UAV Engine Test System **WF-EN-17-MAX**

User Manual

5.0

*__WF-EN-17-MAX__ on behalf of the WF-EN-17、WF-EN-55、WF-EN-MAX

*__WF-EN-MAX__ is suitable for Limbach 550 and ROTAX914 series engine testing

*This user manual is applicable to WF-EN-17, WF-EN-55, WF-EN-MAX test benches

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Dear Client,

Thank you for your trust in choosing WING FLYING 's products.

WING FLYING always believes that professionalism creates quality and insists on customer first. Continuous investment in product research and development, pursuit of precision, efficient and excellent service, make us continue to innovate and launch products that satisfy customers.

This manual will guide you to use the WF-EN-17-MAX UAV engine test system safely and efficiently. Before operation, please be sure to read this manual and operate according to the instructions in the manual.

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I. Disclaimer

This statement applies to the licensees of WING FLYING (TIANJIN) TECHNOLOGY CO., LTD., including users who purchase this product, authorized dealers, distributors, and developers. Before using the WF-EN-17-MAX UAV engine test system, please carefully read this statement and the terms of use of the power system test bench. Once used, it will be deemed to be recognized and accepted in its entirety. Please strictly follow the manual for use. Do not replace other versions of the software system on your own to avoid unnecessary damage caused by compatibility differences.

When operating the WF-EN-17-MAX UAV engine test system, WING FLYING (TIANJIN) TECHNOLOGY CO., LTD. will not be responsible for any losses caused by improper use by the user. Please read the following terms carefully:

1. If the user does not adjust the parameter settings of the engine test bench according to the operating manual, resulting in poor test results or product damage, the company will not be responsible.

2. The software provides update services, and users can choose the appropriate version according to their own situation.

3. Users are limited to using factory settings, and the manufacturer's parameters are for factory calibration. Users are not allowed to set them.

4. Due to unauthorized modification or damage to the internal system components of the engine test system, the engine test system software receives data errors. Once it is found that it is not a problem with the company's product itself, the company will not be responsible and has the right to hold accountable.

5. Before using the software, please read this product description carefully. The company is not responsible for product damage and other losses caused by failure to follow this product description.

II. Precautions for use

When the WF-EN-17-MAX UAV engine test system is working, the high-speed rotating propeller may cause a certain degree of injury and damage to personal property. Therefore, when using the system, please pay attention to safety. The company is not responsible for product damage or personal risks caused by not following the manual regulations.

1. The WF-EN-17-MAX UAV engine test system should be placed in an independent space. Before conducting the engine test, the test bench should be fixed and the surrounding environment should be safe. During the test, no one is allowed to enter without the operator's permission to avoid personal injury.
2. Please test within the range allowed by the engine test bench and do not exceed the maximum range of the test bench.
3. Use the test equipment strictly in accordance with the manual and do not operate it illegally to avoid electric shock.
4. Do not get close to or touch the rotating engine or propeller to avoid being cut by the rotating propeller.
5. Please check whether the propeller and engine are firmly assembled before use.
6. Please check whether all parts are intact before use. If any parts are aged or damaged, please replace them with new parts.
7. Operators must not operate the machine while drinking, taking drugs, feeling dizzy, weak, nauseous, or in other poor physical or mental conditions to avoid injury.
8. When the software issues an alarm, the operation should be stopped immediately.

III. Product overview

1.System composition

The WF-EN-17-MAX UAV engine test system consists of the WF-EN-17-MAX test bench (including various sensors, acquisition box, test bench accessories) and MET-E series test software.

FIG 3-1-1WF-EN-55 engine test bench (taking WF-EN-55 as an example)

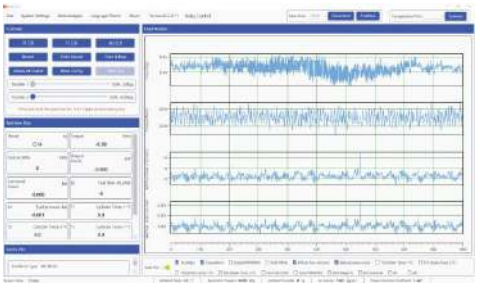


FIG 3-1-2 MET-E test software

*Test bench accessories include engine mounts, supporting cables, etc.

2. Function introduction

The WF-EN-17-MAX UAV engine test system is a test system developed specifically for UAV engines. It is equipped with sensors such as thrust, torque, RPM, fuel consumption (optional), temperature, and environmental parameters. It can measure data such as thrust, torque, speed, fuel consumption, temperature, and environmental parameters.

The WF-EN-17-MAX UAV engine test system is equipped with MET-E series test software. The MET test software is connected to the power system test bench to measure and process the data of the UAV engine.

3. System logic operation diagram

FIG 3-3-1 is the logic diagram of the test bench system operation , which clearly shows the logical control relationship between the test bench, engine, relay, and upper computer, as well as the test bench operation mechanism.

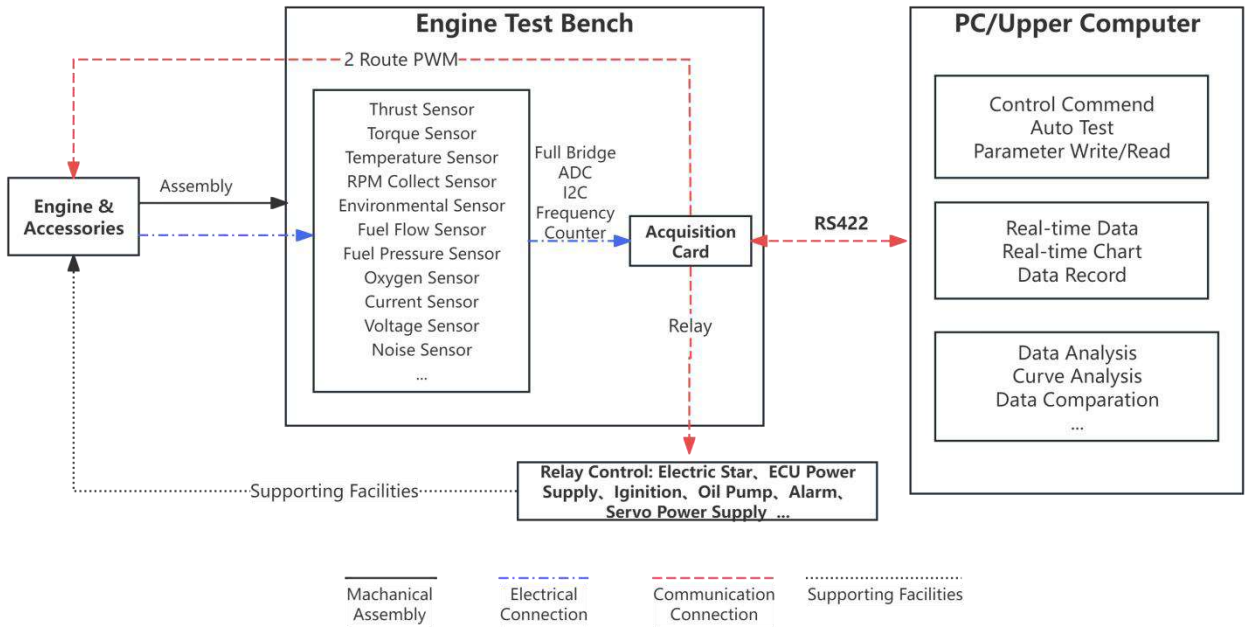


FIG 3-3-1 The logic operation diagram of the test bench

*The engine, accessories and computer in the system operation logic diagram are provided by the user.

*Sensors such as fuel flow pressure, fuel pressure, oxygen concentration, current, voltage and noise are optional.

4. Ez-test acquisition box introduction

1) The interface diagram of the acquisition case

The Ez-test acquisition box is developed by WING FLYING (TIANJIN) TECHNOLOGY CO., LTD.. It is a collection system specially equipped for engine test benches. It can realize multi-channel data collection such as thrust, torque, speed, temperature, etc.

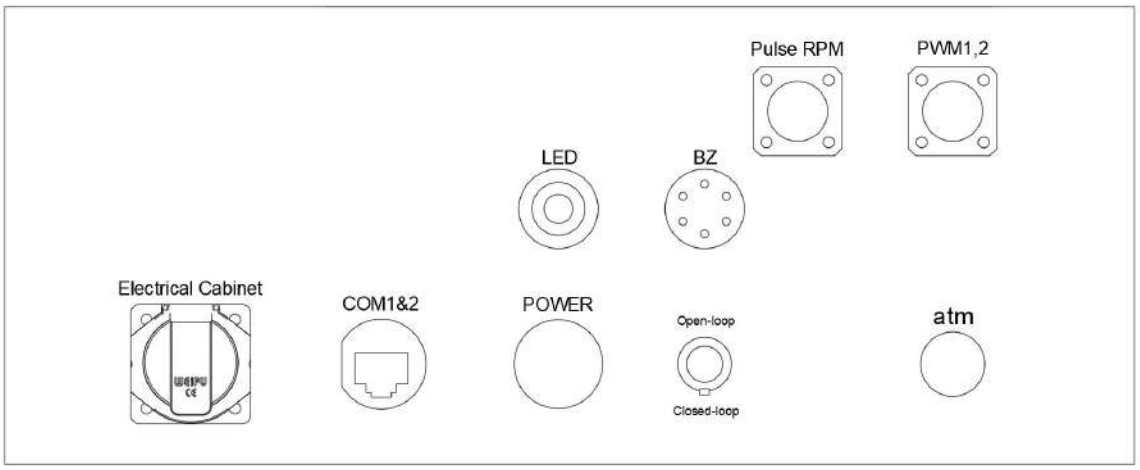


FIG 3-4-1 External interface diagram of the acquisition box

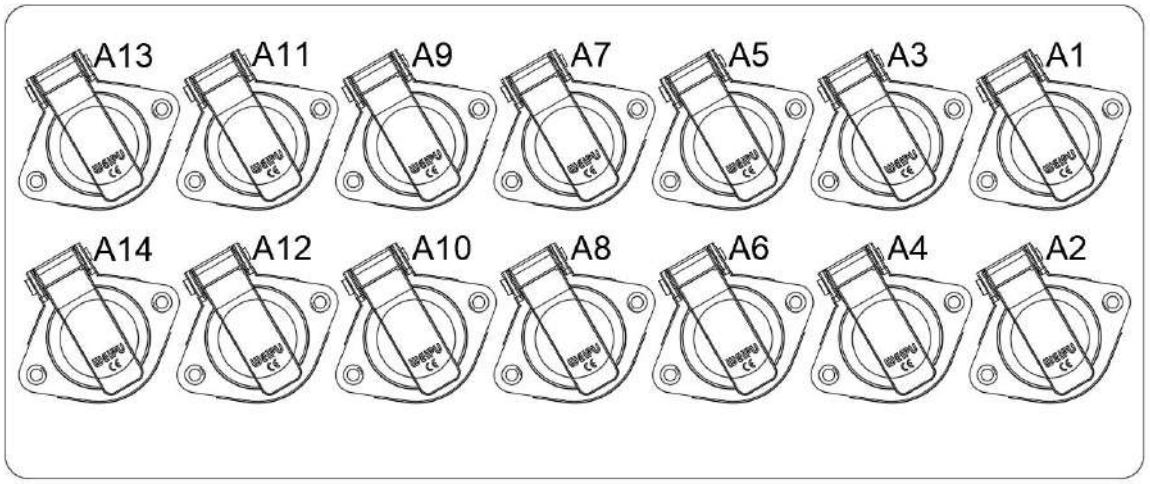


FIG 3-4-2 Inner interface diagram of the acquisition box

*LED indicator: flashes green means normal operation. If the indicator is off when the power is on, there is something wrong with the acquisition box.

*BZ buzzer: the device will emit a three times "beep" sound after powering on successfully, and a "beep" sound when software communication is successful/software communication is disconnected/ignition is allowed or prohibited.

2) Introduction to the interface of the acquisition box

Port Name	Position	Function
Electrical Cabinet	External Interface	Interface of the Electrical Cabinet
COM1 & COM2		Main serial port & Temperature serial port
LED		Running lights
POWER		Power supply of the Acquisition Box
BZ		Buzzer
Open-Loop & Closed-Loop		Open-loop and Closed-loop Switching Knob
Pulse RPM		Pulse speed
PWM1, 2		Signal output of PWM 1，2
atm		Atmospheric Environment Sensor
A1	Internal Interface (Sensor interface)	ADC1 interface, default is voltage sensor
A2		ADC2 interface, default is current sensor
A3		ADC3 interface, default is fuel flow sensor
A4		ADC4 interface, default is fuel pressure sensor
A5		ADC spare interface 5, no default sensor, user can choose different sensors
A6		ADC spare interface 6, no default sensor, user can choose different sensors
A7		ADC spare interface 7, no default sensor, user can choose different sensors
A8		ADC spare interface 8, no default sensor, user can choose different sensors
A9		Thrust sensor interface
A10		Torque sensor interface
A11		RPM sensor interface, including 1 Optical RPM, 1 Pulse RPM (Pulse speed requires user to connect to the pulse signal of the engine to be tested)
A12		485 temperature module interface
A13		ADC13 is an empty interface, used as a backup for expansion function
A14		ADC14 is an empty interface, used as a backup for expansion function

FIG 3-4-1 the interface of the acquisition box

3)Ez-Test acquisition box parameters

Acquisition Box Parameters			Notes
Basic Info	Acquisition speed	100Hz/10Hz	
	Bus type	422@460800bps	
	Operating system	Win 7 and above	
	Device power supply	DC12-24V 0.5A@24V	
PWM Output	Number of channels	2-Route	
	Resolution	1μs	
	Output range	50-500Hz	
	Output error	<1μs	
Full-bridge differential measurement (force sensor)	Number of channels	2-Route	
	ADC resolution	24bit	
	Sampling range	±20mV	
	Channel scan mode	Pseudo-synchronous acquisition	
	Gain error	±0.05%	
AI differential analog measurement	ADC differential channel number	8-Route	Maximum support 70V, 150ma, need to be customized
	ADC resolution	24bit	
	Sampling range	±5V，0-20ma	
	Channel scan mode	Synchronous acquisition	
	Gain error	±0.01%	
Frequency counter (speed)	Number of channels	2-Route	
	Resolution	0.1Hz	
	Function	Frequency measurement	
	Minimum pulse width	10μs	
	Electrical standard	TTL level	
Temperature acquisition card	Number of channels	8-Route	K type and PT100 type, choose one, K type by default
	Resolution	0.1℃	
	Accuracy (K couple)	±1℃±0.05%(10PPM)	
	Accuracy (PT100)	±0.2℃(25PPM)	
Interface of I2C Sensor	Number of channels	3-Route	
	Supported models	Pressure environment sensor	
		Airspeed sensor (custom interface)	
		Infrared sensor (custom interface)	

FIG 3-4-2 Acquisition Box Parameters

IV.Structural components introduction

1.Structural components introduction of WF-EN-55

1) Structural introduction:

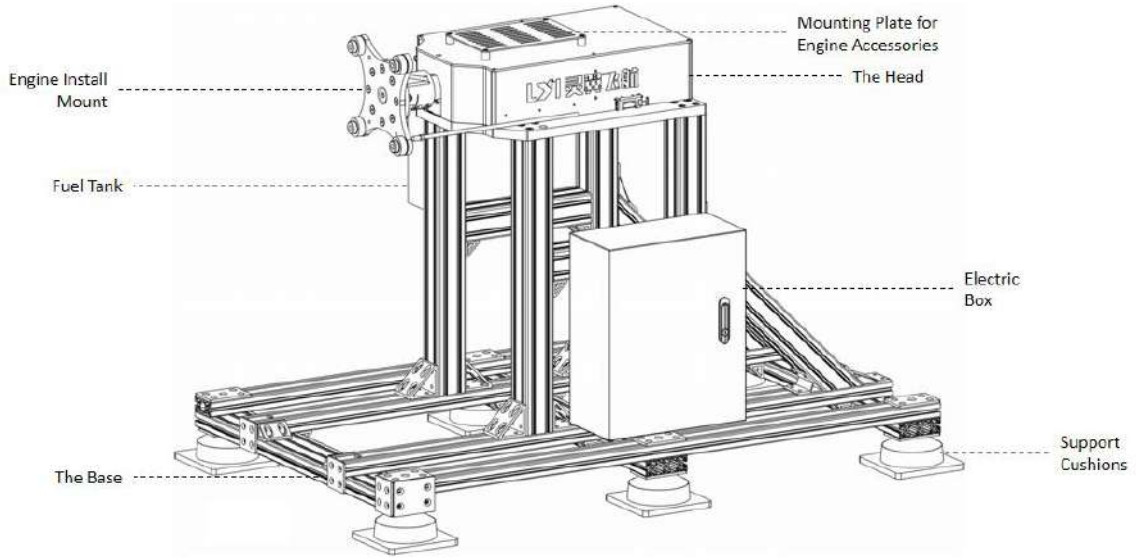


FIG 4-1-1 Structure diagram of the test bench

2) Introduction of the sensors and the acquisition box:

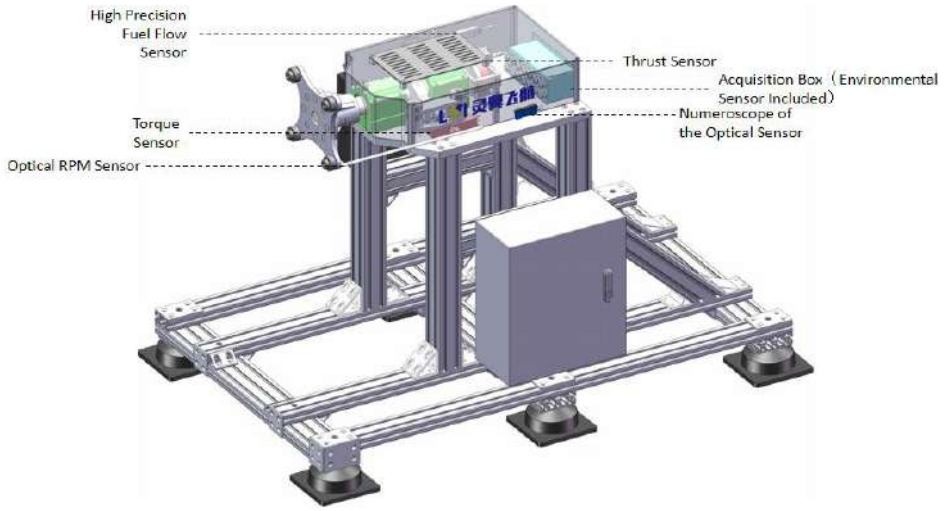


FIG 4-1-2 Location diagram of the sensor and acquisition box

*WF-EN-17-55 structure and sensor introduction takes WF-EN-55 as an example.

*The fuel flow sensor in the diagram is optional.

2.Structural components introduction of WF-EN-MAX

1)Structural introduction:

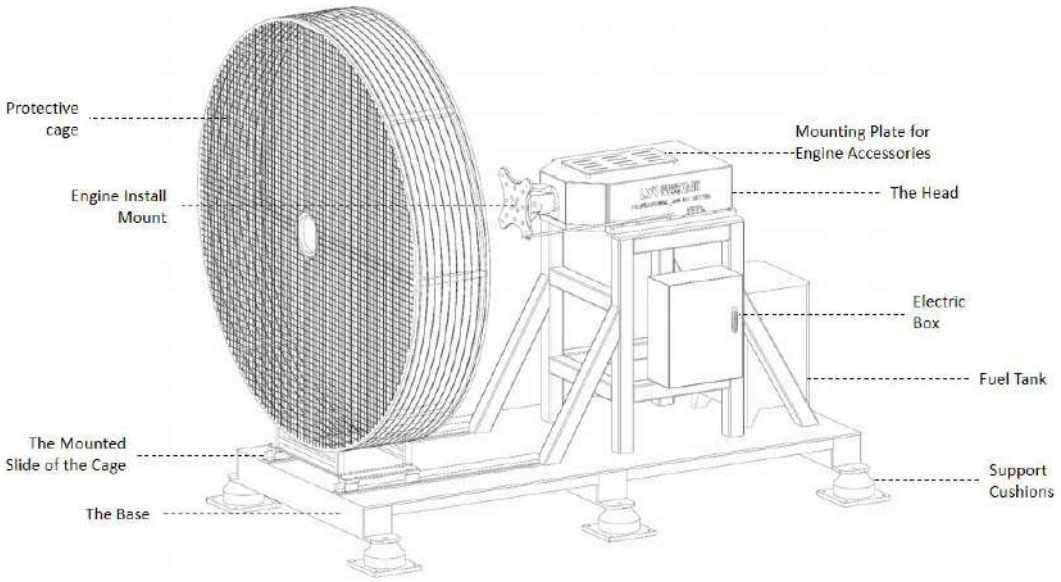


FIG 4-2-1 Structure diagram of the test bench

2) Introduction of the sensors and the acquisition box:

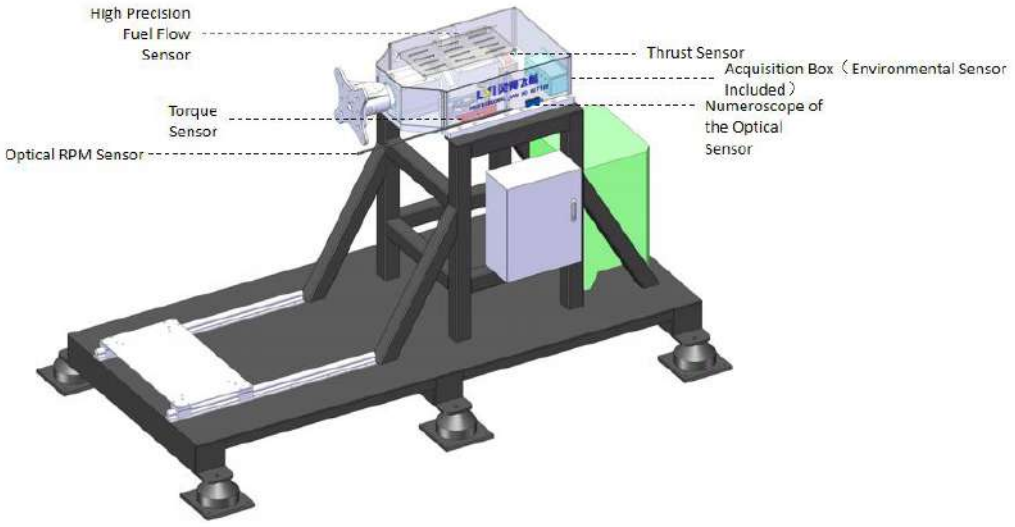


FIG 4-2-2 Position diagram of the Sensor and acquisition box

*The protective cage and fuel flow sensor in the diagram are optional.

3.Structural components Introduction of the electrical box

1) Structure introduction of the Electric box

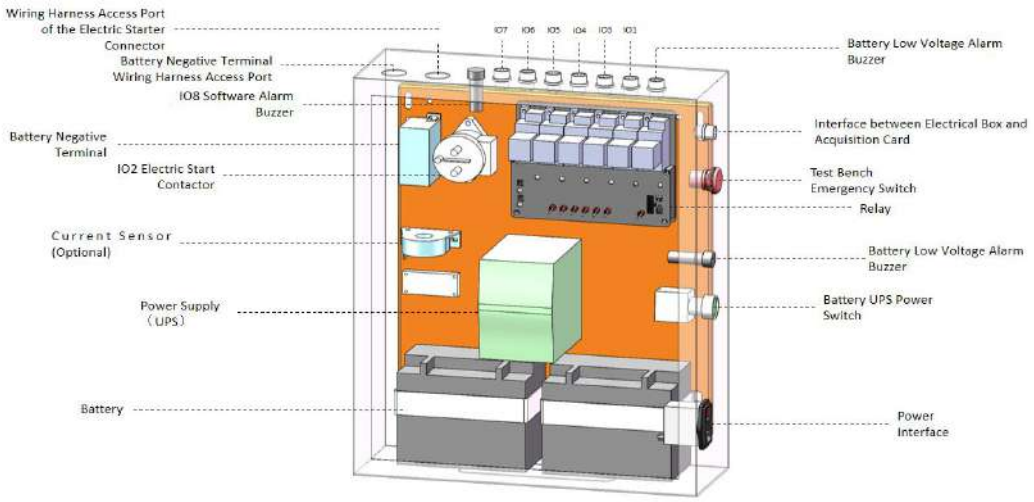


FIG 4-3-1 Electric box structure

*Interpretation of relay control interface: IO1: ECU power supply IO2: Electric start IO3: Ignition 1 IO4: Ignition 2 IO5: Oil pump 1 IO6: Oil pump 2 IO7: Servo power supply IO8: Software alarm

*The battery is a 12V/24V battery, which mainly supplies power for electric starters; turn on the UPS power supply switch, and the battery can power the system.

*Connect the 220V power supply and turn on the UPS power supply switch at the same time to charge the battery.

2) Introduction to the structure of multifunctional relay

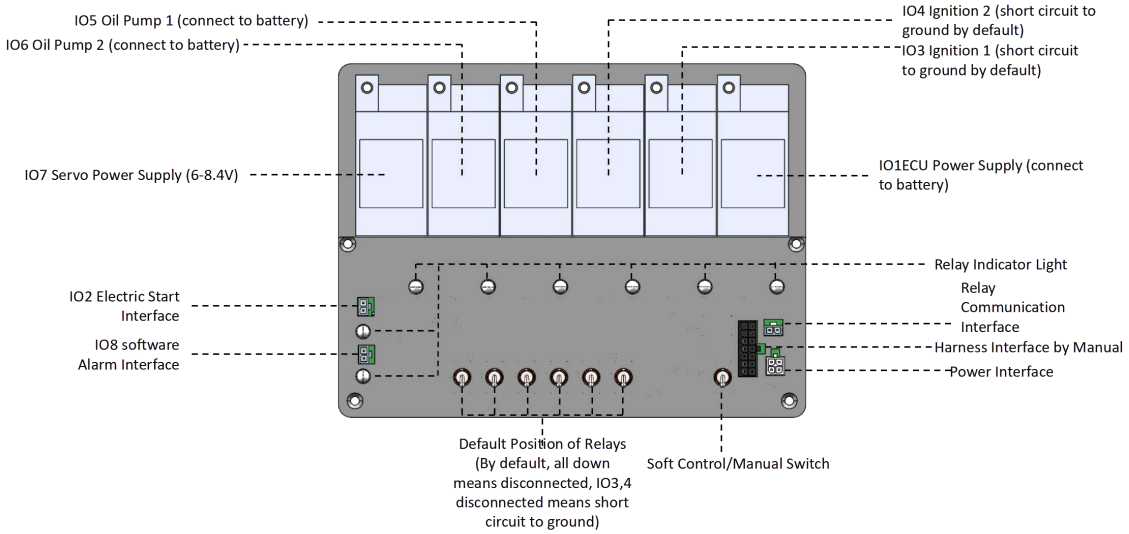


FIG 4-3-2 Multi-function relay structure diagram

Note: The relay indicator light is green for on and red for off.

V. Software introduction

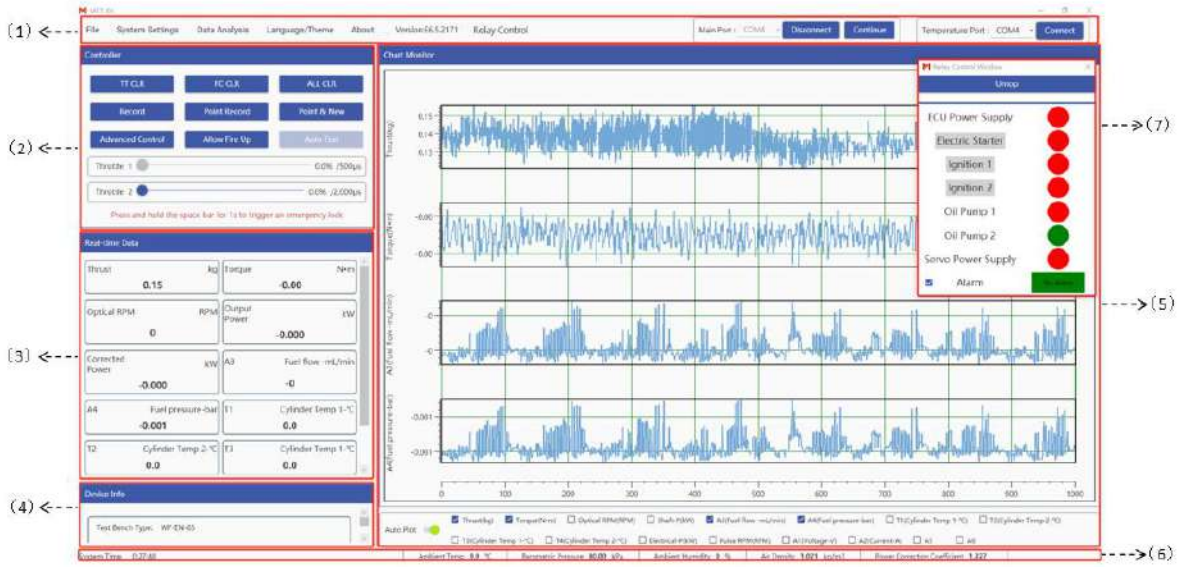


FIG 5-1 Schematic diagram of the main interface

（1）Tool window （2）Control window （3）Real-time data window

（4）Device info window（5）Chart monitor window （6）Environmental parameter display window

（7）Relay control window

1. Tool window

The tool window contains eight modules: File, System settings, Data analysis, Language / Theme, About, Version number, Relay control, and Port. It can realize data search, system basic parameter setting, and data analysis and other functions.

I>File

Click the **File** to open the Test Data Store folder (MetData). View raw test data (Log), point acquisition data (Point), test report (Report), throttle point mean data (Average Throttle Point Data).

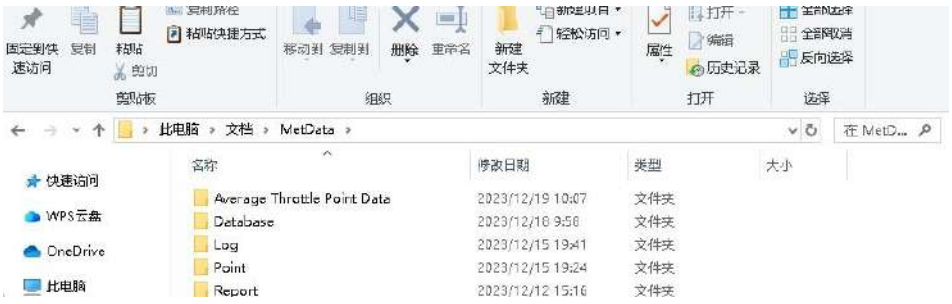


FIG 5-1-1 Location of the data file storage

* The program profile is the Database folder, and the user can replace the test bench model by deleting the Database.

II>System Settings

The system setting includes 9 modules: Basic Setting, Throttle Linear(S), Relay Setting, Safe Guard, Test Info, Auto Test, Data Setting, Factory Setting and Custom Setting.

(I) Basic Setting:

In the basic setting, parameters such as Thrust Direction, Torque Direction, Open/close loop mode, Number of Stickers, and Sampling Rate can be set.

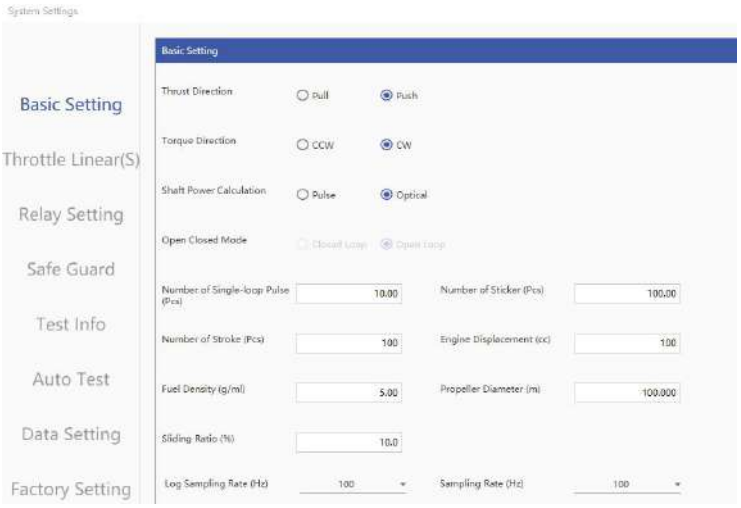


FIG 5-1-2 Basic Settings interface

①**Thrust direction**: the forward force generated by the engine and propeller (the back end of the test table points to the engine) is the pull force. At this time, set the thrust direction to “Pull”: the thrust display value in the real-time data is +, set the thrust direction is "Push", the thrust display value is-; the backward force generated by the engine and the propeller (the engine points to the back end of the test table) is the push force. When setting the thrust direction is "Pull", the thrust display value is-, set the thrust direction is "Push", and the thrust display value is +.

②**Torque direction**: the left hand spiral theorem with the pull direction is CW (clockwise rotation), the right hand theorem is CCW (counterclockwise rotation), select CW, CW steering propeller torque will display +, CCW steering propeller torque will be displayed as-, select CCW shows the opposite polarity.

③**Shaft power calculation enables:** choose to use the pulse speed or optical speed to calculate the shaft power.

④ **Open/closed loop mode:** Open loop mode refers to the test bench control engine is not locked due to communication disconnection, and can be continued through the software, the closed loop mode is opposite, and the communication of the upper machine will be automatically locked to ensure the safety of the test platform, generally open loop mode is used for long time test or poor communication situation.

Switching of open/closed loop mode: Please turn off the power supply of the acquisition box before switching, and then make a mechanical position switch on the control panel of the acquisition box (Open-loop / Closed-loop).

The closed loop mode is the conventional test mode, the relay mechanical switch in the control box should be set to the engine shutdown state, that is, the ECU power supply and the ignition are off (OFF), and the default state setting of the relay on the software. The open loop mode requires the relay mechanical switch in the control box to the engine ignitable state, that is, the ECU power supply and ignition are closed (ON), and the default state setting of the relay on the software.

Note: open loop state, after the test bench powered, the engine will be in an ignition state, the tester must pay attention to safety risks, to prevent danger!!

* Open / closed loop cannot be set, only display the switch status on the acquisition box.

⑤**Number of single loop pulses:** the number of pulses emitted in a circle at the pulse speed, similar to the polar logarithm of a brushless motor.

* It must be set before the test. If the number of pulses per cycle is set correctly, the pulse speed measurement error will occur.

⑥**Number of stickers:** refers to the number of reflective stickers posted on the propeller or engine when using the speed of optical measurement. For example: two-blade speed measurement, the general posted reflective sticker is 2, input 2 in the "optical sticker number", such as the three-blade speed, generally posted reflective sticker is 3 in the "optical sticker number" input 3.

* It must be set before the test. If the number of stickers is set wrong, the Optical RMP measurement will be wrong.

⑦**Number of Stroke:** the number of strokes of the engine cycle, and used to calculate the effective cylinder pressure.

⑧**Engine displacement:** the total engine cylinder volume, used to calculate the effective cylinder pressure.

⑨**Fuel density:** fuel density, used to calculate the fuel consumption rate and specific fuel consumption parameter.

⑩**Propeller diameter:** here the propeller diameter input value, used to calculate the thrust coefficient and the power coefficient, if the user does not need to measurement the related parameters, it is not required to set.

⑪**Sliding ratio:** fuel to oil ratio.

⑫**Sampling rate**: refers to the data acquisition frequency of the data acquisition box, the standard version is 10Hz, the 100Hz version can compatible with 10,50,100Hz, and the random noise will increase with the acquisition frequency. It is recommended to use 100Hz for testing sweep frequency and response, and 10Hz for other tests.

Logging rate: refers to the recording rate of raw data (Log).

*The 100Hz high-frequency acquisition version can support 0.1,1,10,50,100Hz, and the 10Hz version can select three modes of 0.1,1, and 10Hz.

(II) Throttle linear setting

In the throttle linear setting, multiple linear correspondence can be realized for the PWM output frequency, throttle 1 opening and the corresponding PWM, throttle 2 opening and the corresponding PWM. By adjusting the PWM linearity, the linear correspondence between the throttle curve and the valve opening can be realized.

FIG 5-1-3 Throttle linearity setting

①**Frequency of PWM:** refers to the update speed of PWM signal, range of 50-500Hz (general remote control is 72 Hz, flight control is 400 Hz, rudder standard signal is 333 Hz, theoretically the update speed change will not have much impact on the control system).

②**Throttle 1 opening:** refers to the air door opening, generally 0-100% of the throttle corresponds to the air door and the air door fully open.

③**Corresponding PWM:** the throttle valve controls the actual signal of the steering gear, which can adjust the throttle in a linear relationship with the linearity.

④**Throttle 2 opening:** refers to the valve opening, generally 0-100% of the throttle 2 corresponds to the valve fully open and closed.

⑤**Corresponding PWM:** the shutter controls the actual signal of the steering gear, and the throttle 2 and the shutter are linear by adjusting the linearity.

(III) Relay setup

There are eight modules: ECU power supply, electric start, ignition 1, ignition 2, oil pump 1, oil pump 2, servo power and alarm, and the relay should be consistent with the relay switch in the control box. The relay lock and reset setting, which can control the relay switch with software lock (Prohibited ignition state).

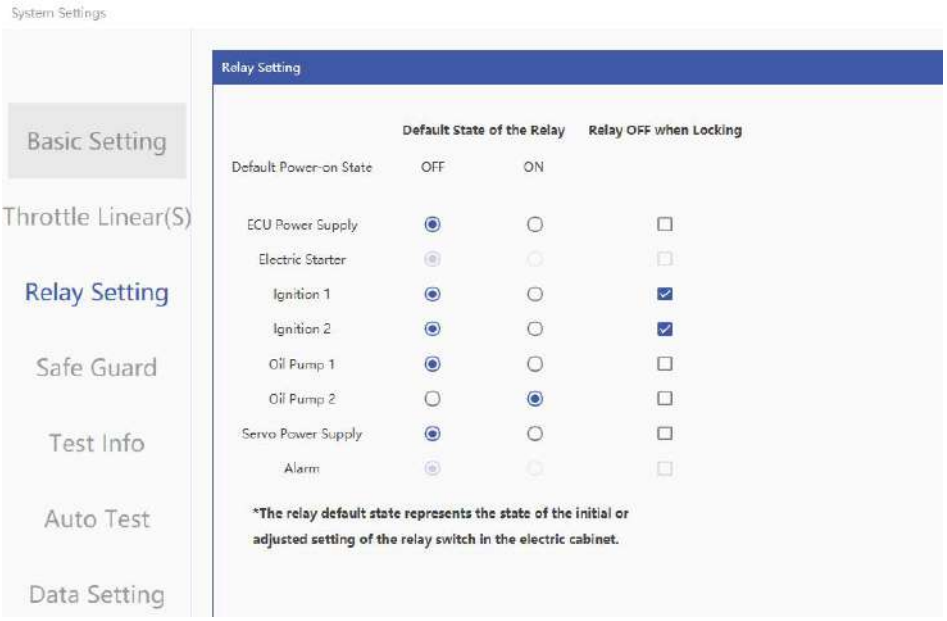
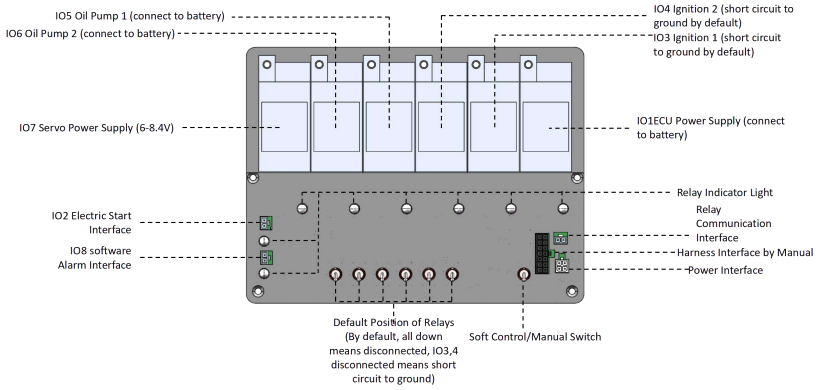


FIG 5-1-4 Relay setting interface and multi-function relay structure diagram



①ECU power supply: ECU power supply switch

②Electric start: the starter power supply switch, the user can not set it

③Ignition 1: Ignition switch, default OFF short to ground

④Ignition 2: Ignition switch, default OFF short to ground

⑤Oil pump 1: Oil pump power supply switch 1

⑥Oil pump 2: oil pump power supply switch 2

⑦Servo Power: power supply switch for steering gear

⑧Alarm: software alarm synchronization, the user can not set The ① ③ ④ ⑤ ⑥ ⑦ in the software relay setting corresponds to the IO 1, IO 3-IO 7 of the relay switch in the control box. Respectively.

Note: The relay default state should be consistent with the relay switch in the control box!

(IV) Safe Guard

In the Safe Guard, you can set protection for parameter values such as thrust, torque, optical RPM, pulse RPM, fuel consumption, temperature, etc.

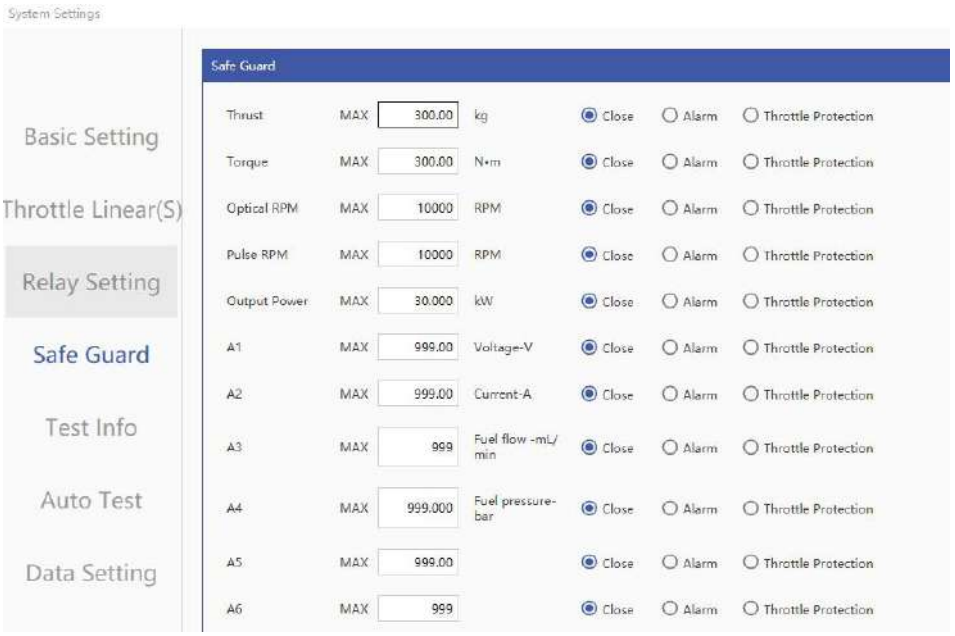


FIG 5-1-5 Security protection settings interface

There are **two modes** of Safe Guard:

One is "alarm". After selecting, when the test value reaches the protection value, the software will execute an alarm (the real-time data display position will turn red and flash, and the device will send an alarm), but the throttle lock operation will not be executed.

The other is "throttle protection". After selecting, when the test value reaches the protection value, the alarm will be executed and the throttle lock operation will be executed.

* When the throttle is lower than 20%, the software will directly lock. When the throttle is higher than 20%, the throttle will slowly drop to 20% and then perform the lock operation.

(V) Test Info

The test info includes engine model, propeller model, drive model, tester and other information that needs to be noted. Users can choose to fill in according to the test situation, and the output test data will simultaneously record relevant information.

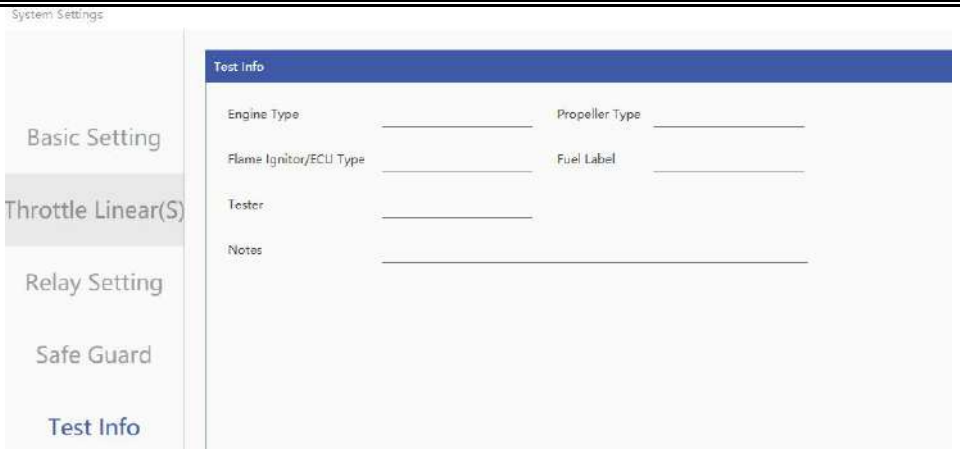


FIG 5-1-6 Test Info Setup Interface

(VI) Auto Test

The Auto test includes 7 test modes: increase, cycle, custom, sine, linear, step, and frequency sweeping test. Users can select the test mode according to their needs, save the parameters, and click "Auto Test" after "unlocking the throttle" in the control window. The software will automatically record the data.

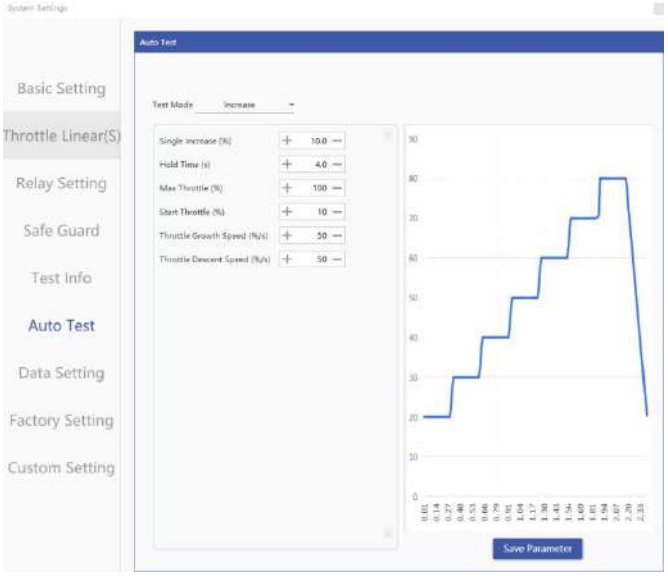


FIG 5-1-7 Auto Test-Increase Mode

①Increase: the throttle value increases from 0 to the set maximum throttle according to the set throttle point.

"Single Increment (%)" indicates the throttle point interval of the Increase test.

"Hold Time (s)" indicates the output time of a single throttle point to maintain the current throttle value.

"Max throttle (%)" indicates the highest throttle value that can be tested in the Increase mode.

"Throttle increase/decrease speed (%/s)" indicates the throttle increase/decrease speed during the throttle point switching process; set to 0, indicating that the switching between throttle points is a

step state.

②Cycle： The throttle is first increased and then decreased, and the test can be cycled.

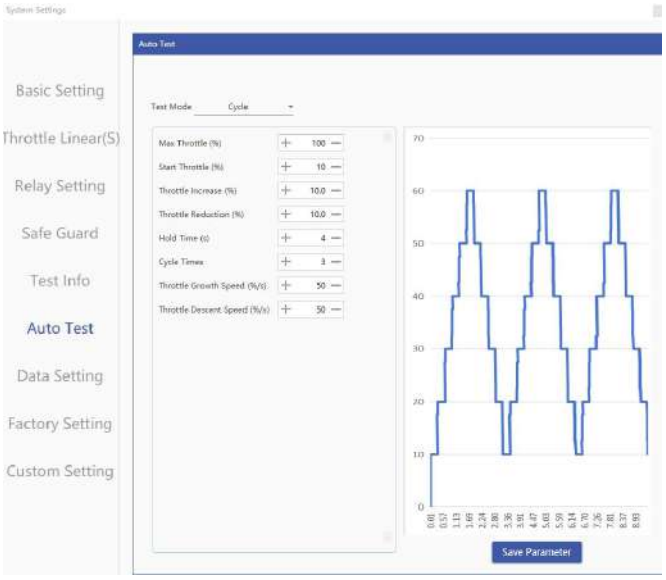


FIG 5-1-8 Auto Test-Cycle Mode

"Max throttle (%)" indicates the upper limit of the throttle range of the cycle test.

"Start throttle (%)" indicates the lower limit of the throttle range of the cycle test.

"Throttle increase/reduction (%)" indicates the throttle interval of the next throttle point in the cycle test to increase/decrease compared to the current throttle point.

"Hold time (s)" indicates the output time of a single throttle value point to maintain the current throttle value.

"Cycle Times" indicates the number of executions of the cycle test program.

"Throttle increase/decent speed (%/s)" indicates the throttle increase/decrease speed during the process of switching throttle points; set to 0, indicating that the switching between throttle points is a step state.

③ **Custom:** Customize the throttle position and hold time to generate a custom test program.

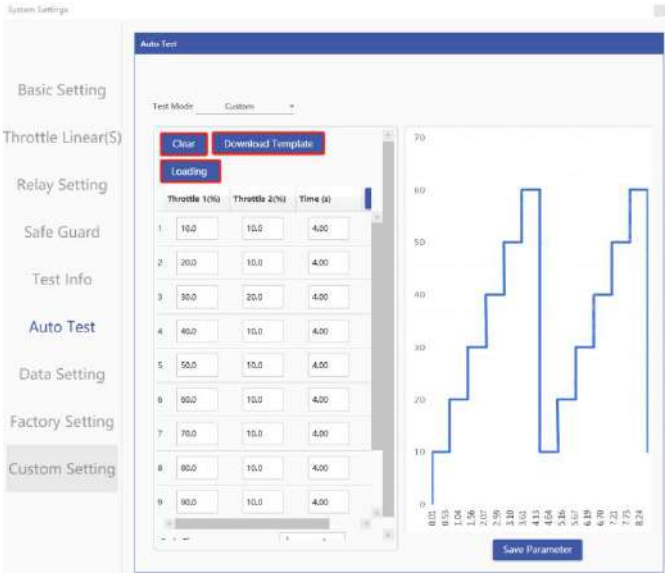


FIG 5-1-9 Auto Test-Custom Test Mode

* Click "Download Template" to download the custom throttle editing template and edit the custom throttle in the EXCEL file; "Load" to load the edited throttle custom file.

④ **Sine:**

The throttle sine function is:

$$\text{Throttle (\%)} = \frac{b-a}{2}\sin\left(\frac{2\pi}{T}t\right)+\frac{a+b}{2}$$

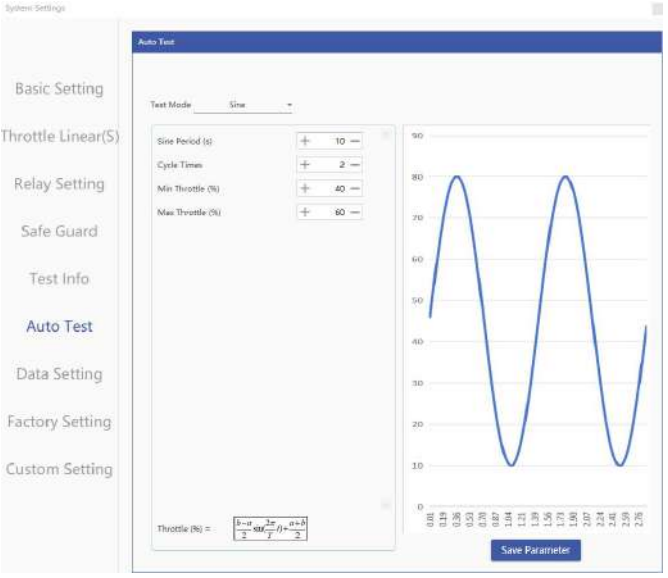


FIG5-1-10 Auto Test-Sine Test

"Sine period (s)", that is, T in the function, indicates the period of the sine function.

"Cycle Times" indicates the number of cycles of the sine function test.

"Max Throttle(%)", that is, b in the function, indicates the upper limit of the throttle range of the

cycle test.

"Min Throttle (%)", that is, a in the function, indicates the lower limit of the throttle range of the cycle test.

⑤ **Linear:** Test the linear increase/decrease of the throttle.

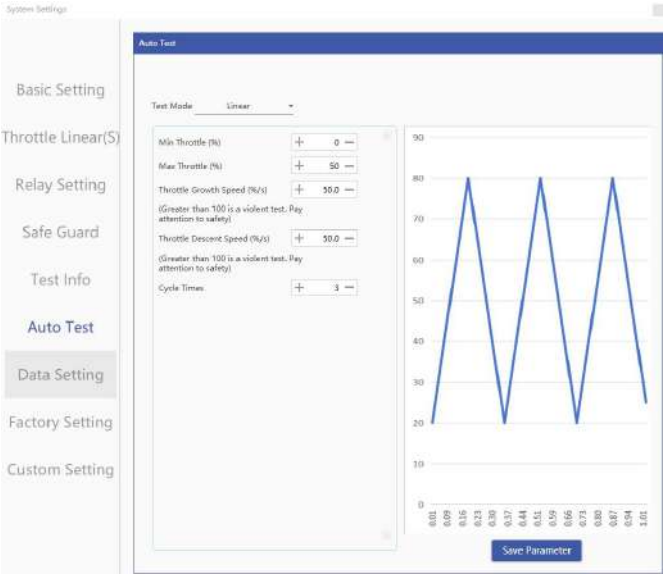


FIG 5-1-11 Automatic test - linear test

"Max Throttle (%)" indicates the upper limit of the throttle range of the cycle test.

"Min Throttle (%)" indicates the lower limit of the throttle range of the cycle test.

"Throttle Growth/Decent speed (%/s)" indicates the throttle increase/decrease speed during the throttle point switching process.

"Cycle Times" indicates the number of executions of the cycle test program.

⑥ **Step test:** Test the throttle's rapid switching response between different throttle positions.

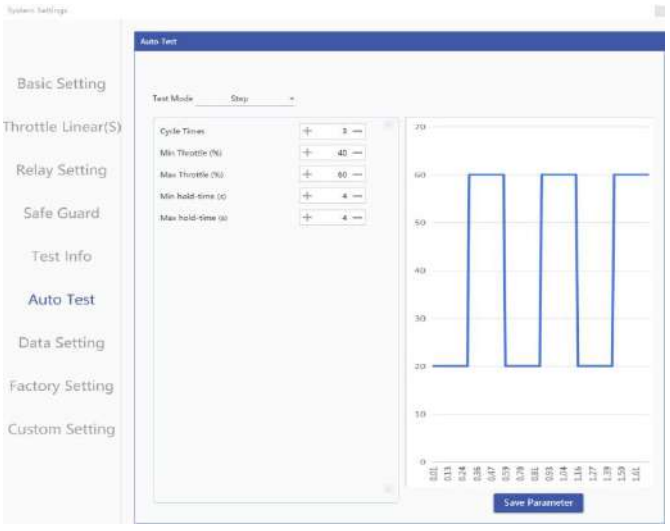


FIG 5-1-12 Auto Test-Step Test

"Max Throttle (%)" indicates the upper limit of the throttle range of the cycle test.

"Min Throttle (%)" indicates the lower limit of the throttle range of the cycle test.

"Max hold time (s)" indicates the time the throttle value is held at the throttle upper limit.

"Min hold time (s)" indicates the time the throttle value is held at the throttle upper limit.

⑦ Frequency sweeping:

The throttle sine sweep function is

$$\text{Throttle (\%)} = \frac{b-a}{2}\sin(\lambda t^2)+\frac{a+b}{2}$$

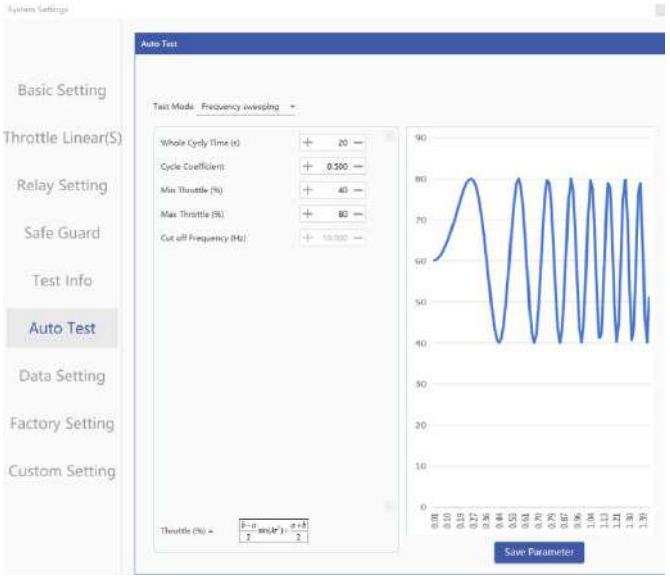


FIG 5-1-13 Auto Test-Frequency sweeping

"Whole cycle time (s)" indicates the total cycle time of the sine sweep function.

"Cycle coefficient" is the λ in the function.

"Max Throttle (%)" is the b in the function, indicating the upper limit of the throttle range of the cycle test.

"Min Throttle (%)" is the a in the function, indicating the lower limit of the throttle range of the cycle test.

"Cut-off frequency" is the calculation result item and cannot be entered. The cut-off frequency value is equal to the full cycle time (s) multiplied by the cycle coefficient.

(VII) Data setting

There are multiple data channels that can be set in the data settings. You can select the box in front of "Real-time" or "Log" to display the data in the real-time data window and storage log.

No.	Parameters	Definition	Notes
1	Throttle 1	PWM1 percentage throttle, you can set multi-segment linear throttle in the setting interface	Preset parameters, displayed in the control interface and storage log
2	PWM1	PWM high level length	Preset parameters, displayed in the control interface and storage log
3	Throttle 2	PWM2 percentage throttle, you can set multi-segment linear throttle in the setting interface	Preset parameters, displayed in the control interface
4	PWM2	PWM high level length	Preset parameters, displayed in the control interface
5	Relay Switch State (simple)	8-way relay switch status, 0 means disconnected, 1 means connected	Users can set in the data settings, displayed in the storage log
6	Relay Switch State (detailed)	Single-way relay switch status*8, 0 means disconnected, 1 means connected	Users can set in the data settings, displayed in the storage log
7	Thrust	Axial thrust of the propeller	Preset parameters, displayed in the real-time data window and storage log
8	Torque	The counter torque generated by air on the propeller	Preset parameters, displayed in the real-time data window and storage log
9	Optical RPM	The speed obtained by testing with a optical sensor	Preset parameters, displayed in the real-time data window and storage log
10	Pulse RPM	The speed measured by the engine's own pulse	Preset parameters, displayed in the real-time data window and storage log
11	Output power	Engine own output power	Preset parameters, displayed in the real-time data window and storage log
12	Infrared temperature	The current temperature of the casing	Optional: infrared sensor, user can set in the data settings, displayed in the real-time data window and storage log
13	Vibration X	Engine X-axis lateral vibration	Optional: vibration sensor, user can set in the

			data settings, displayed in the real-time data window and storage log
14	Vibration Y	Engine Y-axis lateral vibration	Optional: vibration sensor, user can set in the data settings, displayed in the real-time data window and storage log
15	Vibration Z	Engine Z-axis vibration	Optional: vibration sensor, user can set in the data settings, displayed in the real-time data window and storage log
16	Cumulative Fuel	The accumulated value of flow	Optional: the fuel flow sensor, users can set it in data settings, and it will be displayed in the real-time data window and storage log
17	Fuel consumption	Fuel flow ml/min*fuel density converted to kg/h for display	Optional: the calculation value of the fuel flow sensor, users can set it in data settings, and it will be displayed in the real-time data window and storage log
18	Specific fuel consumption	Engine unit work fuel consumption, unit g/kW·h	Optional: the fuel flow sensor calculation value, users can set it in data settings, and it will be displayed in the real-time data window and storage log
19	Propeller power efficiency	Propeller force efficiency represents the efficiency of the rotor propeller in generating static thrust, which is calculated by thrust/ shaft power is obtained in g/W	Preset parameters, displayed in the real-time data window and storage log
20	Propeller power coefficient	Propeller characteristic parameters, expressing the relationship between propeller power consumption and shaft power	Unless there are related parameter test requirements, users generally do not need to check
21	Propeller thrust coefficient	Propeller characteristic parameters, expressing the relationship between propeller thrust and shaft power	Unless there are related parameter test requirements, users generally do not need to check
22	Electric power	Electric power is the total power consumed by the UAV engine during operation,	Optional: the voltage and current sensor calculation value, users can set it in data settings, and it will be displayed in the real-

		including the power of the motor driving the propeller to rotate and do work and the heat energy consumption of the power system (thermal effect of current), obtained by voltage * current	time data window and storage log
23	PC (Ah)	Current value is integrated over time	Optional: the voltage and current sensor calculation value, users can set it in data settings, and it will be displayed in the real-time data window and storage log
24	PC (Wh)	Electric power is integrated over time	Optional: voltage and current sensor calculation value, users can set it in data settings, and it will be displayed in the real-time data window and storage log
25	Power correction coefficient	The ratio of the actual output power of the engine under certain working conditions to the ideal output power	Optional: voltage and current sensor calculation value, users can set it in data settings, and it will be displayed in the real-time data window and storage log
26	Corrected power	Test shaft power * shaft power corrected after power correction coefficient	Unless there are related parameter test requirements, users generally do not need to check
27	Effective cylinder pressure	Engine combustion effective pressure converted from torque, speed, and displacement	Preset parameters, displayed in the real-time data window and storage log
28	Pressure difference	Pressure difference sensor, usually used with pitot tube, unit is bar	Users can set it in data settings, and it will be displayed in the storage log
29	Airspeed	True airspeed calculated by pressure difference and pitot tube test (calculated using real air density)	Optional airspeed sensor, users can set it in data settings, and it will be displayed in the real-time data window and storage log
30	Propeller power	The output power corresponding to the thrust generated by the power system in the current state. Thrust *	Unless there are related parameter test requirements, users generally do not need to check

		airspeed (only valid in dynamic thrust test)	
31	Propeller efficiency	The efficiency of the system output corresponding to the motor output in the current state. System output/motor output (valid only in dynamic thrust test)	Unless there are related parameter test requirements, users generally do not need to check
32	Advance ratio	Propeller characteristic parameters (valid only in dynamic thrust)	Unless there are related parameter test requirements, users generally do not need to check
33	Ambient temp	Ambient temperature under current test environment	Preset parameters are displayed in the environmental parameter window
34	Ambient humidity	Ambient humidity under current test environment	Preset parameters are displayed in the environmental parameter window
35	Atmospheric pressure	Atmospheric pressure under current test environment	Preset parameters are displayed in the environmental parameter window
36	Air density	Air density under current test environment	Preset parameters are displayed in the environmental parameter window
37	Run time	System parameters, referring to the frame time of the lower computer	Preset parameters are displayed in the environmental parameter window
38	Delayed	System parameters, referring to the communication time difference between the lower computer and the upper computer	Unless there are related parameter test requirements, users generally do not need to check
39	A1 voltage	DC voltage sensor value, generally users can choose 70V, 150V or 500V, 1000V four gears	Optional: voltage sensor, users can set it in data settings, and it will be displayed in the real-time data window and storage log
40	A2 current	DC bidirectional current sensor value, through different installation positions, can measure motor bus current, engine starting current, engine power generation current, etc.	Optional: current sensor, users can set it in data settings, and it will be displayed in the real-time data window and storage log

41	A3 fuel flow	Engine fuel consumption, unit is ml/min , note that this sensor can only test one-way flow. For models with fuel return inside the engine, 2 sensors need to be installed	Optional: fuel flow sensor, users can set it in data settings, and it will be displayed in the real-time data window and storage log
42	A4 fuel pressure	Engine fuel pressure, note that this value will decrease at high flow and reach the maximum value when the oil circuit is closed	Optional: fuel pressure sensor, users can set it in data settings, and it will be displayed in the real-time data window and storage log Displayed in the storage log
43	A5 spare AD interface 1	Sensor backup interface	Backup interface, users can connect other sensors, displayed in the real-time data window and storage log
44	A5 spare AD interface 2	Sensor backup interface	Backup interface, users can connect other sensors, displayed in the real-time data window and storage log
45	A5 spare AD interface 3	Sensor backup interface	Backup interface, users can connect other sensors, displayed in the real-time data window and storage log
46	A5 spare AD interface 4	Sensor backup interface	Backup interface, users can connect other sensors, displayed in the real-time data window and storage log
47	T1 cylinder temperature 1	Engine cylinder head temperature, generally installed inside the cylinder head near the spark plug	Preset parameters, displayed in the real-time data window and storage log
48	T2 cylinder temperature 2	Engine cylinder head temperature, generally installed inside the cylinder head near the spark plug	Preset parameters, displayed in the real-time data window and storage log
49	T3 exhaust temperature 1	Engine exhaust temperature, generally installed inside the front end of the exhaust pipe	Preset parameters, displayed in the real-time data window and storage log
50	T4 exhaust temperature 2	Engine exhaust temperature, generally installed inside the front end of the exhaust pipe	Preset parameters, displayed in the real-time data window and storage log

51	T5 spare temperature 1	Temperature backup interface	Temperature backup interface, users can connect other temperature sensors, displayed in the real-time data window and storage log
52	T6 spare temperature 2	Temperature backup interface	Temperature backup interface, users can connect other temperature sensors, displayed in the real-time data window and storage log
53	T7 spare temperature 3	Temperature backup interface	Temperature backup interface, users can connect other temperature sensors, displayed in the real-time data window and storage log
54	T8 spare temperature 4	Temperature backup interface	Temperature backup interface, users can connect other temperature sensors, displayed in the real-time data window and storage log

FIG 5-1-1 Data Setting Sheet

* The initial version has preset general data parameters. Unless there are special parameters or customized parameters that need to be tested, users generally do not need to set them separately.

(VIII) Factory Setting

The parameters in the factory settings are factory set parameters, which require a password to set. Users do not need to set them separately.

(IX) Custom Setting

In the custom settings interface, A1-A8 corresponds to the ADC1-8 interfaces of the acquisition card, of which A1-A4 is the system default sensor and cannot be modified by the user. For A5-A8, customers can connect different analog sensors (0-20ma/±5V) and enter the corresponding name, unit and decimal place to be displayed, and the data can be displayed in the software interface. Similarly, T1-T8 corresponds to the 8-channel temperature of the temperature acquisition card, and users can customize the name.

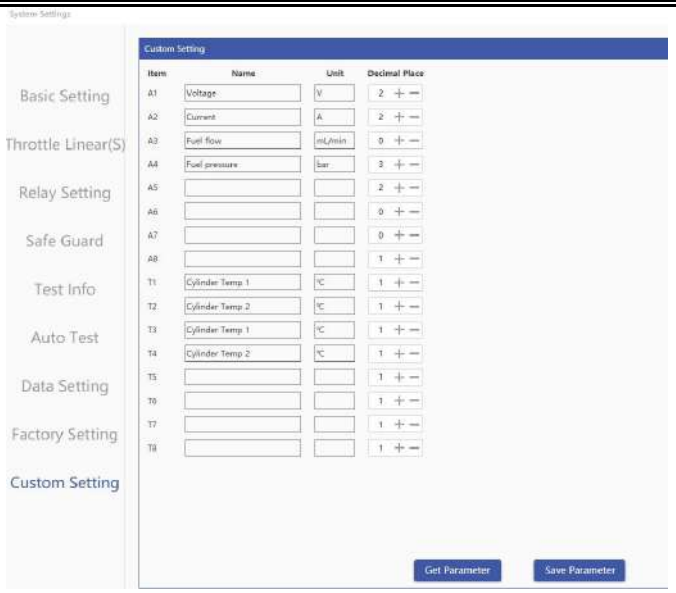


FIG 5-1-14 Custom Setting Interface

III>Data Analysis

MET test software is equipped with professional data analysis software DataAnalyzer. Users can select test data through the data analysis option and enter the data analysis software. Users can view chart views, data views, average throttle point output, and perform data curve analysis. Average throttle point output and reports can also be output.

*For data analysis software, please refer to Part 6 Data Analysis Software Introduction.

IV>Language/Theme

The software can be set in two language modes: Simplified Chinese and English. There are multiple colors that can be configured, and users can set it according to their own needs.

V>About

There is a brief introduction to the manufacturer and its official website in the About section. Users can click on the website address to view the latest product information.

VI>Version

Ver refers to the current software version number.

VII>Relay Control

The multifunctional relay control station can open the relay control station window, in which the power supply of 7-way of the engine equipment can be controlled.

VIII>Port Connection

The software and temperature sensor connection status can be viewed in the upper right corner of the software. Users can choose to connect to the serial port or disconnect the device.

2. Control window

The control window contains 9 commands: TT CLR (Thrust and torque reset), FC CLR (fuel consumption reset) , ALL CLR (one-key reset), Record (start recording), Point Record (point sampling), Point & New (point sampling and new creation), Advanced control, Allow Fire Up (Forbid Fire Up) , and Auto Test (start automatic test).

Figure 5-2-1 Control window interface

①**TT CLR (Thrust and torque reset)**: Click "TT CLR" to reset the thrust and torque.

*It is recommended to reset before each test to ensure the accuracy of data testing.

②**FC CLR (Fuel consumption reset)**: Click "FC CLR" to reset the fuel consumption data.

*If you need to test the fuel consumption of a single test, you can use this function.

③**ALL CLR (one-key reset)**: Click "ALL CLR" to reset the thrust, torque, current, and power consumption data.

④**Record (start recording)**: Click "Record" to record data. The recorded data is saved in the (Document-METData-Log) file. You can open the "File" in the upper left corner to directly find the storage file location. After clicking "Record", "Record" is displayed as "Stop". Click again to stop recording data.

*Manual testing requires data recording, and Auto test will automatically record data. There is no need to click “Record” to record data separately.

⑤**Point Record (point sampling)**: Click "Point Record", the software will record a piece of data at the current moment (data collected in 1 second=Data average) and save it in the log. Click "Point

Record" again, and the software will record the data to the log where the previous data was saved again.

⑥**Point & New (point sampling and new creation)**: Click "Point & New", the software will record a data at the current moment (the average of the data collected in 1 second) and save it in a new log file.

⑦**Advanced control**: Click "Advanced control" to pop up the advanced control window, which can achieve precise control of the throttle.

⑧**Allow Fire Up (Forbid Fire Up)**: Click "Allow Fire Up", the software is in the state of allowing ignition, the button display switches to "Forbid Fire Up", and the "Electric start", "Ignition 1", and "Ignition 2" in the relay control window are in the operable state, that is, ignition operation is allowed, and throttle 1 is in the controllable state; click "Forbid Fire Up", the software is in the state of not allowing ignition, the button display switches to "Allow Fire UP", and the "Electric start", "Ignition 1", and "Ignition 2" in the relay control window are in the inoperable state, that is, ignition operation is prohibited, and throttle 1 is in the uncontrollable state.

*When the ignition is allowed and the button displays "Forbid Fire Up", long press the space bar for 1 second to achieve emergency locking and switch to the ignition prohibition state.

⑨**Auto Test (start automatic test)**: After the throttle is unlocked, you can click "Auto Test" to execute the automatic test program. The automatic test includes multiple test modes. You can select the automatic test mode in (System Settings-Auto Test) and set it.

3.Real-time data window

After the throttle is unlocked, drag the throttle, and the real-time data window can realize real-time data changes.

FIG 5-3-1 Real-time data window interface

*The system is initially set to display 12 sets of data, including thrust, torque, speed, output power, etc.

4. Device Info

The device information window can display the basic parameter information of the test bench model, thrust range, and torque range.

Figure 5-4-1 Device information window interface

5. Chart Monitor window

In the real-time chart window, after the ignition switch is unlocked, drag the throttle to display the data curves of thrust, torque, speed, etc. in real time. Check the data box below according to the needs to realize the chart display (up to 4 groups of data are displayed).

Figure 5-5-1 Real-time chart window interface

The real-time chart window has the function of automatic data adjustment. When auto test is turned on, the range of the vertical coordinate can be adjusted in real time according to the changes in real-time data, which is convenient for users to observe the real-time changes of data. when automatic adjustment is turned off, users can select the vertical coordinate of the real-time icon, hold down the

Ctrl key, and use the mouse to adjust it.

*Before the power test, turn on the automatic adjustment function, drag the throttle to the maximum throttle position to be tested, lock the throttle after the data is stable, turn off the automatic adjustment function, and quickly obtain the vertical coordinate adaptation range of the real-time chart.

6. Environmental parameter display window

The environmental parameter display window can display four environmental parameters: ambient temperature, ambient humidity, atmospheric pressure, and air density, and display the running time of the lower computer system at the same time.

Figure 5-6-1 Environmental parameter window interface

7. Relay control station

The multifunctional relay control station includes 7-way engine equipment power supply control, including ECU power supply, electric start, ignition 1, ignition 2, oil pump 1, oil pump 2, and servo power supply. It also includes 1-way software alarm synchronization function, which is powerful. The test bench uses batteries to power these devices by default. If necessary, users can customize the settings according to their needs, or connect an external DC module to adjust the power supply voltage (you can contact the manufacturer to match different modules). This module also supports manual/programmed switching function, and can also be used with an external switch without using software.

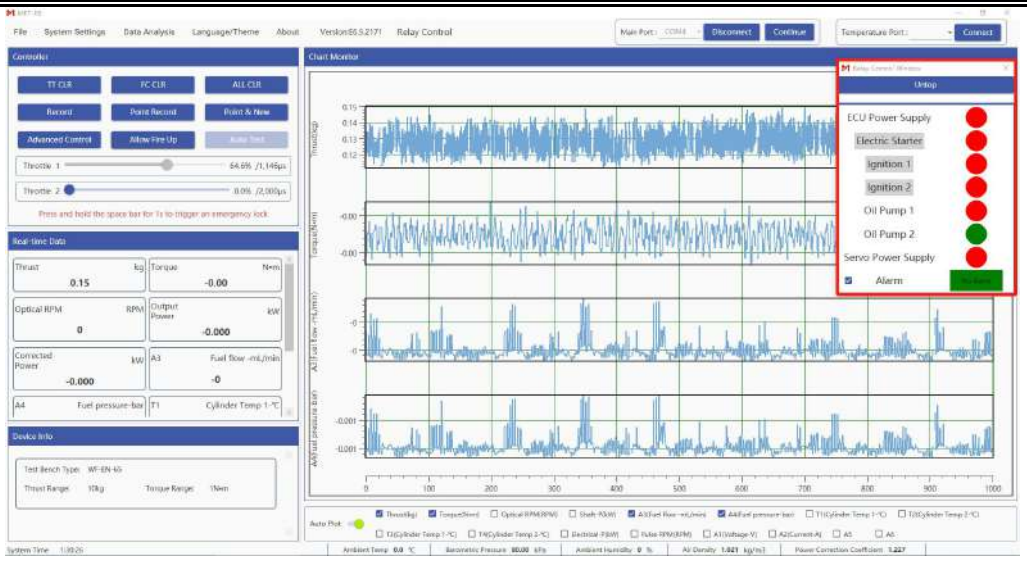


FIG 5-7-1 Relay control station interface

*The relay control button is a green/red circular button. Green represents the "ON" closed state, and red represents the "OFF" closed state. Click to switch the switch state.

*Among them, "Electric Start", "Ignition 1", and "Ignition 1" are inoperable in the ignition prohibited (locked) state.

*The "Electric Start" button, long press is the "ON" closed state, and after releasing, it is the "OFF" closed state.

VI. Data Analysis

MET test software is equipped with professional data analysis software **DataAnalyzer**. The data tested by MET test software can be analyzed by data analysis software. After the data test is completed, the user clicks the data analysis in the toolbar to view the data of the most recent test or finds the data to be viewed through the data search function. Click the data to directly enter the data analysis software.

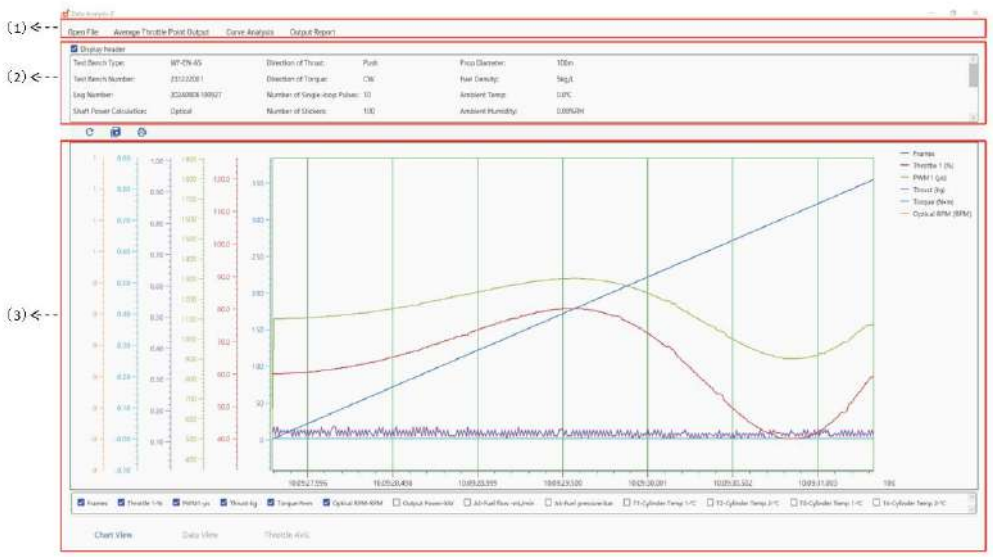


Figure 6-1 Main interface of data analysis software

(1) Tool window (2) Header window (3) Chart window

1.Tool window

I>Open File

Click "Open File" to find the file storage location, open the Log file in the File, select the original test data, **DataAnalyzer** software can be used for analysis based on the original data.

II>Average Throttle Point Output

Click "Average Throttle Point Output" to output the throttle point average data of the current test data and store the .xlsx file, which can be compared and analyzed with other data curves in the curve analysis software interface.

III>Curve Analysis

Click "Curve Analysis" to draw the power system characteristic curve of the current loaded data.

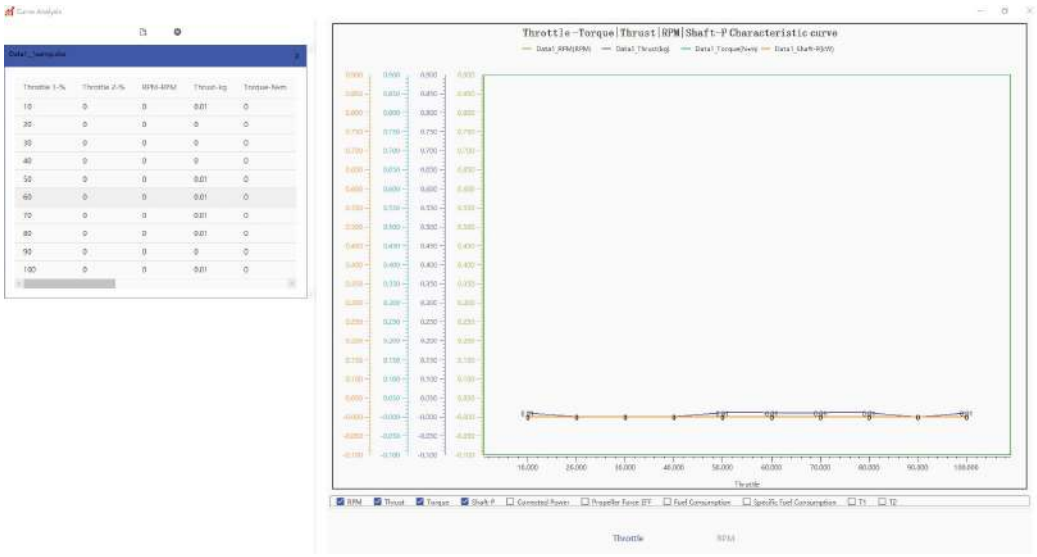


Figure 6-1-1 Characteristic Curve Interface

*The test data can generate the throttle average at different points to achieve the drawing and analysis of the power characteristic curve.

*The throttle, RPM, thrust and various parameter characteristic curves can be analyzed.

IV>Output Report

There are report output setting options in this part. Users can choose to set the company name, filter settings (delete unstable data within the time set before the throttle point, and obtain a more stable data average under the throttle), and characteristic curve settings according to their needs. After the settings are completed, users can output reports, and the output reports are stored in (File/METData/Report).

2. Header Window

By checking the box in front of the header, you can display or hide the header. By checking the box below, users can view the data curve. At the bottom right of the chart, users can select chart view, data view and throttle average data.

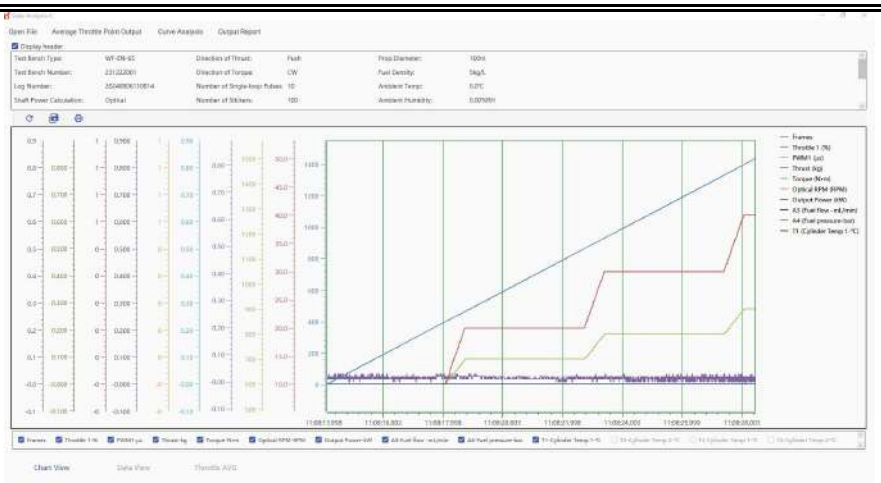


Figure 6-1-2 Chart view interface

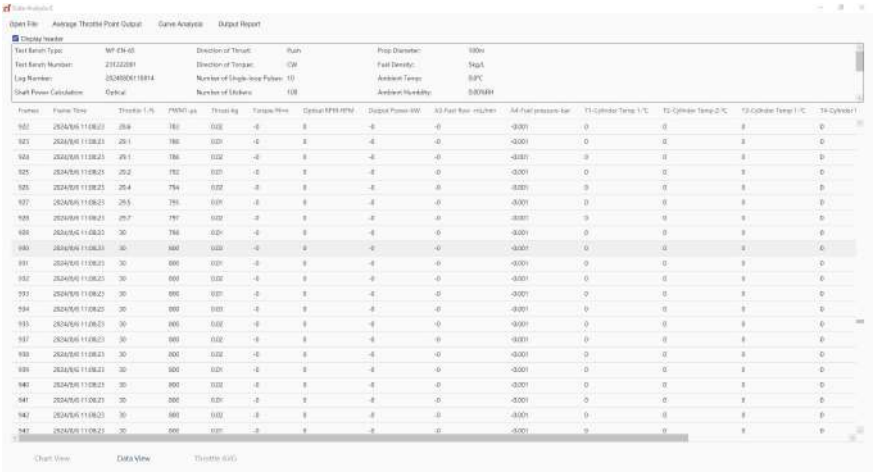


Figure 6-1-3 Data view interface

Figure 6-1-4 Throttle average interface

VII. Troubleshooting

Troubleshooting Checklist				
No.	**Fault Type**	**Performance**	**Possible Cause**	**Solution**
1	Communication fail	Unable to connect to the software	1. The test bench is not powered on.	Power on the test bench according to the quick start guide
2			2. The test bench is not connected to the computer communication line.	Connect the communication line according to the quick start guide
3			3. The acquisition chassis is not working properly (the acquisition card indicator light does not show blue light).	Check the power-on status of the test bench; if the test bench is powered on normally but the indicator light of the acquisition chassis is not on, please contact the manufacturer
4			4. The valid serial port is not recognized.	Install the serial port driver (serial port driver is included in the U disk file)
5			5. The USB port is damaged.	Replace the USB port
6			6. The communication module is damaged.	Contact the manufacturer
7	Thrust /Torque Data abnormal	The thrust/ torque readings are obviously deviated	1. The connecting wires between the engine and the test bench are not kept loose.	Keep the connecting wires between the engine and the test bench loose and not tight.
8			2. The thrust/torque sensor is damaged or broken.	1. Click "Pull and Torque Reset" on the software 2. Unplug the plug at the port for collecting the force/torque. 3. If the force/torque reading on the software exceeds 5% of the range, the sensor is damaged or damaged, please contact the manufacturer.
9	Current /Voltage Data abnormal	The current/voltage readings show obvious deviations	1. The electrical plug has poor contact.	Check and plug in tightly.
10			2. The reference device has low accuracy.	Use a multimeter to measure. If the reading deviation is too large, please contact the manufacturer
11			3. The current and voltage sensors are damaged.	Use a multimeter to measure. If the reading deviation is too large, please contact the manufacturer
12	Optical RPM abnormal	The photoelectric speed indication ratio is proportional to the actual speed.	1. The number of optical stickers in the basic software settings is inconsistent with the actual number.	The number of photoelectric stickers in the basic software settings is consistent with the actual number of stickers. Calibrate the photoelectric speed module according to the quick use guide.
13			2. The optical RPM module is not calibrated according to the process and requirements.	The number of photoelectric stickers in the basic software settings is consistent with the actual number of stickers. Calibrate the photoelectric speed module according to the quick use guide.

FIG 7-1-1 Troubleshooting Checklist

VIII. Maintenance

The UAV engine system test bench is a high-precision test equipment. When using the equipment, you need to strictly abide by the terms and precautions in the user manual. Routine inspections should be carried out before testing. Regular inspections, maintenance, and regular calibration can reduce test risks and failures, effectively improve product reliability, and ensure test accuracy.

1. Pre-test inspection

To ensure test safety and test data accuracy, you are advised to check the following items before testing.

Pre-test Inspection List				
No.	Status	Inspected Items	Inspected Content	Yes /No
1	Before powering on the test bench	Test Environment	The test environment should be an open, non-flowing test site. Make sure the site is clean and free of easily blown debris.	
2		Test Bench Fixed	Make sure the test bench is firmly fixed to the ground (or the contact surface below). If you push the test bench body by hand and find a shaking gap, you need to re-fix it.	
3		Engine	Make sure the engine is installed firmly on the mounting seat.	
			Make sure the connecting bolts between the mounting seat and the base are tightened.	
4			Make sure the propeller is installed in the correct direction. If the propeller is tested for a long time, the thread glue needs to be applied to tighten it.	
5		Line	Make sure the connection lines between the engine and the test bench are kept loose. Dragging or hard connection will affect the test accuracy of thrust/torque.	
6	Software Connection	Software Setting	Check and fill in the correct throttle PWM value range to prevent excessive power output after the engine starts, which may cause safety hazards.	
7			Check the initial status of each relay switch and use software operation to confirm whether it is effectively triggered.	
8			Set the number of optical stickers	
9			Set the security protection value in the software security protection.	
10	Start the engine	Start the process	Confirm the startup process and test content, and ensure that no personnel enter the test site during the startup and test process	
11		Propeller	Before starting, confirm that the propeller is installed tightly, without damage or deformation	
12			Ensure that the propeller rotation will not interfere with any test bench or other components	
13		Test Range	Ensure that the power test is performed within the range of the test bench	

FIG 8-1-1 Pre-test Inspection List

2.Regular inspection and maintenance

It is recommended that users refer to the following standards and conduct regular inspections and maintenance to maintain the test bench in the best condition and reduce safety hazards.

Periodic Inspection and Maintenance Checklist						
No.	Check item	Per Test	Per Disassembly	100 tests/3 months	300 tests/1 year	Maintenance recommendations
1	Engine and mounting bolts	√	√	√	√	Self-inspection
2	Linear bearing lubrication	×	×	√	√	Return to factory/self-inspection
3	Acquisition card mounting bolts	×	×	√	√	Self-inspection
4	Sensor installation	×	×	√	√	Self-inspection
5	Test bench structure installation	×	×	√	√	Self-inspection
6	Thrust sensor calibration	×	×	×	√	Return to factory for calibration
7	Torque sensor calibration	×	×	×	√	Return to factory for calibration

FIG 8-2-1 Pre-Test Checklist

* The time or number of tests specified in the maintenance/inspection cycle shall prevail whichever comes first.

*The start time in the table shall be based on the first factory delivery time of the equipment.

*Bolt tightening inspection method: For threads that require thread glue, use a hexagonal screwdriver to tighten the bolts in a positive direction. If the bolts can be easily turned, remove the bolts and reapply thread glue to install them back to the original position; for threads that do not require thread glue, tighten the bolts.

*Linear bearing lubrication: Use WD-40 cleaning agent to clean, and then inject mechanical lubricant.

*Do not use high-viscosity or medium-viscosity mechanical lubricants, otherwise it will increase the static friction when measuring thrust and reduce the measurement accuracy.

If you have any questions with reading this manual, please contact:
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