Arc Guard System™ – TVOC-2
### Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc guard system with communication module</td>
<td>5</td>
</tr>
<tr>
<td>Introduction</td>
<td>6</td>
</tr>
<tr>
<td>System description</td>
<td>7</td>
</tr>
<tr>
<td>Functionality</td>
<td>8</td>
</tr>
<tr>
<td>Ordering details</td>
<td>9</td>
</tr>
<tr>
<td>Technical data</td>
<td>11</td>
</tr>
<tr>
<td>Applications</td>
<td></td>
</tr>
<tr>
<td>Basic installation tips</td>
<td>13</td>
</tr>
<tr>
<td>Diagrams</td>
<td>14</td>
</tr>
<tr>
<td>Configuration</td>
<td></td>
</tr>
<tr>
<td>Trip condition configuration – Manual/auto reset configuration</td>
<td>15</td>
</tr>
<tr>
<td>Current condition configuration</td>
<td>16</td>
</tr>
<tr>
<td>Dimensions</td>
<td>17</td>
</tr>
<tr>
<td>Circuit diagrams</td>
<td>18</td>
</tr>
</tbody>
</table>
Arc guard system with communication module
Monitor your installation, anytime and anywhere

ABB is a leader in electrical safety with the TVOC-2 arc guard system providing an unrivaled optical arc mitigation device with SIL-2 safety certification. The plug-in communication module provides operators real time status updates and instant information regarding the location of any arcs.

Saving lives and minimizing damage to equipment
With a market-leading reaction time of under 1 ms, TVOC-2 is already the fastest, most reliable arc guard solution available on the market. By adding this communication module, information regarding any trip travels faster, reaching the right people sooner.

Keeping the business running
An arc flash accident can have a catastrophic effect on equipment and lead to outages. The TVOC-2 detects the light from an arc flash and, together with the installed breaker, cutting the current feeding the arc extremely quickly, minimizing disruption of the system.

Factory calibrated sensors
Configuration of the TVOC-2 is done in minutes and with the HMI verifying every setting done, it is extremely unlikely that mistakes will happen during the configuration. With the possibility to accommodate up to 30 sensors, the system is highly flexible and can grow with any system.
Arc Guard System™

TVOC-2, ABB’s Arc Monitor, builds on the well known TVOC design. Its new functions and features improve an already great product, putting even more focus on reliability, flexibility and simplicity.

Arc Guard System™ protects people and equipment, and eliminates unnecessary production stops.

Arc monitor type TVOC-2 is ABB’s state-of-the-art solution for arc fault protection in all applications, providing functional safety. With over 35 years of experience, Arc Guard System™ has become an industry standard in several key markets, helping to protect personnel and businesses around the world.

Typical applications include all low- and medium-voltage switchgears.

Reliability
• Certified according to functional safety (SIL-2) standard
• Over 35 years experience in Arc Guard Systems
• Pre-calibrated optical sensors

Flexibility
• HMI (Human Machine Interface) can be mounted on the panel door
• COM Module operates in the same way as HMI. With added ability to communicate with a remote station using Modbus RTU
• Expandable with up to 30 optical sensors
• Configure the system according to various needs

Simplicity
• User-friendly start-up menu
• DIN-rail or wall-mounted
• Easy to expand as the switchgear functions are added
Arc Guard System™

Arc Guard System™ quickly detects an arc fault and trips the incoming circuit-breaker. Using light as the main trip criteria, Arc Guard System™ trips instantaneously. Thanks to this key functional advantage, it overrides all other protections and delays, which is crucial when reaction times need to be measured in milliseconds.

How it works

The system acts in three phases:

1. Light passes through an optical sensor (Detection)
2. The Arc monitor determines the intensity of light (Recognition)
3. The Arc monitor sends signal to trip breaker(s) (Action)

Arc Faults

Short-circuit faults in LV and MV switchgears are often accompanied by an electric arc. An arc fault always leads to considerable damage to equipment and injury to personnel unless it is detected very quickly. To avoid serious damage and give the person involved a good chance of surviving the accident without severe injury, the fault should be disconnected as fast as possible, typically in less than 50 ms.
Functionality

Arc Monitor

With its modular concept, the Arc Monitor is designed to fit all types and sizes of low- and medium-voltage switchgears.

It is designed according to Functional Safety, and is SIL 2-certified according to IEC 61508 and IEC 62061 which puts full focus on reliability. This corresponds to performance level d according to EN ISO 13849-1. Safety functions are exclusively handled by hardware. In addition, the system, trip logs and user-interface are all microprocessor-monitored.

The system can be configured to trip selected breakers, depending on which sensor that detects the light. The DIP-switches that take care of this function also handle settings like auto-reset and Current Sensing Units (see pages 12-13 for more details).

Energy is stored in the unit for operation up to 0.2 s if the supply voltage fails. This is sufficient to close the tripping circuit even if voltage disappears at a short-circuit fault.

Note: The circuit breaker still needs a back-up energy source for its tripping circuit.

Connections

All connections can be accessed from the front of the arc monitor. Pluggable terminal blocks allow electrical wiring before mounting TVOC-2 into the cabinet. The solid state tripping contacts are type IGBT, which guarantees fast and reliable tripping.

More details can be found on page 8, technical data.

HMI (Human Machine Interface)

• Handles settings with key-pad and full text display
• Holds error log and trip information after power loss
• Error log and trip log include time/date stamp from a real-time clock
• TVOC-2 can handle two separate HMI:s (cabinet door and on product)
• Three-meter cable included
• COM Module available using Modbus RTU

Sensor & Sensor modules

• Fiber-optic sensors not affected by electrical noise
• Pre-calibrated sensors remove need for manual configuration
• Up to 30 detectors can be connected

Current Sensing Unit (optional)

The Current Sensing Unit (CSU) is an accessory needed only in those few specific applications where strong light is expected on a regular basis.

CSUs are connected with an optical fiber using light as signal for normal current. If this was removed by accident, the system would treat it as an over-current and trip if an arc flash is seen of reliability reasons.

Adding a CSU will result in an additional operating time depending on the size of the over-current and the number of phases measured. Under normal conditions the time from over-current occurring to actuating optical output is in the region between 2 and 8 milliseconds.

Arc Monitor connections

3 IGBT solid state tripping contacts
2 change-over trip signal relays
1 change-over self supervision alarm relay (IRF)
2 current sensing unit inputs
1 current sensing unit output

Mounting alternatives

DIN-rail
Wall mounting

Optical detector inputs

1-10 Main unit X1
1-10 Extension module X2
1-10 Extension module X3

HMI

Can be mounted on door
IP54
Additional HMI possible
User-friendly start up meny
COM Module version available

8 | ABB Arc Guard System™ - TVOC-2
## Ordering details

<table>
<thead>
<tr>
<th>Description</th>
<th>Rated supply voltage</th>
<th>Type</th>
<th>Order code</th>
<th>Weight (1 pce)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arc Monitor</strong> including one HMI and door mounting accessories</td>
<td>24...48</td>
<td>TVOC-2-48</td>
<td>1SFA664001R1002</td>
<td>0.95</td>
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<tr>
<td>100...240</td>
<td>100...250</td>
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<td><strong>Arc Monitor</strong> including one COM Module and door mounting accessories</td>
<td>24...48</td>
<td>TVOC-2-48-C</td>
<td>1SFA664001R1004</td>
<td>0.95</td>
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<td>100...240</td>
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### Accessories

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<td>Extension</td>
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<tr>
<td>10 optical inputs</td>
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<td>Extension</td>
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<td>10 optical inputs for cable TVOC-2-DP60 only</td>
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<td><strong>HMI (Human machine interface)</strong></td>
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<td>additional</td>
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<td>with communication interface (Modbus RTU) and door mounting accessories</td>
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### Detectors

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<th>Weight (1 pce)</th>
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<td>1 m</td>
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<td>2 m</td>
<td>TVOC-2-DP2</td>
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<td>4 m</td>
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<td>6 m</td>
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<td>10 m</td>
<td>TVOC-2-DP10</td>
<td>0.10</td>
</tr>
<tr>
<td>15 m</td>
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<td>25 m</td>
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<tr>
<td>60 m</td>
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(1) Only to be used with TVOC-2-E3

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ABB Arc Guard System™ - TVOC-2 | 9
### Ordering details

<table>
<thead>
<tr>
<th>Description</th>
<th>Type</th>
<th>Order code</th>
<th>Weight (1 pce) kg</th>
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<tr>
<td>Current sensing unit</td>
<td>CSU</td>
<td>1SFA663002-A</td>
<td>1.500</td>
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<td>Optical cable between TVOC-2 Arc monitor and Current sensing unit</td>
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<tr>
<td>Cable length 0.5 m</td>
<td>TVOC-1TO2-OP05</td>
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<td>Optical cable between two TVOC-2 – Arc monitors (transferring CSU signal)</td>
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<td>Cable length 0.5 m</td>
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<td>Optical cable between two Current sensing units (CSU)</td>
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<td>Cable length 0.5 m</td>
<td>TVOC-2-OP05</td>
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<td>Cable length 1 m</td>
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<td>800/1000 mm</td>
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<td>Label</td>
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<tr>
<td>Mounting bracket</td>
<td>1 set incl. 5 bracket pcs and 10 cable strap pcs</td>
<td>1SFA663008R1010</td>
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</table>
## Optical inputs and output

### Optical detectors
- 10 inputs on Arc Monitor
- 10 inputs on Extension unit X2 (optional)
- 10 inputs on Extension unit X3 (optional)

### Current signal from CSU
- 2 inputs: X1.21, X1.22 (optical)

### Forward current signal to another Arc Monitor
- 1 output: X1.23 (optical)

## Breaker trip contacts (K4, K5, K6)

### Solid state tripping contacts
- 3 NO solid state type IGBT
- Rated voltage: 250 V AC / DC
- Make and carry for 0.2 s: 30 A
- Make and carry for 1 s 0.15% duty ratio: 10 A
- Breaking capacity:
  - 250 V: 1.5 A, AC-15
  - 250 V: 1 A, DC-13
  - 110 V: 3 A, DC-13
  - 48 V: 3 A, DC-13
- Reinforced insulation between separate contacts
- Voltage drop: 5 V 30 A, 3 V 3 A, 2 V 10 mA
- Off state current: < 1 mA at 250 V 60 Hz
- Min. recommended load current: 10 mA

### Signal relay outputs (K2, K3)

#### Manual or auto resetable
- 2 CO gold-plated contacts
- Rated voltage: 250 V AC / DC
- Continuous carry, I<sub>c</sub>
  - 5 A
- Make and carry for 0.2 s: 30 A
- Make and carry for 3 s 10% duty ratio: 15 A
- Breaking capacity:
  - 250 V: 3 A, AC-15
  - 250 V: 0.3 A, DC-13
  - 110 V: 0.6 A, DC-13
  - 48 V: 2 A, DC-13
- Reinforced insulation between separate contacts
- I<sub>c</sub> = 5 A
- Min switching load:
  - 1 mA at 5 V DC with contacts not used for switching current
  - > 0.5 A if inductive/capacitive load before

### Internal Relay Fault (IRF) signal (K1)

#### Self supervision alarm relay
- 1 CO gold-plated contact
- Rated voltage: 250 V AC/DC
- Continuous carry, I<sub>c</sub>
  - 5 A
- Make and carry for 3 s: 8 A
- Breaking capacity:
  - 250 V: 1.5 A, AC-15
  - 250 V: 0.15 A, DC-13
  - 110 V: 0.3 A, DC-13
  - 48 V: 0.5 A, DC-13
- Reinforced insulation between separate contacts
- I<sub>c</sub> = 5 A
- Min switching load:
  - 1 mA at 5 V DC with contacts not used for switching current
  - > 0.5 A if inductive/capacitive load before
### Technical data

#### Settings and indications

| Connections for HMI on base module | 1 output RJ45 male at front side  
|------------------------------------|----------------------------------|
| Display on HMI                     | 1 output RJ14 female at right side  
| Keyboard on HMI                    | 52 x 26 mm graphic LCD with LED backlight  
| LED signal on HMI                  | Membrane buttons, 4 soft keys  
| LED signal on Arc Monitor and extension units | Power, Trip  
| Configuration switches              | 8-pole DIP-switch on Arc Monitor front  
| Settings (HMI)                     | Time and display language  
| COM Module version                 | Modbus RTU protocol  
| Configuration (DIP switches)       | Manual or auto reset of K2 and K3  
|                                    | Use of CSU or not  
|                                    | Trip configuration  
| Display information                | Trip log, connected modules, actual configuration  
|                                    | self diagnostic test result and error log  

#### Power supply

<table>
<thead>
<tr>
<th>Power supply</th>
<th>TVOC-2-240</th>
<th>TVOC-2-48</th>
</tr>
</thead>
</table>
| Rated supply voltage, $U_s$ | 100-240 V AC, 50-60 Hz  
|                          | 100-250 V DC  
| $U_s$ variation         | AC -20% - +10%  
|                          | DC -25% - +30%  
| Rated insulation voltage, $U_{\text{ins}}$ | 250 V with reinforced insulation  
| Rated impulse withstand Voltage $U_{\text{imp}}$ | 4 kV  
| Main MCB/fuse           | Max. 10 A char. C/fuse 10 A gG  
| Power consumption       | 5 W  
| Start-up time           | < 15 ms from power on  
| Trip possible           | < 100 ms from power on  

#### Reaction time

| From light detection to trip (contacts K4, K5, K6) | Approx. 1 ms (depends on light intensity)  
| From light detection to indication signal (relay K2, K3) | < 10 ms  
| Current condition from input to output | < 0.4 ms  

#### Environmental conditions

| Altitude   | Less than 2000 m above sea level.  
| Permissible ambient temperature | -25 to +55°C  
| Degree of protection            | IP20 Arc Monitor  
| IP54 HMI front side            |  

#### Detector cable

| Maximum length | 30 m with Arc Monitor and extension – E1  
|                | 60 m with extension – E3  
| Service temperature range | -25 to +70°C continuous  
|                          | -25 to +85°C short-time  
| Smallest permissible bending radius | 45 mm after installation  
|                                    | 10 mm on handling  

#### Optical cable

| Maximum length | 3000 Lux  
|                |  

#### Standards

| UL508          | Industrial control equipment  
| CSA C22.2 No.14 | Industrial control equipment  
| IEC 61508      | Functional safety of electrical/electronic/programmable electronic safety-related systems  
| IEC EN60947-1  | Low voltage switchgear and controlgear – Part 1: General rules  
| IEC EN60947-5-1 | Low voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements - Electromechanical control  
| IEC 61010-1    | Safety requirements for electrical equipment for measurement, control and laboratory use  

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12 | ABB Arc Guard System™ - TVOC-2
Applications
Basic installation tips

Arc Monitor (TVOC-2)
The Arc Monitor can be mounted anywhere in the switchgear, e.g. in the breaker cubicle or in a separate control cabinet. Tripping is handled by a separate tripping circuit. The task of the Arc Monitor is to close the circuit very quickly. You can connect up to 3 breakers in this way and, if required, trip different breakers depending on where the arc occurs.

CSU (Current Sensing Unit)
The CSU is an accessory used if you cannot prevent direct sunlight or other highly intensive light reaching the sensors frequently. CSUs can be mounted in series if more than two are needed.

Connection of current transformers (for CSU)
The CSU measures either 1, 2 or 3-phase. Three-phase is, however, preferable for reasons of safety and reliability. Current transformers with a secondary current of 1, 2 or 5 A are used for this purpose.

Note: Current transformers for relay protection are preferable since they do not saturate as quickly as standard current transformers. The transformers should not saturate before at least twice the set over-current level.

Detectors
Detector cables are available in standard lengths (see ordering details). They cannot be cut or joined. Avoid sharp bends or pinching when installing the cables.

The plastic fiber is made of polymethylene acrylate (PMMA) with a polyethylene jacket. Each detector consists of an optical cable and a lens that are calibrated together to give the same sensitivity independent of cable length. The detector has a plug-in connector that fits the arc monitor. The lens collects light from all directions, with the exception of a small shaded area behind the detector (see the polar diagram). Practical experiments have shown that arc light reflected between metallic surfaces is normally sufficient to cause tripping.

Detector positioning
The basic strategy for positioning the sensors is to make sure to cover all parts that may suffer from an arc. Typically this involves the horizontal and vertical bus bar system and the breaker cubicle. If possible, it’s also normally preferable to supervise each cubicle. Avoid placing the detector so that it sees the normal light from a breaker. The sensor can detect arcs within a 3-meter distance (see illustration). To raise the safety level even higher, you can separate them at a 1.5-meter distance, thereby creating redundancy between them.
Applications
Diagrams

Example 1:
Arc Guard System™ installed to trip all breakers in case of an arc.

Example 2:
Arc Guard System™ installed to trip different breakers depending on where the arc occurs.
**Configuration**

**Trip condition configuration – Manual/auto reset configuration**

**System configuration using DIP switch**

DIP switches are used to configure the system regarding use of current condition (activated CSU inputs) and assigning detectors to breaker trip outputs (so-called selectivity). They are located on the front (low, left) of the arc monitor.

<table>
<thead>
<tr>
<th>DIP switches</th>
<th>Breaker trip output</th>
<th>Detector inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sw1</td>
<td>Current condition inputs Terminals X1:21-22</td>
<td>Output relay K4 Terminals X1:1-10</td>
</tr>
<tr>
<td>Sw2</td>
<td>Current condition output Terminal X1:23</td>
<td>Output relay K5 Terminals X2:1-10</td>
</tr>
<tr>
<td>Sw3</td>
<td>Trip output assign</td>
<td>Output relay K6 Terminals X3:1-10</td>
</tr>
<tr>
<td>Sw4</td>
<td></td>
<td>Sw5 Not used</td>
</tr>
<tr>
<td>Sw5</td>
<td>Autoreset K2, K3 (signal relays)</td>
<td>Sw6 Not used</td>
</tr>
<tr>
<td>Sw6</td>
<td></td>
<td>Sw7 Not used</td>
</tr>
<tr>
<td>Sw7</td>
<td></td>
<td>Sw8 Not used</td>
</tr>
</tbody>
</table>

**Trip condition configuration**

TVOC-2 can be configured to trip selected breakers depending on which detector is signalling for an arc. This can be used to trip sections of a switchgear or use one monitor for several small switchgears. It also has an option to add a current condition, see page 13.

**DIP switch configurations**

- **Sw3** = 0 = Any detection trips all breakers K4, K5, K6
- **Sw4** = 1 = Detectors X1, X2, X3 operate K4
- **Sw5** = 1 = Detectors X1:1-3 operate K4
- **Sw6** = 1 = Detectors X1:4-6 operate K5
- **Sw7** = 1 = Detectors X1:7-10, X2 and X3 operate K6

**Manual/auto reset configuration**

The signal relays K2, K3 can be configured to react as the trip contacts (auto reset) or to be de-energized by manual reset on the HMI. See below for explanation.

![Configuration diagram](image-url)
Configuration

Current condition configuration

Normal trip configuration with additional current condition

A current condition is an option that could be used to avoid the risk of nuisance tripping due to strong light from other sources than arcs. The main risks are light from arc chutes and direct sunlight, which in normal cases can be avoided. Therefore the standard configuration is without CSU:s (Current Sensing Units).

All trip configurations on page 12 can be combined with an additional current condition. It is possible to connect up to two CSU:s directly to the Arc Monitor (AM) (input 21 and 22). To connect additional current sensing units in series is also possible if required. To share the current condition between different Arc Monitors can be done by connecting output 23 on the first Arc Monitor to the standard CSU input on the other. The Arc Monitor will then block the trip condition until it sees an over current.

<table>
<thead>
<tr>
<th>No current sensing unit</th>
<th>Sw1</th>
<th>Sw2</th>
<th>Function current condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>0</td>
<td>0</td>
<td>Not used</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>One current sensing unit</th>
<th>Sw1</th>
<th>Sw2</th>
<th>Function current condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>1</td>
<td>0</td>
<td>Input CSU21 used</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Two current sensing units</th>
<th>Sw1</th>
<th>Sw2</th>
<th>Function current condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>1</td>
<td>1</td>
<td>Both inputs used</td>
</tr>
</tbody>
</table>

Special trip configuration depending on over current

The arc monitor has a special trip configuration that determines trips depending on where it sees the over current. This configuration will then trip different breakers depending on which supply is showing an over current.

<table>
<thead>
<tr>
<th>Symbol description</th>
<th>Configurable tripping relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc detected</td>
<td>Any detector + current condition CSU21 operate K4 + K6</td>
</tr>
<tr>
<td>Arc not detected</td>
<td>Any detector + current condition CSU22 operate K5 + K6</td>
</tr>
</tbody>
</table>

DIP switches 1, 2, 3 and 4 to position ON
See manual for more details
Dimensions

Arc Monitor

A flange with 6 tapped holes (size 18.6 mm), 4 cable glands (sealing diameter 5.5-8.5 mm), and 2 plastic blank plugs are supplied.

HMI, COM Module

Detector with optical cable
Arc Monitor

**Terminals**

- **X1 1-10**: Detector input
- **X2 1-10**: Extra detector unit detector input (option)
- **X3 1-10**: Extra detector unit detector input (option)
- **A1, A2**: Power supply
- **A3**: Power supply
- **PE**: Power supply
- **43, 44**: Solid-state contacts
- **53, 54**: Solid-state contacts
- **63, 64**: Solid-state contacts
- **11, 12, 14**: Indication contacts
- **21, 22, 24**: Indication contacts
- **31, 32, 34**: Indication contacts

Current Sensing Unit

**Terminals**

- **1 ... 6**: Current transformer terminals
- **7 and 8**: Output current signal to another Current Sensing Unit or Arc Monitor
- **9**: Input current signal from another Current Sensing Unit

**Power supply terminals**

- **10 and 12**: 24 V DC
- **11 and 12**: 60 V DC
- **11 and 12**: 48 V DC Interconnection 11-13
- **13 and 12**: 110 V - 125 V AC / DC
- **14 and 12**: 220 V DC, 230 V AC

**A) Testing facilities:**

- **R29**: Simulating a test current
- **S1**: 1 = Test position
- **2 = Operation position

**B) Setting facilities:**

- **R21**: Overcurrent setting
- **S1**: 1 = Input 9 not used
- **2 = Input 9 used

**X) Current range bridge connections**

- **1A**: 24-17, 25-20, 26-23
- **2A**: 24-16, 25-19, 26-22
- **5A**: 24-15, 25-18, 26-21
For more information please contact:

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Protection & Connection
Motorgränd 20
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