PRE-INSULATED HEATING PIPELINES
BATTERY-SUPPLIED STATIONARY STATUS METER
(RESISTANCE ALARM SYSTEM)

SAR-2b

OPERATING MANUAL

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1. General information

The SAR-2b device is intended for monitoring 2 sections of a pre-insulated heating pipelines with a resistance alarm system. The meter may be supplied by external 5x1.5V alkaline (5xR20) or lithium (2xR20) batteries or a 7.5VDC 0.5A/230V 50Hz plug-in power supply. During a measuring cycle, measurements of polyurethane insulation resistance, leak location, voltages appearing an alarm system (e.g. galvanic), supply voltage (battery version), as well as device autocalibration are executed. Polyurethane insulation resistance is measured at two polarizations of the measuring voltage. Ambient temperature variations, as well as interference resulting from physical phenomena of electric nature present on a line pipe, do not affect measurement accuracy.

In the mains power supply version of the device, measurement information is presented on an alphanumeric display in the form of numerical values of measurement results and text messages. The backlit meter indication field consists of two rows containing 16-character fields each. In addition, failure states are signalled by an illuminated red LED diode.

In the battery version, an SAR-2b device spends most of its time in dormant mode, in order not to use the supply batteries. Activation may be manual or automatic. The automatic activation is executed by external devices after a programmed period of time. An activated device performs a measurement cycle, as in the mains supply version. Measurement information is not shown on an alphanumeric display. In order to save power, the display field is not backlit. A button located on the side of a device is used for manual activation. After activation, a device performs one standard measurement cycle, and results and potential text messages are shown, for a certain period of time, on the alphanumeric display. The display is backlit. Then, the device switches off.

Detailed data regarding the device are included in section 8. Technical data herein.

2. Comments regarding the technical data of an SAR-2b device

An SAR-2b device measures the resistance of polyurethane insulation and an alarm loop. Insulation resistance value is converted into the MH moisture degree or the direct shorting C of an alarm wire and a steel pipe. The relationships between the insulation resistance value and the MH or C parameters are shown in Table no. 1.

Table 1

Polyurethane insulation degree of moisture (MH)	Direct shorting C of an alarm cable and a steel pipe	Polyurethane resistance value range
1	1	100Ω÷500Ω
2	2	500Ω÷1.2kΩ
3	3	1.2k÷Ω5kΩ
4	4	5kΩ÷20kΩ
5	5	20kΩ÷65kΩ
6	6	65kΩ÷200kΩ
7	7	200kΩ÷300kΩ
8	8	300kΩ÷450kΩ
9	—	450kΩ÷1MΩ
10	—	1MΩ÷3MΩ
11	—	3MΩ÷10MΩ
12	—	10MΩ÷20MΩ
13	—	20MΩ÷30MΩ
14	—	30MΩ÷50MΩ
0	—	>50MΩ

Whereas, the alarm loop resistance value is automatically converted into the length of the tested heating pipelines section. The display shows both the measures, as well as calculated values.

The technical conditions of a resistance alarm system stipulate that the maximum length of a resistance alarm loop is 1000 m, and for this length, the polyurethane insulation moisture degree shall satisfy the condition: MH≥12 (resistance value ≥10MΩ).

In the case of shorter sections, this value shall be determined from the formula:

$$R = \frac{R_{min}}{L / L_{max}}$$

R [MΩ] - lowest permissible polyurethane insulation resistance value for a heating pipelines section length of $L \neq L_{max}$.

R_{min} [MΩ] - the minimum polyurethane insulation resistance value for an L_{max} maximum length of a heating pipelines, stated in the technical conditions

L [km] - length of the tested heating pipelines section, $L \neq L_{max}$.

L_{max} [km] - the maximum section length of a pre-insulated heating pipelines with a pulse alarm system, stated in the technical conditions.

Device indications and the provided formula may be used for potential expansion of a heating pipelines. They enable us to determine the value of polyurethane insulation resistance of a new section, in order for the resultant resistance of the entire network to be larger than the minimum resistance value determined in the technical conditions of the alarm system.

A wide range of measured values of polyurethane insulation resistance enables to rather accurately track the speed and direction of variations for the moisture between the line and protective pipes. This enables you to distinguish the event of a leak from moisture confined within heating pipelines cable joints. The date of commencing repair works may also be forecast.

An SAR-2b device is manufactured in two versions: with and without automatic leak/moisture localization. The localization is performed when the polyurethane insulation resistance value drops below 1MΩ.

3. Interpreting L>L_{max} and PRZERWA (*GAP*) messages.

As inferred by the technical data of the device, the L>L_{max} message appears when the measured resistance of an alarm loop adopts a value in the range of 12051Ω ÷ 100kΩ. The lower limit corresponds to a sensor loop length equal to 2000m, under the assumption that a NiCr8020 resistance wire was executed with a tolerance of ±3%. In practice, there are cases of bad execution of connections between alarm loop sections. Connection resistance increases loop resistance; therefore, it artificially extends it. A similar effect can be experienced in the event of moisture between broken ends of a wire forming an alarm loop. Exactly these two events are signalled by the L>Lmax message. Whereas, in the second of the described cases, a device indicates a small MH degree (high moisture level) and galvanic voltage value.

The **Przerwa** (*Gap*) message signals the lack of electrical contact between the terminations of wires forming an alarm loop.

4. Reasons for distinguishing a leak from a short-circuit.

Leak and direct shorting of a sensor loop wire with a steel pipe are characterized by a relatively small value of resistance measured between a line pipe and an alarm loop wire. The measured galvanic voltage value indicates the presence of moisture. For the services supervising a heating pipelines, there are important reasons to distinguish both events. Starting with the fact that each of the events requires different technical preparation for failure removal and ending with the evaluation of the situation severity and response speed.

5. Specification of the SAR-2b operating environment.

The device is designed for operation in confined rooms. The meter operates within ambient temperature ranges of +5°C ÷ +50°C, while the relative humidity should not exceed 80%. The ambient storage temperature can vary from –40°C to +70°C.

After storage or transportation of the device at a temperature below +5°C, it is recommended to wait at least 3 hours before energizing. After such a period, the device should reach operating temperature.

The meter may not operate in rooms with high dustiness and in an atmosphere containing explosive or corrosive/aggressive gases.

The measurements errors of parameters and quantities presented in the technical data are obtained after 30 min. of meter operation at meter-appropriate ambient conditions.

6. Maintenance of the SAR-2b.

Use a clean, dry cloth to remove dust off the device casing. The formed soiling shall be removed with a cloth moistened with a 1% detergent solution. Greasy soiling can be removed with special preparations used to maintain the cleanliness of computer hardware. Use soft cloths or special wipes for cleaning computer screens for cleaning the transparent part of the casing. It is forbidden to use spirit, washing benzene and other solvents. Such cleaning agents may cause surface damage to the meter casing. After cleaning is completed, a device shall be wiped dry with a soft cloth. In the course of the aforementioned actions, make sure that large quantities of the cleaning fluids do not penetrate inside the meter.

7. Decommissioning of an SAR-2b device.

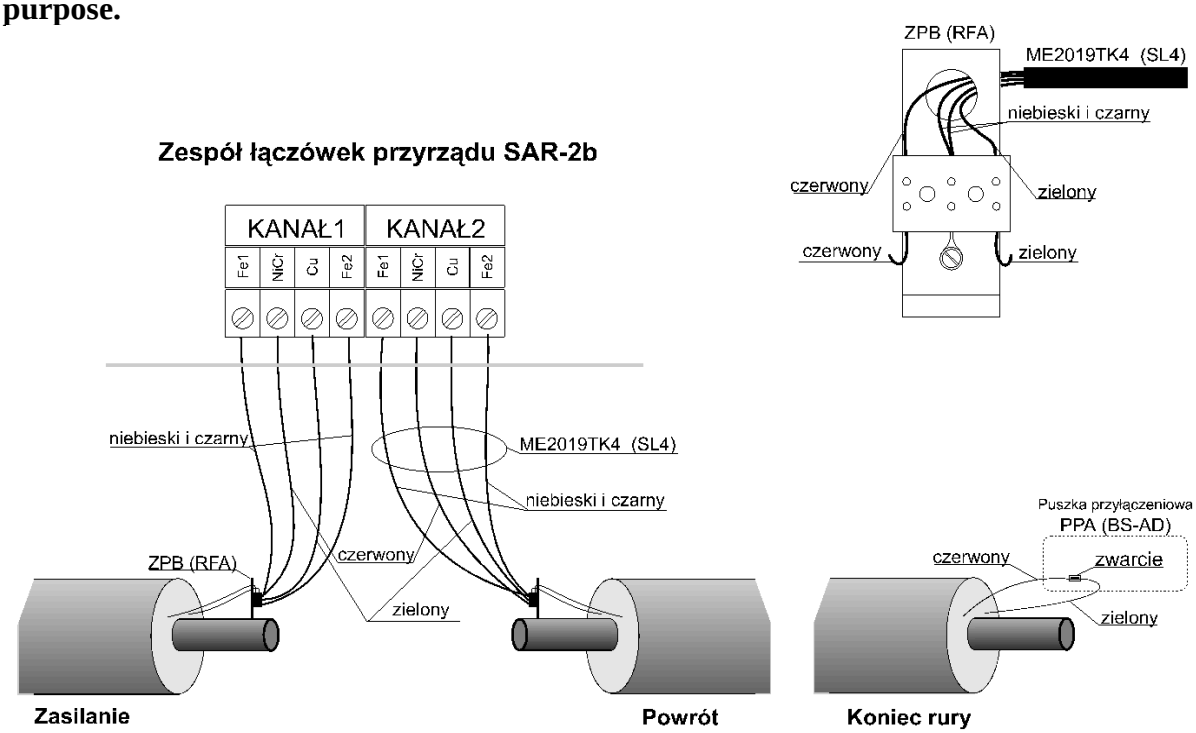
Pursuant to the provisions of the Act of 29 July 2005 on used electrical and electronic equipment (Journal of Laws, item 1495), the device bears a following symbol:

The symbol means that it is forbidden to place used equipment with any waste. A user of equipment marked in this manner is obliged to hand the equipment over to relevant companies dealing with collecting used equipment. The obligations arise from art. 35 and 36 of the aforementioned act.

8. How to connect an SAR-2b device to a pulse alarm

system.

The device may be supplied from a 7.5 VDC 0.5A/230V 50Hz plug-in power supply. The supply cable may be inserted through a cable gland with the ALARM or TRANSMISJA (TRANSMISSION) signs, depending on which of these functions is not used. The red termination of a power supply cable shall be connected to a terminal marked with "+", described with 7.5V. The second one, to the "-" terminal.
Figure below shows the method for connecting an SAR-2b meter to a resistance alarm system.
If a device is supplied by batteries, place used batteries in containers intended for that purpose.



(resistance alarm system)

1. Power supply ..... 5x1.5V(5xR20) batteries or an external 7.5VDC 0.5A/230V 50Hz power supply
2. Number of measurement cycles (cycle=2 channels) per 1 set of batteries 25 000
3. Number of monitored sections of a pre-insulated heating pipelines 2
4. Maximum length of a monitored heating pipelines section 2000m
5. Measurement information presentation manner ..... backlit, alphanumeric LCD 2x20 characters, red LED diode with an AWARIA (*FAILURE*) sign
6. Polyurethane insulation resistance measurement range ..... 0.1kΩ÷200MΩ
   - Polyurethane insulation moisture degree measurement range. ..... MH 1÷14 and 0
   - Polyurethane insulation resistance measurement voltage ..... ±15V
   - Polyurethane insulation resistance measurement accuracy ..... ±5%±2 digits in terms of MH degree
7. Heating pipelines section length measurement range ..... 0 ÷ 2000m
   - Heating pipelines section length measurement accuracy ..... ± 2m)[1]
   - Measurement resolution 1m
8. Measurement range for the localization of a leak (moisture) or direct shorting of an alarm loop wire with a line pipe ..... 0 ÷ 2000m
   - Leak resistance value range ..... 0.1kΩ ÷ 9MΩ (MH = 1 ÷ 9)
   - Localization accuracy of a leak (moisture) ..... or a direct shorting between an alarm loop wire and a line pipe ..... ±2m ±0,2% of the heating pipelines section length
   - Measurement resolution 1m
9. Measurement range for the voltage between a sensor wire and a line pipe ..... 0÷14V)[2]
   - Voltage measurement accuracy ..... ±1% of measured value
10. Measurement ranges distinguished with illuminated red LED diode with an AWARIA (*FAILURE*) sign:
    - Leak (moisture) resistance value range ..... 0.1kΩ ÷ 1MΩ
    - Resistance value range for a direct shorting between an alarm loop wire and a line pipe ..... 1Ω ÷ 0.45MΩ
    - Alarm loop resistance value range for a $L>L_{max}$ message ..... 12051Ω÷100kΩ
    - Alarm loop minimum resistance value for a Przerwa (*Gap*) message ..... ≥100kΩ
11. Content and meaning of symbols and text messages:
    - value of coded limit resistance of polyurethane insulation ..... XYkΩ
    - symbols of measuring channels (heating pipelines sections) 1;2
    - polyurethane insulation moisture degree symbol ..... MH
    - symbol of a direct shorting between a sensor loop wire and a line pipe. C
    - symbols of resistance units ..... Ω, kΩ, MΩ
    - value of polyurethane insulation resistance is larger than 200MΩ ..... Sucho (*Dry*)
    - leak (moisture) symbol ..... W
    - symbol of heating pipelines section length L
    - measurement range for a heating pipelines section length measurement exceeded ..... $L>L_{max}$
    - electrical gap in a sensor loop ..... Przerwa (*Gap*)
    - length unit symbol (metre) ..... m
    - voltage unit symbol V
    - No connection between the device and a line pipe ..... Dołącz Rurę (*Connect Pipe*)
12. Method of transmitting information to the data collection system:
    - contact status (closed/open) of the ALARM junction; between the measurements, the contact status remains in the position set by the last measurement cycle.
    - LPS-RS232 digital data transmission module;
    - LPS-MBus digital data transmission module;
    - LPS-Modbus-RTU or TRACON 1.2 digital data transmission model (compatibility with CONTROL);
    - LPS-GSM radio data transmission external module.
13. Operating temperature range ..... +5 ÷ 50ºC
14. Maximum relative ambient humidity value 80%
15. Casing tightness class IP65
16. Device dimensions 154x125x90

)[1] Measurement accuracy of a heating pipelines section length depends mainly on the resistance values of a NiCr8020 conductor per one linear metre (execution tolerance).

)[2]...Voltage may be generated by various sources (e.g. welder). It can also be galvanic voltage, appearing in the event of moisture between a sensor wire and a pipe.