MVR-21x, MVR-25x

4189341408A

Option D: Arc protection

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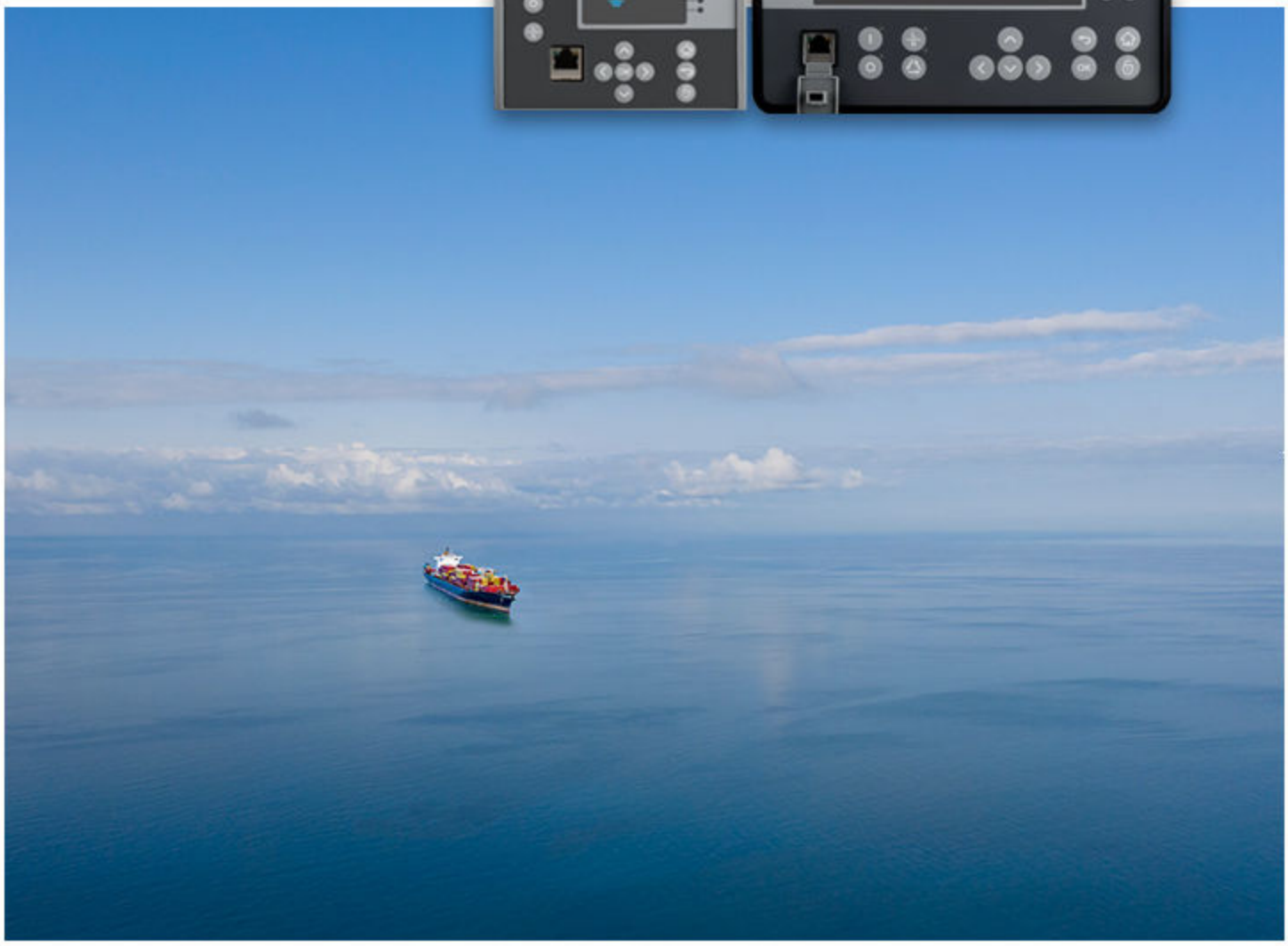


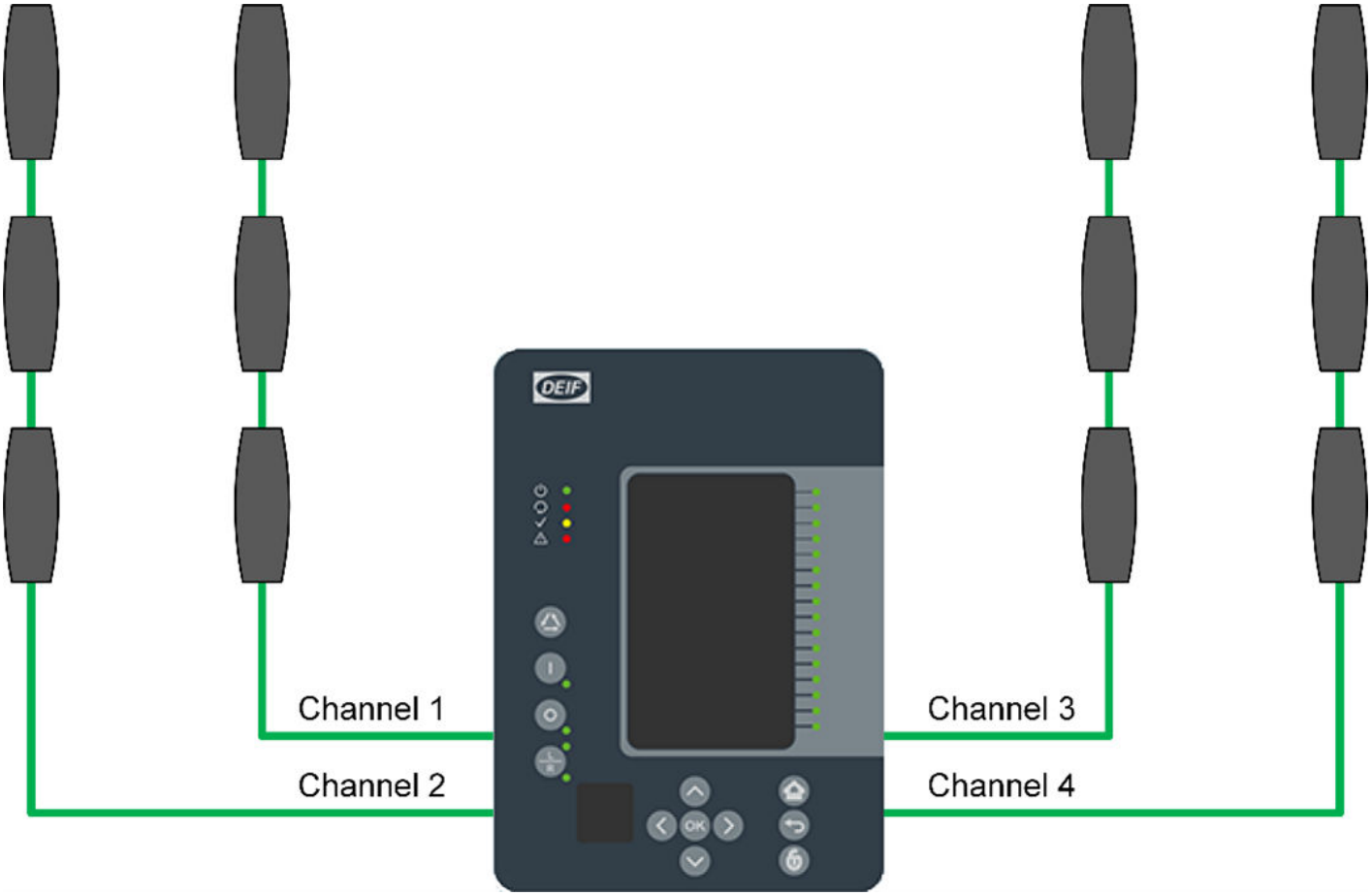
1. Arc protection, option D

1.1 Introduction

Arc faults occur for a multitude of reasons: e.g. insulation failure, incorrect operation of the protected device, corrosion, overvoltage, dirt, moisture, incorrect wiring, or even because of aging caused by electric load. It is important to detect the arc as fast as possible in order to minimize its effects. Using arc sensors to detect arc faults is much faster than merely measuring currents and voltages.

In busbar protection devices with normal protection can be too slow to disconnect arcs within a safe time frame. For example, it may be necessary to delay operation time for hundreds of milliseconds when setting up an overcurrent protection relay to control the feeder breakers to achieve selectivity. This delay can be avoided by using arc protection. The arc protection card has a high-speed output to trip signals faster as well as to extend the speed of arc protection.

1.2 System overview



The module has 4 sensor channels. Each channel supports up to 3 arc point sensors.

The sensors come in 2 variants:

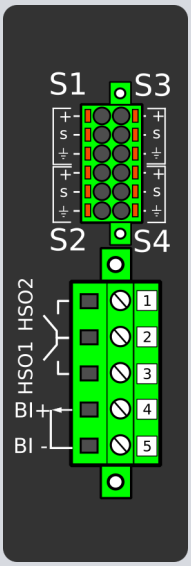
- Light sensing
- Light and pressure sensing

The arc sensing can be combined with overcurrent or residual current sensing so that both arc and overcurrent detection are needed to activate the alarm.

1.3 Arc module hardware

The arc protection module is an add-on module with four (4) light sensor channels, two (2) high-speed outputs and one (1) binary input. This module can be ordered directly to be installed into the device in the factory, or it can be upgraded in the field after the device's original installation when required. If even one of the sensor channels is connected incorrectly, the channel does not work. Each channel can have up to three (3) light sensors serially connected to it. The user can choose how many of the channels are in use.

Table 1.1 Module connections

	Connector	Description
	S1	Light sensor channels 1...4 with positive ("+"), sensor ("S") and earth connectors.
	S2	
	S3	
	S4	
	X 1	HSO2 (+, NO)
	X 2	Common battery positive terminal (+) for the HSOs.
	X 3	HSO1 (+, NO)
	X 4	Binary input 1 (+ pole)
	X 5	Binary input 1 (– pole)

The high-speed outputs (HSO1 and HSO2) operate only with a DC power supply. The battery's positive terminal (+) must be wired according to the drawing. The NO side of the outputs 1 or 2 must be wired through trip coil to the battery's negative terminal (–). The high-speed outputs can withstand voltages up to 250 VDC. The operation time of the high-speed outputs is less than 1 ms.

The rated voltage of the binary input is 24 VDC. The threshold picks up at ≥16 VDC. The binary input can be used for external light information or for similar applications. It can also be used as a part of various ARC schemes. Please note that the binary input's delay is 5...10ms.

NOTE BI1, HSO1 and HSO2 are not visible in the *Binary inputs* and *Binary outputs* menus (*Control → Device I/O*), they can only be programmed in the arc matrix menu (*Protection → Arc protection → I/O → Direct output control* and *HSO control*).

2. Functions

2.1 Introduction

The arc protection function includes:

- Light in arc detection
- Pressure in arc detection
- Arc binary input signal status
- Zone trip
- Zone blocked
- Sensor fault signals

The arc protection function uses eight (8) separate setting groups. These can be selected from one common source.

2.2 Outputs

Table 2.1 Output signals of the IArc>/I0Arc> function.

Outputs	Activation condition
Channel 1 Light In Channel 2 Light In Channel 3 Light In Channel 4 Light In	The arc protection card's sensor channel detects light.
Channel 1 Pressure In Channel 2 Pressure In Channel 3 Pressure In Channel 4 Pressure In	The arc protection card's sensor channel detects pressure.
ARC Binary input signal	The arc protection card's binary input is energized.
I/I0 Arc> Ph. curr. START I/I0 Arc> Res. curr. START	The measured phase current or the residual current is over the set limit.
I/I0 Arc> Ph. curr. BLOCKED I/I0 Arc> Res. curr. BLOCKED	The phase current or the residual current measurement is blocked by an input.
I/I0 Arc> Zone 1 TRIP I/I0 Arc> Zone 2 TRIP I/I0 Arc> Zone 3 TRIP I/I0 Arc> Zone 4 TRIP	All required conditions for tripping the zone are met (light OR light and current).
I/I0 Arc> Zone 1 BLOCKED I/I0 Arc> Zone 2 BLOCKED I/I0 Arc> Zone 3 BLOCKED I/I0 Arc> Zone 4 BLOCKED	All required conditions for tripping the zone are met (light OR light and current) but the tripping is blocked by an input.
I/I0 Arc> S1 Sensor fault I/I0 Arc> S2 Sensor fault I/I0 Arc> S3 Sensor fault I/I0 Arc> S4 Sensor fault	The detected number of sensors in the channel does not match the settings.

2.3 Operational logics

The operational logic consists of the following:

- Input magnitude selection
- Input magnitude processing
- Threshold comparator

- Two block signal checks output processing

The inputs for the function are the following:

- Operating mode selections
- Setting parameters
- Digital inputs and logic signals
- Measured and pre-processed current magnitudes

The function outputs the TRIP, BLOCKED, light sensing etc. signals which can be used for direct I/O controlling and user logic programming.

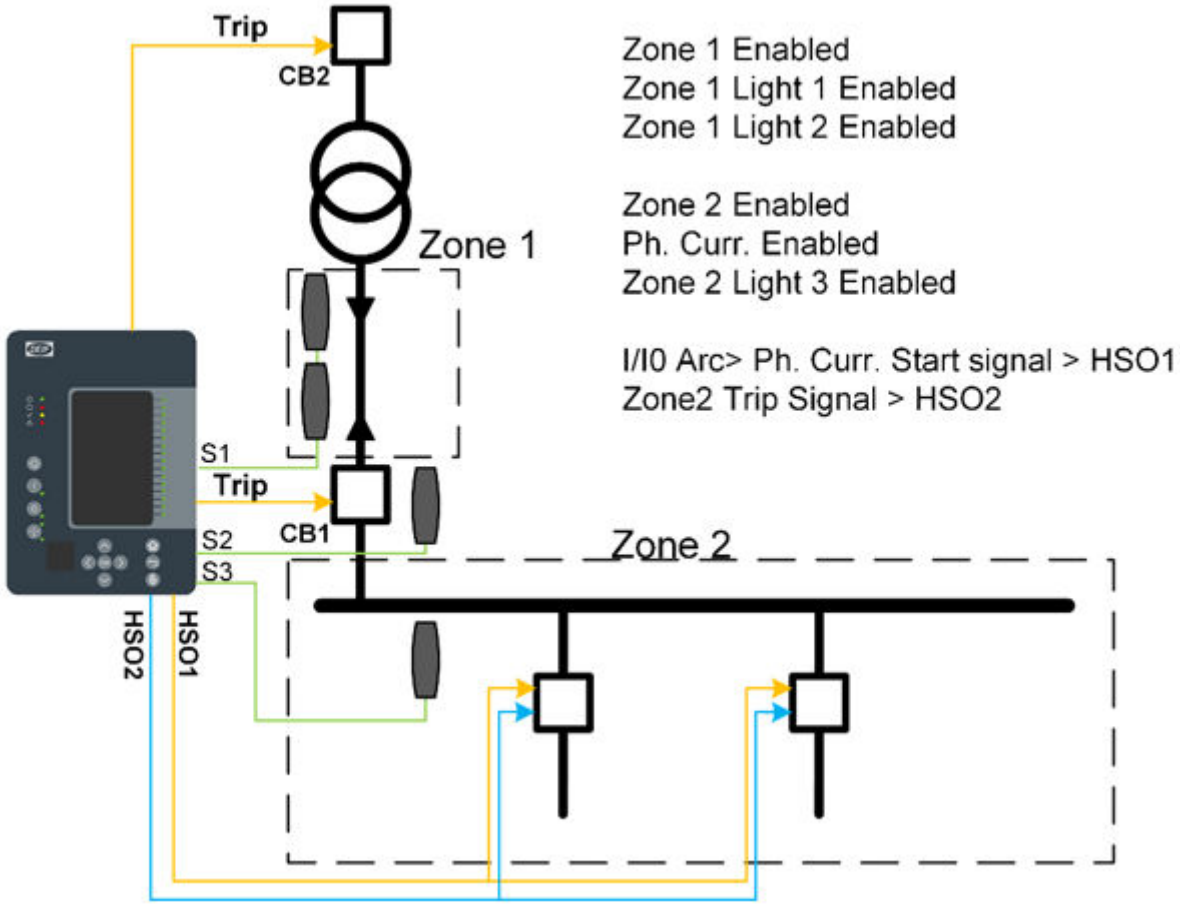
The function generates general time-stamped ON/OFF events to the common event buffer from each of the three (3) output signal.

The time stamp resolution is 1 ms. The function also a resettable cumulative counter for the TRIP and BLOCKED events for each zone.

2.3.1 Examples

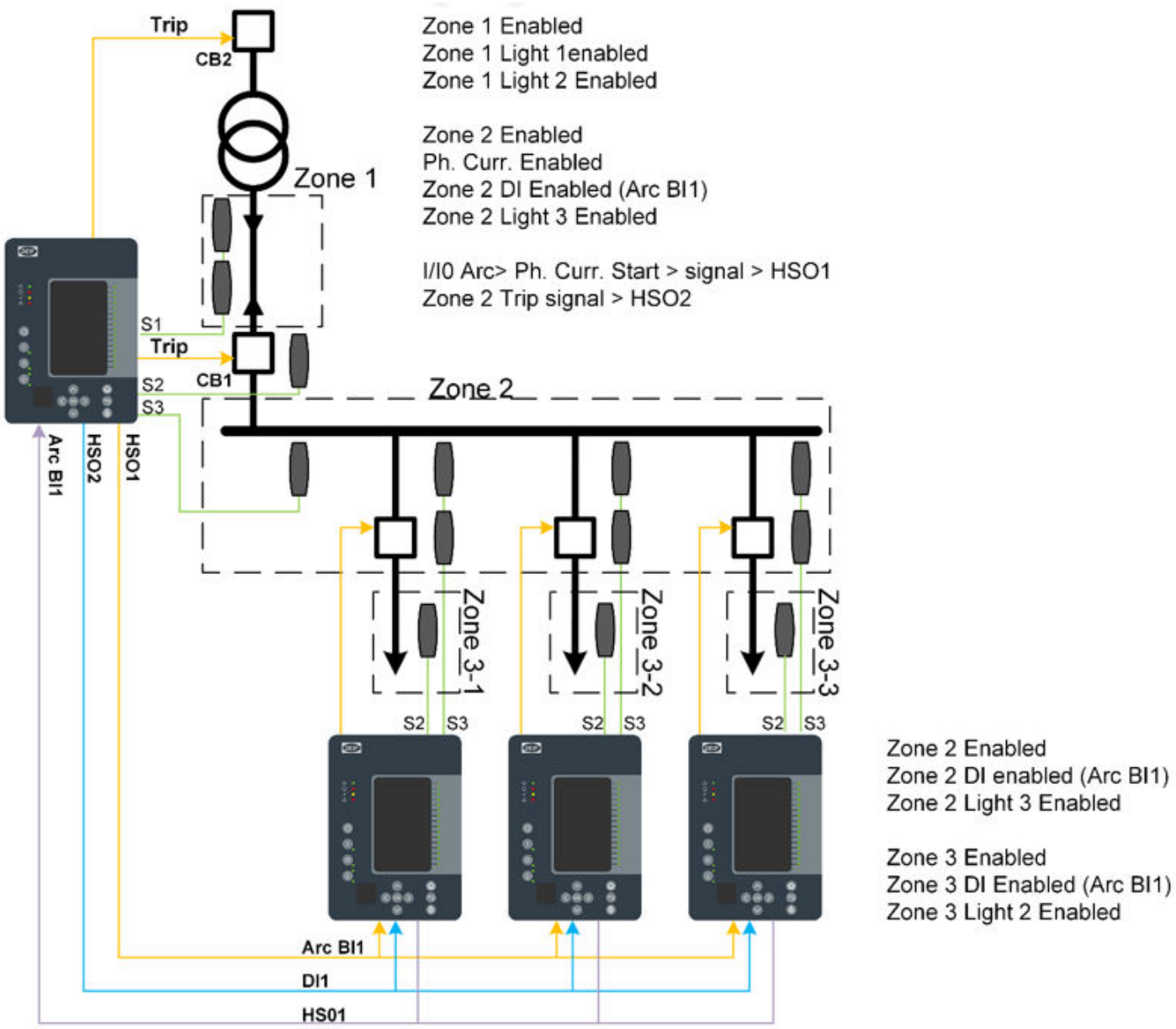
The following examples helps the user better understand how the arc protection function is set.

Figure 2.1 MVR-2xx incomer protection



To set the zones for the MVR-2xx models sensor channels start by enabling the protected zones (in this case, Zones 1 and 2). Then define which sensor channels are sensing which zones (in this case, sensor channels S1 and S2 are protecting Zone 1). Enable Light 1 of Zone 1 as well as Light 2 of Zone 2. The sensor channel S3 deals with Zone 2. Enable Light 3 of Zone 2. The high-speed output contacts HSO1 and HSO2 have been set to send overcurrent and master trip signals to the consumer breaker.

Figure 2.2 Scheme with MVR-2xx protection for each feeder



The settings for the device supervising the incoming feeder are the same as in the first example. The devices supervising the busbar and the outgoing feeder, however, have a different setting. Both Zones 2 and 3 need to be enabled as there are sensors connected to both Zone 2 and 3 starts. Sensors connected to the channel S3 are in Zone 2. Then enable Light 3 of Zone 2. The sensor connected to the channel S2 is in Zone 3. Then enable Light 2 of Zone 3.

If any of the channels have a pressure sensing sensor, enable it the same way as the regular light sensors. If either phase overcurrent or residual overcurrent is needed for the tripping decision, they can be enabled in the same way as light sensors in the zone. When a current channel is enabled, the measured current needs to be above the set current limit in addition to light sensing.

2.4 Measured inputs

Arc protection uses samples based on current measurements. If the required number of samples is found to be above the setting limit, the current condition activates. The arc protection can use either phase currents, residual currents or both.

2.4.1 Pick-up settings

The pick-up of each zone of the Iarc>/I0arc> function is controlled by one of the following: the phase current pick-up setting, the residual current pick-up setting, or the sensor channels. The pick-up setting depends on which of these are activated in the zone.

Setting group selection controls the operating characteristics of the function, i.e. the user or user-defined logic can change function parameters while the function is running.

Table 2.2 Enabled Zone pick-up settings

Name	Range	Step	Default	Description
Phase current pick-up	0.05...40.00 x I_n	0.01 x I_n	1.2 x I_n	The phase current measurement's pick-up value (in p.u.).
I0 input selection	• None • I01 • I02	-	None	Selects the residual current channel (I01 or I02).
Res.current pick-up	0.05...40.00 x I_{0n}	0.01 x I_{0n}	1.2 x I_{0n}	The residual current measurement's pick-up value (in p.u.).
Zone1/2/3/4 Enabled	• Disabled • Enabled	-	Disabled	Enables the chosen zone. Up to 4 zones can be enabled.
Zone1/2/3/4 Ph. curr. Enabled	• Disabled • Enabled	-	Disabled	The phase overcurrent allows the zone to trip when light is detected.
Zone1/2/3/4 Res. curr. Enabled	• Disabled • Enabled	-	Disabled	The residual overcurrent allows the zone to trip when light is detected.
Zone1/2/3/4 Light 1 Enabled	• Disabled • Enabled	-	Disabled	Light detected in sensor channel 1 trips the zone.
Zone1/2/3/4 Light 2 Enabled	• Disabled • Enabled	-	Disabled	Light detected in sensor channel 2 trips the zone.
Zone1/2/3/4 Light 3 Enabled	• Disabled • Enabled	-	Disabled	Light detected in sensor channel 3 trips the zone.
Zone1/2/3/4 Light 4 Enabled	• Disabled • Enabled	-	Disabled	Light detected in sensor channel 4 trips the zone.
Zone1/2/3/4 Pres. 1 Enabled	• Disabled • Enabled	-	Disabled	Pressure detected in sensor channel 1 trips the zone.
Zone1/2/3/4 Pres. 2 Enabled	• Disabled • Enabled	-	Disabled	Pressure detected in sensor channel 2 trips the zone.
Zone1/2/3/4 Pres. 3 Enabled	• Disabled • Enabled	-	Disabled	Pressure detected in sensor channel 3 trips the zone.
Zone1/2/3/4 Pres. 4 Enabled	• Disabled • Enabled	-	Disabled	Pressure detected in sensor channel 4 trips the zone.
Zone1/2/3/4 DI Enabled	• Disabled • Light In • Current In	-	Disabled	Arc protection option card digital input function selection. "Light In" mode trips the zone when digital input is active. In "Current In" mode digital input must be active at the same time as any of the sensor channels for the zone to trip.

The pick-up activation of the function is not directly equal to the TRIP signal generation of the function. The TRIP signal is allowed if the blocking condition is not active.

2.5 Function blocking

The block signal is checked in the beginning of each program cycle. The blocking signal is received from the blocking matrix in the function's dedicated input. If the blocking signal is not activated when the pick-up element activates, a START signal is generated and the function proceeds to the time characteristics calculation.

If the blocking signal is active when the pick-up element activates, a BLOCKED signal is generated and the function does not process the situation further.

If the START function has been activated before the blocking signal, it resets and the release time characteristics are processed similarly to when the pickup signal is reset.

The blocking of the function causes an HMI display event and a time-stamped blocking event with information of the startup current values and its fault type to be issued. The blocking signal can also be tested in the commissioning phase by a software switch signal when the relay's testing mode "Enable stage forcing" is activated (General → Device).

The variables the user can set are binary signals from the system. The blocking signal needs to reach the device minimum of 5 ms before the set operating delay has passed in order for the blocking to activate in time.

2.6 Events and registers

The arc fault protection function (abbreviated "ARC" in event block names) generates events and registers from the status changes in the events listed below. The user can select which event messages are stored in the main event buffer: ON, OFF, or both. The events triggered by the function are recorded with a time stamp.

The function's outputs can be used for direct I/O controlling and user logic programming. The function also provides a resettable cumulative counter for the events.

Table 2.3 Event messages

Event number	Channel number	Event block name	Event code	Event names
4736,4740,4744,4748	74	ARC1	0,4,8,12	Zone 1...4 Trip ON
4737,4741,4745,4749	74	ARC1	1,5,9,13	Zone 1...4 Trip OFF
4738,4742,4746,4750	74	ARC1	2,6,10,14	Zone 1...4 Block ON
4739,4743,4747,4751	74	ARC1	3,7,11,15	Zone 1...4 Block OFF
4752	74	ARC1	16	Phase current Blocked ON
4753	74	ARC1	17	Phase current Blocked OFF
4754	74	ARC1	18	Phase current Start ON
4755	74	ARC1	19	Phase current Start OFF
4756	74	ARC1	20	Residual current Blocked ON
4757	74	ARC1	21	Residual current Blocked OFF
4758	74	ARC1	22	Residual current Start ON
4759	74	ARC1	23	Residual current Start OFF
4760,4764,4768,4772	74	ARC1	24,28,32,36	Channel 1...4 Light ON
4761,4765,4769,4773	74	ARC1	25,29,33,37	Channel 1...4 Light OFF
4762,4766,4770,4774	74	ARC1	26,30,34,38	Channel 1...4 Pressure ON
4763,4767,4771,4775	74	ARC1	27,31,35,39	Channel 1...4 Pressure OFF
4776	74	ARC1	40	DI Signal ON
4777	74	ARC1	41	DI Signal OFF

Event number	Channel number	Event block name	Event code	Event names
4778,4780,4782,4784	74	ARC1	42,44,46,48	I/I0 Arc> Sensor 1...4 Fault ON
4779,4781,4783,4785	74	ARC1	43,45,47,49	I/I0 Arc> Sensor 1...4 Fault OFF
4786	74	ARC1	50	I/I0 Arc> I/O-unit Fault ON
4787	74	ARC1	51	I/I0 Arc> I/O-unit Fault OFF

The function registers its operation into the last twelve (12) time-stamped registers. The table below presents the structure of the function's register content.

Table 2.4 Register content.

Register	Description
Date and time	dd.mm.yyyy hh:mm:ss.mss
Event	Event name
Phase A current	Trip current
Phase B current	
Phase C current	
Residual current	
Active sensors	1...4
Setting group in use	Setting group 1...8 active

2.7 Arc fault protection (IArc>/I0Arc>; 50Arc/50NArc) (optional)*

NOTE * Not approved for marine.

Table 2.5 Technical data for the arc fault protection function.

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C) Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine)
Current input magnitudes	Sample-based phase current measurement Sample-based residual current measurement
Arc point sensor inputs	Channels S1, S2, S3, S4 (pressure and light sensor, or light-only sensor) Up to three (3) sensors per channel
System frequency operating range	6.00...75.00 Hz
Pick-up	
Pick-up current setting (phase current) Pick-up current setting (residual current) Pick-up light intensity	0.50...40.00 × I_N, setting step 0.01 × I_N 0.10...40.00 × I_N, setting step 0.01 × I_N 8, 25 or 50 kLx (the sensor is selected in the order code)
Starting inaccuracy (IArc> and I0Arc>)	±3 % of the set pick-up value > 0.5 × I_N setting. 5 mA < 0.5 × I_N setting.
Point sensor detection radius	180 degrees
Operation time	
Light only: - Semiconductor outputs HSO1 and HSO2 - Regular relay outputs	 Typically 7 ms (3...12 ms) Typically 10 ms (6.5...15 ms)
Light + current criteria (zone 1...4):	

- Semiconductor outputs HSO1 and HSO2 - Regular relay outputs	Typically 10 ms (6.5...14 ms) Typically 14 ms (10...18 ms)
Arc BI only: - Semiconductor outputs HSO1 and HSO2 - Regular relay outputs	 Typically 7 ms (2...12 ms) Typically 10 ms (6.5...15 ms)
Reset	
Reset ratio for current	97 % of the pick-up setting
Reset time	<35 ms

2.8 Arc protection module (option card D)

Table 2.6 Technical data for the point sensor arc protection module

Connections	
Input arc point sensor channels	S1, S2, S3, S4 (pressure and light, or light only)
Sensors per channel	3
Maximum cable length	200 m
Performance	
Pick-up light intensity	8, 25 or 50 kLx (the sensor is selectable in the order code)
Point sensor detection radius	180 degrees
Start and instant operating time (light only)	Typically <5 ms with dedicated semiconductor outputs (HSO) Typically <10 ms regular output relays

Table 2.7 High-Speed Outputs (HSO1...2)

Rated values	
Rated auxiliary voltage	250 VDC
Continuous carry	2 A
Make and carry 0.5 s Make and carry 3 s	15 A 6 A
Breaking capacity, DC (L/R = 40 ms)	1 A/110 W
Control rate	5 ms
Operation delay	<1 ms
Polarity	Normally Off
Contact material	Semiconductor

Table 2.8 Binary input channel

Rated values	
Voltage withstand	265 VDC
Nominal voltage Pick-up threshold Release threshold	24 VDC ≥16 VDC ≤15 VDC
Scanning rate	5 ms
Polarity	Normally Off
Current drain	3 mA

Table 2.9 Terminal block connections

Arc point sensor terminal block connections	
Spring cage terminal block	Phoenix Contact DFMC 1,5/ 6-STF-3,5
Solid or stranded wire Nominal cross section	1.5 mm^2
Binary input and HSO terminal block connections	
Screw connection terminal block (standard)	Phoenix Contact MSTB 2,5/5-ST-5,08
Spring cage terminals block (option)	Phoenix Contact FKC 2,5/10-STF-5,08
Solid or stranded wire Nominal cross section	2.5 mm^2

NOTE The polarity must be correct!

3. Arc sensors

3.1 Introduction

DEIF provides a choice of arc sensors to be used in different units and different switchgear types according to specific application requirements. Available sensor types are arc light point sensors and combined pressure and arc light point sensors.

Arc light point sensors are typically installed in metal clad compartments providing quick accurate location of the faulted area.

3.2 Arc light point sensor AQ 01

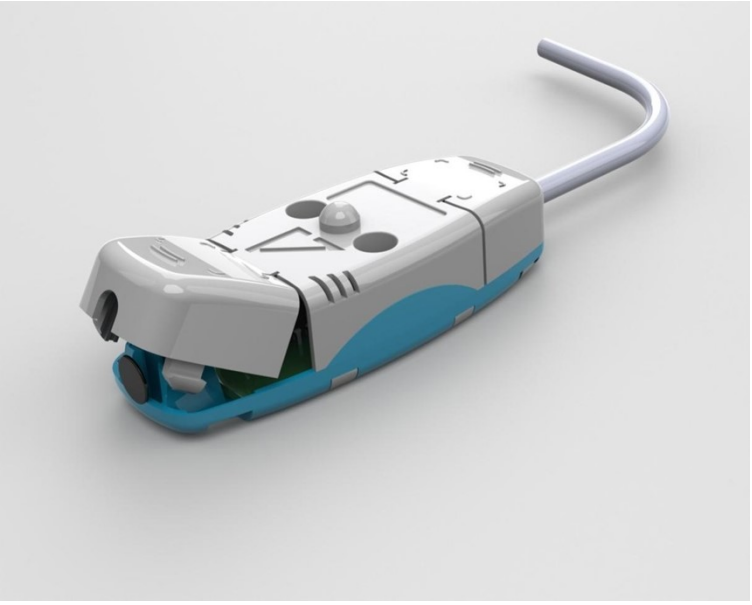
AQ 01 is an arc light point sensor with a light sensitive photodiode element activated by arc light.

AQ 01 arc sensors should be mounted in the switchgear cubicles in such a way that the light sensitive part covers the protected area as completely as possible.

One sensor should be used per closed metal clad compartment. In open spaces, such as the busbar section, arc sensors should be mounted maximum 2 meters apart.

The fixed light sensitivity of the AQ 01 sensor is 8000/25000/50000 Lux. The sensor does not require user settings. The detection radius is 180 degrees.

Figure 3.1 Arc sensor AQ 01



The module has 4 sensor channels. Each channel supports up to 3 arc point sensors.

The sensors come in 2 variants:

- Light sensing
- Light and pressure sensing

The arc sensing can be combined with an overcurrent / residual current sensing in such a manner than only sensing of an arc AND overcurrent will trigger the alarm.

3.2.1 AQ 01 Installation and wiring

AQ 01 is installed either on the compartment wall or through the wall.

AQ 01 is fixed to the wall using two screws. The same screw pattern is also used in a through wall mounting arrangement. The sensor is turned around and the eye is pushed to the compartment to be protected. Two screws are attached from the back side of the sensor. No external mounting plates are needed.

Figure 3.2 AQ 01 mounted on a compartment wall

AQ 01 comes without a connection cable. The connection cable installation at site is simple. The cable connectors are located beneath the covers that can be conveniently detached for fastening the sensor wires. The cover must be attached after installing the wires. The cable connectors are located at both ends of the sensor. You can use these for connecting a maximum of three sensors in series (daisy chained).

3.2.2 AQ 01 Technical data

Supply voltage	24 V DC
Supply current (standby)	2 mA
Light intensity threshold	8000Lux/25000Lux/50000Lux
Detection radius	180 degrees
Mechanical protection	IP 64
Sensor wiring arrangement	2 wires and shield
Sensor cable specification	Shielded twisted pair 0.75 mm²
Maximum sensor cable length per sensor channel	200 meters
Operating temperature	-20...+85 C

3.3 Pressure and arc light point sensor AQ 02

AQ 02 is a combined pressure sensor and arc light point sensor with a light sensitive photodiode element activated by arc light.

AQ 02 will only trigger if both pressure threshold and light sensitivity are exceeded.

AQ 02 arc sensors should be mounted in the switchgear cubicles in such a way that the light sensitive part covers the protected area as completely as possible.

One sensor should be used per closed metal clad compartment. In open spaces, such as the busbar section, arc sensors should be mounted maximum 2 meters apart.

The fixed pressure threshold of the AQ 02 is 0.2 bar relative (above ambient pressure).

The fixed light sensitivity of the AQ 02 sensor is 8000/25000/50000 Lux. The sensor does not require user settings. The light detection radius is 180 degrees.

3.3.1 AQ 02 Installation and wiring

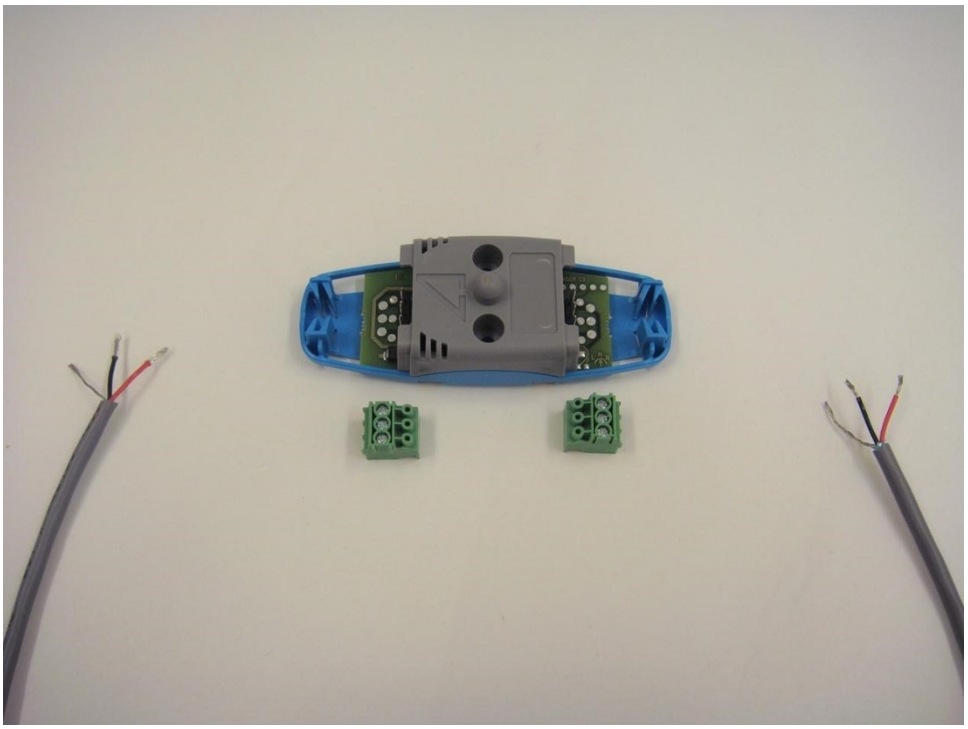
The installation and wiring of the AQ 02 is the same as for AQ 01.

3.3.2 AQ 02 Technical data

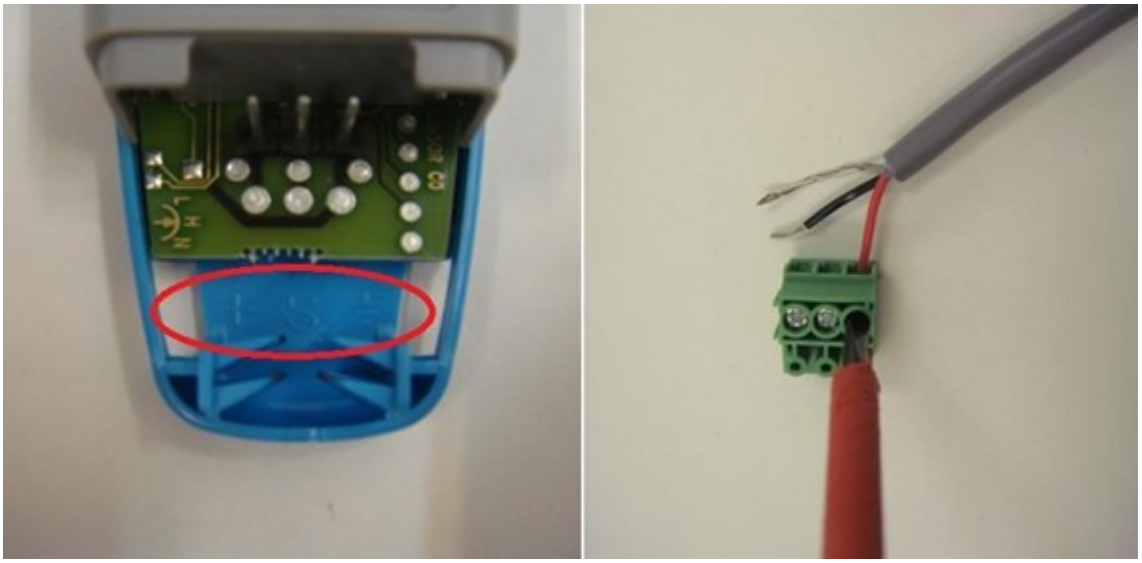
Supply voltage	24 V DC
Supply current (standby)	2 mA
Light intensity threshold	8000Lux/25000Lux/50000Lux
Detection radius	180 degrees
Pressure threshold (fixed)	0.2 bar relative
Pressure pick up time	< 1 ms
Mechanical protection	IP 64
Sensor wiring arrangement	2 wires and shield
Sensor cable specification	Shielded twisted pair 0.75 mm^2
Maximum sensor cable length per sensor channel	200 meters
Operating temperature	-20...+85 C

3.4 Connection of AQ 01, AQ 02

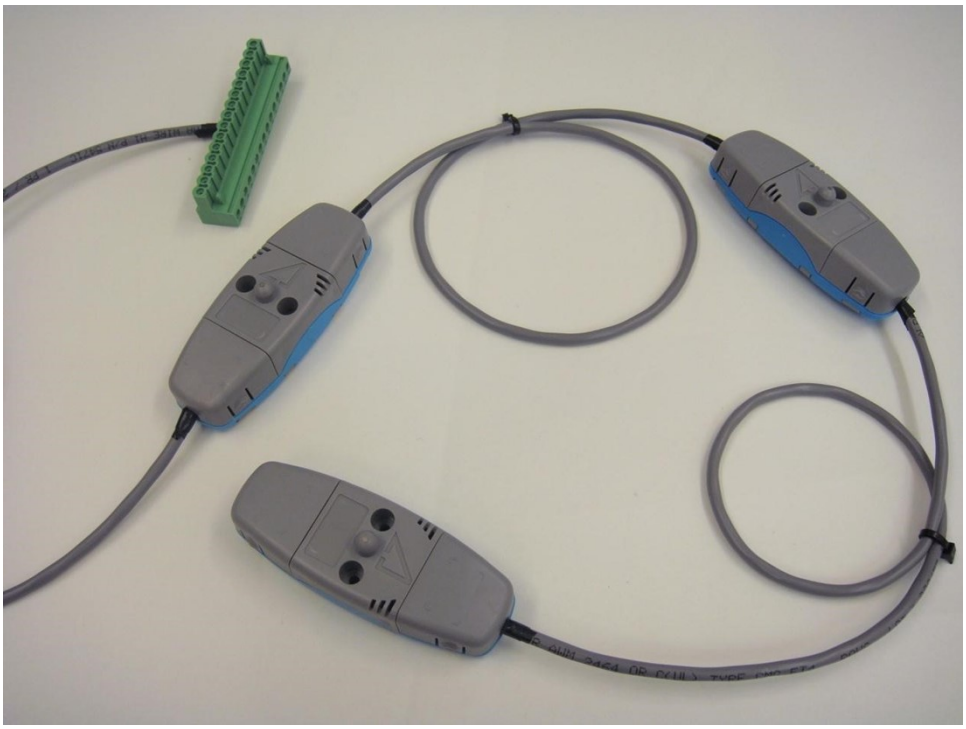
1. Open the sensor side-covers, then detach the pluggable connectors from the sensor PCB, and prepare the three-twisted shielded pair cable connecting.



2. Before connecting the cable to connector, make sure that the connecting order is right (+, signal, shield). The appropriate pins information is shown on the bottom shell of the sensor. Plug the wires into connector and fasten them by using the screw driver.



3. Connect the other end of the cable to a sensor channel on MVR Arc Flash module.
4. A maximum of 3 arc sensors can be daisy-chained to the same sensor input on the MVR option D input.



5. The MVR has an Auto Configuration function. This is a part of the Self Supervision Function. This function makes sure that all connections and sensors are fully functional and ready to operate at all times.

3.5 Ordering code

AQ - 0 X X

Sensor function
1 Light point sensor unit
2 Pressure & light point sensor unit

Light intensity threshold
A 8000 Lux
B 25000 Lux
C 50000 Lux

4. Legal information

4.1 Disclaimer

DEIF A/S reserves the right to change any of the contents of this document without prior notice.

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