Faithtech

Wide Range High Power
bidirectional programmable
DC Power Supply

Modbus Communication Protocol

(FTB9000 Series)

Version V1.00

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Version revision record

Date	Vision	Revised Chapters
July,2023	1.00	Complete this Manual

Menu

1. Modbus Description

The FTB9000 series power supply supports Modbus protocol.

1.1. Frame Format

1.1.1. Modbus RTU

For serial communication (such as RS232), Modbus messages are transmitted in RTU mode, with the format as below.

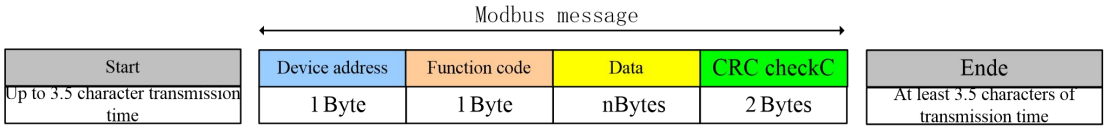


Figure 1-1 RTU frame format

Device Address: Modbus communication address,range 1～247;

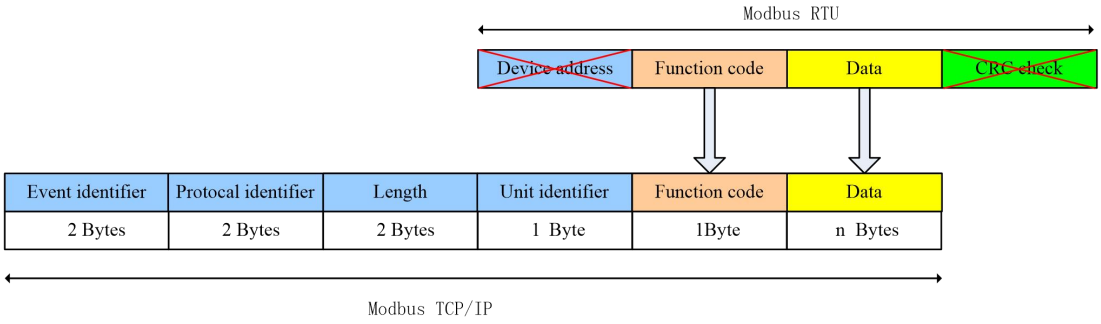
Function code:Request to perform certain operations, such as reading registers, writing registers, reading block data etc;

Data:describe the specific information of the operation, such as the starting address of the read register and the number of read registers;

CRC check: calculate CRC check result of “Device Address”、“Function code”、“Data”.

1.1.2. Modbus TCP

Modbus TCP is derivative of Modbus series communication protocol,it enable Modbus_RTU to running in Ethernet.Modbus TCP communication message are encapsulated in Ethernet TCP/IP packets.Compared to traditional serial port methods, Modbus TCP inserts a standard MODBUS message into the TCP message without data checksum and address.



Figure

1-2 Modbus TCP message

Modbus TCP data frame contain 3 parts of MBAP message header,function code and data.

MBAP message header contain the information as below.

Domain	length	Description	Client	Server
Transaction identifier	2Byte	Request/answer ID of the Transaction processing	Client start	Server replicates from received requests
Protocol identifier	2Byte	0=MODBUS protocol	Client start	Server replicates from received requests
Length	2Byte	The number of bytes as below	Client start （request）	Server(response） startup
Unit identifier	1Byte	The identification code of a remote slave station connected on a serial link or other bus	Client start	Server replicates from received requests

Modbus TCP communicates via 502 registration terminal.

1.1.3. Modbus UDP

The power supply support Modbus communication transmission by UDP,it directly encapsulates Modbus RTU frames in Ethernet UDP/IP packets.

Modbus UDP uses port 7000 for communication transmission.

1.2. Function Code

The FTB9000 supports read register and write register operation， other function codes are customized.

1.2.1. 03(0x03)Read Register

The function code is used for reading several register continuously.

Due to the system use 32-bit register design, so the numbers of read registers must be a multiple of 2.

Request

Function code	1Byte	0x03
Start address	2Bytes	0x0000～0xFFFF
Register number	2Bytes	

Answer

Function code	1Byte	0x03
Returns the number of bytes	1Byte	2×N
Register value	N×2Bytes	value

Error

Error code	1Byte	0x83
Exception code	1Byte	01/02/03/04

Exception code description

Error code	Description
0x01	Unsupported function code
0x02	Register address out of range
0x03	Register number out of range
0x04	Read fail

Example

Request		**Response**	
Field	**Hex**	**Field**	**Hex**
Device Address	A0	Device address	A0

Function code	03	Function code	03
Register Address（high Byte）	00	Byte numbers	04
Register Address（low byte）	08	Register value（high byte）	81
Register numbers(high Byte）	00	Register value	00
Register numbers（low byte）	02	Register value	00
CRC check（low byte）	5C	Register value（low byte）	00
CRC check（high Byte）	B8	CRC check（low byte）	62
		CRC check（high Byte）	C5

1.2.2. 16(0x10)Write Register

The function code is used for writing several register continuously.

Due to the system use 32-bit register design, so the numbers of register that limit the function frame must be 2.

Request

Function code	1Byte	0x10
Start address	2Bytes	0x0000～0xFFFF
Register numbers	2Bytes	2
Byte numbers	1Byte	4
Register value	4Bytes	value

Answer

Function code	1Byte	0x10
Start address	2Bytes	0x0000～0xFFFF
Register numbers	2Bytes	2

Error

Error code	1Byte	0x90
Exception code	1Byte	01/02/03/04

Exception code description

Exception code	Description
0x01	Unsupported function code
0x02	Register address out of range
0x03	Register numbers out of range or byte numbers error, or register value error
0x04	Write failure

Example：

Request		Response	
Field	**Hex**	**Field**	**Hex**
Device Address	A0	Device Address	A0
Function code	10	Function code	10
Register Address（high Byte）	00	Register Address（high Byte）	00
Register Address（low Byte）	1C	Register Address（low Byte）	1C
Register numbers(high Byte）	00	Register numbers(high Byte）	00
Register numbers(low Byte）	02	Register numbers(low Byte）	02
Byte numbers	04		99
Register value（high byte）	00		7F
Register value	00		
Register value	00		
Register value（low byte）	01		
CRC check（low byte）	35	CRC check（low byte）	
CRC check（high byte）	C8	CRC check（high byte）	

1.2.3. 65(0x41)Read register range

The function is used for reading setting range of 32bit register.

Request

Function code	1Byte	0x41

Register address	2Bytes	0x0000～0xFFFF

Answer

Function code	1Byte	0x41
Parameter setting (low limit)	4Bytes	
Parameter setting (high limit)	4Bytes	

Error

Error code	1Byte	0xC1
Exception code	1Byte	01/02/04

Exception code description

Exception code	Description
0x01	Unsupported function code
0x02	Register Address out of range
0x04	Read failure

For example

Request		**Response**	
Field	**Hex**	**Field**	**Hex**
Device address	A0	Device address	A0
Function code	41	Function code	41
Register address(high byte)	00	Low limit of parameter setting	00
Register address(low byte)	36	（high byte）	00
CRC check（low byte）	F2	Low limit of parameter setting	00
CRC check（high byte）	26	Low limit of parameter setting	00
		Low limit of parameter setting	00
		（low byte）	00
		High limit of parameter	00
		setting（high byte）	04
		High limit of parameter	4B

		setting High limit of parameter setting High limit of parameter setting（low byte） CRC check（low byte） CRC check（high byte）	15

1.2.4. 66(0x42)Reading block data

The function code is used to read the character information of the device,example for read model,software vision etc.

Request

Function code	1Byte	0x42
Block data address	2Bytes	String address

Answer

Function code	1Byte	0x42
Number of characters	1Byte	
string	NBytes	

Error

Error code	1Byte	0xC2
Exception code	1Byte	01/02/04

Exception code description

Exception code	Description
0x01	Unsupported function code
0x02	Address out of range
0x04	Read failure

Example

Request		**Response**	
Field	**Hex**	**Field**	**Hex**
Device address	A0	Device address	A0
Function code	42	Function code	42

Structure data address（high byte）	00	Character numbers	05
	03	Block data	46
Structure data address（low byte）	C2	Block data	61
	31	Block data	69
CRC check（low byte）		Block data	74
CRC check（high byte）		CRC check（low byte）	68
		CRC check（high byte）	48
			E3

1.2.5. 68(0x44)Reading structure data

This function code is used to read various structural data of the device,example for read sampling FIFO.

Request

Function code	1Byte	0x44
Start address	2Bytes	Structure address

Answer

Function code	1Byte	0x44
Byte numbers	2Bytes	
Byte sequence	NBytes	

Error

Error code	1Byte	0xC4
Exception code	1Byte	01/02/04

Exception code description

Exception	Description
0x01	Unsupported function code
0x02	Address out of range
0x04	Read failure

Example:

Request		**Response**	
Field	**Hex**	**Field**	**Hex**

Device address	A0	Device address	A0
Function code	44	Function code	44
Structure data address（high byte）	00	Byte numbers（high byte）	03
	00	Byte number（low byte）	24
Structure data address（low byte）	62	data	00
	31	……	69
CRC check（low byte）		……	74
CRC check（high byte）		data	9A
		CRC check（low byte）	8C
		CRC check（high byte）	FE

2. Address list

2.1. Register address

FTB9000 power supply register as below.

Table 2-1 bidirectional power register

Address	Name	Read Write	Data type	Range	Description
0	Self-check procedure	OR	int		
2	Self-check status	OR	int		
4	Self-check result	OR	int		
6	Status register2	OR	int		
8	Status register1	OR	int		access by bit
10	Echoed voltage	OR	float		Unit V
12	Echoed current	OR	float		Unit A
14	Echoed power	OR	float		Unit：W
16	Echoed resistance	OR	float		Echoed resistance,Unit：Ω
18	Echoed electricity	WR	float	0.0	Echoed electricity,write 0 to clear
20	Echoed energy	WR	float	0.0	Echoed energy,write 0 to clear
22	Loading time	WR	int	0	Load time,resolution 1ms
24	Echoed temperature	OR	int		Echoed temperature,Unit：centigrade
28	Testing function	WR	int	0～6	0-STATIC，1-CR，2-SEQ，3-CHARGE ，4-DISCHARGE，5-RAMP，6-WAVE，

30	Advanced testing function	WR	int	0～5	0-CR，1-SEQ，2-CHARGE ，3-DISCHARGE，4-RAMP，5-WAVE，
32	Test switch	WR	int	0～1	0-close test，1-startup test
36	Trigger signal	WR	int		Write 1 to produce trigger signal
40	Restore factory setting	WR	int		Write 1 to restore factory setting
42	Clear protection	WR	int		Write 1 to clear protection
44	Save test parameter	WR	int	1～20	
46	Call test parameter	WR	int	1～20	
76	Function mask	OR	int		Indicate what features the product has
82	STATIC voltage	WR	float	MIN ～ MAX	Unit：V
84	STATIC source current	WR	float	MIN ～ MAX	Unit A
86	STATIC load current	WR	float	MIN ～ MAX	Unit A
88	STATIC source power	WR	float	MIN ～ MAX	Unit W
90	STATIC load power	WR	float	MIN ～ MAX	Unit W
92	STATIC voltage rise slope	WR	float	MIN ～ MAX	Unit：V/s
94	STATIC voltage drop slope	WR	float	MIN ～ MAX	Unit：V/s
96	STATIC source current rise slope	WR	float	MIN ～ MAX	Unit：A/s
98	STATIC source	WR	float	MIN ～	Unit：A/s

	current drop slope			MAX	
100	STATIC load current rise slope	WR	float	MIN ～ MAX	Unit：A/s
102	STATIC load current drop slope	WR	float	MIN ～ MAX	Unit：A/s
104	Voltage/current priority	WR	int	0～1	0-voltage priority ，1-current priority，2.Off
106	Voltage function DAC	WR	int	0～65535	
108	Source current function DAC	WR	int	0～65535	
110	Load current function DAC	WR	int	0～65535	
112	Source power function DAC	WR	int	0～65535	
114	Load power function DAC	WR	int	0～65535	
116	Zero DAC	WR	int	0～4095	
118	Sampling voltage ADC	OR	int		
120	Sampling current ADC	OR	int		
122	Sampling temperature ADC	OR	int		
124	Over voltage protection	WR	float	MIN ～ MAX	Unit：V
126	Over current protection	WR	float	MIN ～ MAX	Unit：A
128	Over power protection	WR	float	MIN ～ MAX	Unit：W
130	Low voltage	WR	float	MIN ～	Unit：V

	protection			MAX	
132	Reverse detection switch	WR	int	0～1	0-disable detection,1-enable detection
134	Mode change protection	WR	int	0～2	0-Off ， 1-CV_To_CC ， 2-CC_To_CV
136	Mode change protection time	WR	float	0.1～600.0	Unit:s
138	Continuous load time	WR	int	0～999999	Unit ： s ， write 0 into unlimited time
140	Communication watchdog	WR	float	0.0～60.0	Unit：：s，set 0 to disable
142	CV operation upper limit	WR	float	MIN～MAX	Unit：V
144	CV operation lower limit	WR	float	MIN～MAX	Unit：V
146	Source CC operation upper limit	WR	float	MIN～MAX	Unit：A
148	Source CC operation lower limit	WR	float	MIN～MAX	Unit：A
150	Source CP operation upper limit	WR	float	MIN～MAX	Unit：W
152	Source CP operation lower limit	WR	float	MIN～MAX	Unit：W
154	Load CC operation upper limit	WR	float	MIN～MAX	Unit：A
156	Load CC operation lower limit	WR	float	MIN～MAX	Unit：A

158	Load CP operation upper limit	WR	float	MIN～MAX	Unit：W
160	Load CP operation lower limit	WR	float	MIN～MAX	Unit：W
162	SCPI channel status	OR	int		
164	SCPI channel events	OR	int		
166	SCPI channel events summary	OR	int		
168	Enable SCPI standard events	WR	int	0～65535	
170	Enable SCPI service request	WR	int	0～65535	
172	SCPI-PSC control switch	WR	int	0～1	
174	PTR of SCPI channel	WR	int	0～65535	
176	NTR of SCPI channel	WR	int	0～65535	
178	Enable SCPI channel	WR	int	0～65535	
180	Power down save	WR	int	0～1	0-off，1-on
182	Power on output	WR	int	0～1	0-off，1-on
184	IP address	WR	int		
186	Subnet mask	WR	int		
188	Gateway	OR	int		
190	Serial port rate	WR	int	0～4	0-4800,1-9600,2-19200, 3-38400，4-115200
192	Serial port check	WR	int	0～2	0-None，1-Odd，2-Even
194	GPIB address	WR	int	0～30	

196	communication protocol	WR	int	0～1	0-SCPI，1-Modbus
198	Modbus address	WR	int	1～247	
200	Keyboard sound	WR	int	0～1	0-Off，1-ON
202	System language	WR	int	0～2	0-simplified chinese，1-tranditional，2-English
204	Quick call	WR	int	0～1	0-Off，1-ON
206	External control	WR	int	0～2	0-Trigger，1-Toggle，2-Hold
208	Sampling FIFO rate	WR	int	0～4	0-1000Hz，1-500Hz，2-200Hz，3-100Hz，4-10Hz
210	APG voltage switch	WR	int	0～1	0-Off，1-On
212	APG current switch	WR	int	0～1	0-Off，1-On
214	APG power switch	WR	int	0～1	0-Off，1-On
220	APG reference voltage	WR	int	0～1	0-5V，1-10V
222	Master/slave device select	WR	int	0～9	0-master，1-slave N0.1，2-slave No.2，3-slave No.3，4-slave No.4，and so on
226	Slave device numbers	WR	int	1～9	
228	Enable to cascade	WR	int	0～1	0-disable cascade，1-enable cascade
230	Cascade status	OR	int		
232	External protection	WR	int		
234	CR voltage	WR	float	MIN～MAX	Unit：V

236	CR source current	WR	float	MIN～MAX	Unit：A
238	CR source power	WR	float	MIN～MAX	Unit：W
240	CR source resistance	WR	float	MIN～MAX	Unit：Ω
242	CR load current	WR	float	MIN～MAX	Unit：A
244	CR load power	WR	float	MIN～MAX	Unit：W
246	CR load resistance	WR	float	MIN～MAX	Unit：Ω
318	CR adjustment filtering times	WR	int	1～1000	
320	CR adjustment scale factor	WR	float	0.001～1.0	
322	Adjustment upper limit for CR source current	WR	float	MIN～MAX	Unit：A
324	Adjustment upper limit for CR load current	WR	float	MIN～MAX	Unit：A
248	SEQ edit file	WR	int	1～10	
250	SEQ edit length	WR	int	1～100	
252	SEQ edit cycle times	WR	int	0～60000	0 for infinite loop
254	SEQ edit link	WR	int	0～10	0 represents unlinked file
256	SEQ edit step	WR	int	1～100	
258	SEQ single step voltage	WR	float	MIN～MAX	Unit：：V
260	SEQ single	WR	float	MIN～	Unit：：A

	step source current			MAX	
262	SEQ single step source power	WR	float	MIN ～ MAX	Unit：：W
264	SEQ single step load current	WR	float	MIN ～ MAX	Unit：：A
266	SEQ single step load power	WR	float	MIN ～ MAX	Unit：：W
268	SEQ single step delay	WR	float	0.001 ～ 99999	Unit：：s
270	SEQ save	WR	int		Write in 1 to save the file you are currently editing.
272	SEQ running file	WR	int	1～10	
274	SEQ running status	OR	int		
276	CHARGE charge voltage	WR	float	MIN～ MAX	Unit：V
278	CHARGE charge current	WR	float	MIN～ MAX	Unit：A
280	CHARGE charge power	WR	float	MIN～ MAX	Unit：W
282	CHARGE cut-off voltage	WR	float	MIN～ MAX	Unit：V，write 0 to disable it
284	CHARGE cut-off current	WR	float	MIN～ MAX	Unit：A，write 0 to disable it
286	CHARGE cut-off electricity	WR	float	0.0～ 999999	Unit：Ah，write 0 to disable electricity detection
288	CHARGE cut-off time	WR	int	0～360000	Unit：s，write 0 to disable time detection
292	DISCHARGE current	WR	float	MIN～ MAX	Unit：A
296	DISCHARGE power	WR	float	MIN～ MAX	Unit：W

298	DISCHARGE cut-off voltage	WR	float	MIN～MAX	Unit：V，write 0 to disable it
300	DISCHARGE cut-off electricity	WR	float	0.0～999999	Unit：Ah，write 0 to disable electricity detection
302	DISCHARG cut-off time	WR	int	0～360000	Unit：s，write 0 to disable time detection
304	RAMP of Ua	WR	float	MIN～MAX	Unit：：V
306	RAMP of Ub	WR	float	MIN～MAX	Unit：：V
308	RAMP of Uc	WR	float	MIN～MAX	Unit：：V
310	The slope AB Of RAMP	WR	float	MIN～MAX	Unit：：V/s
312	The slope BC Of RAMP	WR	float	MIN～MAX	Unit：：V/s
314	RAMP of current	WR	float	MIN～MAX	Unit：：A
316	RAMP of power	WR	float	MIN～MAX	Unit：：W
326	WAVE run status	OR	int		
328	WAVE run file number	WR	int	1～32	
330	WAVE save file	WR	int		Write 1 to save downloaded file

Table 2-2 status register 1 bit definition

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Startup finish	calibration in progress	remote locked	ringtone			Enable cascaded	Analog programming			Occur protection indication					
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
In Testing	Test finished	Remote control	Voltage SENSE bit	Function indicator			Mode indicator					Source load mode indication	Current sampling out of range	Voltage sampling out of range	Output indication

Bit 0	Output indication bit，0-off，1-on
Bit 1	0-voltage sampling normal,1-voltage sampling out of range
Bit 2	0-current sampling normal，1-current sampling out of range
Bit 3	0-source mode，1-load mode
Bit 4-6	0-CV，1-CC，2-CP，3-CR
Bit 7-11	0-STATIC，1-CR，2-SEQ，3-CHARGE，4-DISCHARGE，5-RAMP，6-WAVE
Bit 12	0-near，1-far
Bit 13	0-local，1-remote

Bit 14	0-test not completed，1-test completed
Bit 15	0-test not performed，1-test in progress
Bit 16-21	0-no protection event，1-PMF，2-TSD，3-OTP2，4-OTP1，5-RV，6-OC，7-OV，8-OP，9-OCP，10-OVP，11-OPP，12-LVP，13-ALT，14-CMF，15-SLA1，16-SLA2，17-SLA3，18-SLA4，19-SLA5，20-SLA6，21-SLA7，22-SLA8，23-SLA9，
Bit 22-24	0-Off，1-V，2-I，3-V&I，4-P
Bit 29	0-remote not locked，1-remote locked
Bit 30	0-calibration not performed，1-calibration in progress
Bit 31	0-startup uncomplete，1-startup complete

2.2. Block data address

Table 2-3 Power supply block data

Address	Name
0	specification string for Voltage,current and power
1	Main board program version
2	Communication board program version
7	Running parameter
101	Start block address of WAVE file
500	End block address of WAVE file

2.3. Structure data address

Table 2-4 power supply structure data

Address	Name
0	Voltage current sampling FIFO

3. Programming reference

3.1. Communication model

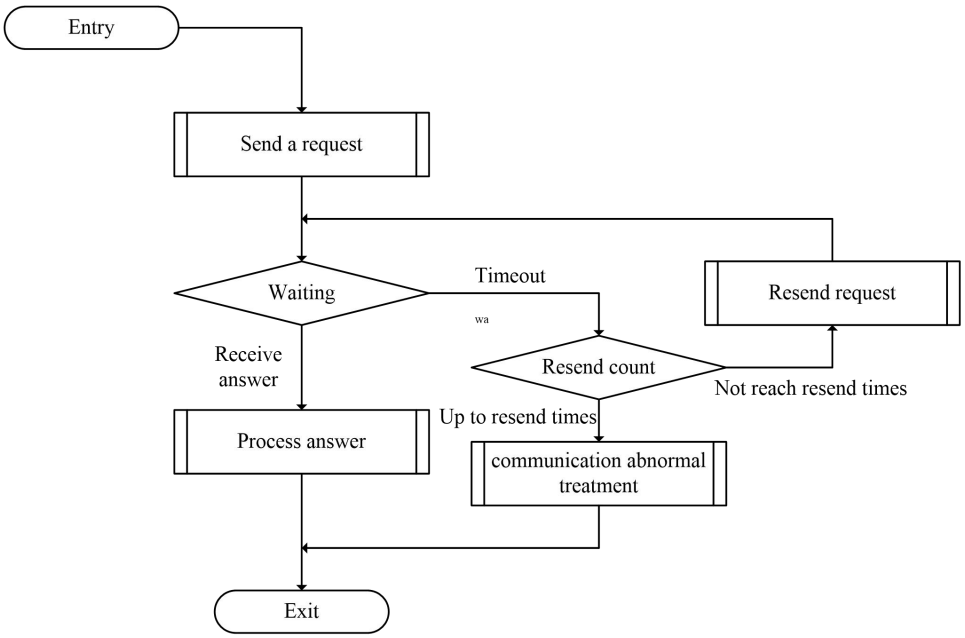


图 3-1 Communication reference

Recommend set timeout to 50～500ms，depend on answer frame length.the longer answer frame, the longer timeout.

Recommend set resend times to 3～5 times.

3.2. Convert data format

The Modbus adopt big-endian to transmit data.If control device adopt little -endian （PC、PLC、configuration software、user APP etc.）,need to convert data format before using the data.

```
typedef union
{
    int         reg_int;            //32bit signed integer
    float       reg_float;          //single precision floating point type
    UCHARreg_bytes[4];      //byte sequence
}unReg32Type;
UCHAR     buff_modbus[256];         //Modbus data buffer
```

unReg32Type data_reg; //composite register data

In little endian device

data_reg.reg_bytes[3] = buff_modbus[0];

data_reg.reg_bytes[2] = buff_modbus[1];

data_reg.reg_bytes[1] = buff_modbus[2];

data_reg.reg_bytes[0] = buff_modbus[3];

In big-endian device

data_reg.reg_bytes[0] = buff_modbus[0];

data_reg.reg_bytes[1] = buff_modbus[1];

data_reg.reg_bytes[2] = buff_modbus[2];

data_reg.reg_bytes[3] = buff_modbus[3];

The above codes are only for reference.In communication applications, users should process data correctly based on the actual situation of the control device.

3.3. Reading echoed voltage and current

A0 03 00 0A 00 04 7D 7A //read echoed voltage and echoed current register

3.4. Start/stop test

A0 10 00 20 00 02 04 00 00 00 01 36 89 //startup the power output

A0 10 00 20 00 02 04 00 00 00 00 F7 49 //close the power output

3.5. Change testing function

Write different integer values to the output function setting register (address 26),can change the power test function.

A0 10 00 1C 00 02 04 00 00 00 00 F4 08 //change to VI output

A0 10 00 1C 00 02 04 00 00 00 01 35 C8 //change to CR output

Notice: stop testing first before changing function.

3.6. VI output

A0 10 00 20 00 02 04 00 00 00 00 F7 49 //close output

A0 10 00 1C 00 02 04 00 00 00 00 F4 08 //change to VI output

A0 10 00 52 00 02 04 43 16 00 00 85 F4 //Set output voltage 150.0V

A0 10 00 54 00 02 04 41 20 00 00 E4 68 //Set output source current 10.0A

A0 10 00 56 00 02 04 41 20 00 00 65 BE //set output load current 10.0A

A0 10 00 58 00 02 04 42C8 00 00 64 4D //set output source power 100.0W

A0 10 00 5A 00 02 04 42C8 00 00 E5 94 //set output load power 100.0W

A0 10 00 20 00 02 04 00 00 00 01 36 89 //startup power supply output