

# AFR-3

## Arc Flash Protection Relay

### User Manual



**Version:1.0**

**Revision: 2023.05**

## Read me

**When you use AFR-3, 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 exception records, event records, and operation records;
- All information power-off retention;
- Equipped with RS485 communication interface;
- Integrated MODBUS standard communication protocol;
- Small and exquisite appearance, reasonable structure;
- Using high-grade, high-quality components;
- Using multi-layer board technology and SMT process;
- The product has high electrical performance;
- Can collect 3 channels of arc light signals;
- Support ST visible light and ST ultraviolet sensor access.

### APPLICATIONS

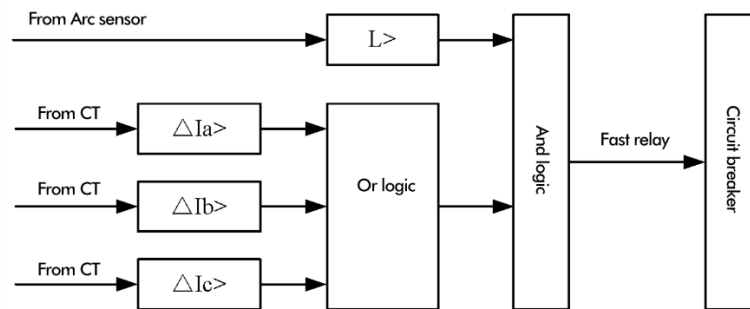
- Reduce the harm of arc light to human body;
- Reduce damage to equipment caused by arc short-circuit faults;
- Avoid transformer damage caused by bus failure;
- Protect the dc system in the station;
- Ensure the stable operation of power substations;
- Thermal power plant electrical section switchgear;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

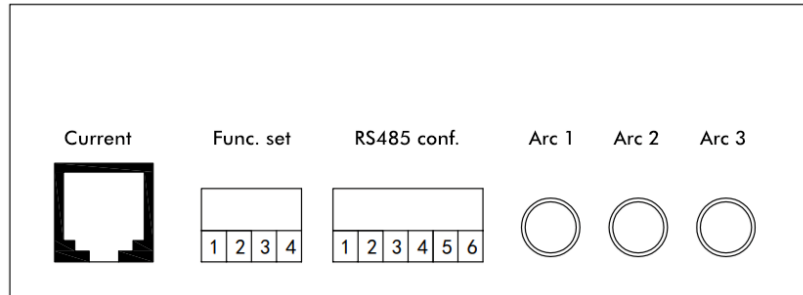
Pressing function set 1 means that arc point 1 is switched on. When function set 1 is switched on, the protection function of single criterion arc point 1 is switched on.

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.

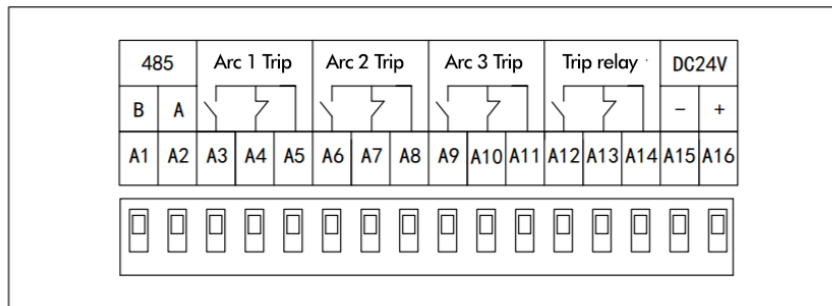
Current setting can be modified through 485 communications. **The default setting is 10A.**



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.

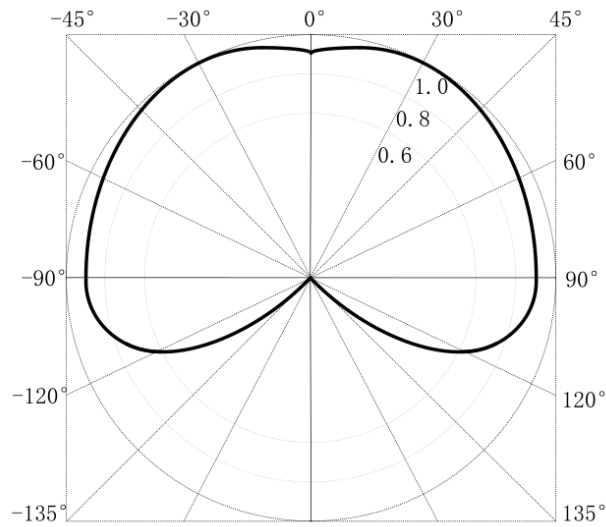
The arc light sensor is installed in the relevant parts of the switchgear to monitor those fragile and important parts. Such as the busbar interval in the switchgear, the CT and PT components in the lower part of the switchgear, the contacts of the circuit breaker, the cable connector, etc.

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.

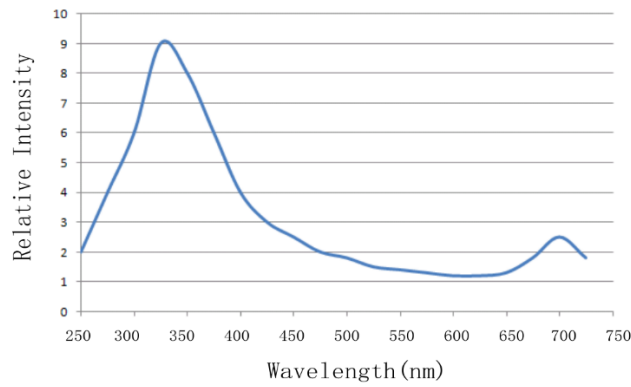
The ultraviolet arc light sensor is designed for arc light spectral characteristics, using special optical materials, polymer blending and doping technology, and optical lens technology. It can filter out the arc light detection sensor probe that interferes with visible light. The ultraviolet arc light 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

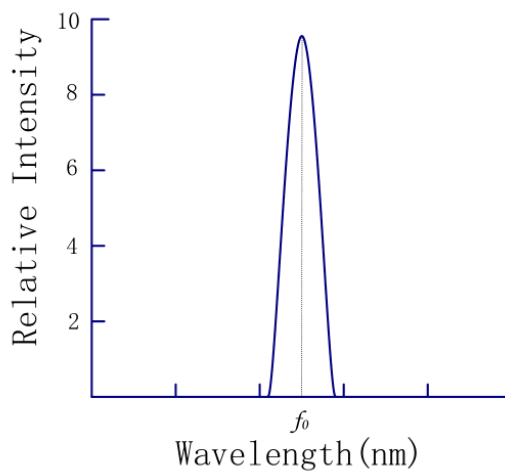
- High reliability.
- High sensitivity, especially sensitive to ultraviolet light and blue light that can reflect the characteristics of arc light.
- Widely detection range, and the detection angle range exceeds 240 degrees.
- Spectral response bandwidth: 280nm~700nm.
- Standard ST fiber optic interface.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

#### Basic parameters

Rated working voltage	DC24V
AC current	5A or 1A (specify when ordering)
Frequency	50HZ
Working power consumption	Working normally, $\leq 3W$ Protection operates, $\leq 6W$
AC current loop consumption	$< 1VA/phase (IN =5A);$ $< 0.5VA/phase (IN =1A);$
Current working range	0.08In~10In
Time working range	0~99s
Setting accuracy	$\leq \pm 5\%$ ;
Time accuracy	$< \pm 1\% * \text{setting time} + 20ms$
The whole group action time	Single criterion $\leq 7ms$ Double criterion $\leq 20ms$

#### Arc signal input

Input type	Passive optical signal
Input quantity	3
Interface type:	Optical fiber

#### Output contact capacity

##### A) Export relay: (3 routes)

Contact rated current carrying capacity	250Vac/220Vdc, 5A
Output type	Passive (NO/NC)

##### B) Signal relay: (1 way)

Contact rated current carrying capacity	250Vac/220Vdc, 5A
Output type	Passive (NO/NC)
Address	1~99

#### Communication interface

Electrical characteristics	RS485
Transmission method	Asynchronous
Communication protocol	Modbus RTU
Communication medium	Shielded twisted pair

#### Environment

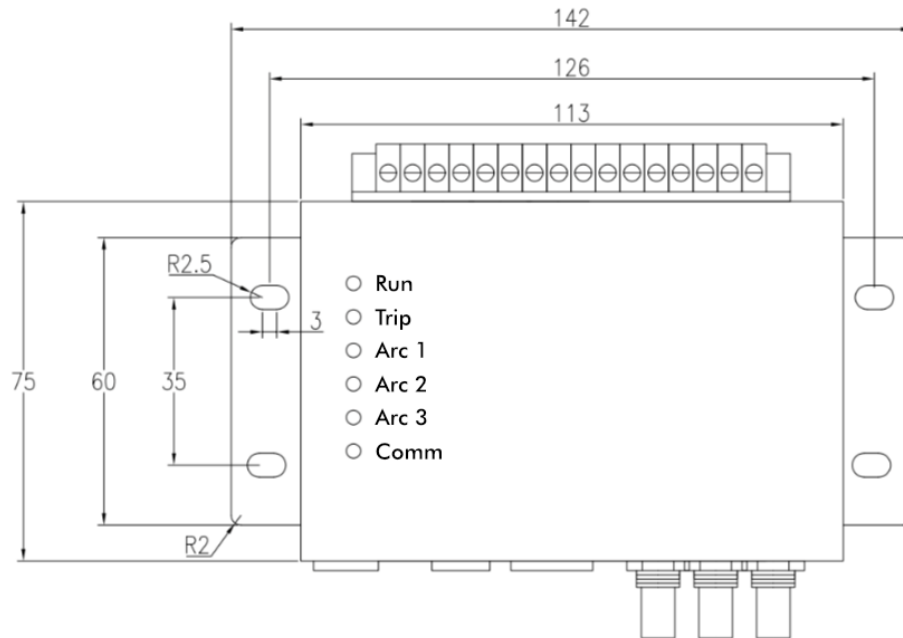
Working temperature	-30 ~ 70°C
Storage temperature	-40 ~ +85°C
Humidity	5~95%RH

**Electromagnetic compatibility**

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

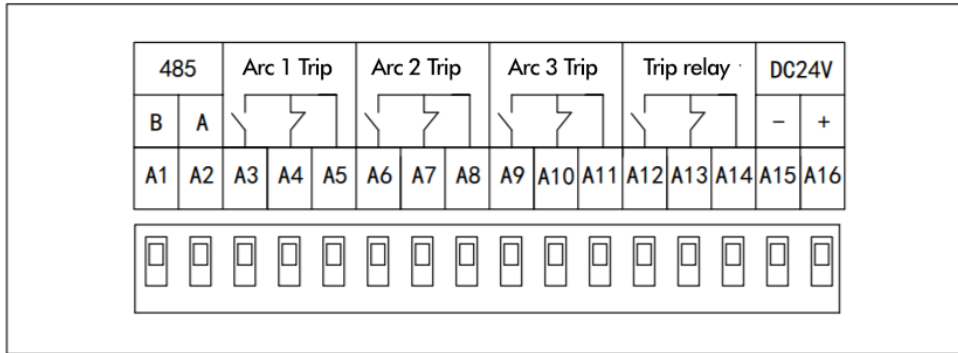
## 4.- INSTALLATION

### 4.1 - Dimension (unit: mm)

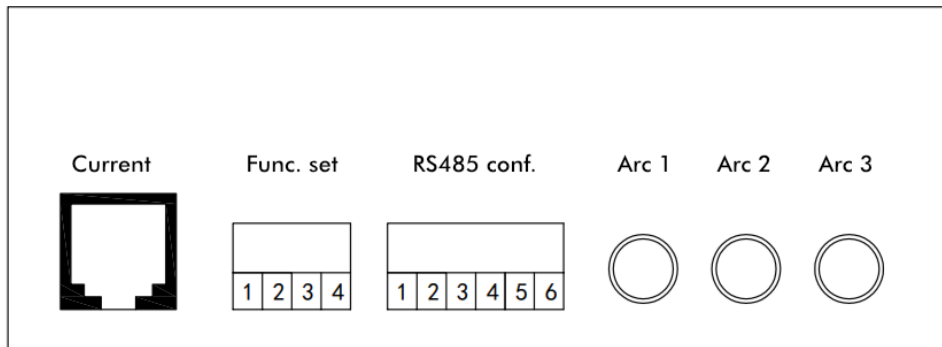


## 4.2 - Terminal definition diagram

### Upper terminal



### Lower terminal



## 5. - COMMUNICATION INTERFACE

### 5.1. - 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 05</b>	Write Single Coil	<i>To device time synchronization</i>
<b>FUNCTION 06</b>	Write Single Register	<i>Writes a value into a single holding register.</i>

#### Notes:

1. The transmission mode of the device is RTU (remote terminal unit) mode, and the information transmission is asynchronous.
2. Communication method: support RS485 communication method;
3. Baud rate 9600bps.
4. Start bit=1, data bit=8, stop bit=1, parity bit=none.
5. This protocol adopts the standard calculation method of MODBUS RTU CRC16, and the verification sequence is (low-high)
6. Physical address setting range: 1~254;

## 5.2.- Register Map

### 5.2.1 – Read DI Signal (FUN=0x02)

ID	Bit	Item	Value
00	0	ARC1	0:OFF ; 1:ON
	1	ARC2	0:OFF ; 1:ON
	2	ARC3	0:OFF ; 1:ON
	3		0:OFF ; 1:ON
	4	1#Arc Function	0:OFF ; 1:ON
	5	2#Arc Function	0:OFF ; 1:ON
	6	3#Arc Function	0:OFF ; 1:ON
	7	Current Function	0:OFF ; 1:ON
01	0	General Alarm output	0:OFF ; 1:ON
	1	Arc 1 output	0:OFF ; 1:ON
	2	Arc 2 output	0:OFF ; 1:ON
	3	Arc 3 output	0:OFF ; 1:ON
	4		0:OFF ; 1:ON
	5		0:OFF ; 1:ON
	6		0:OFF ; 1:ON
	7		0:OFF ; 1:ON

#### Example:

##### Host inquiry:

01 02 00 00 00 0C 78 0F

##### Slave response:

01 02 02 70 03 DC 79

**5.2.2 - Read input registers (FUN=0x04)**

ID	Byte	Format	Item	Type
00 00	2	int	la	Current value secondary
00 01	2	int	lb	Current value secondary
00 02	2	int	lc	Current value secondary
00 03	2	int	lset	Current value secondary

**Example:**

**Host inquiry:**

01 04 00 00 00 04 F1 C9

**Slave response:**

01 04 08 07 CE 00 C6 00 63 00 00 32 28

**The conversion coefficient is 100.**

### 5.2.3 – Remote Control/ Reset (FUN=0x05)

**1.General Action:** Host inquiry: General signal

Slave response: 01 05 00 01 FF 00 DD FA

**2. Arc 1 output:** Host inquiry: 01 05 01 01 FF 00 DC 06

Slave response: 01 05 01 01 FF 00 DC 06

**3. Arc 2 output:** Host inquiry: 01 05 02 01 FF 00 DC 42

Slave response: 01 05 02 01 FF 00 DC 42

**4. Arc 3 output:** Host inquiry: 01 05 03 01 FF 00 DD BE

Slave response: 01 05 03 01 FF 00 DD BE

### 5.2.4 - Current Value Modification (FUN=0x06)

**1. Modify the value: for example, modify the value to 5.04A (01 F8).**

Host inquiry: 01 06 00 01 F8 89 D8

Slave response: 01 06 00 01 F8 89 D8

**2. Read value**

Host inquiry: 01 04 00 00 00 04 F1 C9

Slave response: 01 04 08 00 00 00 00 00 01 F7 64 1B



## 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 AFR-3 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)