EKRA

INSULATION MONITORING DEVICES

for DC networks

CONTENTS

Our enterprise has been developing and producing the insulation monitoring systems since 2006.

Based on a great number of scientific researches, we have developed unique technical solutions and got patents.

At the moment, more than 1,000 sets of insulation monitoring systems have been successfully operated at substations, power plants and industrial enterprises in Russia and other countries.

Vladimir Alexandrovich Naumov

PhD in Engineering sciences
Deputy General Director -
Technical Director of EKRA

APPLICATION

EKRA equipment provides reliable and proficient solutions for the insulation resistance monitoring of DC networks.

Depending on it’s complexity, an insulation monitoring system can:

- continuously monitor the level of insulation resistance of network poles;
- automatically detect feeders with damaged insulation;
- manually measure the insulation resistance of feeders.

ED2-IMS

IMD-02

DCS

IMR

PIM

PIMS

IMS Tester

The DC networks are widely used nowadays, starting from the large power facilities to the electric vehicle charging station.

Insulation level reduction in DC network can lead to an earth fault and a subsequent failure or maloperation of the protection and control systems at the facility.

The insulation monitoring equipment of EKRA ensures reliable and timely damage detection of the DC network section and, therefore, prevents accidents.

Substation

Hydro power plant

Thermal power plant

Nuclear power plant

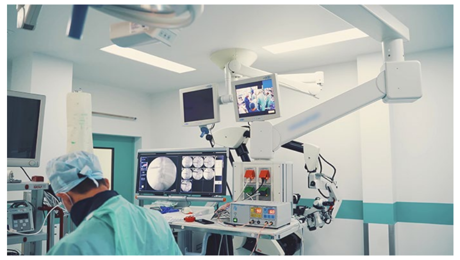
Solar power plant

Industrial companies

Electrolysis plant

Marine electrical installations

Medical electrical installations



Railroads rolling stock

Aircraft transport

Electric vehicles and charging stations

AUTOMATIC DETECTION OF FEEDERS WITH REDUCED INSULATION RESISTANCE

Feeder-by-feeder insulation resistance monitoring is the most common and efficient solution for DC networks.

In this case the head unit (IED) monitors the network’s insulation resistance, and automatically monitors the insulation resistance of feeders using differential current sensors.

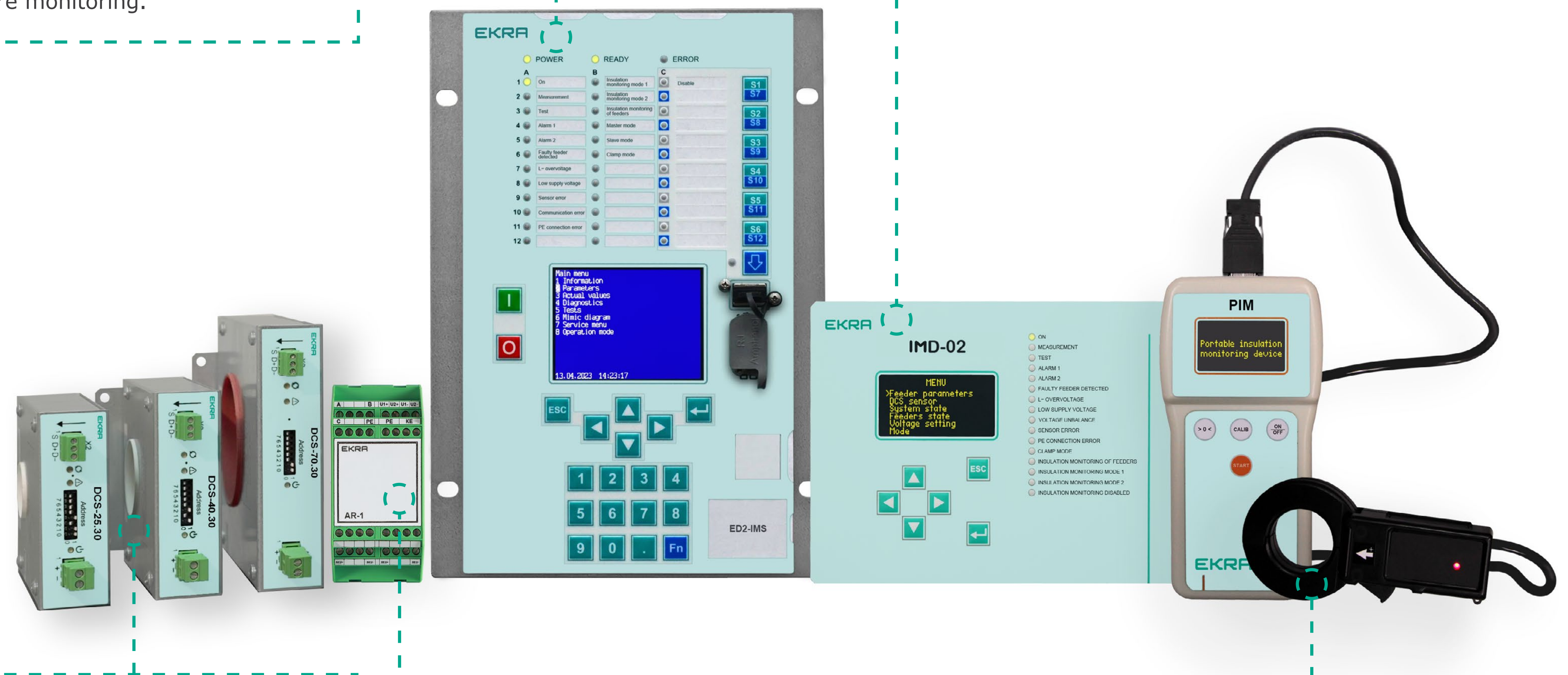
Special feature of the EKRA equipment is that our devices detect both symmetrical feeder insulation damages, and asymmetrical damages of different feeder poles.

The ED2-IMS monitors the network poles insulation resistance and insulation resistance of up to 510 feeders. Data transfer from ED2-IMS to SAS is available via the protocols:

- Modbus RTU
- Modbus TCP
- IEC 60870-5-103
- IEC 60870-5-104
- IEC 61850

Optional:
- event recorder of the DC power supply system;
- battery symmetry monitoring;
- charge/recharge current monitoring;
- battery room temperature monitoring.

The IMD-02 monitors the network poles insulation and insulation of up to 255 feeders.
The IED has an option of data transfer to SAS via Modbus RTU protocol.



DCS differential current sensors are permanently installed, one for each monitored feeder. Every sensor measures differential current of it’s own feeder. Data exchange with the IED (head unit) is made via RS-485 interface.

If a faulty feeder has no DCS differential current sensor installed, then upon receiving the information from the IED on network insulation reduction, the fault can be detected using the PIM portable device.

Coupling devices AR are used to extend the nominal voltage range of the EKRA insulation monitoring systems. The insulation monitoring relays and devices together with the coupling device AR monitors the insulation resistance of IT systems up to 1,500 V DC.

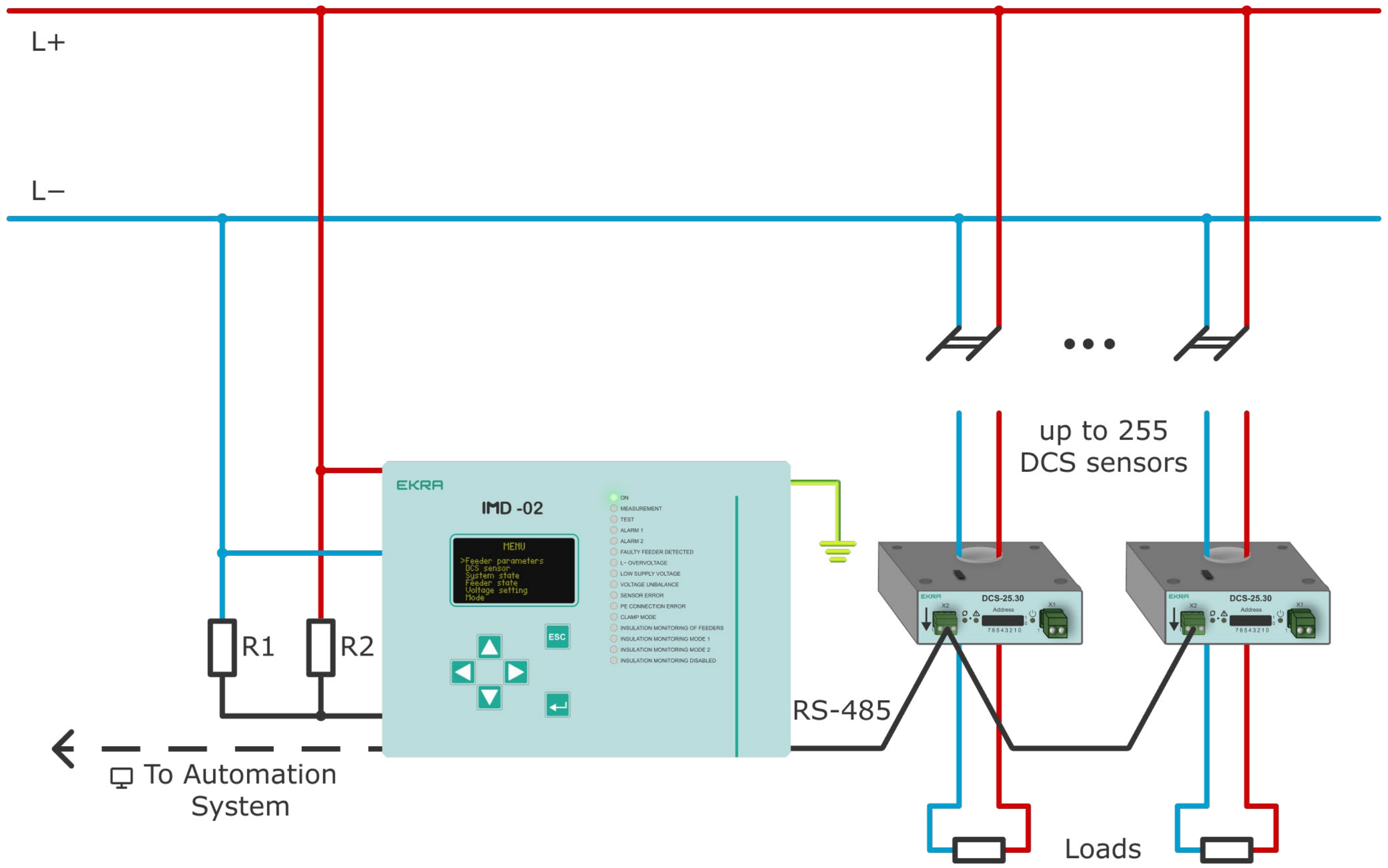
Visit EKRA website for more information

Principle of the feeder-by-feeder monitoring system

The IMD-02 or ED2-IMS monitors the network poles insulation and automatically monitors the insulation resistance of feeders with permanently installed DCS differential current sensors. The IED and sensors are connected via RS-485 interface.

The damaged feeder without DCS differential current sensor can also be identified manually using the PIM portable device.

Connection of IMD-02 and DCS differential current sensors

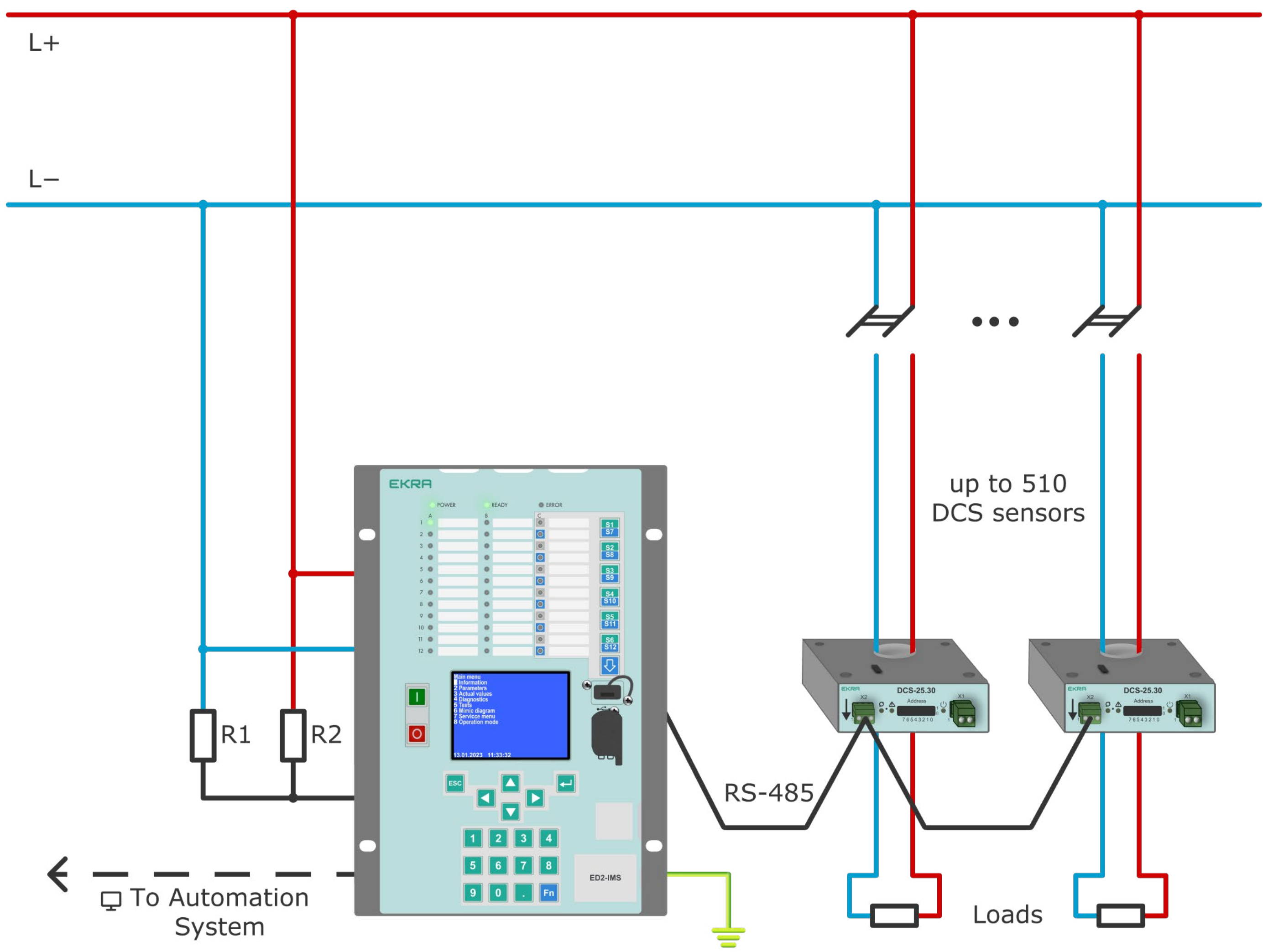


Key features of IMD-02

- Network insulation resistance monitoring up to 1,000 kOhm
- Connection of up to 255 DCS sensors
- Modbus RTU protocol support

See Appendix for the detailed connection diagram

Connection of ED2-IMS and DCS differential current sensors



Key features of ED2-IMS

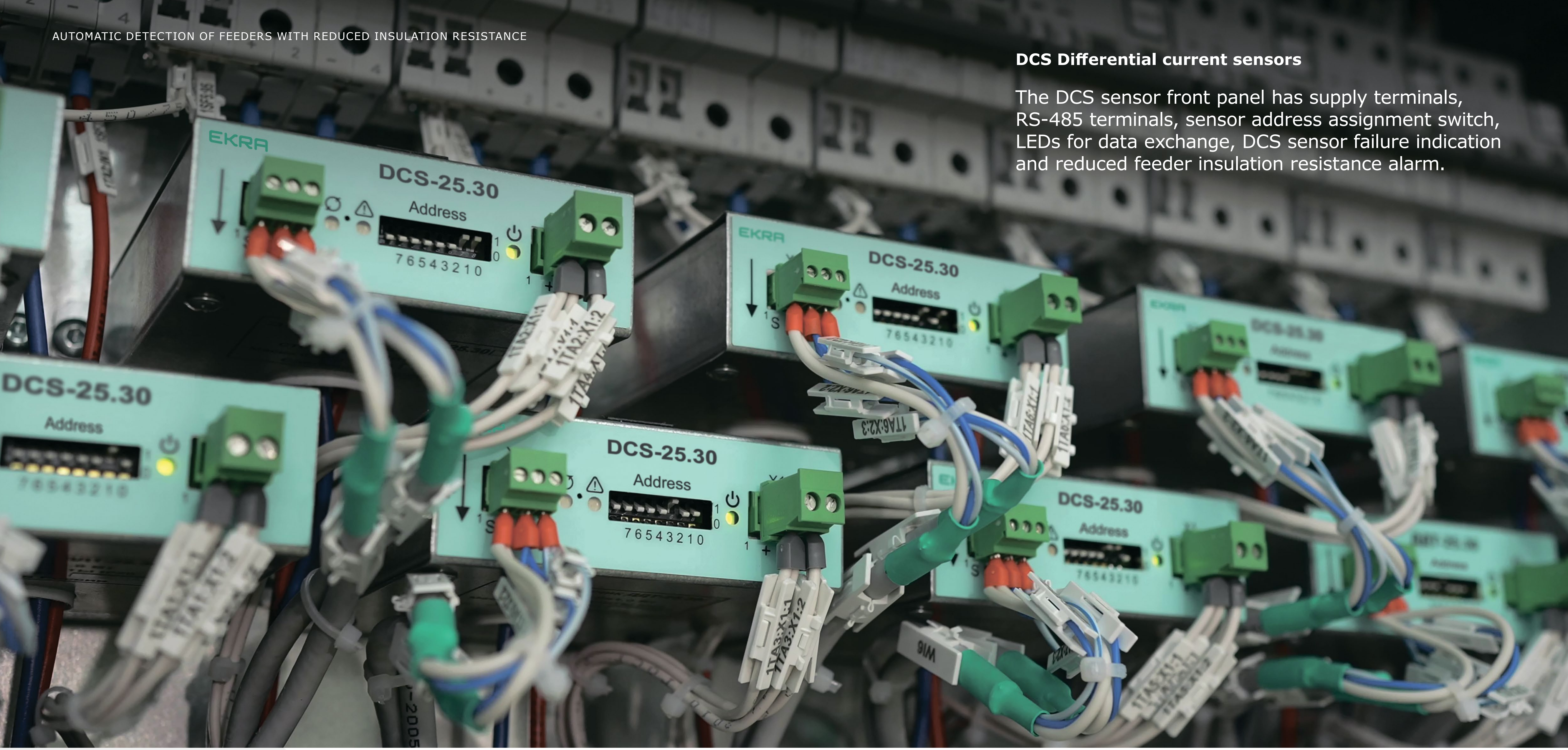
- Network insulation resistance monitoring up to 10,000 kOhm
- Connection of up to 510 DCS sensors
- Battery symmetry monitoring
- Charge/recharge current monitoring
- Battery room temperature monitoring
- Event recording
- Remote access and configuration
- IEC 61850 support

See Appendix for the detailed connection diagram

IMD-02 and ED2-IMS characteristics

	IMD-02	ED2-IMS
Voltage of monitored network	- 110 V DC - 220 V DC - up to 1,500 V DC (with coupling device AR)	- 110 V DC - 220 V DC - up to 1,500 V DC (with coupling device AR)
Maximum capacity of monitored network	Up to 200 μF*	Up to 200 μF*
Network insulation resistance measurement	Up to 1,000 kOhm	Up to 10,000 kOhm
Measurement error	Less than ±10 %	Less than ±10 %
Pole insulation monitoring	●	●
Network voltage monitoring	●	●
Battery symmetry monitoring		○
Charge/recharge current monitoring		○
Battery room temperature monitoring		○
Event recording, oscillography		○
Number of monitored feeders	Up to 255	Up to 510
Interface for communication with DCS differential current sensors	RS-485	RS-485
Operation modes of two devices in one system	Master-Slave Pair	Master-Slave Pair
Measuring cycle duration	From 15 to 55 s	From 15 to 55 s
Device power supply voltage	24 V DC	220 V DC
Permissible deviations of power supply voltage	from -20 to +10 %	from -20 to +10 %
Power consumption	10 W	35 W
Number of settings for insulation resistance of network poles relative to ground	2	3
Number of settings for insulation resistance of feeder with DCS differential current sensor	1	1
Number of relay outputs	5	16
Number of LEDs	16	36
Communication interface	RS-485	RS-485, Ethernet
Communication protocol	Modbus RTU	Modbus TCP (RTU) IEC 60870-5-103 (104) IEC 61850
Recommended operating temperature range	From +1 to +55 °C	From -10 to +55 °C
Recommended storage temperature	From -50 to +55 °C	From -40 to +70 °C
Installation	Flush mounting	Flush mounting
Overall dimensions	72x212x150 mm	276x192x211 mm
Weight	1.2 kg	7 kg

*-values are applicable for 220V voltage DC network



DCS Differential current sensors

The DCS sensor front panel has supply terminals, RS-485 terminals, sensor address assignment switch, LEDs for data exchange, DCS sensor failure indication and reduced feeder insulation resistance alarm.

DCS differential current sensor characteristics

Range of monitored differential current	From -50 to +50 mA
Feeder insulation resistance measurement	Up to 150 kOhm *
Measurement error	Less than 20 %
Device power supply voltage	24 V DC
Power consumption	1 W
Interface of communication with IED	RS-485
Maximum length of the communication cable from sensor to IED	1000 m
Recommended operating temperature range	From +1 to +55 °C
Recommended storage temperature	From -50 to +55 °C

*-values are applicable for 220V voltage DC network

Jaw diameter, mm	25	40	70	100	150
Presence of binary output	○				
Overall size, mm	90x36x131	97x60x133	125x60x167	167x60x206	207x60x259
DIN-rail mounting	•				
Plate mounting	•	•	•	•	•

MANUAL MEASUREMENT OF FEEDER INSULATION RESISTANCE

The PIM portable device can be used together with all kinds of relays and insulation monitoring IEDs of EKRA production.

When the information about insulation reduction in the network is received, the damaged feeder is detected through sequential measurement of the feeders’ insulation.

The PIM portable device is designed as a measuring unit with current clamp connected to it. Control buttons and display are located on the front panel.

Key features

- Easy to connect
- Fast measurement
- No need for a separate communication channel of the portable device with relay or insulation monitoring IED
- Insulation resistance measurement up to 100 kOhm
- Determination of polarity of the damaged pole

PIM characteristics

Voltage of monitored network	110/220 V DC other design types upon request
Maximum capacity of monitored network	200 μF*
Display	●
Range of feeder insulation resistance measurement	From 0 to 100 kOhm*
Measurement error	Less than ±20 %
Determination of the damaged feeders pole	●
Measuring cycle duration	10 sec
Clamp diameter for monitored feeder coverage	30 mm
Length of clamp connection cable	1 m
Power supply source	Two 3 V DC elements (AA type)
Recommended operating temperature range	From +1 to +55 °C
Recommended storage temperature	From -50 to +55 °C
Weight with clamp	0.4 kg

*-values are applicable for 220V voltage DC network

POLE INSULATION MONITORING

The IMR relay is a cost-efficient solution for organization of insulation monitoring system at power facilities. The IMR relays continuously monitor the level of insulation resistance of DC network poles.

The IMR-02 relay allows to specify two settings and issues «WARNING» and «ALARM» signals, if the insulation resistance of network poles decreases below these values.

If the voltage between the network poles decreases below the user specified value, the IMR-02 relay issues a signal of DC network fault.

Data on the insulation resistance value of network poles can be transferred via RS-485 interface using Modbus RTU protocol.

The IMR-01 relay allows to specify one setting and issues a binary signal, if the insulation resistance of network poles decreases below the set value.

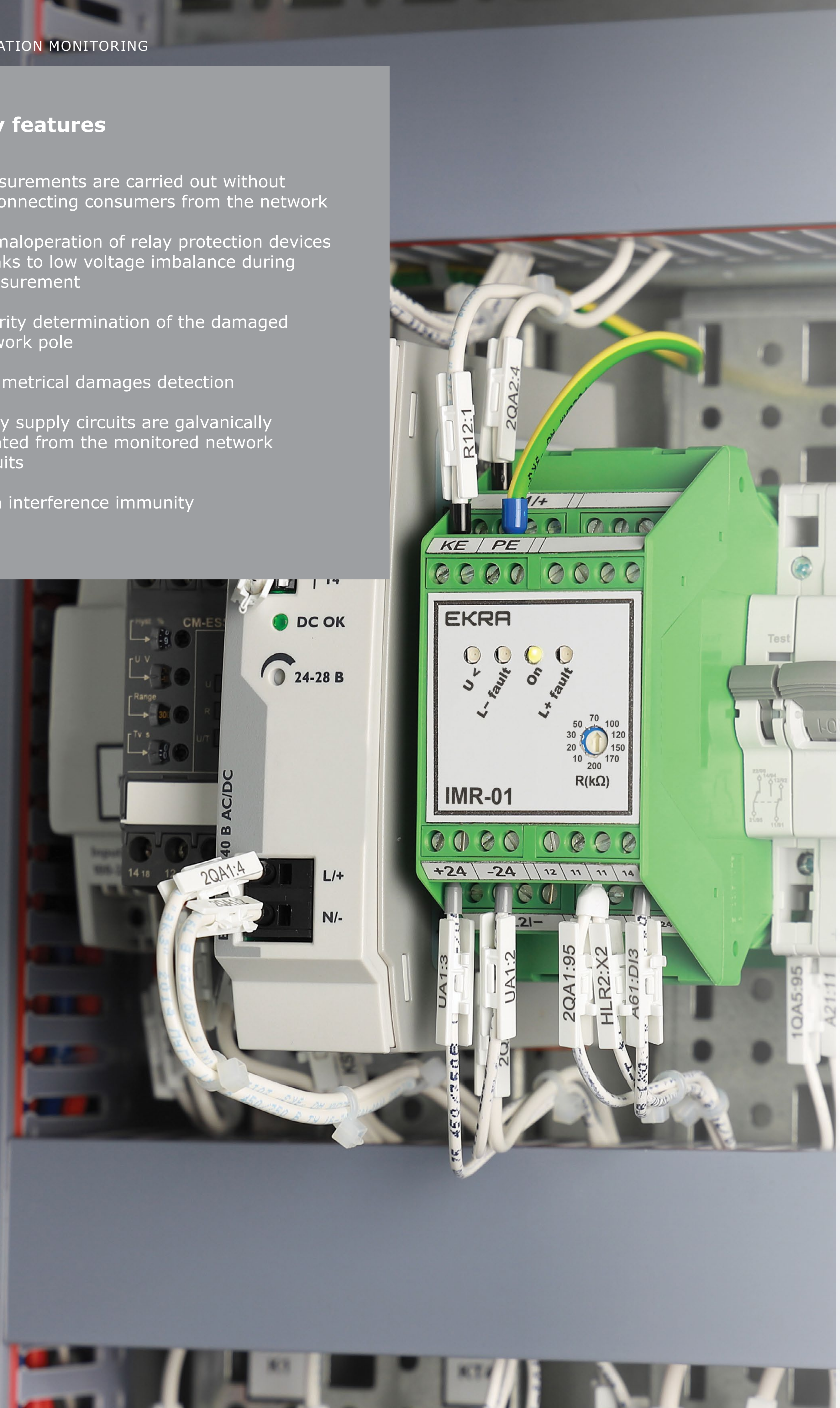
Also, if the voltage between the network poles decreases below 0,5Unom, IMR-01 relay issues a signal of DC network fault.

The PIM portable device is designed as a measuring unit with current clamp connected to it, covering the positive and negative feeder wires. The result of the insulation impedance and the polarity of the damaged wire is displayed.

Visit EKRA website for more information

Key features

- Measurements are carried out without disconnecting consumers from the network
- No maloperation of relay protection devices thanks to low voltage imbalance during measurement
- Polarity determination of the damaged network pole
- Symmetrical damages detection
- Relay supply circuits are galvanically isolated from the monitored network circuits
- High interference immunity



IMR-01 and IMR-02 characteristics

	IMR-01	IMR-02
Voltage of monitored network	- 24 V DC - 48 V DC - 110 V DC - 220 V DC - up to 1,500 V DC (with coupling device AR)	- 110 V DC - 220 V DC - up to 1,500 V DC (with coupling device AR)
Maximum capacity of monitored network	200 μF*	200 μF*
Pole insulation monitoring	●	●
Network voltage monitoring	●	●
Measuring cycle duration	20 sec	20 sec
Measuring of network capacity	-	●
Setting adjustment range	1 – 200 kOhm*	5 – 500 kOhm*
Measurement error	Less than ±10 %	Less than ±10 %
Number of settings for insulation resistance of network poles relative to ground	1	2
Number of output relays	2	3
Display	-	●
LED indication	4	7
Communication interface	-	RS-485
Communication protocol	-	Modbus RTU
Device power supply voltage	24 V DC 220 V DC	24 V DC
Permissible deviations of power supply voltage	from -20 to +10 %	from -20 to +10 %
Power consumption	Less than 7 W	Less than 10 W
Readiness time of after device energizing	10 sec	10 sec
Recommended operating temperature range	From +1 to +55 °C	From +1 to +55 °C
Recommended storage temperature	From -50 to +55 °C	From -50 to +55 °C
Installation	DIN-rail mounting	Flush mounting
Overall dimensions	111x45x99 mm	54x165x99 mm
Weight	0.3 kg	0.85 kg

*-values are applicable for 220V voltage DC network

See Appendix for the detailed connection diagram

STAND-ALONE PORTABLE INSULATION MONITORING SYSTEM

The portable insulation monitoring system PIMS is applied for temporary connection and scheduled testing of DC network insulation resistance levels at power and industrial facilities without permanently installed insulation monitoring systems.

The portable insulation monitoring system PIMS has a shockproof case and is supplied as an independent device.

The PIMS includes:

- Insulation monitoring relay IMR-02[1];
- PIM[2] portable device;
- Wire set for connection to the DC network at the facility.

1 The IMR-02 characteristics can be found on the page 25
2 The PIM characteristics can be found on the page 19

See Appendix for the connection diagram

Key features

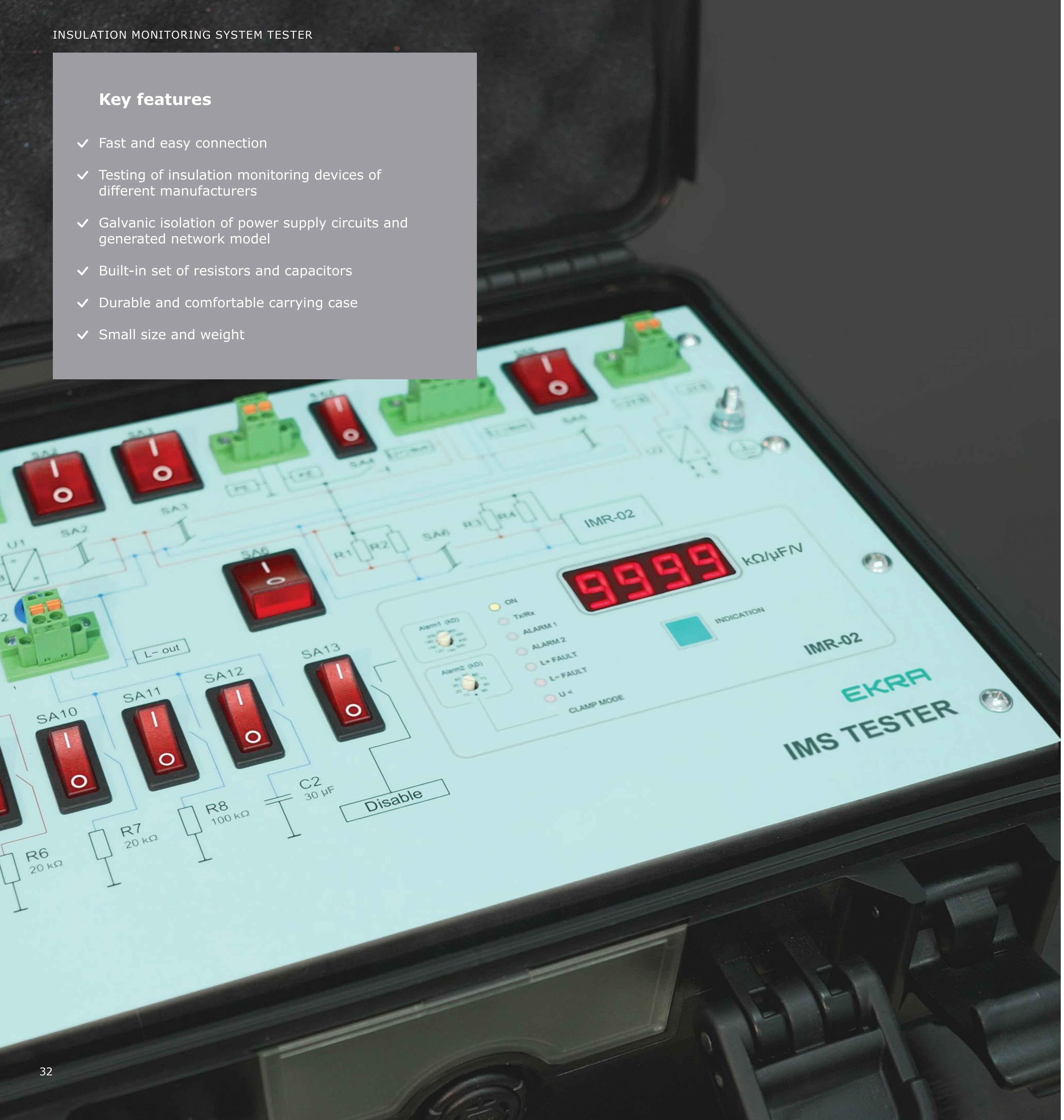
- ✓ Fast and easy connection
- ✓ Application at several facilities in turn
- ✓ Measurements are carried out without disconnecting consumers from the network
- ✓ Durable and comfortable carrying case
- ✓ Small sizes (403 x 334 x 165 mm) and weight (5.5 kg) of the set

INSULATION MONITORING SYSTEM TESTER

Insulation monitoring system (IMS) tester is designed for testing of insulation monitoring devices of different manufacturers in the 220 V DC networks, before their commissioning.

Key features

- Fast and easy connection
- Testing of insulation monitoring devices of different manufacturers
- Galvanic isolation of power supply circuits and generated network model
- Built-in set of resistors and capacitors
- Durable and comfortable carrying case
- Small size and weight



Insulation monitoring system tester:

- represents a model of DC network with different insulation resistance values and capacity of poles relative to ground;
- provides fast and convenient testing of insulation monitoring devices;
- verifies the accuracy of measurements of the equipment through comparison of measured values with the model values;
- tests the correct operation of IMS in the network.

Tester has a shockproof case and includes:

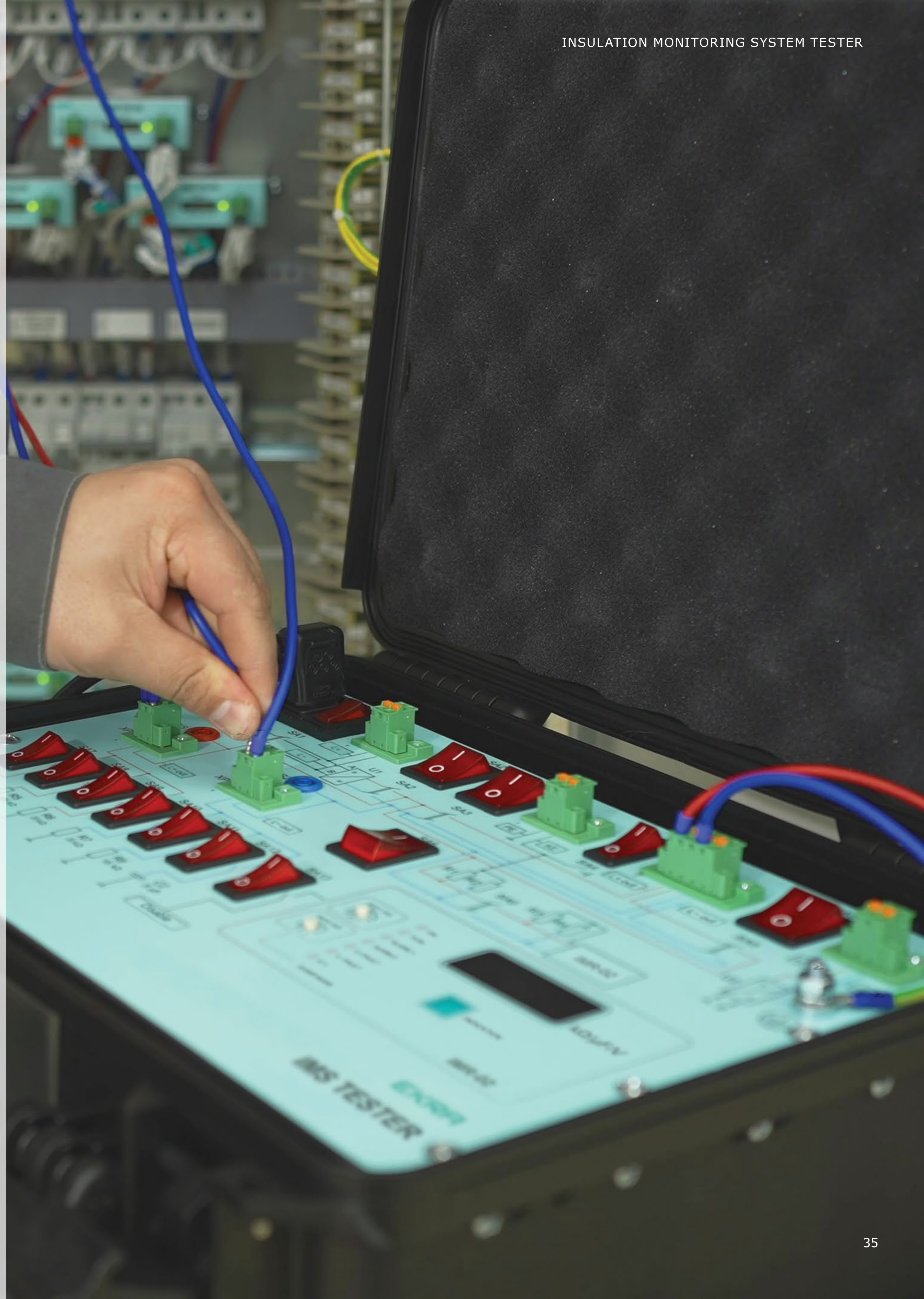
- 220 V DC power supply source for network model generation;
- 24 V DC power supply source for tested devices;
- set of resistors, capacitors, switches and connectors;
- insulation monitoring relay IMR-02[1].

Connection wire set is supplied together with the IMS tester.

1 The IMR-02 characteristics can be found on the page 25

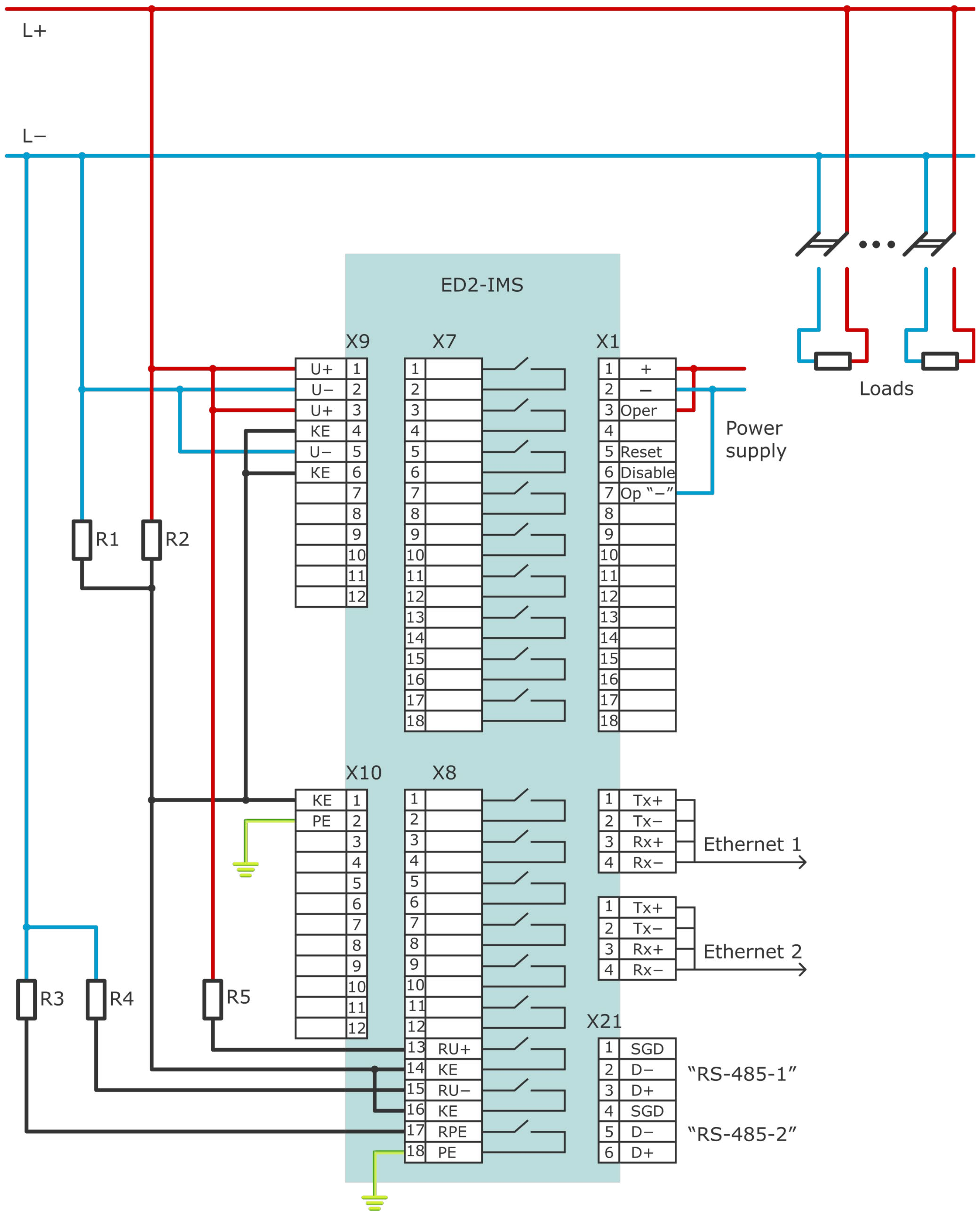
IMS tester characteristics

Power supply voltage for the network model	220 V DC
Power supply voltage for the tested devices	24 V DC
Device power supply voltage	220V AC (50Hz) or 220V DC
Variation range of network model insulation resistance	From 10 to 100 kOhm
Variation range of network model pole capacity	From 0 to 60 μF
Resistance of neutral generation module resistors	10 kOhm
Device power consumption	15 W
Recommended operating temperature range	From +1 to +45 °C
Recommended storage temperature	From -25 to +50 °C
Overall dimensions	403x334x165 mm
Weight	5.5 kg



APPENDIX

Connection diagram of the ED2-IMS



R1, R2 Resistors of 10 kOhm are designed for reducing voltage drop of network poles relative to ground during the IED operation. Can be included in the scope of supply at the request.

R3 Resistor of 100 kOhm is designed for the RE line break monitoring.

R4, R5 Resistors of 30 kOhm are designed for creation of voltage imbalance of network poles, used for network insulation resistance measurement.

X1 Device power supply.

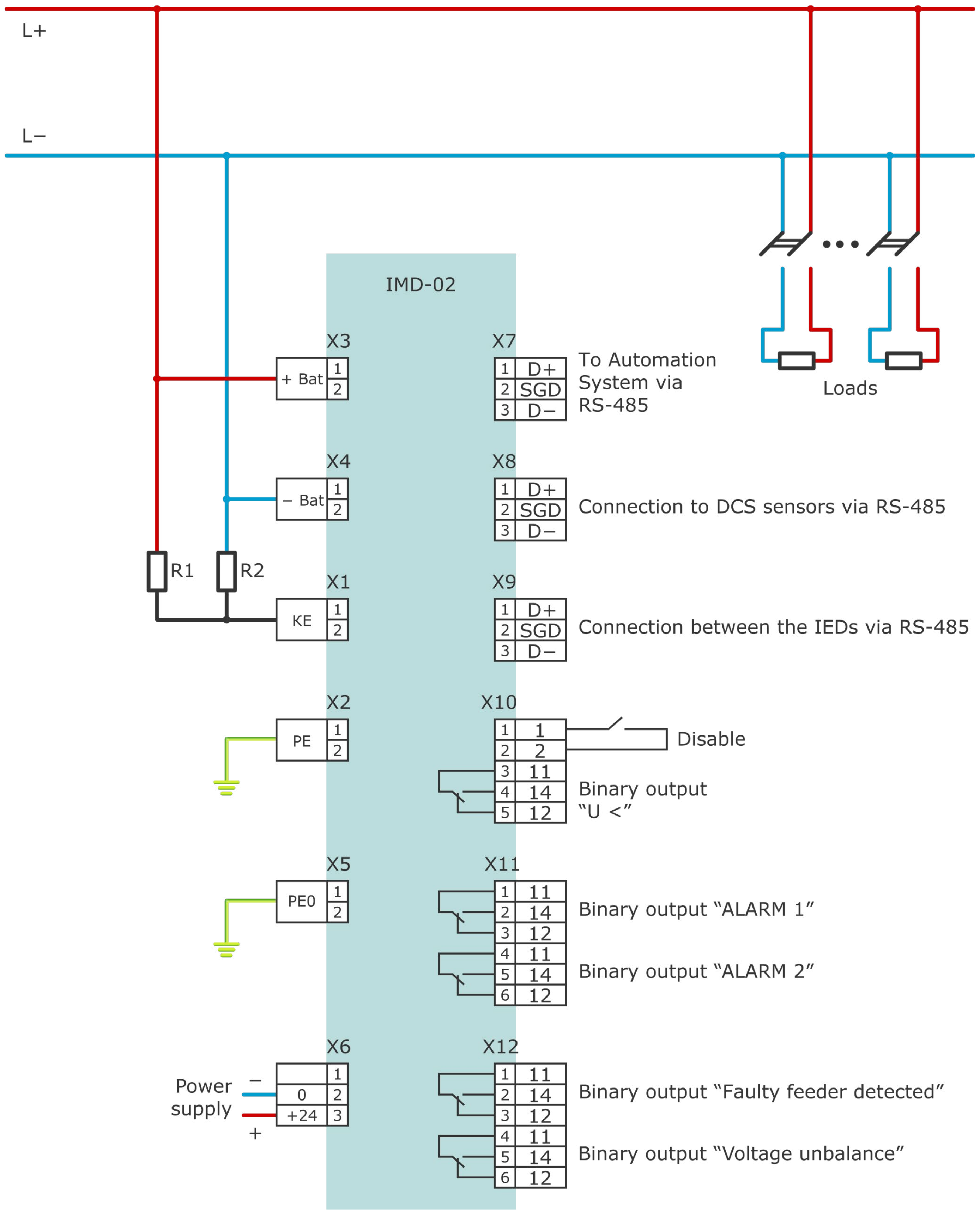
X7, X8 Configured binary outputs. 3 binary outputs are reserved for insulation monitoring function.

X9, X10 Analog inputs (X9 for input voltage circuits and X10 for input current circuits). 3 inputs of voltage circuits and 1 input of current circuit are used for insulation monitoring function.

Ethernet 1, Ethernet 2 Ethernet-connection of IED to Automation System. The Modbus TCP, IEC 60870-5-103, IEC 60870-5-104 and IEC 61850 protocols can be used for the communication.

X21 For connection of DCS sensors to the IED via RS-485 interface.

Connection diagram of the IMD-02



R1, R2 Resistors of 10 kOhm are designed for reducing voltage drop of network poles relative to ground during the IED operation. Can be included in the scope of supply at the request.

X1 Common connection point of R1 and R2 resistors.

X2 RE protective earthing.

X3, X4 For connection of the IED to positive and negative poles of monitored network.

X5 PE0 protective earthing wire for monitoring the PE terminal's contact with ground.

X6 Device power supply. Relay supply circuits are galvanically isolated from the monitored network circuits.

X7 Connectors Data transmission to SAS via RS-485 interface. Modbus RTU is used a communication protocol.

X8 For connection of DCS sensors via RS-485 interface.

X9 For connection between the IEDs via RS-485 interface. Used in case of simultaneous operation of two IEDs.

X10 (1-2) Upon closing of the 1 and 2 contacts, the IED is disabled, stops monitoring the network insulation and giving the output signals.

X10 (3-5) Programmable binary output of the output relay 1. By default - "U <".

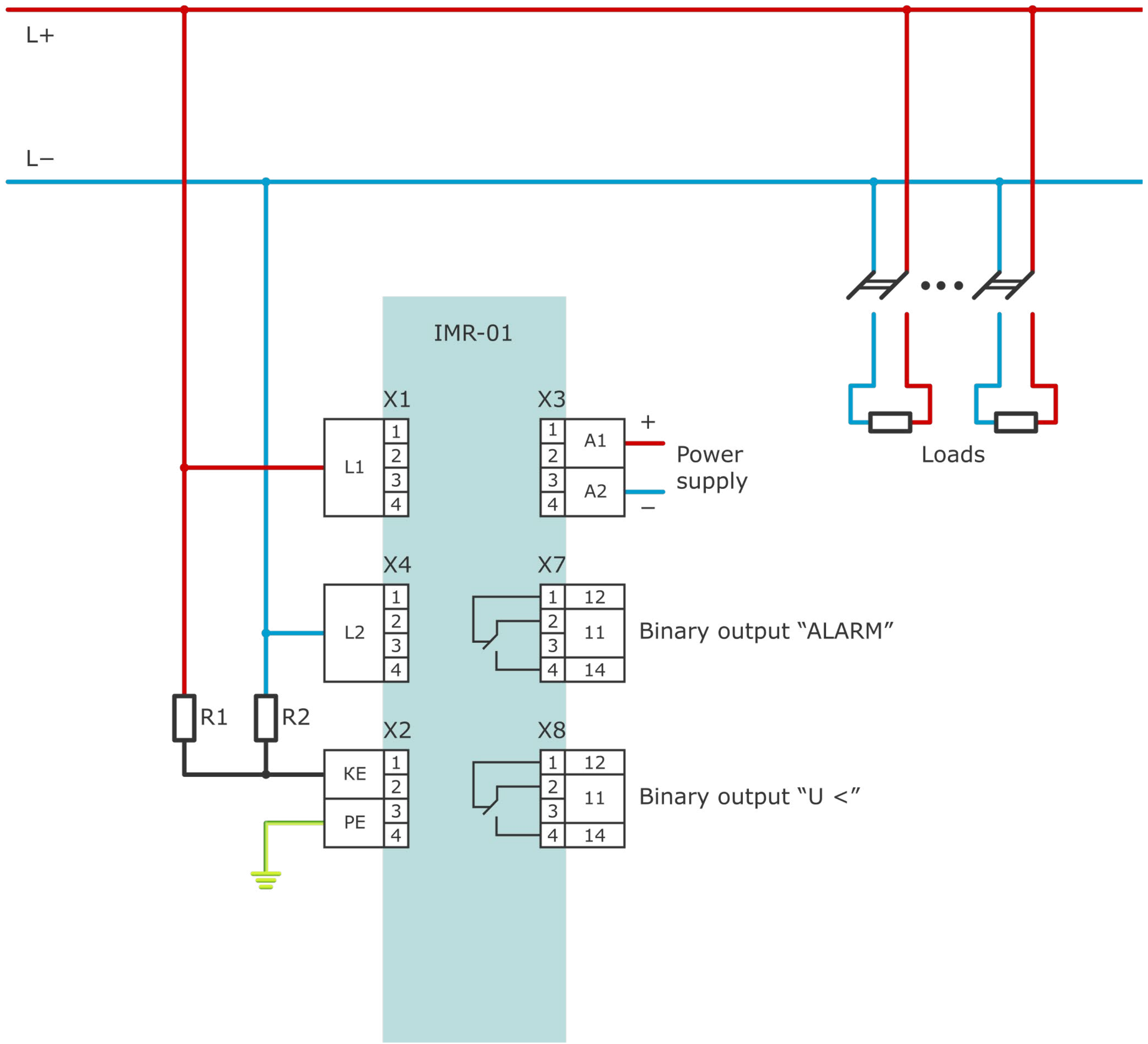
X11 (1-3) Programmable binary output of the output relay 2. By default - "ALARM 1".

X11 (4-6) Programmable binary output of the output relay 3. By default - "ALARM 2".

X12 (1-3) Programmable binary output of the output relay 4. By default - "Faulty feeder detected".

X12 (4-6) Programmable binary output of the output relay 5. By default - "Voltage unbalance".

Connection diagram of the IMR-01



R1, R2 Resistors of 10 kOhm are designed for reducing voltage drop of network poles relative to ground during the IED operation. Can be included in the scope of supply at the request.

X1, X4 For connection of the relay to positive and negative poles of monitored network.

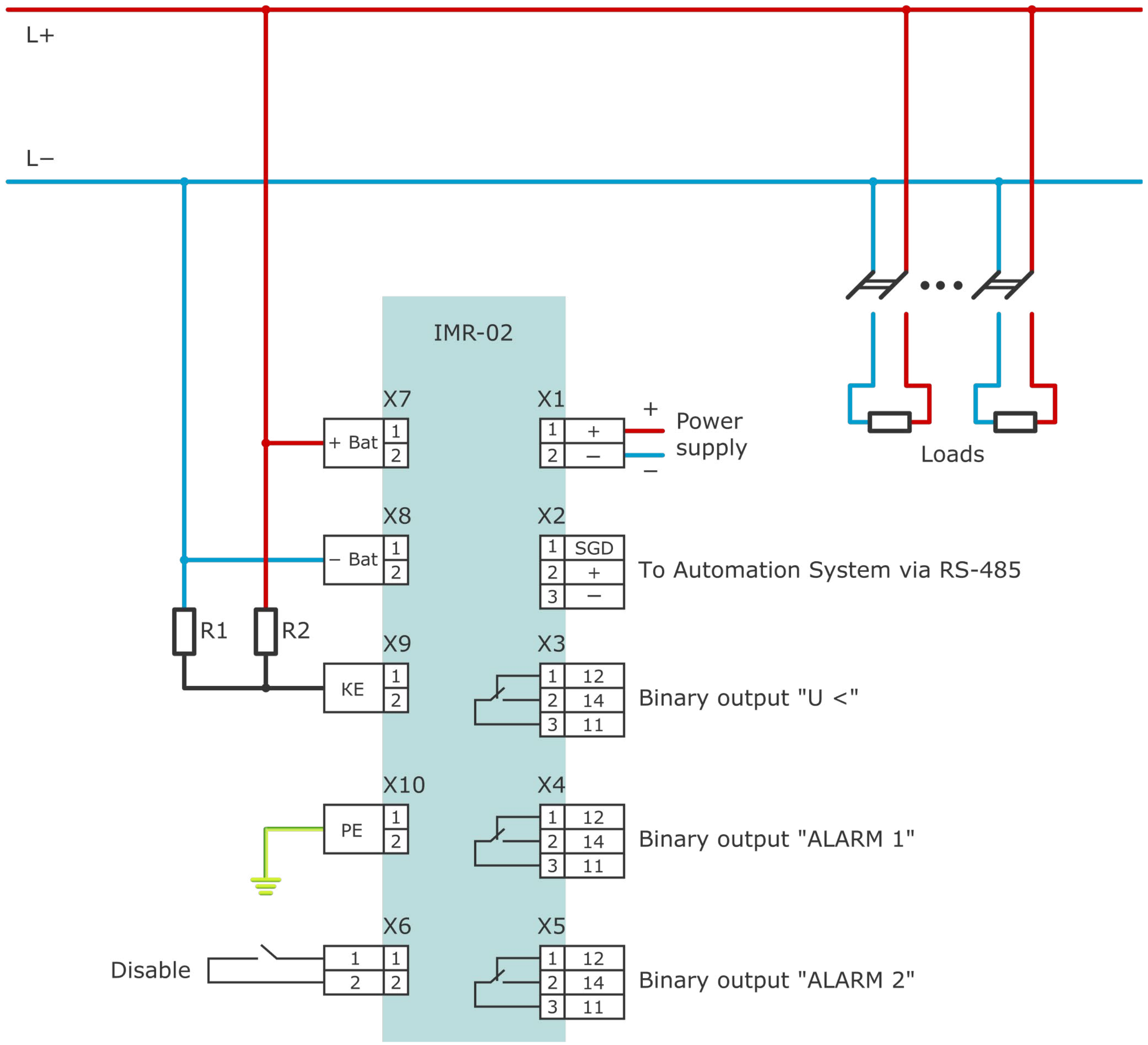
X2 Common connection point of R1 and R2 resistors, and the PE protective earthing.

X3 Device power supply. Relay supply circuits are galvanically isolated from the monitored network circuits.

X7 The “ALARM” binary output actuates at the reduction of the equivalent impedance value of pole insulation below the setting specified by the user.

X8 The “U <” binary output actuates at the reduction of voltage between the monitored network poles for more than 50 %, and indicates a failure in it.

Connection diagram of the IMR-02



R1, R2 Resistors of 10 kOhm are designed for reducing voltage drop of network poles relative to ground during the IED operation. Can be included in the scope of supply at the request.

X1 Device power supply. Relay supply circuits are galvanically isolated from the monitored network circuits.

X2 For connection of relay to control systems via RS-485 interface. Modbus RTU is used as communication protocol.

X3 The "U <" binary output actuates at the reduction of voltage between the monitored network poles for more than 50 %, and indicates a failure in it.

X4 The "ALARM 1" binary output actuates at the reduction of the equivalent impedance value of pole insulation below the setting 1 specified by the user.

X5 The "ALARM 2" binary output actuates at the reduction of the equivalent impedance value of pole insulation below the setting 2 specified by the user.

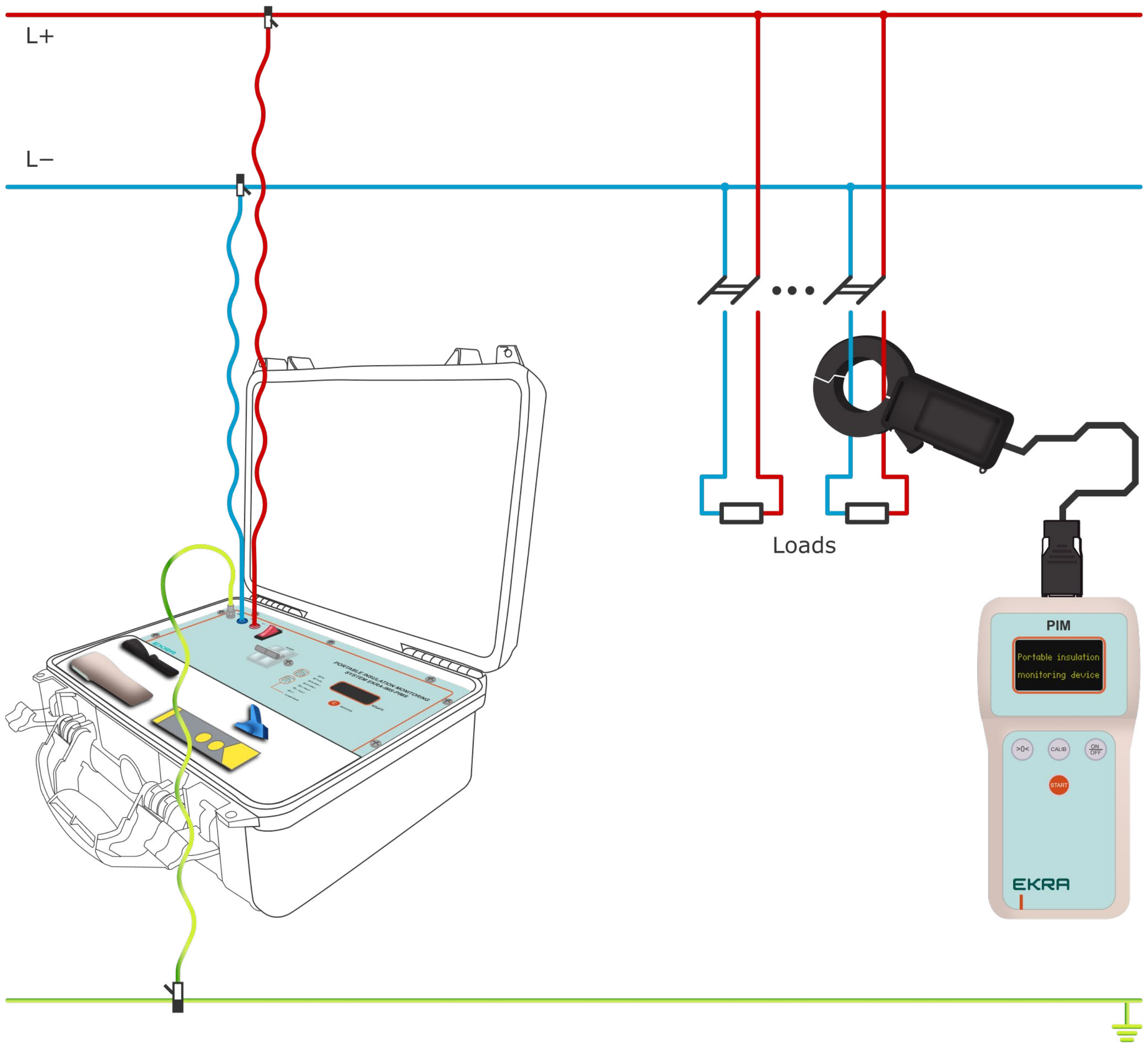
X6 Upon closing of the 1 and 2 contacts, the relay is disabled, stops monitoring the network insulation and giving the output signals.

X7, X8 For connection of the relay to positive and negative poles of monitored network.

X9 Common connection point of R1 and R2 resistors.

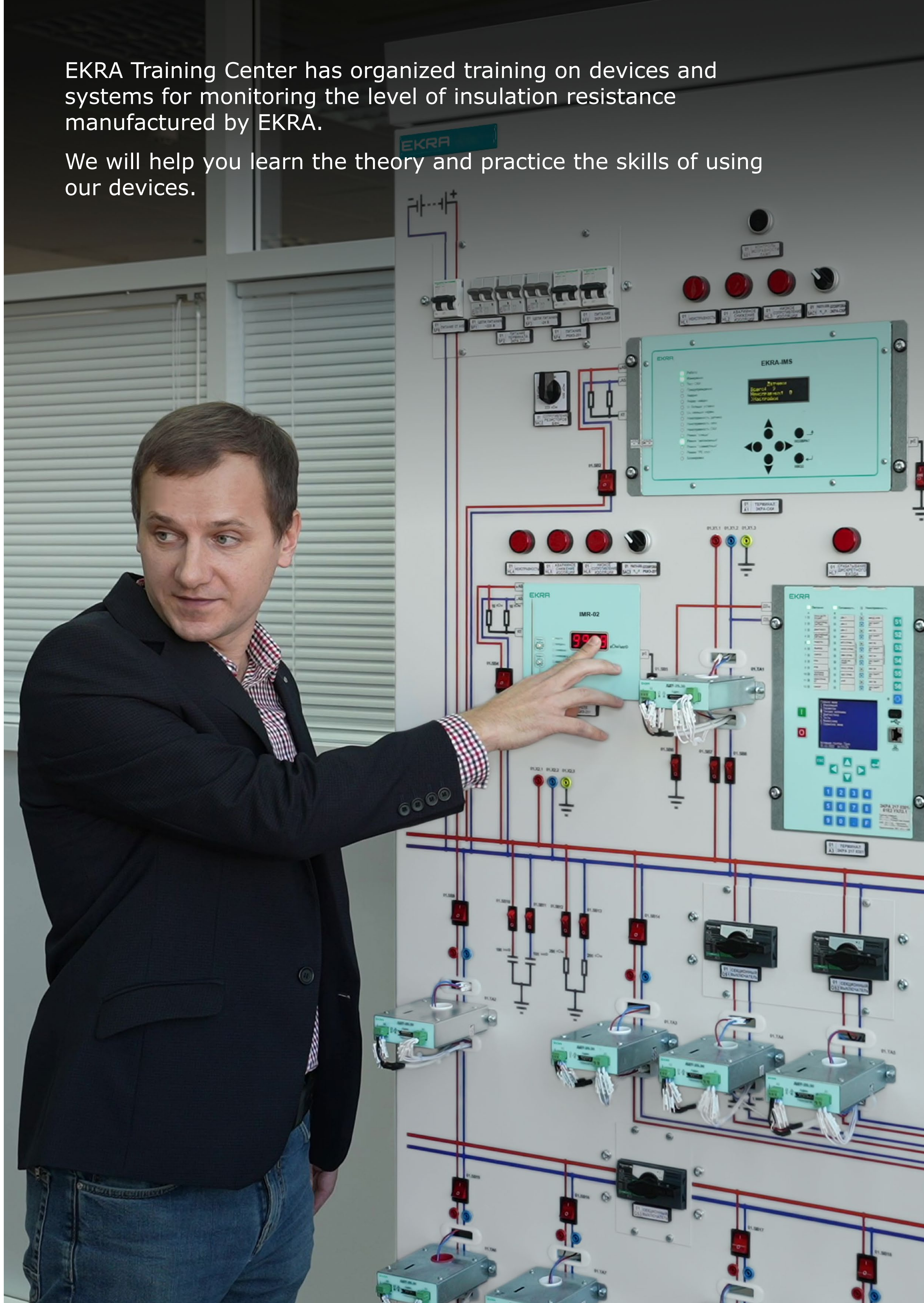
X10 RE protective earthing connection.

Connection diagram of the PIMS



EKRA Training Center has organized training on devices and systems for monitoring the level of insulation resistance manufactured by EKRA.

We will help you learn the theory and practice the skills of using our devices.



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