DC Insulation Monitor Device (High Voltage)

GYDCG-UBCW2K　V5102

Insulation monitoring device for unearthed DC systems (IT systems)DC 100 V to 2000 V

Real-time monitoring of 0 ~ 2000 Vd.c. DC voltage values

RS485 communication, standard MODBUS RTU protocol，with alarm relay output

Suzhou Gongyuan Automation Technology Co., Ltd.

1. DC Bus Voltage Range Is Higher

It can meet the insulation resistance monitoring of DC systems below 2000V.

2. Comprehensive Functions

Basic configuration: insulation resistance monitoring, DC voltage monitoring, DC voltage reverse alarm, insulation monitoring module internal self-test, low insulation resistance alarm.

3. Wider power supply range

Compatible with 12V or 24V power supplies, operating range 10~30V.

4. Broader Insulation Monitoring Range

Capable of insulation resistance monitoring within a DC range of 100V~2000V, with a resistance monitoring range of 0KΩ~10MΩ.

5. Real-time Insulation Resistance Monitoring

Upon activation, the module continuously monitors the insulation resistance of both poles to the ground, unaffected by the symmetry of positive and negative pole insulation resistances. Monitoring data is updated in real time.

6. Higher reliability

Insulation resistance monitoring results are not affected by low-frequency fluctuations in DC voltage.

7. Greater Internal Ground Resistance

The internal resistance of the IMD to the ground ≥ 1 MΩ.

8. Faster Monitoring Speed, Adaptive to Ground Capacitance

Quick insulation resistance monitoring is achieved when the capacitance of both positive and negative poles to the ground does not exceed 3uF, with a monitoring period between 0.7 and 2 seconds. The larger the ground capacitance, the longer the monitoring period.

9. Monitoring Accuracy

In cases of smaller ground capacitance, the monitoring error can be within 1%.

Catlog

1 Overview and Type Selection

GYDCG-UBCW2K-□□

A:With alarm relay output
None:Without

RS:RS485 communication
None:Without

The GYDCG-UBCW2K DC Insulation Monitor Device(IMD) has an insulation monitoring start/stop function. Once insulation monitoring is activated, it can real-time monitor the insulation resistance of positive and negative poles to the ground. The monitoring results are not affected by DC voltage fluctuations or the symmetry of the insulation resistance of the positive and negative poles.

The GYDCG-UBCW2K-RS and GYDCG-UBCW2K-RSA models is controlled through RS485 communication. After the IMD are powered on, the status is deactivated by default.

The GYDCG-UBCW2K-A model uses the relay dry contact output and has no communication function. After the module is powered on, the IMD status is active by default.

• Monitors insulation resistance values of positive and negative poles to the ground in 100 ~ 2000Vd.c. floating ground DC systems;

• Resistance measurement range 0KΩ～10MΩ;

• Detects DC voltage values, range 0 ~ 2000Vd.c.;

• DC voltage reverse connection alarm function;

• Self-test of insulation monitoring module;

• RS485 communication, standard MODBUS RTU protocol；

• With dry contact relay output alarm function；

• Suitable for DC systems such as electric vehicle DC charging systems, photovoltaic systems, energy storage systems, and DC power grids；

2 Interfaces and Features

2.1 Principle and Topology

The IMD principle is shown in the following figure. When the IMD is powered on, The DC voltage value can be read in real-time. Upon activating IMD, the ground switch K closes, allowing for the reading of the insulation resistance values R_{fP} and R_{fN}. In the IMD active state, R_{fP}, R_{fN} are updated in real time, with R_{fP} and R_{fN} data updating every 0.7s ~ 2s. When IMD is deactivate, the ground switch K is disconnected, and thereafter R_{fP}, R_{fN} are invalid values.

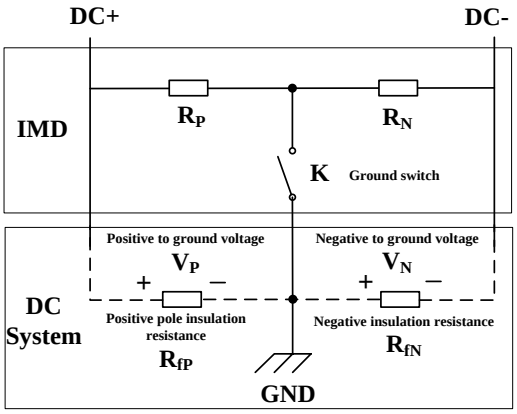


Figure 1: Schematic Diagram

2.2 Internal self-test

When the DC voltage is ≥100V, and the IMD is in the deactivation status, it will automatically perform a self-test on its internal circuitry (without the need for external control), with a self-test cycle of 5 seconds. A successful self-test is indicated when the sampled values of the bridge voltage match the bridge resistance values. The current status of the IMD's self-test can be determined by reading Bit4 of the 0x0014 register, where a successful self-test is represented by "1"; unsuccessful ones by "0". If the self-test result is not updated, it will retain the last result.

2.3 Insulation resistance monitoring function

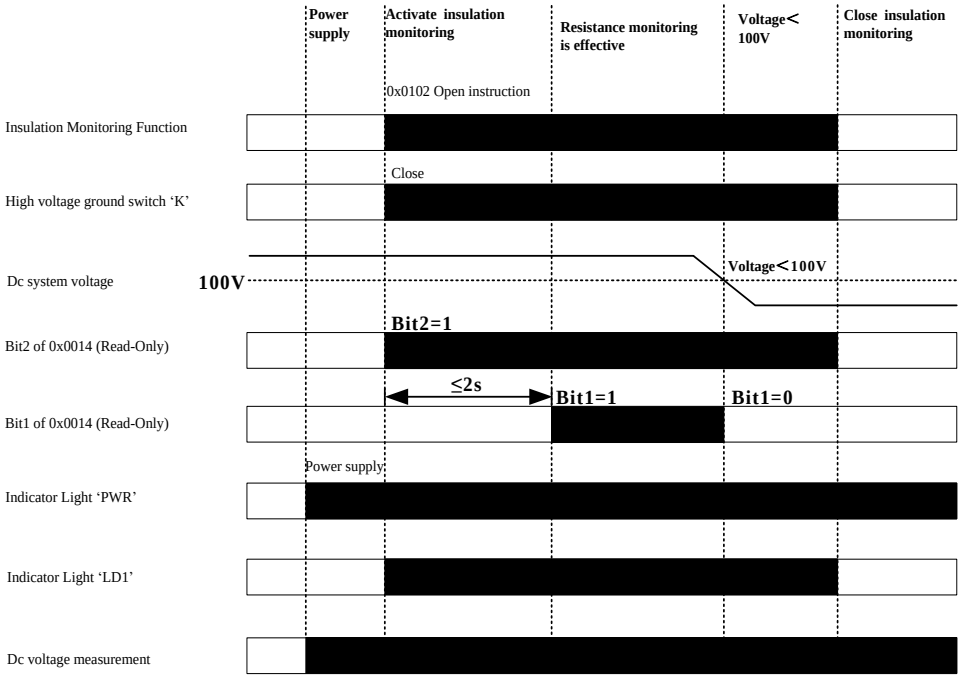
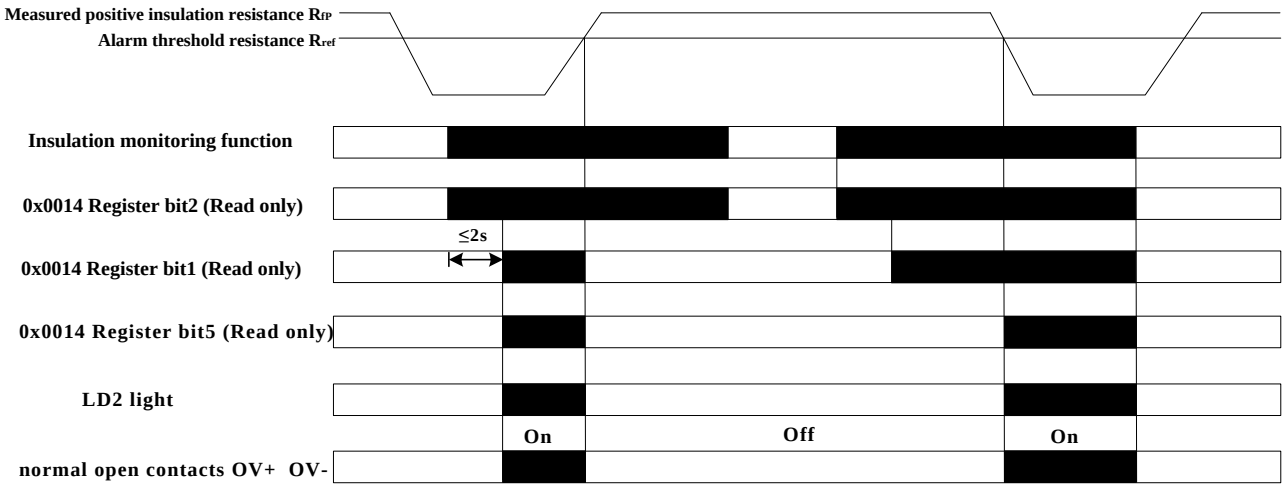


Figure 2. Sequence diagram of insulation monitoring function control



Fig

Figure 3. Alarm timing diagram

The control timing sequence for the insulation monitoring function is as shown above.

• After the IMD is powered, the 'PWR' light turns on, and the DC voltage is continuously monitored.

• Insulation monitoring can be activated and deactivated by writing the 0x0102 register.

• The current status of the IMD, whether it is activated or deactivated, can be determined by reading bit2 of the 0x0014 register.

• IMD is activated, the ground switch K closes, and the 'LD1' light turns on. Conversely, IMD is deactivated, the ground switch K disconnects, and the 'LD1' light turns off.

• The following conditions in Table 1 must be met for the insulation resistance values in registers 0x0012 and 0x0013 to be valid and readable. If the resistance value is >10MΩ, it displays 0xEA60, i.e., 60000; if the values in 0x0012 and 0x0013 are invalid, they display 0xFFFF, i.e., 65535.

• The user can read the insulation resistance values as soon as 0.7s~2s after activating the insulation monitoring function. For systems with DC ground capacitance, the IMD can adaptively monitor ground capacitances up to 3uF for each pole (The capacitance of both the positive and negative poles to the ground is each less than 3uF, with a total capacitance of less than 6uF), ensuring the monitoring time does not exceed 2 seconds in the presence of ground capacitance.

• When the measured insulation resistance is less than the alarm threshold, the alarm relay is closed, the LD2 light is on, and the bit5 or bit6 of register 0x0014 is set to '1'; When the measured insulation resistance is greater than the alarm threshold, the alarm is automatically reset, the alarm relay is disconnected, the LD2 is off, and the bit5 or bit6 of register 0x0014 is set to '0'.

Table 1、DC Ground Resistance/Voltage Monitoring

Content	**Validity**	**Conditions**	**Readable Values**
Insulation	Valid	Conditions to be met simultaneously: 1. IMD activated;	0x0012 for positive ground resistance R_{fP} 0x0013 for negative ground resistance R_{fN}

resistances R_{fP} and R_{fN}		2.0.7s~2s after IMD activation; 3.DC voltage ⩾100V;	Bit1 of 0x0014 as "1"
	Invalid	Conditions to be met simultaneously: 1. IMD deactivated; 2.Open the module within 0.7-2s; 3.DC voltage ＜100V;	0x0012 as 0xFFFF 0x0013 as 0xFFFF Bit1 of 0x0014 as "0"

2.4 RS485 Communication

Users can send and receive data frames via the RS485 communication port. The circuit includes a 510Ω terminal resistor, and specific operational methods can be found in '6 Communication Protocol'. Terminals A and B correspond to the A and B outputs of RS485, respectively. The internal circuit is illustrated in the diagram on the right.

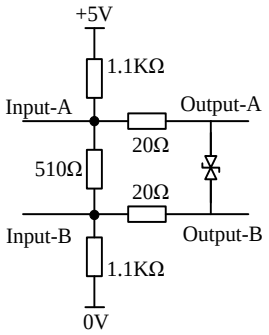


Figure 4: RS485 Internal Circuit

2.5 Communication Parameter Configuration

DIP switches are used to configure communication parameters:
The 'ON' direction indicates setting to '1'.
CONFIG 1 :
• Position 1 sets the baud rate.
• Positions 2 ~ 4 set the communication address.
CONFIG 2 :
• Positions 1 ~ 4 set the alarm threshold.
• Position 5 sets the multiplier for the alarm threshold.

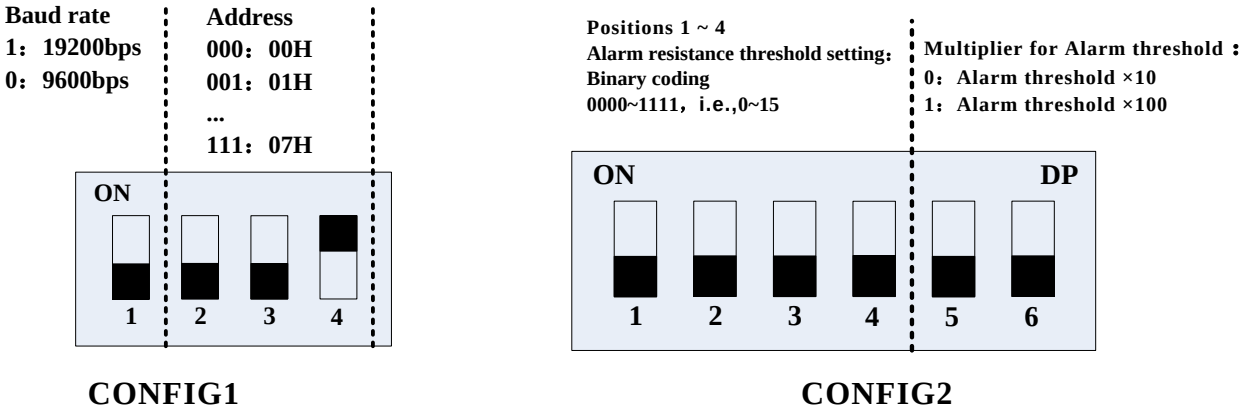


Figure 5. Dip switch Settings

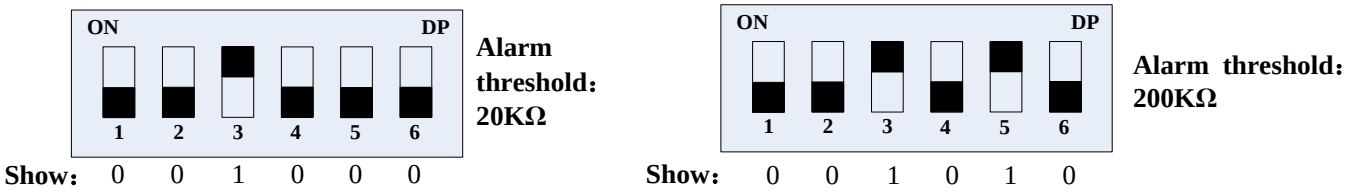


Figure 6. Insulation resistance alarm threshold setting

2.6 Relay Output (Model with -A)

'OV+' and 'OV-' is normally open contact of the relay, When the insulation resistance is lower than the set threshold, the normally open contact closes.

3 Wiring diagram

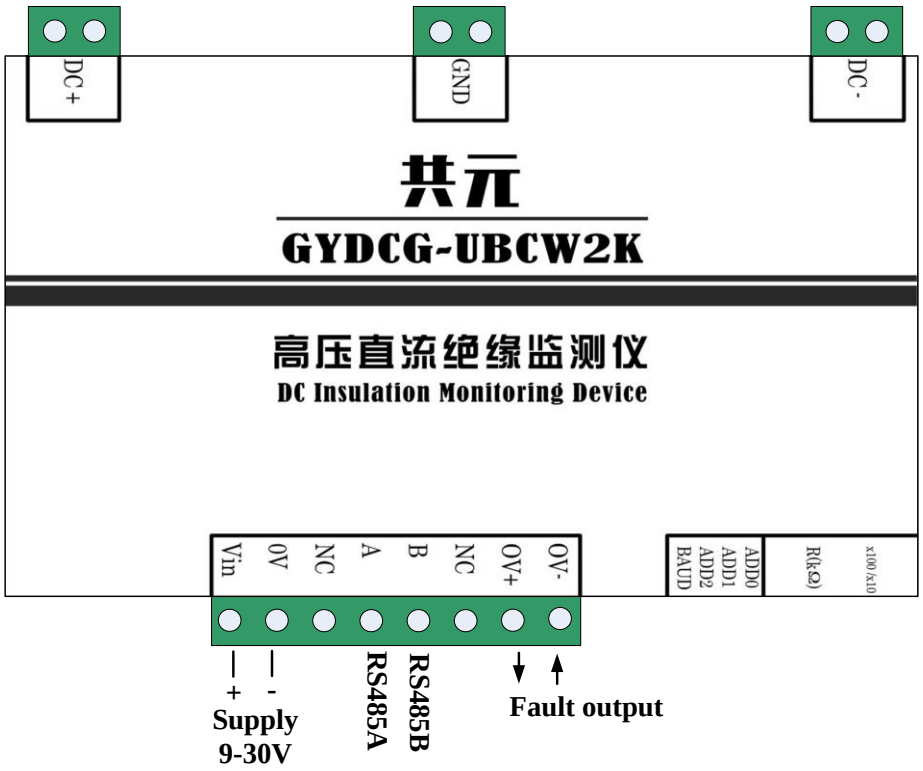


Figure 7: Wiring Diagram

Table 2: Wiring Methods

Terminal	Connections	Terminal	Connections
DC+	DC positive pole	DC-	DC negative pole
Vin	Power input positive pole	0V	Power input negative pole

A	RS485-A	B	RS485-B
OV+	Alarm output normally open contact	OV-	Alarm output normally open contact
GND	GND		

4 Structure Parameters

The module can be mounted by rail or fixed by screws. The guide rail uses a standard width of 35mm. Overall dimensions are shown as follows: (Unit: mm)

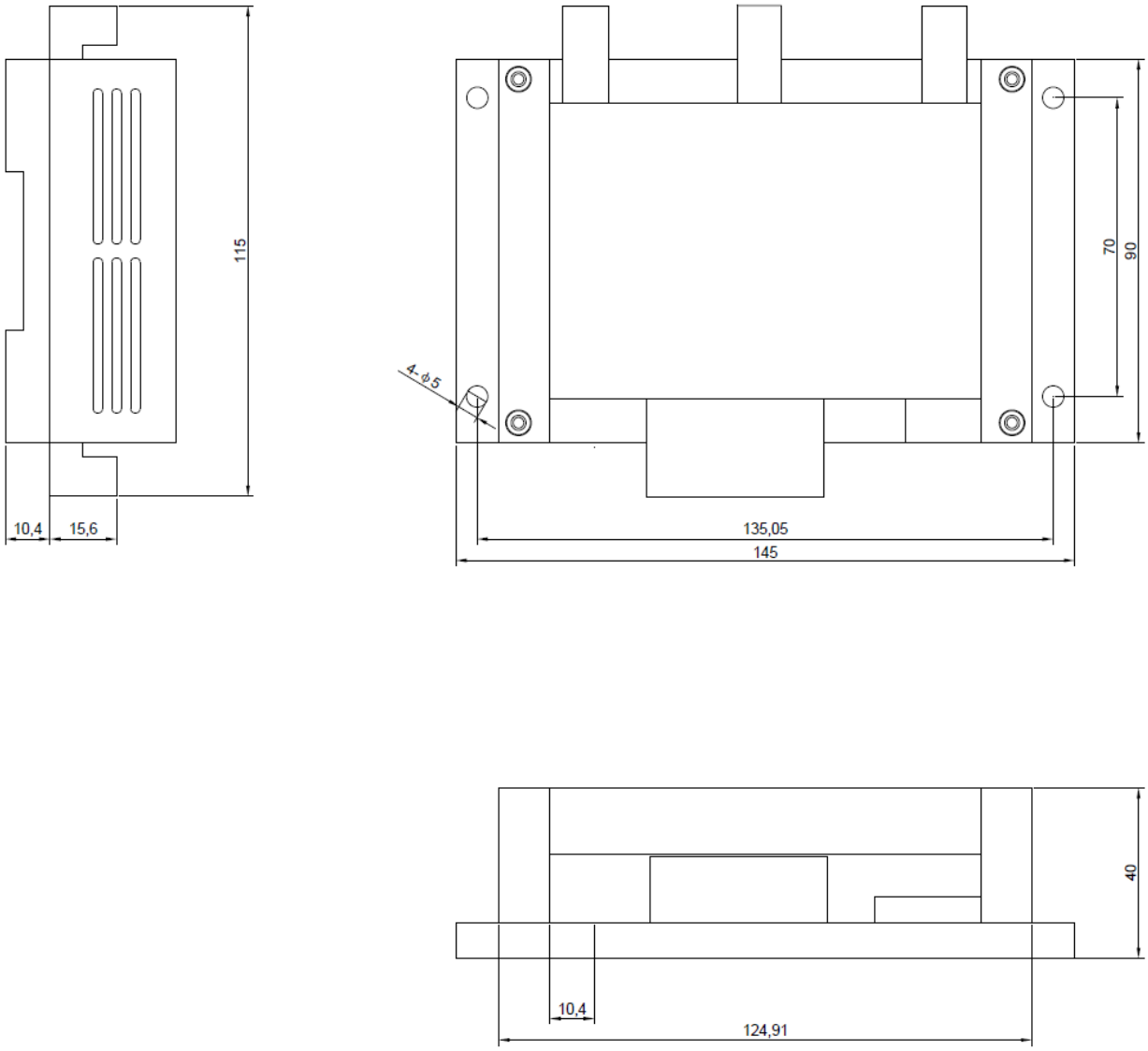


Figure 8. Dimensional Diagram

5 Electrical Parameters

Table 3: Electrical Parameters

Parameter	**Condition**	**Typical Value**
DC System Voltage Measurement Range		0~2000VDC
DC System Voltage Measurement Accuracy	0~400Vd.c.	≤2V
	400~2000Vd.c	≤0.5%
Auxiliary Power Supply Range		10~30Vdc
Auxiliary Power Supply Power Consumption	12V: 90mA 24V: 45mA	≤1.5W
Insulation Resistance Measurement Range	DC System Voltage100V~2000V	0KΩ~10MΩ
Insulation Monitoring Accuracy①	Dc voltage range 100V~300V	≤3KΩ+10%
	Dc voltage range 300V~2000V	≤3KΩ+5%
	CY②＞0.3μF, Insulation resistance＞1MΩ or CY②＞1μF	＞10%
Time to Update Insulation Resistance Value after Activation	After the insulation monitoring is turned on, the time until the effective resistance value can be read for the first time	0.7s~2s
Insulation Resistance Value Update Time	Switch the insulation resistance until the module can read the switched insulation resistance value	0.5s~3s
Maximum switching voltage of alarm relay		250VAC/30VDC
Maximum switching current of alarm relay		3A
Alarm relay contact resistance		<100mΩ
Alarm relay insulation resistance		100MΩ
Storage Temperature		-55℃~90℃
Operating Temperature		-40℃~75℃
Altitude		≤3500m
Operating Humidity		≤90%

①When the positive-to-ground insulation resistance R_{fP} and the negative-to-ground insulation resistance R_{fN} differ significantly, by more than 5 times, the higher resistance value of R_{fP} or R_{fN} may not meet the typical value.

②C_Y refers to the capacitance values of the system bus positive and negative to ground.

- Offline Dielectric Strength Test <2mA:

Table 4. Withstand pressure test

Voltage Application Point		**Level**	**Test Time**
D+/D- to G	DC voltage positive and negative poles to ground	4200VDC/3000VAC	≤1min
+/- to G	Power supply positive and negative poles to ground	3500VDC/2500VAC	≤1min

A/B to G	RS485 port to ground	3500VDC/2500VAC	≤1min
D+/D- to +/-	DC voltage positive and negative poles to power supply positive and negative poles	4200VDC/3000VAC	≤1min
D+/D- to A/B	DC voltage positive and negative poles to RS485 port	4200VDC/3000VAC	≤1min

Note: The power supply side, RS485 and G ground should be isolated from each other.

6 Communication Protocols

The device provides the Modbus RTU protocol interface, using Modbus RTU 0x03/0x06 command. Baud rate, communication address, parity check mode, can be set by dip switch, stop bit 1, data bit 8. The time interval between each byte in the sent frame must not exceed 20ms, otherwise the frame will be cleared.

This module works in slave mode.

Read operation: Function code 0x03: Read hold register (multiple register addresses can be read at a time)

Request Command	Response Command
BYTE[0] Device Address	BYTE[0] Device Address
BYTE[1] Function Code 0x03	BYTE[1] Function Code 0x03
BYTE[2] Register Start Address High Byte	BYTE[2] Register Byte Length
BYTE[3] Register Start Address Low Byte	BYTE[3] Register High Byte
BYTE[4] Register Length High Byte	BYTE[4] Register Low Byte
BYTE[5] Register Length Low Byte	BYTE[5] Register High Byte
BYTE[6] CRC Check Low Bit	… …
BYTE[7] CRC Check High Bit	BYTE[n] CRC Check Low Bit
	BYTE[n+1] CRC Check High Bit

Write Operation: Function code 0x06 - Write Single Register (can set only one register address at a time)

Request Command	Response Command
BYTE[0] Device Address	BYTE[0] Device Address
BYTE[1] Function Code 0x06	BYTE[1] Function Code 0x06
BYTE[2] Register Address High Byte	BYTE[2] Register Address High Byte
BYTE[3] Register Address Low Byte	BYTE[3] Register Address Low Byte
BYTE[4] Register Parameter High Byte	BYTE[4] Register Parameter High Byte
BYTE[5] Register Parameter Low Byte	BYTE[5] Register Parameter Low Byte
BYTE[6] CRC Check Low Bit	BYTE[6] CRC Check Low Bit
BYTE[7] CRC Check High Bit	BYTE[7] CRC Check High Bit

Generates a check data based on the CRC polynomial rule, with the result added to the command as a check code.

Polynomial: X^16+X^15+X^2+1

1. Set the CRC register and initialize it to 0Xffff.

2. XOR the first 8-bit character of the data with the lower 8 bits of the 16-bit CRC register, and store the result in the CRC register.

3. Shift the CRC register right by one bit. MSB is replaced with 0, and the LSB is shifted out and checked.

4. If the LSB is 0, repeat step 3; if the LSB is 1, XOR the CRC register with the polynomial code.

5. Repeat steps 3 and 4 until all 8 shifts are completed. This completes the processing of one 8-bit data.

Table 5 Register address definition

Function Code	**Register ADD**	**Content**	**Send Example (Address 01)**	**Remarks**
03 Read Register	0x0010	Bus Voltage	01 03 00 10 00 01 85 CF	Unit 0.1V, voltage between positive and negative bus
	0x0012	Positive Pole-to-Ground Insulation Resistance	01 03 00 12 00 01 24 0F	Unit KΩ, rounded to the nearest integer (0xFFFF indicates invalid value; 0xEA60 indicates resistance >10MΩ)
	0x0013	Negative Pole-to-Ground Insulation Resistance	01 03 00 13 00 01 75 CF	
	0x0014	Status Bits	01 03 00 14 00 01 C4 0E	As shown in the table below
	0x001A	Read Version Number	01 03 00 1A 00 01 A5 CD	
06 Write Register	0x0102	Activate Insulation Monitoring	01 06 01 02 00 11 E9 FA	The ground switch is closed
		Deactivate Insulation Monitoring	01 06 01 02 00 00 29 F6	The ground switch is disconnected

Table 6. 0x0014 register bit definition

Register ADD	Bit	Read/Write	definition	
0x0014	bit15~bit8	Blank	Blank	
	bit7	R	Bus voltage reverse alarm	0：The DC voltage is not reversed or the reverse voltage is less than 100V
				1：The DC reverse voltage is greater than 100V
	Bit6	R	The negative electrode insulation is faulty	0：Negative insulation without fault
				1：The negative insulation is faulty, that is, the negative insulation resistance is lower than the threshold

	Bit5	R	The positive electrode insulation is faulty	0：Positive insulation without fault
				1：The positive insulation is faulty, that is, the positive insulation resistance is lower than the threshold
	bit4	R	Self-check status bit	0: Self-test unsuccessful
				1: Self-test successful (default)
	bit2	R	Whether the insulation monitoring function is enabled	0：IMD Deactivate, Ground switch K is disconnected
				1：IMD Activate, Ground switch K closed
	bit1	R	Insulation resistance monitoring is effective	0：Insulation resistance monitoring incomplete, resistance value invalid
				1：Insulation resistance monitoring valid, resistance value can be read

Examples:

1. Activate IMD: 01 06 01 02 00 11 E9 FA

Return frame: 01 06 01 02 00 11 E9 FA

2. Deactivate IMD: 01 06 01 02 00 00 29 F6

Return frame: 01 06 01 02 00 00 29 F6

3. Read Bus Voltage and Positive/Negative Pole-to-Ground Resistances

(Read 4 registers): 01 03 00 10 00 04 45 CC

Return frame: 01 03 08 07 D0 02 58 EA 60 02 58 11 4F

Reading DC voltage 0X07D0 (200V), reading positive pole insulation resistance 0XEA60 (infinitely large), reading negative pole insulation resistance 0X0258 (600KΩ).

4. Read Status Bits: 01 03 00 14 00 01 C4 0E

Return frame: 01 03 02 00 94 B9 EB

0x0094 = 0000 0000 1001 0100, Bit7 = 1 indicates bus voltage reverse connection, Bit2 = 1 insulation monitoring function is activated, Bit1 = 0 insulation resistance value is invalid, Bit4 = 1 self-test successful.

Return frame: 01 03 02 04 16 3B 4A

0x0416 = 0000 0100 0001 0110, Bit7 = 0 indicates no reverse connection of bus voltage, Bit2 = 1 insulation monitoring function is activated, Bit1 = 1 insulation resistance value is valid, Bit4 = 1 self-test successful.

7 Contact Us

Product Inquiries: Leo
Mobile/WeChat: 18551146612
Email: 18813093352@163.com

Product Manager: Oliver
Mobile/WeChat:18813093352

Beijing Gongyuan Technology Co., Ltd
(Web: http://www.bjgongyuan.com)

Suzhou Gongyuan Automation Technology Co., Ltd.
(Web: http://www.global-gongyuan.com)

8 Product Iteration and Document Revision

Date	Document Version	Product Version	Status/Changes
2022/4	©2022V1	V5.0	Final Version
2023/7	©2023V1	V5.1	Optimize the reliability of insulation resistance detection with low frequency fluctuation of DC voltage Optimize the detection speed and accuracy in the presence of capacitance to earth Optimize RS485 communication reliability
2023/12	©2023V2	V5102	Manual revision; Added internal self-test function Communication Protocol 0x06 Command Reply command changes to standard Modbus RTU protocol.