

Energom-AFR-M Busbar Arc Flash Protection Relay

User Manual



Version:1

Revision 2023.04

Read me

When you use EnergoM-AFR-M, 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 arc protection device, and help to solve the various problems at the scene.

1. This product must be earthed reliably.
2. Do not drop this product during installation to avoid damage to this product.
3. The terminal blocks must be connected firmly to avoid serious consequences caused by dropping.
4. Please do not plug or unplug the circuit board during the normal operation of this product; otherwise, the data of this product will be lost and the product may not operate normally.
5. The rated value is not changed randomly and it can be only changed by relevant professionals.
6. When installing, please install this product according to the terminal definition, and do not wire randomly.
7. After installation and energizing, do not touch the exposed terminals and the bare parts of the power supply and do not place this product in a damp area to avoid leakage and short circuit at the terminals.



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

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1. - SUMMARIZE

Arc protection relays are mainly used to detect arc faults in electrical systems and protect equipment and personnel in electrical systems from arc faults. Arc protection relays can detect arcs by monitoring parameters such as current, voltage, and electric power, and quickly disconnect the power supply before an electrical fire occurs, thereby reducing the risk of fire.

Arc protection relays are usually used in medium and high voltage power distribution systems, control cabinets, transformers, generators, motors and other electrical equipment. They adopt the dual-criteria principle of arc light detection and overcurrent detection, and have the characteristics of fast protection action and high reliability.

FEATURES

- Complete digital design, simple principle;
- Strong electrical performance;
- Comprehensive record of fault information;
- Double criterion of over-current and arc, high reliability;
- Optical fiber transmits, strong electromagnetic interference resistance;
- Programmable logic of trip exit;
- Fast exit tripping, short total fault clearing time.

APPLICATIONS

- Reduce the harm of arc light to human body;
- Reduce damage to equipment caused by arc short-circuit faults;
- Avoid transformer damage caused by bus failure;
- Protect the dc system in the station;
- Ensure the stable operation of power substations;
- Thermal power plant electrical section switchgear;
- Wind farm and photovoltaic station switchgear;
- Large municipal engineering project;

2. - TECHNICAL PARAMETERS

- Power supply

AC/DC85 ~ 265V

- Consumption

≤ 8W

- Current input

Current rated : 5A/1A
Measurement range: protection current: 0~20 *In*
Consumption: ≤ 5VA

- Electrical parameters tolerance

Protection current: ≤ 2%
Protection frequency: 0.1Hz

- Arc signal input

Channels number: 12-48 channels (optional)
Sensor type: optical fiber
Detect light type: Visible light/UV light (optional)

- Relay output

Channels number: 9 channels
Operating Voltage: AC250V/8A
Input method: passive contact
Isolation method: Photoelectric isolation, isolation voltage 2500V

- Action time tolerance

Pure arc protection: ≤10ms
Double criterion protection: ≤20ms

- RS485 communication

Interface: RS485 (one standard, two optional)
Isolation type: photoelectric isolation, lightning protection
Baud rate: 9600bps
Protocol: Modbus

- Ethernet communication

Interface: 2-way Ethernet optional
Network parameters: 10M/100M adaptive
Default ip: 192.168.12.2/192.168.13.2
Standard: IEC60870-5-103

- Environment

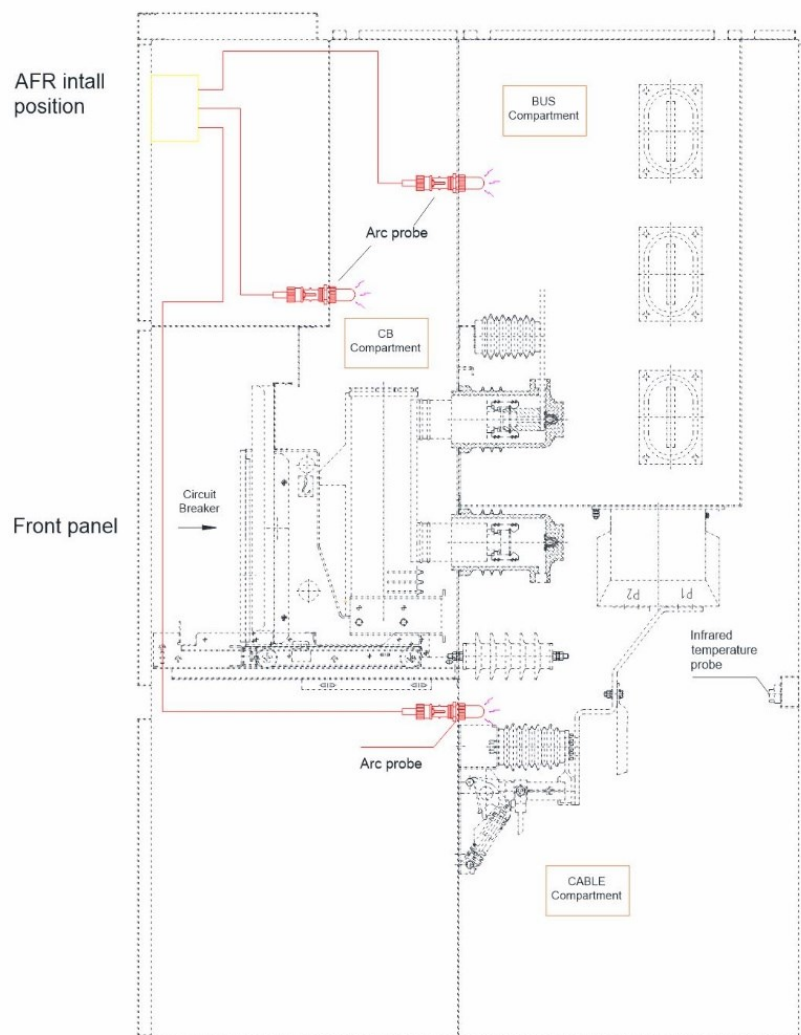
Working environment: -10 ~ 55°C/ < 93% RH (Non-condensing)
Storage environment: -30 ~ 70°C/ < 70% RH (Non-condensing)
Relative humidity: 5%~ 95%
Atmospheric pressure: 60kPa ~ 106kPa

- Electromagnetic compatibility

Item	Standard
Electrostatic discharge test:	GB/T 14598.14-2010. level-4
Fast transient dry resistance test:	GB/T 14598.10-2007. level-A
1mhz burst interference test:	GB/T 14598.13-2008. level-3
Surge immunity test:	GB/T 14598.9-2010.level-3
Conducted disturbance immunity test:	GB/T 14598.18-2007

3.- INSTALLATION AND START-UP

3.1 - Wiring Method

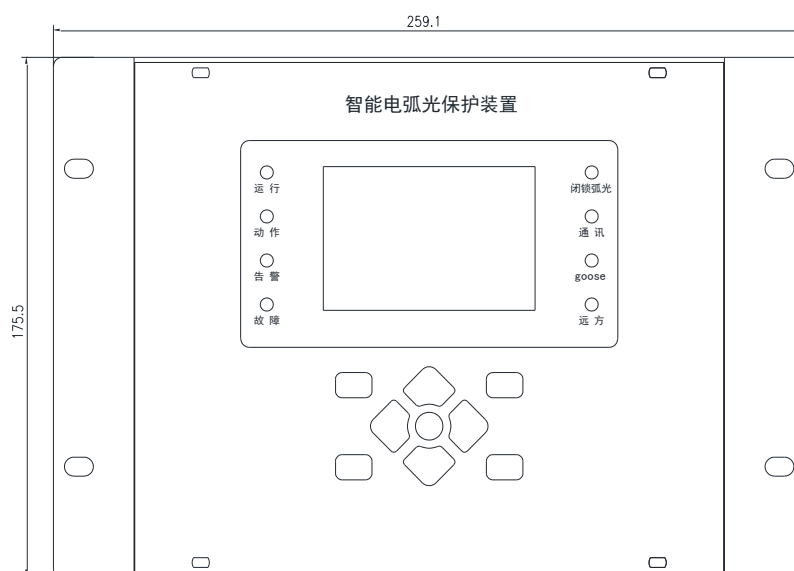


Note:

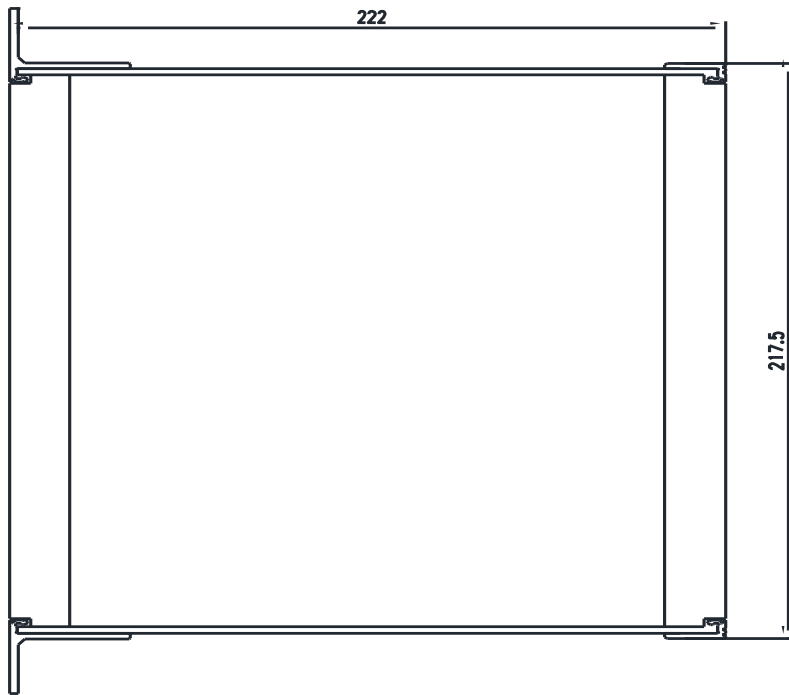
The picture above is an installation example. For the specific installation method, please refer to the document: [AFR-Installation instruction-1](#)

3.2 - Installation Dimensions (Unit: mm)

The host adopts the fully enclosed 4U 1/2 standard case, and is mounted on the screen (switchgear). The plug-in is a rear-insert guide rail with tight screws up and down. dimensions are as follows: (unit: mm)



Front view




Upper view



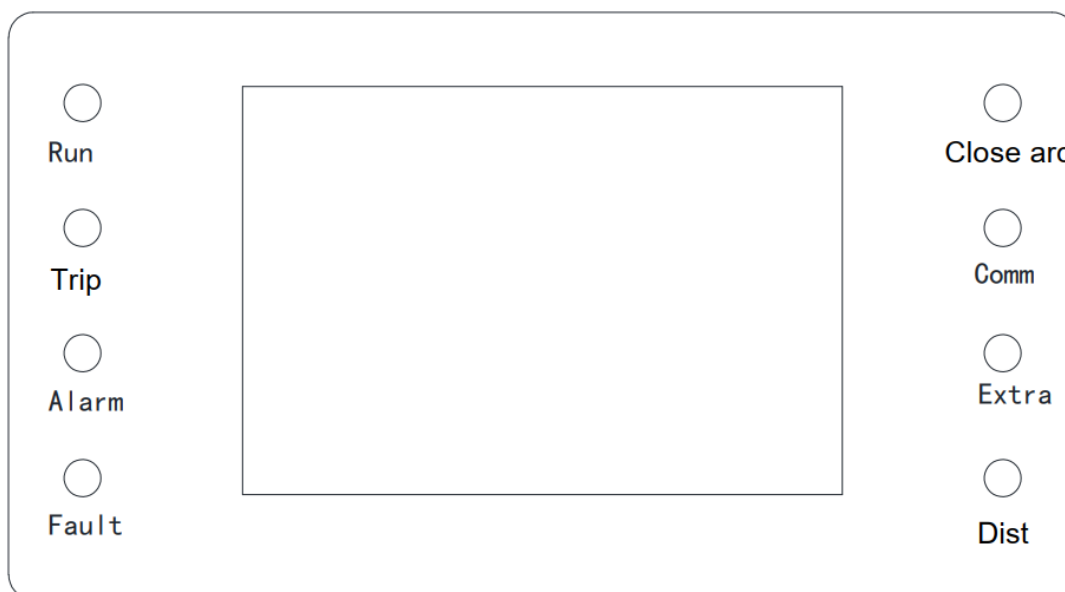
Hole size

3.3 - Terminal Definition

A - 电源板	B - 继电器板	C - 弧光板	D - 弧光板	E - 弧光板	F - 弧光板	G - CPU板	H - 交流板																																																																																																																																																												
<table border="1"> <tr><td>A01</td><td>远方/就地</td></tr> <tr><td>A02</td><td>1DL合位</td></tr> <tr><td>A03</td><td>1DL合位</td></tr> <tr><td>A04</td><td>2DL合位</td></tr> <tr><td>A05</td><td>2DL合位</td></tr> <tr><td>A06</td><td>3DL合位</td></tr> <tr><td>A07</td><td>3DL合位</td></tr> <tr><td>A08</td><td>4DL合位</td></tr> <tr><td>A09</td><td>4DL合位</td></tr> <tr><td>A10</td><td>弧光闭锁1</td></tr> <tr><td>A11</td><td>弧光闭锁2</td></tr> <tr><td>A12</td><td>灭弧元件分位</td></tr> <tr><td>A13</td><td>灭弧元件合位</td></tr> <tr><td>A14</td><td>开入14</td></tr> <tr><td>A15</td><td>开入15</td></tr> <tr><td>A16</td><td>开入16</td></tr> <tr><td>A17</td><td>开入公共端</td></tr> <tr><td>A18</td><td>失电告警信号</td></tr> <tr><td>A19</td><td></td></tr> <tr><td>A20</td><td>L/+</td></tr> <tr><td>A21</td><td>N/-</td></tr> <tr><td>A22</td><td>PGND</td></tr> </table>	A01	远方/就地	A02	1DL合位	A03	1DL合位	A04	2DL合位	A05	2DL合位	A06	3DL合位	A07	3DL合位	A08	4DL合位	A09	4DL合位	A10	弧光闭锁1	A11	弧光闭锁2	A12	灭弧元件分位	A13	灭弧元件合位	A14	开入14	A15	开入15	A16	开入16	A17	开入公共端	A18	失电告警信号	A19		A20	L/+	A21	N/-	A22	PGND	<table border="1"> <tr><td>B01</td><td>跳闸出口1</td></tr> <tr><td>B02</td><td></td></tr> <tr><td>B03</td><td>跳闸出口2</td></tr> <tr><td>B04</td><td></td></tr> <tr><td>B05</td><td>跳闸出口3</td></tr> <tr><td>B06</td><td></td></tr> <tr><td>B07</td><td>跳闸出口4</td></tr> <tr><td>B08</td><td></td></tr> <tr><td>B09</td><td>跳闸出口5</td></tr> <tr><td>B10</td><td></td></tr> <tr><td>B11</td><td>跳闸出口6</td></tr> <tr><td>B12</td><td></td></tr> <tr><td>B13</td><td>跳闸出口7</td></tr> <tr><td>B14</td><td></td></tr> <tr><td>B15</td><td>跳闸出口8</td></tr> <tr><td>B16</td><td></td></tr> <tr><td>B17</td><td>跳闸出口9</td></tr> <tr><td>B18</td><td></td></tr> <tr><td>B19</td><td>保护动作</td></tr> <tr><td>B20</td><td></td></tr> <tr><td>B21</td><td>保护告警</td></tr> <tr><td>B22</td><td></td></tr> </table>	B01	跳闸出口1	B02		B03	跳闸出口2	B04		B05	跳闸出口3	B06		B07	跳闸出口4	B08		B09	跳闸出口5	B10		B11	跳闸出口6	B12		B13	跳闸出口7	B14		B15	跳闸出口8	B16		B17	跳闸出口9	B18		B19	保护动作	B20		B21	保护告警	B22		<ul style="list-style-type: none"> • ARC01 • ARC02 • ARC03 • ARC04 • ARC05 • ARC06 • ARC07 • ARC08 • ARC09 • ARC10 • ARC11 • ARC12 	<ul style="list-style-type: none"> • ARC13 • ARC14 • ARC15 • ARC16 • ARC17 • ARC18 • ARC19 • ARC20 • ARC21 • ARC22 • ARC23 • ARC24 	<ul style="list-style-type: none"> • ARC25 • ARC26 • ARC27 • ARC28 • ARC29 • ARC30 • ARC31 • ARC32 • ARC33 • ARC34 • ARC35 • ARC36 	<ul style="list-style-type: none"> • ARC37 • ARC38 • ARC39 • ARC40 • ARC41 • ARC42 • ARC43 • ARC44 • ARC45 • ARC46 • ARC47 • ARC48 	<table border="1"> <tr><td>G01</td><td>IRIG-B+</td></tr> <tr><td>G02</td><td>IRIG-B-</td></tr> <tr><td>G03</td><td>IRIG-G</td></tr> <tr><td>G04</td><td>485A1</td></tr> <tr><td>G05</td><td>485B1</td></tr> <tr><td>G06</td><td>485A2</td></tr> <tr><td>G07</td><td>485B2</td></tr> <tr><td>G08</td><td>485GND</td></tr> </table> 	G01	IRIG-B+	G02	IRIG-B-	G03	IRIG-G	G04	485A1	G05	485B1	G06	485A2	G07	485B2	G08	485GND	<div style="text-align: center;">1n</div> <table border="1"> <tr><td>la1</td><td>H01</td><td>H02</td><td>la1'</td></tr> <tr><td>lb1</td><td>H03</td><td>H04</td><td>lb1'</td></tr> <tr><td>lc1</td><td>H05</td><td>H06</td><td>lc1'</td></tr> <tr><td>la2</td><td>H07</td><td>H08</td><td>la2'</td></tr> <tr><td>lb2</td><td>H09</td><td>H10</td><td>lb2'</td></tr> <tr><td>lc2</td><td>H11</td><td>H12</td><td>lc2'</td></tr> <tr><td>la3</td><td>H13</td><td>H14</td><td>la3'</td></tr> <tr><td>lb3</td><td>H15</td><td>H16</td><td>lb3'</td></tr> <tr><td>lc3</td><td>H17</td><td>H18</td><td>lc3'</td></tr> <tr><td>la4</td><td>H19</td><td>H20</td><td>la4'</td></tr> <tr><td>lb4</td><td>H21</td><td>H22</td><td>lb4'</td></tr> <tr><td>lc4</td><td>H23</td><td>H24</td><td>lc4'</td></tr> <tr><td>H25</td><td>H26</td><td></td><td></td></tr> </table>	la1	H01	H02	la1'	lb1	H03	H04	lb1'	lc1	H05	H06	lc1'	la2	H07	H08	la2'	lb2	H09	H10	lb2'	lc2	H11	H12	lc2'	la3	H13	H14	la3'	lb3	H15	H16	lb3'	lc3	H17	H18	lc3'	la4	H19	H20	la4'	lb4	H21	H22	lb4'	lc4	H23	H24	lc4'	H25	H26		
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Items	Definition	Explanation
A01-A17	DI:1-16	Digital input
A18-A19	Power loss alarm output	Device power loss
A20-A22	Power	Device power
B01-B18	Trip:1-9	Programmable outlet
B19-B20	Act signal	Trips total output
B21-B22	Alarm signal	Alarm total output
ARC1- ARC48	Arc signal:1-48	Arc sensor input
G01-G03	GPS Timing	Device timing
G04- G05	RS485-1	Serial communication
G05- G06	RS485-2	
EXTRA	Ethernet	System networking communication
H01-H06	Four sets of three-phase current input	Sampling current
H07-H012		
H13-H18		
H19-H24		

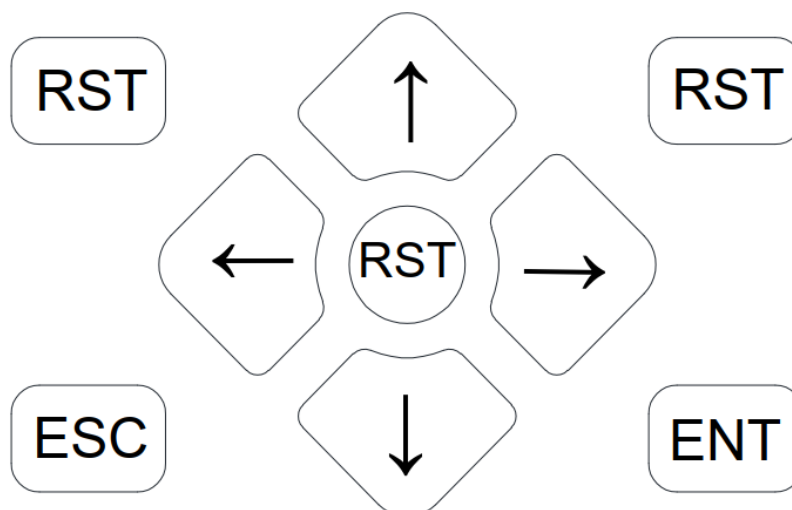
3.4 - Signal Light Description



Item	Color	Definition
"Run"	Green	device is working, it flashes once a second.
"Trip"	Red	protection device trips.
"Alarm"	Red	indicator of protection device.
"Fault"	Red	device system fails.
"Close arc"	Red	close arc protection function.
"Comm"	Green	communication status of the device
"Extra"	Green	indicator device communicates with the device interactively.
"Dist"	Green	indicator device is in remote state and can be remotely controlled.

3.5 - Key Description

There are 9 keys on the keyboard, namely “RST”, “ENT”, “ESC”, “+”, “-”, “↑”, “↓”, “→”, “←”.



Item	Definition
“RST”	Resetting protection warning signals
“ENT”	Confirming a specific operation or proceed to the following menu
“ESC”	Cancelling the operation done or return to the previous menu
“↑” “↓” “→” “←”	Cursor movement and numerical shift

4. - SETUP PROCEDURE

4.1 Run interface

After the device is powered on, the LCD screen will display the type, time, date and current measurement value of the protection device during normal operation.

When the device protection acts, the main screen displays the latest action report, and displays the record number, action time, action name, arc channel and action current value of the action report. According to different report types, the system is divided into trip report, self-inspection report, remote signaling report, fault recording, etc.



4.2. Main menu

In the operation interface, press the "ENT" key to enter the main menu, and select the submenu through the "↑", "↓", "←", "→" keys.



4.3. "Analog"

"Analog" is mainly used to display the current sampling value and phase angle of the protection device in real time.

Press the "ENT" key to enter the screen diagram of viewing protection value and measured value. The "Protect" shows the real-time sampling value of the secondary side protection transformer.

The "Measure" shows the primary side value multiplied by the transformation ratio coefficient. "offset" can be used to verify the measured value.

-Analog -	Name	Value	Angle
1.Protect	Ia1=	0.000 A	0 °
	Ib1=	0.000 A	0 °
2.Measure	Ic1=	0.000 A	0 °
	Ia2=	0.000 A	0 °
3.Offset	Ib2=	0.000 A	0 °
	Ic2=	0.000 A	0 °
	Ia3=	0.000 A	0 °
	Ib3=	0.000 A	0 °
	Ic3=	0.000 A	0 °
	Ia4=	0.000 A	0 °
	Ib4=	0.000 A	0 °
	Ic4=	0.000 A	0 °

4.4. "Report"

4.4.1- Trip

"Trip" can be used to verify the measured value. "Trip report" displays the protection trip report records. Please check these records after the device trips. Press the "ENT" key to enter the accident record screen. First, display the latest accident record; Press "↑" to display the previous report and "↓" to display the next report.

```

-Report - 0009.2022-02-22 10:36:29:190
          1# Arc Trip          0.000 APH
1. Trip   Arc in:1 2 3
          0010.2022-02-22 10:36:29:335
2. Alarm  1# Arc Trip          0.000 APH
          Arc in:1
3. Signal 0011.2022-02-22 10:36:29:434
          1# Arc Trip          0.000 APH
4. Waveform Arc in:1
          0012.2022-02-22 10:36:48:245
          Protection Start
  
```

4.4.2- Alarm

"Alarm" displays the system self-inspection alarm report record. Press the "ENT" key to enter the self-inspection report screen. First, display the latest alarm record; Press "↑" to turn one page of report forward and "↓" to turn one page of report back.

```

-Report - 0001.2022-02-22 10:36:48:245
          Alarm:1# Arc Alarm
1. Trip   0002.2022-02-22 10:36:48:459
          Alarm:1# Arc Alarm
2. Alarm  0003.2022-02-22 10:36:48:735
          Alarm:1# Arc Alarm
3. Signal
4. Waveform
  
```


4.4.3-Signal

"Signal" displays the remote signaling report record. Press the "ENT" key to enter the operation record screen. First, display the latest operation record, press "↑" to display the previous report, and press "↓" to display the next report.

```

-Report - 0265.2022-02-22 10:36:48:735
          Alarm:1# Arc Alarm      0->1
1.Trip    0266.2022-02-22 10:36:48:735
          General Alarm           0->1
2.Alarm   0267.2022-02-22 10:36:48:752
          Arc 1                   1->0
3.Signal  0268.2022-02-22 10:36:48:757
          Alarm:1# Arc Alarm      1->0
4.Waveform 0269.2022-02-22 10:36:48:757
          General Alarm           1->0
          0270.2022-02-22 10:36:49:254
          Protection Start        1->0

```

4.4.4-Waveform

"Waveform" this menu displays the displacement report record. Press the "ENT" key to enter the wave recording screen. First, the latest recording record is displayed; Press "↑" to display the previous report and "↓" to display the next report.

```

-Report - 01.2022-02-22 10:36:27:548
          02.2022-02-22 10:36:48:204
1.Trip
2.Alarm
3.Signal
4.Waveform

```

4.5. "Function"

The arc protection function can be switched on and off in the pressing plate setting menu. You can not only modify the status of the pressing plate, but also view it at the same time.

-Function-	Name	Status
1. Display	1# Arc Function	ON
	2# Arc Function	ON
2. Settings	3# Arc Function	ON
	4# Arc Function	ON

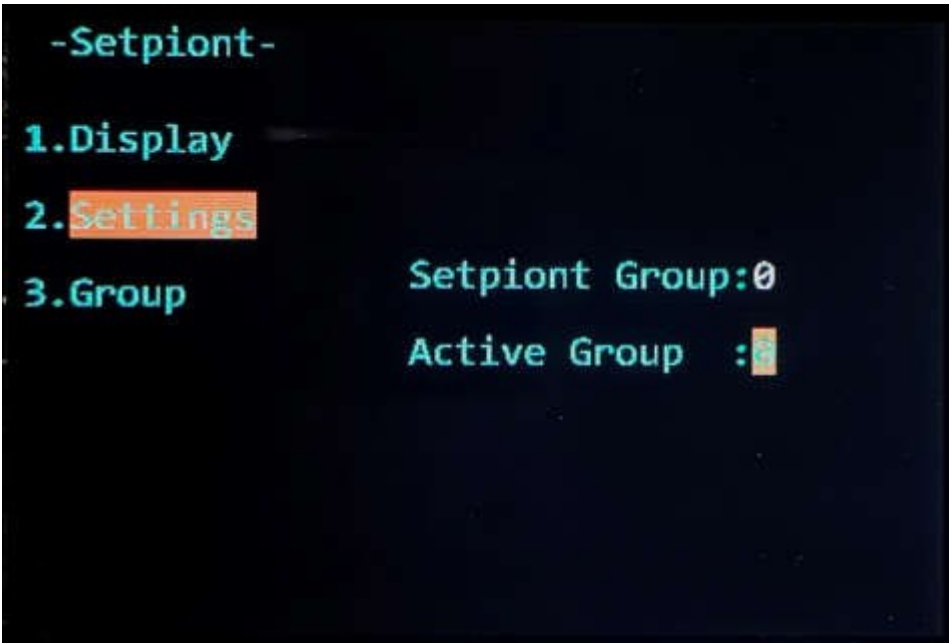
No.	Name	Default	Explanation
1	1# Arc protect	On/off	Associated with I1 current
2	2# Arc protect	On/off	Associated with I2 current
3	3# Arc protect	On/off	Associated with I3 current
4	4# Arc protect	On/off	Associated with I4 current

4.6. "Setpoint"

This menu is mainly used to set or view the setting value of the device.

Press the "ENT" key to enter the secondary menu. Switch the serial number through "↑" and "↓", shift with "→" and "←", and adjust the value with "+" and "-". After setting the fixed value, press the "ESC" key to return to the primary menu, and a dialog box will pop up. Enter the correct password (the default factory password is: 00). At this time, the "save successful!". Fixed value saving. If it is cancelled directly, the fixed value will not be saved. If the input password is incorrect, the device will pop up "Password error! " Screen and return to the first level menu interface.

When setting the setting value, you can first select the setting value ZONE for setting. The set value entered after selection is the set value in the corresponding set value area. After setting, you can view it in the "Display". At the same time, when you need to switch the fixed value, enter the "Group". After switching, the serial number of the setting value after the displacement switching of the initial value will be displayed and set accordingly.



"1#" "2#" "3 #" "4 #" in the "Settings" menu means 4 groups of sampling currents for arc protection. The current criteria of 1# arc protection are IA1, IB1, IC1 and so on.

Due to the protection device has large number of setting outlets and arc sensors, the corresponding mode of outlet setting and arc channel is designed as a setting method from binary to hexadecimal. Let's take the setting of "1# arc Function" as an example:

After entering the menu option of "Settings", the fixed value will appear on the right side of the screen. There are 21 corresponding set values in "1# arc Function". There are 9 corresponding outlets that can be set separately. These nine outlets correspond to trips 1-9 on the drawing respectively. Arc sensors can be selected for each outlet. This setting can be repeated. One sensor can correspond to multiple outlets.

Take "I1Trip1-Arc1-24" as an example. "000000" is displayed below the fixed value item. In this menu, we can select and associate our sensors. "000000" represents the corresponding arc sensor 1-24 (each bit represents 4 arc points). The six bits from right to left correspond to "1-4", "5-8", "9-12", "13-16", "17-20" and "21-24" respectively. When the cursor is at the rightmost position of the fixed value, press the "→" button again to enter the single Arc setting menu. It is also possible to input and exit individual arc channel.

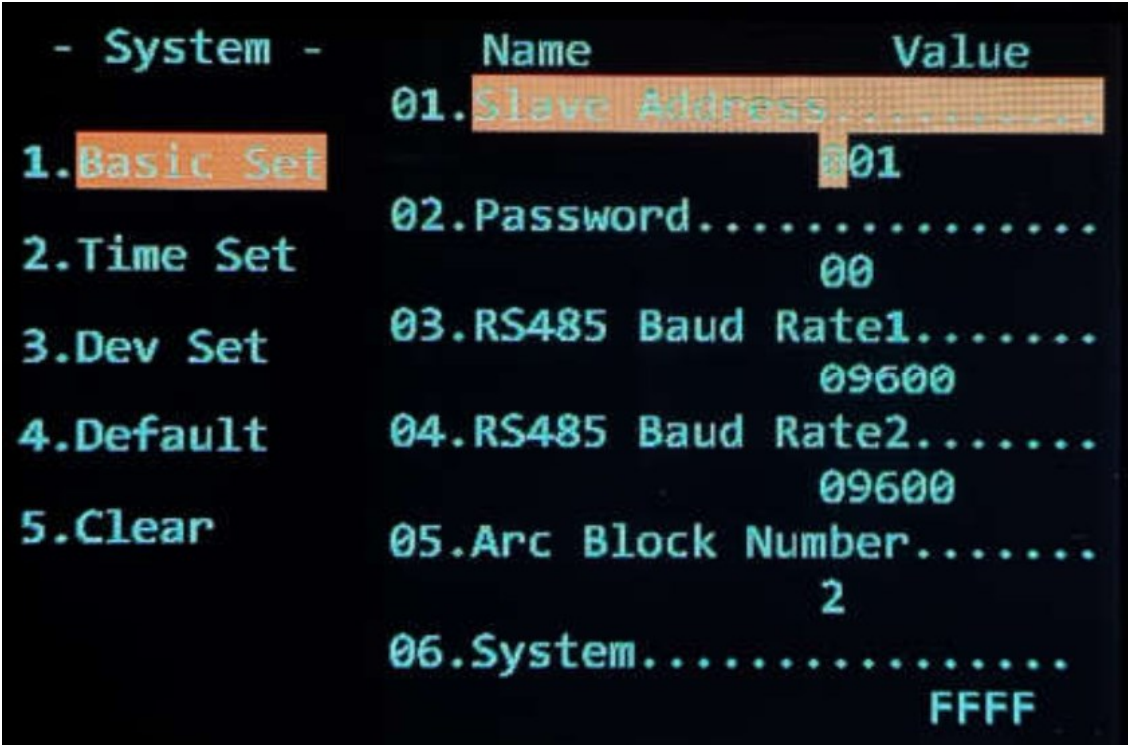
The binary bit of the arc sensor that needs to be input is converted to “1”, and the exiting bit is “0”. According to the actual input of the sensor, first determine the binary code, and then convert it into the corresponding hexadecimal value input. The general array is shown in the following table (arc points 25-48 are the same).

NO.	Binary value	Hexadecimal value	Explanation
ARC:1	0000 0000 0000 0000 0000 0001	000001	Arc1:on
ARC:1-2	0000 0000 0000 0000 0000 0011	000003	Arc1-2:on
ARC:1-3	0000 0000 0000 0000 0000 0111	000007	Arc1-3:on
ARC:1-4	0000 0000 0000 0000 0000 1111	00000F	Arc1-4:on
ARC:1-5	0000 0000 0000 0000 0001 1111	00001F	Arc1-5:on
ARC:1-6	0000 0000 0000 0000 0011 1111	00003F	Arc1-6:on
ARC:1-7	0000 0000 0000 0000 0111 1111	00007F	Arc1-7:on
ARC:1-8	0000 0000 0000 0000 1111 1111	0000FF	Arc1-8:on
ARC:1-9	0000 0000 0000 0001 1111 1111	0001FF	Arc1-9:on
ARC:1-10	0000 0000 0000 0011 1111 1111	0003FF	Arc1-10:on
ARC:1-11	0000 0000 0000 0111 1111 1111	0007FF	Arc1-11:on
ARC:1-12	0000 0000 0000 1111 1111 1111	000FFF	Arc1-12:on
ARC:1-13	0000 0000 0001 1111 1111 1111	001FFF	Arc1-13:on
ARC:1-14	0000 0000 0011 1111 1111 1111	003FFF	Arc1-14:on
ARC:1-15	0000 0000 0111 1111 1111 1111	007FFF	Arc1-15:on
ARC:1-16	0000 0000 1111 1111 1111 1111	00FFFF	Arc1-16:on
ARC:1-17	0000 0001 1111 1111 1111 1111	01FFFF	Arc1-17:on
ARC:1-18	0000 0011 1111 1111 1111 1111	03FFFF	Arc1-18:on
ARC:1-19	0000 0111 1111 1111 1111 1111	07FFFF	Arc1-19:on
ARC:1-20	0000 1111 1111 1111 1111 1111	0FFFFFF	Arc1-20:on
ARC:1-21	0001 1111 1111 1111 1111 1111	1FFFFFF	Arc1-21:on
ARC:1-22	0011 1111 1111 1111 1111 1111	3FFFFFF	Arc1-22:on
ARC:1-23	0111 1111 1111 1111 1111 1111	7FFFFFF	Arc1-23:on
ARC:1-24	1111 1111 1111 1111 1111 1111	FFFFFFF	Arc1-24:on

4.7. "System"

- "Basic Set" set the serial communication address and baud rate of the device, operation password, the number of arc access plug-ins and the number of pressure sensors.
- "Time Set" set the real-time clock of the device.
- "Dev Set" set CT transformation ratio, current rating, wiring mode and relevant parameter setting information. (except for CT transformation ratio, users are not recommended to set it by themselves).
- "Default" returns the unit to factory mode.
- "Clear " clears all types of report records currently generated. It can also be cleared separately according to the type.

After the menu is set, the device will restart automatically. Therefore, it is recommended to set all information at one time and then return to save.



4.8. "ETH"

This menu is mainly used to set the IP address corresponding to the Ethernet interface of the device. After setting, the device will restart automatically.

	Name	Value
01.	Eth IP address1	192.168.011.002
02.	Eth subnet mask	255.255.000.000
03.	Eth IP address2	192.168.012.002
04.	Eth subnet mask	255.255.000.000

4.9. "Test"

This menu is mainly used to test the output, input, arc and communication of the device. "Output" is used to test all signal outlets and trip outlets. The outlet scan be driven by "→" and "←" keys.

- Test -		Name	Status
1.	Output	Output Relay1	OFF
		Output Relay2	OFF
2.	Input	Output Relay3	OFF
		Output Relay4	OFF
3.	Arc	Output Relay5	OFF

"Input" can view the status of remote signaling input in real time.

- Test -	Name	Status
1.Output	01.Remote sta	OFF
	02.1DL OFF	OFF
2.Input	03.1DL ON	OFF
	04.2DL OFF	OFF
3.Arc	05.2DL ON	OFF

"Arc" displays the arc channel status in real time.

- Test -	Name	Status
1.Output	Arc 1	OFF
	Arc 2	OFF
2.Input	Arc 3	OFF
	Arc 4	OFF
3.Arc	Arc 5	OFF

4.8. “Version”

The version interface can display the version information of the product.



5. - 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;

6. - MAINTENANCE

The EnergoM-AFR-M 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.