685

AIM-D100-CA series DC Insulation Monitor

User Manual V1.2

Acrel Co., Ltd.

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The contents of this description will be updated and amended constantly, and it is inevitable that there will be a slight discrepancy between the physical product and the description in the product function upgrading. Please refer to the physical product purchased and obtain the latest version of the description through www.acrel-electric.com or sales channels.

Modified Records

No.	Date	Version	Description
1	2023.10.20	V1.0	First version
2	2024.05.20	V1.1	Modified power supply, voltage, temperature; appearance of the size of the accuracy of 0.1; communication to increase the 06 example, registers to increase 40H, 42H, increase the time description
3	2025.02.10	V1.2	Updated overview images, wiring diagrams, communication, application, added 9 Fault Resolution, updated bottom
Note:			

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AIM-D100-CA series DC Insulation Monitor

1 Introduction

With the development of industry, many electrical equipment and factory equipment are powered by DC systems, and the positive and negative poles of the DC system are not grounded. For ungrounded (IT) power distribution systems, insulation resistance should be monitored to ensure the safe operation of the power supply system.

AIM-D100-CA series DC insulation monitor can be applied in DC system of 100~1000V, used for on-line monitoring of DC ungrounded system positive and negative pole to ground insulation resistance, when insulation resistance is lower than the set value, it will send out warning or alarm signal.

The product is mainly designed for DC 100~1000V range of electric vehicle charging device insulation monitoring, but also can be applied in energy storage DC, substation DC screen, UPS power supply system, photovoltaic DC system and other DC power grid DC system.

2 Model Description

AIM – D 100 – CA I

- I: Extra Features: Default -normal; I - Current Monitoring
- CA: Model Code: CA - Charging Equipment
- 100: Design Serial Number: 100 - Initial Serial Number
- D: Function Code: D - DC Monitoring
- AIM: Product Name: AIM - Acrel Insulation Monitor

3 Functional Characteristics

- Resistance monitoring. The product can monitor the insulation resistance of the positive and negative poles of the DC system to the ground. When the insulation resistance is lower than the set warning and alarm values, it can send out warning and alarm signals.
- Voltage monitoring. The product can monitor the voltage between the positive and negative poles of the DC system and the voltage between the positive and negative poles with respect to ground. The measurement range is 100~1000V.
- Current monitoring function. The product can monitor the current of DC system, only the AIM-D100-CAI model has this function.
- LED indication. The product panel has operation, communication, and fault LED indicators.

■ Communication function. The product has RS485 interface and adopts Modbus-RTU protocol.

■ Metal casing. The product adopts a metal shell and can be wall-mounted or guide rails-mounted.

■ Plug-in terminals. The product adopts plug-in terminal wiring, which is convenient.

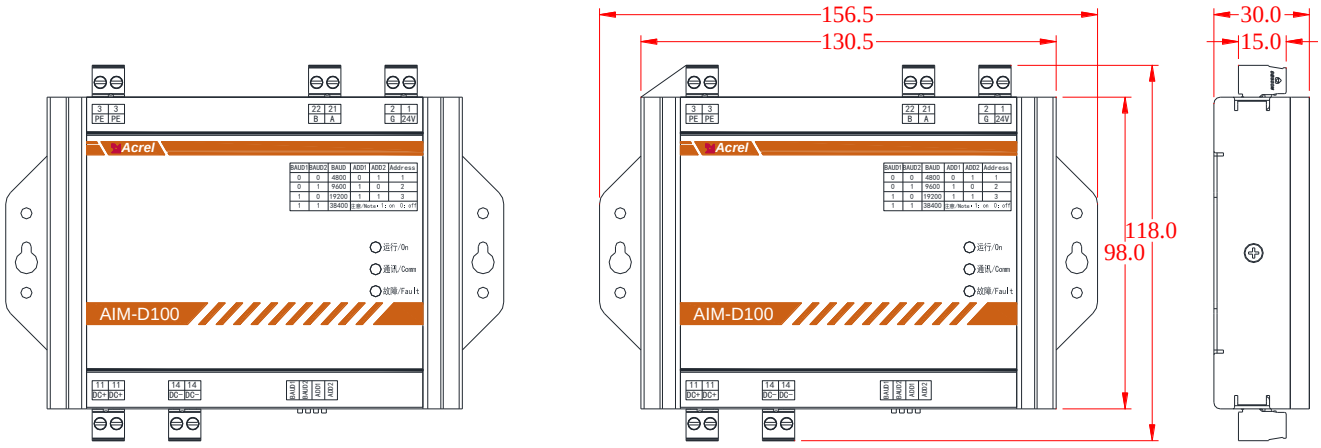
4 Technical Parameters

Technical Parameter		Technical Specifications
Auxiliary power		DC 12~36V
Maximum power consumption		≤3W
Voltage monitoring	Voltage range	DC 100~1000V
	Accuracy	0.5
Current monitoring	Current monitoring	Connect with current shunt base on rated current; CAI models only
	Accuracy	5%
Insulation monitoring	Insulation resistance range	1kΩ~10MΩ
	Warning and alarm range	10kΩ~10MΩ
	Accuracy	1~10kΩ: ±1k; 10k~500k: ≤3%
	System leakage capacitance	≤5μF
	Insulation monitoring speed	500ms/cycle; 1000ms/cycle
Alarm method		LED indicator
Communication		RS485 interface, Modbus-RTU protocol
Installation		Wall-mounted installation or DIN-rail installation (plastic stent included)
Protection level		IP30
Environment	Operating temperature	-20~+60℃
	Storage temperature	-25~+75℃
	Relative humidity	<95%, without condensation
	Altitude	<2000m

5 Installation and Connection

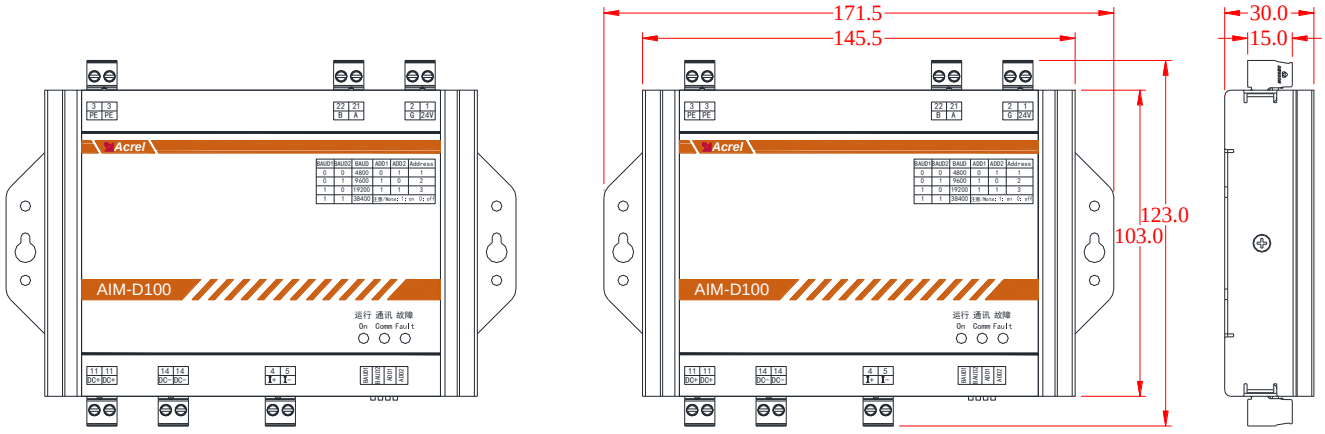
5.1 Shape and Size

The overall dimensions of the AIM-D100-CA DC Insulation Monitor are shown in the figure below. (Unit: mm)



Appearance Front view Side view

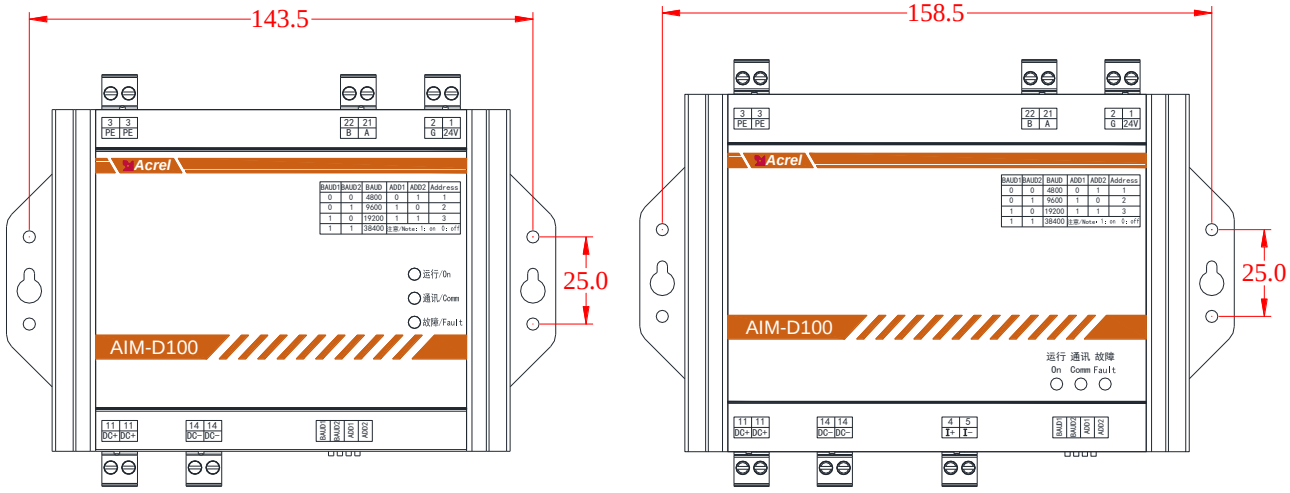
The overall dimensions of the AIM-D100-CAI DC Insulation Monitor are shown in the figure below. (Unit: mm)



Appearance Front view Side view

5.2 Installation

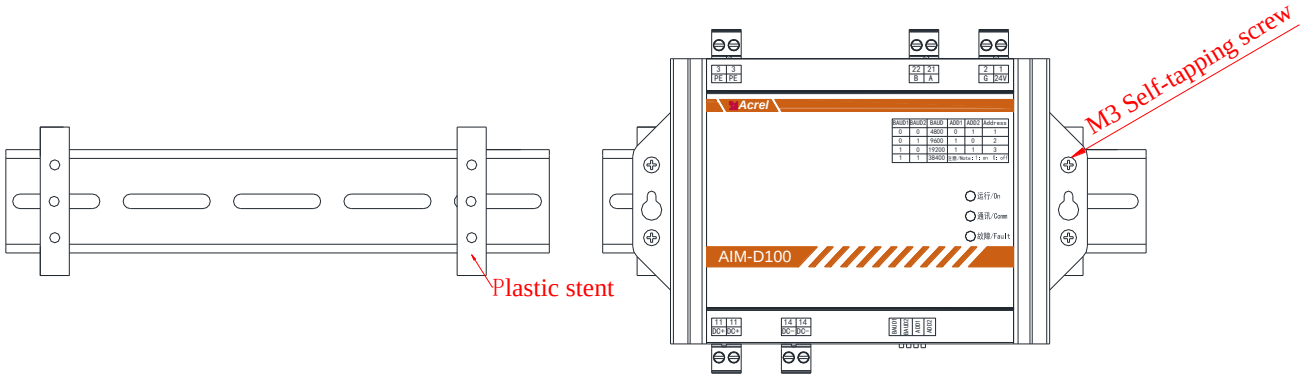
The AIM-D100-CA and CAI DC Insulation Monitors can be mounted in two ways. The mounting dimensions are shown below. (Unit: mm)



AIM-D100-CA Mounting Dimensions AIM-D100-CAI Mounting Dimensions

First installation method: wall-mounted installation. When installing the product, use the two M3 self-tapping screws (or other screws) provided with the product to pass through the mounting holes on both sides of the instrument and fix it to the bracket in the cabinet or the galvanized metal plate.

Second installation method: guide rail installation. When installing the product, first clamp the plastic stent that comes with the product on the guide rail. Align the mounting holes on both sides of the device with the plastic stent mounting holes. Use the 4 included M3 self-tapping screws to align the mounting holes and tighten them. The guide rail installation is as follows as shown in the below.



5.3 Wiring

AIM-D100-CA DC Insulation Monitor product wiring terminals are shown below:

1	2	3	3	11	11	14	14	21	22
24V	G	PE	PE	DC+	DC+	DC−	DC−	A	B
Power		Ground		Positive		Negative		RS485	

AIM-D100-CAI DC Insulation Monitor product wiring terminals are shown below:

1	2	3	3	4	5	11	11	14	14	21	22
24V	G	PE	PE	I+	I−	DC+	DC+	DC−	DC−	A	B
Power		Ground		Current		Positive		Negative		RS485	

Description:

Terminal 1 and 2: Connect to DC 24V power supply;

Terminal 3: Connect to the on-site grounding bar, the terminals are connected inside and can be wired from either terminal;

Terminals 4 and 5: Connect with current shunt;

Terminal 11: Connect to the positive pole of the DC system, the terminals are connected inside and can be wired from either terminal;

Terminal 14: Connect to the negative pole of the DC system, the terminals are connected inside and can be wired from either terminal;

Terminal 21 and 22: RS485 interface.

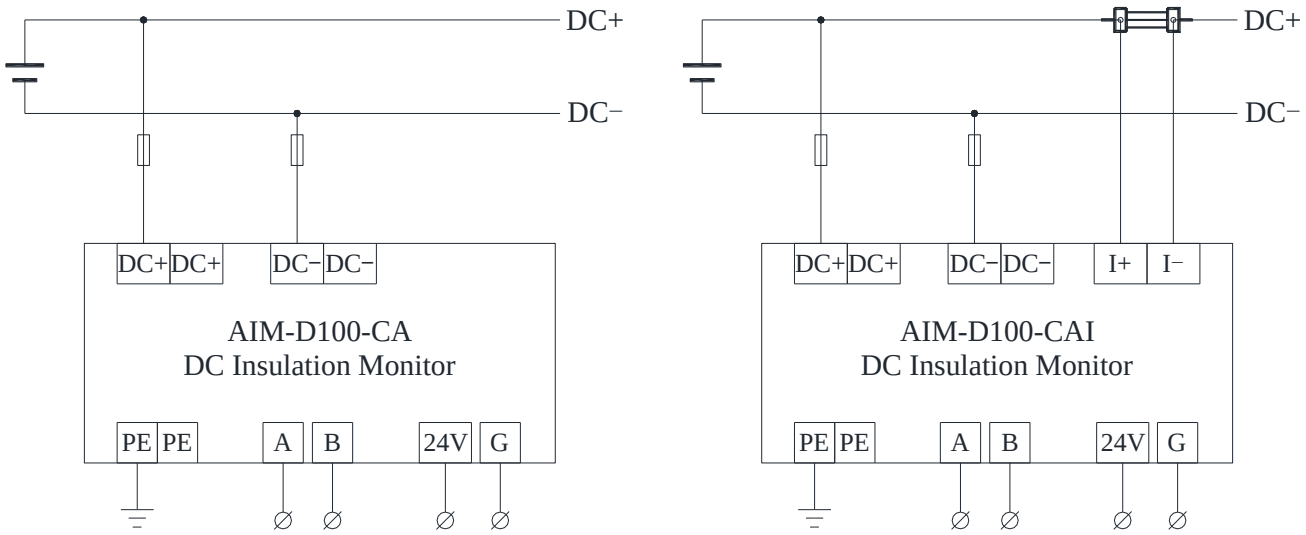
Wiring Specification:

For power supply, functional grounding, and DC system positive and negative wiring, current shunt wiring, 1.5mm^{2}multi-core copper wires can be used. RS485 communication wiring can use

0.75~1.5mm^2 shielded twisted pair.

5.4 Wiring Diagram

The AIM-D100-CA and CAI DC Insulation Monitor is wired as shown in the following schematic when monitoring the DC system:



5.5 Attention

(1) When designing and installing insulation monitors, it should be noted that only one insulation monitor can be installed in a system. If multiple insulation monitors are installed in different locations of the same system, a control strategy should be used for insulation resistance monitoring.

(2) The insulation monitor can be installed in the distribution box, and the installation location is free of dripping water, corrosive chemical gases, and sedimentation substances.

(3) When wiring the insulation monitor, you should strictly follow the wiring diagram. It is best to use a pin socket connector for crimping, then insert the instrument terminal and tighten the screws to avoid abnormal operation of the instrument due to poor contact.

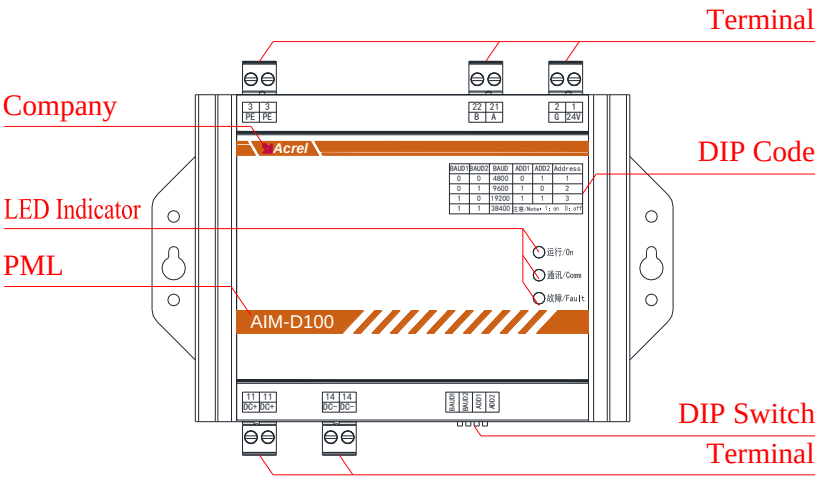
(4) The insulation monitor should be reliably connected to the DC system being monitored to ensure the effectiveness of insulation monitoring.

(5) Non-professionals are strictly prohibited from opening the product casing without authorization to avoid affecting product functions.

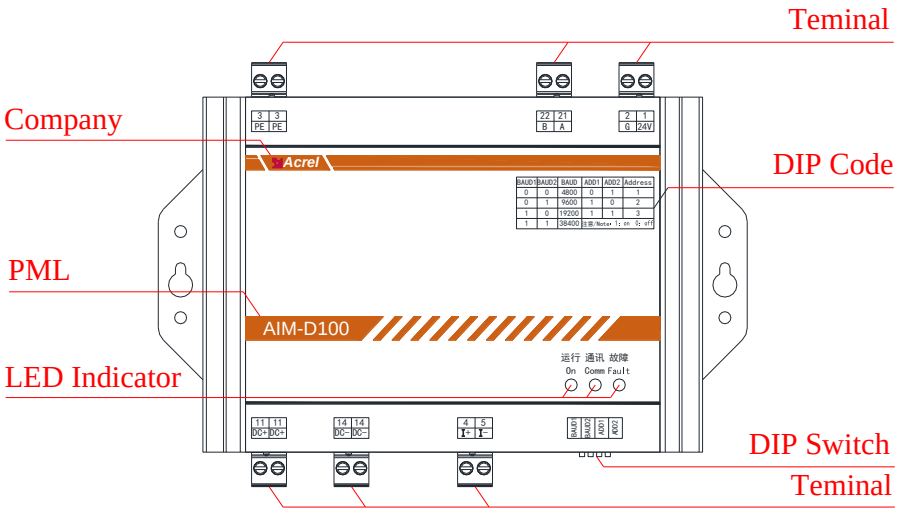
6 Programming and Usage

6.1 Panel Description

The AIM-D100-CA panel description is shown below:



The AIM-D100-CAI panel description is shown below:



6.2 LED Indicator Instructions

Indicator	Function Description
On	When the instrument is running normally, the indicator light flashes with a flashing frequency of approximately once per second.
Comm	When there is no data communication, the indicator light is off. When there is data communication, the indicator light flashes.
Fault	The indicator light flashes when an insulation fault occurs and is always on when an insulation fault occurs.

6.3 DIP Switch Description

AIM-D100-CA series Insulation Monitor is equipped with a 4-digit dipswitch at the lower row of terminals, and the functions corresponding to each set of dial codes are shown in the table below:

BAUD1	BAUD2	Baud rate	ADD1	ADD2	Address
0	0	4800	0	0	——
0	1	9600	0	1	1
1	0	19200	1	0	2
1	1	38400	1	1	3
Notes: 1: on 0: off					

The combination of BAUD1 and BAUD2 DIP switch: used to set the baud rate of RS485 communication. The factory default value is 10.

The combination of ADD1~ADD2 DIP switch: used to set the address of the instrument's RS485 communication. the default is 01.

7 Communication Instruction

7.1 Communication Protocol

The RS485 interface of the instrument adopts the Modbus-RTU communication protocol. The protocol defines the address, function code, data, check code, etc. in detail, which is a necessary content to complete the data exchange between the host and the slave.

7.2 Function Code Introduction

7.2.1 Function code 03H or 04H: read register

This function allows users to obtain data and system parameters collected and recorded by the device. There is no limit to the number of data requested by the host at one time, but it cannot exceed the range.

The following example reads data from the 00 25H register from the slave at address 01.

Host send		Sent information
Address code		01H
Function code		03H
Starting address	High byte	00H
	Low byte	25H
Register count	High byte	00H
	Low byte	01H
CRC check code	Low byte	95H
	High byte	C1H

Slave return		Returned information
Address code		01H
Function code		03H
Byte count		02H
Register data	High byte	1FH
	Low byte	68H
CRC check code	Low byte	B1H
	High byte	9AH

The slave returns a read result of 0x1F68, decimal 8040, indicating a system voltage of 804V.

7.2.2 Function code 06H: Write single registers

Function code 06H allows the user to change the contents of a single register without going outside the defined address range.

The following example writes 0xEFEF data to the 0034H register of the slave at address 01.

Host send		Sent information
Address Code		01H
Function Code		06H
Register address	High byte	00H
	Low byte	34H

Slave return		Returned information
Address Code		01H
Function Code		06H
Register address	High byte	00H
	Low byte	34H

Data to be written	High byte	EFH
	Low byte	EFH
CRC check code	Low byte	C5H
	High byte	B8H

Data to be written	High byte	EFH
	Low byte	EFH
CRC check code	Low byte	C5H
	High byte	B8H

The host writes 0xEFEF to 00 34H to indicate that the insulation alarm switch is turned on.

6.2.3 Function Code 10H: Write Multiple Registers

Function code 10H allows the user to change the contents of multiple registers without going outside the defined address range.

The following example writes 0xFEFE, 0x0064, 0x0032 to the 0034H~0036H registers of the slave at address 01.

Host send		Sent information
Address Code		01H
Function Code		10H
Starting address	High byte	00H
	Low byte	34H
Register count	High byte	00H
	Low byte	03H
Register count		06H
0004H Data to be written	High byte	FEH
	Low byte	FEH
0005H Data to be written	High byte	00H
	Low byte	64H
0006H Data to be written	High byte	00H
	Low byte	32H
CRC check code	Low byte	5BH
	High byte	AAH

Slave return		Returned information
Address Code		01H
Function code		10H
Starting address	High byte	00H
	Low byte	34H
Register count	High byte	00H
	Low byte	03H
CRC check code	Low byte	C1H
	High byte	C6H

The host writes 0xFEFE, 0x0064, 0x0032 to 00 34H~00 36H to indicate that the insulation alarm switch is turned on, setting warning value of 100kΩ and alarm value of 50kΩ.

Note: The above data is for reference only. Please refer to the address table for register definitions.

7.3 Register Address Table

No.	Address	Parameter	Read /Write	Value Range	Data Types
0	00H	Reserved			UINT16
1	01H	Address	R	1~63 (default 1)	UINT16
2	02H	Baud rate	R	0~3: 4800, 9600, 19200, 38400	UINT16

				(Unit: bps) (default 1)	
3~11	03H~0BH	Reserved			UINT16*9
12	0CH	Software number	R		UINT16
13	0DH	Software version	R		UINT16
14~31	0EH~1FH	Reserved			UINT16*18
32	20H	Fault type	R	bit15: 1 DC+ and DC- connected reversely; 0 is normal bit14~bit6: Reserved bit5: 1 negative pole insulation fault warning; 0 is normal bit4: 1 negative pole insulation fault alarm; 0 is normal bit3:1 positive pole insulation fault warning; 0 is normal bit2:1 positive pole insulation fault alarm; 0 is normal bit1~bit0: Reserved 00 18 means 0000 0000 0001 1000	UINT16
33	21H	Positive pole insulation resistance	R	Unit: kΩ; Ratio is 1 For example, 10000, the resistance is 10MΩ	UINT16
34	22H	Negative pole insulation resistance	R		UINT16
35	23H	Positive pole voltage to ground	R	Unit: V; Ratio is 0.1 For example, 4567, the voltage is 4567*0.1=456.7V	UINT16
36	24H	Negative pole voltage to ground	R		UINT16
37	25H	System voltage	R	Unit: V; Ratio is 0.1	UINT16
38	26H	System current	R	Unit: A; Ratio (0.01). Value is 2500 (mV), current ratio (4000), current is 2500*0.01*4000=100000mA=100A	UINT16
39~51	27H~33H	Reserved			UINT16*13
52	34H	Insulation alarm switch	R/W	0xFEFE is on (default is on) 0xEFEF is off	UINT16
53	35H	Positive pole insulation resistance warning value	R/W	10~10000kΩ (default 100)	UINT16
54	36H	Positive pole insulation resistance alarm value	R/W	10~10000kΩ (default 50)	UINT16
55	37H	Negative pole insulation resistance warning value	R/W	10~10000kΩ (default 100)	UINT16
56	38H	Negative pole insulation resistance alarm value	R/W	10~10000kΩ (default 50)	UINT16
57~62	39H~3EH	Reserved			UINT16*6
63	3FH	Insulation monitor speed	R/W	0: 500ms/cycle; 1: 1000ms/cycle	UINT16
64	40H	Insulation monitor	R/W	0x01: Cycle	UINT16

		trigger mode		0x10: Communication (default 10)	
65	41H	Capacitor delay time	R/W	0~60000ms (default 0)	UINT16
66	42H	Resistances monitor delay time	R/W	5~500s (default 5s)	UINT16

7.4 Register Operation Description

7.4.1 Trigger Insulation Monitoring

40H is the insulation monitoring trigger form, there are three main types: cycle trigger, communication trigger, cycle and communication trigger, default cycle trigger.

Cycle trigger form, timed monitoring, monitoring time 500ms or 1000ms once, after monitoring update register data, after a polling delay (42H), continue to trigger monitoring. After a polling delay (42H), the monitoring will continue to be triggered. The host communication reads 20H~24H register data, and the instrument returns the latest data in the register.

Communication trigger form, polling delay (42H) is invalid, insulation monitoring in standby mode. Host communication read 20H~24H register data, the instrument triggers a monitoring, monitoring time 500ms or 1000ms once, **monitoring register data refresh and return data, monitoring time repeated reading data is invalid, not monitoring can not return data. It is recommended that the interval between two readings when communication is triggered is more than 2500ms, and the timeout time is more than 1500ms.**

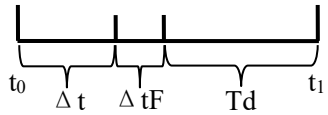
7.4.2 Insulation Monitoring Speed

3FH is the insulation monitoring resistance time, and the insulation monitoring period can be set to 500ms or 1000ms. The accuracy of 500ms is slightly worse.

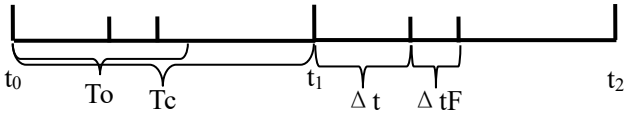
7.4.3 Delay Time of Insulation Monitoring Capacitor

41H is the insulation monitoring capacitance time. When the system capacitance is >5μF, the insulation resistance monitoring has a long response time and the insulation monitoring accuracy deteriorates. You can set the insulation monitoring capacitance time to 1000ms/10μF and increase the monitoring time to stabilize the insulation measurement and eliminate the influence of capacitance.

The cycle trigger defines polling delay as Td, insulation monitoring resistance time as Δt, insulation monitoring capacitance time as ΔtF; the communication trigger defines reading interval time as Tc, and timeout as To. The time correspondence is shown in the following figure:



Cycle trigger



Communication trigger

7.5 Message Example

7.5.1 Read the insulation monitoring status

Host Send: 01 03 00 20 00 05 84 03

Slave Response: 01 03 0A 00 18 00 64 00 0A 11 94 01 C2 F7 A0

Data Analysis: 00 18 represents the fault type, the binary system is 0000 0000 0001 1000, the fault is positive insulation fault warning, negative insulation fault alarm; 00 64 represents the positive pole to ground insulation resistance, 100kΩ; 00 0A represents the negative pole to ground insulation resistance, 10kΩ; 11 94 represents the positive electrode to ground voltage, 4540/10 =454.0V; 01 C2 represents the negative electrode to ground voltage, 450/10=45.0V.

7.5.2 Read the system voltage status

Host Send: 01 03 00 25 00 01 95 C1

Slave Response: 01 03 02 1F 68 B1 9A

Data Analysis: 1F 68 represents the system voltage, 8040/10=804V.

7.5.3 Set Alarm Parameters

The alarm switch is turned on by default, the positive and negative insulation fault warning values default to 100kΩ, and the positive and negative insulation fault alarm values default to 50kΩ. No changes are required without special requirements. If you need to change, please refer to the following example.

(1) Turn on the alarm switch

Host Send: 01 06 00 34 FE FE 09 E4

Slave Response: 01 06 00 34 FE FE 09 E4

(2) Turn off the alarm switch

Host Send: 01 06 00 34 EF EF C5 B8

Slave Response: 01 06 00 34 EF EF C5 B8

(3) Alarm threshold setting

Host send: 01 10 00 35 00 04 08 00 64 00 32 00 64 00 32 26 3E

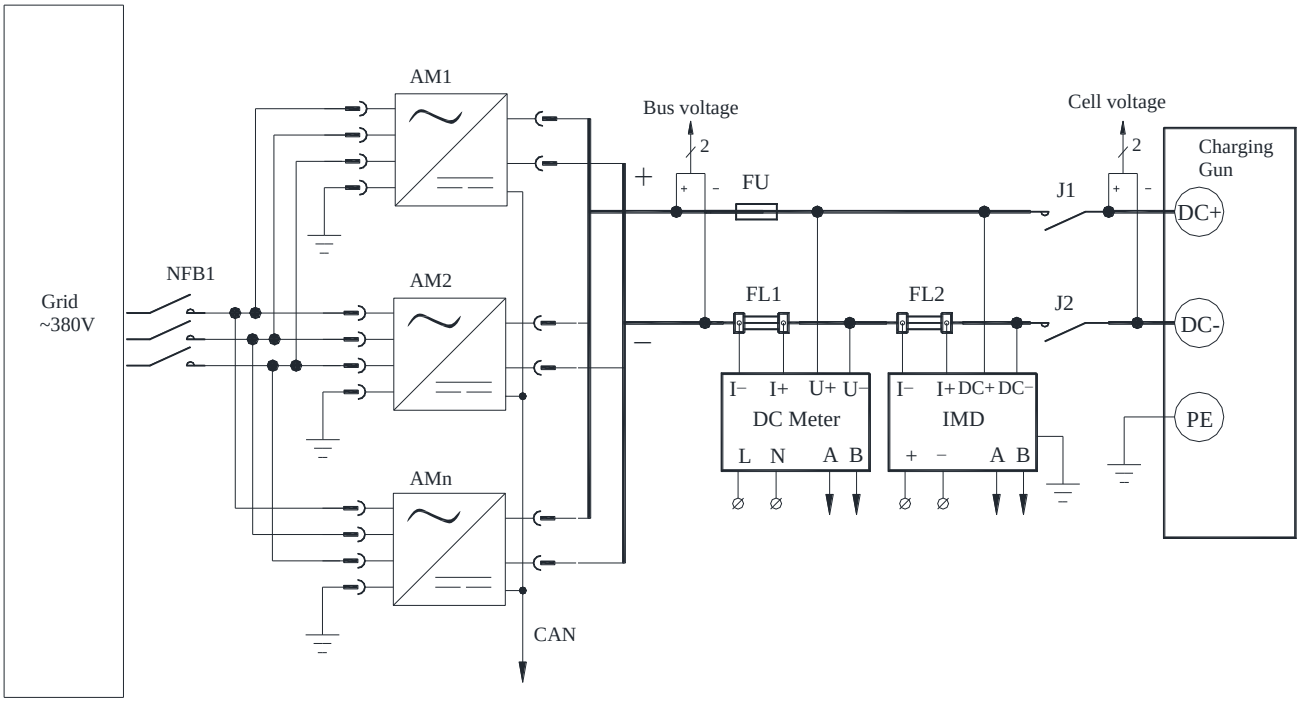
Slave response: 01 10 00 35 00 04 D1 C4

Data analysis: 00 64 means setting the positive insulation fault alarm value to 100kΩ; 00 32 means setting the positive insulation fault alarm value to 50kΩ; 00 64 means setting the negative insulation fault alarm value to 100kΩ; 00 32 means setting the negative insulation fault alarm value to 50kΩ.

8 Application

Electric vehicle charging device generally consists of cabinet, several AC to DC charging modules, intelligent switching unit, measuring instrument, controller, contactor, charging gun and so on.

The following figure shows the schematic of a 60kW DC charging unit.



Among them, the input is three-phase AC 380V, and after the combination of multiple charging modules, the output is DC 200~750V. The DC meter measures the current, and the insulation monitor measures the voltage, current, and insulation resistance. When the charging pile is in use, the controller sends a command to control the insulation monitor to start, and it returns the results, the controller judges whether to carry out the next operation according to the results. If the insulation level does not meet the requirements, the next operation will not be carried out.

Relevant regulations describe that when R>500 Ω/V is regarded as safe; 100 Ω/V<R≤500 Ω/V, insulation alarm, but can still be charged normally; R≤100 Ω/V is regarded as an insulation fault, and charging should be stopped.

According to the calculation of the output voltage, the insulation resistance value R>100~375kΩ is regarded as safe, and the insulation resistance value R<20~75kΩ is regarded as insulation fault, and charging should be stopped. The safety, stability and reliability of the DC charging system is guaranteed through the coordinated work of the controller and the insulation monitor.

9 Fault Resolution

Make sure the wiring is correct, then turn on the meter auxiliary power. Check whether the meter is normal, for common problems, you can judge the cause and troubleshoot according to the fault phenomenon.

No.	Fault Phenomenon	Causes and Troubleshooting
1	LEDs do not light up	Check whether the meter power supply is normal. if the power supply is normal, then replace the meter.
2	Meter can't communication	(1) Check whether the communication tools are normal and whether the communication wiring A and B are correct. (2) Check the communication parameters, confirm the address, baud rate, data forma. (3) Check whether the meter is damaged or not, if the meter is damaged, then replace the met.
3	Meter communication start-up monitoring 20H shows 0x8000	Reverse the positive and negative poles of the meter, replace the positive and negative wiring.
4	Meter communication start-up monitoring LED indicator flashes yellow	(1) Meter monitoring is normal, the corresponding channel insulation resistance warning, remind the site to pay attention to insulation. (2) Insulation is good, judge the meter data is abnormal, 41H write 0x2710 (10s), and then start monitoring to see if the data is getting bigger, bigger than 10M, you can write 0x4E20 (20s), and then start monitoring to see if the data is normal, and so on, the capacitance time can be set to a maximum of 60s. Ref Msg: 01 10 00 41 00 01 02 27 10 B3 7D (10s) 01 10 00 41 00 01 02 4E 20 9D 39 (20s)
5	Meter communication start-up monitoring LED indicator flashes red	(1) Meter monitoring is normal, the corresponding channel insulation resistance alarm, to remind the field troubleshooting. (2) Insulation is good, to determine the meter data abnormal, the same method as above.
6	Meter communication start-up monitoring Insulation data abnormal, LED normal, fault type normal	Meter insulation monitoring alarm switch off, 34H write to 0xFEFE. Ref Msg: 01 06 00 34 FE FE 09 E4

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