

# AFR-M Busbar Arc Flash Protection Relay

## User Manual



Version:1.12

Revision: 2023.05

## Read me

**When you use 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

- Panel mounting design, rugged Aluminum Housing.
- Integrate information displayed on large LCD screen.
- Provide total 4\*3-phase current signal input.
- Single unit max 48pcs opt-sensor connected.
- Less than 10 ms operation time (from arc flash to relay trip).
- 16\* passive DI point, indicate CB status.
- 9\* trip contacts, free to configuration protect trip logic.
- 1\* Ethernet port support IEC60870-5-103 communication.
- Independent trip act and alarm act relay.
  
- Arc-flash mitigation strategies:
  - Light-Sensing Only;
  - Light Flash, Supervised by Current;
  - Light Flash, Supervised by Pressure(Optional).
  
- Optional extra monitor functions by RS-485 connection, user can customize:
  - . Bus temperature monitoring (wireless);
  - . Partial Discharge sensor (TEV);
  - . Smoke sensor.
  
- Optional neighboring AFR-M to expand maximum detect quantities of feeder loop.
  
- Support OEM and add customized program:
  - . For special VCB control and protection logic;
  - . Localized language HMI.

## APPLICATIONS

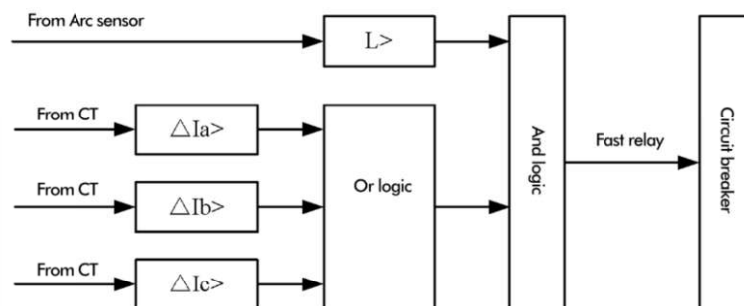
- Reduce the harm of arc light to human body;
- Reduce damage to equipment caused by arc short-circuit faults;
- Avoid transformer damage caused by bus failure;
- Protect the dc system in the station;
- Ensure the stable operation of power substations;
- Thermal power plant electrical section switchgear;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

## 2. - DEVICE PRINCIPLE

### 2.1 - Arc protection function

The device is equipped with 3 arc points, which are used to monitor the internal arc faults of the busbar room, circuit breaker room and cable room in the monitoring cabinet, and can choose to configure arc criterion, arc + current double criterion for protection.

When the optical fiber transmits the light signal from the CT to the the host, and at the same time the current starting element acts, the arc protection acts; the device can select the arc signal action criterion as the action logic judgment.



The arc monitoring point that needs to be put into use can be set through the dial switch of the function set.

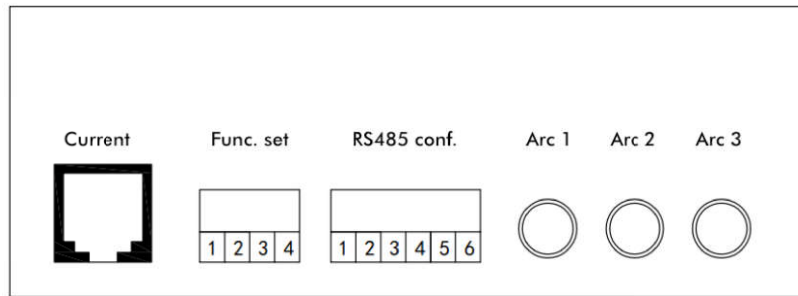
Pressing function set 1 means that arc point 1 is switched on. When function set 1 is switched on, the protection function of single criterion arc point 1 is switched on.

Pressing function set 2 represents arc point 2 input, when pressing function set 2 is input, the single criterion arc point 2 protection function is activated.

The pressing function set 3 represents the input of the arc point 3. When the pressing function set 3 is input, the protection function of the single criterion arc point 3 is activated.

Pressing function set 4 represents the input of the current criterion. When the function set 4 is input, the arc point corresponding to the input of the previous function set 1-3 will realize the double judgment of current and arc light.

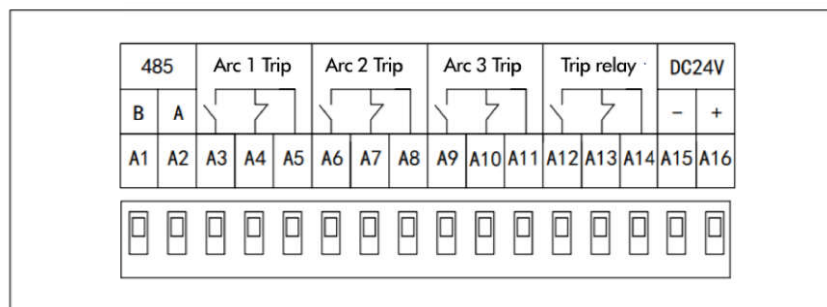
Current setting can be modified through 485 communications. **The default setting is 10A.**



The device has 3 trip relay and 1 general signal relay, and the relay has 1 NO and 1 NC dual node. There is a one-to-one correspondence between the tripping relay and the arc point. When any arc point meets the action conditions, the corresponding trip relay and general signal relay will act and output.

After the protection device operates, the relay state remains. It can be returned by pressing the Reset key or Communication reset.

**(Note: It cannot be reset when the arc continues to exist or the current does not disappear).**





## 2.2 - Sensor introduction

Arc sensors are light sensing elements that detect arcs. When no arc fault occurs, the light intensity increases greatly, and the arc sensor converts the optical signal into an electrical signal and sends it to the arc protection or arc extension unit. Arc sensor wiring has no polarity.

The arc light sensor is installed in the relevant parts of the switchgear to monitor those fragile and important parts. Such as the busbar interval in the switchgear, the CT and PT components in the lower part of the switchgear, the contacts of the circuit breaker, the cable connector, etc.

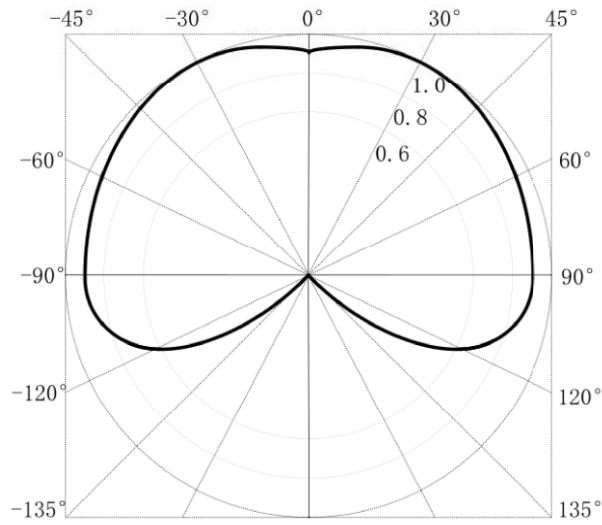
At present, there are three main types of arc light probes in the market: arc light probes, white light arc light sensing probes and ultraviolet arc light sensing probes. Among them, the ultraviolet arc light sensor has the strongest photosensitive ability, and is also the most effective in sensing arc ultraviolet light inside the switchgear. No interference and influence on visible light.

The ultraviolet arc light sensor is designed for arc light spectral characteristics, using special optical materials, polymer blending and doping technology, and optical lens technology. It can filter out the arc light detection sensor probe that interferes with visible light. The ultraviolet arc light probe can quickly detect the arc light that occurs within a range of more than 240 degrees, and transmit it to the control equipment through the optical fiber, so as to quickly cut off the fault at the millisecond level and avoid serious consequences.

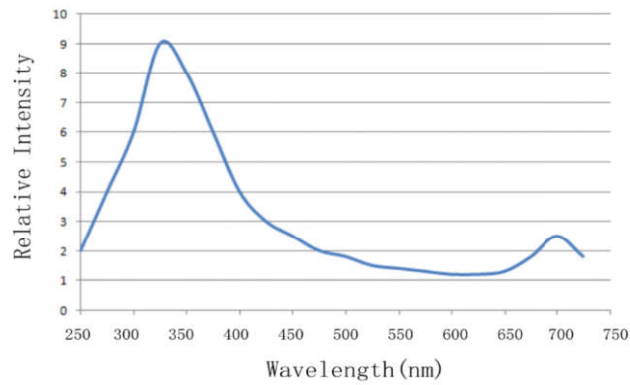
### Features of UV arc light sensor

- High reliability.
- High sensitivity, especially sensitive to ultraviolet light and blue light that can reflect the characteristics of arc light.
- Widely detection range, and the detection angle range exceeds 240 degrees.
- Spectral response bandwidth: 280nm~700nm.
- Standard ST fiber optic interface.
- Working temperature: -50~85°C

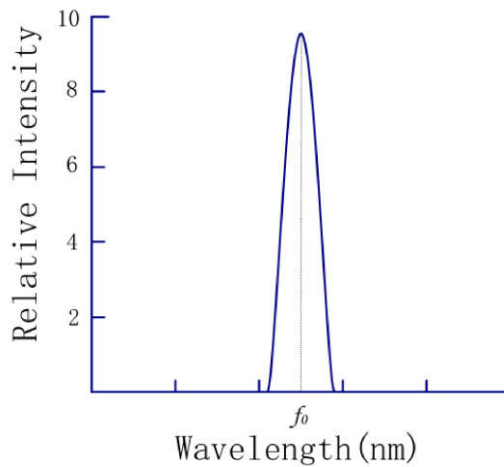




**Fig1. Arc sensor angle response characteristic curve**



**Fig2. Typical characteristic curve of spectral response**



**Fig3. The arc light sensor outputs a laser with a fixed wavelength**

### 3. - TECHNICAL PARAMETERS

#### - Power supply

AC/DC85 ~ 265V

#### - Consumption

≤ 8W

#### - Current input

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

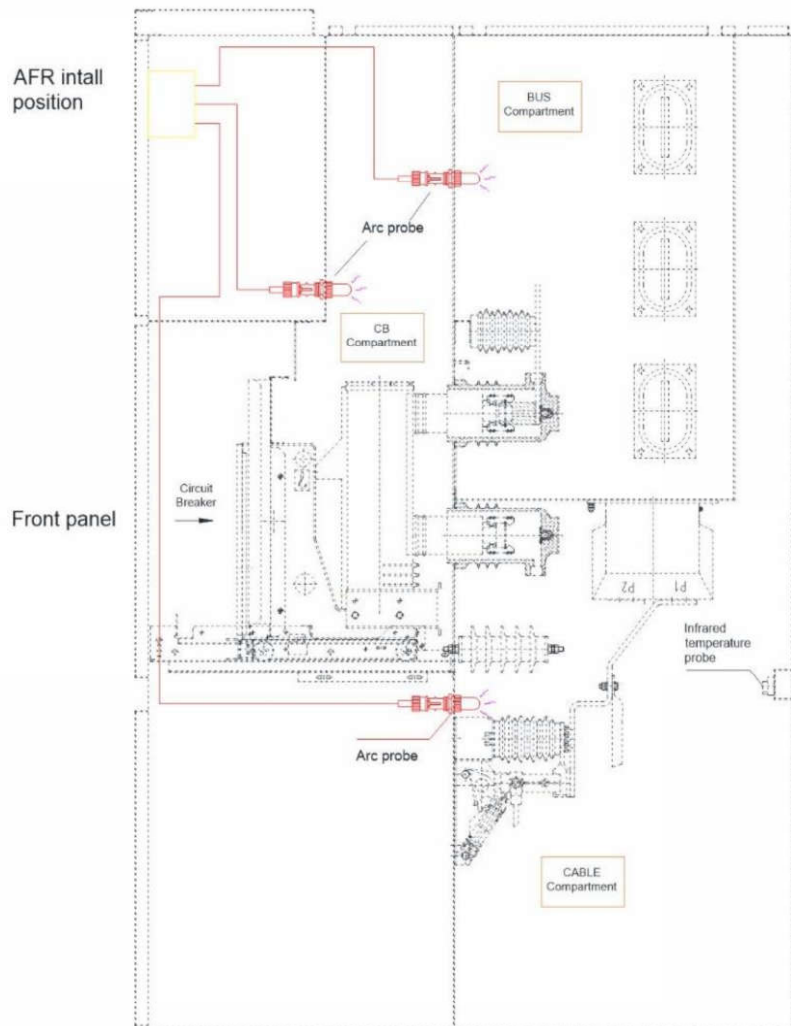
Working environment:	-10 ~ 55°C/ < 93% RH (Non-condensing)
Storage environment:	-30 ~ 70°C/ < 70% RH (Non-condensing)
Relative humidity:	5%~ 95%
Atmospheric pressure:	60kPa ~ 106kPa

**- Electromagnetic compatibility**

<b>Item</b>	<b>Standard</b>
Electrostatic discharge test:	IEC 60255-22-2:2008. level-4
Fast transient dry resistance test:	IEC 60255-22-4:2008. level-A
1mhz burst interference test:	IEC 60255-22-1-2007. level-3
Electrical disturbance test:	IEC 60255-22-2:2008.level-3
Surge immunity test:	IEC 60255-22-5:2008

## 4.- INSTALLATION AND START-UP

### 4.1 - Wiring Method

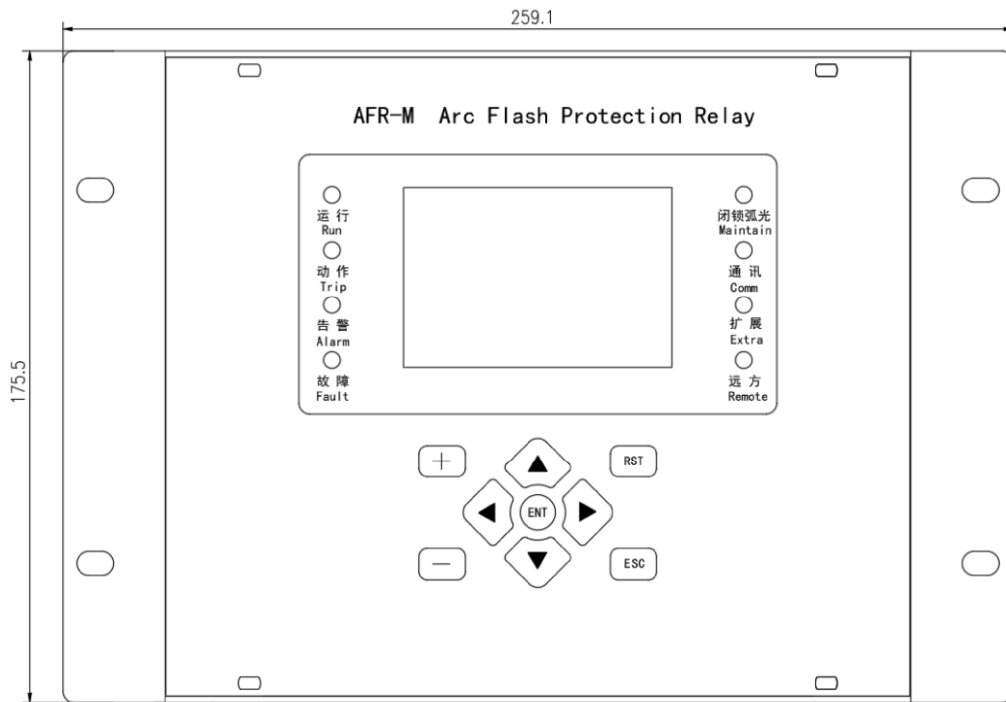


Note:

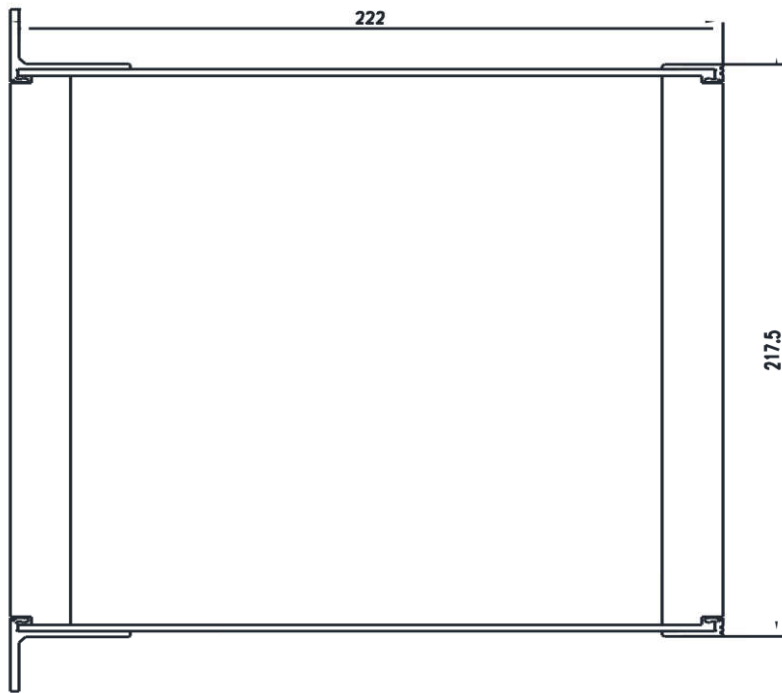
The picture above is an installation example. For the specific installation method, please refer to the document: [AFR-Installation instruction-1](#)

### 4.2 - Installation Dimensions (Unit: mm)

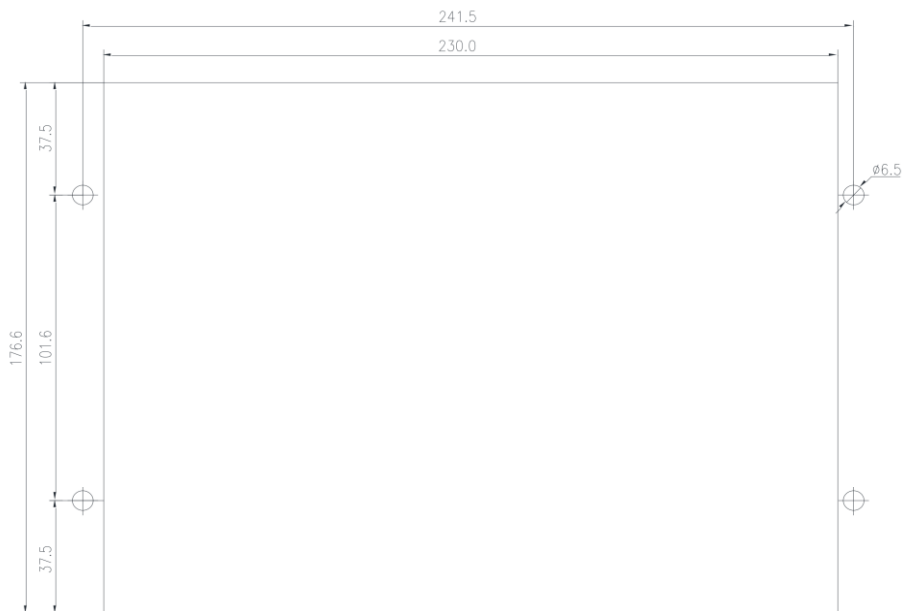
The host adopts the fully enclosed 4U 1/2 standard case, and is mounted on the screen (switchgear). The plug-in is a rear-insert guide rail with tight screws up and down. dimensions are as follows: (unit: mm)



Front view



Upper view



Hole size

### 4.3 - Terminal Definition

## Terminal definition

A-POW		B-DO		C-ARC		D-ARC		E-ARC		F-ARC		G-CPU		H-ACI	
A01	Remote sta	B01	Output Relay1	C01	ARC01	D01	ARC13	E01	ARC25	F01	ARC37	G01	IRIG-B+	H01	Ia1
A02	1DL OFF	B02	Output Relay1	C02	ARC02	D02	ARC14	E02	ARC26	F02	ARC38	G02	IRIG-B-	H02	Ia1'
A03	1DL ON	B03	Output Relay2	C03	ARC03	D03	ARC15	E03	ARC27	F03	ARC39	G03	IRIG-G	H03	Ib1
A04	2DL OFF	B04	Output Relay2	C04	ARC04	D04	ARC16	E04	ARC28	F04	ARC40	G04	485A1	H04	Ib1'
A05	2DL ON	B05	Output Relay3	C05	ARC05	D05	ARC17	E05	ARC29	F05	ARC41	G05	485B1	H05	Ic1
A06	3DL OFF	B06	Output Relay3	C06	ARC06	D06	ARC18	E06	ARC30	F06	ARC42	G06	485A2	H06	Ic1'
A07	3DL ON	B07	Output Relay4	C07	ARC07	D07	ARC19	E07	ARC31	F07	ARC43	G07	485B2	H07	Ia2
A08	4DL OFF	B08	Output Relay4	C08	ARC08	D08	ARC20	E08	ARC32	F08	ARC44	G08	485GND	H08	Ia2'
A09	4DL ON	B09	Output Relay5	C09	ARC09	D09	ARC21	E09	ARC33	F09	ARC45			H09	Ib2
A10	Latch Arc1	B10	Output Relay5	C10	ARC10	D10	ARC22	E10	ARC34	F10	ARC46			H10	Ib2'
A11	Latch Arc2	B11	Output Relay6	C11	ARC11	D11	ARC23	E11	ARC35	F11	ARC47			H11	Ic2
A12	DI 12	B12	Output Relay6	C12	ARC12	D12	ARC24	E12	ARC36	F12	ARC48			H12	Ic2'
A13	DI 13	B13	Output Relay7											H13	Ia3
A14	DI 14	B14	Output Relay7											H14	Ia3'
A15	DI 15	B15	Output Relay8											H15	Ib3
A16	DI 16	B16	Output Relay8											H16	Ib3'
A17	Com	B17	Output Relay9											H17	Ic3
A18	Power loss	B18	Output Relay9											H18	Ic3'
A19	alarm output	B19	Trip Relay											H19	Ia4
A20	L/+	B20	Trip Relay											H20	Ia4'
A21	N/-	B21	Alarm Relay											H21	Ib4
A22	PGND	B22	Alarm Relay											H22	Ib4'
														H23	Ic4
														H24	Ic4'

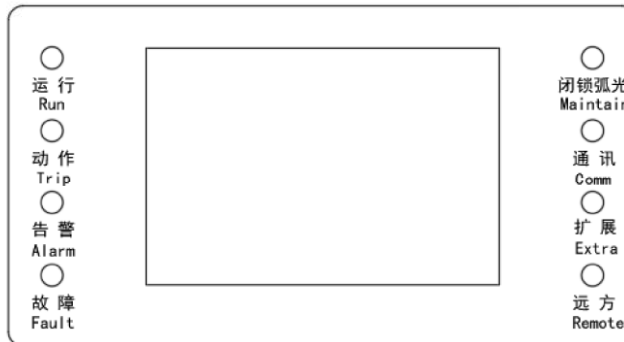
  

EXTRA	Ethernet
ETH1	Ethernet
EHT2	Ethernet

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		



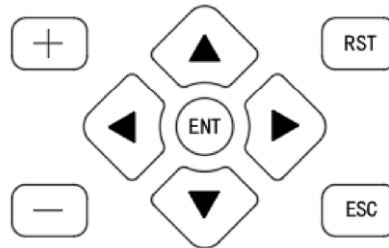
### 4.4 - Signal Light Description



Item	Color	Definition
"Run"	Green	Device in working, it flashes once a second.
"Trip"	Red	DO trips when arc flash or over current fault.
"Alarm"	Red	Indicator of protection device.
"Fault"	Red	Device system fails.
"Maintain"	Red	Disable arc protection function in maintains service.
"Comm"	Green	Communication status of the device
"Extra"	Green	Indicator device communicates with extra AFR-M in over 48 channels feeders.
"Remote"	Green	Device is in remote state and can be remotely controlled.

### 4.5 - 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

## 5. - SETUP PROCEDURE

### 5.1 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.



## 5.2. Main menu

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



### 5.3. "Analog"



Under "Analog" menu, it shows real time measurement current info of 4 channels, include following data:

- Three phase current value
- Phase angle

Press "ENT" key to enter sub-menu,

"Protect" shows real-time sampling value of the secondary side protection transformer.

"Measure" shows primary side value (multiplied by the transformation ratio coefficient).

"Offset" can be used to calibration the measuring value.

-Analog	Name	Value	Angle
1. Protect	Ia1=	0.000 A	0 °
	Ib1=	0.000 A	0 °
	Ic1=	0.000 A	0 °
2. Measure	Ia2=	0.000 A	0 °
	Ib2=	0.000 A	0 °
	Ic2=	0.000 A	0 °
3. Offset	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 °

**Notes:** If current measurement have drift, in Offset submenu can recalibration:

1. Enter Offset menu, default password 00
2. Access standard 5A signal to AFR-M, keep at least 1min for stable
3. Press  , device will automatic in calibration program
4. Press button  to confirm recalibration and exit.

## 5.4. "Report"



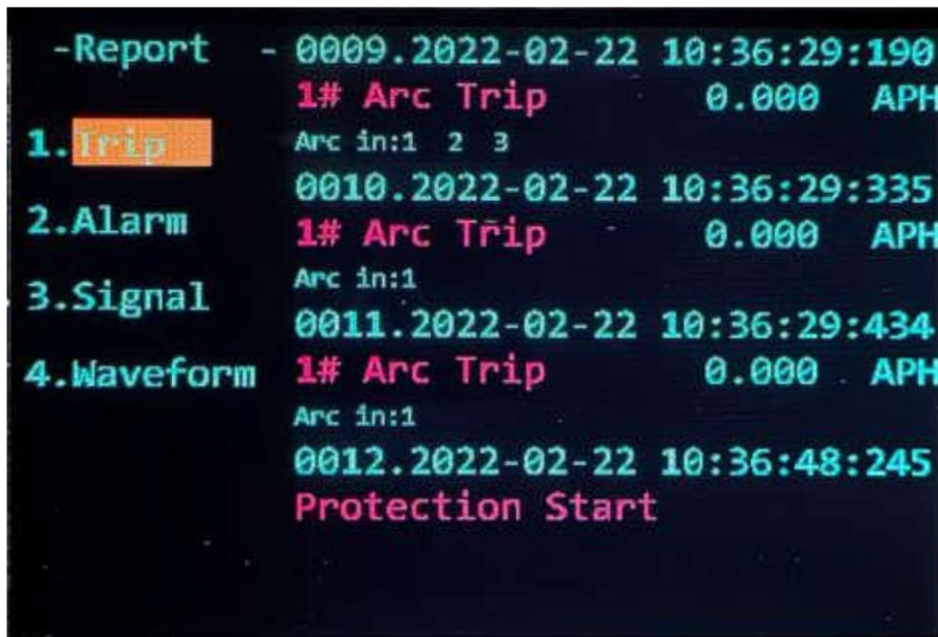
Under "Report" menu, it shows all the record of protection trip and other alarm info:

- DO Trip
- Self-Test Alarm
- Remote Signal
- Captured Waveform

### 5.4.1- Trip

"Trip" shows protection DO trip records. User can view these records to trace any DO trips.

Press **ENT** to entry details page, default show latest trip record, then press direction button can move to previous or next pages.



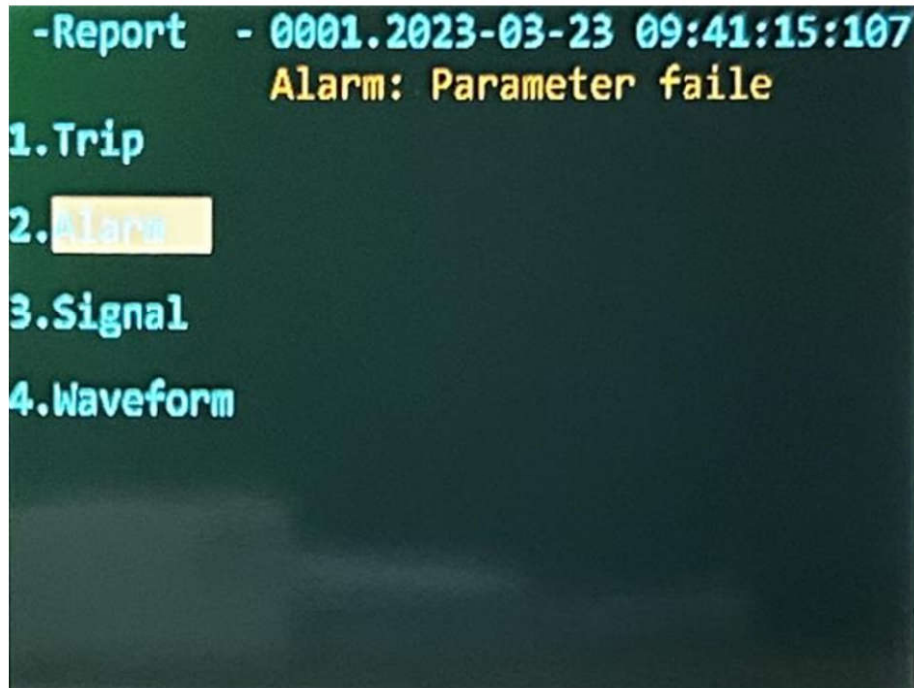
0001-9999	Record list, maximum can storage 9999 record info
2022-02-22	Date info of record generated
10:36:29:190	Timestamp of record generated, resolution 1ms
1# to 4#	Current sampling group, related rear panel current sensor access
Arc Trip	Arc fault event, Ac
Arc in	Arc sensor input, if multiple arc probe detect flash, there will show related channel number, from 1-48
Protection Start	



### 5.4.2- Alarm

“Alarm” show system self-test alarm report record.

Press **ENT** to entry details page, default show latest alarm record, then press direction button can move to previous or next pages.





### 5.4.3-Signal

"Signal" displays the remote signaling report record.

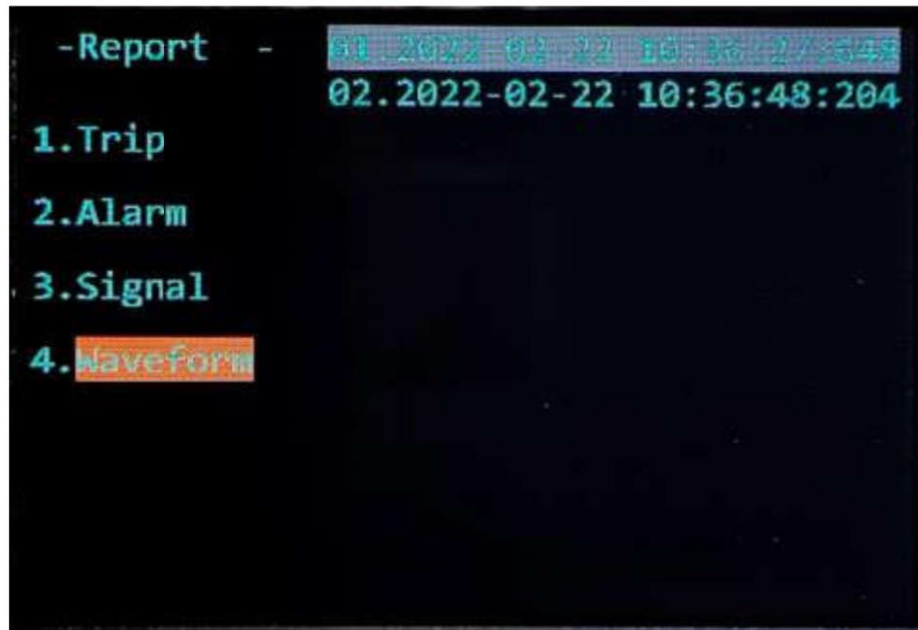
Press **ENT** to entry details page, default show latest Signal record, then press direction button can move to previous or next pages.

```
-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
```

#### 5.4.4-Waveform

"Waveform" this menu displays the displacement report record.

Press **ENT** to entry details page, default show latest waveform record, then press direction button can move to previous or next record.



### 5.5. "Function"

AFR-M provide max 4 current sampling group, Marked 1# to 4#, in this menu can control it shown in screen and setting trip active or not

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

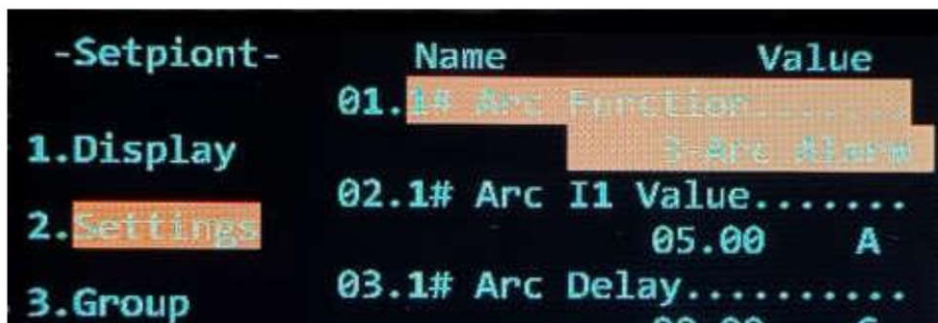
Notes: If purchase device equipped only 12 channels Arc probe, only 1# Arc Function default ON, other group default OFF,

### 5.6. "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).

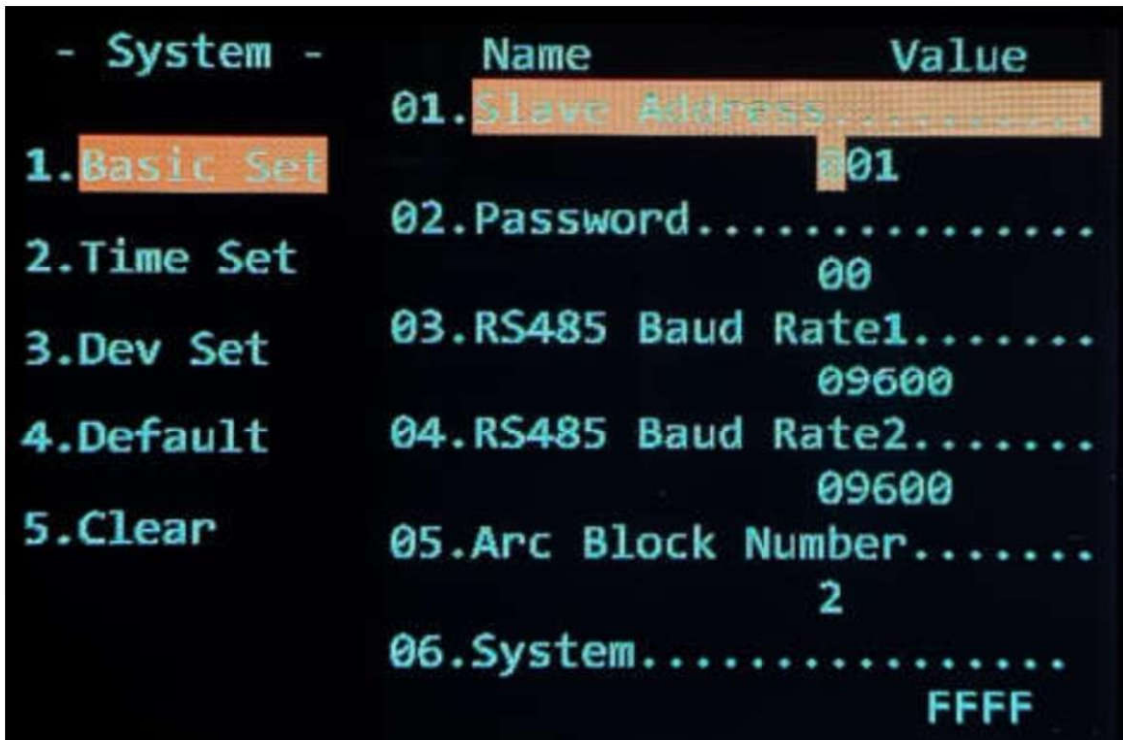
NO.	Binary value	Hexadecimal value	Explanation
<b>ARC:1</b>	0000 0000 0000 0000 0000 0001	000001	Arc1:on
<b>ARC:1-2</b>	0000 0000 0000 0000 0000 0011	000003	Arc1-2:on
<b>ARC:1-3</b>	0000 0000 0000 0000 0000 0111	000007	Arc1-3:on
<b>ARC:1-4</b>	0000 0000 0000 0000 0000 1111	00000F	Arc1-4:on
<b>ARC:1-5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



### 5.7. "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.





### 5.8. "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

### 5.9. "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.

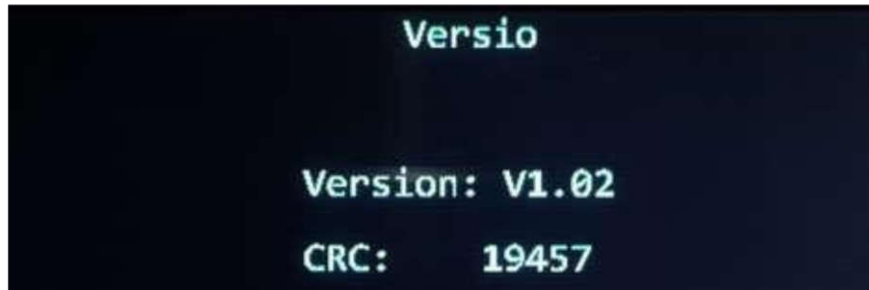
- Test -	Name	Status
1. Output	01. Remote sta	OFF
	02. 1DL OFF	OFF
2. <b>Input</b>	03. 1DL ON	OFF
	04. 2DL OFF	OFF
3. Arc	05. 2DL ON	OFF

"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. <b>Arc</b>	Arc 5	OFF

## 5.10. “Version”

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



## 6. - COMMUNICATION INTERFACE

### 6.1. - MODBUS © Protocol

#### MODBUS FUNCTIONS:

Code	Meaning	Description
<b>FUNCTION 02</b>	Read input status	<i>Read the input status of the device bit by bit</i>
<b>FUNCTION 04</b>	Read input registers	<i>Read the analog quantity of the device</i>
<b>FUNCTION 06</b>	Preset single register	<i>To reset the signal</i>
<b>FUNCTION 10</b>	Preset multiple registers	<i>To device time synchronization</i>

#### Notes:

1. The transmission mode of the device is RTU (remote terminal unit) mode, and the information transmission is asynchronous.
2. Baud rate 2400/4800/9600. The default is 9600.
3. Start bit=1, data bit=8, stop bit=1, parity bit=none.
4. This protocol adopts the standard calculation method of MODBUS RTU CRC16, and the verification sequence is (low-high).
5. Physical address setting range: 1~254;

## 6.2.- Register Map

### 6.2.1 - Read command—Feeder current data

AFR-M can poll and read up to 4 sets of bus current values, the command definition is as follows:

#### Host inquiry:

Data Format	Data	Description
Address	01H	Device address: 1-254
Function code	04H	Read input registers
Starting Register H	00H	Starting register high byte
Starting Register L	00H	Starting register low byte
Inquiry length H	00H	Inquiry length high byte
Inquiry length L	18H	Inquiry length low byte
CRC_H	XXH	CRC check code high byte
CRC_L	XXH	CRC check high low byte

#### Slave response:

Data Format	Data	Description
Address	01H	Device address: 1-254
Function code	04H	Read input registers
Data length	30H	Total data length
1	Float 4	Read input status
2	Float 4	
3	Float 4	
4	Float 4	
...	Float 4	
12	Float 4	
CRC_L	XXH	CRC check code low byte
CRC_H	XXH	CRC check high low byte

**Bit definition map:**

No.	ID	Byte	Item	Data Format
1	00 00	4	Ia1	float
2	00 02	4	Ib1	float
3	00 04	4	Ic1	float
4	00 06	4	Ia2	float
5	00 08	4	Ib2	float
6	00 0A	4	Ic2	float
7	00 0C	4	Ia3	float
8	00 0E	4	Ib3	float
9	00 10	4	Ic3	float
10	00 12	4	Ia4	float
11	00 14	4	Ib4	float
12	00 16	4	Ic4	float

**Notes:**

1. The read data is the secondary current value, please convert the primary current value according to the transformer parameters
2. The floating point data format is HH HL LH LL
3. If the current value is not connected, it will be displayed as 00 00

**Example:**
**Host inquiry:**

01 04 00 00 00 18 F0 00

**Slave response:**

01 04 30 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  
 00  
 00 42 2D

### 6.2.2 - Read command—Device status and Arc fault info

AFR-M provides a variety of DI interfaces and DO ports to indicate different fault points and fault types, and can also read status and fault information through the address table:

#### Host inquiry:

Data Format	Data	Description
Address	01H	Device address: 1-99
Function code	02H	Read input registers
Starting register H	00H	Starting register high byte
Starting register L	00H	Starting register low byte
Inquiry length H	00H	Inquiry length high byte
Inquiry length L	70H	Inquiry length low byte
CRC_H	XXH	CRC check code high byte
CRC_L	XXH	CRC check high low byte

#### Slave response:

Data Format	Data	Description
Address	01H	Device address
Function code	02H	Read input registers
Data length	0EH	Total data length
ID:00	00H	Read input status
ID:01	00H	
ID:02	00H	
...	00H	
ID:0E	00H	
CRC_H	XXH	CRC check code high byte
CRC_L	XXH	CRC check code low byte



**Bit definition map:**

No.	ID	Bit	Item	Value	Type
0	00	0	Total Accident	0:OFF ; 1:ON	General Act Signal
1		1	General Alarm	0:OFF ; 1:ON	General Alarm Signal
2		2	Remote sta	0:OFF ; 1:ON	DI
3		3	1DL OFF	0:OFF ; 1:ON	DI
4		4	1DL ON	0:OFF ; 1:ON	DI
5		5	2DL OFF	0:OFF ; 1:ON	DI
6		6	2DL ON	0:OFF ; 1:ON	DI
7		7	3DL OFF	0:OFF ; 1:ON	DI
8	01	0	3DL ON	0:OFF ; 1:ON	DI
9		1	4DL OFF	0:OFF ; 1:ON	DI
10		2	4DL ON	0:OFF ; 1:ON	DI
11		3	Latch Arc 1	0:OFF ; 1:ON	DI
12		4	Latch Arc 2	0:OFF ; 1:ON	DI
13		5	DI12	0:OFF ; 1:ON	DI
14		6	DI13	0:OFF ; 1:ON	DI
15		7	Reserve	Default:0	/
16	02	0	Reserve	Default:0	/
17		1	Reserve	Default:0	/
18		2	ARC1	0:OFF ; 1:ON	
19		3	ARC2	0:OFF ; 1:ON	Arc State
20		4	ARC3	0:OFF ; 1:ON	Arc State
21		5	ARC4	0:OFF ; 1:ON	Arc State
22		6	ARC5	0:OFF ; 1:ON	Arc State
23		7	ARC6	0:OFF ; 1:ON	Arc State
24	03	0	ARC7	0:OFF ; 1:ON	Arc State
25		1	ARC8	0:OFF ; 1:ON	Arc State
26		2	ARC9	0:OFF ; 1:ON	Arc State
27		3	ARC10	0:OFF ; 1:ON	Arc State
28		4	ARC11	0:OFF ; 1:ON	Arc State
29		5	ARC12	0:OFF ; 1:ON	Arc State
30		6	ARC13	0:OFF ; 1:ON	Arc State
31		7	ARC14	0:OFF ; 1:ON	Arc State
32	04	0	ARC15	0:OFF ; 1:ON	Arc State
33		1	ARC16	0:OFF ; 1:ON	Arc State
34		2	ARC17	0:OFF ; 1:ON	Arc State
35		3	ARC18	0:OFF ; 1:ON	Arc State

36		4	ARC19	0:OFF ; 1:ON	Arc State	
37		5	ARC20	0:OFF ; 1:ON	Arc State	
38		6	ARC21	0:OFF ; 1:ON	Arc State	
39		7	ARC22	0:OFF ; 1:ON	Arc State	
40		<b>05</b>	0	ARC23	0:OFF ; 1:ON	Arc State
41			1	ARC24	0:OFF ; 1:ON	Arc State
42			2	ARC25	0:OFF ; 1:ON	Arc State
43	3		ARC26	0:OFF ; 1:ON	Arc State	
44	4		ARC27	0:OFF ; 1:ON	Arc State	
45	5		ARC28	0:OFF ; 1:ON	Arc State	
46	6		ARC29	0:OFF ; 1:ON	Arc State	
47	7	ARC30	0:OFF ; 1:ON	Arc State		
48	<b>06</b>	0	ARC31	0:OFF ; 1:ON	Arc State	
49		1	ARC32	0:OFF ; 1:ON	Arc State	
50		2	ARC33	0:OFF ; 1:ON	Arc State	
51		3	ARC34	0:OFF ; 1:ON	Arc State	
52		4	ARC35	0:OFF ; 1:ON	Arc State	
53		5	ARC36	0:OFF ; 1:ON	Arc State	
54		6	ARC37	0:OFF ; 1:ON	Arc State	
55	7	ARC38	0:OFF ; 1:ON	Arc State		
56	<b>07</b>	0	ARC39	0:OFF ; 1:ON	Arc State	
57		1	ARC40	0:OFF ; 1:ON	Arc State	
58		2	ARC41	0:OFF ; 1:ON	Arc State	
59		3	ARC42	0:OFF ; 1:ON	Arc State	
60		4	ARC43	0:OFF ; 1:ON	Arc State	
61		5	ARC44	0:OFF ; 1:ON	Arc State	
62		6	ARC45	0:OFF ; 1:ON	Arc State	
63	7	ARC46	0:OFF ; 1:ON	Arc State		
64	<b>08</b>	0	ARC47	0:OFF ; 1:ON	Arc State	
65		1	ARC48	0:OFF ; 1:ON	Arc State	
66		2	1#Arc Function	0:OFF ; 1:ON	Function	
67		3	2#Arc Function	0:OFF ; 1:ON	Function	
68		4	3#Arc Function	0:OFF ; 1:ON	Function	
69		5	4#Arc Function	0:OFF ; 1:ON	Function	
70		6	Arc Alarm	0:OFF ; 1:ON	Function	
71	7	Reserve	Default:0			
72	<b>09</b>	0	Protection Start	0: OFF; 1: ON	Action Event	
73		1	1# Arc Trip	0: OFF; 1: ON	Action Event	
74		2	2# Arc Trip	0:OFF ; 1:ON	Action Event	
75		3	3# Arc Trip	0:OFF ; 1:ON	Action Event	

76		4	4# Arc Trip	0:OFF ; 1:ON	Action Event
77		5	Reserve	0:OFF ; 1:ON	
78		6	Reserve	0:OFF ; 1:ON	
79		7	Reserve	0:OFF ; 1:ON	
80	0A	0	Arc Alarm	0:OFF ; 1:ON	Alarm Event
81		1	Parameter fail	0:OFF ; 1:ON	Alarm Event
82		2	Device parameter fail	0:OFF ; 1:ON	Alarm Event
83		3	FLASH fail	0:OFF ; 1:ON	Alarm Event
84		4	AD fail	0:OFF ; 1:ON	Alarm Event
85		5	Zero drift limit	0:OFF ; 1:ON	Alarm Event
86		6	Communication initialization fail	0:OFF ; 1:ON	Alarm Event
87		7	output break down	0:OFF ; 1:ON	Alarm Event
88	0B	0	Control loop disconnection	0:OFF ; 1:ON	Alarm Event
89		1	Spring discharged	0:OFF ; 1:ON	Alarm Event
90		2	Arc Alarm	0:OFF ; 1:ON	Alarm Event
91		3	Reserve	Default:0	/
92		4	Reserve	Default:0	/
93		5	Reserve	Default:0	/
94		6	Reserve	Default:0	/
95		7	Reserve	Default:0	/

**Example:**
**Host inquiry:**

01 02 00 00 00 70 79 EE

**Slave response:**

01 02 0E 00 00 00 00 00 00 00 40 00 00 00 00 20 45

### 6.2.3. - Write Command

1. When the alarm state occurs, the device can be reset through the 485 command, and the trigger relay is contacted. This command is in a fixed format, and the Device will return the same command after receiving the command and executing it successfully.

**Example:**

**Host inquiry:**

01 06 00 00 00 00 89 CA

**Slave response:**

01 06 00 00 00 00 89 CA

2. AFR-M has a built-in clock chip, and clock deviation may occur during long-term operation. You can set the time by the following command

**Host inquiry:**

Data Format	Data	Description
Address	01H	Device address
Function code	10H	device time synchronization
Starting register H	00H	Starting register high byte
Starting register L	00H	Starting register low byte
Inquiry length H	08H	Inquiry length high byte
Inquiry length L	00H	Inquiry length low byte
Total data bytes	08H	8 bytes
Year H	07H	2021
Year L	E5H	
Month	0AH	October
Date	09H	9th
Hour	0BH	11 o'clock
Minute	05H	5 min
Second H	3EH	15s 877ms
Second L	05H	
CRC_L	XXH	CRC check code low byte
CRC_H	XXH	CRC check code high byte

Note:

After the time is set successfully, the device will return the same command

**Example:**

**Host inquiry:**

01 10 00 00 08 00 08 07 E7 04 14 0B 1B 00 00 48 83

**Slave response:**

01 10 00 00 08 00 08 07 E7 04 14 0B 1B 00 00 48 83

**Modify the device time to 11:27 on April 20, 2023**

## 7. - 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.

## 8. - MAINTENANCE

The 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.

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

*Blue Jay - After-sales service*

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