Arc Protection Relay

REA 10_

Product Guide

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Features

- Loop-type sensor fiber, radial sensor fiber or lens-type sensor for arc detection
- Two high-speed semiconductor outputs for tripping
- Tripping from light only or secured with fast, adjustable three-phase or two-phase and neutral overcurrent condition
- Total operate time <2.5 ms
- Wide area automatic or manual backlight compensation
- Two RJ45 ports for chaining the extension units
- Two opto-connectors for fast ON/OFF signal transfer between central units
- Circuit-breaker failure protection, i.e. delayed output for higher-level circuit breaker
- Self-supervision unit for monitoring the sensor fiber, operating voltages and cabling between central units and extension units

Application

Consequences of an arcing short circuit or earth fault within a low or medium voltage switchgear can be very serious. An arc can destroy costly equipment, and cause prolonged and expensive downtime. Furthermore, an arc can cause serious injuries to personnel.

Sources of arcing can be e.g. failure of insulation, mal-operation of a device, improper bus or cable joints, overvoltage, corrosion, pollution, moisture, ferro-resonance (instrument transformers) and even ageing under electrical stress. Most of these could be prevented by sufficient maintenance. But in spite of all precautions, human errors by personnel can also lead to arc faults.

Time is critical when it comes to detecting and minimising the effects of an arc. An arc fault lasting 500 ms may cause severe damage to the installation. If the arc lasts less than 100 ms the damage is often smaller, but if the arc is eliminated in less than 35 ms the damage is almost unnoticed.

Substantial damages and serious consequences of an arc fault hazard can be mitigated with fast acting REA 101 Arc Protection System. In addition to arcing short circuits, even arcing earth faults with current levels below normal load current can be detected and interrupted already before they escalate to two or three-phase short circuit.

Normally applied bus bar protection relaying arrangements may be too slow to ensure safe fault clearance times at arc faults. E.g. operation time of the overcurrent relay controlling the incoming CB may have to be delayed hundreds of milliseconds for selectivity reasons. This delay can be avoided using REA 10_ arc protection system: Total fault clearance time can be reduced to max 2.5 ms plus circuit breaker's action time.

Furthermore, autoreclosure trials doomed to fail at cable compartment faults can be eliminated with arc protection.

The arc protection relay REA 101 and the extension units REA 103, REA 105 and REA 107 are designed to be used for the protection of medium and low-voltage air-insulated switchgear. The central unit type REA 101 operates independently or together with the extension units REA 103, REA 105 and REA 107. These extension units allow the number of sensor fibers and/or lens sensors to be increased, thus extending the area to be protected. In an arc situation, the fault place is quickly localized by inspecting the area covered by the sensor that detected the arc. The design of the extension units REA 103 and REA 105 is nearly the same. The main difference between the units is that the REA 105 is provided with two fast trip outputs capable of opening, for example, the bus coupler or both circuit breakers of a duplex feeder. Thus selective tripping is achieved. The REA 107 is also used for the extension of the protection area. It has inputs for eight lens-type sensors. The arc protection relay REA 101 is provided with two output ports, to each of which a maximum of five extension units can be chained.

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Design

Arc protection relay REA 101

Overcurrent detection unit
The selection switch is used to select between three-phase current measurement or two-phase and neutral current measurement.

Three-phase current measurement
The three-phase currents are measured via transformers. When the current on one phase exceeds the selected reference level, an overcurrent signal is activated.

The selection switch is used to select the current reference level for the current inputs L1, L2 and L3. The available current level settings are 0.5, 1.0, 1.5, 2.5, 3.0, 5.0 and 6.0 times the rated current (In = 1.0 A or 5.0 A).

Two-phase and neutral current measurement
When the current in L1, L3 or L2 (neutral current) exceeds the selected reference level, an overcurrent signal is activated.

The available current level settings for L1 and L3 are 0.5, 1.0, 1.5, 2.5, 3.0, 5.0 and 6.0 times the rated current (In = 1.0 A or 5.0 A).

The available current level settings for L2 are 0.05, 0.1, 0.15, 0.25, 0.3, 0.5 and 0.6 times the rated current (In = 1.0 A or 5.0 A).

Light detection unit
The light captured by the sensor is amplified and compared to the pre-selected light reference level. Once the light exceeds the set reference level, a light signal is activated.

The selection switch is used to activate the arc detection sensor.

The selection switch is used to select automatic or manual light reference level.

If the automatic reference level is selected, the unit forms the reference level based on the backlight intensity measured by the sensor.

When the manual reference level is selected, the unit forms the reference level based on the value that was selected with the light reference level adjustment potentiometer on the front panel.

The sensor fiber condition is monitored by sending a test pulse through the fiber. If a test pulse is not received at regular intervals at the other end of the fiber loop, the “Sensor Fault” LED and the self-supervision LED “IRF” are activated, and the IRF relay resets.

If the sensor-monitoring feature is not needed, it can be deactivated by using the selection switch.

Sensitivity of sensors

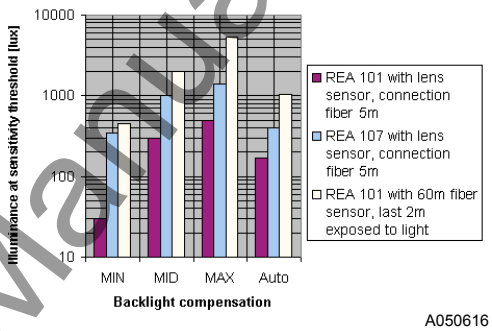

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Fig. 1 Sensitivity of REA 10_ sensors at various backlight compensation settings

The intensity of a high-current arc light in a two- or three-phase short circuit can be tens of thousands of luxes. The intensity of a normal office lighting is 200-300 luxes.

The exact determination of the detecting reach of the light sensors is difficult, because the detecting reach depends on several factors:

- Light source energy
- Fiber length
- Reflectances
- Backlight compensation settings

Sensitivity of fiber sensors
The incidence angle of the light is not relevant with fiber sensors.

When an arc protection system is designed, the length of the sensor fiber per one switchgear compartment must be selected according to the possible short-circuit or earth-fault current, and the distance between the sensor and arc. When selecting sensor fiber length, refer to the table 1.

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Table 1: Minimum length (cm) of the exposed sensor fiber per one switchgear compartment

Fault current (rms)	Distance between sensor and arc			
	100 cm	200 cm	300 cm	400 cm
0.5 kA	20	-[a]	-[a]	-[a]
0.7 kA	20	70	210	280
1.4 kA	20	20	20	140
2.2 kA	20	20	20	20

a) Not operational.

The information in the table 1 is based on the following reference conditions:

- Copper busbars
- Arc length 10 cm
- Surrounding light ~ 400 lux
- No reflecting surfaces
- Light reference level is set one scale mark to the right from the minimum

Sensitivity of lens sensors

The relative sensitivity of the lens sensor from different angles of lightning is presented in figure 2. The normal operating sector is -130°... +130°. In practice, light is also reflected from the compartment walls, so the detecting angle is not critical.

The detection distance of a lens sensor is 3 meters. Therefore, when protecting busbar sections, the maximum distance of lens sensors from one another is 6 meters

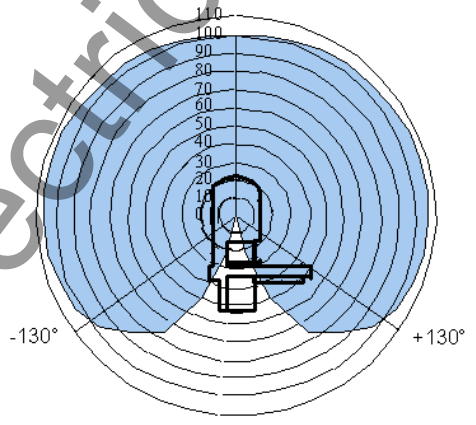

Fig. 2 Relative sensitivity of the REA lens sensor from different angles of lighting

Trip output

The trip output is provided with:

- Two high-speed galvanically isolated IGBT semi-conductor outputs, HSO1 and HSO2
- Relay output, TRIP3

The control signal of the outputs is activated if the overcurrent signal and the light signal, but not the operating voltage fault signal, are active at the same time.

When the “Trip Condition” key switch on the relay’s front panel is in “Light” position, the overcurrent signal is constantly active, and tripping is activated by an arc alone. When a trip signal is delivered, the trip outputs are latched in active state. The outputs can be reseted either by pushing the “Reset” button on the relay’s front panel, or by using a reset signal applied to RESET input.

Ports A and B for connecting extension units

The selection switches are used to activate the ports A and B.

The extension units are connected to the ports A and B by using connection cables. The extension unit receives its operating voltage and operation signals over the port.

The ports are protected against short-circuit and cable breaks. If the connection cable from a port breaks, the concerned chain is disconnected, and the fault LED (Port A Fault” or “Port B Fault”) as well as the “IRF” LED on the central unit are lit, and the IRF relay resets.

A maximum of 5 extension units can be connected to one port. If an extension unit included in the chain connected to the port is damaged, the fault LED of the port starts flashing, the “IRF” LED is lit and the IRF relay resets.

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Optolink communication
The REA 101 relay contains two communication links: Optolink 1 and Optolink 2.

The selection switches are used to select the links to be used, and the messages to be communicated between them.The purpose of the communication link is to communicate ON/OFF type messages between the central units over the signal transfer fiber. The message can be:

- Light signal
- Overcurrent signal
- Trip signal

Only one type of message per optolink can be transmitted between the central units. The data to be communicated depends on the system design.

To monitor the connection, a test pulse is sent through the signal transfer fiber at regular intervals. If the test pulse is not received at the specified time, the optolink fault LED ("Optolink 1 Fault" or "Optolink 2 Fault") and the "IRF" LED of the central unit is lit, and the IRF relay resets.

Circuit-breaker failure protection
The circuit-breaker failure protection (CBFP) is enabled, when the Trip Condition key switch is in "Current&Light" position.

The circuit-breaker failure protection is implemented by delaying either the HSO2 output or the TRIP3 output, or when required, both the outputs. Note that if both the outputs are used, the delay time is the same, but the pick-up time of the relay (5...15 ms) is added to the TRIP3 relay.

The selection switches are used to select the wanted alternative.

The selected delay time, 100 ms or 150 ms, starts running once the HSO1 is activated. Delayed tripping does not take place if the overcurrent signal disappears before the specified time delay elapses.

When the circuit-breaker failure protection is not in use, all the trip outputs operate in parallel.

Self-supervision unit
In addition to that mentioned in the above sections, the self-supervision unit (IRF) monitors the operating voltage of the relay. If a fault is detected in the operating voltages, the self-supervision unit prevents the relay from operating. In addition, the "IRF" LED of the central unit is lit, and the IRF relay resets.

The self-supervision signal output operates on the closed circuit principle as presented in the figure below. Under normal conditions, the output relay is energized and the contact gap between 8 and 10 is closed. If the auxiliary power supply fails, or an internal fault is detected, the contact gap between 8 and 10 is opened.

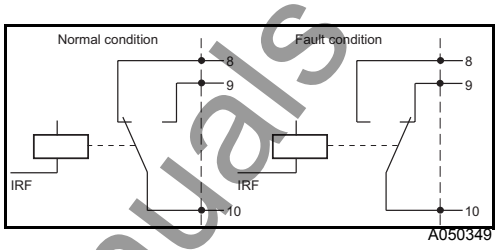

Fig. 3 Self-supervision output (IRF)

Extension unit REA 103
The Arc Protection Module REA 103 is an extension unit designed to be used together with the central unit REA 101.

The function of the REA 103 unit is to detect light and to provide the REA 101 relay with information about this.

The use of the extension unit allows the protection area to be extended and the protected object to be divided into smaller areas

Features:

- Two sensor fibers for arc detection; loop or radial arrangement
- Two signal relays for each sensor fiber
- Relays activated by light detected by the sensor fiber
- Two RJ-45 ports for connecting REA 101 relay and extension units
- Self-supervision unit monitoring operating voltages and sensor fiber loops.

Extension unit REA 105
The Arc Protection Module REA 105 is an extension unit designed to be used together with the central unit REA 101.

The function of the REA 105 unit is to detect light and to carry out tripping, if the REA 101 relay provides an overcurrent signal at the same time, or delivers a trip command.

The use of extension units allows the protection area to be extended and the protected object to be divided into smaller areas. Thus a more selective system is obtained.

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Features:

- Loop-type or radial sensor fiber for arc detection.
- Two high-speed semi-conductor outputs for tripping.
- Signal relay activated by light detected by the sensor fiber.
- Three RJ-45 ports for connecting the REA 101 relay and extension units.
- Circuit-breaker failure protection. Delayed light signal to REA 101, which opens the higher-level circuit breaker.
- Self-supervision unit which monitors operating voltages and the sensor fiber loop.

Extension unit REA 107

The Arc Protection Module REA 107 is an extension unit designed to be used together with the central unit, Arc Protection Relay REA 101.

The function of the REA 107 unit is to detect light and to provide the REA 101 relay with information about this.

The use of the extension unit allows the protection area to be extended and the protected object to be divided into smaller areas.

Features:

- 8 lens-type sensors for arc detection
- 2 signal relays
- 2 RJ-45 ports for connecting REA 101 relay and other extension units
- Self-supervision unit that monitors operating voltages
- LED indicators for each sensor.

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Technical data

Table 2: Current input

Rated current	1 A / 5 A
Continuous load current	4 A / 20 A
Momentary current for 1 s	100 A / 500 A
Dynamic current withstand, half-wave value	250 A/ 1250 A
Input impedance	<100 mΩ/ <20 mΩ
Rated frequency	50 / 60 Hz

Table 3: Outputs

Trip contacts HSO1 and HSO2:	
Rated voltage	250 V DC/AC
Continuous carry	1.5 A
Make and carry for 0.5 s	30 A
Make and carry for 3 s	15 A
Breaking capacity for DC, when the control circuit time constant L/R <40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Trip contact TRIP3:	
Rated voltage	250 V DC/AC
Continuous carry	5 A
Make and carry for 0.5 s	30 A
Make and carry for 3 s	15 A
Breaking capacity for DC, when the control circuit time constant L/R <40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Signal contacts IRF:	
Rated voltage	250 V DC/AC
Continuous carry	5 A
Make and carry for 0.5 s	10 A
Make and carry for 3 s	8 A
Breaking capacity for DC, when the control circuit time constant L/R <40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A

Table 4: Control input

Reset input RESET:	
Control voltages:	
Rated voltages and operating ranges	U_n = 24/48/60/110/220/250 V DC 18...300 V DC U_n = 110/120/220/ 240 V AC 18...265 V AC
Not active, when control voltage	< 9 V DC, 6 V AC
Control current	1.5...20 mA
Minimum pulse length	1 s

Table 5: Circuit-breaker failure protection CBFP

Selectable operate time delays	150 ms / 100 ms
Operate time accuracy:	
HSO2	±5% of setting value
TRIP3	±5% of setting value +5...15 ms

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Table 6: Power supply

Relay types REA101-AAA, REA101-AAAG:	
U_{aux} rated	U_r = 110/120/220/240 V AC U_r = 110/125/220/250 V DC
U_{aux} variation	85...110% U_r (AC) 80...120% U_r (DC)
Relay types REA101-CAA, REA101-CAAG:	
U_{aux} rated	U_r = 24/48/60 V DC
U_{aux} variation	80...120% U_r DC

Table 7: Power consumption

REA 101	Power consumption of relay under quiescent/operating conditions	~9 W / ~12 W
	Max. port output power	~19 W
	Max. number of extension units/port	5
	Max. power consumption with 10 extension units connected	<50 W
REA 103 (operating voltage over the port of REA 101)	Power consumption of relay under quiescent/operating conditions	~1.6 W / ~3.3 W
REA 105 (operating voltage over the port of REA 101)	Power consumption of relay under quiescent/operating conditions	~2.7 W / ~3.7 W
REA 107 (operating voltage over the port of REA 101)	Power consumption of relay under quiescent/operating conditions	~1.7 W / ~2.7 W

Table 8: Sensor fiber

Maximum length without splices or with one splice	60 m
Maximum length with two splices	50 m
Maximum length with three splices	40 m
Service temperature range	-35…+80°C
Smallest permissible bending radius	50 mm

Table 9: Connection cable

Maximum length[a]	40 m

a) Total length of the connection chain between the central unit and extension units

Table 10: Optolink communication

Maximum length of signal transfer fiber:	
Plastic	40 m

Table 11: Setting range

Current setting steps In x	0.5, 1.0, 1.5, 2.5, 3.0, 5.0, 6.0
Neutral current setting steps In x	0.05, 0.10, 0.15, 0.25, 0.3, 0.5, 0.6
Operation accuracy	± 5% of the setting value or ±2% of In

Table 12: Total operate time

HSO1 and HSO2	≤2.5 ms
TRIP3	<15 ms

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Table 13: Environmental tests

Specified service temperature range	-10...+55°C
Transport and storage temperature range	-40...+70°C
Operation in dry heat conditions	According to IEC 60068-2-2
Operation in dry cold conditions	According to IEC 60068-2-1
Damp heat test cyclic	According to IEC 60068-2-30 r.h. >95%, t = 20...55°C
Storage temperature test	According to IEC 60068-2-48

Table 14: Encapsulation

REA 101	Degree of protection, IEC 60529	IP 20
	Weight	about 4.6 kg
REA 103	Degree of protection, IEC 60529	IP 20
	Weight	about 1.1 kg
REA 105	Degree of protection, IEC 60529	IP 20
	Weight	about 1.1 kg
REA 107	Degree of protection, IEC 60529	IP 20
	Weight	about 1.0 kg

Table 15: Insulation tests

Dielectric tests according to IEC 60255-5	2 kV, 50 Hz, 1 min.
Impulse voltage test according to IEC 60255-5	5 kV, 1.2/50 µs, 0.5 J
Insulation resistance according to IEC 60255-5	>100 MΩ, 500 V DC

Table 16: Electromagnetic compatibility tests

EMC immunity test level meets the requirements listed below:	
1 MHz burst disturbance test according to IEC 60255-22-1, class III:	
Common mode	2.5 kV
Differential mode	1 kV
Electrostatic discharge test according to IEC 61000-4-2, class IV and ANSI/IEEE C37.90.3-200:	
For contact discharge	8 kV
For air discharge	15 kV
Radio-frequency electromagnetic field disturbance test according to IEC 61000-4-3 and IEC 60255-22-3:	
Amplitude-modulated:	
Frequency f	80...1000 MHz
Field strength E	10 V/m (rms)
Pulse-modulated:	
Frequency f	900 MHz
Field strength E	10 V/m (rms)
Radio frequency disturbance test according to IEC 61000-4-6 and IEC 60255-22-6:	
Conducted, common mode	10 V, 150 kHz...80 MHz
Fast transient disturbance tests according to IEC 60255-22-4 and IEC 61000-4-4	4 kV
Surge immunity test according to IEC 61000-4-5 and IEC 60255-22-5:	
Aux. voltage input, trip outputs:	
Line-to-line	2 kV
Line-to-earth	4 kV
Signal contacts (IRF), current inputs, RESET input:	
Line-to-line	1 kV
Line-to-earth	2 kV
Electromagnetic emission tests according to EN 55011 and IEC 60255-25:	

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Table 16: Electromagnetic compatibility tests (continued)

Conducted RF emission (mains terminal)	EN 55011, class A, IEC 60255-25
Radiated RF emission	EN 55011, class A, IEC 60255-25
SWC tests according to ANSI/IEEE C37.90.1-2002:	
Oscillatory tests	2.5 kV
Fast transient test	4 kV
Power frequency (50 Hz) magnetic field according to IEC61000-4-8	300 A/m, continuous
Voltage dips and short interruptions according to IEC 61000-4-11:	 30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms

Table 17: CE approval

Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC	EN 50263 EN 60255-6

Table 18: Mechanical tests

Vibration tests (sinusoidal) according to IEC 60255-21-1	class 1
Shock and bump test according to IEC 60255-21-2	class 1
Seismic tests according to IEC 60255-21-3	class 2

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Dimensions

Dimension drawings

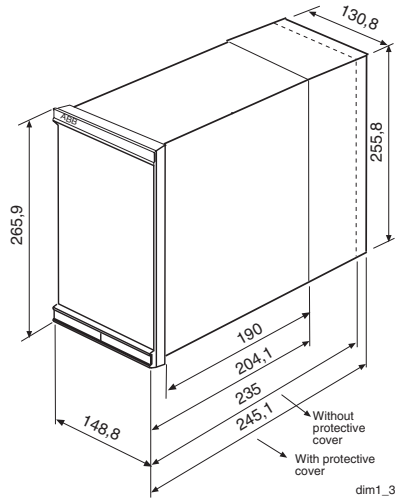

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Fig. 4 Dimensions of REA 101

Mounting alternatives

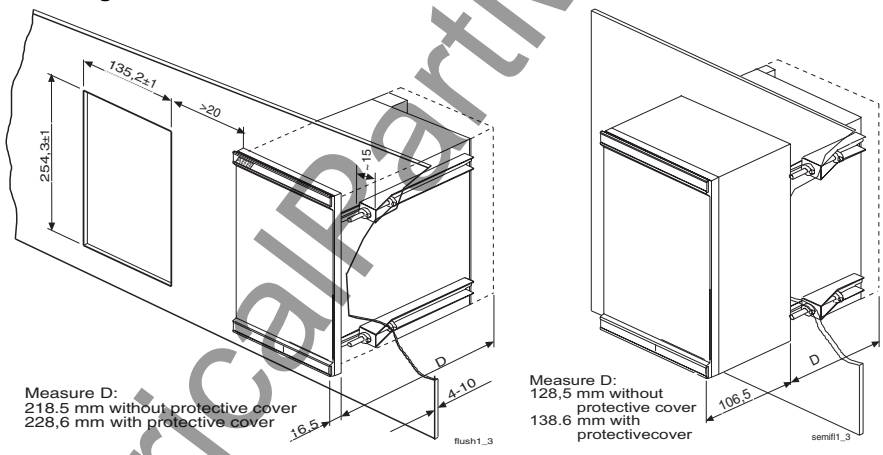

Fig. 5 Flush mounting and semi-flush mounting of REA 101

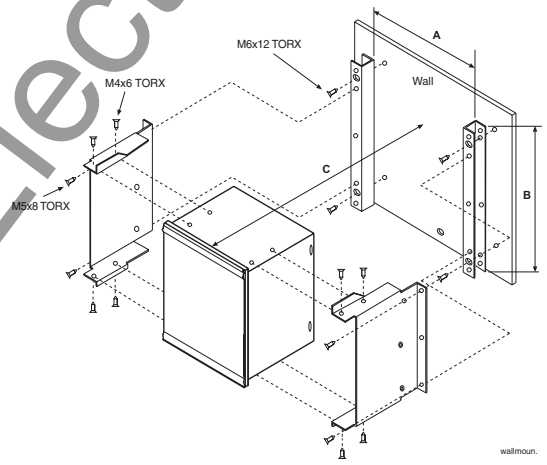

Fig. 6 Surface mounting of REA 101

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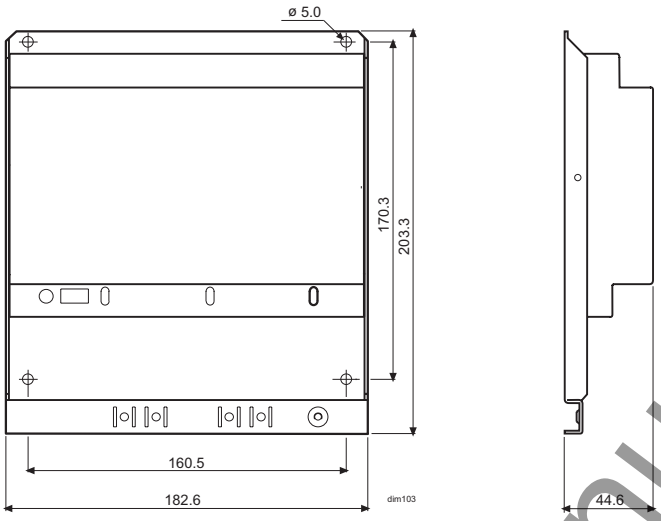

Fig. 7 Dimensions of REA 103

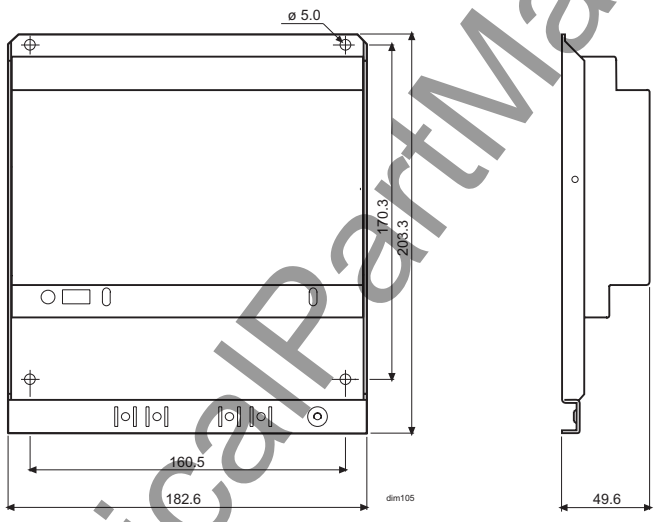

Fig. 8 Dimensions of REA 105

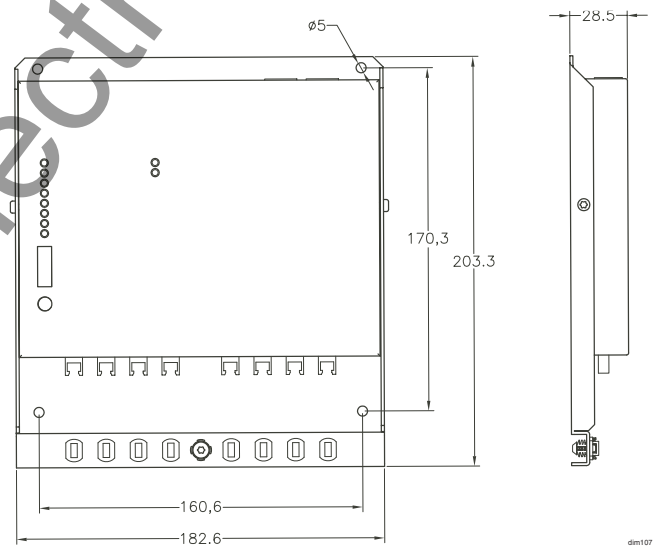

Fig. 9 Dimensions of REA 107

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Ordering

When ordering, please specify:

Ordering information	Ordering example
1. Order number and quantity	REA 101-AAA, 5 pieces
2. Accessories	Connection cables 5m, 1MRS 120511.005, 5 pieces Pre-manufactured fiber sensors 10 m, 1MRS 120512.010, 13 pieces Pre-manufactured lens sensors 7 m, 1MRS 120534-7.0, 16 pieces
3. Number of extension units	REA103 3 pieces REA 105 2 pieces REA 107 2 pieces

REA 10_ order numbers

Arc protection relay REA 101 U_n = 110…240 V AC U_n = 110…250 V DC	REA101-AAA[a]
Arc protection relay REA 101 U_n = 24…60 V DC	REA101-CAA[a]
Arc protection relay REA 101 with optolink connectors for glass fiber U_n = 110…240 V AC U_n = 110…250 V DC	REA101-AAAG[a]
Arc protection relay REA 101 with optolink connectors for glass fiber U_n = 24…60 V DC	REA101-CAAG[a]
Rear plate protective cover	1MRS 060196
Mounting kit for semi-flush mounting	1MRS 050254
Mounting kit for surface mounting	1MRS 050240
Mounting kit for connecting cases together	1MRS 050241
Mounting kit for 19” rack	1MRS 050258
Extension unit REA 103	REA103-AA
Extension unit REA 105	REA105-AA
Extension unit REA 107	REA 107-AA

a) Includes mounting kit 1MRS 050209 for flush mounting.

Pre-manufactured fiber sensors

Length	Order number
5 m ±3%	1MRS 120512.005
10 m ±3%	1MRS 120512.010
15 m ±3%	1MRS 120512.015
20 m ±3%	1MRS 120512.020
25 m ±3%	1MRS 120512.025
30 m ±3%	1MRS 120512.030
40 m ±3%	1MRS 120512.040
50 m ±3%	1MRS 120512.050
60 m ±3%	1MRS 120512.060

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Accessories for manufacturing fiber sensors

Sensor fiber 100 m	1MSC 380018.100
Sensor fiber 300 m	1MSC 380018.300
Sensor fiber 500 m	1MSC 380018.500
ST connector	SYJ-ZBC 1A1
ST splice adapter	SYJ-ZBC 1A2
ST fiber termination kit	1MSC 990016

Pre-manufactured lens sensors for REA 107

1,5 m ±3%	1MRS 120534-1.5
3 m ±3%	1MRS 120534-3.0
5 m ±3%	1MRS 120534-5.0
7 m ±3%	1MRS 120534-7.0
10 m ±3%	1MRS 120534-10
15 m ±3%	1MRS 120534-15
20 m ±3%	1MRS 120534-20
25 m ±3%	1MRS 120534-25
30 m ±3%	1MRS 120534-30

Pre-manufactured lens sensors for REA 101, REA 103 and REA 105

2 m ±3%	1MRS 120536-2
3 m ±3%	1MRS 120536-3
5 m ±3%	1MRS 120536-5
10 m ±3%	1MRS 120536-10

Spare parts for lens sensors

Light collecting lens	1MRS060743

Cables for connecting REA 101 to an extension unit, or the extension units to each other

1 m ±3%	1MRS 120511.001
3 m ±3%	1MRS 120511.003
5 m ±3%	1MRS 120511.005
10 m ±3%	1MRS 120511.010
15 m ±3%	1MRS 120511.015
20 m ±3%	1MRS 120511.020
30 m ±3%	1MRS 120511.030
40 m ±3%	1MRS 120511.040

Plastic fiber optolink for signal transfer between central units

1 m ±3%	SPA-ZF AA 1
2 m ±3%	SPA-ZF AA 2
3 m ±3%	SPA-ZF AA 3
5 m ±3%	SPA-ZF AA 5
10 m ±3%	SPA-ZF AA 10
20 m ±3%	SPA-ZF AA 20
30 m ±3%	SPA-ZF AA 30
40 m ±3%	1MRS 120517

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Technical data for glass fiber

Type	Multimode graded-index OM1 (ISO/IEC11801)
Diameter	62.5/125 µm core/gladding
Attenuation	Max. 3.5 dB/km at 850 nm wavelength
Tip polishing shape	Rounded fiber tip
Connector	ST type

Ordering
You can order fibers of fixed lengths from well-known manufacturers or distributors.

ABB has successfully tested fibers from the following manufacturers:

Draka NK Cables

Brügg Kabel AG

www . ElectricalPartManuals . com

References

Additional information

REA 101 Operator's Manual	1MRS 751003-MUM EN
REA 103 Operator's Manual	1MRS 751004-MUM EN
REA 105 Operator's Manual	1MRS 751005-MUM EN
REA 107 Operator's Manual	1MRS 752135-MUM EN

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