REA 101
Arc protection relay

Operator's manual

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1. General

The REA 10_ arc protection system is designed to give fast trip commands to all CBs that may feed an arc fault in low voltage or medium voltage air insulated metal-clad switchgears. In an arc situation, the fault can be quickly localised by inspecting the area covered by the sensor that detected the arc. Two sensor types are available:

- Patented long fibre sensor that detects light along its entire length
- Light collecting lens type sensors, distributed one per each compartment.

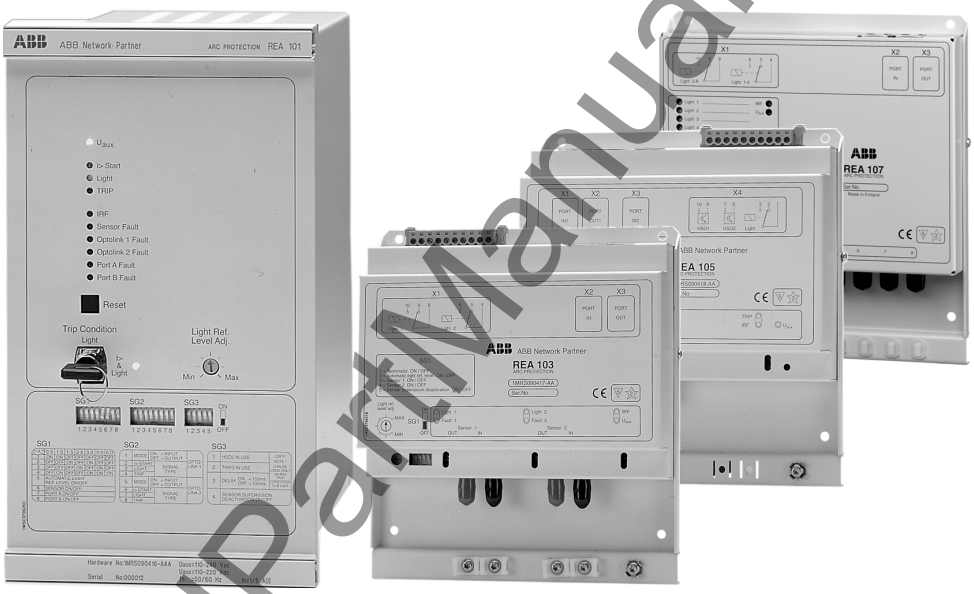

Fig. 1.-1 REA 10_ arc protection units

The central unit REA 101 operates independently or together with extension units REA 103, REA 105 or REA 107. REA 103 is used for extending the protected area, and REA 105 is provided with fast trip outputs capable of opening, e.g., a bus coupler. REA 107 is designed for the extension of the protection area. It has inputs for eight lens type sensors. The REA 101 is provided with two output ports, to each of which a maximum of five extension units can be chained. Several REA 101 units can be connected together via optical links or via REA 105 units.

1.1. Features

- Fast, adjustable three-phase overcurrent condition to secure tripping
- Wide area automatic or manual backlight compensation
- Loop-type or radial sensor fibre or alternatively lens type sensors for arc detection
- Two high-speed solid-state (Insulated Gate Bipolar Transistor) outputs for tripping of CBs
- One heavy-duty relay output for delayed control of an up-stream CB or as an alarm output
- Two RJ-45 type ports for chaining extension units

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- Two opto-connectors for signal transfer between central units
- Continuous self-supervision of sensor fibre loop, operating voltages and cabling between central units and extension units

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2. Safety

	National and local electrical safety regulations must always be followed.
	Dangerous voltages can occur on the connectors, even though the auxiliary voltage is disconnected.
	The frame of the device has to be carefully earthed.
	Only a competent electrician is allowed to carry out the electrical installation.
	Sensor fibres have to be handled with care avoiding sharp bends.
	Settings and configuration changes have to be done with the auxiliary supply voltage (U_{aux}) disconnected. Malfunction may occur if changes are made with the supply voltage connected.

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3. Block diagram

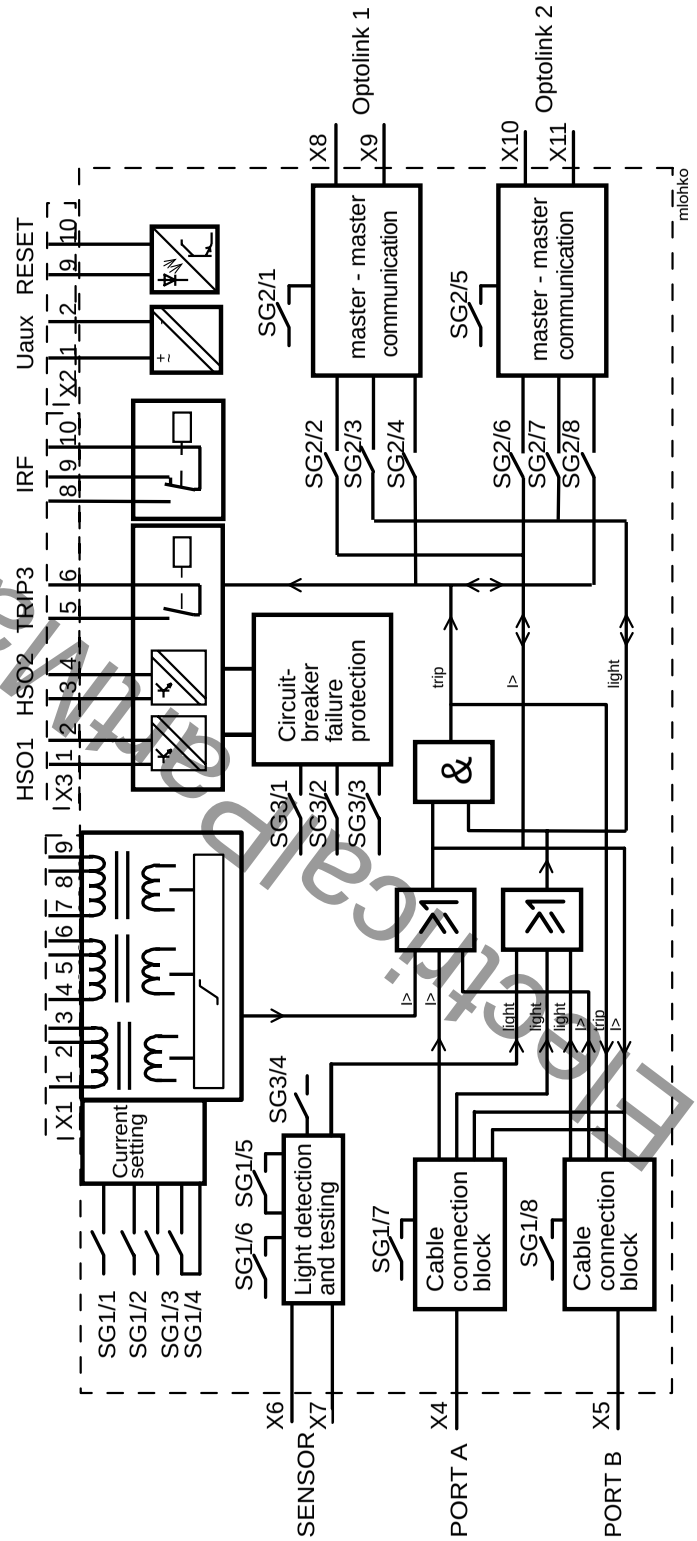

Fig. 3.-1 Block diagram of REA 101 arc protection relay

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4. Description of operation

4.1. Current indication unit

The three phase currents are measured via transformers. An overcurrent signal is activated once the current on one phase exceeds the reference level. The SG1/1...4 switches are used for selecting the reference level. 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).

4.2. Light detection unit

The switch SG1/6 is used for activating the sensor. Automatic or manual reference level is selected with the switch SG1/5.

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

When the automatic reference level has been selected, the unit forms the reference level based on the back light intensity measured by the sensor.

When the manual reference level has been selected, the unit forms the reference level based on the value selected with the potentiometer "Light Ref. Level Adj." on the front panel.

The condition of the sensor fibre is monitored by sending a test pulse through the fibre. Unless the test pulse is received at regular intervals at the other end of the loop, the LED "Sensor Fault" 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 means of the switch SG3/4. Then no test pulse will be sent and a radial, i.e. terminating, sensor fibre or lens sensor can be used.

Protect the end of the radial sensor fibre from light.

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4.3. Sensitivity

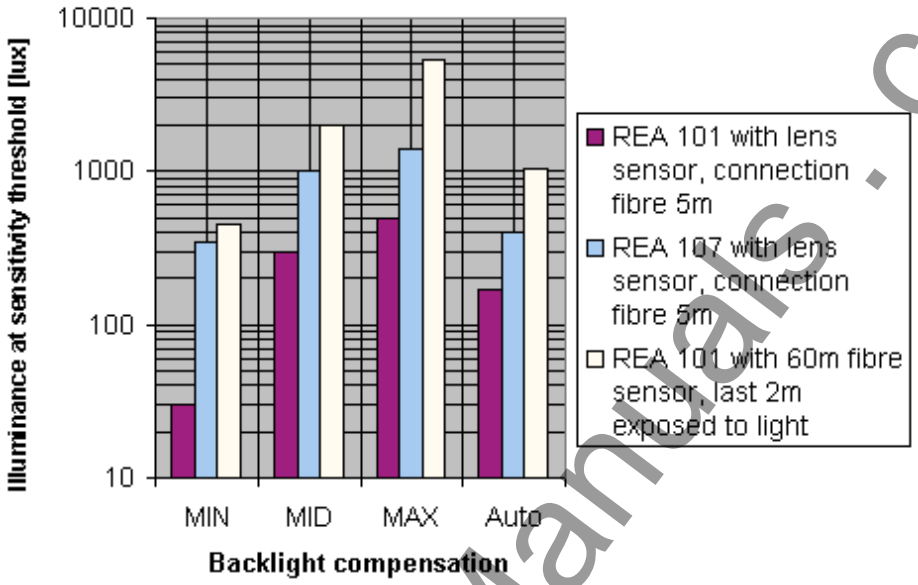

Fig. 4.3.-1 Sensivity of REA 10_ sensors at various back light compensation settings

The intensity of the arc light is tens of thousands of lux in comparison to normal office lighting which is 200-300 lux. The detecting reach of the sensors depends on many factors: light source energy, fiber length, reflectances and back light compensation settings, which makes exact formulation difficult. Detecting distances of at least 3 meters has been experienced with both sensor types when installed into MV switchgears and tested with normal camera flash lights (guide number 20 or more).

The incidence angle of the light is not relevant with fibre sensors. Relative sensitivity of the lens sensor from different angles of lightning is presented in Fig. 4.3.-2. Normal operating sector is +130°. In practical applications, light is also reflected from the compartment walls, so the detecting angle is not critical. When protecting busbar sections, recommended distance of sensors from one another is 6 meters.

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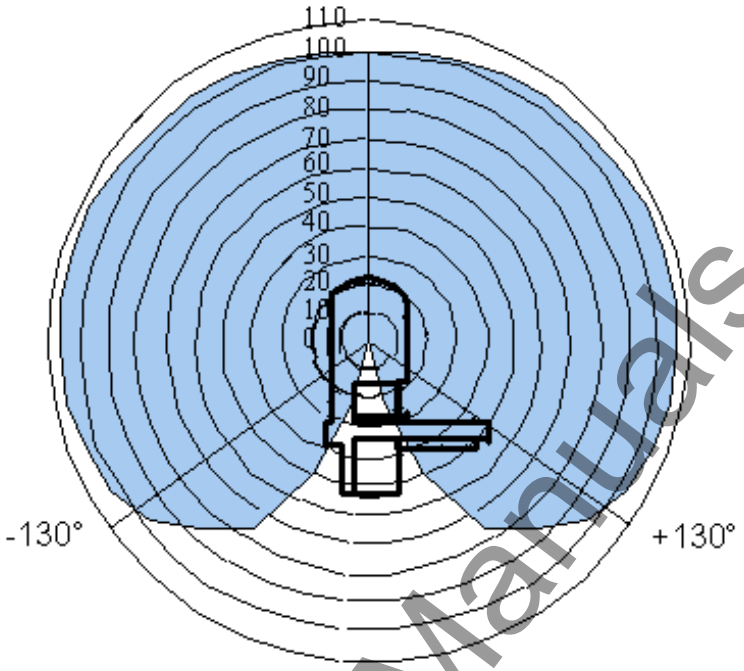

Fig. 4.3.-2 Relative sensitivity of the REA lens sensor from different angles of lighting

4.4. Trip output

The trip output is provided with two high-speed, galvanically isolated IGBT semiconductor outputs, HSO1 and HSO2, and a relay output TRIP3. These outputs can be used in DC and AC circuits.

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.

If tripping is to be activated by an arc alone, the overcurrent signal can be set to be constantly active by means of the key switch "Trip Condition" located on the front panel. When a trip signal is delivered, the trip outputs are locked in the active state. The Reset push-button on the front panel or a reset signal applied to the RESET input can be used to reset the outputs.

4.5. Ports A and B for the connection of extension units

Ports A and B are activated using the switches SG1/7-8.
The extension units connect to the ports via connection cables. The extension unit receives its operating voltages 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") of the port as well as the IRF indicator on the central unit are activated, 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, then the fault LED of the port starts flashing, the IRF indicator is lit and the IRF relay resets.

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4.6. Communication REA 101 / REA 101 (optolink)

The REA 101 relay contains two communication links: Optolink 1 and Optolink 2. The SG2/1-8 switches are used to select the links to be used and the messages to be communicated between them. Each link can be programmed either as a transmitter or as a receiver.

The purpose of the communication link is to communicate ON/OFF type messages between the central units over the signal transfer fibre. The message can be light, overcurrent or trip signals. Only one type of message per optolink is allowed to 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 fibre at regular intervals. Should the test pulse not be received at the specified time, the optolink fault LED ("Optolink 1 Fault", "Optolink 2 Fault") and the IRF indicator of the central unit will be lit, and the IRF relay resets.

4.7. Circuit-breaker failure protection (CBFP)

The circuit-breaker failure protection has been implemented by delaying either the HSO2 output or the TRIP3 output, or when required, both outputs. The switches SG3/1-3 are used for selecting the desired alternative.

If both outputs are used, it should be noted that the delay time is the same, but the pick-up time of the relay (5...15 ms) has been added to the TRIP3 relay.

The selected delay time, i.e. 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 out of use, all the trip outputs operate in parallel.

4.8. Self-supervision unit (IRF)

In addition to that mentioned above, the self-supervision unit monitors the operating voltage of the relay. Should a fault be detected in the operating voltages, the self-supervision unit will prevent the relay from operating. In addition, the IRF indicator is lit and the IRF relay resets.

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4.9. Front panel

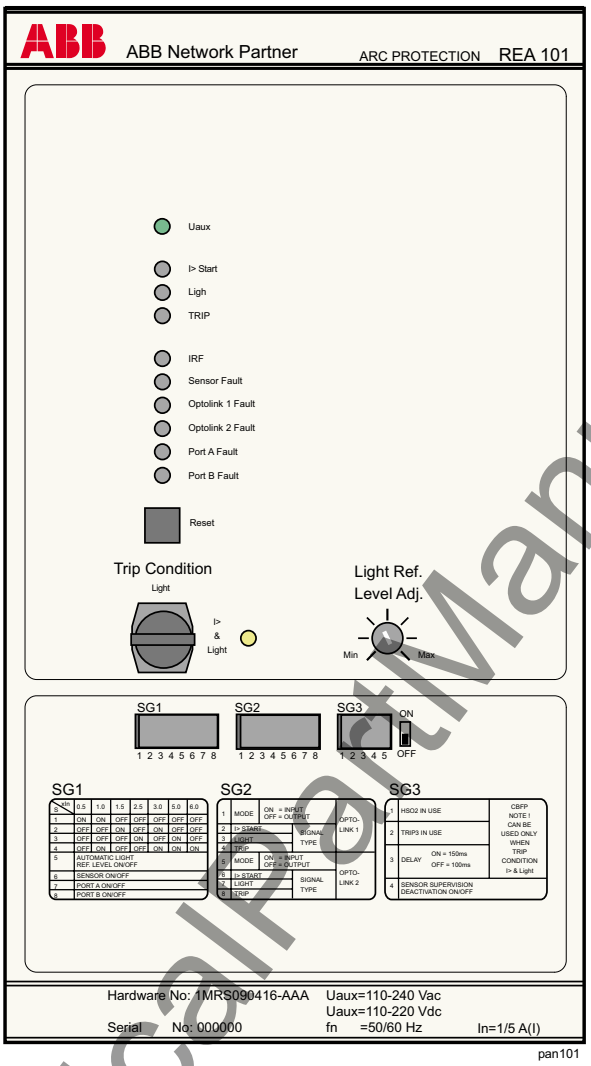

Fig. 4.9.-1 Front panel of REA 101

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4.10. Functions of LEDs and switches

Table 4.10.-1 LEDs activated

U_{aux}	The power supply to the central unit is connected.
I>Start	The overcurrent signal of the central unit is active when: - either the measured current exceeds the set current limit or - the overcurrent condition has been eliminated (Trip Condition key switch in position Light). - the overcurrent signal may also originate in another central unit and be received via an REA 105 unit or an Optolink connection.
Light	The sensor fibre of the central unit has detected light.
TRIP	The central unit has tripped.
IRF	• The self-supervision system of the central unit has detected an internal relay fault, the IRF relay has also reset. • At a fault in the operating voltage, the IRF indicator is the only fault LED that is lit and the operation of the central unit is prevented. • In other fault situations, the IRF indicator plus the other fault LEDs are active. • The IRF indicator is also lit when the IRF indicator of another extension unit is active and, in addition, the fault LED of the port is flashing.
Sensor Fault + IRF	• A breakage in the sensor fibre connected to the central unit. (The sensor fibre may still detect light between the sensor input and the breakage.) • The transmitter or receiver is defective.
Optolink 1 Fault + IRF	A fault in the signal transfer fibre connected to the Input port of Optolink 1. An optolink fault does not prevent the operation of the central unit.
Optolink 2 Fault + IRF	A fault in the signal transfer fibre connected to the Input port of Optolink 2. An optolink fault does not prevent the operation of the central unit.
Port A Fault + IRF	• Steady light, when there is a fault in port A or in the connection cable (bus) connected to it. A fault in the port does not prevent the operation of the central unit. • Flashes, if there is a fault in the extension unit connected to the port A. (IRF light steady.)
Port B Fault + IRF	The same operation as for port A.

Reset push-button:

- Resetting of LED indicators of the central unit and the extension units connected to the central unit, semi-conductor outputs and output relays; operation in parallel with binary input (RESET X2/9-10).

Trip Condition key switch with I> & Light LED:

- Key switch in position I> & Light and I> & Light LED lit (normal operation). Overcurrent condition level selected with SG1/1-4 switches in use, i.e. both overcurrent and light required for tripping.
- Key switch in position Light (I>Start LED active), overcurrent condition not in use (for example, during servicing), i.e. light alone is required for tripping.

The Trip Condition key switch must always be in an extreme position.

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Light Ref. Level Adj.:

Potentiometer for manual back light compensation:

- Switch SG1/5 in OFF position = Light Ref. Level Adj. potentiometer in use.

Switchgroup SG1:

- Switch 1 in ON position: current limit 0.5 x In (switches 2, 3 and 4 in OFF position)
- Switch 2 in ON position: current limit 1.5 x In (switches 1, 3 and 4 in OFF position)
- Switch 3 in ON position: current limit 2.5 x In (switches 1, 2 and 4 in OFF position)
- Switch 4 in ON position, with only one of the switches 1- 3 in ON position: doubles the selected current limit
  Switch 4 in ON position, with the switches 1...3 in OFF position:
  current limit 6.0 x In

Only one of the switches 1...3 is allowed to be in position ON

- Switch 5 (Automatic light ref. level ON/OFF)
  Switch in ON position: automatic back light compensation selected (potentiometer Light Ref. Level Adj. not in use).
  Switch in OFF position: manual back light compensation selected (potentiometer Light Ref. Level Adj. in use).
- Switch 6 (Sensor ON/OFF)
  Switch in ON position: the sensor fibre of the central unit is used for arc detection
- Switch 7 (Port A ON/OFF)
  Switch in ON position: Port A in use.
- Switch 8 (Port B ON/OFF)
  Switch in ON position: Port B in use.

Switchgroup SG2, Optolink communication:

Optolink 1, switches 1...4:

- Switch 1 (Mode ON=Input, OFF=Output)
  Switch in ON position: the Optolink 1 Input port operates as signal input
  Switch in OFF position: the Optolink 1 Output port operates as signal output
- Switch 2 (I>Start)
  Switch in ON position: the overcurrent signal is either received or transmitted, depending on the setting of switch 1
  Switch in OFF position: no overcurrent signal is transmitted or received
- Switch 3 (Light)
  Switch in ON position: the light signal is either received or transmitted, depending on the setting of switch 1
  Switch in OFF position: no light signal is transmitted / received
- Switch 4 (Trip)
  Switch in ON position: the trip signal is either received or transmitted, depending

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on the setting of switch 1
Switch in OFF position: no trip signal is transmitted / received

Only one of the switches 2...4 is allowed to be in position ON

Optolink 2, switches 5...8:

- Switch 5 (Mode ON=Input, OFF=Output)
  Switch in ON position: the Optolink 2 Input port operates as signal input
  Switch in OFF position: the Optolink 2 Output port operates as signal output
- Switch 6 (I>Start)
  Switch in ON position: the overcurrent signal is either received or transmitted, depending on the setting of switch 5
  Switch in OFF position: no overcurrent signal is transmitted/received
- Switch 7 (Light)
  Switch in ON position: the light signal is either received or transmitted, depending on the setting of switch 5
  Switch in OFF position: no light signal is transmitted/received
- Switch 8 (Trip)
  Switch in ON position: the trip signal is either received or transmitted, depending on the setting of switch 5
  Switch in OFF position: no trip signal is transmitted/received

Only one of the switches 6...8 is allowed to be in position ON

Switchgroup SG3, circuit-breaker failure protection (CBFP), switches 1-3:

When the circuit-breaker failure protection is in use, in a trip situation:

- no delayed tripping occurs, if the overcurrent signal disappears during the set delay time
- delayed tripping always occurs when the overcurrent condition is not in use (Trip Condition key switch in position Light, I>Start LED active)

- Switch 1 (HSO2 in use):
  Switch in ON position: circuit-breaker failure protection is in use. HSO2 operates once the time specified by switch 3 elapses provided the overcurrent signal is still active. The time starts running when HSO1 operates.
- Switch in OFF position: circuit-breaker failure protection is not in use and HSO2 operates at the same time as HSO1
- Switch 2 (Trip3 in use):
  Switch in ON position: circuit-breaker failure protection is in use. Trip3 operates once the time specified by switch 3 elapses provided the overcurrent signal is still active. The time starts running when HSO1 operates.
  Switch in OFF position: the circuit-breaker failure protection is not in use and Trip3 operates at the same time as HSO1 (+output relay pick-up time).
- Switch 3 (Delay ON=150 ms, OFF=100 ms):
  This switch has a function only when the circuit-breaker failure protection is in use.

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- Switch in position ON: the output selected with switch 1 and/or 2 operates 150 ms after the operation of HSO1, provided the overcurrent signal is still active.
  Switch in position OFF: the output selected with switch 1 and/or 2 operates 100 ms after the operation of HSO1, provided the overcurrent signal is still active.
- Switch 4 (Sensor supervision deactivation ON/OFF):
  Switch in ON position: sensor fibre condition monitoring is not in use, i.e. a radial sensor fibre can be used.
  Switch in OFF position: sensor fibre condition monitoring is in use.
  A sensor fibre loop can be used.
- Switch 5 has no function.

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5. Connections

5.1. Connector X1

Current transformer connections:

1. I_{L1} Common
2. $I_{L1\ 5A}$ In = 5 A
3. $I_{L1\ 1A}$ In = 1 A
4. I_{L2} Common
5. $I_{L2\ 5A}$ In = 5 A
6. $I_{L2\ 1A}$ In = 1 A
7. I_{L3} Common
8. $I_{L3\ 5A}$ In = 5 A
9. $I_{L3\ 1A}$ In = 1 A

5.2. Connector X2

Auxiliary voltage and RESET terminal:

1. U_{aux} +(~) Auxiliary voltage +(~)
2. U_{aux} -(~) Auxiliary voltage -(~)
3. Not in use
4. Not in use
5. Not in use
6. Not in use
7. Not in use
8. Not in use
9. RESET +(~) Reset input: indications, outputs
10. RESET -(~) Reset input: indications, outputs

5.3. Connector X3

I/O terminal:

1. HSO1 +(~) Heavy-duty high-speed semi-conductor output 1
2. HSO1 -(~) Heavy-duty high-speed semi-conductor output 1
3. HSO2 +(~) Heavy-duty high-speed semi-conductor output 2
4. HSO2 -(~) Heavy-duty high-speed semi-conductor output 2
5. TRIP3 +(~) Heavy-duty relay output
6. TRIP3 -(~) Heavy-duty relay output
7. Not in use
8. IRF/NO Self-supervision alarm relay/normal open contact
9. IRF/NC Self-supervision alarm relay/normal closed contact
10. IRF common Self-supervision alarm relay/common contact

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5.4. Connectors X4 and X5

Extension unit connection ports:

X4	PORT A
X5	PORT B

5.5. Connectors X6 and X7

Sensor fibre connectors:

X6	Output
X7	Input

5.6. Connectors X8 and X9

Signal transfer fibre connectors of OPTOLINK 1:

X8	Output
X9	Input

5.7. Connectors X10 and X11

Signal transfer fibre connectors of OPTOLINK 2:

X10	Output
X11	Input

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6. Rear panel

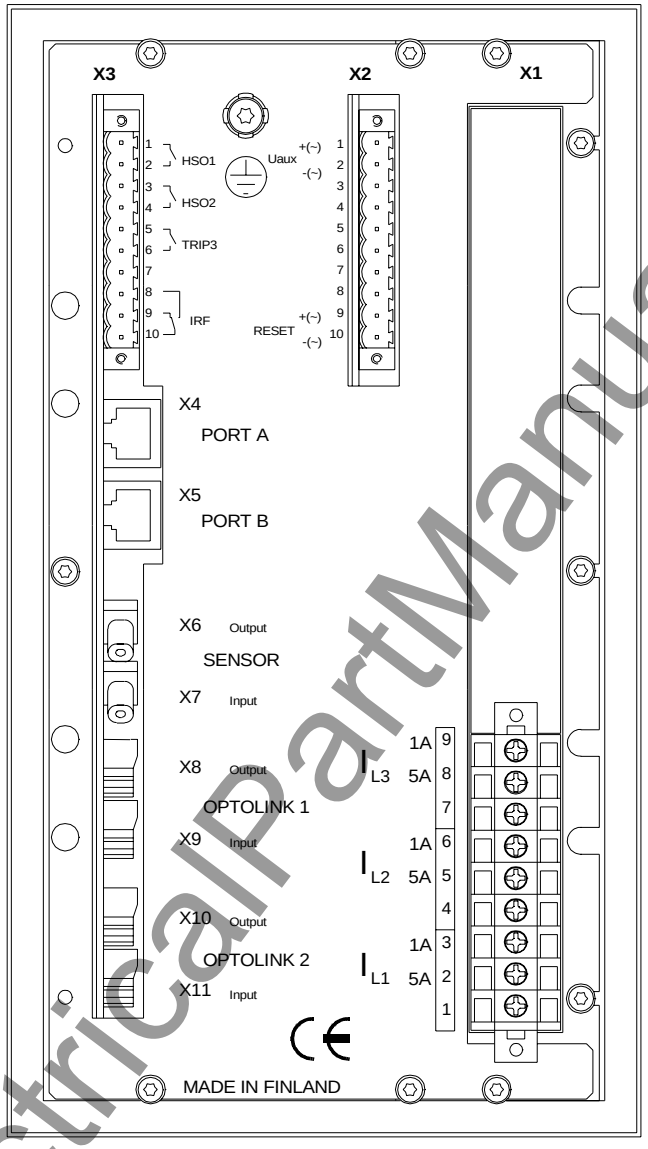

Fig. 6.-1 Terminals on the rear of REA 101

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7. Commissioning

7.1. Checkings and settings

Follow the procedure below when commissioning the relay.

All the checks and switch settings have to made before the auxiliary voltage supply is connected.

1. Auxiliary voltage:
   Check the supply voltage range (U_{aux}) of the supply unit. The voltage range is marked on the bottom marking strip on the front of the arc protection relay. See also section "Technical data".
2. Control voltage of the input "RESET":
   Check the voltage range of the reset input if the input is to be used for resetting. The rated voltages and voltage ranges are specified in section "Technical data".
3. Programming switchgroups SG1, SG2 and SG3:
   The default settings of the switchgroups are:

SG1	SG2	SG3
00000000	00000000	00000

4. Set the switches of the programming switchgroups SG1, SG2 and SG3 as required by the specific application. See sections "Function of LEDs and switches" and "Application examples".
5. Potentiometer "Light Ref.Level Adj.":
   As a default the potentiometer is in the middle position. If automatic back light compensation has been selected (switch SG1/5 in pos. ON), the setting of the potentiometer does not have to be changed.
6. Key switch "Trip Condition"
   The default setting of the key switch is I>&Light.

7.2. Testing the arc protection system

1. Check the current measurement function by measuring the primary or secondary circuit. When the current limit is exceeded, the I>Start LED of the concerned REA 101 relay is lit. Each REA 101 relay is submitted to this measurement.
2. Turn the "Trip Condition" key switch into position Light to check that overcurrent data is transmitted through the entire system arrangement, as required by the application.
3. Check that the LED I>Start of the concerned REA 101 units is lit.
4. Finally, turn the "Trip Condition" key switch into position I>&Light.

Check each REA 101 relay included in the application in the same way.

7.3. Light reference setting

1. Set the lighting level as close to normal work conditions as possible.
2. Turn the "Light Ref. Level Adj." potentiometer until the Light LED is lit or goes out.
3. Then turn the potentiometer one scale mark interval to the right.

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4. Should the Light LED remain dark, even though the potentiometer is in the Min. position, the potentiometer can be left in this position, or turned one scale mark interval to the right, depending on the sensitivity level desired.
5. Turn the "Trip Condition" key switch of one REA 101 relay into position Light.
6. Expose one sensor at a time to light, for example using a flash light, and check that the right circuit breakers operate.
7. When all of the sensors have been tested, set the "Trip Condition" key switch/ key switches as required by the application.

The Trip Condition key switch muast always be in an extreme position.

The flash duration should be ≥ 0.5 ms. Integrated flashes of pocket cameras are normally not powerful enough. Use of separate flash units (with fresh batteries), guide nr 20 or more, is recommended.

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8. Dimension drawings

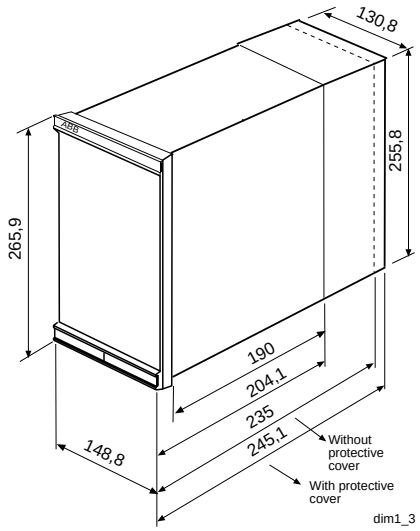

Fig. 8.-1 Dimensions

8.1. Mounting alternatives

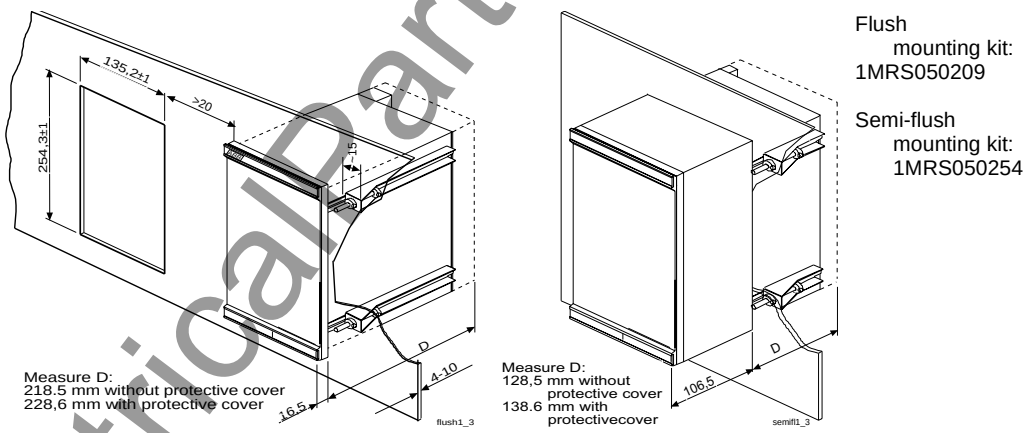

Fig. 8.1.-1 Flush mounting and semi-flush mounting

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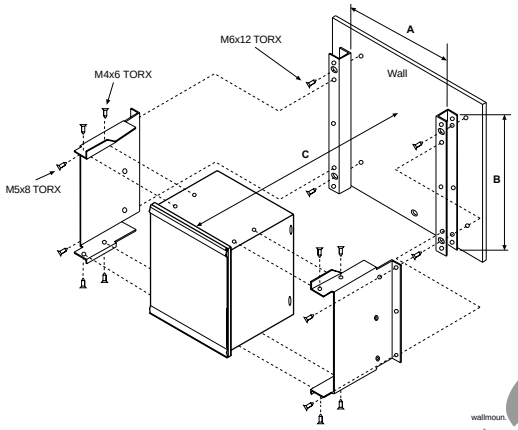
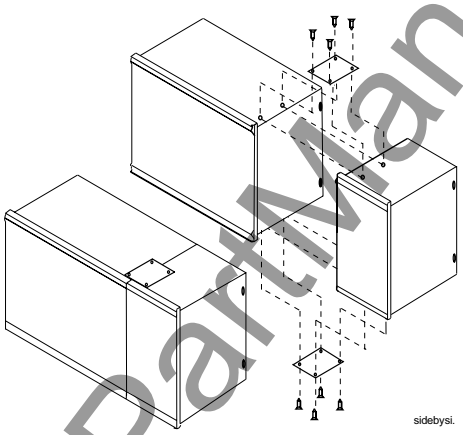


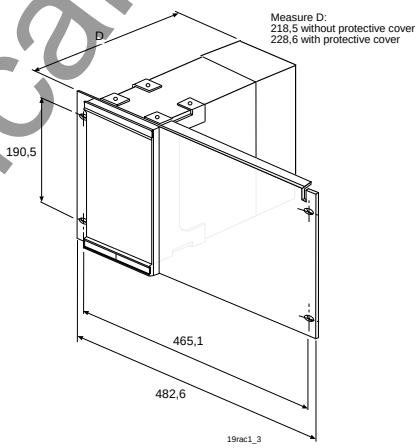
Surface mounting kit:
1MRS050240

Fig. 8.1.-2 Surface mounting



Mounting kit:
1MRS050241

Fig. 8.1.-3 Connecting cases together



19" Mounting kit:
1MRS050258

Fig. 8.1.-4 19" Rack mounting/single unit

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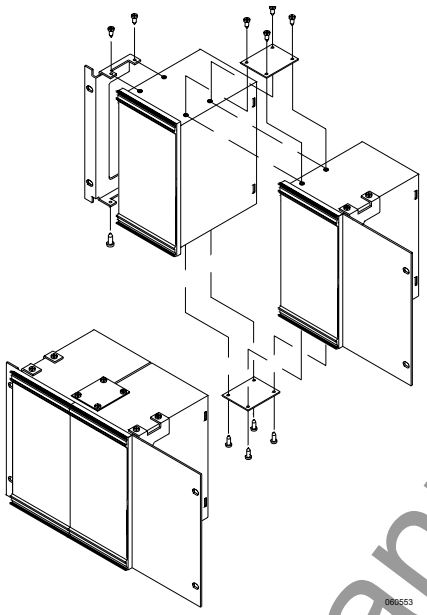

19" Mounting kits:
1MRS050241
1MRS050377

Fig. 8.1.-5 19" Rack mounting/two units

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9. Application examples

9.1. Remember when constructing applications

- Do not change connections or set any switches when the supply voltage is connected to the units.
- Condition monitoring of a radial sensor fibre is not possible. When commissioning a radial sensor fibre, remember to set the SG3/4 switch in position ON.
- Check the switches of the ports, when adding or removing extension units. Remember that the maximum number of extension units to be linked to one port is five, i.e. ten extension units at the maximum can be connected to one REA 101 relay. Check that the terminal resistor of the last extension unit of either port is switched in the ON position (SG1/1).
- When the circuit-breaker failure protection is used, it should be noted that the delay of the circuit-breaker failure protection is controlled by the overcurrent signal. Should the first trip be successful and the overcurrent disappear before the delay time runs out, no delayed tripping will occur. If the overcurrent situation lasts throughout the delay time, a delayed trip signal will be delivered. The "Trip Condition" key switch can be used to activate an overcurrent signal. Then the delayed trip function always operates in a trip situation, provided the circuit-breaker failure protection is in use.
- Overcurrent information between two REA 101 central units has to be transmitted either over OPTOLINK connections and the signal transfer fibre, or over the connection cable of the extension units and the REA 105 unit, but not via both at the same time.
- When the central unit REA 101 performs tripping, it simultaneously delivers a trip command to the REA 105 extension units connected to it.

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9.2. Examples

Switch settings of the examples: 0 = OFF and 1 = ON.

Example 1:

Arc protection implemented using the arc protection relay REA 101. The arc sensor loop of the relay passes through all the spaces to be protected. Tripping requires a light signal generated by an arc and an overcurrent signal caused by a fault current. Current is measured three-phase as 5 A or 1 A secondary current. When an arc occurs, the Q2 circuit breaker is operated via the semiconductor output HSO1. In alternative 2, the semi-conductor output HSO2 is used as a circuit-breaker failure protection output. Should, for some reason, the feeder circuit breaker Q2 be unable to break the fault current in 100 ms after the trip operation, then the circuit breaker Q1 on the transformer primary side is opened via output HSO2.

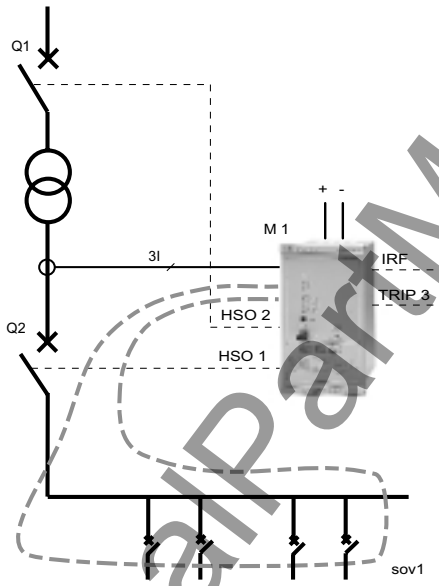

Fig. 9.2.-1 Example 1

Settings of central unit M1:

- alternative 1:

SG1 = 1001 0100 SG2 = 0000 0000 SG3 = 00000

HSO2 is not used as CBFP, i.e. HSO2 operates at the same time as HSO1.

- alternative 2:

SG1 = 1001 0100 SG2 = 0000 0000 SG3 = 10000

HSO2 is used as CBFP, time delay 100 ms.

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Example 2:

This application is similar to that of the example 1, with the exception that the terminal end of the arc sensor fibre has not been brought back to the arc protection relay. However, the loop arrangement, where both ends of the sensor fibre are connected to the relay, is preferred, because this radial arrangement does not allow monitoring of the sensor fibre. The condition monitoring feature has to be deactivated (switch SG3/4).

A radial sensor fibre is always connected to terminal X7 (Sensor Input)

The free sensor fibre end is much more sensitive to light than the side of the fiber and has to be protected with a plug to prevent light from penetrating.

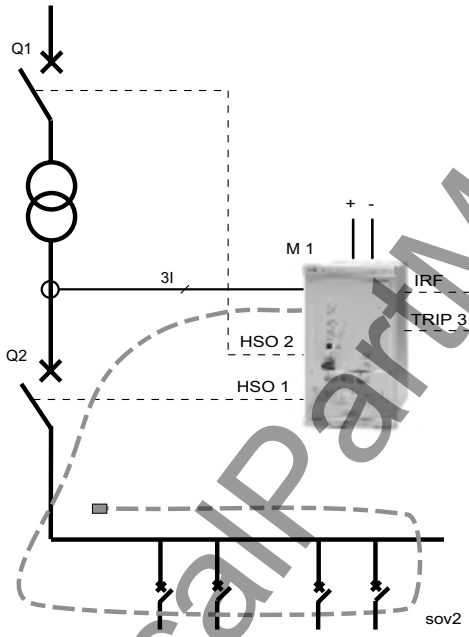

Fig. 9.2.-2 Example 2

Settings of central unit M1:

- alternative 1:

SG1 = 1001 0100 SG2 = 0000 0000 SG3 = 00010

HSO2 is not used as CBFP, i.e. HSO2 operates at the same time as HSO1.

- alternative 2:

SG1 = 1001 0100 SG2 = 0000 0000 SG3 = 10010

HSO2 is used as CBFP, time delay 100 ms

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Example 3:

In this example, the number of arc sensor loops has been increased to five by adding two REA 103 extension units, which have been linked to the chain connected to port A via connection cables.

Tripping is activated in the same way as in the examples 1 and 2. Information about the loop that detected the arc is obtained via the alarm relay outputs Light1 and Light2 of the REA 103 extension units. As the extension unit S2 is the last one in the chain connected to port A, the connection cable has to be terminated here by connecting the terminators (programming switch SG1/1 = ON).

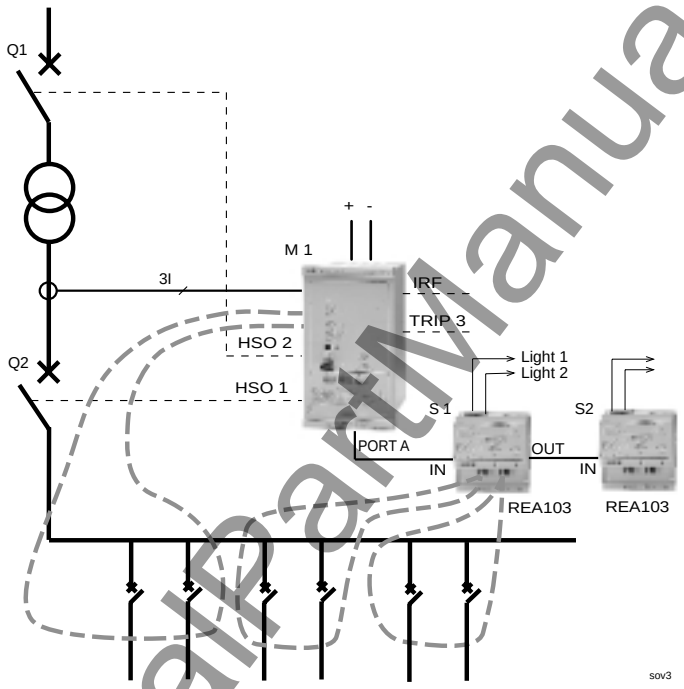

Fig. 9.2.-3 Example 3

Settings of central unit M1:

- alternative 1:

SG1 = 1001 0110 SG2 = 0000 0000 SG3 = 00000

HSO2 is not used as CBFP, i.e. HSO2 operates at the same time as HSO1.

- alternative 2:

SG1 = 1001 0110 SG2 = 0000 0000 SG3 = 10100

HSO2 is used as CBFP, time delay 150 ms

Settings of extension unit S1: SG1 = 01110

Settings of extension unit S2: SG1 = 11110

The extension unit S2 is the last one in the chain, which means that the connection cable has to be terminated here (SG1/1=ON).

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Example 4:

In this application, the CB compartments of outgoing feeders and cable terminations are protected by the sensors of the REA 107. The busbar is protected by the sensor loop of the REA 101. After tripping, the Light LED of the REA 101 or the REA 107 indicates where the fault has occured.

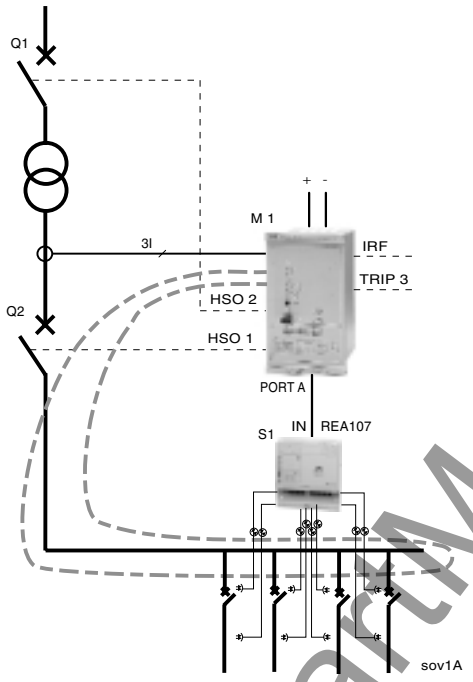

Fig. 9.2.-4 Example 4

Settings of the central unit M1:

• alternative 1:

SG1 = 1001 0110 SG2 = 0000 0000 SG3 = 00000

HSO2 is not used as CBFP, i.e. HSO2 operates at the same time as HSO1.

• alternative 2:

SG1 = 1001 0110 SG2 = 0000 0000 SG3 = 10000

HSO2 is used as CBFP, time delay 100 ms.

Settings of the extension unit S1:

SG1 = 1011 1111

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Example 5:

In this application, the CB compartments of outgoing feeders, cable terminations and bus bar compartment are protected by the lens sensors of the REA 107.

The incoming CB is protected by the lens sensor of the REA 101. After tripping, the Light LED of the REA 101 or the REA 107 indicates where the fault has occured.

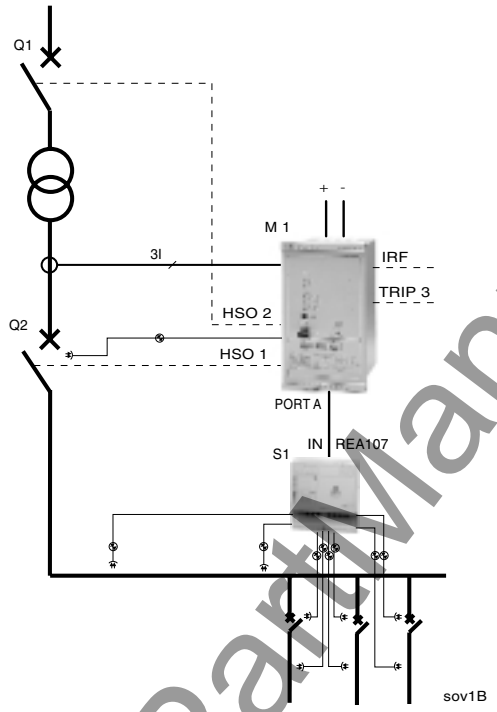

Fig. 9.2.-5 Example 5

Settings of the central unit M1:

SG1 = 1001 0110 SG2 = 0000 0000 SG3 = 00010

HSO2 is not used as CBFP, i.e. HSO2 operates at the same time as HSO1.

Settings of the extension unit S1:

SG1 = 1011 1111

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Example 6:

In this example, two REA 105 extension units with trip outputs are connected to port A of the central unit. Should an arc occur, e.g., in the area monitored by the extension unit S3, the circuit breaker Q3 is the only one to be opened. Thus selective tripping is obtained, and the healthy part of the system remains live. If the circuit-breaker failure protection (CBFP) of the REA 105 extension unit is in use, and the opening of circuit breakers Q3 or Q4 does not eliminate the fault current during the time delay (150 ms), the central unit REA 101 will open the circuit breaker Q2. Correspondingly, if the circuit-breaker failure protection of the central unit is also in use, and the fault current does not disappear during the time delay following the opening of the circuit breaker Q2, the central unit will open the circuit breaker Q1.

When the central unit REA 101 performs a tripping, it simultaneously delivers a trip command to the REA 105 extension units connected to it.

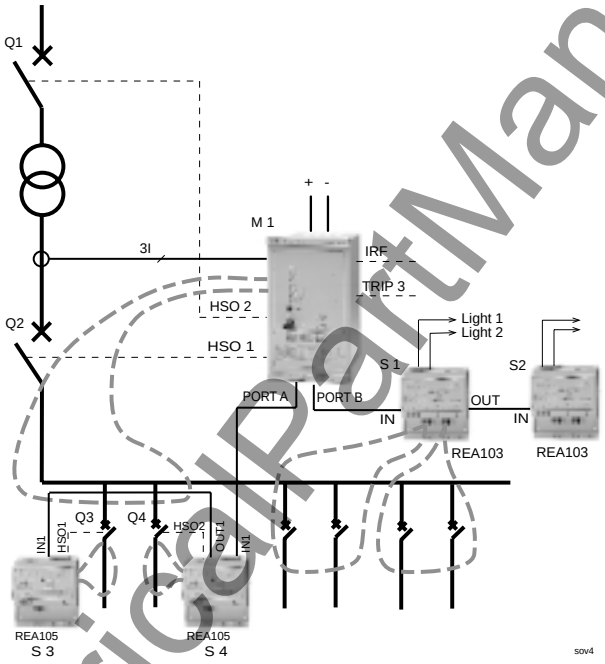

Fig. 9.2.-6 Example 6

Settings of central unit M1:

- alternative 1:

SG1 = 1001 0111 SG2 = 0000 0000 SG3 = 00000

HSO2 is not used as CBFP, i.e. HSO2 operates at the same time as HSO1.

- alternative 2:

SG1 = 1001 0111 SG2 = 0000 0000 SG3 = 10100

HSO2 is used as CBFP, time delay 150 ms.

Settings of extension unit S1: SG1 = 01110

Settings of extension unit S2: SG1 = 11110

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Settings of extension unit S3: CBFP not in use: SG1 = 1011 0000

Settings of extension unit S4: CBFP not in use: SG1 = 0011 0000

Circuit-breaker failure protection, with 150 ms delay, used in extension units S3 and S4

S3: SG1 = 1011 0110
S4: SG1 = 0011 0110

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Example 7:

Regarding operation, this application is similar to the application in the example 6. The only difference between these applications is the devices used.

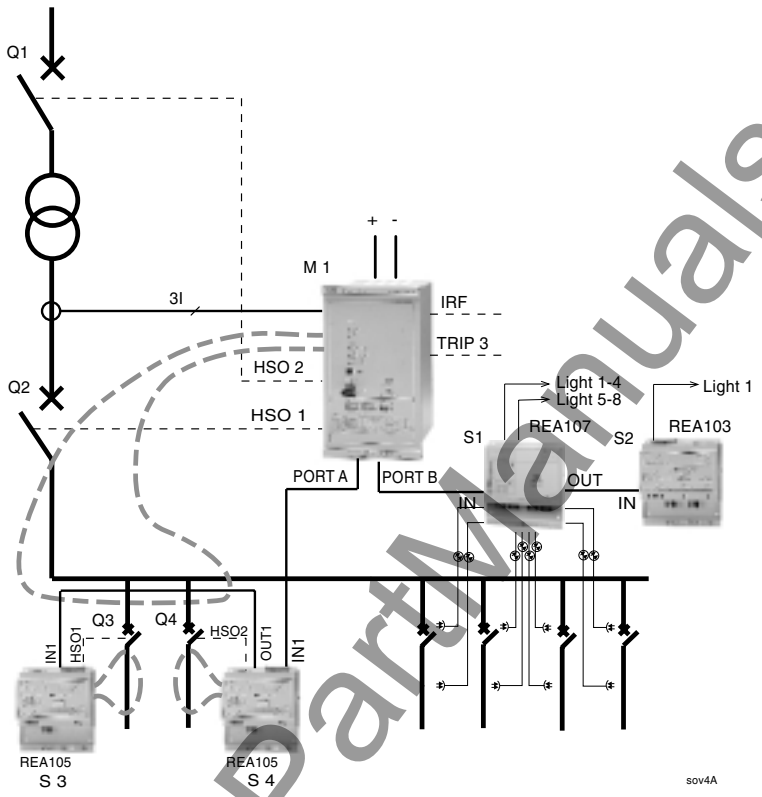

Fig. 9.2.-7 Example 7

Settings of central unit M1:

- alternative 1:

SG1 = 1001 0110 SG2 = 0000 0000 SG3 = 00010

HSO2 is not used as CBFP, i.e. HSO2 operates at the same time as HSO1.

- alternative 2:

SG1 = 1001 0110 SG2 = 0000 0000 SG3 = 10110

HSO2 is used as CBFP, time delay 150 ms.

Settings of the extension unit S1:

SG1 = 0011 1111

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Example 8:

Substation with two power transformers, equipped with a bus coupler. Since the fault current can arrive from two supply directions, two REA 101 central units, one for each direction, are required. The arc sensor loops of the central units have been arranged so that the bus coupler Q5 separates the areas to be protected. When an arc occurs, the concerned central unit trips its own infeeder circuit breaker and the bus coupler, the healthy part of the switchgear remaining connected. The central units send on/off overcurrent information to each other over the signal transfer fibre connection. In this case, it is enough for the protection relay to operate if one of the units detects overcurrent, even in a situation where one transformer is out of service and the other transformer feeds the whole switchgear over the bus coupler. The extension units REA 105 perform selective tripping in situations where the arc fault is located behind the concerned circuit breakers.

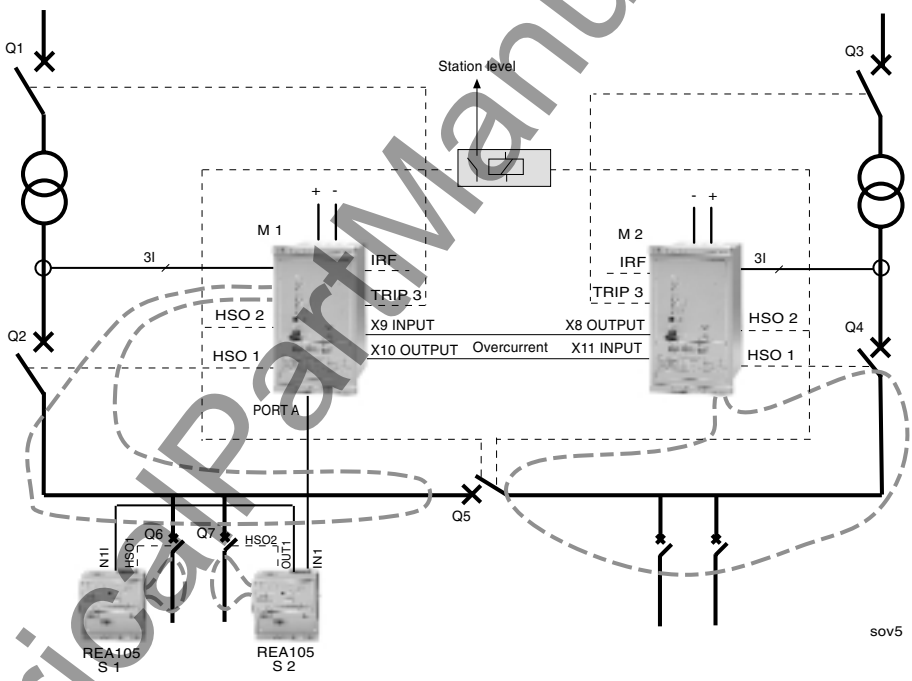

Fig. 9.2.-8 Example 8

Settings of central unit M1:

SG1 = 1001 1110 SG2 = 1100 0100 SG3 = 01100

Settings of central unit M2:

SG1 = 1001 1100 SG2 = 0100 1100 SG3 = 01100

Settings of extension units S1 and S2: CBFP not in use

S1: SG1 = 1011 0000

S2: SG1 = 0011 0000

Circuit-breaker failure protection with 150 ms delay used in extension units S1 and S2:

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S1: SG1 = 1011 0110

S2: SG1 = 0011 0110

If the circuit-breaker failure protection of the infeeder circuit breakers is out of use, the TRIP3 can be used to provide information for the substation level. Then no intermediate relay is needed.

Settings of central unit M1, when TRIP3 provides information to the substation level:

SG1 = 1001 1110 SG2 = 1100 0100 SG3 = 00000

Settings of central unit M2, when TRIP3 provides information to the substation level:

SG1 = 1001 1100 SG2 = 0100 1100 SG3 = 00000

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Example 9:

Functionally, this application corresponds to that described in the example 5. The difference is that the overcurrent signals between the central units are transmitted via the connection cable of the extension units. An REA 105 unit (not REA 103) has to be used in the connection point between the coverage areas of the central units. This REA 105 unit can normally be used as a part of the system that ends in a central unit in the direction of the terminal IN1. Since the links from both directions end in extension unit S3, the terminators of the ports IN1 and IN2 have to be connected (SG1/1, 2 = ON).

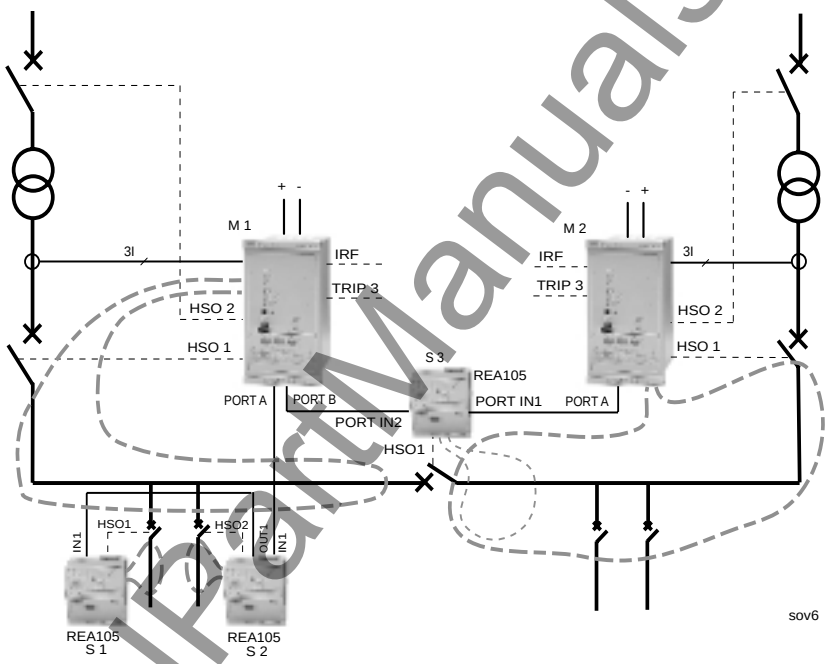

Fig. 9.2.-9 Example 9

Settings of central unit M1:

SG1 = 1001 1111 SG2 = 0000 0000 SG3 = 10100

Settings of central unit M2:

SG1 = 1001 1110 SG2 = 0000 0000 SG3 = 10100

Settings of extension units S1 and S2: CBFP not in use

S1: SG1 = 1011 0000
S2: SG1 = 0011 0000

Settings of extension units S1 and S2: CBFP with 150 ms delay in use

S1: SG1 = 1011 0110
S2: SG1 = 0011 0110

Settings of extension unit S3:

SG1 = 1111 1000

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Example 10:

Substation with three power transformers. Each infeeder has its own central unit measuring fault current. Overcurrent data is transmitted to each extension unit over the connection cable of the units. Once the central unit M1 or the extension unit S1 detects an arc, the circuit breakers Q2 and Q3 are opened. When the central unit M2 or the extension unit S3 detects a fault, the circuit breakers Q3, Q5 and Q6 are opened. Correspondingly, when the M3 or the S2 unit detects an arc, the circuit breakers Q6 and Q8 will be opened. This arrangement allows just the faulty part of the switchgear to be disconnected. The extension units S1 and S2 are located in the section where the protection areas are separated so the connection cables from both directions have to be terminated (SG1/1, 2 = ON). The trip signal of the circuit-breaker failure protection of the three central units is linked to the transformer primary circuit breakers (Q1, Q4 and Q7), with a delay of 150 ms.

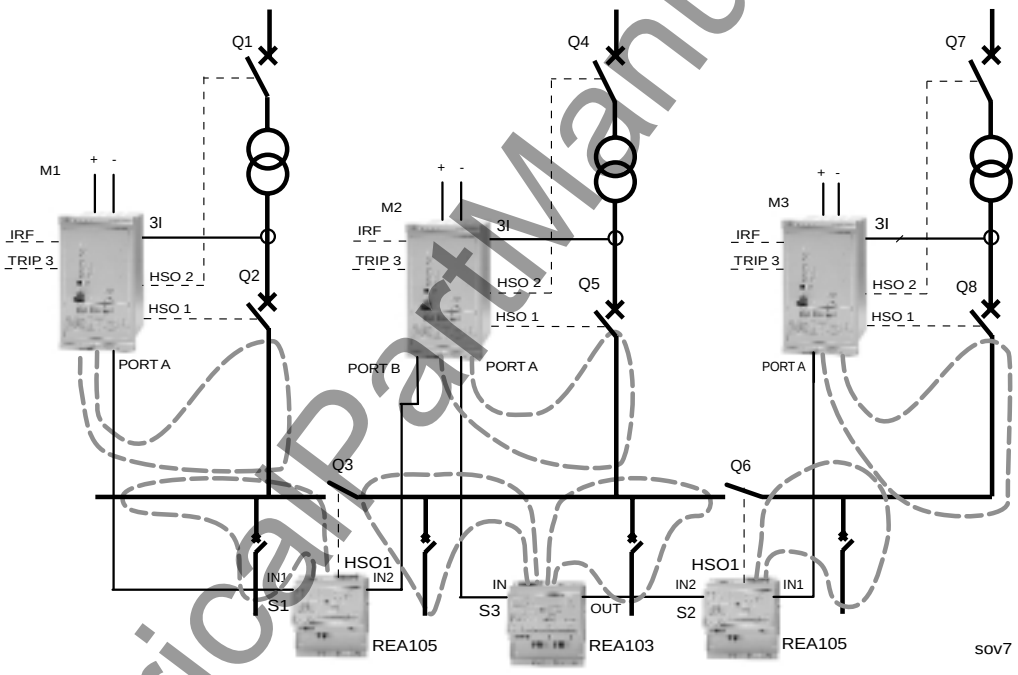

Fig. 9.2.-10 Example 10

Settings of central unit M1:

SG1 = 1001 1110SG2 = 0000 0000SG3 = 10100

Settings of central unit M2:

SG1 = 1001 1111SG2 = 0000 0000SG3 = 10100

Settings of central unit M3:

SG1 = 1001 1110SG2 = 0000 0000SG3 = 10100

Settings of extension units S1 and S2:

SG1 = 1101 1000

Settings of extension unit S3:

SG1 = 00110

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10. Technical data

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
Outputs	
Trip contacts HSO1 and HSO2: Maximum system 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: Maximum system 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: Maximum system 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
Control input	
Reset input RESET	
Control voltages: Rated voltages and operating ranges	U_n = 24/48/60/110/ 220 V dc 18...265 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	>0.6 s
Circuit-breaker failure protection CBFP	
Selectable operate time delays Operate time accuracy	150 ms / 100 ms
- HSO2	±5% of setting value
-TRIP3	±5% of setting value +5...15 ms
Power supply	
Relay types 1MRS090416-AAA, 1MRS090416-AAAG:	U_n = 110/120/220/ 240 V ac

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	85...110% U_n ac U_n = 110/125/220 V dc 80...120% U_n dc
Relay type 1MRS090416-CAA, 1MRS090416-AAAG:	U_n = 24/48/60 V dc 80...120% U_n dc
Power consumption	
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
Sensor fibre	
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
Connection cable	
Maximum length [1)]	40 m
Optolink communication	
Max. length of signkkkkkkkkkal transfer fibre	
• plastic	40 m
• glass	2000 m
Setting range	
Current setting steps In x	0.5, 1.0, 1.5, 2.5, 3.0, 5.0, 6.0
Operation accuracy	± 5% of the setting value
Total operate times	
HSO1 and HSO2	≤2.5 ms
TRIP3	<15 ms
Environmental tests	
Specified service temperature range	-10...+55°C
Transport and storage temperature range	-40...+70°C
Operation in dry heat conditions	Acc. to IEC 60068-2-2 (BS 2011:Part 2.1 B)
Operation in dry cold conditions	Acc. to IEC 60068-2-1 (BS 2011:Part 2.1 A)
Damp heat test cyclic	Acc. to IEC 60068-2-30 (BS 2011:Part 2.1 Db) r.h. >95%, t = 20...55°C
Storage temperature test	Acc. to IEC 60068-2-48
Enclosure	
Degree of protection, IEC 60529	IP 20
Weight	~ 4.6 kg
Insulation tests	
Dielectric tests acc. to IEC 60255-5	2 kV, 50 Hz, 1 min.
Impulse voltage test acc. to IEC 60255-5	5 kV, 1.2/50 µs, 0.5 J
Insulation resistance acc. to IEC 60255-5	>100 MΩ, 500 Vdc
Electromagnetic compatibility	
1 MHz burst disturbance test	

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acc. to IEC 60255-22-1, class III:	
- common mode	2.5 kV
- differential mode	1 kV
Electrostatic discharge test	
acc. to IEC 61000-4-2, class III:	
- contact discharge	6 kV
- air discharge	8 kV
Radio-frequency electromagnetic field	
disturbance test acc. to IEC 61000-4-3	
- frequency f	80...1000 MHz
- field strength E	10 V/m (rms)
Radio frequency disturbance test (conducted,	
common mode) acc. to IEC 61000-4-6	10 V, 150 kHz...80 MHz
Fast transient disturbance tests acc. to	
IEC 60255-22-4 and IEC 61000-4-4	4 kV
Surge immunity test acc. to IEC 61000-4-5:	
Aux. voltage input, current inputs, trip outputs:	
- common mode	4 kV
- differential mode	2 kV
Signal contacts (IRF), RESET input:	
- common mode	2 kV
- differential mode	1 kV
Electromagnetic emission tests acc. to EN 55011 and EN 50081-2	
- conducted RF emission (mains terminal)	EN 55011, class A
- radiated RF emission	EN 55011, class A
CE approval	
Complies with the EMC directive 89/336/EEC and	
the LV directive 73/23/EEC	
Mechanical tests	
Vibration tests (sinusoidal) acc. to IEC 6255-21-1	class 1
Shock and bump test acc. to IEC 6255-21-2	class 1
Seismic tests acc. to IEC 60255-21-3	class 2

[1] Total length of the connection chain between the central unit and extension units

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11. Order information

Order numbers

Arc protection relay REA 101 U_n = 110…240 V ac U_n = 110…220 V dc	1MRS 090416-AAA *)
Arc protection relay REA 101 U_n = 24…60 V dc	1MRS 090416-CAA *)
Arc protection relay REA 101 with optolink connectors for glass fibre U_n = 110…240 V ac U_n = 110…220 V dc	1MRS 090416-AAAG *)
Arc protection relay REA 101 with optolink connectors for glass fibre U_n = 24…60 V dc	1MRS 090416-CAAG *)
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	1MRS 090417-AA
Extension unit REA 105	1MRS 090418-AA
Extension unit REA 107	REA 107-AA

*) Includes mounting kit 1MRS 050209 for flush mounting

Pre-manufactured fibre 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

Accessories for manufacturing fibre sensors

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

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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 extension units to each another

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 fibre 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

Glass fibre optolink for signal transfer between central units

50 m ±3%	SPA-ZF1MM50
60 m ±3%	SPA-ZF1MM60
70 m ±3%	SPA-ZF1MM70
80 m ±3%	SPA-ZF1MM80
90 m ±3%	SPA-ZF1MM90
100 m ±3% *)	SPA-ZF1MM100

*) Note! Lengths over 100 m on request, max. length 2000 m.

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12. References

REA 10_ Technical Overview Brochure	1MRS 750929-MBG
REA 103 Operator's Manual	1MRS 751004-MUM
REA 105 Operator's Manual	1MRS 751005-MUM
REA 107 Operator's Manual	1MRS 752135-MUM

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