

Faithtech

Wide range high power Bidirectional
programmable DC power supply

User manual

(FTB9000 series)

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Introduction

Dear users :

First of all, thank you for choosing Shenzhen Faith technology co., LTD. (hereinafter referred to as the Faithtech), FTB9000 series regenerative high power Bidirectional programming power system (hereinafter referred to as FTB9000 series). This User manual (hereinafter referred to as the manual) is applicable to the FTB9000 series and includes detailed information on installation, operation and specifications of the equipment.

In order to ensure safe and correct use of the equipment, please read this manual carefully before use, especially the safety precautions.

Please keep this manual for use in the process of inspection.

Notice

The copyright of this manual belongs to our company. The information contained in the manual is for the user's reference only and is subject to change without notice.

The Company is not responsible for errors that may be contained in this manual or damages caused by the provision, implementation and use of this manual.

The warranty service

The company guarantees that the specifications and use characteristics of this instrument fully meet the technical indicators claimed in the manual, and the raw materials and manufacturing processes used in this product are strictly checked to ensure that the product is stable and reliable.

Since the acquisition date, one year warranty, the product in normal use and maintenance condition of what's going on fault, the company responsible for free maintenance. For free maintenance products, users need to prepay the one-way freight to the company's maintenance department, and the return freight shall be borne by the company. If the product is returned to the factory from another country for repair, all freight, duties and other taxes shall be borne by the customer.

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No OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY, REASONABILITY AND FITNESS FOR PARTICULAR APPLICATIONS, WHETHER IN CONTRACT, CIVIL NEGLIGENCE, OR OTHERWISE, ARE MADE. The company shall not be liable for any special, incidental or indirect damages.

Safety Summary

In the process of operating and using the equipment, please strictly observe the following safety instructions. Failure to comply with the following precautions or specific warnings as indicated in other sections of this manual may impair the protection provided by the device.

The Company is not responsible for the consequences caused by the user's non-compliance with these precautions.

Safety instructions

Please ground it reliably	Before turning on the equipment, make sure the equipment is reliably grounded to prevent electric shock
3 phase 380VAC Input	The input wire meets the specified standards; Be sure to install a protective cover to prevent electric shock.
Output terminal cable connection	The input wire meets the specified standards; Be sure to install a protective cover to prevent electric shock.
Do not open the instrument housing	The operator shall not open the equipment shell; Non-professional personnel do not perform maintenance or adjustment.
Do not use in dangerous environment	Do not use the equipment in inflammable and explosive environment.

Safety mark

Please refer to the following table for the explanation of international symbols used in the case and user manual of this product.

Symbol	Meaning	Symbol	Meaning
	Direct current		Zero or neutral line
	AC current		Line of fire
	AC/DC current		Power on
	3 phase current		Power off
	Ground		Backup power supply
	Protective grounding		The button switch is pressed
	Connect the enclosure or chassis		Button switch popup
	Signal ground		Be careful with the shocks
WARNING	Sign of danger		High temperature Warning
Caution	be careful		Warning

Revised version record

Date	Version	Chapter of Revision
March,2021	1.00	Complete this manual
October 2022	1.01	Added PV simulation function
January 2023	2.02	Added battery simulation function
April 2023	2.03	Updated the PV description section
February 2024	2.04	Improved accuracy index
April 2024	2.05	Updated current rise time and switch time parameters
August, 2024	2.06	Increase the Halt emergency stop signal

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1. overview

1.1. Introduction

FTB9000 series is a wide range of high power bidirectional programmable DC power supply products that can not only be used as a DC power supply, but also have DC load function. The state of DC power supply has the characteristics of fast response, stability and low ripple. The load state not only has the function of traditional consumption load, but also feedbacks the energy consumed by the traditional load to the grid cleanly to achieve the purpose of energy saving. It can be widely used in new energy equipment testing, lithium ion, fuel and other battery charging and discharging test, automatic test system, AC/DC, DC/DC, DC/AC and other unidirectional and bidirectional module product testing, aging. The product is equipped with rich communication, programming interface and color screen and a variety of text menu interface, easy to operate and intuitive, power electronics, new energy, sensor, motor drive, system integration and other industries commonly used equipment.

1.2. Main Features

- Single machine range: voltage: 0 ~ 2250V current: 0 ~ ± 4500 A Power: 0 ~ ± 180 kW;
- master-slave parallel machine can reach 1.8MW.
- Voltage accuracy: 0.02%+0.02%F.S. Current accuracy: 0.1%+0.1%F.S.;
- power factor of 0.99, overall efficiency higher than 93%;
- two-way energy transfer, seamless switching across quadrants;
- automatic compensation for line loss;
- constant voltage, constant current, constant power, and constant resistance.
- with voltage, current preference, and slope setting options
- With the function of voltage output slow rise or fall
- With battery charging and discharging function;
- With sequence and waveform function, can realize such as automotive electronic test voltage waveform, user defined and other complex voltage and current waveform;

- Battery simulation function (optional), photovoltaic cell simulation function (optional);
- Over voltage, over current, over power, over temperature, under voltage, power down, island protection and other comprehensive protection function;
- With high voltage isolation digital, analog, monitoring interface;
- Standard LAN, USB serial port, optional GPIB, CAN, RS485 communication interface;
- Support SCPI, Modbus, CAN-Open protocol, provide host computer software and SDK development kit for secondary development;
- TFT color wide-angle LCD display, Chinese, English, traditional Chinese menu interface;
- Intelligent fan control, long life, low noise.

1.3. Overall dimensions

1.3.1. 5kW/10kW/15kW;6kW/12kW/18kW;

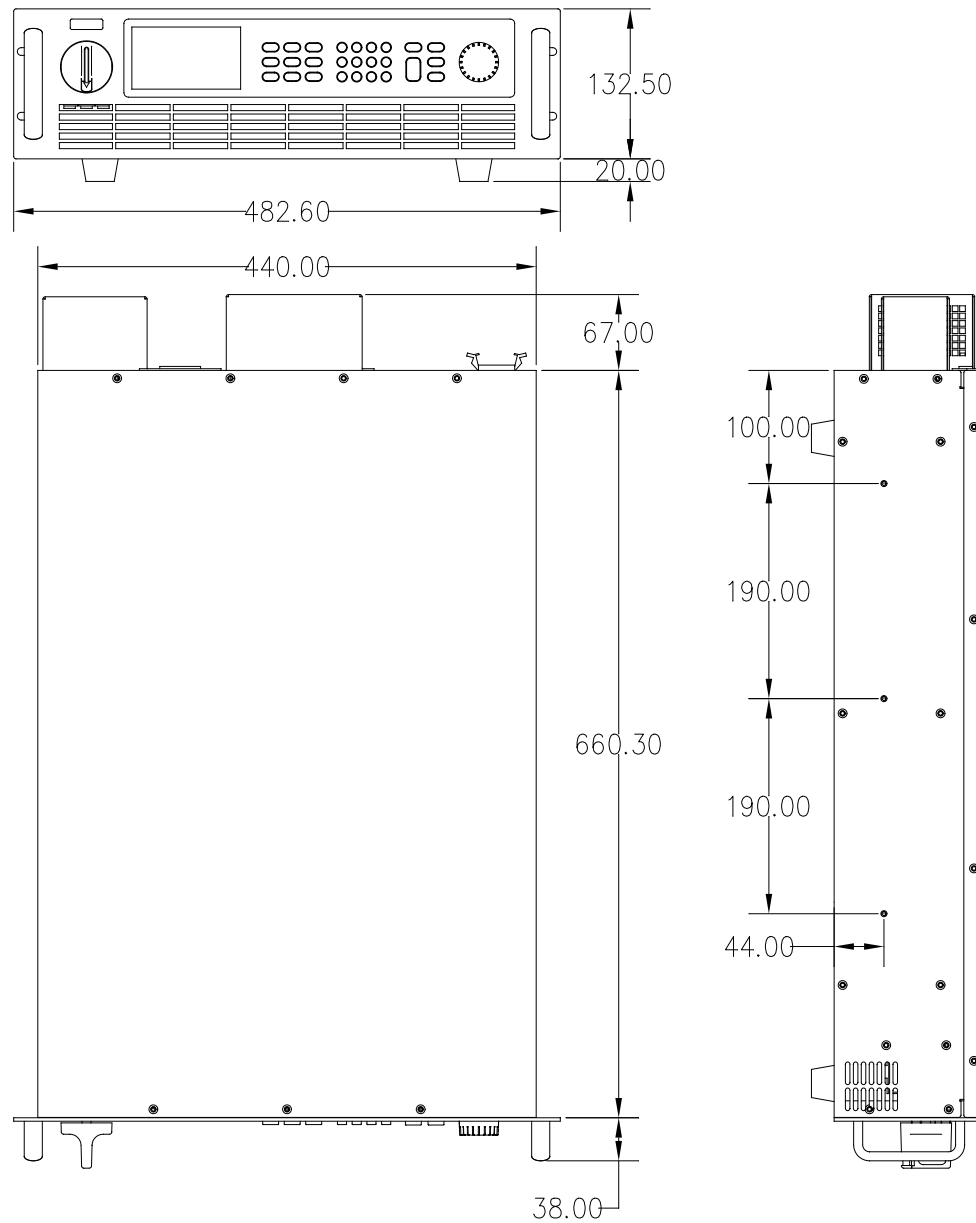


Figure 1- 1 5kW~18kW model size

1.3.2. 20kW/25kW/30kW;24kW/30kW/36kW;

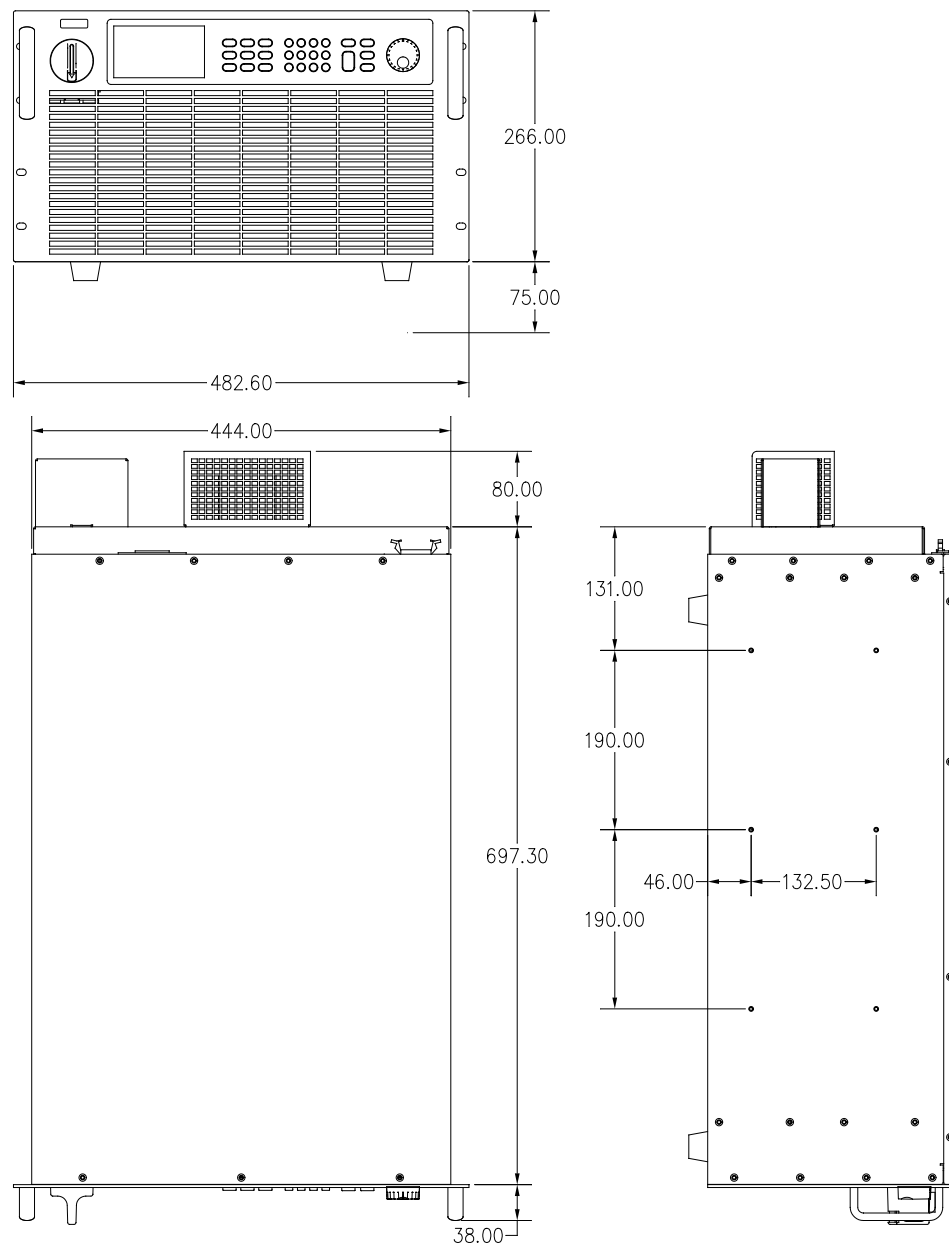
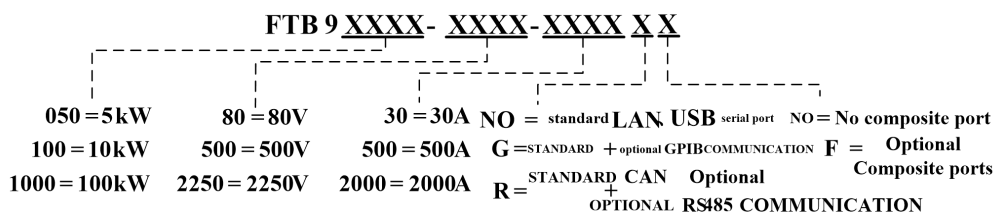


Figure 1-2 20kW~36kW model size

1.4. Model designation



1.5. Specification

Table 1- 1 FTB9000 Series specification sheet1

Model	FTB9050-80-150	FTB9060-300-75	FTB9060-500-40	FTB9060-800-25
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-150~150A	-75~75A	-40~40A	-25~25A
Resistance	0.02~106Ω	0.3~800Ω	0.5~2.5kΩ	1.2~6kΩ
Power	-5~5kW	-6~6kW		
Model	FTB9100-80-300	FTB9120-300-150	FTB9120-500-80	FTB9120-800-50
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-300~300A	-150~150A	-80~80A	-50~50A
Resistance	0.01~50Ω	0.15~400Ω	0.25~1.25kΩ	0.6~3kΩ
Power	-10~10kW	-12~12kW		
Model	FTB9150-80-450	FTB9180-300-225	FTB9180-500-120	FTB9180-800-75
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-450~450A	-225~225A	-120~120A	-75~75A
Resistance	0.006~35Ω	0.1~266Ω	0.16~833Ω	0.4~2kΩ
Power	-15~15kW	-18~18kW		
Model	FTB9300-80-900	FTB9360-300-450	FTB9360-500-240	FTB9360-800-150
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-900~900 A	-450~450A	-240~240A	-150~150A
Resistance	0.003~17Ω	0.05~133Ω	0.08~416Ω	0.2~1kΩ
Power	-30~30kW	-36~36kW		
Model	FTB9450-80-1350	FTB9540-300-675	FTB9540-500-360	FTB9540-800-225
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-1350~1350 A	-675~675A	-360~360A	-225~225A
Resistance	0.002~11Ω	0.03~88Ω	0.05~277Ω	0.1~666Ω
Power	-45~45kW	-54~54kW		
Model	FTB9600-80-1800	FTB9720-300-900	FTB9720-500-480	FTB9720-800-300
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-1800~1800 A	-900~900A	-480~480A	-300~300A
Resistance	0.002~8.8Ω	0.025~66Ω	0.042~208Ω	0.1~500Ω

Power	-60~60kW	-72~72kW		
Model	FTB9750-80-2250	FTB9900-300-1125	FTB9900-500-600	FTB9900-800-375
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-2250~2250 A	-1125~1125A	-600~600A	-375~375A
Resistance	0.002~9Ω	0.02~53Ω	0.033~166Ω	0.08~400Ω
Power	-75~75kW	-90~90kW		
Model	FTB9900-80-2700	FTB91080-300-1350	FTB91080-500-720	FTB91080-800-450
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-2700~2700 A	-1350~1350A	-720~720A	-450~450A
Resistance	0.001~6Ω	0.017~44Ω	0.027~138Ω	0.066~333Ω
Power	-90~90kW	-108~108kW		
Model	FTB91050-80-3150	FTB91260-300-1575	FTB91260-500-840	FTB91260-800-525
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-3150~3150	-1575~1575A	-840~840A	-525~525A
Resistance	0.001~4.4Ω	0.014~38Ω	0.024~119Ω	0.057~285Ω
Power	-105~105kW	-126~126kW		
Model	FTB91200-80-3600	FTB91440-300-1800	FTB91440-500-960	FTB91440-800-600
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-3600~3600A	-1800~1800A	-960~960A	-600~600A
Resistance	0.001~4.4Ω	0.013~33Ω	0.021~104Ω	0.05~250Ω
Power	-120~120kW	-144~144kW		
Model	FTB91350-80-4050	FTB91620-300-2025	FTB91620-500-1080	FTB91620-800-675
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-4050~4050A	-2050~2050A	-1080~1080A	-675~675A
Resistance	0.001~3.9Ω	0.011~30Ω	0.018~92Ω	0.044~222Ω
Power	-135~135kW	-162~162kW		
Model	FTB91500-80-4500	FTB91800-300-2250	FTB91800-500-1200	FTB91800-800-750
Voltage	0~80V	0~300V	0~500V	0~800V
Current	-4500~4500A	-2250~2250A	-1200~1200A	-750~750A
Resistance	0.001~3.5Ω	0.01~26Ω	0.017~83Ω	0.04~200Ω
Power	-150~150kW	-180~180kW		
Voltage programming①				
resolution	16bits			
accuracy	0.02%+0.02%F.S.			
Current programming①				
resolution	16bits			
accuracy	0.1%+0.1% F.S.			
Resistance programming①				
resolution	0.001Ω			
accuracy	1%+0.5%I.F.S.			
Power programming①				
resolution	1W			

accuracy	0.5%F.S.				
External analog programming①					
Control voltage	0~5V Correspond to 0~100%F.S.				
Voltage accuracy	0.5%F.S.				
Current accuracy	0.5%F.S.				
Linear adjustment rate②					
Voltage	0.01%F.S.				
Current	0.05%F.S.				
Load adjustment rate③					
Voltage	0.02%F.S.				
Current	0.1%F.S.				
Voltage measurement①					
resolution	16bits				
accuracy	0.02%+0.02%F.S.				
Current measurement①					
resolution	16bits				
accuracy	0.1%+0.1% F.S.				
Resistance measurement①					
resolution	0.001Ω				
accuracy	1%+0.5%I.F.S.				
Power measurement①					
resolution	1W				
accuracy	0.5%F.S.				
Output noise & ripple④					
Voltage ripple p-p	5kW	160mV	300mV	450 mV	800 mV
	10kW	320mV	300 mV	450 mV	800 mV
	15kW	320 mV	300 mV	450 mV	800 mV
Voltage ripple rms	5kW	16mV	40mV	70 mV	200mV
	10kW	25 mV	40 mV	70 mV	200 mV
	15kW	25 mV	40 mV	70 mV	200 mV
Voltage rising slope					
Maximum slope	5000V/s	20000V/s			40000V/s
Voltage drop time					
No load	< 5s	< 10s			
full load	≤30ms				
Current rise time (CC)					
≥10ms					
Current switching time (+90%~-90%)					
≤6ms					
Transient	With 10%~90% dynamic load change, it takes less than 2ms for the equipment				

response	voltage to recover to 0.75% accuracy range of the rated value
Parallel device	It supports 10 master and slave parallel machines of the same model
Protection	Over voltage, over current, over power, over temperature, under voltage, etc
Communication interface	LAN, USB serial port (optional GPIB, CAN, RS485)
Communication protocol	SCPI、Modbus、CAN-Open protocol(optional)
input features	
input Voltage	340VAC~480VAC, frequency 45Hz~63Hz
PF	0.99(Typical values)
efficiency	>93% (Typical values)
Operating Environment	
Working temperature	0℃~40℃
Storage temperature	-20℃~70℃
altitude	< 2000m
cooling way	Air cooling, intelligent fan control
Size (WxHxD)	5kW~18kW: 482.6mm x 132.5mm x 702.0mm, With output shield 20kW~36kW: 482.6mm x 266.0mm x 767.0mm, With output shield
Weight	5kW≈18kg, 10kW≈25kg, 15kW≈32kg, 36kW≈65kg

Table 1- 2

Model	FTB9120-1000-40	FTB9120-1500-25	~
Voltage	0~1000V	0~1500V	~
Current	-40~40A	-25~25A	~
Resistance	1~5kΩ	2.25~11kΩ	~
Power	-12~12kW	-12~12kW	~
~	~	FTB9180-1500-40	FTB9180-2250-25
~	~	0~1500V	0~2250V
~	~	-40~40A	-25~25A
~	~	1.5~7.5kΩ	3.6~18k
~	~	-18~18kW	
Model	FTB9240-1000-80	FTB9360-1500-80	FTB9360-2250-50
Voltage	0~1000V	0~1500V	0~2250V
Current	-80~80A	-80~80A	-50~50A
Resistance	0.5~2.5 kΩ	0.75~7.5kΩ	1.8~9kΩ
Power	-24~24kW	-36~36kW	
Model	FTB9360-1000-120	FTB9540-1500-120	FTB9540-2250-75
Voltage	0~1000V	0~1500V	0~2250V
Current	-120~120A	-120~120A	-75~75A
Resistance	0.33~1.6kΩ	0.5~2.5kΩ	1.2~6kΩ

Power	-36~36kW	-54~54kW	
Model	FTB9480-1000-160	FTB9720-1500-160	FTB9720-2250-100
Voltage	0~1000V	0~1500V	0~2250V
Current	-160~160A	-160~160A	-100~100A
Resistance	0.25~1.25kΩ	0.375~1.875kΩ	0.9~4.5kΩ
Power	-48~48kW	-72~72kW	
Model	FTB9600-1000-200	FTB9900-1500-200	FTB9900-2250-125
Voltage	0~1000V	0~1500V	0~2250V
Current	-200~200A	-200~200A	-125~125A
Resistance	0.2~1kΩ	0.3~1.5kΩ	0.72~3.6kΩ
Power	-60~60kW	-90~90kW	
Model	FTB9720-1000-240	FTB91080-1500-240	FTB91080-2250-150
Voltage	0~1000V	0~1500V	0~2250V
Current	-240~240 A	-240~240 A	-150~150A
Resistance	0.166~250Ω	0.25~1.25kΩ	0.6~3kΩ
Power	-72~72kW	-108~108kW	
Model	FTB9840-1000-280	FTB91260-1500-280	FTB91260-2250-175
Voltage	0~1000V	0~1500V	0~2250V
Current	-280~280A	-280~280A	-175~175A
Resistance	0.143~714Ω	0.214~1.07kΩ	0.514~2.5kΩ
Power	-84~84kW	-126~126kW	
Model	FTB9960-1000-320	FTB91440-1500-320	FTB91440-2250-200
Voltage	0~1000V	0~1500V	0~2250V
Current	-320~320A	-320~320A	-200~200A
Resistance	0.125~625Ω	0.188~938Ω	0.45~2.25kΩ
Power	-96~96kW	-144~144kW	
Model	FTB91080-1000-360	FTB91620-1500-360	FTB91620-2250-225
Voltage	0~1000V	0~1500V	0~2250V
Current	-360~360A	-360~360A	-225~225A
Resistance	0.11~555Ω	0.167~833Ω	0.4~2kΩ
Power	-108~108kW	-162~162kW	
Model	FTB91200-1000-400	FTB91800-1500-400	FTB91800-2250-250
Voltage	0~1000V	0~1500V	0~2250V
Current	-400~400A	-400~400A	-250~250A
Resistance	0.1~500Ω	0.15~750Ω	0.36~1.8kΩ
Power	-120~120kW	-180~180kW	
Voltage programming①			
resolution	16bits		
accuracy	0.02%+0.02%F.S.		
Current programming①			
resolution	16bits		
accuracy	0.1%+0.1% F.S.		

Resistance programming①				
resolution	0.001Ω			
accuracy	1%+0.5%I.F.S.			
Power programming①				
resolution	1W			
accuracy	1%F.S.			
External analog programming①				
Control voltage	0~5V & 0~100%F.S.			
Voltage accuracy	0.5%F.S.			
Accuracy of current	0.5%F.S.			
Linear adjustment rate②				
Voltage	0.01%F.S.			
Current	0.05%F.S.			
Load adjustment rate③				
Voltage	0.02%F.S.			
Current	0.05%F.S.			
Voltage measurement①				
resolution	16bits			
accuracy	0.02%+0.02%F.S.			
Current measurement①				
resolution	16bits			
accuracy	0.1%+0.1% F.S.			
Resistance measurement①				
resolution	0.001Ω			
accuracy	1%+0.5%I.F.S.			
Power measurement①				
accuracy	1%F.S.			
Output noise & ripple④				
Voltage ripple Vpp	10kW	1600mV		
	15kW		2400mV	3600mV
Voltage ripple rms	10kW	350mV		
	15kW		400mV	400mV
Voltage rising slope				
Maximum slope	40000V/s			
Voltage drop time				
no load	< 10s			
full load	≤30ms			
Current rise time (CC)				
≥10ms				
Current switching time (+90%~-90%)				

≤6ms	
Transient response	With 10%~90% dynamic load change, it takes less than 2ms for the equipment voltage to recover to 0.75% accuracy range of the rated value
Parallel device	It supports 10 master and slave parallel machines of the same model
Protection	Over voltage, over current, over power, over temperature, under voltage, etc
Communication interface	LAN、USB serial port (optional GPIB、CAN、RS485)
Communication protocol	SCPI、Modbus、CAN-Open protocol
input features	
Input voltage	340VAC~480VAC, frequency 45Hz~63Hz
PF	0.99(Typical values)
efficiency	>93% (Typical values)
Operating Environment	
Working temperature	0℃~40℃
Storage temperature	-20℃~70℃
Using altitude	< 2000m
cooling way	Air cooling, intelligent control
size (WxHxD)	5kW~18kW: 482.6mm x 132.5mm x 702.0mm, With output shield 20kW~36kW: 482.6mm x 266.0mm x 767.0mm, With output shield
weight	5kW≈18kg, 10kW≈25kg, 15kW≈32kg, 36kW≈65kg

Note:

(1) Accuracy measurement conditions: 25℃±5℃

(2) Linear adjustment rate measurement conditions: input voltage change ±10%

(3) Voltage and current load adjustment rate measurement conditions: load change 0 ~ 100%; Power load adjustment rate measurement conditions: voltage, current change 10% ~ 90%

④ Ripple measurement conditions: voltage measurement bandwidth 0 ~ 20MHz; The oscilloscope test port shall be connected with 10uF and 0.1uF capacitors.

2. Quick start

2.1. Inspection

After receiving the equipment, please check the equipment as follows:

- Check whether the damage in the transport process

If the packing case or protective pad is seriously damaged, please immediately contact our authorized dealer or after-sales service department.

Note: Do not return the device until you have received a positive response.

- Check the accessories

Confirm that you receive the following attachments along with receiving the equipment:

Table 2- 1 Accessories Description

Accessories	Qty	Description
Shield	1set	Input and output protection
2PIN 5.08mm terminal	1PCS	Voltage remote compensation terminal
2PIN 3.81mm terminal	1PCS	Master and slave parallel wiring terminals
USB Communication line	1PCS	CONNECT PC-USB
LAN Wire of connection	1PCS	CONNECT PC-LAN
User manual	1PCS	Includes installation and operation information
CD	1PCS	Software and technical information
Warranty card and certificate of quality	1PCS	Warranty and after-sales service information

If there is any loss or damage, please contact our authorized distributor or after-sales service department immediately.

- Check the whole machine

If the chassis is damaged or works abnormally, contact the authorized distributor or after-sales service department of the company immediately.

- clean

If you need to clean the shell of the machine, please use a dry cloth or a slightly wet cloth to wipe gently, do not wipe the inside of the machine.

 **Warning: Disconnect the device before cleaning!**

2.2. Front panel introduction

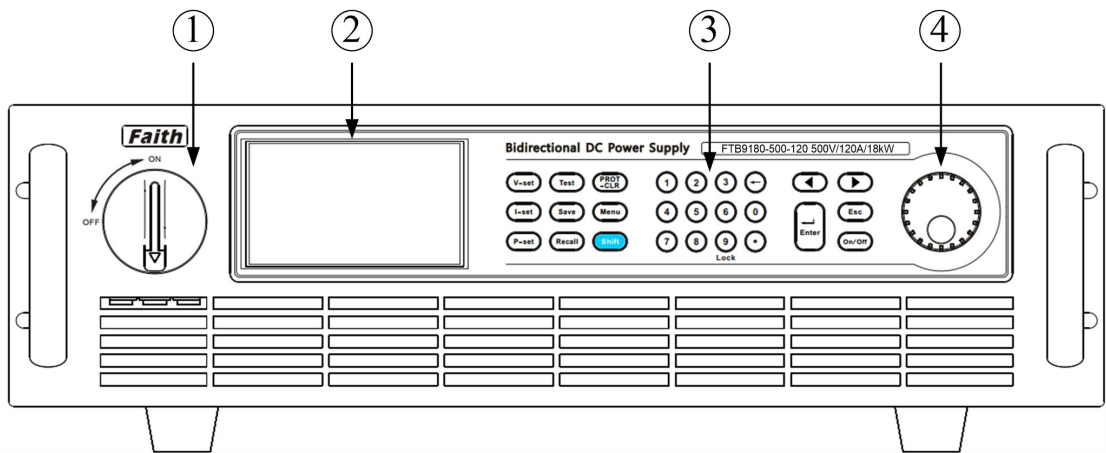


Figure 2- 1 FTB9000 front panel

- ① Equipment switch

② TFT color display
- ③ Function and digital keys

④ knob

2.3. Keyboard introduction

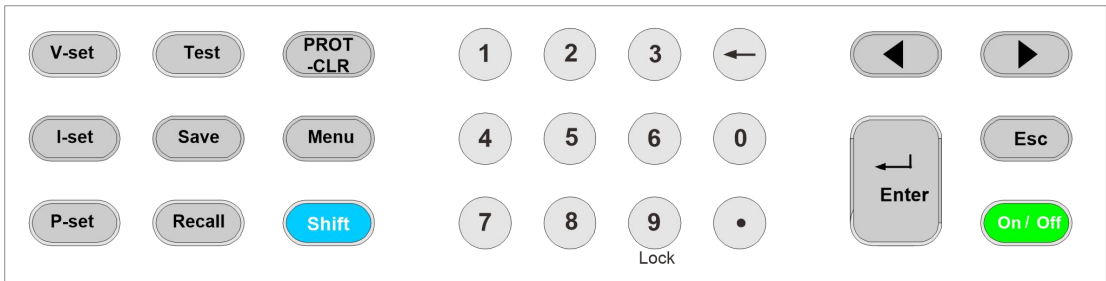
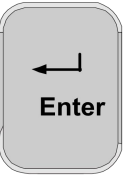


Photo 2- 2 FTB9000 key button

Basic key function

Table 2- 2 Key function table

item	symbol	instructions
1		Voltage setting key. Press this key to switch from other functions to voltage setting function and enter voltage editing state
2		Current setting key, press this key to switch from other functions to source and load current setting function, and enter current editing state

3		Power setting key, press this key to switch from other functions to source and load power setting function, and enter the power editing state
4		Advanced test function keys
5		Save the current function parameters to a file
6		Calls the saved function parameters from the file
7		Protect the clear key, press this key to clear the fault and warning information Reset key. Press this key to reset the accumulated value of charge and time
8		System Menu key. Press this key to enter the system menu
9		Multiple use key
10		Number key and decimal point key
11		Digital clear key
12	 与 	Used to move or select Settings in menu items. These two keys are used to move the cursor between digits when setting parameters
13		Used to enter Settings or to confirm input and exit Settings
14		Used to exit a setting item or menu
15		Enable or disable device output

Composite function key

Combined with Shift key, to achieve the logo function under the key, the detailed

function is described in the following table.

Table 2- 3 Composite function key table

item	symbol	Functional specifications
1	 + 	After the keyboard is locked, all keys and knobs cannot be operated except the key  and the key  can be operated, and the screen displays "Keyboard Lock".
2	 +  or 	Switch power, time, resistance, electricity parameter display.

2.4. Screen introduction

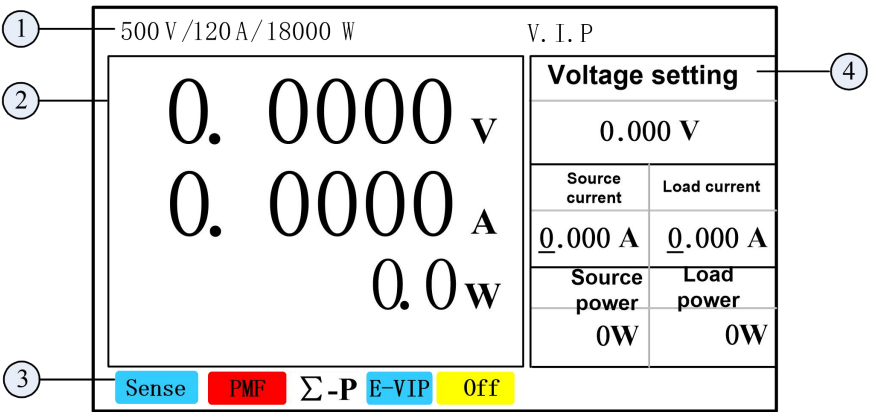


Photo 2- 3Main interface display

- ① Specification parameter display area
- ② Voltage current and other parameters echo area
- ③ Status indicating area
- ④ Function Parameter setting area

Specification parameters display area introduction

Displays rated output voltage, current, and power ranges of the device.

Voltage current and other parameters display area introduction

The parameter echo area is used to display information such as sampling voltage, current, power, and measurement results. In different functions, the echo parameters will be different, for example, in the V.I.P stationary function, the voltage, current and power

will be displayed. Under the SEQ function, voltage, current, numbers of sequence running, and sequence running steps will be displayed. Under the charge and discharge function, the voltage, current, electricity, time and other parameters will be displayed.

Status prompt area introduction

- Voltage sampling: blank (proximal sampling), Sense (voltage distal sampling) External programming: blank (analog programming not enabled), E-VIP
- Protection indication: Blank (no protection occurs)、PMF、OVP、OCP、OPP、OTP、LVP、OP、OC、OV、RVP、CMF
- Mode: CV、CC、CP、CR、Off
- Operation tips

Introduction of functional parameter setting area

Set the test parameters in this area.

1. Scroll the knob or press the arrow keys to move focus to the parameter to be edited.

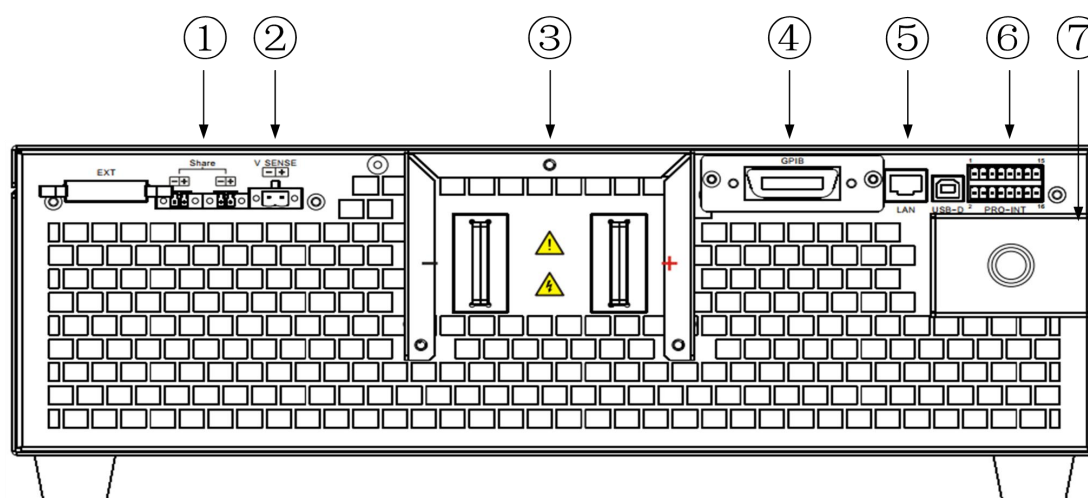


2. Press , Enter the parameter editing state;
3. Press a number key or scroll button to enter a value.



4. Press , Validates the value entered and exits the edit state.

2.5.Rear Panel Introduction



Drawing 2- 4 FTB9000 Rear panel

- ① Share Master/slave parallel port
- ② V Sense Voltage remote sampling port
- ③ +、- device outputs positive and negative terminals
- ④ GPIB OR CAN、RS485 Communication port
- ⑤ LAN、USB
- ⑥ PRO-INT Composite signal port (pin13 and pin14 for RS485-A, pin15 and pin16 for RS485-B)
- ⑦ L1、L2、L3、PE Three-phase power input port

2.6. Installation

2.6.1. Ventilation and heat dissipation

The equipment dissipates heat through the fan. When installing, please ensure that the upper part of the equipment and the surrounding area maintain a gap of more than 20 cm with other objects, so that air can circulate.

2.6.2. Input requirements

FTB9000 series equipment power supply input connection, please pay attention to the following items:

- ①. Three-phase input: 340VAC~480VAC, 47~63Hz;
- ②. Ensure reliable grounding;
- ③. 3.5kW/6kW type equipment access L1, L2 and ground terminal, other types of equipment need to access L1, L2, L3 and ground terminal;
- ④. Please refer to "Table 6-1 Recommended Cable Diameter Table" for input wire diameter selection to avoid potential safety hazards caused by small wire diameter selection.

 **Warning: Before operation, please make sure that the grounding end of the equipment is well grounded.**

2.6.3. Startup self-test

After the device is powered on, the device performs the self-test procedure first, and the screen displays the self-test process and self-test results, as shown in the figure below.

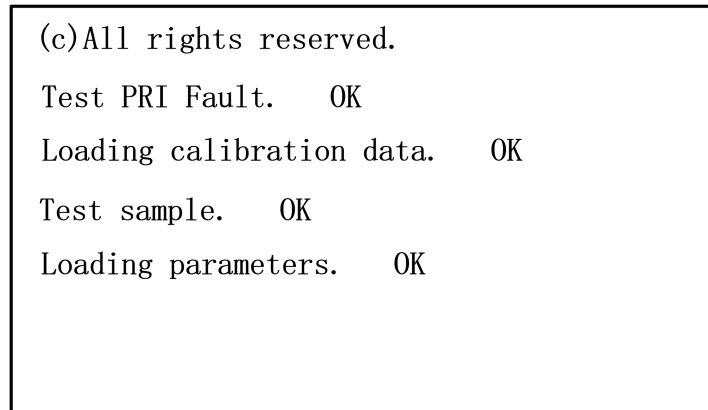


Figure 2- 5 Device self-check screen

During the self-test, the screen will display the self-test items and results. If all check items are OK, enter the application screen immediately. Otherwise, wait 5 seconds before entering the application screen.

Note: For the description of self-test faults, see "Table 5-2 Self-check Table for Startup Faults".

2.7. Connection mode

2.7.1. Input connections

The user connects the three-phase wire and the ground wire to the input terminal of the device as shown in Figure 2-6. The size of the access wire can be referred to the "Table 6-1 Recommended Cable Size Table".

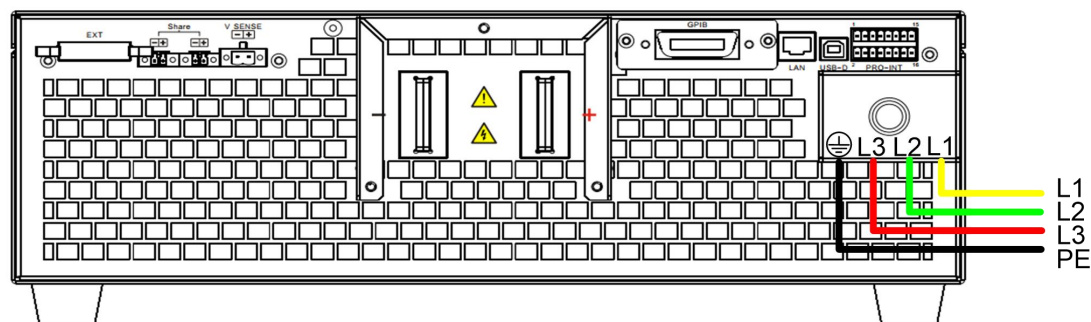


Photo 2- 6 Device input connection

Warning: Before operation, please make sure that the grounding terminal of the equipment is well grounded.

2.7.2. Input connection of multiple devices

Multiple 5kW/6kW or 10kW models are connected to the grid, and it is suggested to evenly distribute the access points as shown in the following figure. When the 15kW model is connected to the three-phase power grid, there is no need to consider the imbalance problem on the power grid.

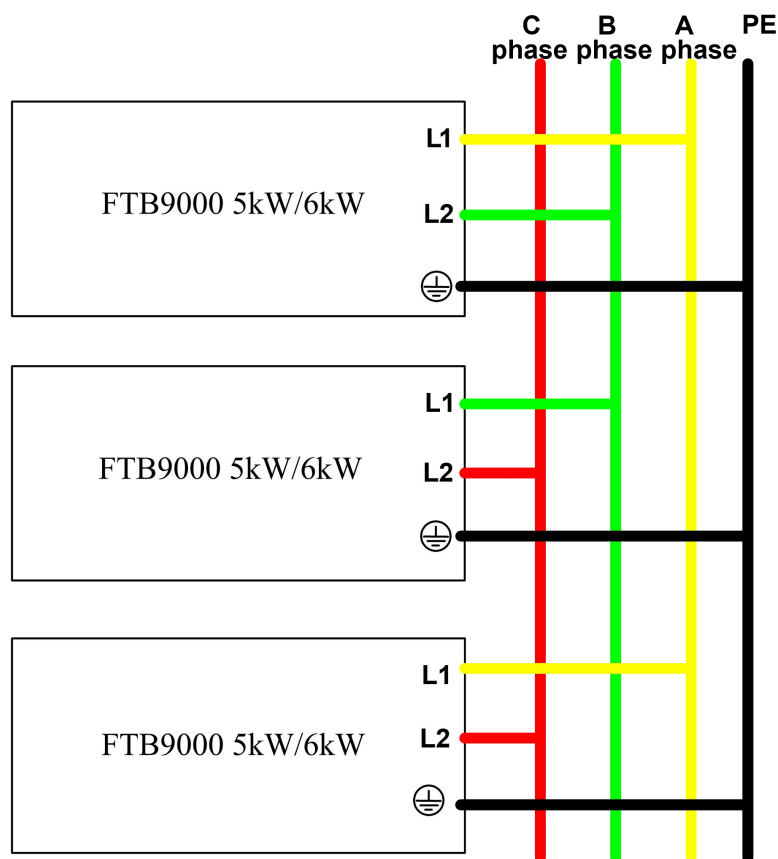


Photo 2- 7 Multiple 5kW/6kW input connections

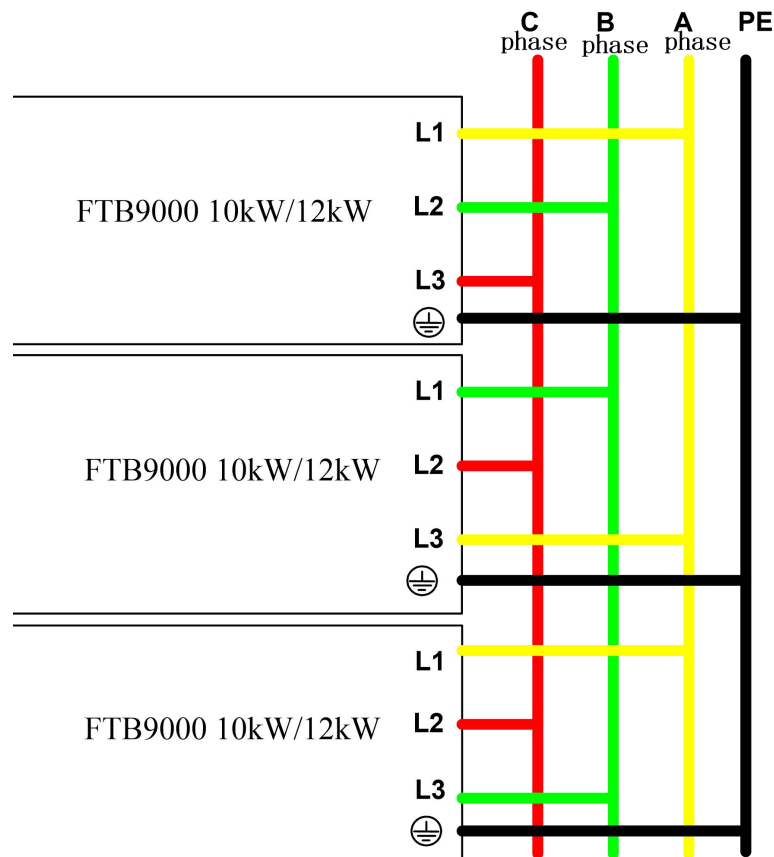


Photo 2- 8Multiple 10kW/12kW input connections

2.7.3. Connection of positive and negative terminals

Positive and negative port connections are the + and - end of the rear panel of equipment connected to the device under test. When connecting, pay attention to the wire diameter, length and polarity of the cable. To avoid the safety accidents caused by too small wire diameter, which may affect the test accuracy and produce large heat, please refer to "Table 6-1 Cable Recommended Wire Diameter Table" for wire diameter selection.

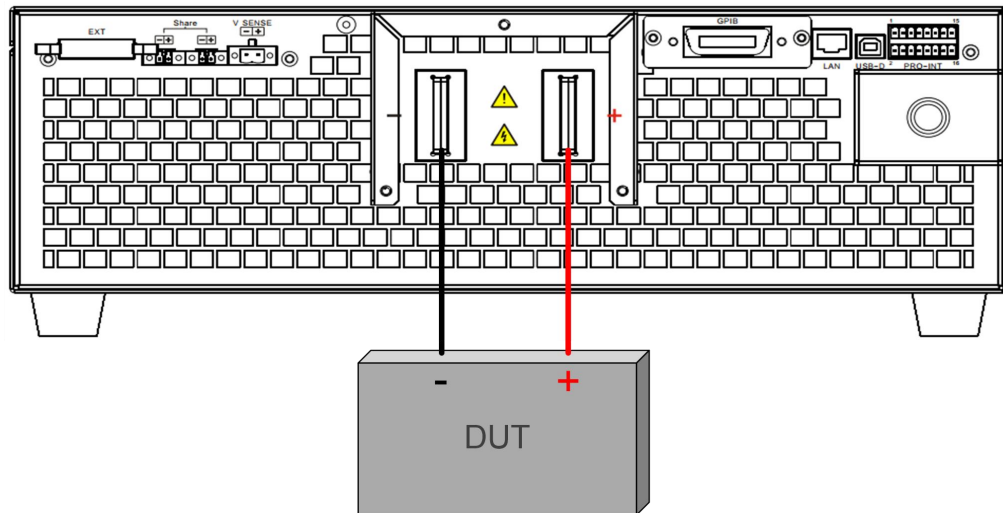


Photo 2- 9 Positive and negative device ports are connected

2.7.4. Voltage compensation connection

When the device is working, the input and output currents will produce voltage drops on the connecting cable and contact surface, resulting in voltage errors at the end of the device connection. FTB9000 series devices have automatic line loss compensation capability to compensate for voltage drops caused by cables and contact resistors.

Use the "V Sense" voltage compensation sampling terminal on the back panel to connect the positive and negative wiring terminals to the positive and negative terminals to be compensated. When the device is working, the voltage difference between this point and the device will be automatically compensated, and the status bar of the main interface displays "Sense".

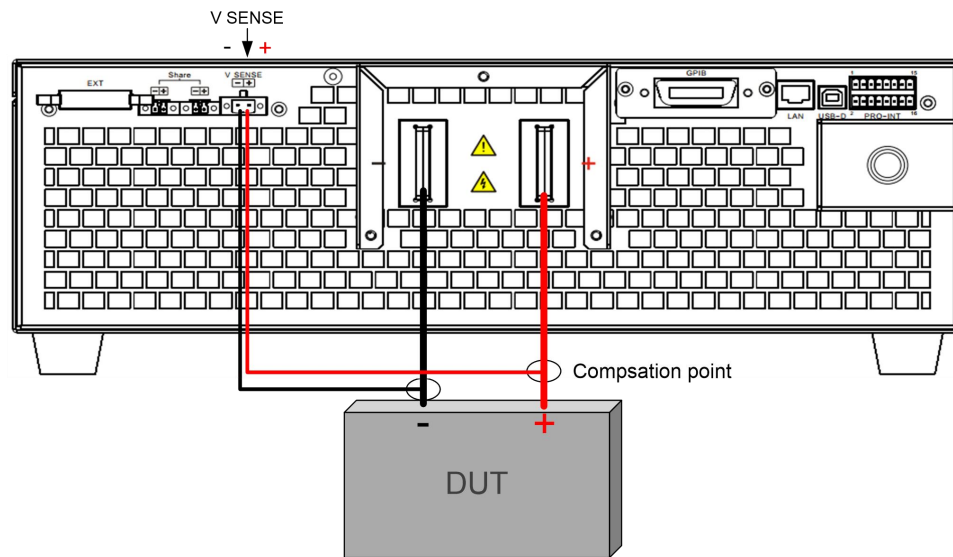


Photo 2- 10V voltage compensated connection

Note:

1. The voltage compensation wire can use red, black wire $0.5\text{mm}^2 \sim 1\text{mm}^2$ cross-section area, and twisted it as much as possible.
 2. The compensation voltage drop of 80V model of FTB9000 series equipment is less than 1.5V, and that of other voltage models is less than 5V
- For special requirements, please consult your dealer or Faith Technology Technical Department.
-

2.7.5. Energy feedback connection

FTB9000 series products not only realize the load function, but also can feed the absorbed energy back to the grid without pollution. The connection mode is shown in Figure 2-11 energy feedback connection. If the efficiency of "source equipment" in the figure is 85%, and the feedback efficiency of FTB9000 series products is 94%, users can theoretically save 80% of electric energy.

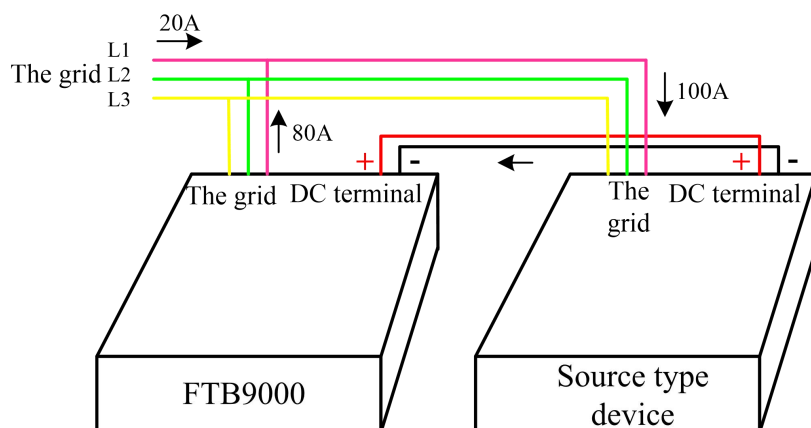


Figure 2- 11 Energy feedback connection

2.7.6. Composite signal port connection

The rear panel of the device is optionally equipped with the composite signal terminal "PRO-INT", which is used to connect the analog monitoring signal, trigger input signal and status output indicator signal.

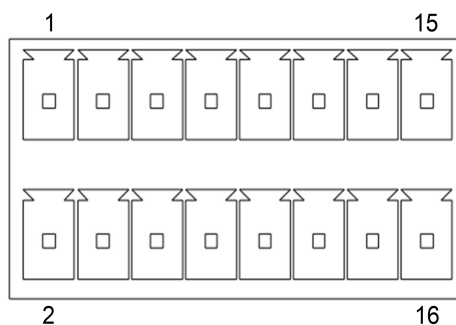


Photo 2- 12 Composite signal terminal

Table 2- 4 Compound signal function description

pin	Name	I/O	instructions
1	Ready	Output	Device working status indicator port. 5V TTL level, H: fault; L: normal
2	Mode	Output	Device working mode indicates port. 5V TTL level, H: CC or CP, L: CV
3	Inhibit	Input	External control port. 5V TTL level. The falling edge or low level is valid. Multiple control modes can be configured. For details, see "3.8 External Control Function".
4	DGND	-	Digital ground

5	DGND	-	Digital ground
6	AGND	-	Analog ground
7	VMON	Output	Output voltage monitoring port. Monitoring output range 0 to 5V Source and load port voltage of the device 0 to rated voltage
8	IMON	Output	Source and load current monitoring port. Monitoring Output Range 0 to 5V Indicates the device source or load monitoring current 0 to the source or load rated current
9	I-Set	Input	Analog programming current input port. Input range 0 to 5V or optional 0 to 20mA Corresponding to the device source or load control current 0 to the source or load rated current
10	AGND	-	Analog ground
11	V-Set	Input	Analog programming voltage input port. Input range 0 to 5V or optional 0 to 20mA Device voltage 0 to the rated voltage
12	P-Set	Input	Analog programming power input port. Input range 0 to 5V or optional 0 to 20mA Corresponding to the device source or load control power 0 to the source or load rated power
13、14	RS485-A	-	Master/slave parallel communication port, RS485-A。
15、16	RS485-B	-	Master/slave parallel communication port, RS485-B。

3. Function introduction

This chapter describes the functions and features of the device. After reading this chapter, you will have a deeper understanding of FTB9000 series devices.

3.1. Source load state and working mode of the equipment

FTB9000 has two working states: source and load. When used as a DC power source, the device provides energy to the outside in the source state. When used as a load, the device absorbs external energy and is in a loaded state. The transition between source and load state is determined by the output voltage of the device and the external voltage. When the output voltage is higher than the external voltage, the device is in the source state. When the output voltage is lower than the external voltage, the device is in the loaded state.

The equipment can achieve CV (constant voltage), CC (constant current), CP (constant power) three working modes in both source and load states.

In CV (constant voltage mode), the status bar of the main interface displays "CV", and the DC port voltage of the device is adjusted according to the set value. When the output or input current of DC port exceeds the set current value of source and load, the device will enter CC (constant current mode), and the status bar will display "CC". The output and input current can be changed by the source and load setting current value respectively. At this time, the device port voltage is determined by the external source and load. When the external power exceeds the set power value of the source and load of the equipment, it will enter the CP (constant power mode) status bar to display "CP". The power can be changed by adjusting the device source and load setting power value.

Note:

- 1. If just equipment work on source state, load current can be set value is 0.**
 - 2. If just equipment work on load condition, but the voltage value is 0.**
-

3.2. Local/Remote operation mode

The device provides two operation modes: local operation and remote operation. In the local operation mode, the user mainly operates through the keyboard and knob of the front panel, and checks the device status through the LCD screen. In remote operation mode, users perform Settings and operations mainly through the communication interface and programming commands provided by the device.

Local operation mode

After the device is powered on, the default mode is local operation. In the local operation mode, the user operates the device through the front panel keyboard. The LCD screen provides the user with the display functions such as parameter viewing, measurement display and status indication.

Some parameters can be set only in local mode, including:

- system language
- Serial port baud rate and parity mode
- Keyboard sound
- IP address and subnet mask
- Communication protocol selection

Remote operation mode

To enter remote operation mode, use the correct communication cable to connect the PC to the device. Communication configuration parameters must be consistent with the control device Settings. After receiving the programming command, the device automatically enters the remote operation mode from the local control mode.

In remote control mode, the device can only be controlled by programming commands. To return to local operation mode, press the  key.

3.3. Menu configuration

3.3.1. Set item menu

Press key , Enter the menu Settings interface, select the "Set" item,



press The sub-menu pops up. As following table::

Table 3- 1 Settings menu table

Application Settings	Sampling rate	Sampling transmission rate setting, with 5 optional levels:1000Hz, 500Hz, 200Hz, 100Hz, 10Hz, default 10Hz.
	Output priority	Voltage or current is preferred. Default: Volt (voltage first)
	Voltage	Voltage rising slope configuration. The value ranges from 0.0006V/s to 40,000 V/s. The default value is 10000 V/s
	Voltage	Voltage drop slope configuration. The value ranges from 0.0006V/s to 40,000 V/s. The default value is 10000 V/s
	Source current	Source current rising slope configuration. The default value is 2000A/s
	Source current	Source current rising slope configuration.The default value is 2000A/s
	Load current	Load current rising slope configuration. The default value is 2000A/s
	Load current	Load current down the slope configuration. The default value is 2000A/s
Protection setting	Overvoltage protection	Set the OVP overvoltage protection point and set it to 0 to disable the protection
	Overcurrent protection	Set the OCP overcurrent protection point and set it to 0 to disable the protection
	Overpower protection	Set the OPP overpower protection point and set it to 0 to disable the protection
	Low voltage protection	Set the LVP low voltage protection point to 0 to disable this protection
	Timeout time	Set the communication failure timeout period. The value ranges from 0.0 to 60.0s. Set this parameter to 0 to disable the protection

	Detecting reverse connection	Enable or disable Output reverse RVP prompt. Default: Disable.
	Output time	Set the output duration of the device, the default: 0s is off.
Limit Settings	Voltage	Limit stationary state sets the voltage upper limit. Default: Maximum output voltage
	Voltage	Limit stationary state sets the voltage lower limit. Default: 0 is unlimited
	Source current	Limit stationary state sets the voltage upper limit. Default: Maximum output current
	Source current	Limit stationary state sets the voltage lower limit. Default: 0 is unlimited
	Load current	Limit stationary state sets the voltage upper limit. Default: Maximum input current
	Load current	Limit stationary state sets the voltage lower limit. Default: 0 is unlimited
	Source power	Limit stationary state sets the upper limit of power. Default: Maximum output power
	Source power	Limit stationary state sets the lower limit of power. Default: 0 is unlimited
	Load power	Limit stationary state sets the upper limit of power. Default: Maximum input power
	Load power	Limit stationary state sets the lower limit of power. Default: 0 is unlimited
External programming	Voltage programming	Enable or disable external voltage programming control, default: off
	current programming	Enable or disable external current programming control, default: off
	power programming	Enable or disable external power programming control, default: off
	External control	Set the behavior of the external input signal, Optional Trigger/Toggle/Hold; default: Trigger

Parallel machine	Master-slave setting	Configure the local machine as a host or slave machine; Default: Host
	Number of slave devices	Configure the number of slaves in the host. The setting range was 1 to 9
	Master-slave control	Enable parallel machine function; The default is off

3.3.2. System item menu

Press key , Enter the menu setting interface and select the "System" item,

press  The sub-menu pops up. as following table:

Table 3- 2system Menu table

communication setting	IP address	Default: 192.168.1.123
	Subnet mask	Default:255.255.255.0
	Serial port rate	Optional :4800/9600/19200/38400/115200 , Default: 9600。
	Mode of verification	Optional no check/odd check/even check, default: no check.
	Device address	Device address in the MODBUS frame. The value ranges from 0 to 254. Default: 160
	GPIB address	Set GPIB communication device address, range 0 ~ 30, default: 5
	Communication protocol	Optional SCPI or MODBUS; default: MODB, (MODBUS protocol)
Factory setting	Restore factory Settings	To restore the system parameters to the factory configuration, the device needs to be restarted to take effect。
Other setting	system language	Optional Simplified Chinese, Traditional Chinese, English, Default: Simplified Chinese
	Keyboard sound	Optional Enable or Disable. Default: Enable
	Power failure	Optional Enable or Disable. Default: Enable

	preservation	
	Quick call	Optional Enable or Disable. Default: disable

3.3.3. Edit item menu

press  button, Enter the menu setting interface and select "Edit" item, press  button, The sub-menu pops up. The edit item is used for sequence editing; see "3.12 Sequence Output Function (SEQ)" for details."。

Table 3- 3 Edit menu list

sequence file	sequence file	Sequence file number selection, range: 1 to 10
return	return	Exit the Sequence file submenu

3.3.4. About Menu

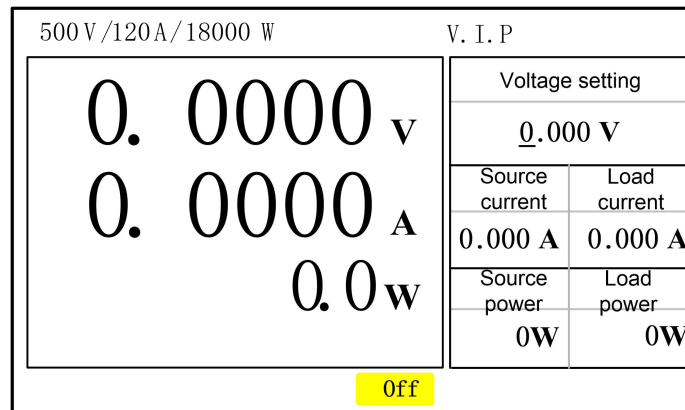
press  button , enter menu setting interface , select "about" , press  button, Pop up version numbers about HMI, MAIN, COMM programs。

3.4. Stationary function

FTB9000 series equipment as a wide range of high power bidirectional programmable DC power supply, can achieve DC power supply and feedback load function in the full power range. Voltage, current, power use range: 0 ~ 102% rated value.

3.4.1. V.I.P setting :

press  ,  or  Function key, the device enters the steady state function. The display interface is shown below.



Photot 3- 1Stationary functional interface

Voltage setting :

Under the stationary functional interface, press  button to Enter the "Voltage Setting" edit state.

In the edit state, turn the knob to change the voltage value, or press the number key



to input the voltage value, press  button again, Make the input value valid.

After restoring the factory Settings, the voltage setting value defaults to 0V.

Current setting :

Under the stationary functional interface, press  button to Enter the "Source Current" editing state. press  again to enter the "load Current" editing state, You can switch between the "source current" and "load current" editing states.

In the edit state, turn the knob to change the current value, or press the number key



to enter the current value, press  button again, Make the input value valid.

After restoring the factory Settings, the source and load current Settings are default: maximum current.

Power setting

Under the stationary output functional interface, press  button to enter "source power" editing state, press  button again, You can switch between the Source Power and Load Power editing states.

In the edit state, turn the knob to change the power value, or press the number key to



enter the power value,press button to Make the input value valid.
After the factory Settings are restored, the default source and load power Settings are the maximum power.

3.4.2. Limit parameter Settings

The device provides voltage, current, power set point upper and lower limit function. When the upper and lower limits are set to non-0, the voltage, current and power parameters under the steady-state output function can be set between the upper and lower limits. If the input number exceeds the limit value range, it will be invalid and the screen will prompt "input out of range". This function has a good effect on preventing the user's equipment from being damaged by misoperation. If the upper and lower limit is set to 0, the limit is removed.

1.

press  button, enter menu setting interface;
2.

select“setting”->“Limit Settings” sub-menu, press  button,enter ouput setting interface as following,

setting	system	editting	about
voltage↑	0.000	V	Source↑
voltage↓	0.000	V	power Source↓
Source↑	0.000	A	power Load↑
current Source↓	0.000	A	power Load↓
current Load↑	0.000	A	power
current Load↓	0.000	A	
current			

Photo 3- 2 The voltage and current upper and lower limits setting interface

3.

select“voltage↑”、“voltage↓”、“source current↑”、“source current↓”、“source power↑”、“source power↓”、“load power↑”、“load power↓”to Set up。(↑: upper limit; ↓: lower limit)

3.5. Voltage slope and current slope

FTB9000 series devices support voltage slope and current slope Settings. The

adjustable slope can better adapt to the user's requirements for smooth voltage and current waveform, and can effectively avoid the impact of the output on the measurement object.

1. press  button, enter menu setting interface;
2. select“setting”->“Application Settings”Sub-menu , press  button to enter Application Settings interface as following,

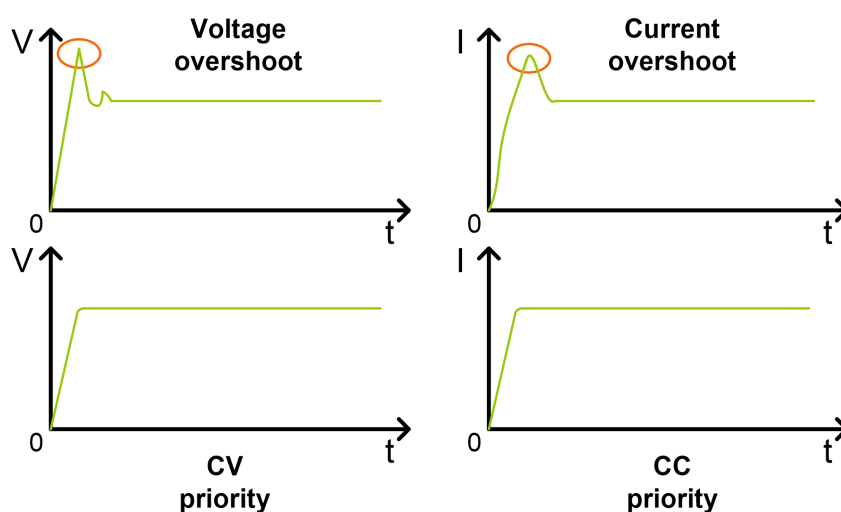
Setting	System	Editing	About
Sampling rate	10Hz	Load current	 2000.0 A/s
Output first	Volt	Load current	 2000.0 A/s
Voltage	 10000.0 V/s		
Voltage	 10000.0 V/s		
Source current	 2000.0 A/s		
Source current	 2000.0 A/s		

Photo 3- 3Voltage slope and current slope setting interface

3. select“voltage ”、“voltage ”、“source current ”、“source current ”、“load current ”、“source current ”to set up, The unit of voltage slope is V/s, and the unit of current slope is A/s.

3.6. CV/CC priority

FTB9000 series equipment with CV, CC, CP output mode, enough to meet the general needs of the market. In the face of more stringent application areas, to meet the special requirements of customers, FTB9000 series equipment provides CV priority and CC priority options, so that the device can be forced to run in CC mode or CV mode at the moment of startup. To avoid current or voltage spikes caused by users using capacitive or inductive loads.



loads.

Photo 3- 4 CV priority and CC priority output voltage current waveform

1. Press  button, enter menu setting interface;
2. select“setting”->“application setting”sub-menu , press  button to enter application setting interface as following:

Setting System Editing About		
Sampling rate	10Hz	
Output first	VOLT	
Voltage	10000.0 V/s	Load current 
Voltage	10000.0 V/s	Source current 
Source current	2000.0 A/s	
Source current	2000.0 A/s	

Photo 3- 5 CV and CC Priority Setting screen

3. select“Output first”to set up, “VOLT”is voltage priority, “CURR”is current priority,

3.7. Output control

After the device is powered on, it is turned off. You can control output by pressing the keys  on the front panel.

 button indicator light is on, indicating that the output is open, and the screen displays real-time voltage, current, power, mode and other information;  button indicator light is Off, indicating that the output is off, and the screen shows the OFF state.

The screen shows the output switch status, and the user can also observe whether the output is turned on by pressing the indicator light.

3.8. Introduction of external monitoring functions

3.8.1. Monitoring function

FTB9000 composite port provides the analog monitoring output function of source, load voltage and current, and the rate can reach 1000 points per second. The device source, load output, and input are from 0 to the rated value, corresponding to the monitoring output port 0 to 5V voltage, and this function is always effective after the device is started.

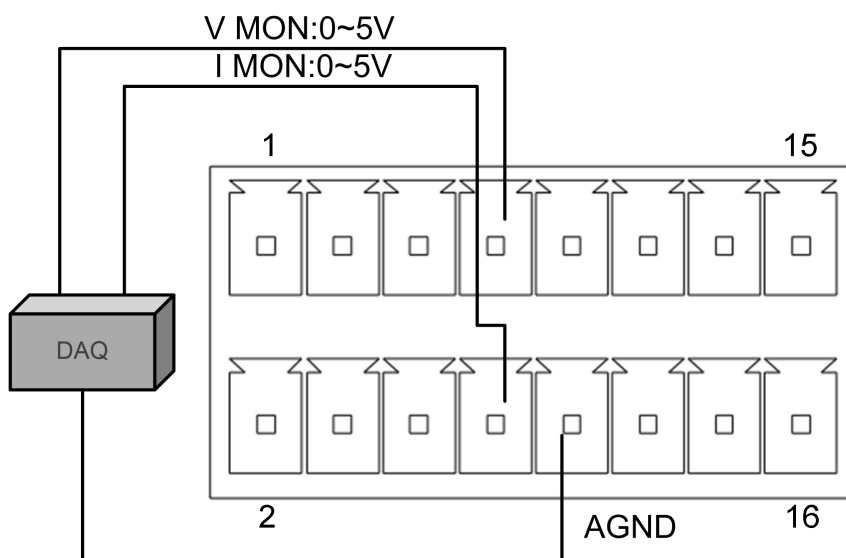


Photo 3- 6 Voltage and current analog monitoring connection

Monitor voltage and current output and equipment as shown in the figure below.。

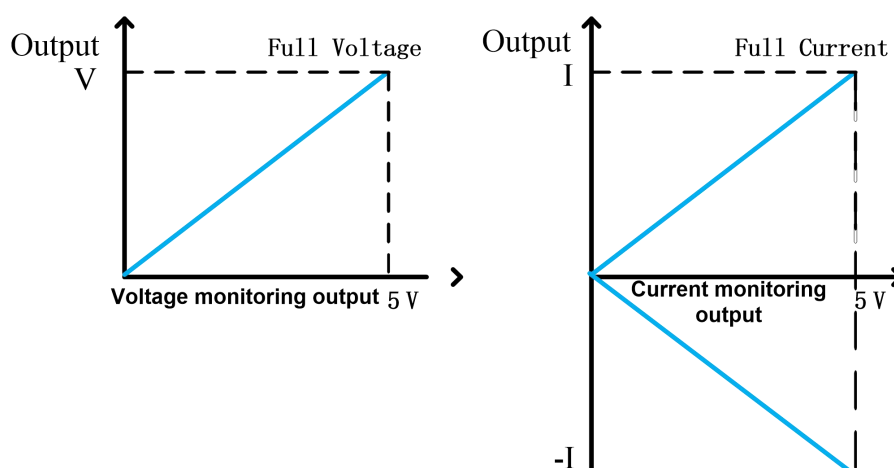


Figure 3- 7 Monitoring signal and equipment voltage, current relationship

3.8.2. Simulation programming function

The source, load rated voltage, current and power of the device can be set by external 0-5V DC voltage signal, which is connected as shown below.

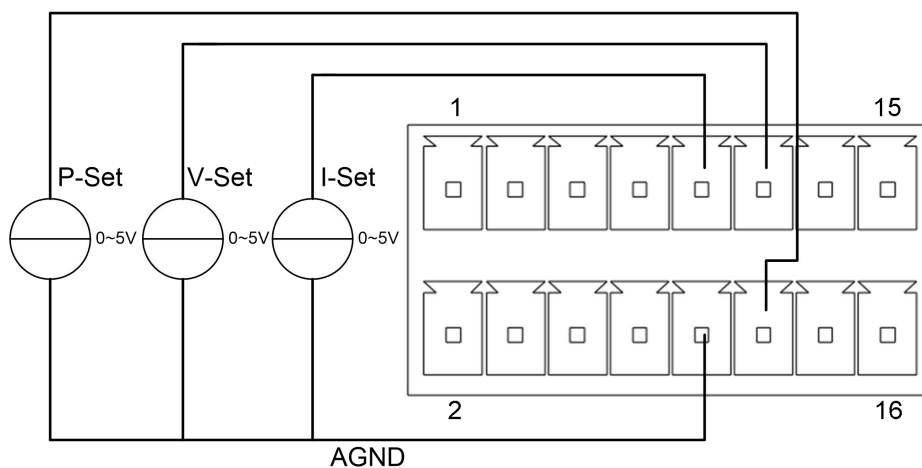


Figure3- 8 Composite port simulation programming wiring mode

Simulation programming function control rate is 1000 points per second. The relationship between output voltage, input, output current, power and programming input signal after opening is shown as below.

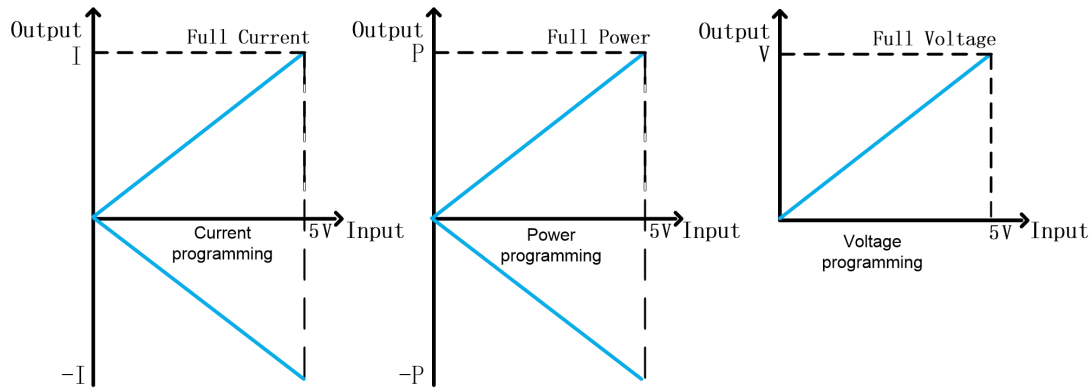


Figure3- 9 Relationship between input programming signal and output

Procedure of operation

1. press  button, enter menu setting interface ;
2. select "setting"->"External programming" sub-menu , press  button to enter External programming interface as following;

Setting	System	Editting	About
Voltage programming	Close		
Current programming	Close		
Power programming	Close		
External control	Trigger		

Figure 3- 10 External programming setting interface

3. Select "Voltage programming", "current programming", and "power programming" to enable or disable the Settings; Three analog programming input switches can be selected arbitrarily, after opening the main interface has "E-VIP" character prompts.
4. press  button to start output.

Note:

1. You are allowed to change the Analog Programming Settings only when the device is turned off.
2. External simulation programming only determines the output related quantity by external signal when the corresponding function item is opened, otherwise the device setting can still be controlled by man-machine interface or remote communication.
3. Compound port "I-Set" input analog programming signal, which is valid for device source and load control current and set the same value; "P-Set" is valid for both source and load control power, and the set value is the same.

3.8.3. External control function

FTB9000 composite signal port provides a trigger signal input port "Inhibit", which is connected as shown below:

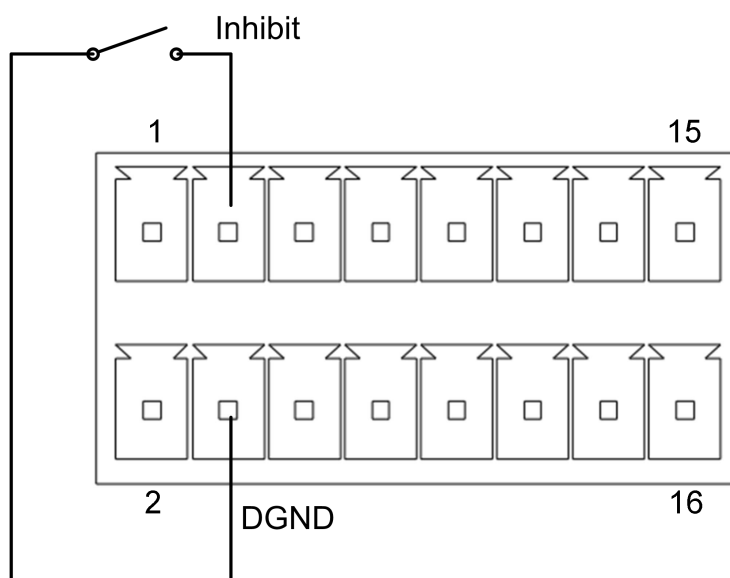


Figure 3- 11 Trigger signal connection

This port receives a 5V TTL level signal, which is valid at low level. You can use a physical switch such as Figure 3-11 Trigger Signal Connection or a 0 to 5V signal source to trigger the signal. Closed or 0V is a low level and disconnected or 5V is a high level. The response time of the port is about 20ms, and it can be set to Trigger, Toggle and Hold and Halt.

For the specific electrical performance, please refer to "Description of Composite Signal Function in Table 2-4".

- Trigger: It is used as a trigger signal by default. The input port detects a valid low level pulse, that is, it receives a trigger signal;
- Toggle: As the equipment output switch control signal. The input port detects a valid low level pulse, that is, the output switch is switched once, which has the same function as the front panel button  ;
- Hold: As the device output switch control signal. If the input digital signal port detects a valid low level, the device output is turned on, and if a valid high level is detected, the device output is turned off.
- Halt: indicates an emergency stop signal. If the input signal port detects a valid low level, the device stops output and a Halt alarm is displayed on the screen. When a valid high level is detected, the alarm status can be cleared.

Note: Key control, external control and bus control are effective at the same time and work together.

Procedure of operation

1. press  button, enter menu setting interface;
2. select“setting”->“Ext Prog”sub-menu , press  button to enter External programming interface as following 3-8,
3. select“External control”, press  button to select“Trigger”or“Toggle”or“Hold”。

3.8.4. Mode and status monitoring function

FTB9000 series devices have mode signal ports and fault indicator ports. The port outputs a 5V TTL level signal with the following functions:

- Mode signal port, low level indicates that the device is working in source, load CV mode, high level indicates that the device is working in source, load CC or CP mode;

- Fault indication signal port, low level indicates that the equipment is working normally, high level indicates that the equipment is abnormal or has been protected and the protection has not been cleared.

For details about electrical features, see Table 2-4 Compound Signal Function Description.

3.9. Protection

The FTB9000 series devices have the following protection functions:

- over voltage protection
- over current protection
- over power protection
- Under voltage protection
- Output reverse connection warning
- Communication timeout
- output time
- Over temperature protection

When the protection condition occurs, the device automatically shuts down the output.

The screen shows the specific protection content, while the buzzer emits an alarm.

1. Press  button, enter menu setting interface;

2. select“setting”->“Protection setting”Sub-menu , press  button to enter Protection setting interface as following :

Setting	System	Editing	About
Overvoltage protection	0.000 V		
OverCurrent protection	0.000 A		
OverPower protection	0 W		
Undervoltage protection	0.000 V		
Communication timeout	0.0 s		
Detecting reverse connection	Close		

Photo 3- 12Protection setting interface

3. Set protection parameters.

4. After protection occurs, press  button, you Can clear the protection status.

Over voltage protection

The device has two types of overvoltage protection: hardware overvoltage and software overvoltage.

- Hardware overvoltage protection: when the output voltage exceeds 105% of the rated voltage of the device, the hardware overvoltage protection will be triggered, and the screen will prompt "OV".
- Software overvoltage protection: The device provides the option of "overvoltage protection" for users to set. The relevant configuration items refer to the protection Settings in "Menu Configuration". Set to 0 to turn off software overvoltage protection. When the input voltage exceeds the "overvoltage protection" setting, the software overvoltage protection will be triggered, and the screen will prompt "OVP".

Over current protection

The device has two types of overcurrent protection: hardware overcurrent and software overcurrent.

- Hardware overcurrent protection: when the output current exceeds 105% of the rated current of the device, the hardware overcurrent protection will be triggered, and the screen will prompt "OC".
- Software overcurrent protection: The device provides the option of "overcurrent protection" for users to set. The related configuration items refer to the protection Settings of "Menu Configuration". Set to 0 means to turn off software overcurrent protection. When the output current exceeds the value of overcurrent protection, the software overcurrent protection is triggered and OCP is displayed on the screen.

Over power protection

The device has two types of overpower protection: hardware overpower and software overpower.

- Hardware overpower protection: When the output power exceeds 110% of the rated power of the device, the hardware overpower protection will be triggered, and the screen prompts "OP".
- Software overpower protection: The device provides the option of "power protection" for users to set. The related configuration items refer to the protection

Settings of "Menu Configuration". When set to 0, the software overpower protection is turned off. When the output power exceeds the value of Power Protection, the software overpower protection is triggered, and the screen prompts OPP.

Under voltage protection

The device provides the option of "undervoltage protection" for users to set. The related configuration items refer to the protection Settings of "Menu Configuration". Set to 0 means to turn off the undervoltage protection. When the output voltage is lower than the "undervoltage protection" setting, the undervoltage protection will be triggered and the screen will prompt "LVP".

Output reverse connection warning

When the polarity of output voltage (such as battery connection, etc.) is reversed, a reverse warning will be triggered, and the screen will prompt "RVP".

Communication timeout

When the device is under remote control, you can enable communication timeout protection. If the upper computer does not send communication commands to the device for a period of time, the communication timeout protection will be triggered, and the device will automatically shut down the output, and the screen displays "CMF". You can set the timeout period in Menu Configuration. The value ranges from 0.0 to 60.0 seconds.

Output time

Control the device output time, when the device output open time reaches the set time, the device automatically shut down. Output time setting range: 0 ~ 99999s, set 0 to turn off this function. This function is effective in "steady state function" and "constant resistance function".

Over temperature protection

When the temperature of the power device inside the device exceeds the allowable temperature range, the over-temperature protection will be triggered, and the screen will prompt "OTP".

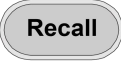
3.10. Save and Call

The device provides 20 sets of storage locations for users to save steady-state function parameters, such as voltage setting, source-load current setting, source-load power setting, voltage slope and current slope to the specified location for users to quickly

and conveniently call up. If the quick call function is enabled, you can simply press a numeric key to bring up the saved parameters. This function can significantly reduce user operations and improve test efficiency.

Procedure of operation

When users need to use the save and call functions, they should first configure the steady-state output function parameters, as illustrated by the following examples:

1. Switch to steady-state output function, set voltage to 12V, source current to 10A, source power to 1000W, voltage slope to the maximum, current slope to the maximum;
2. press  button, enter save interface;
3. Enter the number 1, PRESS  button to put it into effect, Save parameters to storage location 1
4. Change the steady-state output function parameters, set the voltage to 24V, the source current to 20A, the source power to 2000W, the voltage slope to the maximum, the current slope to the maximum;
5. press  button, enter save interface;
6. Enter the number 2, press  button to Put it into effect, Save the parameters to storage location 2.
7. press  button, enter call interface;
8. Enter the number 1, press  button to Put it into effect, The parameter of position 1 will be called, and the device will switch to the steady-state output function. The voltage is set to 12V, the source current is set to 10A, the source power is set to 1000W, and the voltage slope and current slope are maximum.
9. press  button, enter call interface interface;
10. Enter the number 2, press  button to Put it into effect, , The parameter of position 2 will be called, and the device will switch to the steady-state output function. The voltage is set to 24V, the source current is set to 20A, and the

source power is set to 2000W, with the maximum voltage slope and current slope.

Quick call

1. press  button, enter menu setting interface;
2. select "setting" -> "system", press  button, select "other setting",
press  button again;
3. Set the "Quick call" option to on, even if it can be called quickly;
4. press  button, Back to the main interface;
5. On the main interface and not in the parameter editing state, press the number key to call up the parameters at positions 1 to 10, button  ~
 Corresponds to storage location 1~9, button  Corresponds to storage location 10.

3.11. Save after power failure

FTB9000 series devices provide power-down saving function. When power down saving is turned on, the device will restore the parameters of the last shutdown when it is powered on, otherwise the device will be initialized to the default parameters.

1. press  button, enter menu setting interface;
2. select "setting" -> "system", press  button, select "other setting",
press  button again;
3. Set the "power-down Save" option to on, even if the power-down save function is available.

3.12. Lock operation

press  +  button, The device can be locked. In the locked state, only open output (close output) and unlock operations are supported, other key actions will be shielded, the main interface will prompt "keyboard lock". At the same time, the operation Settings area of the screen will be displayed in grayscale color to distinguish the normal unlocked state.

Exit the locked state, Need to operate again, press  +  button once more.

3.13. Sequence function(SEQ)

Sequence output function, menu option is "SEQ", allows users to edit voltage, current waveform. FTB9000 series devices provide 10 sequence files, each supporting up to 100 running steps. In the running step, voltage setting, current setting and single-step delay can be set. Support "run times" and "linked files" attributes. "Number of runs" can control the sequence loop running, set to 0 to indicate an infinite loop. "Link file" adds steps to file running, set to 0 means no link.

When the sequence is running, the highest voltage, current slope is adopted by default.

Table 3- 4Sequence parameter description table

Parameter name	Description of parameters
File length	SEQ file running steps, ranging from 1 to 100
Running times	Set the number of sequence file loop runs, ranging from 0 to 60000, set to 0 for infinite loop, default to 1
Link files	The range of 0 ~ 10, calls the different sequence file to run this step, set to 0 means no link.
Edit steps	Control which step of the file is currently edited, ranging from 1 to 100
voltage	The voltage set value of the current step, ranging from

	0 to the maximum voltage
Source current	Source current set value for the current step, ranging from 0 to maximum source current
Source power	Source power set value for the current step, ranging from 0 to maximum source power
Load current	The load current set value of the current step, ranging from 0 to the maximum load current
Load power	The load power set value of the current step, ranging from 0 to the maximum load power
Single-step delay	The delay of the current step, ranging from 0.001 to 99999s. The delay starts from the moment when the voltage, current and power of the current step reach the set value.

Edit sequence file

1. press  button, enter menu setting screen;
2. select“edit”->“sequence file”, press  button to Enter the sequence file selection screen;
3. Turn the knob or enter a number to select the file number you want to edit,

press  button to enter editing files screen;

Setting	System	Editing	About
File size	100	Running times	60000
Link sequence	10	Editing steps	100
Voltage	0.000 V	Source current	0.000 A
Source power	0 W	Load current	0.000 A
Load power	0 W	Single-step delay	86400.0 s

Photo 3- 13Sequence file editing screen

4. set“Length of file”, press  button to confirm, The edit focus automatically

moves to the next item, "number of runs";



5. set "Number of runs", press  button to confirm; The edit focus automatically moves to the next item, "link files";

6.



7. set "link files", press  button to confirm, The edit focus automatically moves to the next item, "edit steps";



8. set "edit steps", press  button to confirm, The edit focus automatically moves to the next item, "voltage";



9. set "voltage", press  button to confirm, The edit focus automatically moves to the next item, "source current";



10. set "source current", press  button to confirm, The edit focus automatically moves to the next item, "source power";



11. set "source power", press  button to confirm, The edit focus automatically moves to the next item, "load current";



12. set "load current", press  button to confirm, The edit focus automatically moves to the next item, "load power";



13. set "load power", press  button to confirm, The edit focus automatically moves to the next item, "Single-step delay";



14. set“Single-step delay” , press  button to confirm , The edit focus automatically moves to the next item, "edit steps; And add 1 to the edit step;

15. Repeat step 7 to 13, until all the steps of programming is complete;



16. press  button, Save the sequence file you just edited;



17. press  button, Exit the sequence file editing screen.

Note: Editing sequence files is not allowed while the device is on.

Running sequence files



1. press  button, Enter the Test function selection screen;



2. Turn the knob , select“SEQ”, press  button to Enable the sequence test function, the screen displays the sequence test running screen;

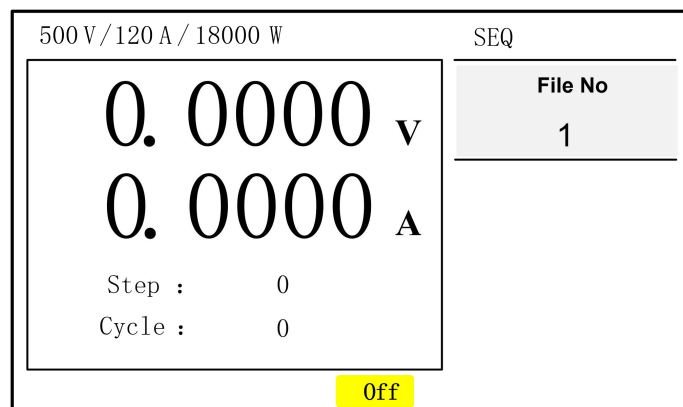


Photo 3- 14Sequence test running screen



3. select“File number”, press  button to put it into effect;



4. press  button to Start sequence testing.

screen“Step : ”The data is shown as the current running step of the sequence ,

“Cycle : ”The data shown are the number of sequence loop runs.

SEQ The output function enables more complex waveforms, such as the one described below, to be easily implemented using the sequence function.

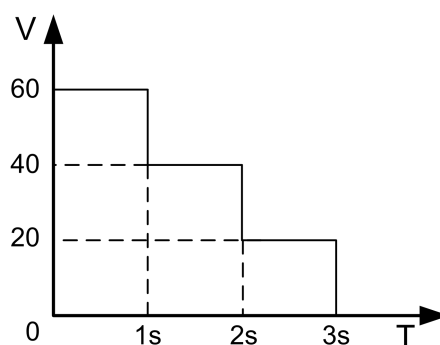


Figure 3-15 Sequence function Output waveform

Editing Procedure:

1. press  button, enter menu setting interface.
2. select "edit" -> "sequence file", press  button to Enter the sequence file selection screen.
3. Turn the knob or enter a number to select the file number you want to edit, press  button to Enter the Edit File screen.
4. After Enter the Edit File screen, set "Length of file" to 3, press  button to confirm, Automatically enter "Run Times" setting, set "Run times" to 1, press  button to confirm, Automatically enter "Link Sequence" setting, set "Link sequence" to 0, press  button to confirm, Automatically enter the "edit step".
5. Set "Edit Step" to 1, press  button to confirm, Automatically enter the "Voltage" setting, set the voltage value to 60V, press  button to confirm. Set the values of "source current", "source power", "load current", "load power" to the rated value of the device, and the value of "single step delay" to 1s as described above. After completion, it will automatically jump to the "Edit step".

and the step number will automatically add 1 to enter the second step of editing.

6. In turn, sets the "voltage" in step 2 to 40 v, "the source current", "power source", "current", "power", equipment ratings, "one-step delay" is set to 1 s. After completion, it will automatically jump to "Edit step" and the number of steps will be automatically increased by 1 to enter the third step of editing
7. In turn, sets the "voltage" in step 3 to 20 v, other remain unchanged. After the waveform editing is completed, press  button, Save the sequence file.
8. According to the above "Run sequence file" introduction, call the sequence file to run.

3.14. Waveform function(Wave)

FTB9000 series product support arbitrary waveform output function. Waveform files can be edited and downloaded by "FTB9000 demonstration software", and the files can be saved on the device for offline use. For details, see FTB9000 Demo Software Manual.

Call and run the waveform file:

1. press  button, Enter the Test function selection screen;
2. Scroll the knob, select "Wave", press  button, Enable the waveform function, the screen shows the Wave screen;

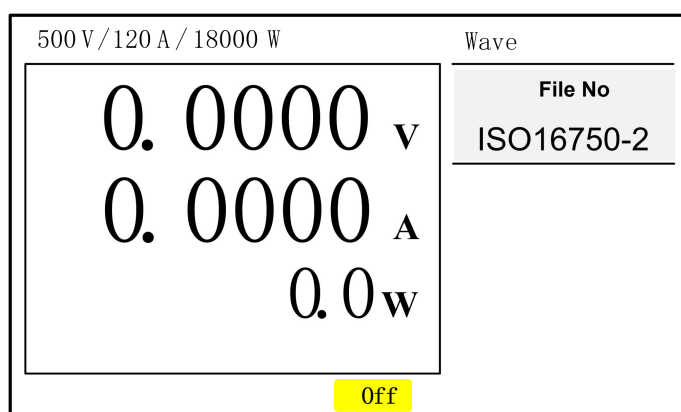


Photo 3- 16 Sequence test running screen

3. Scroll the knob, select "Wave", press  button, Enable the waveform function, the screen shows the Wave screen;



4. select "File number", press button to put it into effect
5. press button to Run the waveform file;
6. After the waveform file finishes running, the device enters the "Off" state.

3.15. Constant resistance function(CR)

FTB9000 series products as a regenerative load can not only achieve constant voltage, constant current, constant power, but also work in constant resistance mode.

In constant resistance mode, the set value of equipment resistance meets the following formula:

$$R_{\text{set}} = \frac{U_{\text{in}}}{I_{\text{in}}}$$

U_{in} :input voltage, I_{in} :input current, R_{set} :Resistance set value

Procedure of operation

1. press button, Enter the Test function selection screen;
2. Scroll the knob , select "CR", press button, Enable constant resistance function, the screen displays CR screen;

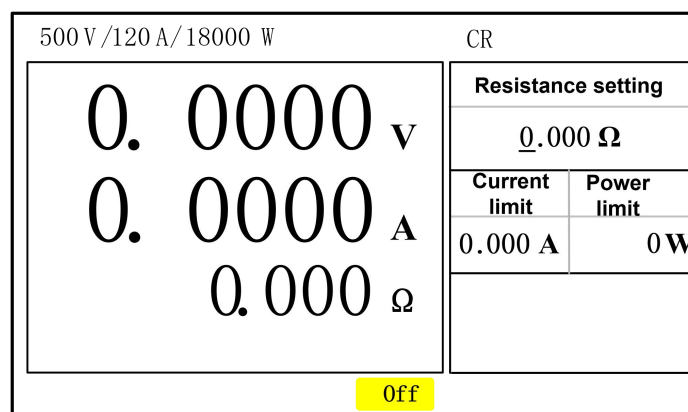


Photo 3- 17Constant resistance function parameter setting

3. Set CR test parameters;
4. press button to Turn on the output.

Table 3- 5Constant resistance function parameter description table

Parameter name	Description of parameters
Resistance setting	Resistance setting value, setting range: refer to Table 1- 1 FTB9000 Series specification sheet1, Table 1- 2Table 2.
current setting	Current limit value under CR function of the device, set the range from 0 to the maximum current
Power setting	Power limit value under CR function of the device, set the range from 0 to the maximum current

3.16. Voltage slow rise, slow drop function (RAMP)

FTB9000 series equipment supports the function of voltage slow rise and slow drop, which can realize the output voltage rise and fall according to the set slope. This function is suitable for use as a DC power supply.

Procedure of operation

1. press  button, Enter the Test function selection screen;
2. Scroll the knob, select "RAMP", press  button, Enter the "RAMP" function parameter setting screen as follows:

500 V / 120 A / 18000 W		RAMP	
0. 0000 V 0. 0000 A 0.0 W		Current setting	
		0.000 A	
		Power setting	Voltage A
		0W	0.000 V
		Voltage B	Voltage C
0.000V	0.000V		
UAB SLOPE		Ubc slope	
0.000V/s		0.000V/s	
Off			

Photo 3- 18 RAMP function parameters setting

3. Set the "RAMP" function parameters, the parameters are described in Table 3-6 voltage slow rise and slow fall function parameters;
4. press  button, Start "RAMP" function output.

Table 3- 6Voltage slow rise and slow fall function parameter description table

name		Parameter Description
Current setting		Output current value, range: 0 ~ maximum output current
Power setting		Output power value, range: 0 to the maximum output power
voltage a		Set the voltage value of point a, ranging from 0 to maximum output voltage
voltage b		Set the voltage value of point b, ranging from 0 to maximum output voltage
voltage c		Set the voltage value of point c, ranging from 0 to maximum output voltage
Voltage slope	ab	Set the voltage slope value from point a to point b, range: 0.0006V/s ~ 40000V/s, default: 10000V/s
Voltage slope	bc	Set the voltage slope value from point b to point c, range: 0.0006V/s ~ 40000V/s, default: 10000V/s

For example, to achieve a slow drop and slow rise waveform as shown below,

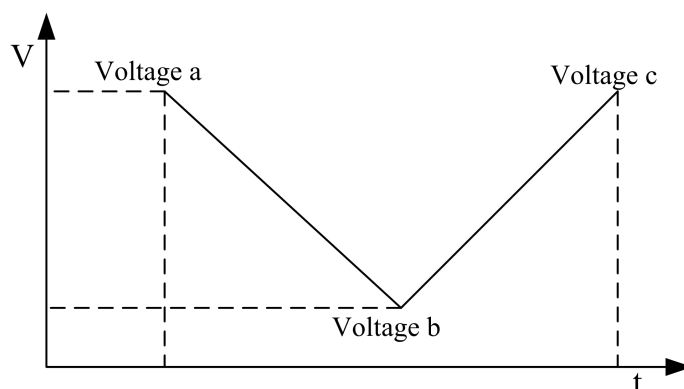


Photo 3- 19 RAMP Function parameter setting

Follow the above steps of RAMP function to enter the parameter setting interface. Complete the configuration of the voltage at each point and the slope value required by the voltage section, press again  button to perform.

3.17. Charging function (CHG)

FTB9000 series products can charge the battery and super capacitor products under the

working condition of DC power supply.

Procedure of operation

1. press  button, Enter the Test function selection screen;
2. Scroll the knob, select "CHG",press  button,Enter the "CHG" function parameter setting screen as follows:

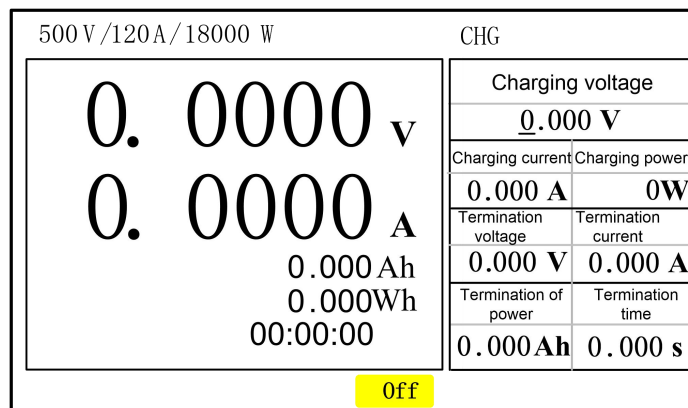


Photo 3- 20 Parameter setting of charging function

3. In addition to the display of voltage and current in the echo area, Ah (amp-hour), Wh (watt-hour) and time display are also added.
4. Set "CHG" function parameters, parameters are described in Table 3-7 charging function parameter description table;
5. press  button Turn on charging , press again  button ,will Stop charging。

Table 3- 7 Charging function parameter description

name	Description of parameters
Charging voltage	Charging voltage setting value, range: 0 ~ maximum voltage value
Charging current	Charging current set value, range: 0 ~ maximum current value
Charging power	Charging power setting value. Range: 0 to maximum power
Termination voltage	When charging is completed, judge the voltage value, range: 0 ~ maximum voltage value
Termination	Charging complete judgment of current value, range: 0

current	to the maximum current value
Termination electricity	The charging is completed to determine the electricity value, range: 0 ~ 99999Ah
Termination time	Charging complete judgment time value, range: 0 ~ 99999 s

Note:

1. Charging completion judgment conditions such as "termination voltage", "termination current", "termination quantity", "termination time" if one of the conditions is reached, the charging will be terminated.
2. In order to facilitate customers to obtain the total charge and time of multiple charging, the charge and time will not be cleared at the beginning of the next charging after the completion of charging. Customer can according to the need, press the button to zero power and time value.

3.18. Discharge function (DSIC)

FTB9000 series products not only have the function of charging, but also can be used to discharge the battery, super capacitor and other products.

Operation steps:

1. press  button, Enter the Test function selection screen
2. Scroll the knob , select "DISC" , press  button, enter "DISC" functional parameters setting interface as following :

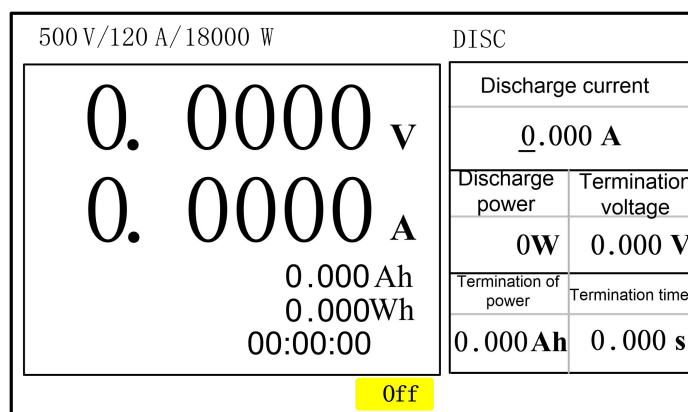


Photo 3- 21 Discharge function parameter setting

In addition to the voltage and current display, the echo area also adds Ah (amper hour), Wh (watt hour), and time display.

5. Set the "DISC" function parameters, and the parameters are described in Table 3-8 discharge function parameter description table;
6. press  button to Turn on charging, press  button again, will Stop the discharge and zero the power and time at the same time.

Table 3- 8 Discharge function parameter specification table

name	Description of parameters
Discharge current	Discharge current value, range: 0 to the maximum current value
Discharge power	Discharge power value, range: 0 ~ maximum power value
Termination voltage	Discharge completed to determine the voltage value, range: 0 to the maximum voltage value
Termination electricity	Discharge completed judgment power value, range: 0 ~ 99999Ah
Termination time	Discharge completion judgment time value, range: 0-99999s

Note:

1. Discharge completion judgment conditions such as "termination voltage", "termination power", "termination time" if one of the conditions, will end the discharge.
2. In order to facilitate customers to obtain the total charge and time of multiple discharges, the charge and time will not be cleared at the beginning of the next discharge after the completion of the discharge. Customer can according to the need, press the button to zero power and time value.

3.19. Output timing

FTB9000 series products provide start output time recording, by pressing

 +  or  button, Switch to the display area as shown below:

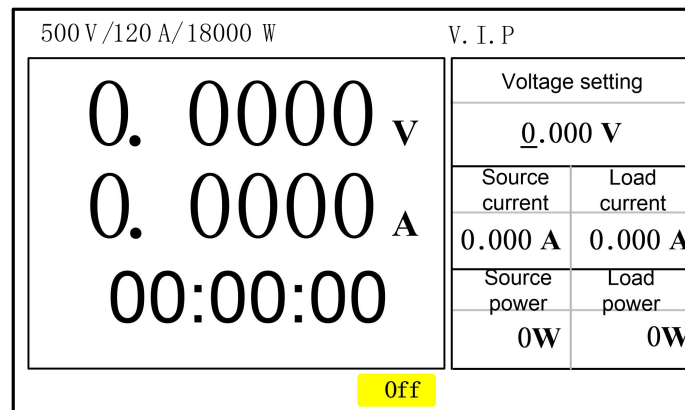


Photo 3- 22 Output timing display screen

Press  button, Time can be reset to zero.

3.20. Master/slave parallel function

3.20.1. Master/Slave Parallel connection

FTB9000 series devices provide master/slave parallel mode, so that users can achieve more power expansion of the same model.

The user connects the "Share" signal interface in the rear panel, the "RS485" parallel communication interface in the composite signal port, and the positive and negative output poles according to the "Figure 3-19 master-slave Parallel Connection", and then performs the corresponding configuration of the device to realize the master-slave parallel function. The operation of the device after the master-slave parallel connection is as good as that of a single machine.

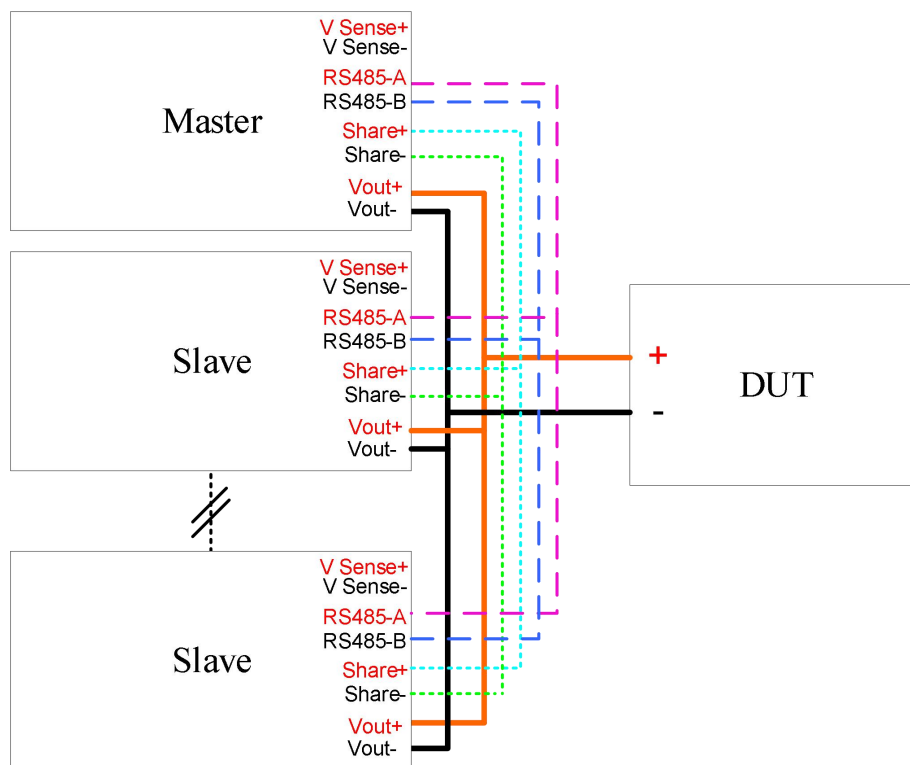


Figure 3- 23Master/slave parallel connection

Master/slave parallel signal cable requirements

Composite signal port parallel communication line RS485, parallel interface line Share: can use $0.5\text{mm}^2 \sim 1\text{mm}^2$ cross-sectional area, twisted pair.

Master/slave parallel connection Note:

1. The master-slave parallel machine only supports the parallel connection of the same type of equipment.
2. The maximum number of parallel machines is 10.
3. If you need to use the voltage compensation line loss function after the master and slave are combined, you only need to operate the Vsense port of the host.
4. Master-slave series is not supported.

3.20.2. Master/Slave Parallel setting

Slave machine setting

1. press  button, enter menu setting interface;
2. select "setting" -> "Parallel machine", press  button, Pop up the master and slave parallel machine setting interface;
3. The "Master and Slave Settings" option is set to "Slave1" or "Slave2", etc. Each number corresponds to one slave device and cannot be repeated. If there is only one slave, the slave number must be set to "Slave1". If there are two slave machines, one of them must be set to "Slave1", and the other one must be set to "Slave2" and so on. otherwise the communication will fail.

The device is set as a slave, and the screen will automatically hide the unnecessary configuration items after returning to the main interface.

Host Settings

Setting	System	Editting	About
Master-slave setting	Master		
Number of slave machines	1		
Master-slave control	Close		

Photo 3- 24 Master/slave parallel setting

1. press , Enter the menu setting interface;
 2. select "setting" -> "Parallel machine", press , Pop up the master and slave parallel machine setting interface;
 3. Set "Master/Slave Settings" to Master.
 4. The "number of slave machines" option is set to the actual number of slave machines;
- "Master and Slave Control" option is set to "On"

After setting parallel parameters, press  to Return to the main screen. At this time, the host model and parameters will be updated to the new model after the parallel machine.

3.20.3. Master/Slave parallel operation

After the master/slave parallel function is set for FTB9000 series devices, you only need to operate the host to control the whole device.

After both master and slave systems are enabled, all protection functions still take effect. When one of them is protected, the system will automatically shut down all device outputs. The slave displays the specific fault information, and the host displays the fault information of the host and the fault slave code, as shown in the following figure:

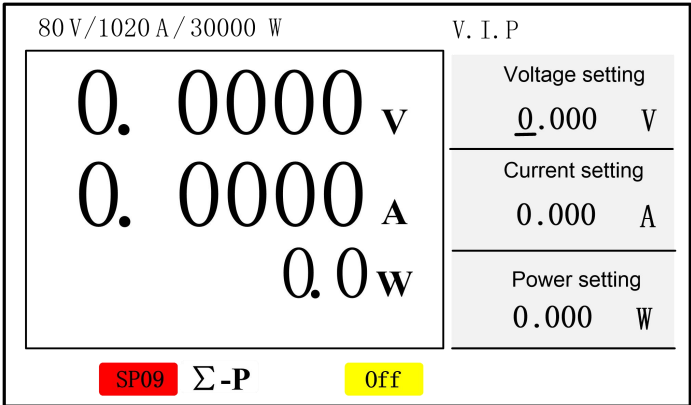


Photo 3- 25The host display screen

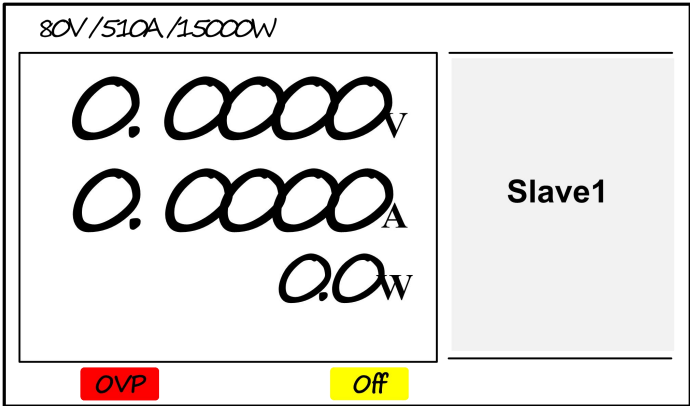


Photo 3- 26Slave machine display screen

When the slave machine is protected, press  key on the slave machine and the host to clear the fault. If only the host is faulty, just press the  key on the host to clear the fault. The following table lists the protection and failure situations that can occur in master-slave parallel applications.

Table 3-7 Master - slave parallel machine protection instructions

Protection display	instructions
Σ -P	Parallel communication is normal, and there is no flashing black characters on white background in the host interface
Σ -P	The parallel communication is abnormal, and the host interface is flashing red and black characters
SP01 ~ SP09	Indicates the number of the slave machine that failed and  needs to be operated, Clear the fault.

Notes on master-slave parallel operation:

1. Set the Settings on the slave server first and then the host to avoid communication failures on the host.
 2. If multiple devices are set as hosts and the parallel function is enabled, the parallel operation fails.
 3. If the signal cable of the Share port of the slave machine is not connected or falls off during the parallel operation, the model and parameters will be updated according to the number of slave machines after the parallel function is enabled, but the actual output will be inconsistent with the setting of the host machine due to the fault of the Share signal cable.
 4. The external programming function of the host is effective for the whole host.
 5. After the device is set to the slave device, the protection value in the Protection Settings item will be cancelled. During recovery, the user needs to reset.
 6. Do not parallel devices of different models. Otherwise, damage may occur.
-

3.21. Photovoltaic simulation(optional)

The photovoltaic simulation can be simulated output I-V curve of solar panels, is used for researching and product test of solar inverter. Built in Sandia, EN50530 standard raw, can test static and dynamic MPPT of solar inverter. The PV function only support static curve test, it has more function test with upper computer software, example for dynamic MPPT, typical weather data, customize illuminance/temperature curve and statements etc.

The advantages of FTB9000 include high accuracy and fast speed, which can improve the simulation accuracy of I-V curves and improve the accuracy of measuring MPPT.

The upper computer software has up to 100 photovoltaic files edited, each of them supports voltage Vmp of maximum power point, power Pmp of maximum power point, and fill factor parameters. Users can also edit the IV curve by defining the open circuit voltage Voc, short circuit current Isc, maximum power point voltage Vmp, and maximum power point current Imp. Built in various typical weather data, such as Cloud day, Cold day, Hot day etc. Equipped with data recording function, it stores the data of the inverter tracking process for easy calculation and analysis.

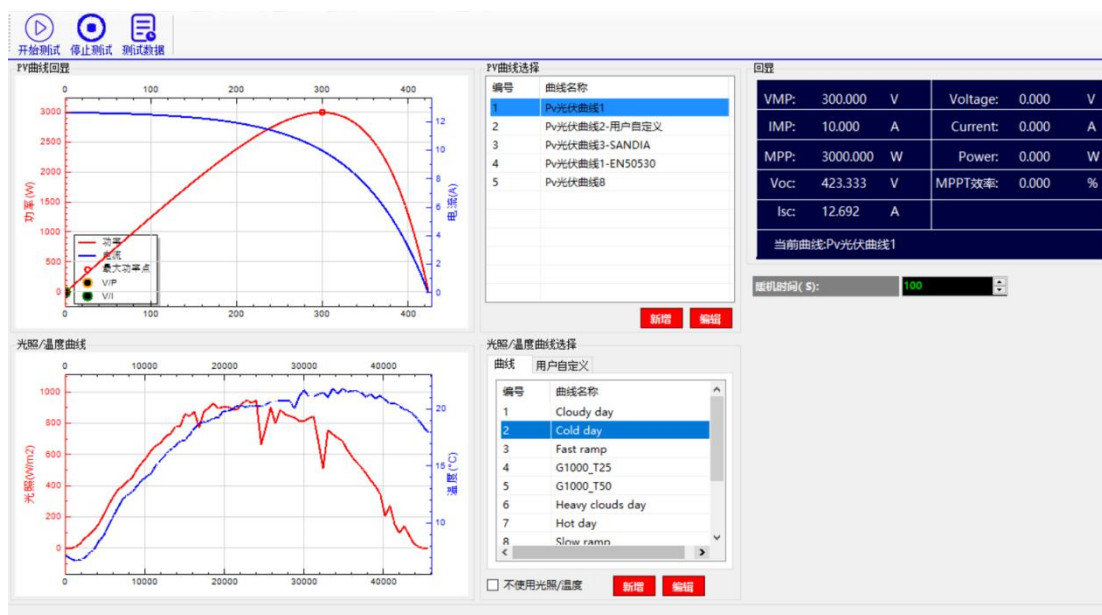


Figure 3- 23 Photovoltaic interface for upper computer

Figure 3- 8 Table of Photovoltaic Curve Parameters

Parameter	Description
File number	File number for photovoltaic running,range 1~20。

PMP	Max power of photovoltaic curve,range 0~Max source power.
VMP	Voltage for Max power of photovoltaic curve,range 0~Max voltage.
Raw	Support SANDIA and EN50530。
Material	SANDIA option material include TF,SCMC,HEC; EN50530 option material include TF,CSI。

Edit photovoltaic file

1. Press button  , enter menu set,
2. Select“Edit”->“photovoltaic file”, press button  to enter option interface of photovoltaic file;
3. Turning the knob or press digital key, select edited file number you want,press  button to enter the edit file interface;

Set	System	Edit	About
PMP	0W	VMP	600 V
Law	SANDIA		
Material	TF		

Figure 3- 24 Edit interface for photovoltaic file

4. Set“PMP”, press button  to confirm,move the edit cursor to next“VMP”;
5. Set“VMP”, press button  to confirm,move the edit cursor to next“Law”;
6. Set“Law”, press button  to confirm, move the edit cursor to next“Material”;

- 7. Press button  , save the photovoltaic curve file edited;
- 8. Press button  , exit edit interface of photovoltaic file.

Caution: Don't allow to edit photovoltaic file when device is turning on.

Running photovoltaic simulation mode

Menu setting and Operating setting of photovoltaic simulation mode:
Select user photovoltaic running type as below:

- 1. Press button  to enter Menu setting interface,select application setup of set option;
- 2. Application setup->photovoltaic mode,press button  and scroll the knob to select configuration option you need, Curve or user Define.

Operating step

- 1.Press button  to enter test option interface;
- 2.Scroll the knob,select“PV-SIM”, press button  to enter“PV-SIM”User defined function parameter settings interface as below:

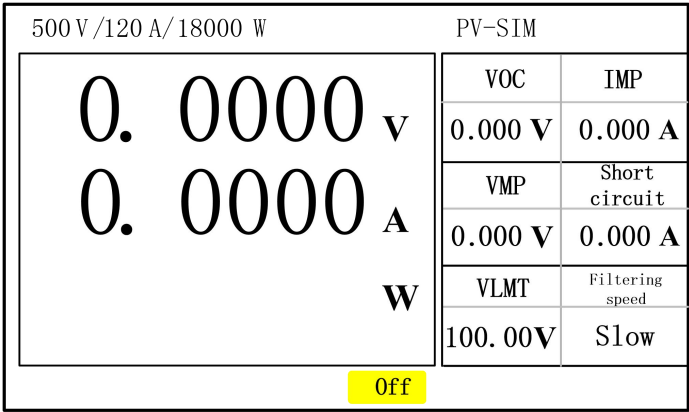


Figure 3- 25 Customized edit interface for photovoltaic file

- 3. Set“PV-SIM”function parameters, detail as figure3- 9 customized parameter list of photovoltaic function;

4. Press button  to start charging, press button  again to stop discharge, clear capacity and time meantime.

Figure3-9 Customized parameter list of photovoltaic function

Parameter	Description
VOC	Setup value of open circuit voltage, range: 0 ~ max voltage
IMP	Current set value for Max power, range: 0 ~ Max current
VMP	Voltage set value for Max power, range: 0 ~ Max voltage
Short-circuit current	range: 0 ~ Max current
VLMT	range: 0 ~ Max voltage
Filtering speed	range: Slow(slow), MIDD(middle), Fast(fast)

Figure3-10 Curve mode parameter list of photovoltaic function

Parameters	Description
File number	Running file number, range: 1 ~ 20
VLMT	Range: 0 ~ Max voltage
Filtering speed	Range: Slow(slow), MIDD(middle), Fast(fast)

3.22. Battery simulation (BATT-SIM)

There is a certain relationship between the battery's SOC, open circuit voltage, and internal resistance: The larger the SOC, the higher the open circuit voltage of the battery and the smaller the internal resistance of the battery; The smaller the SOC, the lower the open circuit voltage of the battery and the greater the internal resistance of the battery. Charging the battery increases SOC, discharging the battery reduces SOC.

The FTB9000 has a unique current bipolar design that can simulate the charging and discharging characteristics of batteries for various tests. Users need to edit the battery file under the battery simulation function. The battery file mainly describes the characteristic curves of battery capacity, open circuit voltage, and battery internal resistance. Enabling the battery simulation function, the FTB9000 will absorb current (charging) or output current (discharging) based on external load conditions, adjusting the output voltage to match the characteristic curve specified in the file meantime.

Figure3-11 Battery file parameters list

Parameter	Description
File number	Range 1~20
File length	Points of single battery characteristic curve
Discharge limit	Max discharge current for battery pack
Charge limit	Max charge current for battery pack
Paralleling number	Battery paralleling number
Series number	Battery series number
Edit step	Select which point to edit the battery characteristic curve
Capacity	Battery capacity at a specific point on the characteristic curve, 0~999999Ah
Voltage	Open circuit voltage of the battery at a specific point on the characteristic curve
Internal resistance	Internal resistance of the battery at a specific point on the characteristic curve, unit mΩ

Edit battery file

1. Press button  to menu interface;

2. Select "Edit" -> "Battery file", press button  to enter battery file option interface;

3. Scroll the knob or enter digital key, select file number you want to edit, press

button  to enter edit file interface;

Setting	System	Edit	About
File length	20		
Discharge limit	40.800 A	Charge limit	40.800 A
Paralleling number	1	Series number	1
Edit step	1	Capacity	0.000 Ah
Voltage	0.000 V	Internal resistance	0.000 mΩ

Figure 3- 26 Battery file edit interface

4. Set“File length”, it indicates points of battery characteristic curve;
5. Set“discharge limit”,it indicates Max discharge current for battery pack;
6. Set“charge limit”, it indicates Max charge current for battery pack;
7. Set“Paralleling number”, it indicates battery paralleling number;
8. Set“Series number”, it indicates series number of battery;
9. Set“Edit step”,Select to edit a specific point of the feature curve;
10. Set“Capacity”, it indicates battery capacity of specific point of the feature curve,unit Ah;
11. Set“voltage”, it indicates open circuit voltage of specific point of the feature curve, unit V;
12. Set“internal resistance”, it indicates battery internal resistance of specific point of the feature curve,unit mΩ;
13. After finishing the edit step,press button  to save battery file.

Caution:

- 1.Don't allow to edit battery files when the device is turned on.
- 2.The first step of the editing step corresponds to the first point of the feature curve (SOC minimum), and the last step corresponds to the last point of the feature curve(SOC 100%)
- 3.When selecting the editing step, follow the order from small to large, and correspondingly, when setting capacity, voltage, and internal resistance, it should also correspond to the editing step.The larger the editing step, the larger the capacity, the higher the voltage, and the smaller the internal resistance.

Run battery simulation

- 1.press button  to test option interface;
- 2.Turning the knob,select“BATT”, press button  to battery simulation;

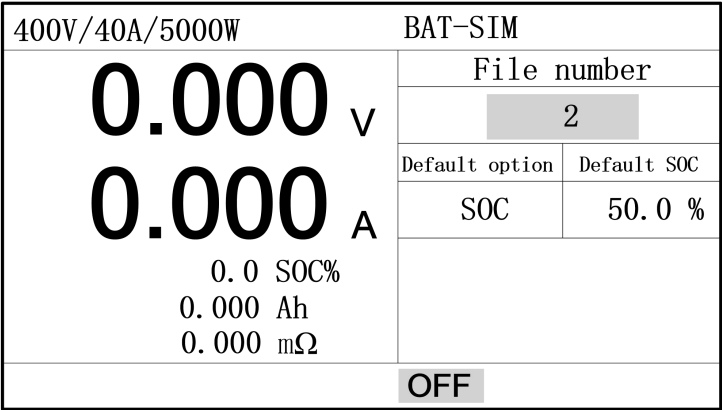


Figure 3- 27 Running interface for battery simulation

3. Set“BAT-SIM”parameter,include“file number”,“Default option”etc;
4. Press button  to start or end the test.

Figure3-12 Parameter for battery simulate

Parameter	Description	
File number	Select battery simulation file,range:1~20	
Default option	Optional SOC、 VOLT、 CAP	
Default SOC	Range 0~100	
Default voltage	Default open voltage	
Default capacity	Range 0~999999Ah	

4. Communication

FTB9000 series devices provide users with five kinds of communication interfaces. Standard USB (serial port), LAN (Ethernet), optional GPIB or CAN, RS485 communication interface. The communication protocol supports standard Modbus and SCP. The default is Modbus. Users can select communication interfaces and protocols as required.

4.1. Communication configuration

1. Press  , Enter the menu setting interface;
2. select“setting”->“system”->“Communication setting” , Press  ,Pop-up system parameter Settings interface;

Setting	System	Editing	About
IP address	192. 168. 1. 123		
Subnet mask	255. 255. 255. 0		
Serial port speed	9600		
Mode of verification	No check	Communication protocol	MODB
Device address	160		
GPIB Address	5		

Photo 4- 1Communication parameter setting interface

3. For LAN communication, the default "IP address" is 192.168.1.123, and the default "subnet mask" is 255.255.255.0. Secondly, it is necessary to set the IP address of the computer network connected to it and the IP address of the device in the same network segment, different IP address, otherwise it will lead to unsuccessful communication. For example, the computer network IP address is set to 198.168.1.100.
4. USB serial port communication needs to set the "serial port rate", the default is 9600, support 4800, 9600, 19200, 38400, 115200 Settings. The default of "Check mode" is "no check".
5. Set Serial Port Rate for the RS485 communication. The default value is 9600, which can be set to 4800, 9600, 19200, 38400, and 115200. The default of "Check mode" is "no check". Device Address defaults to 160 and ranges from 0 to 254.
6. Set Device Address for CAN communication. The default value is 160, which ranges from 0 to 254.
7. Set GPIB Address for GPIB communication. The default value is 5, ranging from 0 to 30.
8. Communication protocol can be set, supporting Modbus or SCPI.

Note: The modification takes effect only after the device is restarted.

4.2. Voltage and current acquisition rate

After the above communication configuration is completed, if the user needs to improve the speed of communication and acquisition of device parameters, the configuration can be as follows:

1. press  button, Enter the menu setting interface;

2. select "setting" -> "application setting", press  button to pop up application setting screen;

Setting	System	Editing	About
Sampling rate	10Hz		
Output first	VOLT	Load current	☒ 2000.0 A/s
Voltage ☒	10000.0 V/s	Load current	☒ 2000.0 A/s
Voltage ☐	10000.0 V/s		
Source current ☒	2000.0 A/s		
Source current ☐	2000.0 A/s		

Photo 4- 2Application Setting Interface

3. In Sampling Rate, select the required communication rate. Step 5 is optional.
The default value is 10Hz.

4.3. Communication interface

4.3.1. USB (serial port)

FTB9000 provides a USB virtual serial port communication, compatible with WindowsXP/7/8/10 and other operating systems, the specific driver and installation instructions, please see "CD and PC user manual".

The default rate of virtual serial port is 9600bps. The check mode is None, and the flow control mode is not supported.

Using USB-B port, users can use random distribution of USB communication cable, easy

connection with PC USB port. Its pin signal is described in the following table.

Table 4- 1 USB interface signal

Pin NO.	Description
1	5V equipment
2	Data-
3	Data+
4	GND

4.3.2. LAN

The FTB9000 series devices have Ethernet communication interfaces and adopt UDP communication mode. The default IP address is 192.168.1.123, subnet mask is 255.255.255.0, the default TCP/IP port number is 502 and UDP port number is 7000.

Note: Before communication, ensure that the IP addresses of the PC and the device are in the same network segment, and ensure that there are no duplicate IP addresses with the device in the network segment; otherwise, the connection fails.

4.3.3. CAN

The CAN interface is fixed with 500kbps communication speed, and the communication address can be set from 0 to 255.

Note: CAN interface is fixed using CANOpen communication protocol.

CAN communication connection is shown below:

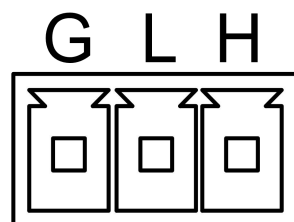


Photo 4- 3 CAN Communication connection

4.3.4. RS485 interface

The configuration of the RS485 port is the same as that of the USB serial port. You can configure the baud rate and verification mode in Figure 4-1 Communication Parameter Settings. The connection is as follows:

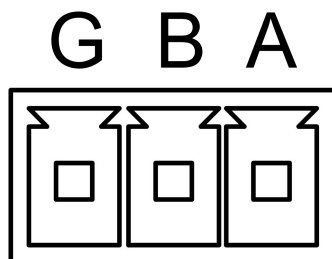


Photo 4- 4 RS485Communication connection

4.4. Communication protocol

FTB9000 series devices support SCPI, Modbus and CANopen communication protocols. For LAN, USB serial port, RS485 interface users can choose SCPI or D; The GPIB interface supports only SCPI protocol, and the CAN interface supports only CANopen protocol.

4.4.1. SCPI protocol

Standard Commands for Programmable Instruments (Programmable Instruments) Standard Command set. SCPI is a standard instrument programming language based on the existing standards IEEE488.1 and IEEE 488.2, and follows the floating-point arithmetic rules of IEEE754 standard, ISO646 information exchange 7-bit coding symbol (equivalent to ASCII programming) and other standards. It adopts a set of commands with hierarchical structure in tree structure, puts forward a universal instrument model, and adopts signal-oriented measurement. Its mnemonic generation rules are simple, clear and easy to remember.

Device commands include two types: IEEE488.2 public commands and device-specific SCPI commands.

IEEE 488.2 Common Commands define some control and query commands common to instrumentation. You can use common commands to perform basic operations on the device, such as reset and status query. All IEEE 488.2 public commands consist of "" and a three-letter mnemonic such as: *RST, *IDN? , *ESE? And so on.

The SCPI command implements most of the test, setup, calibration, and measurement functions on the device. Such commands are organized as command trees. Each command can contain multiple mnemonics, and the nodes of the command tree are separated by the character ":", as shown below. The "ROOT" at the top of the command tree is called "root". The

full path from the root to the leaf is a complete programming command.

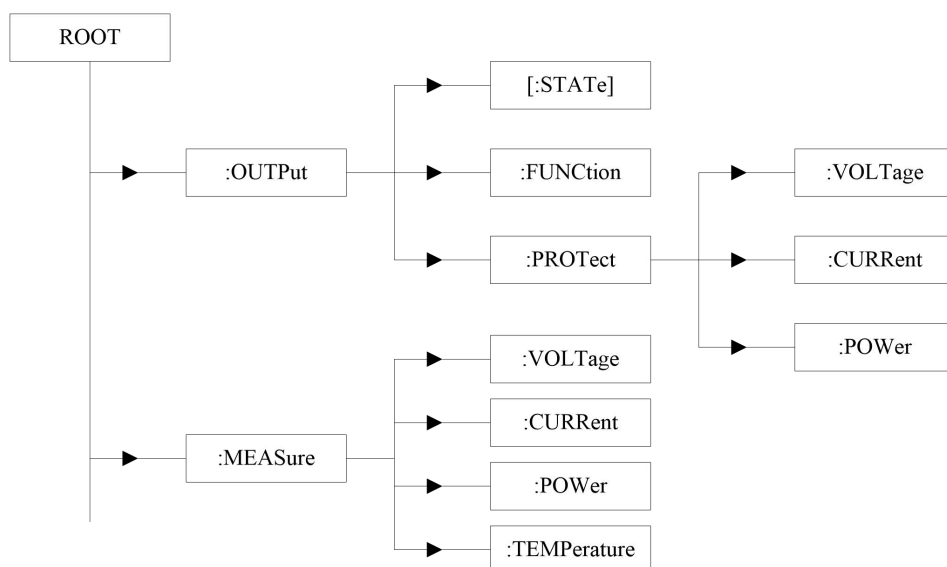


Photo 4- 5 SCPI command tree

For details about the SCPI protocol, refer to the FTB9000 Programming Manual SCPI Edition.

4.4.2. Modbus protocol

Modbus is a serial communication protocol that was published by Modicon (now Schneider Electric) in 1979 for communication using programmable logic controllers (PLC). Modbus has become an industry standard for communication protocols in the industrial field and is the common way to connect industrial electronic devices. Modbus protocol is a master/slave architecture protocol. One node is the master node, and the other nodes that use Modbus protocol to participate in communication are slave nodes. Each slave device has a unique address. Only nodes designated as master nodes can start a command.

A Modbus command contains the Modbus address of the device to be executed. All devices will receive the command, but only the device with the specified address will execute and respond to the command (except for address 255, where the command is broadcast and all devices that receive the command will run, but do not respond to the command). All Modbus commands include a check code to ensure that the arriving command is not corrupted. Basic Modbus commands can direct a device to change its register value, control or read an I/O port, and direct the device to send back data from one or more registers.

Note: FTB9000 series devices only support RTU communication mode.

For details about Modbus protocol, please refer to FTB9000 Programming Manual Modbus Edition.

4.4.3. CANopen protocol

CANopen is a high-level communication protocol on Controller Area Network (CAN), including communication sub-protocol and equipment sub-protocol. It is a field bus commonly used in industrial control. CANopen implements protocols above and including the network layer in the OSI model. The CANopen standard includes an addressing scheme, several small communication sub-protocols, and an application layer defined by a device sub-protocol. CANopen supports network management, device monitoring, and inter-node communication, including a simple transport layer that handles the segmented transmission of data and its combination. Generally speaking, the data link layer and the physical layer will be implemented by CAN.

Note: The CANopen protocol is optional

For details of CANopen protocol, please refer to FTB9000 Programming Manual CANopen Edition.

5. Check the fault

If the device does not work properly, check and rectify the fault according to the description in this section. If the problem still cannot be solved, please contact the agent or Faith Technology after-sales service.

Table 5- 1 Fault self-check table

Problem	Possible reasons	Solution
Measurement accuracy is not within the specification range	Device aging causes characteristic deviation	recalibrate
Output accuracy is not within the specification range	Device aging causes characteristic deviation	recalibrate
PMF Fault	1. power grid is lower than the requirements of the device 2. device PMF is triggered by a power failure	1. Check whether the power grid is normal; 2. PMF fault triggered by power failure can be ignored.
Over temperature protection OTP	1. environment temperature is too high 2. Poor ventilation 3. Fan damage	1. Place the instrument in the environment of 0 ~ 40℃; 2. Improve ventilation of the machine; 3. press  Clear the fault.
Over power protection OPP、OP	output power exceeds the setting	1. Reduce the load or increase the OPP setting; 2. press  Clear the fault.
Over current protection OCP、OC	output current exceeds the setting	1. Reduce the load or increase the OCP setting; 2. press  Clear the fault.
Over voltage protection OVP、OV	output voltage exceeds the setting	1. Decrease the output or increase the OVP setting; 2. press  clear the fault.

Table 5- 2 Startup fault self-check

Problem	Reasons	Solution
The PRI Fault...Error!	Abnormal internal communication	Please consult Faithtech after-sales
Test sample.Error!	The power module is abnormal	
Loading calibration data. Error!	Abnormal sampled data	
Loading parameters. Error!	Failed to load calibration data	
	Failed to load system parameters	

6. Appendix

Table 6- 1(Recommended wire diameters)

Model	Cross-sectional area	Different temperature conditions			
AWG	mm ²	60℃	75℃	85℃	90℃
		Wire type: RUW,T,UF	Wire type: RHW,RH	Wire type: V,MI	Wire type: TA,TBS,SA,AV
		Rated Power (unit: A)			
14	2.08	20	20	20	20
12	3.31	25	25	30	30
10	5.26	30	35	40	40
8	8.36	40	50	55	55
6	13.3	55	65	70	75
4	21.1	70	85	95	95
3	26.7	85	100	110	110
2	33.6	95	115	125	130
1	42.4	110	130	145	150
0	53.5	125	150	165	170
00	67.4	145	175	190	195
000	85	165	200	215	225
0000	107	195	230	250	260