



DC Insulation Monitor Device IMD

GYDCG-UBCS1 V5202

Insulation monitoring device for unearthed DC systems (IT systems)DC 100 V to 1000 V
Real-time monitoring of 0 ~ 1000 Vd.c. DC voltage values
RS485 communication, standard MODBUS RTU protocol



1. Comprehensive Functions

Basic configuration: Insulation resistance monitoring, DC voltage monitoring, reverse DC voltage alarm, Self-Test function and positive and negative pole-to-ground voltage monitoring.

2. Wider Power Supply Range

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

3. Broader Insulation Monitoring Range

Capable of insulation resistance monitoring within a DC range of 100V~1000V, with a resistance monitoring range of 0K Ω ~10M Ω .

4. 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.

5. Higher Reliability

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

6. Greater Internal Ground Resistance

Internal ground resistance of the insulation monitoring module is 3M Ω or 600K Ω .

7. 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 3 μ F, with a monitoring period between 0.7 and 2 seconds. The larger the ground capacitance, the longer the monitoring period.

8. Higher Monitoring Accuracy

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

9. More Convenient Parameter Settings

All communication parameters can be set using DIP switches (including communication address, baud rate, and parity).

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1 General instructions

The GYDCG-UBCS1 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.

- Monitors insulation resistance values of positive and negative poles to the ground in 100 ~ 1000Vd.c. floating ground DC systems;
- Resistance measurement range $0K\Omega \sim 10M\Omega$;
- Detects DC voltage values, range 0 ~ 1000Vd.c.;
- Uses RS485 for communication, MODBUS RTU protocol;
- DC voltage reverse connection alarm function;
- Two operating modes available: Auto switching bridge mode and fixed bridge mode;
- Internal self-test in insulation monitoring module;
- 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 right figure. When the IMD is powered on, the ground switch K is normally disconnected. Upon activating IMD, the ground switch K closes, allowing for the reading of the insulation resistance values R_{fP} and R_{fN} or the ground voltage values V_P and V_N of the positive and negative poles. In the IMD active state, R_{fP} , R_{fN} , V_P , and V_N data are updated in real time, with R_{fP} and R_{fN} data updating every 0.7s ~ 2s, and V_P and V_N updating every 100ms. When IMD is deactivate, the ground switch K is disconnected, and thereafter R_{fP} , R_{fN} , V_P , and V_N are invalid values.

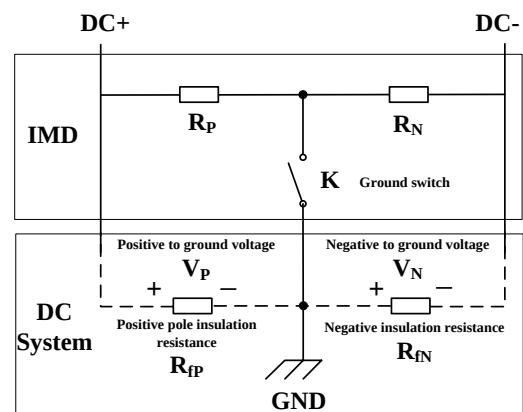


Figure 1: Schematic Diagram

2.2 Operating Modes

By writing to the 0x0100 register, two operating modes can be selected: the Auto Switching Bridge Mode or the Fixed Bridge Mode.

Auto Switching Bridge Mode refers to the IMD automatically switching the internal positive and negative pole-to-ground resistances (R_P and R_N), as shown in the diagram above. This alternates between **【 $R_P=3M\Omega$, $R_N=600K\Omega$ 】** and **【 $R_P=600K\Omega$, $R_N=3M\Omega$ 】**. In this mode, ground insulation resistance monitoring is conducted, and registers 0x0012 and 0x0013, which represent the positive and negative pole-to-ground insulation resistance values, can be read. Positive-to-ground and negative-to-ground voltage monitoring is not conducted, making registers 0x0015 and 0x0016 invalid values (0xFFFF).

Fixed Bridge Mode refers to the IMD having fixed internal positive and negative pole-to-ground resistances (R_P and R_N), with both R_P and R_N being $3M\Omega$. This mode monitors the positive and negative pole-to-ground voltages, and registers 0x0015 and 0x0016, representing the positive and negative pole-to-ground voltage values, can be read. Positive and negative pole-to-ground insulation resistance monitoring is not conducted, making registers 0x0012 and 0x0013 invalid values (0xFFFF).

The Operating Modes can be selected by writing to the 0x0100 register. After powering up the module, the default mode is the Auto Switching Bridge Mode. IMD's activation status and deactivation status does not affect the state of the IMD's Operating Modes. Users can check the current operating mode by querying bits 8 to 10 of register 0x0014.

Table 1: Operating Modes Table

Send Data to 0x0100	Operate Modes	bridge circuit	Read Status
0x0004	AUTO Switching Bridge Mode	Alternating between 【$R_P=3M\Omega$, $R_N=600K\Omega$】 and 【$R_P=600K\Omega$, $R_N=3M\Omega$】	The positive and negative pole-to-ground voltages V_P and V_N are invalid values, displaying 0xFFFF. The ground insulation resistances R_{IP} and R_{IN} are valid values.
0x0000	Fixed Bridge Mode	$R_P=3M\Omega$, $R_N=3M\Omega$	The ground insulation resistances R_{IP} and R_{IN} are invalid values, displaying 0xFFFF. The positive and negative pole-to-ground voltages V_P and V_N are valid values.

2.3 Internal Self-Test

When the DC voltage is $\geq 100V$, 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

2.4 Monitoring of the insulation resistance

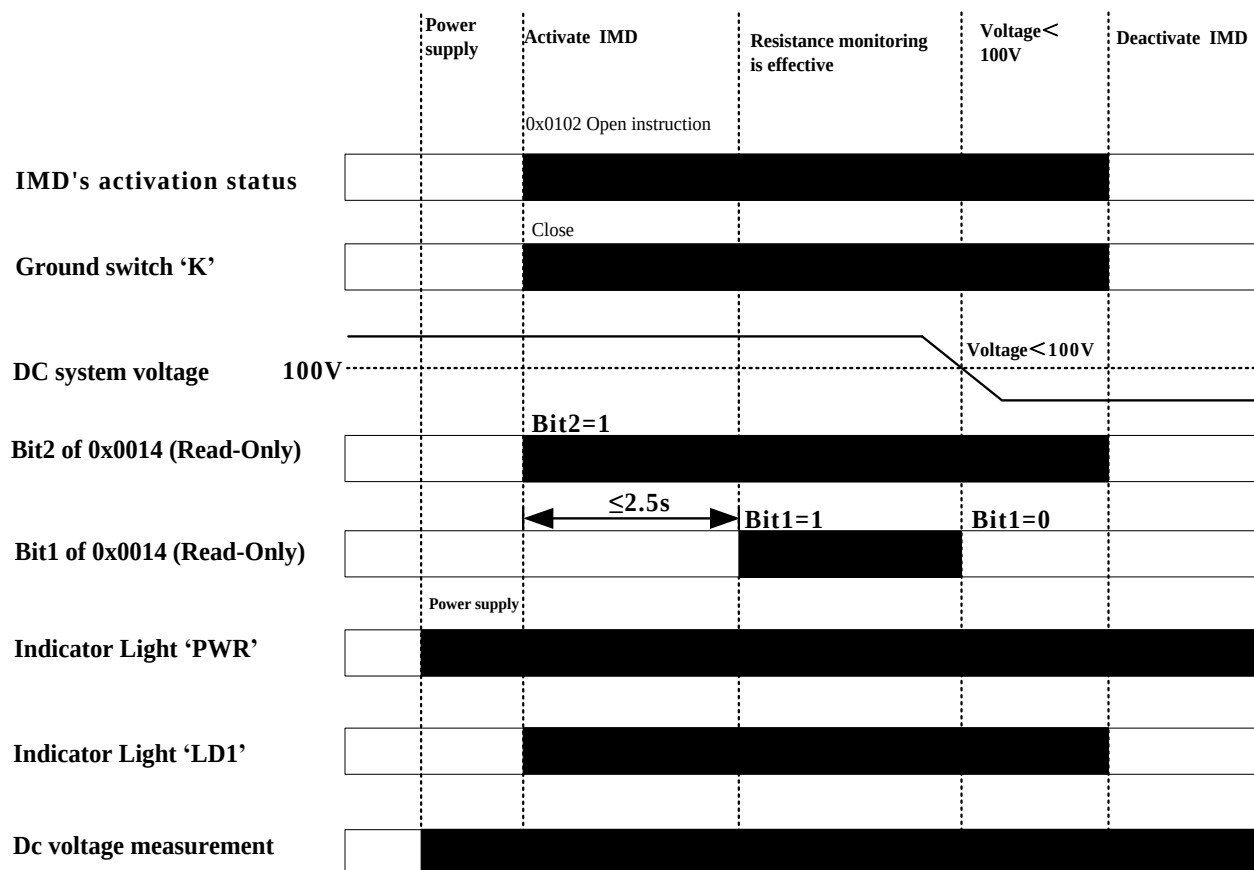


Figure 2. Sequence diagram of insulation monitoring function control

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

- After the product 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.
- After sending the activation command to the module, the ground switch K closes, and the 'LD1' light turns on. Conversely, after sending the deactivation command, the ground switch K disconnects, and the 'LD1' light turns off.
- The following conditions in Table 2 must be met for the insulation resistance values in registers 0x0012 and 0x0013 to be valid and readable. If the resistance value is $>10M\Omega$, 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 module 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.

Table 2: DC Ground Resistance/Voltage Monitoring

Content	Validity	Conditions	Readable Values
Insulation resistances R_{fP} and R_{fN}	Valid	Conditions to be met simultaneously: 1. IMD activated; 2. 0.7s~2s after IMD activation; 3. DC voltage $\geq 100V$; 4. Set to AUTO Switching Bridge Mode.	0x0012 for positive ground resistance R_{fP} 0x0013 for negative ground resistance R_{fN} Bit1 of 0x0014 as "1"
	Invalid	If any of the following conditions are met: 1. IMD deactivated; 2. Within 0.7s~2s of IMD activation; 3. DC voltage $< 100V$; 4. Set to Fixed Bridge Mode.	0x0012 as 0xFFFF 0x0013 as 0xFFFF Bit1 of 0x0014 as "0"
DC Ground Voltage Value V_P and V_N	Valid	Conditions to be met simultaneously: 1. Set to Fixed Bridge Mode; 2. IMD activated.	0x0015 for positive ground voltage V_P 0x0016 for negative ground voltage V_N Bits 8~10 of 0x0014 as "000"
	Invalid	If any of the following conditions are met: 1. Set to AUTO Switching Bridge Mode; 2. IMD deactivated.	0x0015 as 0xFFFF 0x0016 as 0xFFFF

2.5 RS485 Communication

Users can send and receive data frames via the RS485 communication port. The circuit includes a 510 Ω 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.

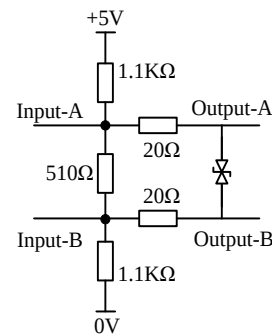


Figure 3: RS485 Internal Circuit

2.6 Communication Parameter Configuration

DIP switches are used to configure communication parameters:

- The 'ON' direction indicates setting to '1'.
- Position 1 sets the baud rate.

- Positions 2 ~ 4 set the communication address.
- Positions 5 ~ 6 set the parity check.

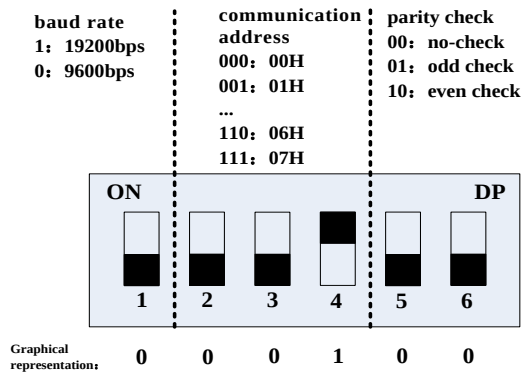


Figure 4: DIP Switch Parameter Configuration Diagram

3 Wiring diagram

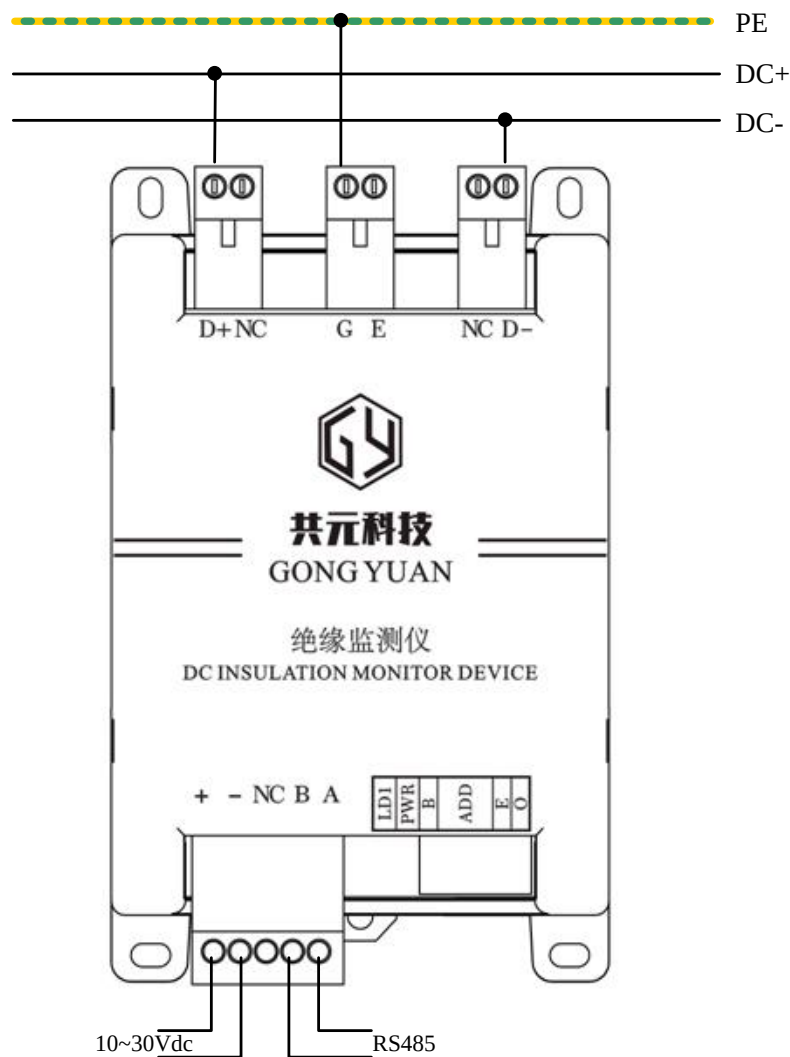


Figure 5: Wiring Diagram

Table 3: Wiring Methods

Terminal	Connections	Terminal	Connections
D+	DC positive pole	D-	DC negative pole
G	PE	E	No wiring
+	Power input positive pole	-	Power input negative pole
A	RS485-A	B	RS485-B

4 Dimensions and mounting

The module can be installed using either rail mounting or screw fixing. The rail conforms to a standard width of 35mm. The external dimensions are as shown in the diagram below:
(unit: mm)

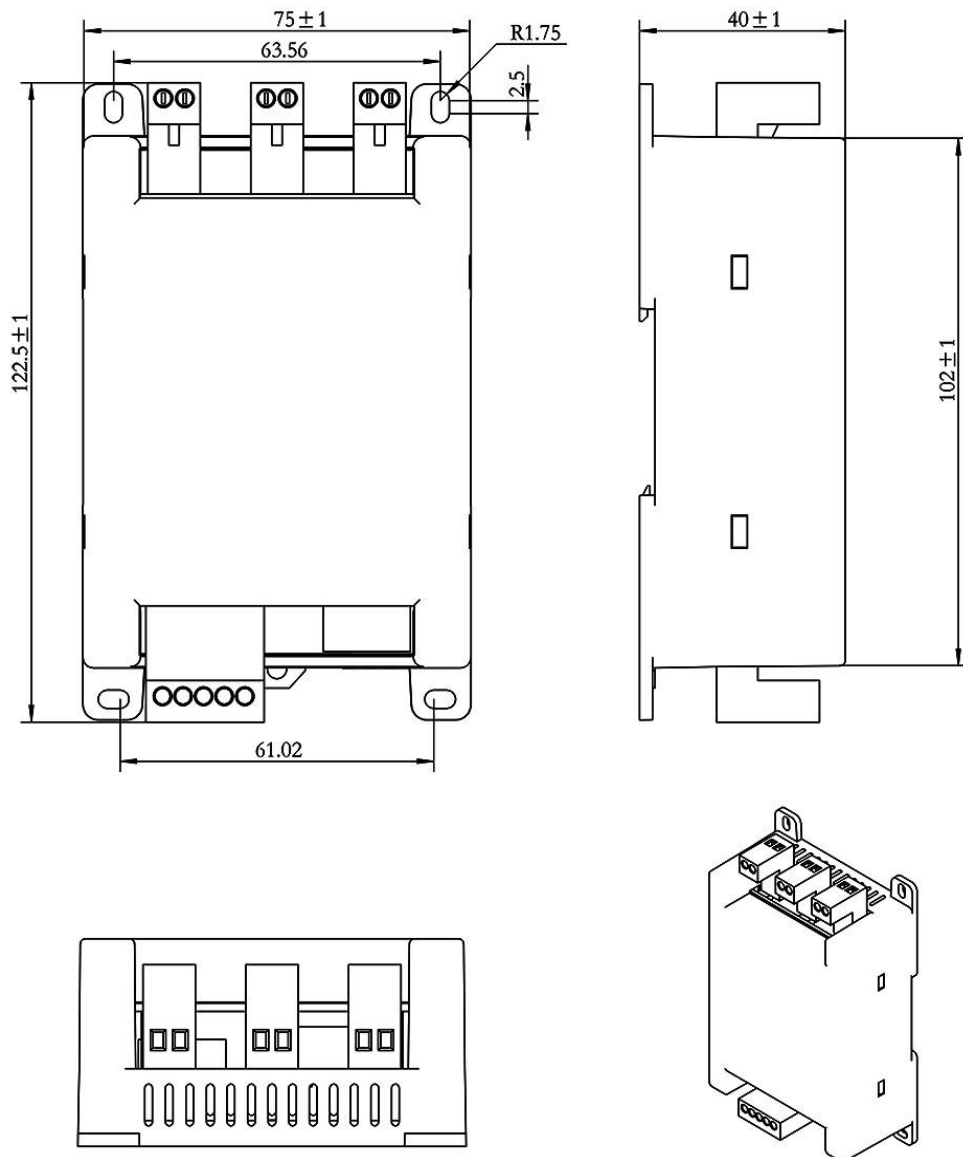


Figure 6: GYIM-DAR Dimensional Diagram

5 Electrical Parameters

Table 4: Electrical Parameters

Parameter	Condition			Typical Value
DC System Voltage Measurement Range				0~1000 Vd.c.
DC System Voltage Measurement Accuracy	0~400Vd.c.			≤2V
	400~1000 Vd.c.			≤0.5%
Auxiliary Power Supply Range				10~30Vd.c.
Auxiliary Power Supply Power Consumption	12V: 120mA 24V: 60mA			≤1.5W
Insulation Resistance Measurement Range	DC System Voltage 100~1000 Vd.c.			0KΩ~10MΩ
Insulation Monitoring Accuracy①	DC V Range	C _Y ^② Range	R Range	Accuracy
	100~1000 V	0~0.8μF	≤60kΩ	≤3KΩ
			60kΩ ~ 1MΩ	≤5%
		0.8μF~2.5μF	≤60kΩ	≤6KΩ
			60kΩ ~ 1MΩ	≤20%
Time to Update Insulation Resistance Value after Activation	Time from insulation monitoring activation to the first valid resistance value			0.7s~2s
Insulation Resistance Value Update Time	Time from switching insulation resistance to the module reading the new insulation resistance value			0.5s~3s
The IMD Counts the Number of Times the Ground Switch K is Turned On				50×10 ⁵ times
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.

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

●Offline Dielectric Strength Test <2mA:

Table 5: Dielectric Strength 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 should be isolated from each other.

6 Communication Protocol

This IMD provides a Modbus RTU protocol interface, utilizing Modbus RTU 0x03/0x06 commands. Baud rate, communication address, and parity can be set using DIP switches, with 1 stop bit and 8 data bits. The time interval between each byte in the transmitted frame must not exceed 20ms; otherwise, the frame will be reset.

The module operates in slave mode.

Read Operation: Function code 0x03: Read Holding Registers (can read multiple register addresses at once)

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

■CRC-16 Algorithm (RS485):

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 6: Register Address Definitions

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 K Ω , rounded to the nearest integer (0xFFFF indicates invalid value; 0xEA60 indicates resistance >10M Ω)
	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	See Table 7 below
	0x0015	Positive Pole-to-Ground Voltage	01 03 00 15 00 01 95 CE	Unit 0.1V, rounded to the nearest integer
	0x0016	Negative Pole-to-Ground Voltage	01 03 00 16 00 01 65 CE	
	0x001A	Read Version Number	01 03 00 1A 00 01 A5 CD	0x1001
06 Write Register	0x0102	Activate Insulation Monitoring	01 06 01 02 00 11 E9 FA	Ground switch K closes
		Deactivate Insulation Monitoring	01 06 01 02 00 00 29 F6	Ground switch K is disconnected
	0x0100	AUTO Switching Bridge Mode	01 06 01 00 00 04 89 F5	Positive and negative bridge resistances alternate
		Fixed Bridge Mode	01 06 01 00 00 00 88 36	Positive bridge resistance is 3M Ω , negative bridge resistance is 3M Ω
0xFF	0x 66	Master Broadcast Read Slave Address	Master sends FF 66 A5 AA 2B Slave replies FF 66 add CRClo CRChi add is the slave's communication address	Example of slave reply: FF 66 01 AB 90 Slave address is 0x01

Table 7: 0x0014 Register Bit Definitions

Register ADD	Bit	Read/Write	Definition	
0x0014	bit15~bit11	Blank	Blank	
	bit10~bit8	R	Current Operating Mode	000: Fixed Bridge Mode
				100:Auto Switching Bridge Mode (default)
	bit7	R	Bus Voltage Reverse Connection Alarm	0: No reverse connection of DC voltage or reverse voltage <100V
				1: Reverse DC voltage $\geq$ 100V

	bit4	R	Self-Test Result Bit	0: Self-test unsuccessful
				1: Self-test successful (default)
	bit2	R	Insulation Monitoring Function Status	0: IMD Deactivate, Ground switch K is disconnected
				1: IMD Activate, Ground switch K closed
	bit1	R	Insulation Resistance Monitoring Validity	0: Insulation resistance monitoring incomplete, resistance value invalid
				1: Insulation resistance monitoring valid, resistance value can be read
	bit0	Blank	Blank	

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, Bit10:Bit9:Bit8 = 000 represents Fixed Bridge Mode, with positive bridge resistance at 3MΩ and negative bridge resistance at 3MΩ, 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, Bit10 = 1 represents Auto Switching Bridge Mode, 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

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8 Product Iteration and Document Revision

Date	Document Version	Product Version	Status/Changes
2022/9	©2022V5	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	V5201 V5202	V5201 appearance change, retain the old version of the function and communication protocol content; V5202 appearance changes, adding functions Fixed bridge mode, adding internal self-check function, communication protocol 0x06 command answer command changed to standard Modbus RTU protocol.