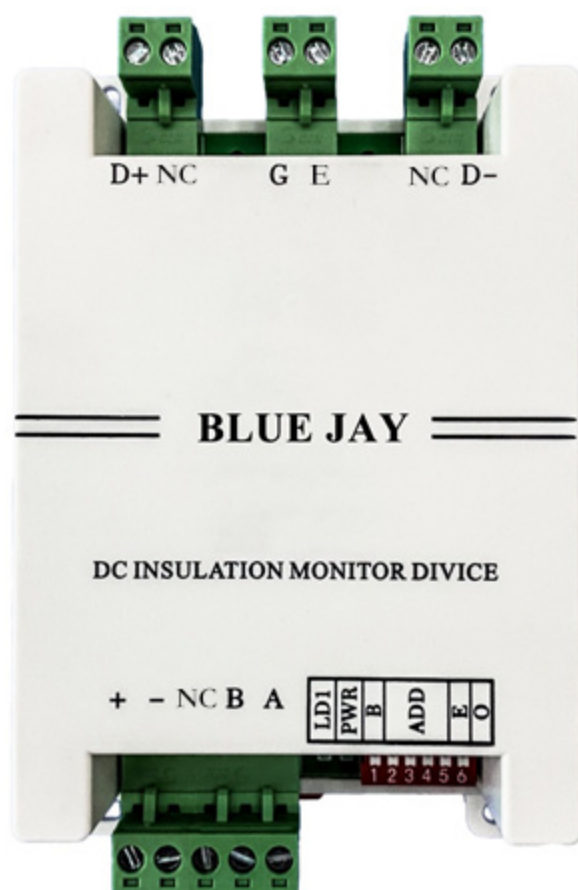


# GYDCG-UBCS1-ST DC Insulation Monitor

## User Manual



Version: 1.12

Revision: 2024.7

## Read me

**When you use GYDCG-UBCS1-ST, be sure to read this user manual carefully, and be able to fully understand the implications, the correct guidance of operations in accordance with user manual, which will help you make better use of GYDCG-UBCS1-ST, and help to solve the various problems at the scene.**

1. Before turning on the power supply, be sure that the power supply within the provisions of the instrument;
2. When installation, the current input terminal must non-open, voltage input terminals must Non-short circuit;
3. Communication terminal (RS485) is strictly prohibited to impose on high pressure;
4. Be sure the instrument wiring consistent with the internal system settings;
5. When communicating with the PC, instrument communication parameters must be consistent with the PC.



- **Please read this user manual carefully**
- **Please save this document**

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## 1. - SUMMARIZE

GYDCG-UBCS1-ST is a DC insulation monitoring device based on MODBUS protocol, including DC to ground insulation impedance monitoring, DC voltage monitoring, DC voltage reverse connection alarm, ground wire disconnection detection function and other safety monitoring functions. It can be used for electric vehicle DC charging system, photovoltaic system, energy storage system, DC grid 100V~1000V.

GYDCG-UBCS1-ST has the function of starting and stopping insulation monitoring. After insulation monitoring is started, the insulation resistance of positive and negative poles to ground can be monitored in real time. The monitoring result is not affected by DC voltage fluctuation, and is not affected by the symmetry of insulation resistance of positive and negative poles, external self-suspension grounding line disconnection line function.

### FEATURES

- Monitor the insulation resistance value:100~1000VDC;
- Insulation resistance measurement range 0KΩ~10MΩ;
- Detect DC voltage value, range 100 ~ 1000 VDC.;
- RS485 communication, MODBUS RTU communication;
- DC voltage reverse connection alarm function;
- External self-test of insulation monitoring module;
- Ground line disconnection detection;
- Two types of work models available: Automatically switching battery model (Non-equilibrium battery method, using the local power supply system); Fixed power network model (balanced battery method, using the local power supply system).

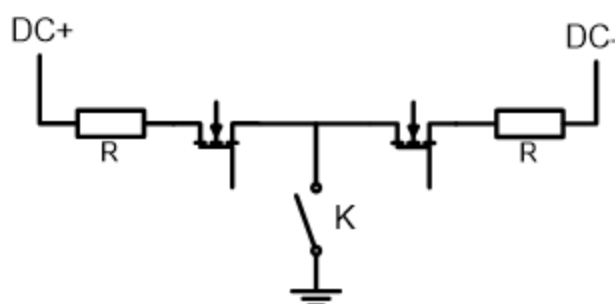
### APPLICATIONS

- Photovoltaic system;
- DC systems such as DC grids;
- Electric vehicle DC charging system;
- Energy storage system.

## 2. - Function introduction

### 2.1. - Insulation monitoring working principle

The product can send communication frames through RS485 to turn on or off the insulation monitoring function. After the insulation monitoring function is turned on, the high-voltage grounding switch K is closed and the real-time measurement of insulation resistance is realized. After the insulation monitoring function is turned off, the high-voltage grounding switch K is disconnected. The host machine can send read command to read the insulation resistance value of positive and negative poles at any time.



### 2.2. - Insulation monitoring working mode

The insulation resistance monitoring can be realized only when the DC voltage is between 100V and 1000V.

By writing the 0x0100 register, you can select two working modes: Automatic switching bridge mode / Fixed bridge mode.

Automatic switching bridge mode means that the insulation monitor automatically switches the internal positive and negative poles to ground resistance.

As shown in Figure, [RP=3MΩ, RN=600KΩ] and [RP=600KΩ, RN=3MΩ] switch between each other. This mode monitors the insulation resistance to ground, and can read the 0x0012 and 0x0013 registers, that is, the insulation resistance values of the positive and negative poles to ground.

The positive and negative voltages to ground and negative to ground voltage are not monitored, and the 0x0015 and 0x0016 registers are invalid values (0xFFFF).

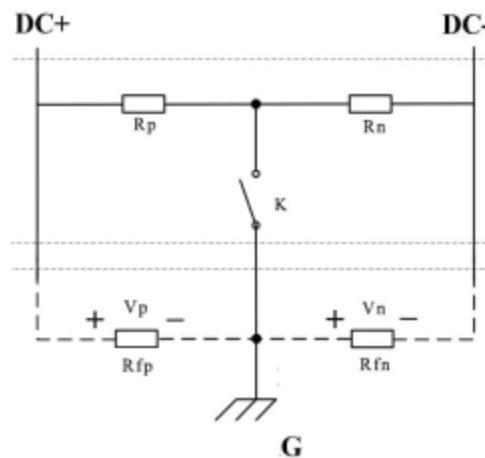
Fixed bridge mode means that the internal positive and negative pole-to-ground resistances (RP and RN) of the insulation monitor are fixed values. This mode monitors the positive and negative pole-to-ground voltages and can read the 0x0015 and 0x0016 registers, which are the positive and negative pole-to-ground voltage values., the insulation resistance of the positive and negative poles to ground is not monitored, and the 0x0012 and 0x0013 registers are invalid values

(0xFFFF). The fixed bridge mode can be realized by writing the 0x0100 register. The fixed bridge resistance is [ $R_P=3M\Omega$ ,  $R_N=3M\Omega$ ].

### Working mode table

Write 0x0100	Working mode	Bridge resistor	Reading status
0x0004	Automatically switch to bridge mode	$\{R_P=3M\Omega, R_N=600K\Omega\}$ and $\{R_P=600K\Omega, R_N=3M\Omega\}$ switch between	Positive and negative pole-to-ground voltages $V_P$ and $V_N$ are both invalid values and display 0xFFFF.  Insulation resistance to ground $R_{fP}$ and $R_{fN}$ are both valid values
0x0000	Fixed bridge mode	$R_P=3M\Omega, R_N=3M\Omega$	Insulation resistance to ground $R_{fP}$ and $R_{fN}$ are both invalid values and display 0xFFFF.  Positive and negative pole-to-ground voltages $V_P$ and $V_N$ are both valid values.

After the module is powered on, it defaults to automatically switching to bridge mode. After changing the working mode, turning the insulation monitoring on and off will not change the working mode status. Users can check the current working mode by querying bit8-bit10 of the 0x0014 register.

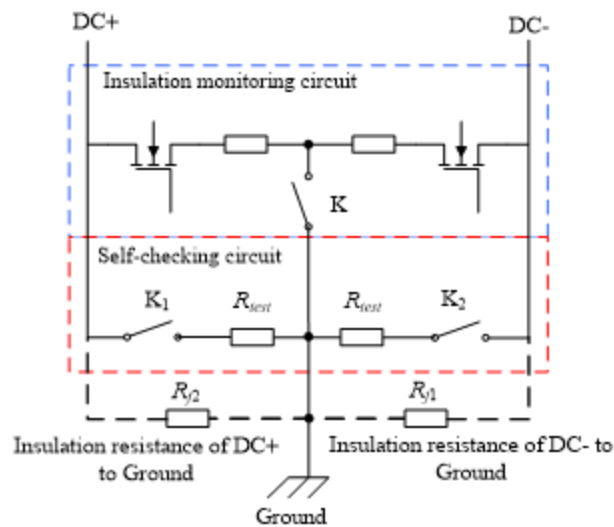


### 2.3. - Insulation monitoring internal self-test function

When the DC voltage is  $\geq 100V$  and the insulation monitoring module is turned off, the module will automatically self-test on its internal circuit (no control required) with a self-test period of 5 seconds.

When the sampled value of the monitored bridge voltage matches the bridge resistance value, it means that the self-test is passed.

By reading Bit4 of the 0x0014 register can judge the self-test whether is passed or not. passed self-test is "1"; not passed is "0". If the self-test results are not updated, the last result will remain unchanged.



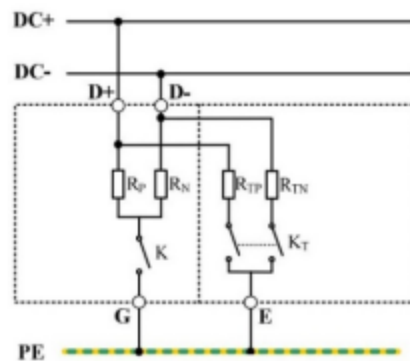
## 2.4. - Insulation monitoring external self-test function

GYDCG-UBCS1-ST has self-test function which achieve self-test by switching the DC-to-ground resistance, as shown in the figure below.

In automatic switching bridge mode, when the DC voltage is  $>100V$  and the insulation monitoring function is turned on. (Grounding switch K is closed), and the self-test function is turned on (self-test switch  $K_T$  is closed), the self-test is passed.

If the insulation monitoring can detect the resistance values of the switched resistors  $R_{TP}$  and  $R_{TN}$ , it means that the self-test has passed. At this time, bit4 of 0x0014 is '1';

If the resistance values of  $R_{TP}$  and  $R_{TN}$  cannot be detected, it means the self-test has failed, and bit4 of 0x0014 is '0' at this time. When the self-test is not working, bit4 of 0x0014 defaults to '0'. The  $R_{TP}$  and  $R_{TN}$  used in this module are both  $750\text{ K}\Omega$ .



External self-test can detect whether the insulation monitoring circuit can work normally, whether the grounding switch K works reliably, whether the grounding point 'G' of the insulation monitoring is reliably connected to the ground wire, and whether the ground wire is reliably connected to the earth such as the ground bar or shell.

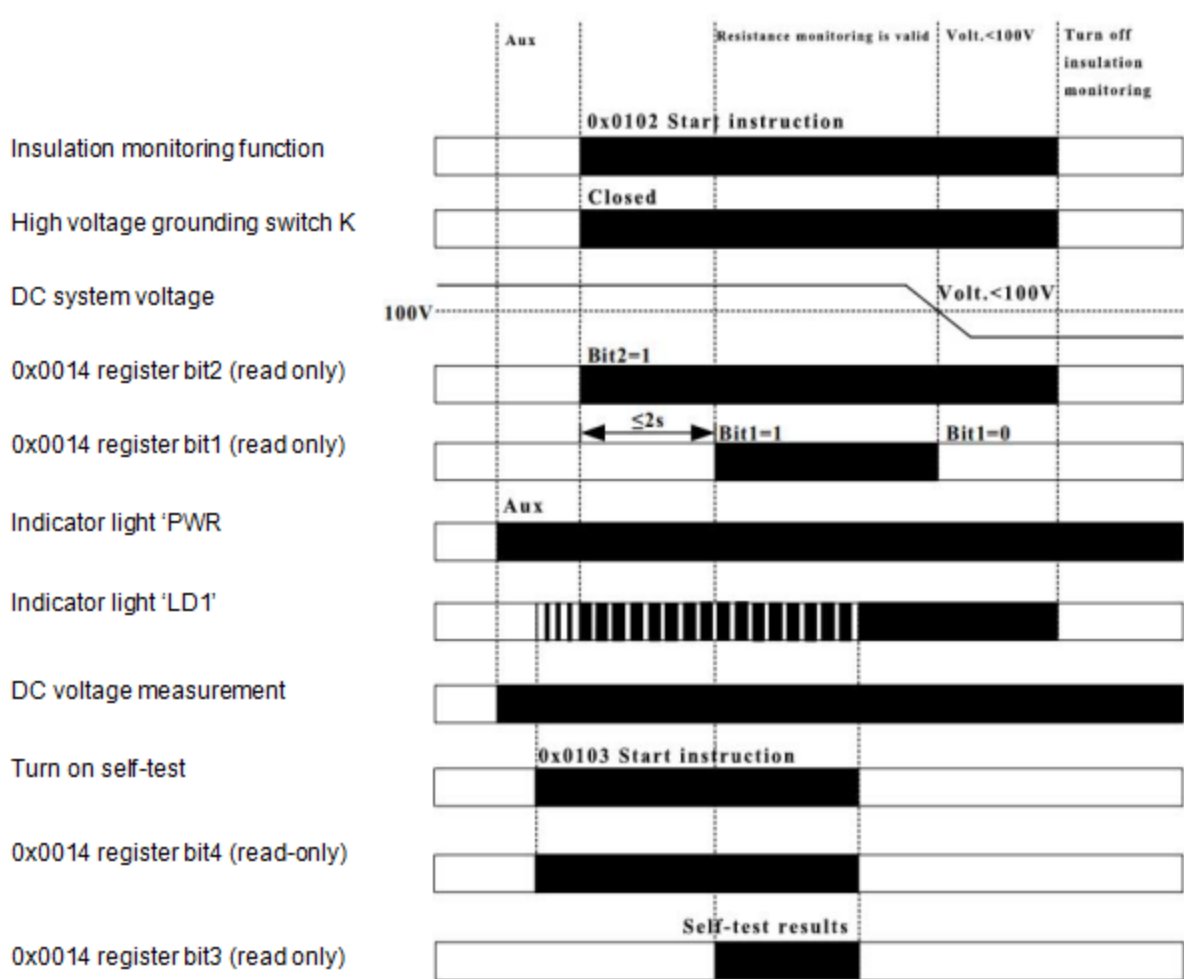
In order to detect whether the grounding point is reliably grounded, 'G' needs to be connected to the system grounding wire, and 'E' needs to be connected to the earth line such as the ground bar or chassis. When 'G' and 'E' are disconnected, the self-test fails. you can detect whether it is reliably grounded. Therefore, it is not allowed to connect 'G' and 'E' directly on the terminals, otherwise it will not be possible to detect whether the ground point is grounded. The connection method is as shown in the figure below.



Because of the self-test switch  $K_T$  uses a relay, so the self-test opening and closing actions must not be too frequent, and the total number of self-test opening and closing times must not exceed 100,000 times.



## 2.5. - Insulation resistance monitoring function



### Insulation monitoring function control sequence

- After the product is powered on, the 'PWR' light turns on and the DC voltage is continuously monitored.
- Insulation monitoring can be turned on and off by writing to the 0x0102 register.
- You can determine whether the current insulation monitoring is on or off by reading bit2 of the 0x0014 register.
- After sending the opening command to the module, the grounding switch K is closed and the 'LD1' light is on; after sending the closing command to the module, the grounding switch K is open and the 'LD1' light is on.
- The conditions for the effective DC-to-ground insulation resistance in Table 2 below must be met. The insulation resistance values of 0x0012 and 0x0013 are valid values. The resistance values of 0x0012 and 0x0013 can be read; if the resistance value is  $> 10M\Omega$ ,

0xEA60 is displayed, which is 60000; if The values of 0x0012 and 0x0013 are invalid values, that is, 0xFFFF is displayed, which is 65535.

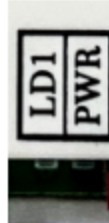
- Users can read the insulation resistance value as soon as 0.7s~2s after turning on the insulation monitoring function. For the presence of DC capacitance to ground, the module can adaptively monitor ground capacitance below 3uF (the positive and negative capacitances to ground are below 3uF respectively, and the total capacitance is below 6uF). When there is capacitance to ground, the monitoring time does not exceed 2s.

### DC to ground resistance/voltage monitoring

Measured value	Valid/invalid	Conition	Readable
DC to ground insulation resistance value	Valid	<b>Need to meet both:</b> <ol style="list-style-type: none"> <li>1. Send the instruction to turn on insulation monitoring to 0x0102;</li> <li>2. 0.7s~2s after turning on the module;</li> <li>3. DC voltage <math>\geq 100V</math>;</li> <li>4. Set to automatically switch to bridge mode;</li> </ol>	0x0012 is the positive to ground resistance RfP 0x0013 is the positive to ground resistance RfN Bit1 of 0x0014 is "1"
	Invalid	<b>Meet any of the following:</b> <ol style="list-style-type: none"> <li>1. Send the turn off insulation monitoring command to 0x0102;</li> <li>2. Turn on the module within 0.7s~2s;</li> <li>3. DC voltage <math>&lt; 100V</math>;</li> <li>4. Set to fixed bridge mode;</li> </ol>	0x0012 is 0xFFFF 0x0013 is 0xFFFF Bit1 of 0x0014 is "0"
DC to ground voltage value	Valid	<b>Need to meet both:</b> <ol style="list-style-type: none"> <li>1. Turn on fixed bridge mode to 0x0100;</li> <li>2. Send the instruction to turn on insulation monitoring to 0x0102;</li> </ol>	0x0015 is the positive to ground voltage VP 0x0016 is the negative ground voltage VN Bit8~bit10 of 0x0014 is "000"
	Invalid	<b>Meet any of the following:</b> <ol style="list-style-type: none"> <li>1. Turn on automatic switching bridge mode to 0x0100;</li> <li>2. Send the shutdown insulation monitoring command to 0x0102</li> </ol>	0x0015 is 0xFFFF 0x0016 is 0xFFFF Bit8~bit10 of 0x0014 is "100"
External self-test measured value	Valid	<b>Need to meet both:</b> <ol style="list-style-type: none"> <li>1. Send the instruction to turn on insulation monitoring to 0x0102;</li> <li>2. 0.7s~2s after turning on the module;</li> <li>3. Send the enable self-test command to 0x0103;</li> <li>4. DC voltage <math>\geq 100V</math>;</li> <li>5. Set to automatically switch to bridge mode;</li> </ol>	0x0012 is RfP, approximately 750 K $\Omega$ 0x0013 is RfN, which is approximately 750 K $\Omega$ Bit1 of 0x0014 is "1" Bit3 of 0x0014 is "1"
	Invalid	When the above conditions cannot be met at the same time	Bit1 of 0x0014 is "0" or Bit3 of 0x0014 is "0"

## 2.6. - LED indicator

After the module is powered on, the PWR indicator is on.



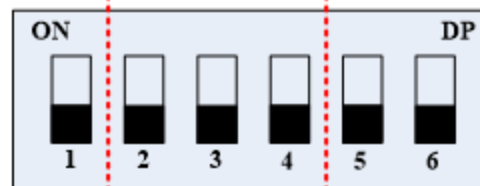
'LD1' light logic	
Insulation monitoring function is ON, and the self-test function is OFF	'LD1 lights Normally ON
Insulation monitoring function is ON, and the self-test function is ON	'LD1' is ON for 1.5 seconds and OFF for 0.5 seconds
Insulation monitoring function is OFF, self-test function is ON	'LD1' is ON for 0.5 seconds and OFF for 1.5 seconds
Insulation monitoring function is OFF, and the self-test function is OFF	'LD1 lights Normally OFF

## 2.7. - Communication parameter configuration bit

Baud rate	Address	Parity check
1: 19200bps	000: 00H	00: NONE
0: 9600bps	001: 01H	01: ODD
	010: 02H	10: EVEN
	011: 03H	
	100: 04H	
	101: 05H	
	110: 06H	
	111: 07H	

### DIP switches used to configure

**Bit 1:** set the baud rate;  
**Bits 2-4:** set communication address;  
**Bits 5-6:** set parity check;  
**"ON":** direction means set to "1".



### 3. - TECHNICAL PARAMETERS

#### Basic parameters

Parameter	Value		
Power supply	10-30VDC, Power 3w		
DC voltage range	100V~1000V		
DC voltage measurement accuracy	$\leq 2V+0.5\%$		
Insulation resistance measurement range	1K $\Omega$ ~10M $\Omega$ (DC System voltage:100V~1000V)		
	<b>C<sub>Y</sub> range</b>	<b>Resistance range</b>	<b>Accuracy</b>
Insulation monitoring accuracy (When :DC voltage:100V-1000V)	0~0.8 $\mu$ F	$\leq 60k\Omega$	$\leq 3k\Omega$
		60k $\Omega$ <R $\leq$ 1M $\Omega$	$\leq 5\%$
	0.8 $\mu$ F ~3 $\mu$ F	$\leq 60k\Omega$	$\leq 6k\Omega$
		60k $\Omega$ <R $\leq$ 1M $\Omega$	$\leq 20\%$
Insulation monitoring function switching times	50*10 <sup>5</sup> times		
Self-test circuit switch frequency	$\leq 1 \times 10^5$		
Insulation resistance value update time after turning on	After 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
Off-line pressure test	<2mA		
Standard	IEC 61851-23 (2014-03):2014-11		
Humidity	85%		
Storage temperature	- 55°C ~90°C		
Operating temperature	- 40°C ~75°C		

Notes:

1.When facing the ground insulation resistance  $R_{ISO+}$  and negative insulation resistance to ground  $R_{ISO-}$ , The difference is too large, Multiplier of difference>5 times,  $R_{ISO+}$  and  $R_{ISO-}$  Large resistors may not be typical values.

2.C<sub>Y</sub> Refers to the positive and negative Y capacitance values of the system bus to ground.

**Other parameters**

<b>Pressure point</b>	<b>Maximum voltage rating</b>	<b>Time</b>
DC+/DC- To GND	4200VDC/3000VAC	≤1min
Power supply +/- To GND	3500VDC/2500VAC	≤1min
RS485 A/B To GND	3500VDC/2500VAC	≤1min
DC+/DC- To Power supply +/-	4200VDC/3000VAC	≤1min
DC+/DC- TO A/B	4200VDC/3000VAC	≤1min

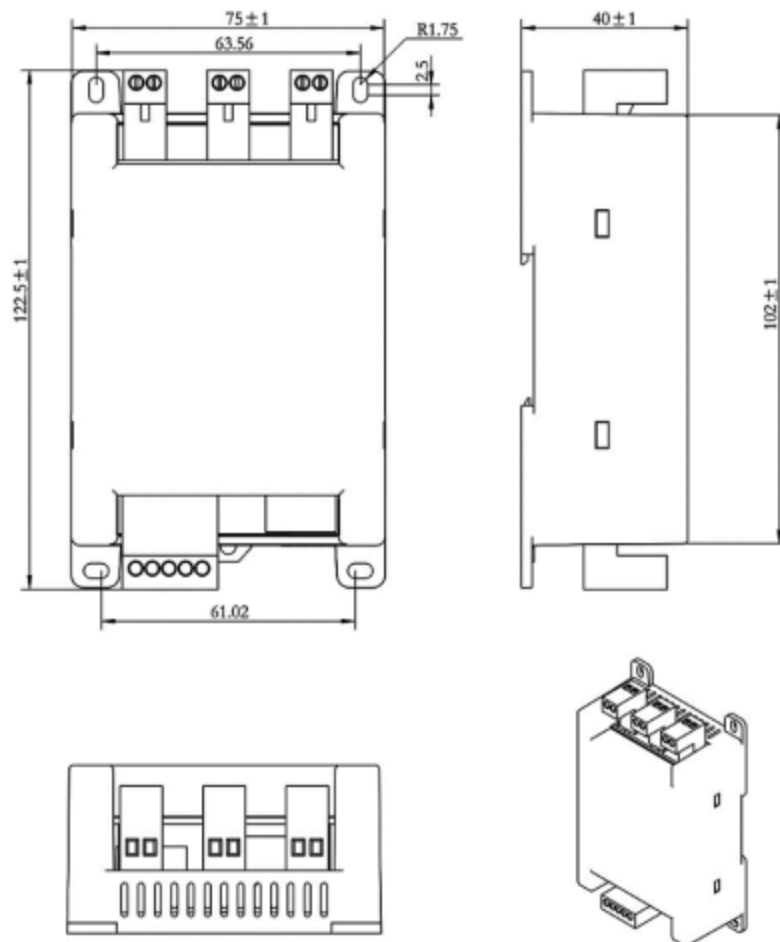
Note:

The power supply side (+/-), RS485(A/B), and Ground(G) should be isolated from each other.

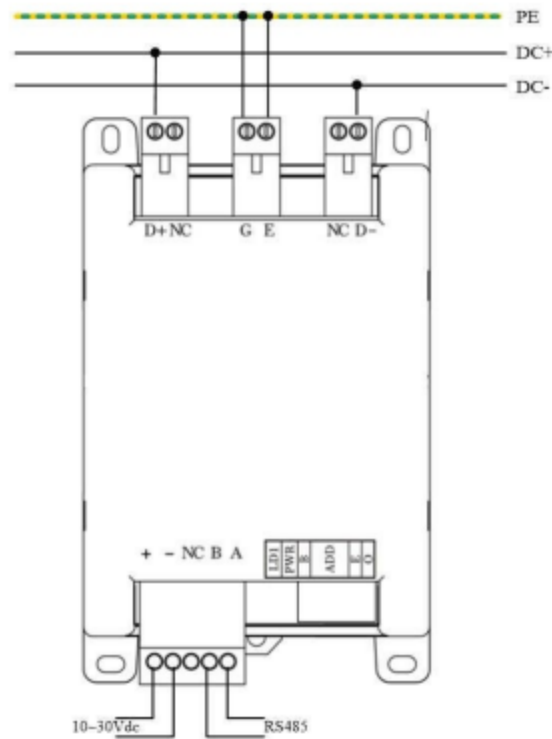
## 4. - INSTALLATION AND STAR UP

### 4.1. - Mounting

GYDCG-UBCS1-ST module can be installed by rail or screw. Guide rails use standard width of 35mm. Overall dimensions are shown in Figure below: (Unit: mm)



## 4.2. - Connection terminal



Terminal	Connection mode	Definition
D+	Positive pole of DC	DC interface
D-	Negative pole of DC	
A	RS485-A	Communication
B	RS485-B	
+	Positive pole of power supply	10-30VDC
-	Negative pole of power supply	
G	System ground wire	
E	Earth or chassis	
NC	Backup	

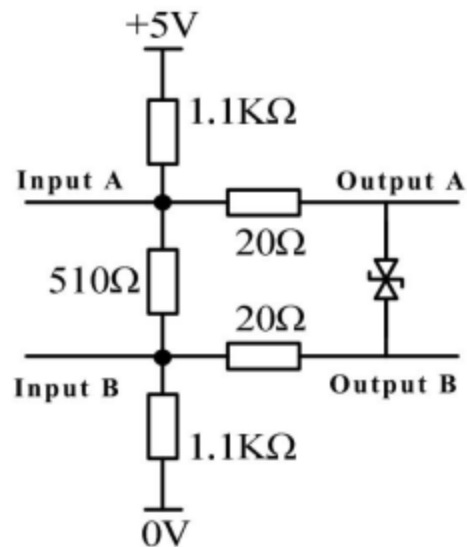
### Note:

Terminal "E" has a disconnection detection function. If do not use this function, you need to short-circuit terminal "G" or "E".

## 5. - COMMUNICATION INTERFACE

### 5.1. - Connection for RS485

Users can send and receive data frames through the RS485 communication port. The circuit is equipped with 510Ω terminal resistance. For details, see [communication protocol](#). Terminals A and B correspond to RS485 outputs A and B respectively.





## 5.2. - Communication protocol

GYDCG-UBCS1-ST use standard Modbus RTU protocol, 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 interval between each byte in the sent frame must not exceed 20ms; otherwise, the frame will be cleared. This module works in slave mode.

### Modbus RTU Frame Format:

<b>Address code</b>	<b>1 BYTE</b>	Slave device address <b>1-247</b>
<b>Function code</b>	<b>1 BYTE</b>	Indicates the function codes like read coils / inputs
<b>Data code</b>	<b>4 BYTE</b>	Starting address, high byte Starting address, low byte Length of registers, high byte Length of registers, low byte
<b>Error Check code</b>	<b>2 BYTE</b>	Cyclical Redundancy Check ( <b>CRC</b> )

### MODBUS FUNCTIONS:

<b>Code</b>	<b>Meaning</b>	<b>Description</b>
<b>FUNCTION 03</b>	Read hold register	This function permits to read all the electrical parameters
<b>FUNCTION 06</b>	Write single register	This function permits to write a value into a single holding register.

### 5.3. - Command samples

#### 5.3.1 - Read Command (Function x 03)

**Sample 1** Read the DC bus voltage and positive and negative insulation resistance to the ground(read 4 registers)

**Host inquiry:**

01 03 00 10 00 04 45 CC

**Slave response:**

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

Notes:

Read the DC voltage 0X07D0 (200V),  
Read the positive insulation resistance 0XEA60 (infinite),  
Read the negative insulation resistance 0X0258 (600KΩ).

Notes:

Only when the DC voltage is between 100V~1000V, Insulation resistance monitoring can be realized. If DC voltage is low than 100V, or it is turned on within a short time, the insulation resistance read is 0xFFFF (means invalid number).

If the read insulation resistance value is a valid number, the insulation resistance value monitoring range is between 1KΩ~10MΩ. When the measured value is greater than 10MΩ, the value received by the communication is 0xEA60 (means infinity).

**Sample 2**      Read IO status**Host inquiry:**

01 03 00 14 00 01 C4 0E

**Slave response:**

(1) 01 03 02 00 84 B8 27

**Means that:**

0x0084=0000 0000 1000 0100,  
Bit10, Bit9, Bit8=000 represents fixed bridge mode,  
Positive bridge resistance is 3MΩ, Negative bridge resistance is 3MΩ,  
Bit7=1 means the bus voltage is reversed.  
Bit2=1 The insulation monitoring function is turned on.  
Bit1=0 The insulation resistance value is invalid.

(2) 01 03 02 04 1E 3A 8C

**Means that:**

0x041E=0000 0100 0001 1110,  
Bit10=1 means automatic switching of bridge mode.  
Bit7=0 means there is no reverse connection of the bus voltage.  
Bit4=1 means self-test passed,  
Bit3=1 means the self-test circuit is turned on.  
Bit2=1 The insulation monitoring function is turned on.  
Bit1=1 The insulation resistance value is valid.

**5.3.2 - Write Command (Function x 06)****Sample 1**      Turn on insulation monitoring:**Host inquiry:**

01 06 01 02 00 11 E9 FA

**Slave response:**

01 06 01 02 00 11 E9 FA

**Sample 2**      Turn off insulation monitoring:**Host inquiry:**

01 06 01 02 00 00 29 F6

**Slave response:**

01 06 01 02 00 00 29 F6

## 5.4. - Register map

Function	Register	Data	Description
0x03	0x0010	DC bus voltage	Unit 0.1V,16-bits <b>01 03 00 10 00 01 85 CF</b>
	0x0012	Insulation resistance of DC+ to Ground	Unit K $\Omega$ , take an integer <b>01 03 00 12 00 01 24 0F</b> (0xFFFF: invalid value; 0xEA60: resistance value greater than 10M $\Omega$ )
	0x0013	Insulation resistance of DC- to Ground	Unit K $\Omega$ , take an integer <b>01 03 00 13 00 01 75 CF</b> (0xFFFF: invalid value; 0xEA60: resistance value greater than 10M $\Omega$ )
	0x0014	Status bit	Refer to: <a href="#">chapter 5.3.1</a> <b>01 03 00 14 00 01 C4 0E</b>
	0x0015	Positive pole to ground voltage value	Unit 0.1V, take an integer <b>01 03 00 15 00 01 95 CE</b>
	0x0016	Negative pole to ground voltage value	Unit 0.1V, take an integer <b>01 03 00 16 00 01 65 CE</b>
	0x001A	Read version number	0x52A2 <b>01 03 00 1A 00 01 A5 CD</b>
0x06	0x0102	Insulation monitoring control	Turn on insulation monitoring function <b>01 06 01 02 00 11 E9 FA</b>
			Turn off insulation monitoring function <b>01 06 01 02 00 00 29 F6</b>
	0x0103	Self-test control	Turn on self-test <b>01 06 01 03 00 13 39 FB</b>
			Turn off self-test <b>01 06 01 03 00 00 78 36</b>
0x0100	Automatically switch to bridge mode	Positive bridge resistance and negative bridge resistance switch each other <b>01 06 01 00 00 04 89 F5</b>	
	Fixed bridge mode	Positive bridge resistance is 3M $\Omega$ , negative bridge resistance is 3M $\Omega$ <b>01 06 01 00 00 00 88 36</b>	
0xFF	0X66	Host reads the slave address	Example: Host inquiry: <b>FF 66 A5 AA 2B</b> Slave response: <b>FF 66 01 AB 90</b> The slave address is <b>0x01</b>

**5.4.1.- 0x0014 Register bit definition**

Bit	Definition	
bit15~bit11	Null	Null
bit10:bit9: bit 8	Present working mode	000: Fixed bridge mode
		100: Automatically switch to bridge mode (default)
bit7	Bus voltage reverse connection alarm	0: There is no reverse connection of DC voltage or the reverse connection voltage is less than 100V
		1: DC reverse voltage is greater than 100V
bit4	Self-test result bit	1: Self-test passed
		0: Self-test not passed or self-test is invalid
bit3	Self-test function query	1: Self-test circuit is turned on, and the self-test switch KT is closed.
		0: Self-test circuit is closed and the self-test switch KT is disconnected.
bit2	Insulation monitoring function turned on or off	0: Insulation monitoring function turned off and the grounding switch K is disconnected.
		1: Insulation monitoring function turned on and the grounding switch K is closed.
bit1	Insulation resistance monitoring valid or invalid	0: Insulation resistance monitoring has not been completed, and the resistance value is an invalid value.
		1: Insulation resistance monitoring is valid and the resistance value can be read

## 6. - SAFETY CONSIDERATIONS



All installation specification described at the previous chapters named:  
**INSTALLATION AND STARTUP, INSTALLATION MODES and SPECIFICATIONS.**

Please note that with the instrument powered on, the terminals could be dangerous to touching and cover opening actions or elements removal may allow accessing dangerous parts. This instrument is factory-shipped at proper operation condition.

- ◆ The device must have a professional installation and maintenance
- ◆ Any operation of the device, you must cut off the input signal and power;

## 7. - MAINTENANCE

The GYDCG-UBCS1-ST does not require any special maintenance. No adjustment, maintenance or repairing action should be done when the instrument is open and powered on, should those actions are essential, high-qualified operators must perform them.

Before any adjustment, replacement, maintenance or repairing operation is carried out, the instrument must be disconnected from any power supply source.

When any protection failure is suspected to exist, the instrument must be immediately put out of service. The instrument's design allows a quick replacement in case of any failure.

For any inquiry about the instrument performance or any failure, contact to Blue Jay's technical service.

*Blue Jay - After-sales service*

E-mail: [tech@cqbluejay.com](mailto:tech@cqbluejay.com)