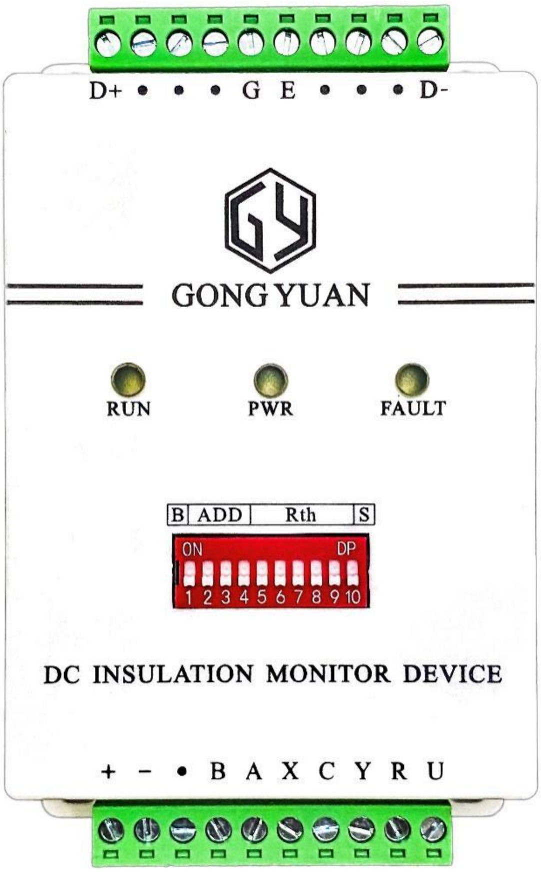
DC Insulation Monitor Device
IMD

GYIM-DAR

Insulation monitoring device for unearthed DC systems (IT systems)DC 12 V to 60 V
Real-time monitoring of 0 ~ 60 Vd.c. DC voltage values



Suzhou Gongyuan Automation Technology Co., Ltd.

1. Comprehensive Functions

Basic configuration: Insulation resistance monitoring, DC voltage monitoring, reverse DC voltage alarm, low insulation resistance alarm, 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 12V~60V, with a resistance monitoring range of 0Ω~600KΩ.

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 100KΩ.

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 5uF, with a monitoring period between 1~5 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%.

Catalog

1 General instructions

1.1 Ordering Example for Variants

GYIM-DAR-☐☐

GE:Broken line detection function
None: Not equipped

A:Equipped with relay alarm output
None: Not equipped

1.2 Summary

The GYIM-DAR 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 12 ~ 60Vd.c. floating ground DC systems;

• Resistance measurement range 0Ω～600KΩ;

• Detects DC voltage values, range 0 ~ 60Vd.c.;

• Uses RS485 for communication, MODBUS RTU protocol;

• DC voltage reverse connection alarm function;

• 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}. In the IMD active state, R_{fP} and R_{fN} data are updated in real time, with R_{fP} and R_{fN} data updating every 1s ~ 5s. When IMD is deactivate, the ground switch K is disconnected, and thereafter R_{fP} and R_{fN}, are invalid values.

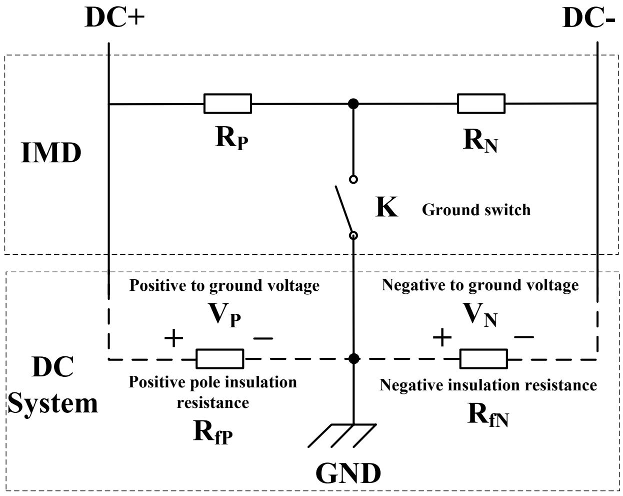


Figure 1: Schematic Diagram

2.2 Internal Self-Test

When the DC voltage is ≥12V, 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 LED Indicator

Upon powering up the IMD, the 'PWR' light turns on.

When the IMD triggers an alarm, the 'FAULT' light turns on.

After the insulation monitoring function is activated, the 'RUN' light turns on; when the insulation monitoring function is deactivated, the 'RUN' light turns off.

2.4 Monitoring of the insulation resistance

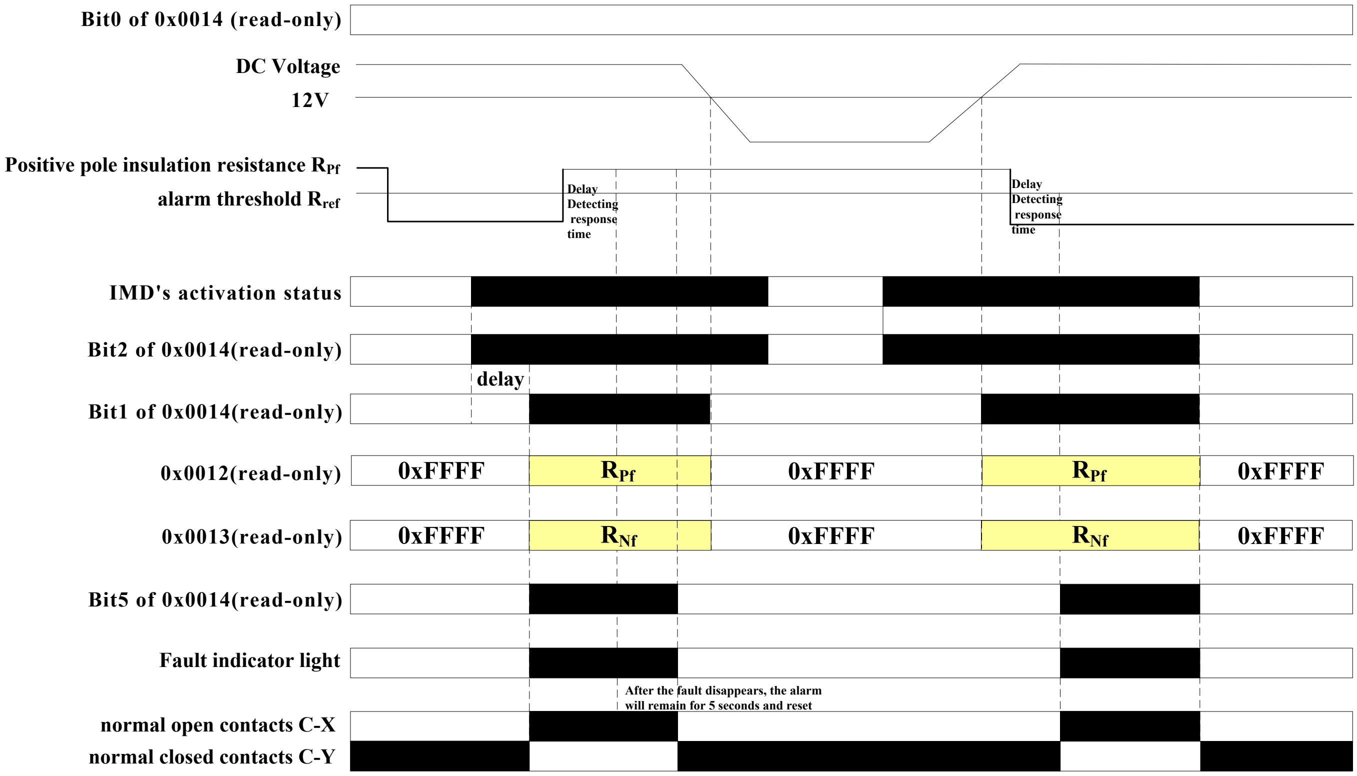


Figure 2: Example Timing Diagram in Auto Reset Mode

Figure 3: Example Timing Diagram in Non-Auto Reset Mode

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.

• IMD can be activated either by writing '0x0011' to the 0x0102 register via RS485 communication or by short-circuiting the 'R' and 'U' ports. Either method will activate the function. It can be deactivated by writing '0x0000' to the 0x0102 register and by disconnecting the 'R' and 'U' ports. Both conditions must be satisfied for deactivation, as shown in the diagram below.

<table>
<tr><td>Write to register 0x0102</td><td>0x0000</td><td colspan="2">0x0011</td><td colspan="2">0x0000</td></tr>
<tr><td>Port 'R' and 'U'</td><td colspan="2">disconnecting</td><td colspan="2">short-circuiting</td><td>disconnecting</td></tr>
<tr><td>Insulation monitoring function</td><td>deactivation</td><td colspan="3">activation</td><td>deactivation</td></tr>
</table>

Figure 4: Activating and Deactivating the Insulation Monitoring Function

• Attention, when short-circuiting the 'R' and 'U' ports, the short-circuiting should be isolated from any other circuits. The short-circuiting method can be implemented using a manual switch or a relay.

• 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 'RUN' light turns on. Conversely, after sending the deactivation command, the ground switch K disconnects, and the 'RUN' 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 >600KΩ, 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 after activating the insulation monitoring function. For systems with DC ground capacitance, the module can adaptively monitor ground capacitances up to 5uF for each pole (The capacitance of both the positive and negative poles to the ground is each less than 5uF, with a total capacitance of less than 10uF), ensuring the monitoring time does not exceed 5 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. 1s after IMD activation; 3. DC voltage ≥12V;	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 1s of IMD activation; 3. DC voltage <12V;	0x0012 as 0xFFFF 0x0013 as 0xFFFF Bit1 of 0x0014 as "0"

2.6 RS485 Communication

Users can send and receive data frames via the RS485 communication port. The circuit includes a 510Ω terminal resistor, Baud rate 9600bps, Parity None, 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.

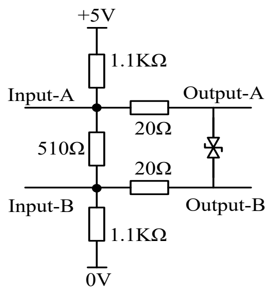


Figure 5: RS485 Internal Circuit

2.7 Communication Parameter Configuration

DIP switches are used to configure communication parameters:

• The 'ON' direction indicates setting to '1'.

• Position 1 sets the Unit for the alarm thershold.

[‘0’: Alarm resistance threshold=(Dialing value × multiplier) Ω,‘1’: Alarm resistance threshold=(Dialing value × multiplier) Ω × DC voltage V].

• Positions 2 ~ 4 set the communication address.

• Positions 5 ~ 8 set the alarm threshold.

• Position 9 sets the multiplier for the alarm threshold.

• Position 10 sets the alarm reset mode.

The setting mode is shown in the diagram on the down.

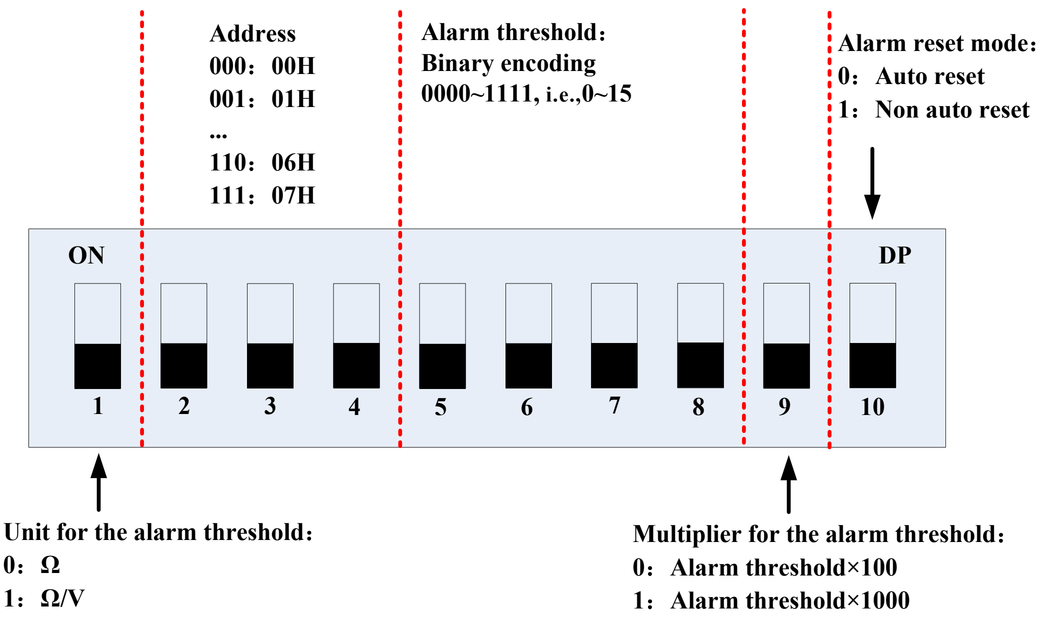
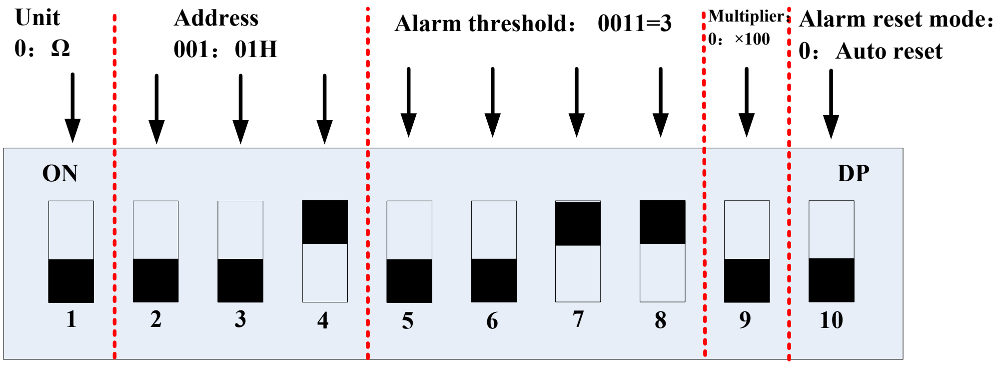
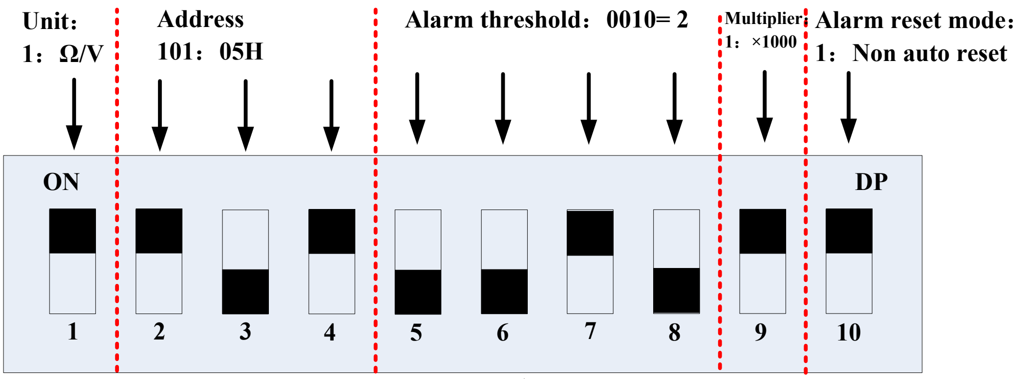


Figure 6: DIP Switch Parameter Configuration Diagram



Alarm resistance threshold=3×100（Multiplier）=300Ω(Unit for the alarm threshold)

Illustration 1



Alarm resistance threshold=2×1000（Multiplier）=2000Ω/V(Unit for the alarm threshold)

Illustration 2

2.8 (Optional function) Relay alarm

‘C’ is the common contact of the relay, ‘X’ is the normally open contact, ‘Y’ is the normally closed contact. When insulation resistance alarm occurs, the normally open contact closes and the normally closed contact opens.

Note:

① When set to auto-reset mode (DIP10 set to '0'), after an alarm is triggered, if the fault disappears or the IMD measurement conditions are no longer met, the IMD will maintain the alarm state for 5s before resetting.

② In both auto-reset and non-auto-reset modes, the alarm will reset when the IMD is deactivate.

2.9 (Optional function) Broken line detection function

Check if there is a line break between point 'G' and point 'E'. In order to detect whether the grounding point is reliably grounded, it is necessary to connect 'G' to the grounding line, and 'E' to the PE such as the ground floor or rack case. When 'G' and 'E' are disconnected, the Broken line detection function does not pass, and at this time, bit 3 position of 0x0014 is' 0 '; When 'G' is connected to 'E', bit 3 position of 0x0014 is' 1 '. Automatic detection after power on, with a detection cycle of 1 second.

3 Wiring diagram

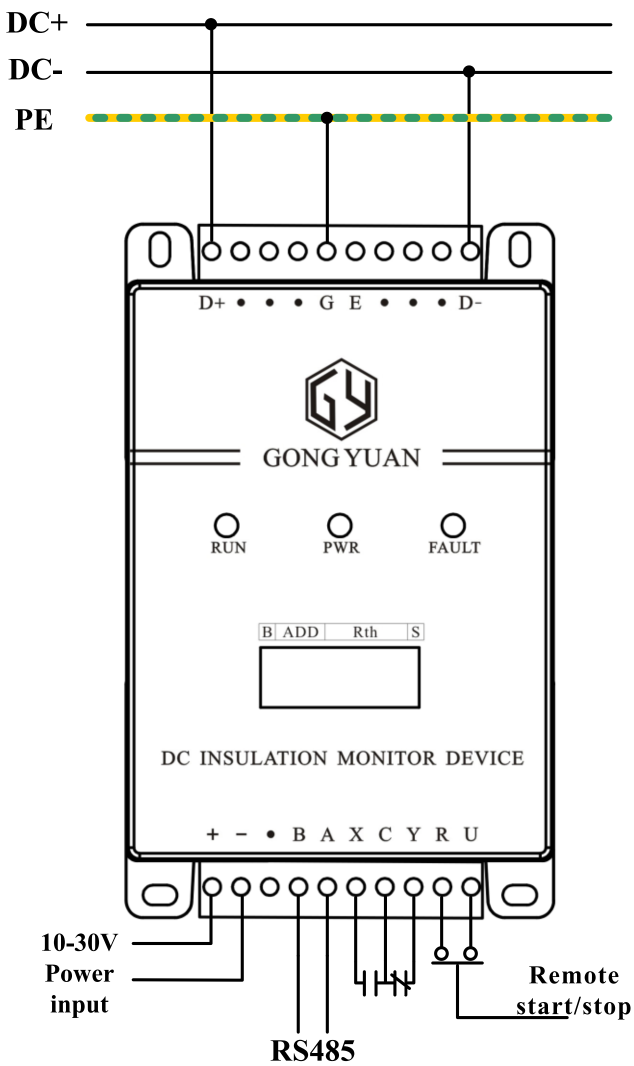


Figure 7: Wiring Diagram

Table 3: Wiring Methods

Terminal	Connections	Terminal	Connections
D+	DC positive pole	D-	DC negative pole

G	PE	E	No wiring(-GE Model connected to PE）)
+	Power input positive pole	-	Power input negative pole
A	RS485-A	B	RS485-B
X	Alarm output normally open contact	Y	Alarm output normally closed contact
C	Alarm output common contact	R	Remote start/stop input contact end
U	Remote start/stop input contact end		

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)

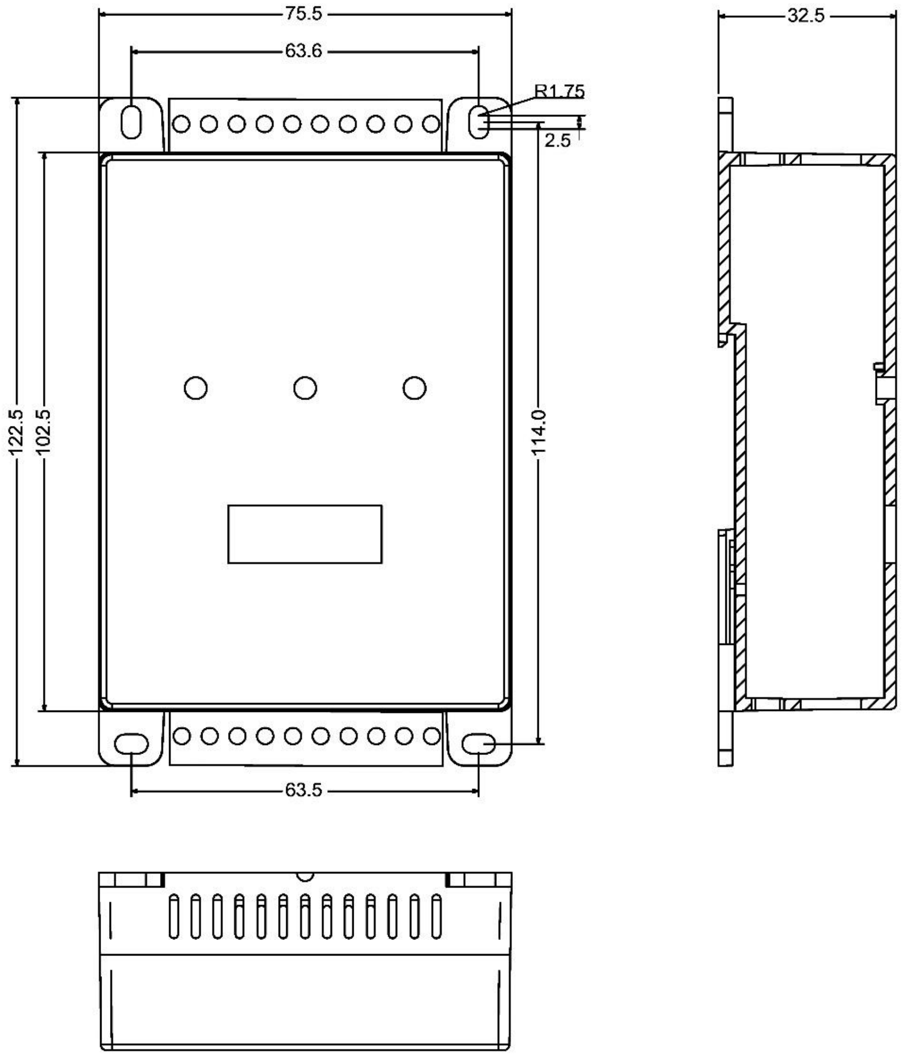


Figure 8: GYIM-DAR Dimensional Diagram

5 Electrical Parameters

Table 4: Electrical Parameters

<table>
<tr><th>Parameter</th><th colspan="2">Condition</th><th>Typical Value</th></tr>
<tr><td>DC System Voltage Measurement Range</td><td colspan="2"></td><td>0~60 Vd.c.</td></tr>
<tr><td>DC System Voltage Measurement Accuracy</td><td colspan="2">0~60Vd.c</td><td>⩽0.5%</td></tr>
<tr><td>Auxiliary Power Supply Range</td><td colspan="2"></td><td>10~30Vd.c.</td></tr>
<tr><td>Auxiliary Power Supply Power Consumption</td><td colspan="2">12V：120mA
24V：55mA</td><td>≤1.5W</td></tr>
<tr><td>Insulation Resistance Measurement Range</td><td colspan="2">DC System Voltage 12~60 Vd.c.</td><td>0Ω~600KΩ</td></tr>
<tr><td rowspan="5">Insulation Monitoring Accuracy①</td><td>R Range</td><td>V Range 12~20Vd.c</td><td>V Range 20~60Vd.c</td></tr>
<tr><td>⩽200Ω</td><td colspan="2">See the notes for details.</td></tr>
<tr><td>200Ω＜R⩽500Ω</td><td>⩽10%</td><td>⩽5%</td></tr>
<tr><td>500Ω<R≤1000Ω</td><td colspan="2">⩽3%</td></tr>
<tr><td>1kΩ<R≤60kΩ</td><td colspan="2">⩽2%</td></tr>
<tr><td rowspan="4">Response time</td><td colspan="2">C_Y = 0μF</td><td>⩽1.5s</td></tr>
<tr><td colspan="2">C_Y = 0.5μF</td><td>⩽2.5s</td></tr>
<tr><td colspan="2">C_Y = 2μF</td><td>⩽4s</td></tr>
<tr><td colspan="2">C_Y = 5μF</td><td>⩽5s</td></tr>
<tr><td>The IMD Counts the Number of Times the Ground Switch K is Turned On</td><td colspan="2"></td><td>50×10^5 times</td></tr>
<tr><td>Maximum switching voltage of alarm relay</td><td colspan="2"></td><td>400VAC/600VDC</td></tr>
<tr><td>Maximum switching current of alarm relay</td><td colspan="2"></td><td>4A</td></tr>
<tr><td>Contact resistance of relay</td><td colspan="2"></td><td><100mΩ(10mA 30mVdc)</td></tr>
<tr><td>Relay insulation resistance</td><td colspan="2"></td><td>1000MΩ(500Vdc)</td></tr>
<tr><td>Storage Temperature</td><td colspan="2"></td><td>-55℃~90℃</td></tr>
<tr><td>Operating Temperature</td><td colspan="2"></td><td>-40℃~75℃</td></tr>
<tr><td>Altitude</td><td colspan="2"></td><td>≤3500m</td></tr>
<tr><td>Operating Humidity</td><td colspan="2"></td><td>≤90%</td></tr>
</table>

Special Note: Resistance ≤ 200Ω — Below Measurement Range (100Ω as Example)

- **12V～30V / 100Ω:** Both positive-to-ground and negative-to-ground resistance readings are significantly lower than the actual resistance under test, gradually converging as voltage increases.
- **30V～60V / 100Ω:** Error narrows to **−10% to −20%**, but still exceeds the normal accuracy range.

Conclusion: When resistance is ≤ 200Ω, the measured resistance is far below the actual value; It is recommended that the resistance under test be greater than 200Ω.

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 5: Dielectric Strength Test

Voltage Application Point		Level	Test Time
D+/D- to G	DC voltage positive and negative poles to ground	3500VDC/2500VAC	≤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	3500VDC/2500VAC	≤1min
D+/D- to A/B	DC voltage positive and negative poles to RS485 port	3500VDC/2500VAC	≤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 9600bps, Parity None, Communication address 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[1] Function Code 0x06 BYTE[2] Register Address High Byte BYTE[3] Register Address Low Byte BYTE[4] Register Parameter High Byte BYTE[5] Register Parameter Low Byte BYTE[6] CRC Check Low Bit BYTE[7] CRC Check High Bit	BYTE[0] Device Address BYTE[1] Function Code 0x06 BYTE[2] Register Address High Byte BYTE[3] Register Address Low Byte BYTE[4] Register Parameter High Byte BYTE[5] Register Parameter Low Byte BYTE[6] CRC Check Low 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 *10Ω, rounded to the nearest integer (0xFFFF indicates invalid value; 0xEA60 indicates resistance >600KΩ)
	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
	0x001A	Read Version Number	01 03 00 1A 00 01 A5 CD	0x1012
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
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	Example of slave reply: FF 66 01 AB 90 Slave address is 0x01

			address	

Table 7: 0x0014 Register Bit Definitions

Register ADD	Bit	Read/Write	Definition	
0x0014	bit15~bit8	Blank	Blank	
	bit7	R	Bus Voltage Reverse Connection Alarm	0: No reverse connection of DC voltage or reverse voltage <10V
				1: Reverse DC voltage ≥10V
	bit6	R	Negative Pole Insulation Fault	0: No fault in negative pole insulation
				1: Fault in negative pole insulation, i.e., negative pole insulation resistance less than the set threshold
	bit5	R	Positive Pole Insulation Fault	0: No fault in positive pole insulation
				1: Fault in positive pole insulation, i.e., positive pole insulation resistance less than the set threshold
	bit4	R	Self-Test Result Bit	0: Self-test unsuccessful
				1: Self-test successful (default)
	Bit3	R	Broken line detection	0：'G'-'E' Disconnect
				1：'G'-'E' Connect
	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	R	Alarm Mode Query	0: Auto reset
				1: Non-auto reset

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 (6000Ω).

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

Return frame: 01 03 02 00 9C B8 2D

0x0094 = 0000 0000 1001 0100, Bit7 = 1 indicates bus voltage reverse connection, Bit3=1 'G'-'E' Connect, 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 1E 3A 8C

0x041E = 0000 0100 0001 1110, Bit7 = 0 indicates no reverse connection of bus voltage, Bit3=1 'G'-'E' Connect,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
2023/12	©2023V1	V10	Final Version
2024/09	@2024V1	V11	The alarm relay output function has become an optional feature; Add optional function: PE Broken line detection;
2025/07	@2025V1	V12	In auto-reset mode (DIP10 set to '0'), the module will maintain the alarm state for 5 seconds after fault clearance before resetting.
2026/4	@2026V1	V1012	Change the insulation resistance measurement range: 0Ω ~ 600kΩ. Resistance resolution 10 Ω