

## SMZ-4D TYPE INDICATOR OF FAULT SPOT IN THE MV CABLE POWER NETWORKS, INCLUDING THE DIRECTIONAL FUNCTION

### Application:

The SMZ-4D indicator is an independent, small-dimensions device installed in MV switchgears or MV/LV stations supplied from cable network, designed for fast location of the damaged section within this network with the application of the threshold or directorial method. The directorial method enables to selectively detect earth faults both under normal and emergency configuration of the network.

The indicator shortens the time of locating the damaged network section, decreasing losses resulting from electrical energy breaks.

### Characteristic features:

Detection of the short-circuit current flow in the case of:

- earth fault, by measurement of zero current with the application of threshold or directorial method;
- phase-to-phase short-circuit, by measurement of phase currents.

It can be used in cable networks with voltage from 6 up to 36 kV operating with the neutral point:

- isolated,
- compensated with Peterson coil independently from installed or not AWSC automation,
- earthed by resistor.

In the case of operation within the compensated network with the application of AWSC automation, the device enables signalization of faults by means of the directional function.

The current transformers can be mounted onto cables:

- individually (every conductor shielded separately),
- traditionally (one common screen for three conductors).

It co-operates with phase current comparators equipped with fibre optic outputs.

It performs measurements of zero current on the basis of:

- a single Ferranti transformer (magnetic adding up) comprising together three conductors with magnetic core diameter of 150 mm,
- three transformers operating within the Holmgreen's system (electric adding up) comprising separately every conductor with magnetic core diameter of 100 mm.

During operation with the application of the directional function, the device is recording zero current values measured in the course of fault current analysis.

It enables simple adaptation to operation within any network through the wide range of settings, programmed in a high definition by means of the keyboard and LCD display in the non-volatile memory.

It shows on the LCD display the number of the registered permanent earth faults, temporary earth faults as well as the number of phase-to-phase short-circuits.

It may be powered with alternating current 230VAC, direct current 24VDC or lithium battery. In the case of alternating current 230VAC or direct current 24V- supply, device operation is supported by a lithium battery or NiMH accumulators (depending on version).

It can be exploited during ca. 7 years as powered with the local battery supply (a lithium battery 3.6 V/17Ah), thanks to which it may be installed in switch-gears without access to the alternating current 230VAC. When powered with accumulators, vigilance time in the situation of 230VAC voltage failure is minimum 5 hours.

It enables both, internal and external light signaling, separately for phase-to-phase short-circuit and earth-fault.

It is equipped with two-coloured (red-green) light indicator with good visibility, resistant to vandalism (disassemble is only possible from the inside of the station/junction).

It co-operates with telemechanics system through:

- relay outputs (galvanic separated contacts) indicating independently an earth fault and phase-to-phase short-circuit,
- galvanic separated inputs of remote testing and alarm resetting with direct voltage 24V-.

### Location of damaged section of cable network:

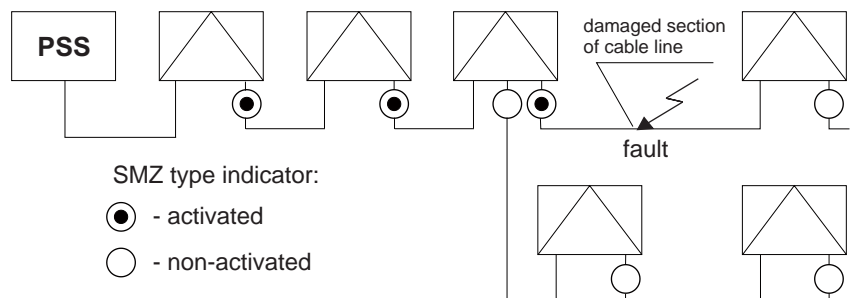
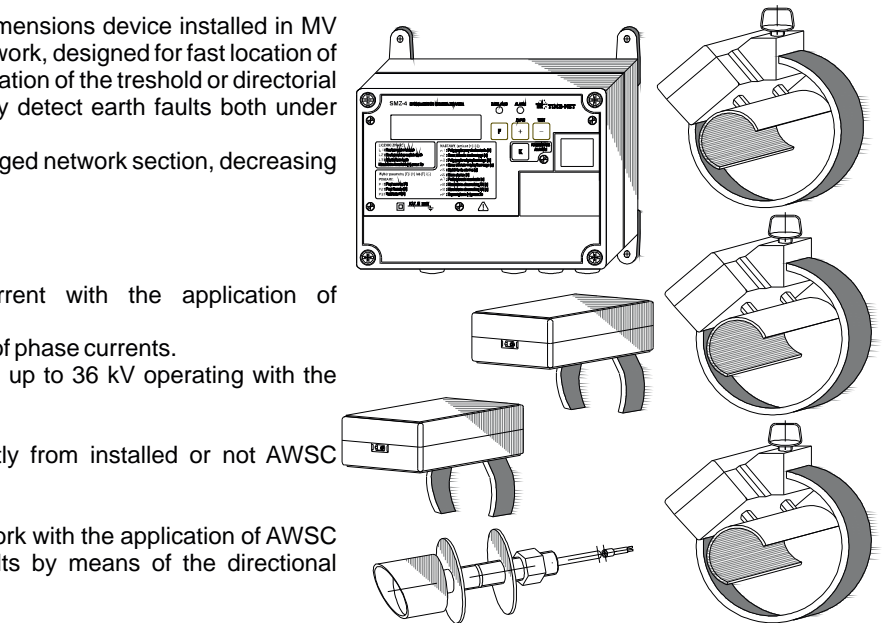
The cable network should be divided into sections and the SMZ-4D indicator should be installed at the start of every section. Occurrence of earth fault or phase-to-phase short-circuit in one of the sections will activate an alarm generated by indicators placed between the short-circuit spot and the main MV power supply station (PSS).

#### Alarm at earth fault:

- the external and internal red light flicker,
- the contacts of adequate bistable relay are closed.

#### Alarm at phase-to-phase short-circuit:

- the external and internal light flicker alternate in red and green,
- the contacts of adequate bistable relay are closed.



Light indication of fault current flow placed outside the station building enables the network supervising personnel to determine in a simple and fast way the last station in a cable line (counting from PSS - Main MV Supply Station), through which the fault current has flowed. This explicitly means the detection of the damaged section of the cable network.

### Required settings when detecting earth faults:

Depending on conditions in the network as well as its type, the following values should be set with the keyboard and the display:

- the zero current threshold value, above which the alarm is generated within the range from 1 up to 160A,
- the minimum time of short-circuit duration, above which the alarm is generated within the range from 0.05 up to 6.5 seconds,
- the delay of alarm signaling needed to mask temporary faults within the range from 0 up to 240 seconds.

### Required settings when detecting earth faults with the application of the directional method (for the compensated networks with AWSC automation connecting the active/resistant load to the net for a short time after earth fault appears):

Depending on conditions in the network, the following values should be set with the keyboard and the display:

- the zero current threshold value, above which the directional function algorithm is launched,
- the minimum time of short-circuit duration, above which the directional function algorithm is launched,
- the delay duration, after which the directional algorithm performs measurement of zero current increment value  $I_0$  following the AWSC activation,
- the expected current increment  $I_0$ ,
- the delay of alarm signaling needed to mask temporary faults.

### Required settings when detecting phase-to-phase short-circuits:

- the phase current threshold value, above which the alarm is generated,
- within the range from 200 up to 1700 A, when using phase comparators,
- within the range from 200 up to 1500 A, when using current transformers,
- the minimum time of short-circuit duration, above which the alarm is generated within the range from 0 up to 1.2 seconds.

The manufacturer offers assistance in determination of optimum settings for earth faults: sensitivity and delay of the alarm signaling for individual indicators located at any point of the network, taking into account its different configurations. Calculations are performed with the application of the PC software application on the basis of the topography of the network submitted by the User. The software application makes it possible to determine zero current in the network at any of its points during simulated, one-phase earth fault, and on this basis, to determine the optimum settings, and then to carry out simulation of operation of all indicators actually installed in this network.

### Technical data:

<b>Supply:</b>	
External power supply (see offered versions)	230VAC+10%-15%, 50Hz±5%, max. 2VA (ca. 1.5 W) or 24VDC/50mA
Internal power supply (see offered versions)	Lithium battery 3.6 V/17Ah or accumulator 2x NiMH 1,2V/800mAh
Working time with one lithium battery/accumulator	Approx. seven years including 200 h of alarm signalling/min. 5 hours
Durability (service life) of the lithium battery	10 to 15 years depending on the particular piece
Time to fully charge of accumulator	48 hours
<b>Parameters of MV network:</b>	
Voltage	From 6 to 36KV~ 50Hz
Operating conditions of the neutral point	Isolated, compensated or earthed through resistor
<b>Earth fault detection:</b>	
Method of detection	Threshold or directional (re. compensated networks incl. the AWSC)
Setting of zero current threshold value	Current threshold at fault 3A (1A – for S ver.) ÷ 160 A step 1A ±5%
Minimum required fault duration time	Earth fault duration from 0.05s up to 6.5s; setting step 0.05s ±5%
Delay of the secondary measurement for the directional function algorithm	From 1.2 s up to 6 s; settings with step 0.05 s ("0" setting switches the directional function off)
Expected current increment $I_0$ for the directional function algorithm	From 1 A up to 10 A; settings with step 0.5 A
Delay of alarm signalling that allows to eliminate signalling of temporary short-circuits	From 0 s up to 240 s; settings with step 10s ±5%
<b>Phase-to-phase short-circuits detection:</b>	
Setting of phase current threshold value for phase current transformers	Threshold value for the phase current 200A ÷ 1500A ; settings with step 100A; ±5%
Setting of phase current threshold value for fibre optic comparators	Threshold value for the phase current 200A ÷ 1700A ; settings with step 100A; ±5%
Minimum required duration of short-circuit	Duration of phase-to-phase short-circuit 0 ÷ 1.2 s ; settings with step 0.05 s ±5% (where "0" means ca. 15ms.)
<b>Alarm signaling</b>	
Alarm signaling for earth fault	Flashing external and internal red light indicator and closing of bistable relay contacts
Alarm signaling for phase-to-phase short circuit	Flashing external and internal light indicator alternate in red and green colour and closing of bistable relay contacts
Flashing frequency	every 1 second
<b>Alarm resetting:</b>	
Automatic at the presence of MV, after the abatement of short circuit	Resetting with MV presence during 0 up to 15 s; settings with step 5 s ±5%; setting for "0" value switches this function off
Automatic at the presence of LV supply after the abatement of short circuit	Resetting with LV return for 0 up to 15s; settings with step 5 s ±5%; setting for "0" value switches this function off

Automatic after the programmed time	Alarm time from 1 up to 8 hours; setting with step 1 hr ±5%
Remote	24 VDC – from telemechanics systems
Manual	With a pushbutton on the device front panel
<b>Testing functions:</b>	
Earth fault and phase-to-phase short-circuits counters	YES – displayed on the LCD every two seconds; L1 –permanent earth faults, L2 – temporary earth faults, L3- phase-to-phase short-circuits
Visualization of zero current measurements carried out for the directional function	YES- after pressing a pushbutton on the front panel: A1 – the first measurement, A2 – the second measurement
Measurement of zero or phase current	YES – after the measurement function has been switched on
Measurement of battery voltage	YES – after the measurement function has been switched on
Efficiency test for the whole measuring circuit and lithium battery condition	YES – with a push-button or 24 VDC from telemechanics systems (checking of all measurement circuits and duty test of the battery)
Indicator of the battery state	YES – LCD display pulses if battery voltage drops below 2.6 V
<b>General technical data:</b>	
Signalling of external power supply	Yellow LED diode on the control unit front panel
Signalling of MV presence	Lit dot on the LCD display
Transmission of the applied current transformers	1/2500
Load capacity of contacts in alarm relays	1A, alternating current 250VAC
Protection class	II acc. EN 61140:2002
Isolation electric strength	2300V r.m.s., 50Hz, 60s acc. EN 61010-1
1) in the case of application of three measuring transformers in the Holmgreen system, the threshold current value I <sub>o</sub> should be set above 20A, particularly at high phase current that exceeds 300A.	

Ambient operating conditions:	Central unit	Transformers	Comparators	Light indicator
Operating temperature	-30 ÷ +55°C	-40 ÷ +55°C	-30 ÷ +55°C	-40 ÷ +70°C
Storage temperature	-30 ÷ +70°C	-40 ÷ +70°C	-40 ÷ +70°C	-40 ÷ +70°C
Humid. (without condensation)	max 90%	max 90%	max 90%	max 95%
Housing protection class (IP) acc.PN - EN 60529	IP 65	IP 40	IP 40	IP 65

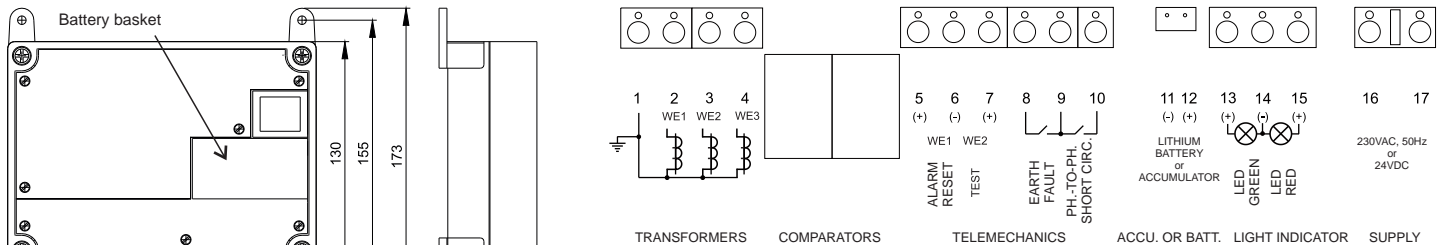
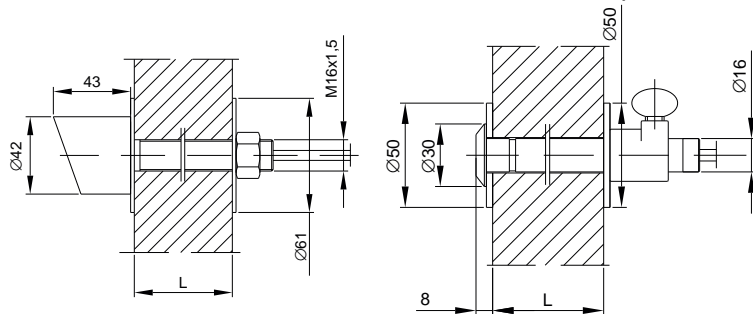


Fig. 1 Dimensions of SMZ-4D central unit.

**Notices:**

- terminal strips are accommodated for cables with max cross-section 2,5mm<sup>2</sup> but sealing glands placed in the housing enable to use cables with external diameter from 4 up to 11mm for cables of transformers, and from 4 up to 8mm for all other cables,
  - terminals 3, 4, 10 and 13 are not envisaged in versions 1 and 2
  - terminals 16 and 17 are not envisaged in version D
  - terminals 11 and 12 and battery basket are not envisaged in version C.
- Description of versions - see table on the last page.



Fastening of the indicator consist in drilling the Ø16mm port in the wall, inserting into it the terminal of light indicator and screwing down the nut at the internal side of the station.

The indicator is equipped with connecting cable OMY 3x0,75mm<sup>2</sup> or OMY 2x0,75mm<sup>2</sup> with a length of 2m, which can be extended to the length of 50m by the cable of the same type.

At choice standard dimensions (L): 140 mm or 440 mm (other lengths available on agreement).

Fig. 2 Dimensions and fastening of light indicator.

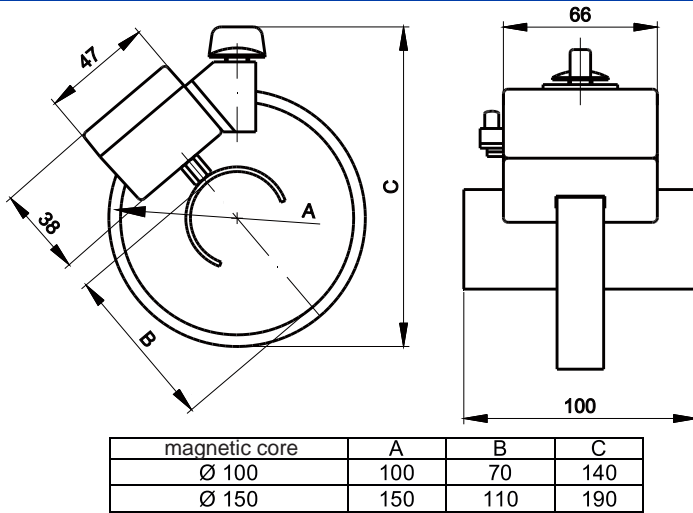


Fig. 3 Dimensions of transformers.

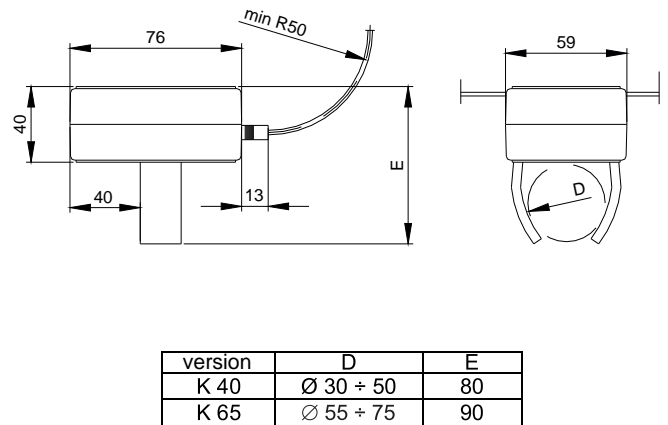


Fig. 4 Dimensions of comparators.

**NOTICE: The current transformers and fibre optic comparators are adapted for fast and easy mounting onto the cable by one person, which shortens to the minimum the voltage outage time necessary to mount the device. The indicator set contains:**

- microprocessor control unit of SMZ-4D type in the housing for mounting it directly on internal wall of the station,
- light indicator for mounting on station building outer wall at the place well visible from the access road,
- current relays depending on the chosen type, according to the below table:

Versions differing in terms of equipment	Versions differing in terms of supply voltages				Current transformers with magnetic core diameter		Fibre optic comparators	Faults to be detected d – earth faults; m – phase-to-phase short-circuits
	A	B	C	D	Ø150	Ø100		
1	SMZ-4D/1	SMZ-4D/24B	SMZ-4D/24	SMZ-4D/DB	1 pce.	-	-	d
2	SMZ-4D/3P	SMZ-4D/24B/3P	SMZ-4D/24/3P	SMZ-4D/DB/3P	-	3 pcs.	-	d
3	SMZ-4D/2	SMZ-4D/24B/2	SMZ-4D/24/2	SMZ-4D/DMB/2	1 pce.	2 pcs.	-	d i m
4	SMZ-4D/3	SMZ-4D/24B/3	SMZ-4D/24/3	SMZ-4D/DMB/3	-	3 pcs.	-	d i m
5	SMZ-4D/K*	SMZ-4D/24B/K*	SMZ-4D/24/K*	-	1 pce.	-	2 pcs.	d i m

**Versions presented in the columns:**

- A - are powered with alternating current 230VAC and a lithium battery 3.6V/17Ah, or optionally with accumulators 2xNiMH 1.2V/800mAh (marking "/A" in the end of the device symbol),
- B - are powered with the guaranteed direct current 24VDC and a lithium battery 3.6 V/17Ah,
- C - are powered solely with direct current 24VDC,
- D - are powered solely with a lithium battery 3.6V/17Ah.

\*) Phase current comparators with fibre optic outputs are manufactured in the following versions:

K40 – with the intended purpose for mounting onto cables with diameter from 30 up to 50 mm,

K65 - with the intended purpose for mounting onto oil cable head 3GOW-A or cable with diameter of approx. 65 mm.

As a standard, each comparator is equipped with a fibre optic cable of the length of 5m (optionally up to 10m).

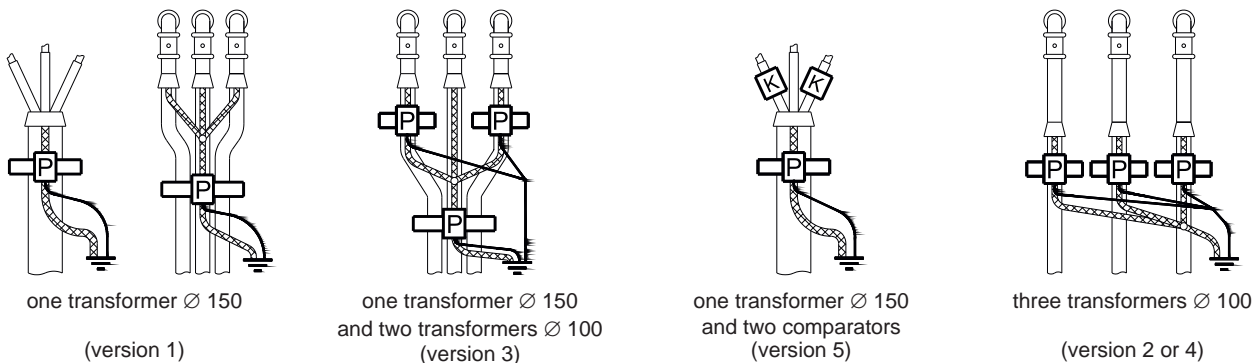


Fig. 5 Assembly of current transformers and comparators onto MV cables depending on version.

Sample order symbol consists of:  
 type of device -  
 description of light indicator -  
 Type of device/description of light indicator e.g.: SMZ-4D/K65/N440, where:  
 the type chosen from the table above  
 N (surface-mounted) or P (flush-mounted) and "L" dimension expressed in [mm].