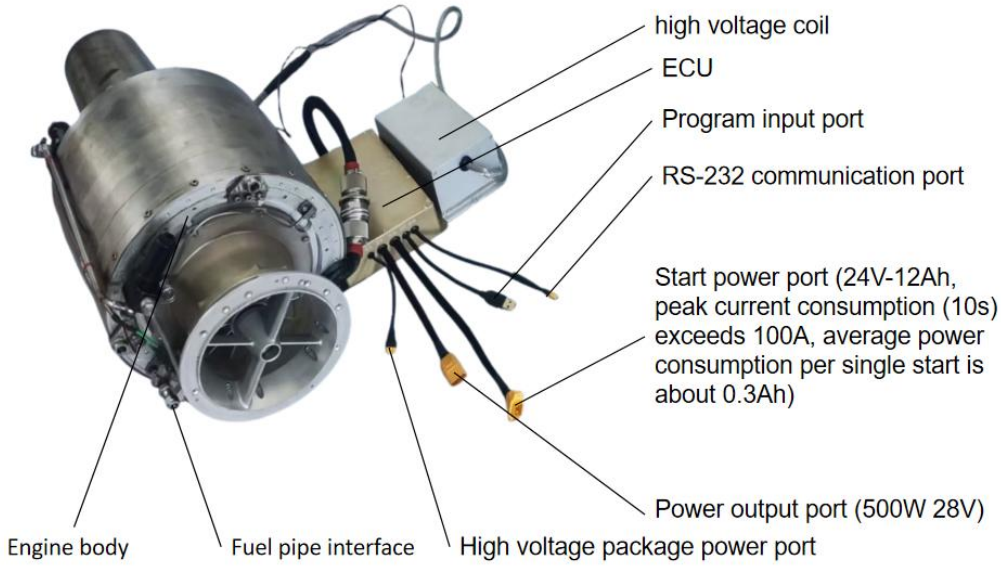
The engine ECU constantly changes the fuel supply by monitoring the difference between the target engine speed and the actual speed, regulating the engine speed to remain stable within ±200 rpm. Simultaneously, it monitors the engine tailpipe exhaust temperature T5 to ensure it does not exceed 780°C.

The engine ECU has data storage functionality. By comparing trends in engine speed and exhaust temperature changes, it 判断s whether various engine operating states are normal. The engine speed sensor is located at the front end of the engine compressor casing, and the temperature sensor is located at the end of the engine tailpipe outlet.

c) System Components

The temperature sensor uses an armored K-type thermometer with a measurement range up to 1300°C. Since the engine exhaust temperature limit is 780°C, this measurement range can cover overtemperature conditions up to 70%, meeting the needs of various extreme engine states. The sensor is fixed at the engine tail and can be tested for failure by direct contact with a heat source.

Appendix I:



System Connection Diagram

Appendix II:

Throttle Opening vs. Operating State Correspondence Table

Parameter	Unit	Max Condition (Takeoff)	Nominal Condition	Cruise Condition	Idle Condition
Speed	%	100	95	85	~50
Thrust	N	≥1200	≥1100	≥1000	<160
SFC	kg/N/h	<0.126	<0.124	<0.123	<0.28
Run Time	min	≤5	≤30	Continuous	Continuous
Exhaust Temp	°C	<800	<750	<690	<500

SFC valid for fuel with calorific value of 43.5 MJ/kg

Engine Ground Test Data

Throttle (%)	Speed (10k rpm)	Temp (°C)	Thrust (KG)	Note: Fuel Consumption (KG/min)
Idle	~2.6	410	10	~0.5
50	5	470	55	~1.1
60	5.4	510	74.6	~1.12
70	5.59	580	90.5	~1.81
80	5.76	639	104.8	~2.11
90	5.88	691	116.2	~2.34
100	5.99	760	123	~2.52

Appendix III

WP-GY120 Turbojet Engine Host Computer Interface

Appendix IV

WP-GY120 Turbojet Engine ECU Control Protocol

一、Overview

1. Introduction

The data communication protocol defined in this document uses RS232 serial communication.

2. Definition of Terms and Abbreviations

Control Computer — Control and Management Computer

Engine ECU — Engine Control Unit

二、Control Instruction Set

Before using serial port commands to control the device, please carefully confirm whether the following parameters are correct: 1) Whether the baud rate is consistent with the controlled device; 2) Confirm the serial cable is a straight-through cable, i.e., pin 2 to pin 2, pin 3 to pin 3.

1. Communication Protocol

Serial Communication

Communication Parameters: Baud Rate: 19200, Data Bits: 8, Stop Bits: 1, Parity: None.

2. Control Codes

The control code sent from the computer to the ECU consists of the following 6 bytes of data:

Sync Byte	Command Word	Parameter
AAH	1 Byte	4 Bytes

The status data returned by the ECU to the computer consists of 18 bytes of data:

Sync Byte	Data
ABH	17 Bytes

The completeness of the control command is determined based on the start code and data length. Note: All data in the control code is in HEX (hexadecimal) format.

三、Protocol Details

Explanation: For convenience of expression, the following conventions are made:

- **Bold black** indicates command parameters;
- All instructions are initiated actively by the computer; control instructions have no return parameters.
- RSV is reserved data, value set to 0; the ECU does not care about this parameter;

Control Instructions

Run Command

- **Send**

  Instruction

Sync Byte	Command Word	Throttle Parameter	Reserved
AA	**40**	**SPEED**	RSV

  Description:

  Sets engine speed after engine is running.

Parameter	Bytes	Description
SPEED	1	Engine speed, percentage. Range: 50~120
RSV	3	Reserved data, unused. Set to 0

- **Return** > Instruction: None

Start Command

- **Send**

  Instruction:

Sync Byte	Command Word	Reserved
AAH	51	RSV

  Description:

  Starts the engine,Requires the engine to be in idle state for this command to be effective.

Parameter	Bytes	Description
RSV	4	Reserved data, unused. Set to 0

- **Return**

  Instruction: None

Stop Command

- **Send**

  Instruction:

Sync Byte	Command Word	Reserved
AA	52	RSV

- Description:

  Stops the engine

Parameter	Bytes	Description
RSV	4	Reserved data, unused. Set to 0

- **Return**

  Instruction: None

Cool Down Command

- **Send**

  Instruction

Sync Byte	Command Word	Reserved
AA	53	RSV

  Description:

  Cools down the engine, cools the starter motor and solenoid valve.

Parameter	Bytes	Description
RSV	4	Reserved data, unused. Set to 0

- **Return**

  Instruction: None

Cold Start Command (No Ignition)

- **Send**

  Instruction

Sync Byte	Command Word	Reserved
AA	55	RSV

  Description:

  Engine cold start, used to verify the engine's starting process. Does not perform ignition operation.

Parameter	Bytes	Description
RSV	4	Reserved data, unused. Set to 0

- **Return**

  Instruction: None

Set Max Thrust Command

- **Send**

  Instruction

Sync Byte	Command Word	Reserved
AA	60	RSV

  Description: This command must be executed with the engine running; invalid in other states.

Parameter	Bytes	Description
RSV	4	Reserved data, unused. Set to 0

- **Return**

  Instruction: None

Set Start Detection Voltage Command

- **Send**

  Instruction

Sync Byte	Command Word	Detect voltage	Reserved

AA	61	VALUE	RSV

Description used to set the determination voltage for engine start. It is used when there are differences among engines. This command should be operated when the engine is not running.

Parameter	Bytes	Description
VALUE	1	Value range: 28 to 40;
RSV	3	Reserved data, unused. Set to 0

- **Return** > Instruction: None

Set Idle Throttle Command

- **Send**

Instruction

Sync Byte	Command Word	Idle throttleIdle throttle	Reserved
AA	50	VALUE	RSV

Description: This command must be operated with the engine not started.

Parameter	Bytes	Description
VALUE	2	High byte first, low byte last
RSV	2	Reserved data, unused. Set to 0

- **Return** > Instruction: None

Relay Switch Command

- **Send**

Instruction

Sync Byte	Command Word	switch	Reserved
AA	70	ONOFF	RSV

Description: This command must be operated with the engine not started, only for production testing.

Parameter	Bytes	Description

ONOFF	1	1-Turn relay ON, 0-Turn relay OFF
RSV	3	Reserved data, unused. Set to 0

- **Return** > Instruction: None

Solenoid Valve Switch Command

- **Send**

  Instruction

Sync Byte	Command Word	switch	Reserved
AA	71	ONOFF	RSV

Description: This command must be operated with the engine not started, only for production testing.

Parameter	Bytes	Description
ONOFF	1	1-Turn relay ON, 0-Turn relay OFF
RSV	3	Reserved data, unused. Set to 0

- **Return** > Instruction: None

High-Voltage Pack Switch Command

- **Send**

  Instruction

Sync Byte	Command Word	switch	Reserved
AA	72	ONOFF	RSV

Description: This command must be operated with the engine not started, only for production testing.

Parameter	Bytes	Description
ONOFF	1	1-Turn relay ON, 0-Turn relay OFF
RSV	3	Reserved data, unused. Set to 0

- **Return** > Instruction: None

Power Board Switch Command

- **Send**

  Instruction

Sync Byte	Command Word	switch	Reserved
AA	73	ONOFF	RSV

Description: This command must be operated with the engine not started, only for production testing.

Parameter	Bytes	Description
ONOFF	1	1-Turn relay ON, 0-Turn relay OFF
RSV	3	Reserved data, unused. Set to 0

- **Return** > Instruction: None

Power Board Charging Current Switch Command

- **Send**

  Instruction

Sync Byte	Command Word	Charging current	Reserved
AA	74	CHARGE	RSV

Description: This command must be operated with the engine not started, only for production testing.

Parameter	Bytes	Description
CHARGE	1	1 - High current, 0 - Low current
RSV	3	Reserved data, unused. Set to 0

- **Return** > Instruction: None

Query Instructions

Query Engine Running Status

- **Send**

  Instruction

Sync Byte	Command Word	Sync Byte
AA	20	RSV

Description: This command is used to query engine running parameters. The computer should query periodically, recommended interval 500ms.

Parameter	Bytes	Description
RSV	4	Reserved data, unused. Set to 0

➢ **Return**

Instruction

Sync Byte	Engine Speed	Pump Speed	Supply Voltage	Inlet Temp	Controller Temp
AB	M_SPEED	G_SPEED	VOL	IN_TEMP	CTRL_TEMP

Exhaust Temp	Status Byte	Run Time	Checksum
OUT_TEMP	STATUS	RUN_TIME	CS

Description:

Parameter	Bytes	Description
M_SPEED	2	High byte first, engine speed. Range: 0~65000
G_SPEED	2	High byte first, fuel pump speed. Indicates the PWM output of the pump ESC.
VOL	2	High byte first, supply voltage. Unit V. Value between 22~30.
IN_TEMP	2	Low byte first, inlet temperature. Unit ° C.
CTRL_TEMP	2	Low byte first, ECU controller temperature. Unit ° C.
OUT_TEMP	2	Low byte first, exhaust temperature. Unit ° C
STATUS	1	BIT7 -- Shutdown status, 1-正常, 0-异常 BIT6 -- Run status, 1-Running, 0-Not running BIT5 -- Reserved BIT4 -- Engine overtemperature, 1-Overtemp, 0-Normal BIT3 -- ECU overtemperature, 1-Overtemp, 0-Normal BIT2 -- Engine stall, 1-Stall, 0-Normal BIT1 -- Engine overspeed, 1-Overspeed, 0-Normal BIT0 -- Power switch, 1-28V, 0-24V
RUN_TIME	3	Three bytes represent 256S, S, 10ms respectively.

		first byte is high 8 bits of seconds, second byte is low 8 bits of seconds, third byte is value for 10ms.
CS	1	Not used yet, set this value to 0xFF.