Arc Guard Systems
Index



20 - Arc Guard Systems

Arc Guard Systems .....20.1 - 20.16

General information
- Description.....20.1
- System description.....20.2
- Overview.....20.3

Ordering details
- Arc monitor with detectors.....20.4
- Current sensing unit.....20.5

Technical data.....20.6 - 20.8

Basic information
- Basic installation tips.....20.9
- Diagrams.....20.10
- Configurations.....20.11 - 20.12

Approximate dimensions.....20.13

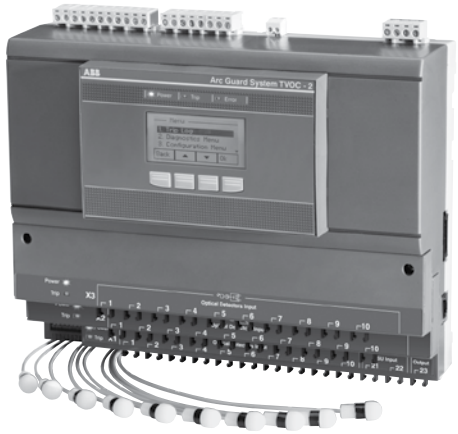
Circuit diagrams.....20.14 - 20.15

Notes

Arc monitor • Current sensing unit

Arc Guard Systems™

Arc Guard Systems™
Arc monitor
Current sensing unit
Accessories



An even better Arc Guard System™

TVOC-2, ABB's latest 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
- 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)

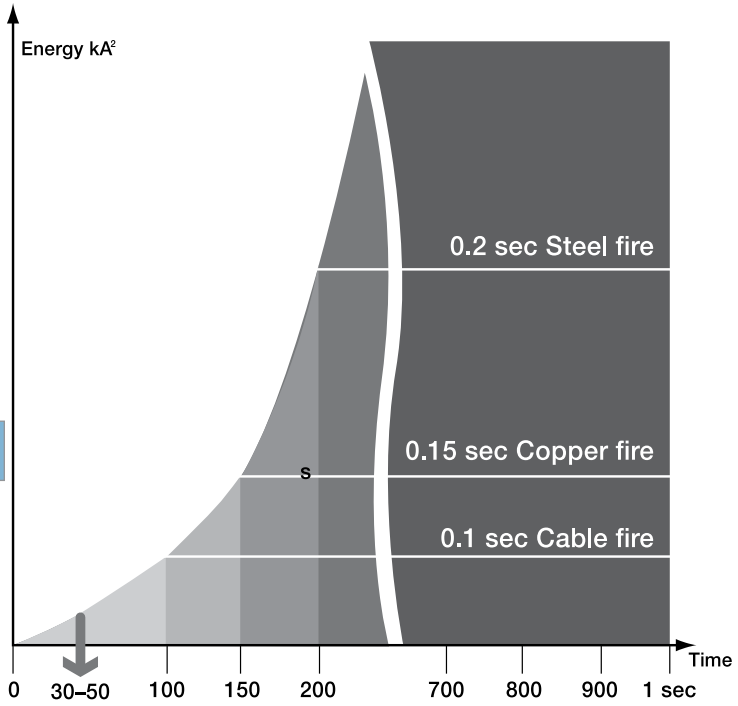


2
- The Arc monitor determines the intensity of light (Recognition)



3
- The Arc monitor sends signal to trip breaker(s) (Action)





Total breaking time = ABB Arc Guard System™ + Breaker

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 30-50 ms.

Arc Guard Systems™

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 20.10 - 20.11 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 20.6, 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 HMIs (cabinet door and on product)
- Three-meter cable included

Sensor & Sensor modules

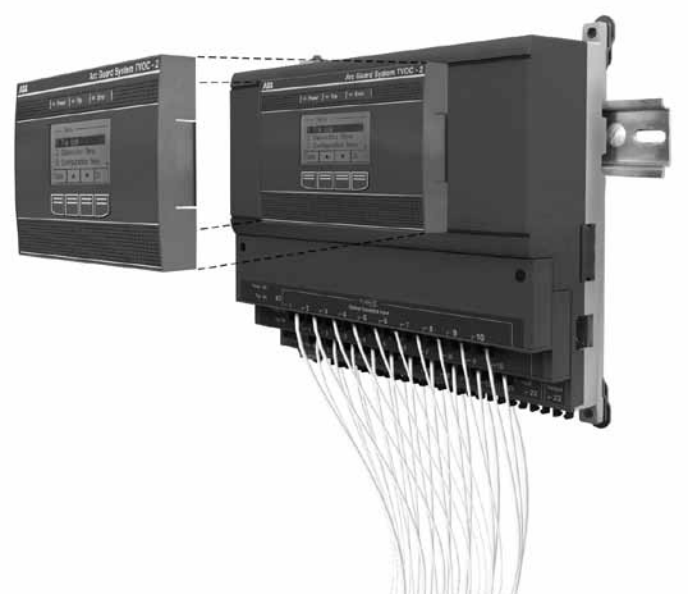
- Fiber-optic sensors not affected by electrical noise
- Pre-calibrated sensors remove need for manual configuration
- Up to 30 detectors can be connected

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 a fiber optic cable 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
IP 54
Additional HMI possible
User-friendly start up meny

Arc Guard Systems™

Arc monitor with detectors



TVOC-2-240



TVOC-2-E1



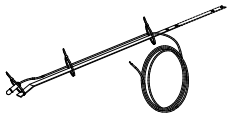
TVOC-2-H1



TVOC-2-DP1



TVOC-2-MK1



AGS-MK600



AGS-LABEL



TVOC-MB

Supply voltage 100-240 V DC or AC 50-60 Hz

Description		Catalog number	Weight lbs.
Arc Monitor Supply voltage 100-240V DC or AC 50-60 Hz including one HMI and door mounting accessories		TVOC-2-240	2.09
Extension (1-30m) 10 optical inputs		TVOC-2-E1	0.33
Extension (60m) 10 optical inputs for 60 meter		TVOC-2-E3	0.33
HMI (Human machine interface) additional		TVOC-2-H1	0.33
Detectors			
Cable length	1 m, 39.37 in	TVOC-2-DP1	0.04
Cable length	2 m, 78.74 in	TVOC-2-DP2	0.04
Cable length	4 m, 157.48 in	TVOC-2-DP4	0.09
Cable length	6 m, 236.22 in	TVOC-2-DP6	1.32
Cable length	8 m, 314.96 in	TVOC-2-DP8	1.76
Cable length	10 m, 393.70 in	TVOC-2-DP10	0.22
Cable length	15 m, 590.55 in	TVOC-2-DP15	0.33
Cable length	20 m, 787.40 in	TVOC-2-DP20	0.44
Cable length	25 m, 984.25 in	TVOC-2-DP25	0.55
Cable length	30 m, 1181.10 in	TVOC-2-DP30	0.66
Cable length ③	60 m, 2362.20 in	TVOC-2-DP60	1.32
Cable straps	1 set incl. 50 pcs	TVOC-2-MK1	0.22
Mounting kit	600 mm, 23.62 in	AGS-MK600	0.77
	800/1000 mm 31.49/ 39.37 in	AGS-MK1000	1.32
Label	1 set incl.10 pcs	AGS-LABEL	0.04
Mounting bracket	1 set incl. 5 bracket pcs and 10 cable strap pcs	TVOC-MB	0.55

③ Only to be used with TVOC-2-E3

Current sensing unit



AGS-CS240



TVOC-1TO2-OP1



TVOC-2-OP1

Description		Catalog number	Weight lbs.
Current Sensing Unit (CSU)		AGS-CS240	3.31
Optical cable between CSU and TVOC-2 Arc monitor and			
Cable length	1 m, 39.37 in	TVOC-1TO2-OP1	0.02
Cable length	2 m, 78.74 in	TVOC-1TO2-OP2	0.04
Cable length	4 m, 157.48 in	TVOC-1TO2-OP4	0.08
Cable length	6 m, 236.22 in	TVOC-1TO2-OP6	0.13
Cable length	8 m, 314.96 in	TVOC-1TO2-OP8	0.18
Cable length	10 m, 393.70 in	TVOC-1TO2-OP10	0.22
Cable length	15 m, 590.55 in	TVOC-1TO2-OP15	0.33
Cable length	20 m, 787.40 in	TVOC-1TO2-OP20	0.44
Cable length	25 m, 984.25 in	TVOC-1TO2-OP25	0.55
Cable length	30 m, 1181.10 in	TVOC-1TO2-OP30	0.66
Optical cable between TVOC-2 and TVOC-2 Arc monitors (transferring CSU signal)			
Cable length	1 m, 39.37 in	TVOC-2-OP1	0.02
Cable length	2 m, 78.74 in	TVOC-2-OP2	0.04
Cable length	4 m, 157.48 in	TVOC-2-OP4	0.08
Cable length	6 m, 236.22 in	TVOC-2-OP6	0.13
Cable length	8 m, 314.96 in	TVOC-2-OP8	0.18
Cable length	10 m, 393.70 in	TVOC-2-OP10	0.22
Cable length	15 m, 590.55 in	TVOC-2-OP15	0.33
Cable length	20 m, 787.40 in	TVOC-2-OP20	0.44
Cable length	25 m, 984.25 in	TVOC-2-OP25	0.55
Cable length	30 m, 1181.10 in	TVOC-2-OP30	0.66

Technical data

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 ration	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	DC13
	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		
Continous carry I_{th}	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_{th} = 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_{th}	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_{th} = 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

Arc Guard Systems™

Settings and indications	
Connections for HMI on base module	1 output RJ45 male at front side 1 output RJ14 female at right side
Display on HMI	52 x 26 mm graphic LCD with LED backlight
Keyboard on HMI	Membrane buttons, 4 soft keys
LED signal on HMI	Power, Trip, Error
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
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	
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_i	250 V with reinforced insulation
Rated impulse withstand Voltage U_{imp}	4 kV
Main MCB/fuse	Max. 10 A char. C/fuse 10 A gG
Power consumption	5 W
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
Start-up time	
Trip possible	< 15 ms from power on
Environmental conditions	
Permissible ambient temperature in operation	- 25 to + 55 °C
Permissible ambient temperature in transportation and storage	- 25 to + 70°C
Humidity	Maximum 95%
Altitude	2000 meter above sea level
Degree of protection	IP20 Arc Monitor IP54 HMI front side
Safety parameters for application according to IEC61508	
Life time	10 years
PFD	3.49×10^{-03}
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
Acceptable backlight intensity light without tripping	3000 Lux
Optical cable	
Maximum length	30 m
Safety integrity level	
	SIL 2 when not used with CSU

Technical data

Current sensing unit

Rated current Selectable, for connection of external current transformers with secondary rated current	1, 2 or 5 A
Load on the external current transformers	0.2 VA connected for 1 A 0.7 VA connected for 5 A
The Current Sensing Unit withstands a maximum of:	
Continuously	1 x rated current
For 1 s	15 x rated current
Optical outputs:	
To Arc Monitor/Current Sensing Unit	Quantity: 2
Optical inputs:	
From other Current Sensing Unit	Quantity: 1
Indications:	
Signal to Arc Monitor/ Current Sensing Unit	Green LED lit up at load current < set overcurrent level
Pre-warning	Yellow LED lit up at load current < approx. 70% of set overcurrent level
Test position	Red LED

Control devices/settings: (on the p.c.b.)	
Change-over switch	
Test position	On/Off
Optical input is used or not	On/Off
Trimming potentiometers	
Setting of overcurrent level	0.5 – 3.5 x rated current
Simulation of overcurrent level in test position	–
Supply voltage	See ordering table
Permitted variation	+/– 20 % at DC +/– 10 % at 110-127 V AC +10 % –15 % at 230 V AC
Power consumption	1 W at 24 V 11 W at 220 V
Permissible ambient temperature	– 25...+ 55 °C
Operating times From overcurrent occurring to actuating optical outputs: At currents ≥2 x set overcurrent level	
3-phase supply.	< 2 ms
1-phase supply.	< 8 ms
Current conditions from optical input to optical outputs	< 0.3 ms
Degree of protection	IP 54

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
IEC61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use

Arc Guard Systems™

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.

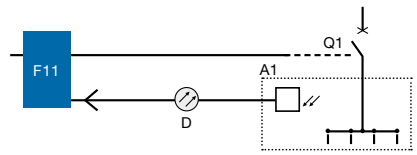
Detectors

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.

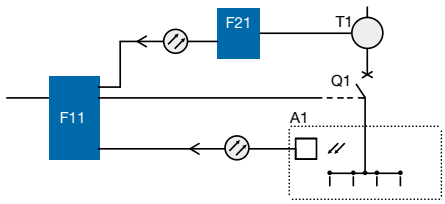
Detector positioning

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.

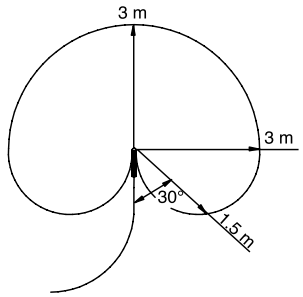


Arc Guard System with Arc Monitor

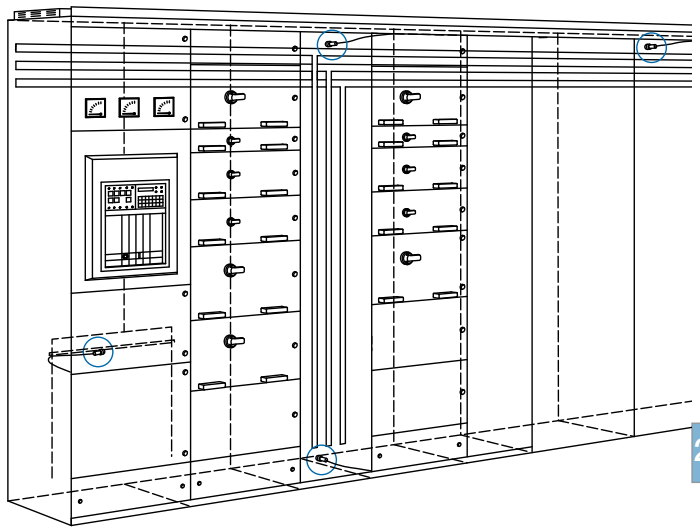
A1	Switchgear
F11	Arc Monitor
F21	Current Sensing Unit
T1	Current transformer
Q1	Circuit-breaker



Arc Guard System with Arc Monitor and Current Sensing Unit



Polar diagram of detector

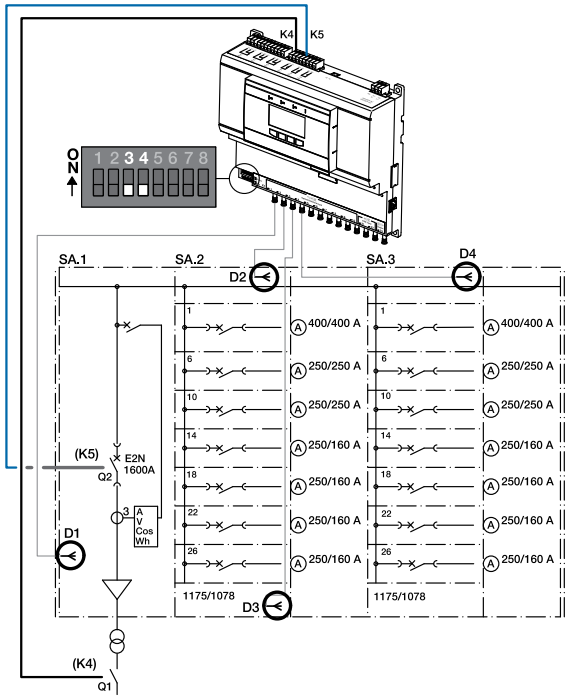


Example showing the position of detectors in:
1. Horizontal and vertical bus bar system
2. Circuit-breaker cubicle

① AWG estimated.

Example 1:

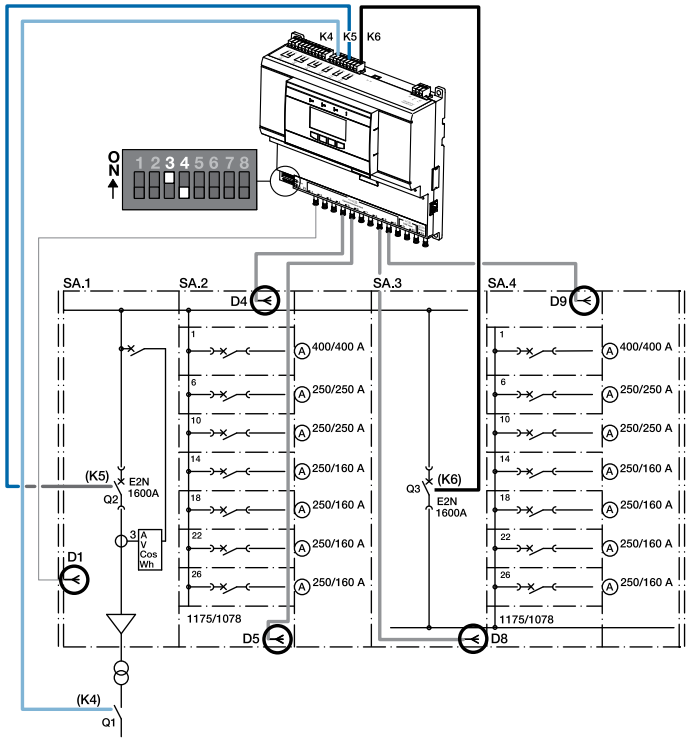
Arc Guard System™ installed to trip all breakers in case of an arc.



SA1... SA3	Switchgear
K4, K5	Solid state tripping contacts
Q1, Q2	Circuit-breaker
D1...D4	Detectors

Example 2:

Arc Guard System™ installed to trip different breakers depending on where the arc occurs.



SA1... SA4	Switchgear
K4, K5, K6	Solid state tripping contacts
Q1, Q2	Circuit breaker
Q3	Bus coupler
D1...D9	Detectors

Configurations
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.

DIP switches

Sw1	Current condition inputs Terminals X1:21-22	Sw5	Not used
Sw2	Current condition output Terminal X1:23	Sw6	Autoreset K2, K3 (signal relays)
Sw3	Trip output assign	Sw7	Not used
Sw4	Trip output assign	Sw8	Not used

Breaker trip output	Detector inputs
Output relay K4	Terminals X1:1-10
Output relay K5	Terminals X2:1-10
Output relay K6	Terminals X3:1-10

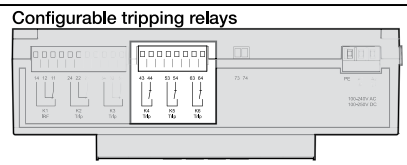
Trip condition configuration

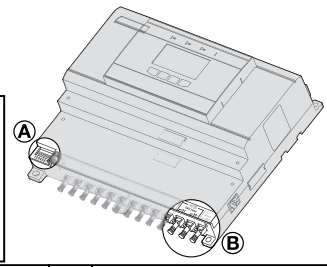
TVOC-2 can be configured to trip selected breakers depending on which detector is signalling for an arc. This can be used to trip sections of a switchgear or use one monitor for several small switchgears. It also has an option to add a current condition.

Symbol description

= Arc detected

= Arc not detected

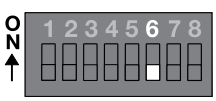




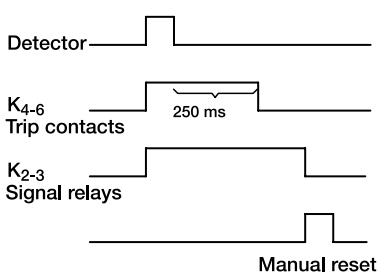
		Sw3	Sw4	Function detectors
A Configuration 1 ON 1 2 3 4 5 6 7 8	Standard configuration, trip all breakers	0	0	Any detection trips all breakers K4, K5, K6
Configuration 2 ON 1 2 3 4 5 6 7 8	Trip different breaker depending on extension module	0	1	Detectors X1 operate K4 Detectors X2 operate K5 Detectors X3 operate K6
Configuration 3 ON 1 2 3 4 5 6 7 8	Trip different breaker depending on detector (1-3, 4-6, 7-)	1	0	Detectors X1:1-3 operate K4 Detectors X1:4-6 operate K5 Detectors X1:7-10, X2 and X3 operate K6

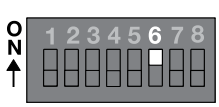
Manual/auto reset configuration

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.

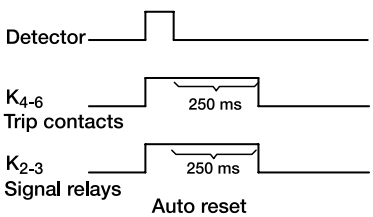


DIP 6=0





DIP 6=1

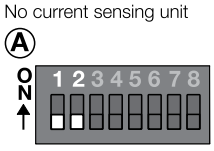
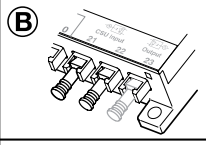
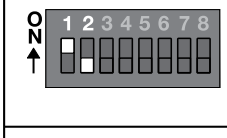
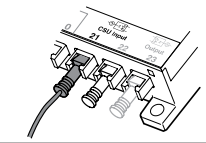
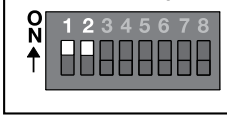
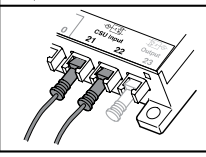


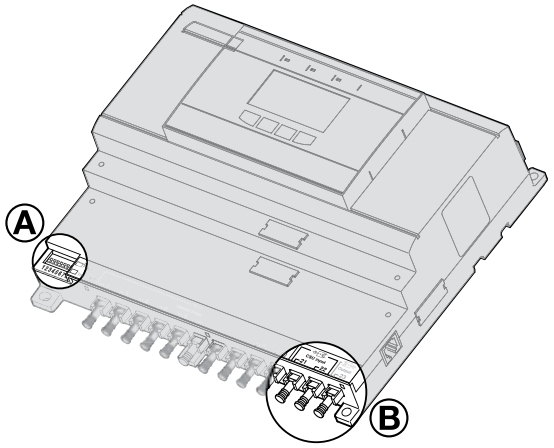
Configuration
Current condition configuration

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 CSUs (Current Sensing Units).

All trip configurations on page 20.12 can be combined with an additional current condition. It is possible to connect up to two CSUs directly to the Arc Monitor (AM) (input 21 and 22). Connecting additional current sensing units in series is also possible if required. Sharing 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.

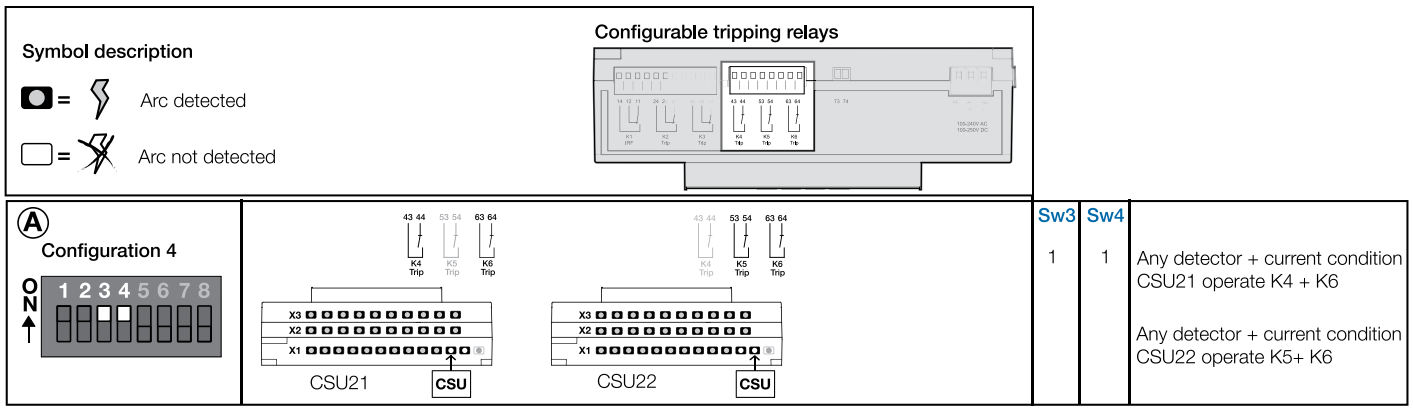
		Sw1	Sw2	Function current condition
No current sensing unit 		0	0	Not used
One current sensing unit 		1	0	Input CSU21 used
Two current sensing units 		1	1	Both inputs used



AM (Arc Monitor)

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.

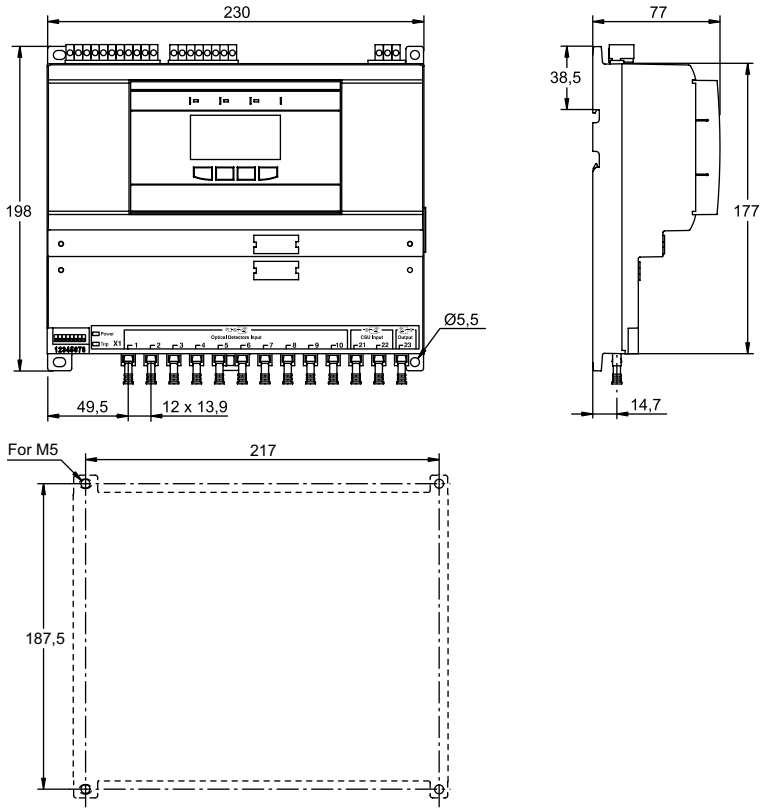


Sw3	Sw4	
1	1	Any detector + current condition CSU21 operate K4 + K6 Any detector + current condition CSU22 operate K5+ K6

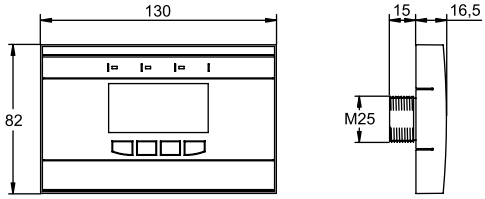
See manual for more details

Approximate dimensions

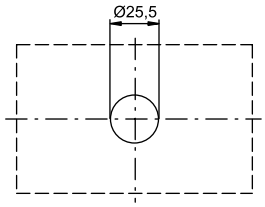
Arc Monitor



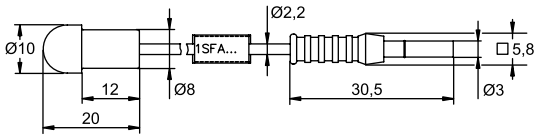
HMI



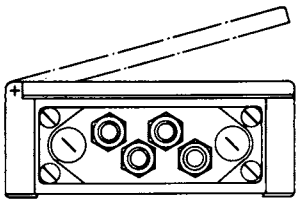
Drilling plan



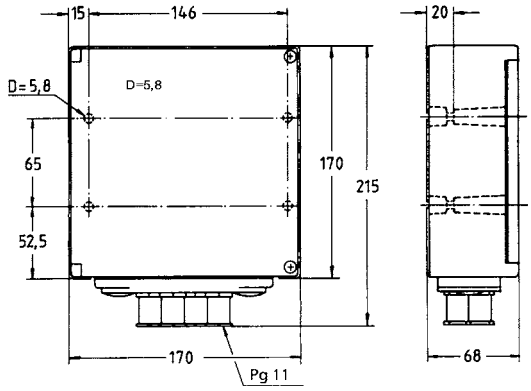
Detector with optical cable



Current Sensing Unit



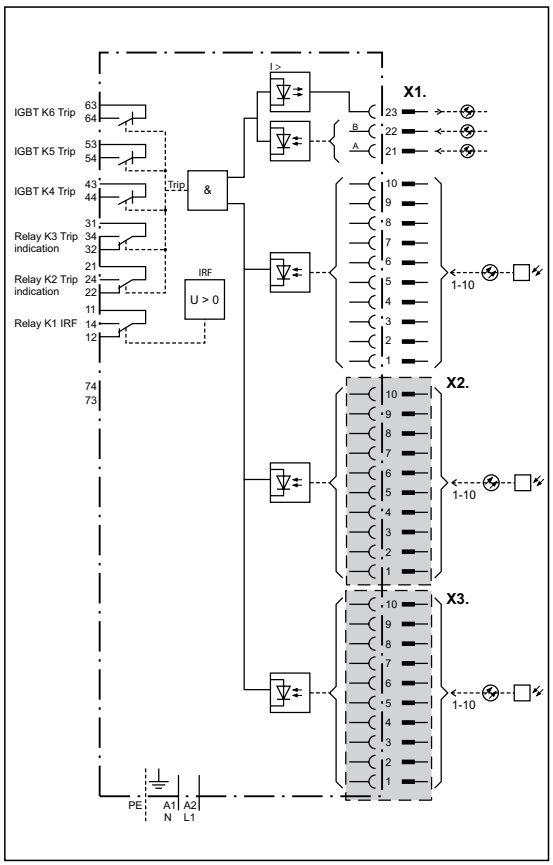
A flange with 6 tapped holes (size 18.6 mm), 4 cable glands (sealing diameter 5.5-8.5 mm), and 2 plastic blank plugs are supplied.



20

Circuit diagrams

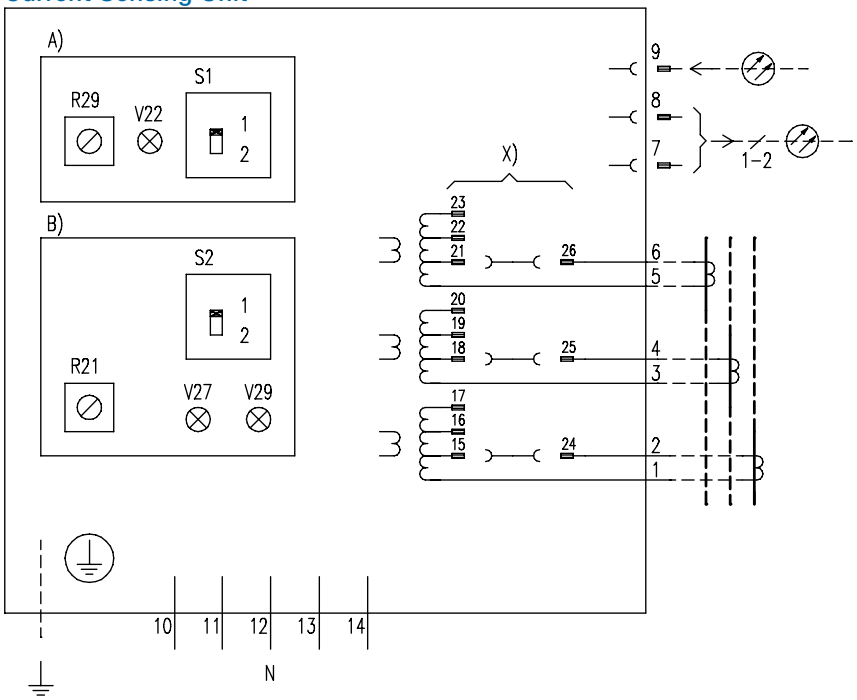
Arc Monitor



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
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	
V22	**Red**	**ON** = S1 in test position **OFF** = S1 in operation position

B) Setting facilities:

R21	Overcurrent setting	
S2	**1** = Input 9 not used **2** = Input 9 used	
V27	**Yellow**	**ON** = Load current less than 70% of set overcurrent level **OFF** = Load current more than 70% of overcurrent level
V29	**Green**	**ON** = Load current less than set overcurrent level **OFF** = Load current more than set overcurrent level

X) Current range bridge connections

Range	Adjustable between	Connections
1A:	0.5 - 3.5	24-17, 25-20, 26-23
2A:	1.0 - 7.0	24-16, 25-19, 26-22
5A:	2.5 - 17.5	24-15, 25-18, 26-21

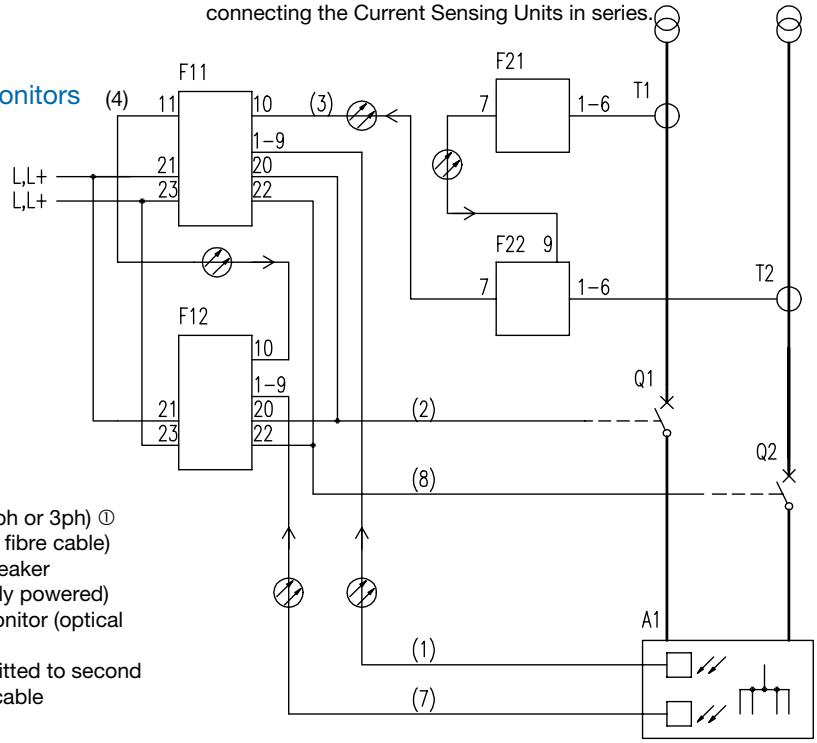
Circuit diagrams
Arc Guard System with two separated circuit-breakers

Several Current Sensing Units

The Arc Monitor can be linked with several Current Sensing Units by connecting the Current Sensing Units in series.

Parallel connection of Arc Monitors

In installations with more than one Arc Monitor.
Current sensing function is transmitted to next Arc Monitor via fibre cable (4).



A1	Switchgear or similar
F11, F12	Arc Monitor
F21, F22	Current Sensing Unit
Q1,Q2	Circuit-breaker
T1, T2	Current transformers (1ph or 3ph) ①
(1), (7)	Detector cables (optical fibre cable)
(2), (8)	Trip circuit for circuit-breaker (electric cable, separately powered)
(3)	Current signal to Arc Monitor (optical fibre cable)
(4)	Current signal is transmitted to second Arc Monitor via optical cable

① Reference page 20.14

Notes