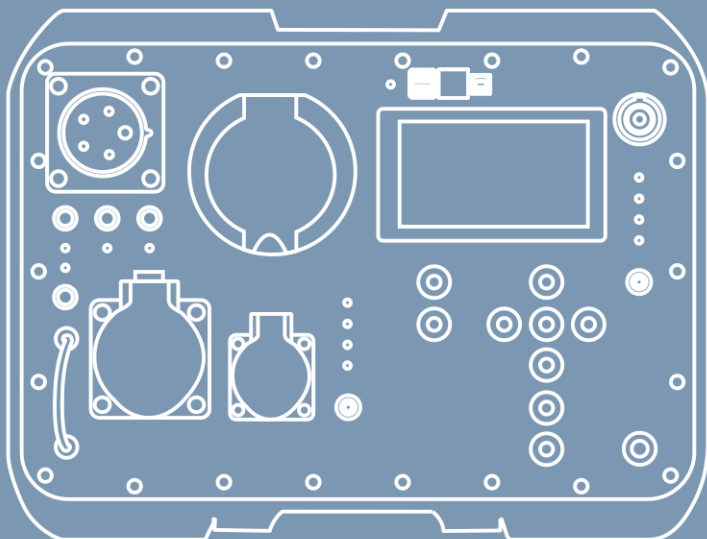
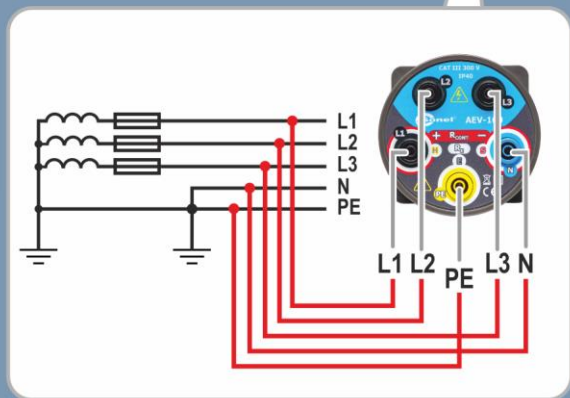
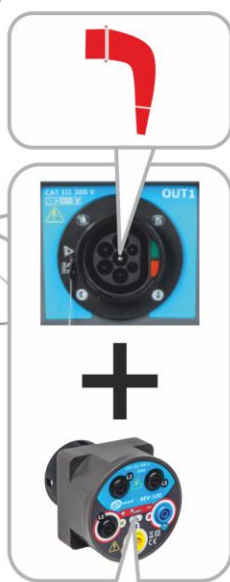
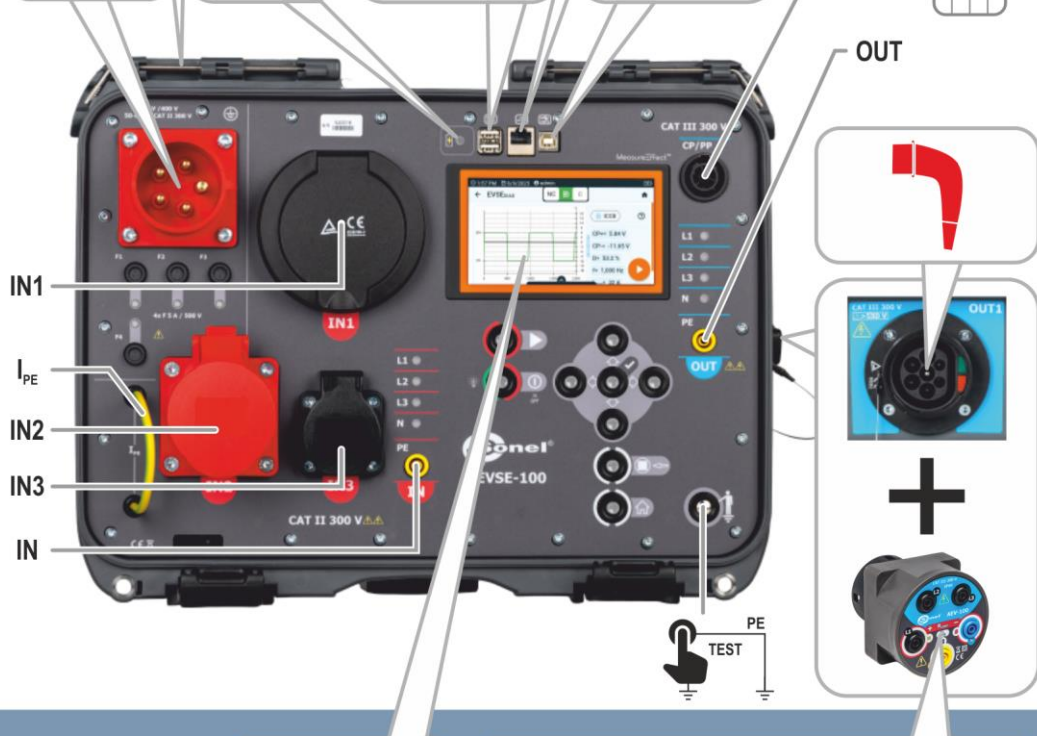
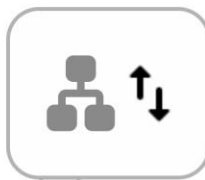




# User manual

## EVSE-100

Multifunctional analyzer for electric vehicle charging stations





## **User manual**

# **EVSE-100**

Multifunctional analyzer for electric vehicle charging stations

**SONEL S.A.**  
Wokulskiego 11  
58-100 Świdnica  
Poland

Version 1.00 27.06.2025

The EVSE-100 meter is a modern, top quality measuring instrument which is easy and safe to use, provided that the principles presented in this manual are observed.

MeasureEffect™

The meters are part of the **Sonel MeasureEffect™** platform. It is a comprehensive system that enables you to take measurements, store and manage data, and provides multi-level control of your instruments. You can find a detailed description of the system in the dedicated user manual.

The manual can be found on the manufacturer's website. Check **www.sonel.com › EN › Download › User manuals (Software section)**, the platform page and the instrument page (**Files** section).

**TROUBLE WITH MEASUREMENTS?**



You can find all the information about the desired test in the help menu of the respective measurement function.



Download the user manual for the **Sonel MeasureEffect™** platform and find information on the test in it. To do so, visit:

- the Sonel MeasureEffect™ platform web page,
- the web page of your instrument.

# CONTENTS

|           |                                                                                              |           |
|-----------|----------------------------------------------------------------------------------------------|-----------|
| <b>1</b>  | <b>General information</b>                                                                   | <b>5</b>  |
| 1.1       | Safety symbols                                                                               | 5         |
| 1.2       | Behaviour of signalling LEDs                                                                 | 5         |
| 1.3       | Safety                                                                                       | 6         |
| 1.4       | General characteristics                                                                      | 7         |
| 1.5       | Compliance with standards                                                                    | 9         |
| <b>2</b>  | <b>Quick start</b>                                                                           | <b>10</b> |
| <b>3</b>  | <b>Voltage check on the PE cable</b>                                                         | <b>11</b> |
| <b>4</b>  | <b>Control signal modulation test</b>                                                        | <b>12</b> |
| <b>5</b>  | <b>Interface</b>                                                                             | <b>13</b> |
| <b>6</b>  | <b>Data transmission</b>                                                                     | <b>14</b> |
| 6.1       | Set of accessories to connect the meter to a PC                                              | 14        |
| 6.2       | Data transmission through USB port                                                           | 14        |
| <b>7</b>  | <b>Fuse replacement</b>                                                                      | <b>15</b> |
| <b>8</b>  | <b>Power supply</b>                                                                          | <b>16</b> |
| 8.1       | Battery power                                                                                | 17        |
| 8.2       | Charging rechargeable battery                                                                | 17        |
| 8.3       | Power supply from mains                                                                      | 18        |
| 8.4       | General rules for using Li-Ion rechargeable batteries                                        | 19        |
| <b>9</b>  | <b>Cleaning and maintenance</b>                                                              | <b>20</b> |
| <b>10</b> | <b>Storage</b>                                                                               | <b>20</b> |
| <b>11</b> | <b>Dismantling and utilisation</b>                                                           | <b>20</b> |
| <b>12</b> | <b>Technical data</b>                                                                        | <b>21</b> |
| 12.1      | Basic data                                                                                   | 21        |
| 12.1.1    | Measurement of AC/DC voltage                                                                 | 21        |
| 12.1.2    | Measurement of frequency                                                                     | 21        |
| 12.1.3    | Measurement of $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$ fault loop impedance                       | 21        |
| 12.1.4    | Measurement of $Z_{L-PE(RCD)}$ fault loop impedance (without tripping the RCD)               | 22        |
| 12.1.5    | Measurement of $Z_{L-PE(RCD)}$ fault loop impedance (without tripping the RCD) – EV type RCD | 23        |
| 12.1.6    | Measurement of earth resistance – 3-pole method ( $R_{E3P}$ )                                | 24        |
| 12.1.7    | Measurement of the RCD parameters                                                            | 24        |
| 12.1.8    | Measurement of insulation resistance                                                         | 27        |
| 12.1.9    | Low-voltage measurement of continuity and resistance                                         | 28        |
| 12.1.10   | Phase sequence                                                                               | 28        |
| 12.1.11   | Resistance of coding resistor                                                                | 28        |
| 12.1.12   | Simulation of PP cable parameters                                                            | 29        |
| 12.1.13   | Simulation of CP communication                                                               | 29        |
| 12.1.14   | EVSE <sub>DIAG</sub> diagnostics                                                             | 29        |
| 12.1.15   | EVSE <sub>ERR</sub> station error simulation                                                 | 30        |
| 12.1.16   | Transition time between states                                                               | 30        |
| 12.2      | Operating data                                                                               | 31        |

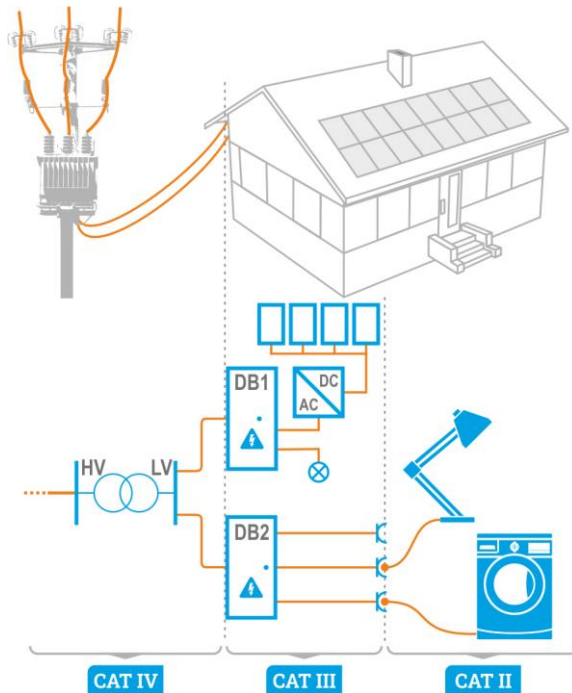
|           |                                                                                                      |           |
|-----------|------------------------------------------------------------------------------------------------------|-----------|
| 12.3      | Bluetooth specification.....                                                                         | 31        |
| 12.4      | Additional data.....                                                                                 | 32        |
| 12.4.1    | Additional uncertainties according to EN IEC 61557-3 (Z).....                                        | 32        |
| 12.4.2    | Additional uncertainties according to EN IEC 61557-4 ( $R \pm 200$ mA).....                          | 32        |
| 12.4.3    | Additional uncertainties according to EN IEC 61557-6 (RCD).....                                      | 32        |
| 12.4.4    | Influence of serial interference voltage on the resistance measurements for function $R_{E3P}$ ..... | 32        |
| 12.4.5    | Influence of the auxiliary electrodes on earth resistance measurements for function $R_{E3P}$ .....  | 33        |
| 12.4.6    | Additional uncertainties according to EN IEC 61557-5 ( $R_{E3P}$ ).....                              | 33        |
| 12.5      | Prospective short-circuit current.....                                                               | 33        |
| <b>13</b> | <b>Manufacturer .....</b>                                                                            | <b>34</b> |

# 1 General information

## 1.1 Safety symbols

The following international symbols are used in the device and/or in this manual:

|                                                                                  |                                                                      |                                                                                   |                                      |                                                                                   |                                                                               |
|----------------------------------------------------------------------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
|  | Refer to the user manual for additional information and explanations |  | Ground                               |  | AC current/voltage                                                            |
|  | DC current/voltage                                                   |  | Double insulation (protection class) |  | Declaration of Conformity with EU directives ( <i>Conformité Européenne</i> ) |
|  | Do not dispose of with other household waste                         |  | Attention, risk of electric shock    |  | Do not connect the device to systems with voltages above 550 V                |



Measurement categories according to EN IEC 61010-2-030:

- **CAT II** – concerns measurements performed in circuits directly connected to low voltage installations,
- **CAT III** – concerns measurements performed in buildings installations,
- **CAT IV** – concerns measurements performed at the source of low voltage installation.

## 1.2 Behaviour of signalling LEDs



The LED is on continuously



The LED flashes slowly



The LED flashes rapidly

## 1.3 Safety

To avoid electric shock or fire, as well as provide the conditions for correct operation and accuracy of obtained results, you must observe the following guidelines:

- Before you proceed to operate the device, acquaint yourself thoroughly with this manual and observe the safety regulations and specifications defined by the producer.
- Any application that differs from those specified in this manual may result in damage to the device and constitute a source of danger for the user.
- The device must be operated solely by appropriately qualified personnel with relevant certificates to realise measurements of electric installation. Operating the meter by unauthorised personnel may result in damage to the device and constitute a source of danger for the user.
- Using this manual does not exclude the need to comply with occupational health and safety regulations and with other relevant fire regulations required during the performance of a particular type of work. Before starting the work with the device in special environments, e.g. potentially fire-risk/explosive environment, it is necessary to consult with the person responsible for health and safety.
- Before starting the work, check the device, wires, adapters and other accessories for any sign of mechanical damage. Pay special attention to the connectors.
- It is unacceptable to operate:
  - ⇒ it is damaged and completely or partially out of order,
  - ⇒ its cords and cables have damaged insulation,
  - ⇒ of the device and accessories mechanically damaged,
  - ⇒ it was stored for an excessive period of time in disadvantageous conditions (e.g. excessive humidity). After moving the device from a cool to a warm place with a high level of relative humidity, do not start measurements until the device is warmed up to the ambient temperature (approximately 30 minutes).
- Before measurement, choose a correct measurement function and make sure that the test leads are connected to their respective measuring terminals.
- The correct operation of the instrument and accessories must be checked regularly to avoid any hazard which may result from erroneous results.
- In a situation where the product works with other instruments or accessories, the lowest measurement category of the connected devices is used.
- Do not power the meter from sources other than those listed in this manual.
- Repairs may only be performed by an authorised service point.



### WARNING

- **Only accessories intended for a given device should be used. Using other accessories may cause damage to measuring terminals, introduce additional measurement errors and create a risk for the user.**
- **Do not touch the tested object during the  $R_{ISO}$  insulation resistance measurement or after the measurement before it is fully discharged. It may result in electric shock.**



### NOTE!

It is forbidden to perform measurements:  $R_{CONT}$  continuity, and test lead compensation, on energized circuits. This may damage the meter.



- OUT1 meter input is electronically protected against overloads (caused by e.g. connecting the meter to a live circuit) up to 550 V RMS for 60 seconds.
- Due to continuous development of the meter's software, the actual appearance of the display for some features may slightly differ from that presented in this user manual. The latest version of the manual is provided on the manufacturer's website.

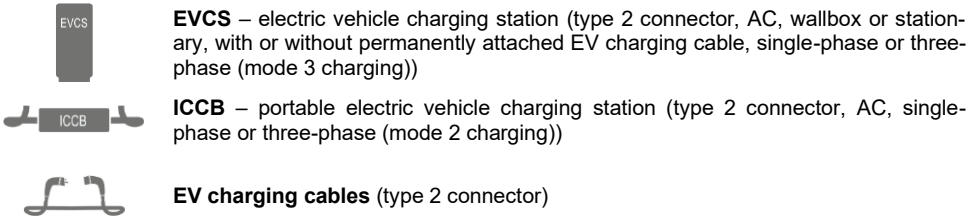


## 1.4 General characteristics

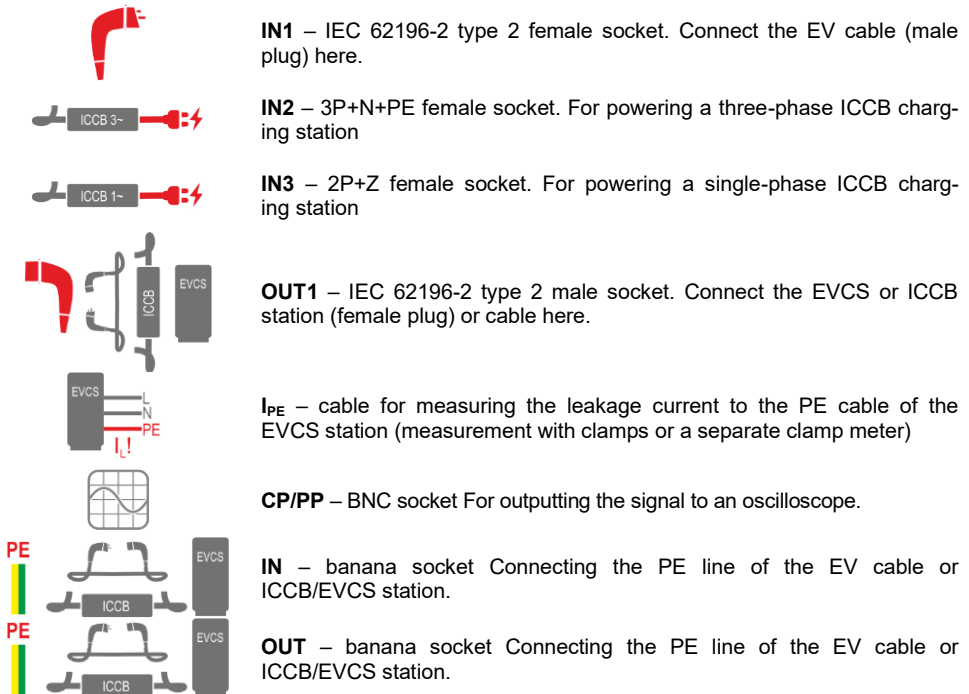
The EVSE-100 is a tool designed for diagnosing electric vehicle charging stations and cables. It can be used to perform a complete range of tests on these items.

By simulating the CP and PP circuits appropriately, the meter can put the station into various operating states. This makes it possible to verify the functionality of the control system and perform electric shock protection measurements. The functionality and safety checks are complemented by error simulations for both the power supply and the vehicle charging function (CP circuit).

### Objects suitable for testing with EVSE-100



### Device sockets



## **Basic functions of the device**

- Simulation of PP cable parameters:
  - open circuit,
  - 13 A, 20 A, 32 A, 63 A, 80 A.
- Simulation of CP communication:
  - state A – vehicle not connected,
  - state B – vehicle connected, not charging,
  - state C – vehicle connected, charging without ventilation,
  - state D – vehicle connected, charging with ventilation.
- Safety measurements:
  - measurement of short circuit loop Z,
  - measurement of parameters of RCD circuit breakers (AC, A, B, 6 mA DC),
  - measurement of insulation resistance  $R_{ISO}$ ,
  - measurement of  $R_{CONT}$ ,
  - phase sequence indication,
  - measurement of resistance of coding resistor  $R_C$ ,
  - measurements of grounding  $R_E$ .
- EVSE analysis – diagnostics:
  - CP+, CP- voltage,
  - frequency f (PWM),
  - signal filling D (PWM),
  - maximum charging current  $I_{MAX}$ ,
  - graph of CP+, CP-, f, D,  $I_{MAX}$ ,
  - $t_{off}$  off time,
  - $t_{on}$  on time.
- EVSE analysis – simulation of errors (ICCB, EVCS):
  - CPsh – short circuit of CP to PE,
  - Dsh – diode short circuit,
  - PEOp – interruption in PE.
- EVSE analysis – simulation of errors (ICCB):
  - L1op – interruption in phase L1,
  - L2op – interruption in phase L2,
  - L3op – interruption in phase L3,
  - Nop – interruption in N,
  - PEOp – interruption in PE,
  - L↔PE – interchanged L and PE wires,
  - $U_{EXT}(PE)$  – voltage on PE wire.
- EVSE analysis – transition time between states.

## 1.5 Compliance with standards

Safety standards:

- EN 61010-1 – Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements.
- EN IEC 61010-2-030 – Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits.
- EN IEC 61010-2-034 – Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-034: Particular requirements for measurement equipment for insulation resistance and test equipment for electric strength.

Standards for electromagnetic compatibility:

- EN IEC 61326-1 – Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements.
- EN IEC 61326-2-2 Electrical equipment for measurement, control and laboratory use – Electromagnetic compatibility (EMC) requirements – Part 2-2: Particular requirements – Test configurations, operational conditions and performance criteria for portable testing, measuring and monitoring equipment used in low-voltage distribution systems.

Referenced standards:

- EN IEC 61851-1 System Electric vehicle conductive charging system – Part 1: General requirements
- IEC 62955 – Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles – applies to charging stations operating in charging mode 3
- IEC 62752 – In-cable control and protection device for mode 2 charging of electric road vehicles (IC-CPD) – applies to portable charging cables with integrated RCD EV 6 mA protective device

## 2 Quick start



When you start the device for the first time, you must set the interface language and create a local user account. Finally, set the date, time and time zone.

1



Turn the meter on.

2



Create or log in to a local user account.

3



Enter the meter settings

4



Select measurement. You can find information about it under  icon and in the **Sonel MeasureEffect™** platform manual.

5



Enter the measurement settings.

6



Connect the meter to the tested object.

7



Start the measurement.

8



End the measurement or wait for it to be completed. Then you can enter additional information about the measurement.

9



Save the result in the memory.

10



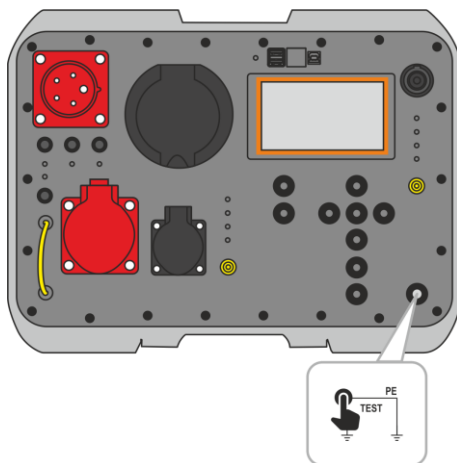
Turn the meter off.



You can save measurements in two ways:

- by performing a measurement and then assigning it to an object in the memory structure,
- entering an object in the memory structure and making a measurement at this memory location

### 3 Voltage check on the PE cable



- Connect the meter to the PE cable of the object being tested, enable the RCD or Z measurement function (except for  $Z_{L-N, L-L}!$ ), touch the electrodes and wait approx. 1 second.
- If the meter detects voltage on the PE cable, it will display a warning. In this case, **immediately stop the measurements and correct the installation error.**



- During the test, be sure to stand on an uninsulated ground. Insulated ground may cause an incorrect test result.
- If the voltage on the PE conductor exceeds the acceptable limit value (approx. 50 V), the meter will signal the fact.
- If the meter is set to IT network, the electrode is inactive.

## 4 Control signal modulation test

Connect the oscilloscope to the CP socket, in order to obtain information about the Pulse-Width Modulation (PWM) of the control signal. The signal has a frequency of 1 kHz. Signal duty cycle indicates the status of the charging station or the maximum current that the station can supply. The current value can be determined based on the following table, contained in EN IEC 61851-1 standard.

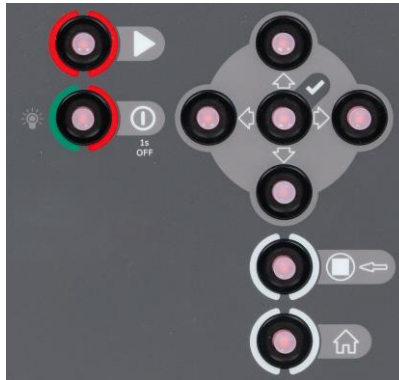
| Nominal duty cycle interpretation by vehicle                                                                                                                         | Maximum current to be drawn by vehicle                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Duty cycle < 3 %                                                                                                                                                     | Charging not allowed                                                                                                                                                                                                                                                                                                                                                              |
| $3 \% \leq \text{duty cycle} \leq 7 \%$                                                                                                                              | Indicates that digital communication will be used to control an off-board DC charger or communicate available line current for an on-board charger. Digital communication may also be used with other duty cycles.<br><br>Charging is not allowed without digital communication.<br><br>5 % duty cycle shall be used if the pilot function wire is used for digital communication |
| $7 \% < \text{duty cycle} < 8 \%$                                                                                                                                    | Charging not allowed                                                                                                                                                                                                                                                                                                                                                              |
| $8 \% \leq \text{duty cycle} < 10 \%$                                                                                                                                | 6 A                                                                                                                                                                                                                                                                                                                                                                               |
| $10 \% \leq \text{duty cycle} \leq 85 \%$                                                                                                                            | Available current = (% duty cycle) $\times$ 0,6 A                                                                                                                                                                                                                                                                                                                                 |
| $85 \% < \text{duty cycle} \leq 96 \%$                                                                                                                               | Available current = (% duty cycle - 64) $\times$ 2,5 A                                                                                                                                                                                                                                                                                                                            |
| $96 \% < \text{duty cycle} \leq 97 \%$                                                                                                                               | 80 A                                                                                                                                                                                                                                                                                                                                                                              |
| Duty cycle > 97 %                                                                                                                                                    | charging not allowed                                                                                                                                                                                                                                                                                                                                                              |
| If the PWM signal is between 8 % and 97 %, the maximum current may not exceed the values indicated by the PWM even if the digital signal indicates a higher current. |                                                                                                                                                                                                                                                                                                                                                                                   |



- Test CP signal in relation to the PE line.
- We recommend using a battery-powered portable oscilloscopes with isolated input and differential probes that ensure galvanic isolation of the oscilloscope.
- If the ground wire of the oscilloscope is not isolated from its casing, then before connecting the oscilloscope, make sure that the PE line of the charging station is free from dangerous voltage!

## 5 Interface

The physical buttons are used to navigate the menu – just like the touch interface controls. They are necessary for when you turn off the screen touch function.



- Turn on the meter / display brightness (short press)
- Turn off the meter (press and hold)



Start / stop measurement



Up



Down



Left



Right



Confirm



Back / delete sign / stop measurement



Go to the main window

To activate a given interface element, use the arrows to select it (successive selected elements will be highlighted), and then press the  button to confirm your selection. The same principle applies to the entire interface: from measurement screens, through the memory management menu and to the help.

## 6 Data transmission

### 6.1 Set of accessories to connect the meter to a PC

In order to ensure the communication of the meter with a computer a USB cable and the relevant software are required:

- Sonel Reader,
- Sonel Reports Plus.

The software may be used for many devices manufactured by SONEL S.A. which are equipped with a USB interface. Detailed information is available from the manufacturer and distributors.

If the required software has not been purchased with the meter, it may be obtained from the manufacturer or from an authorised distributor.

### 6.2 Data transmission through USB port

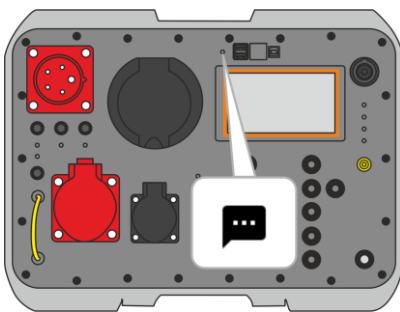
- 

1 Enter the USB mode on the meter.
- 

2 Use the USB cable to connect the meter to the computer.
- 

3 Start the software for data transfer. During data transmission, all buttons on the meter are locked, except for those responsible for interrupting the transmission and switching off the device.

#### Additional information displayed by the meter



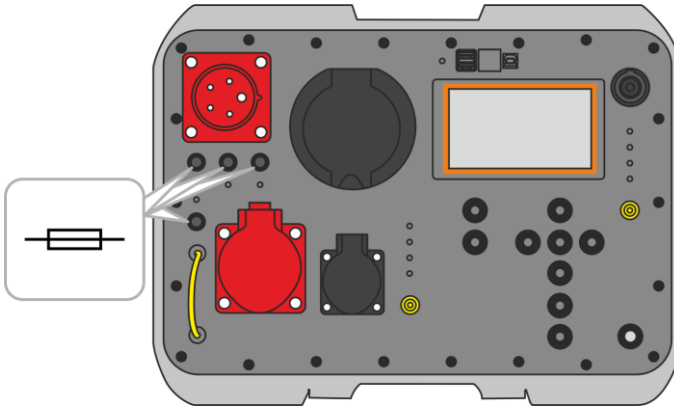
USB communication, data transfer.



## 7 Fuse replacement

The device is protected by one fast-acting fuses 5 x 20 mm 5 A / 500 V AC. To replace the fuse, unscrew the socket head, place a working fuse in place of the damaged fuse, and then screw on the socket head.

- **F1** – protects the L1 line.
- **F2** – protects the L2 line.
- **F3** – protects the L3 line.
- **F4** – protects the N line.



### NOTE!

Do not use fuses other than those listed in this manual.

## 8 Power supply



### NOTE!

Before operating the meter, discharge the battery and then fully charge it, so that the indication of its charged status is correct.

The charge level of the rechargeable battery is indicated by the symbol in the right upper corner of the display on a permanent basis.



Battery charged.



Charging voltage too high. Change the power supply source.



Battery completely discharged – charge it. All measurements are blocked. The meter will turn off automatically when the battery charge drops to a critical level.



Battery temperature out of permissible range. If a charging is in progress, it will be aborted.



Charging of the battery is in progress.



No battery. The meter operates on an external power supply.



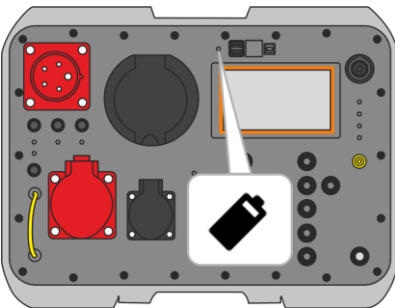
Battery failure. It is recommended to replace it with a new one.



Battery status unknown. Contact the customer service centre.



### Additional information displayed by the meter



Low battery charge level



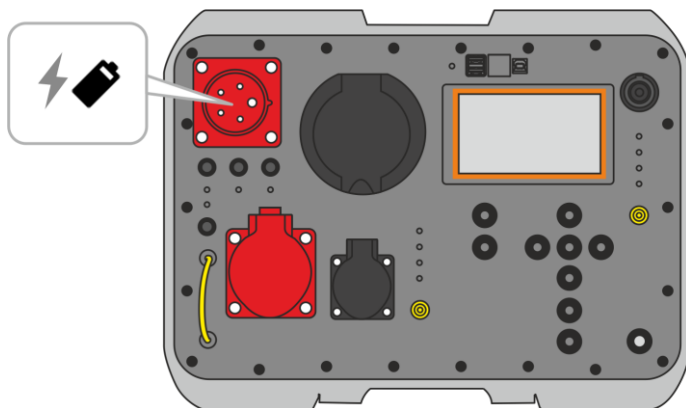
Battery problem



Charging of the battery is in progress

## 8.1 Battery power

The meter is powered by a Li-Ion battery. The whole device is powered via the power cord.



### NOTE!

Do not power the meter from sources other than those listed in this manual.

## 8.2 Charging rechargeable battery

Charging starts once the power supply has been connected to the meter, regardless of whether the meter is on or off. The charging status is indicated on the display and by an active LED.

When the meter is turned off by  button or by AUTO-OFF, the charging process is not stopped.

Indication of completed charging is shown by: .

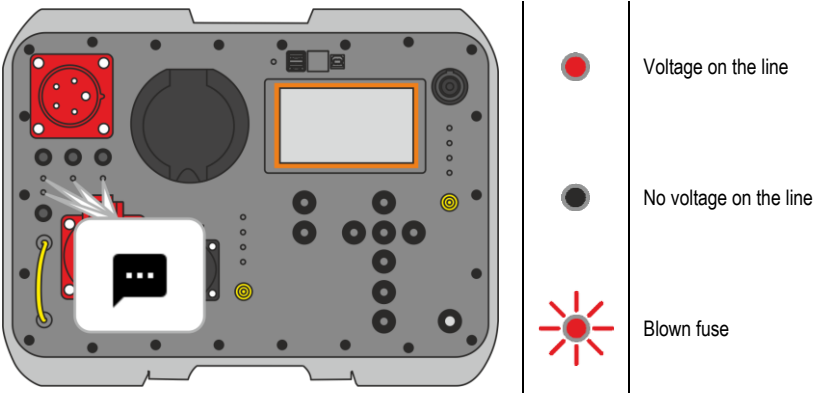
### 8.3 Power supply from mains

It is possible to charge the battery when carrying out the measurements. To do this, just connect the meter to the 230/400 V power supply using a single- or three-phase cable.

When the meter is turned off by  button or by **AUTO-OFF**, the charging process is not stopped.



### Additional information displayed by the meter



## 8.4 General rules for using Li-Ion rechargeable batteries

- Store the meter with batteries charged at least to 50%. The battery pack may be damaged if stored when fully discharged. The ambient temperature for prolonged storage should be maintained within the range of 5°C...25°C. The environment should be dry and well ventilated. Protect the device from direct sunlight.
- Charge the batteries in a cool, well-ventilated place at a temperature of 10°C ... 28°C. Modern fast chargers detect both too low and too high temperature of rechargeable batteries and react to the situation adequately. When the temperature is too low, charging is prevented as it may irreparably damage the batteries.
- Do not charge or use the batteries in extreme temperatures. Extreme temperatures reduce the lifetime of rechargeable batteries. Always observe the rated operating temperature. Do not dispose of the battery pack into fire.
- Li-Ion cells are sensitive to mechanical damage. This kind of damage may cause its permanent damage and thus cause ignition or explosion. Any interference in the structure of Li-ion battery pack may cause its damage. This may result in its ignition or explosion. A short-circuit of the battery poles "+" and "-" may permanently damage the battery pack or even cause its fire or explosion.
- Do not immerse Li-Ion battery in liquids and do not store in humid conditions.
- If the electrolyte contained in the Lithium-Ion battery pack comes into contact with eyes or skin, immediately rinse the affected area with plenty of water and consult with a doctor. Protect the battery against unauthorised persons and children.
- When you notice any changes in the Lithium-Ion battery pack (e.g. changes in colour, swelling, excessive temperature), stop using the battery pack. Li-Ion batteries that are mechanically damaged, overcharged or excessively discharged are not suitable for use.
- Any misuse of the battery may cause its permanent damage. This may result in its ignition. The seller and the manufacturer shall not be liable for any damages resulting from improper handling of the Li-Ion battery pack.

## 9 Cleaning and maintenance



### NOTE!

Use only the maintenance methods specified by the manufacturer in this manual.

The casing of the meter may be cleaned with a soft, damp cloth using all-purpose detergents. Do not use any solvents or cleaning agents which might damage the casing (powders, pastes, etc.).

Clean the probe with water and dry it.

The test leads should be cleaned with water and detergents, and then dried.

The electronic system of the meter does not require maintenance.

## 10 Storage

In the case of storage of the device, the following recommendations must be observed:

- disconnect all the test leads from the meter,
- clean the meter and all its accessories thoroughly,
- wind the test leads,
- in order to prevent a total discharge of the battery pack in the case of a prolonged storage, charge the device **at least once every six months**.

## 11 Dismantling and utilisation

Worn-out electric and electronic equipment should be gathered selectively, i.e. it must not be placed with waste of another kind.

Worn-out electronic equipment should be sent to a collection point in accordance with the regulations valid in a given region.

Before the equipment is sent to a collection point, do not dismantle any elements.

Observe local regulations concerning disposal of packages, waste batteries and rechargeable batteries.

## 12 Technical data

### 12.1 Basic data

⇒ The abbreviation "m.v." used in the specification of accuracy denotes a measured value

#### 12.1.1 Measurement of AC/DC voltage

Measurement range: **0 V...500 V**

| Display range   | Resolution | Accuracy                                   |
|-----------------|------------|--------------------------------------------|
| 0.0 V...299.9 V | 0.1 V      | $\pm(2\% \text{ m.v.} + 6 \text{ digits})$ |
| 300 V...500 V   | 1 V        | $\pm(2\% \text{ m.v.} + 2 \text{ digits})$ |

- Frequency range: 45...65 Hz

#### 12.1.2 Measurement of frequency

| Display range  | Resolution | Accuracy                                    |
|----------------|------------|---------------------------------------------|
| 45.0...65.0 Hz | 0.1 Hz     | $\pm(0.1\% \text{ m.v.} + 1 \text{ digit})$ |

- Voltage range: 50...500 V

#### 12.1.3 Measurement of $Z_{L-PE}$ , $Z_{L-N}$ , $Z_{L-L}$ fault loop impedance

##### $Z_s$ fault loop impedance measurement

Measuring range according to EN IEC 61557:

| Test lead   | $Z_s$ measurement range |
|-------------|-------------------------|
| 1.2 m       | 0.13...1999 $\Omega$    |
| 5 m         | 0.17...1999 $\Omega$    |
| 10 m        | 0.21...1999 $\Omega$    |
| 20 m        | 0.29...1999 $\Omega$    |
| EVCAB 2.2 m | 0.15...1999 $\Omega$    |

Display ranges:

| Display range         | Resolution    | Accuracy                                   |
|-----------------------|---------------|--------------------------------------------|
| 0...19.99 $\Omega$    | 0.01 $\Omega$ | $\pm(5\% \text{ m.v.} + 3 \text{ digits})$ |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  | $\pm(5\% \text{ m.v.} + 3 \text{ digits})$ |
| 200...1999 $\Omega$   | 1 $\Omega$    | $\pm(5\% \text{ m.v.} + 3 \text{ digits})$ |

- Rated operating voltage  $U_{N-L}/U_{N-L-L}$ : 220/380 V, 230/400 V, 240/415 V
- Voltage operating range: 180...270 V (for  $Z_{L-PE}$  and  $Z_{L-N}$ ) and 180...460 V (for  $Z_{L-L}$ )
- Mains rated frequency  $f_n$ : 50 Hz, 60 Hz
- Frequency operating range: 45...65 Hz
- Maximum test current: 7.6 A for 230 V (4x10 ms), 13.3 A for 400 V (4x10 ms)
- Check of PE terminal connection correctness with the contact electrode (for  $Z_{L-PE}$ )

##### Readings of fault loop impedance $R_s$ and fault loop reactance $X_s$

| Display range         | Resolution    | Accuracy                                     |
|-----------------------|---------------|----------------------------------------------|
| 0...19.99 $\Omega$    | 0.01 $\Omega$ | $\pm(5\% + 5 \text{ digits})$ of $Z_s$ value |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  | $\pm(5\% + 5 \text{ digits})$ of $Z_s$ value |

- Calculated and displayed for  $Z_s$  values <200  $\Omega$

## Readings of short-circuit current $I_k$

Measurement ranges according to EN IEC 61557 can be calculated from the measurement ranges  $Z_s$  and rated voltages.

| Display range   | Resolution | Accuracy                                               |
|-----------------|------------|--------------------------------------------------------|
| 0.110...1.999 A | 0.001 A    | Calculated on the basis of accuracy for the fault loop |
| 2.00...19.99 A  | 0.01 A     |                                                        |
| 20.0...199.9 A  | 0.1 A      |                                                        |
| 200...9999 A    | 1 A        |                                                        |

- Prospective fault current calculated and displayed by the meter may slightly differ from the value calculated by the user with a calculator, basing on the displayed value of the impedance, because the meter calculates the current from unrounded value of fault loop impedance (which is used for displaying). As the correct value, consider  $I_k$  current value, displayed by the meter or by firmware.

### 12.1.4 Measurement of $Z_{L-PE[RCD]}$ fault loop impedance (without tripping the RCD)

#### $Z_s$ fault loop impedance measurement

Measuring range according to EN IEC 61557: **0.5...1999  $\Omega$**  for the 1.2 m leads and **0.51...1999  $\Omega$**  for the 5 m, 10 m and 20 m leads and EV CAB 2.2 m

| Display range         | Resolution    | Accuracy                                    |
|-----------------------|---------------|---------------------------------------------|
| 0...19.99 $\Omega$    | 0.01 $\Omega$ | $\pm(6\% \text{ m.v.} + 10 \text{ digits})$ |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  | $\pm(6\% \text{ m.v.} + 5 \text{ digits})$  |
| 200...1999 $\Omega$   | 1 $\Omega$    | $\pm(6\% \text{ m.v.} + 5 \text{ digits})$  |

- Does not trip the RCD's with  $I_{\Delta n} \geq 30 \text{ mA}$
- Rated operating voltage  $U_n$ : 220 V, 230 V, 240 V
- Voltage operating range: 180...270 V
- Mains rated frequency  $f_n$ : 50 Hz, 60 Hz
- Frequency operating range: 45...65 Hz
- Check of PE terminal connection correctness with the contact electrode

#### Readings of fault loop impedance $R_s$ and fault loop reactance $X_s$

| Display range         | Resolution    | Accuracy                                      |
|-----------------------|---------------|-----------------------------------------------|
| 0...19.99 $\Omega$    | 0.01 $\Omega$ | $\pm(6\% + 10 \text{ digits})$ of $Z_s$ value |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  | $\pm(6\% + 5 \text{ digits})$ of $Z_s$ value  |

- Calculated and displayed for  $Z_s$  values <200  $\Omega$

#### Readings of short-circuit current $I_k$

Measurement ranges according to EN IEC 61557 can be calculated from the measurement ranges  $Z_s$  and rated voltages.

| Display range   | Resolution | Accuracy                                               |
|-----------------|------------|--------------------------------------------------------|
| 0.110...1.999 A | 0.001 A    | Calculated on the basis of accuracy for the fault loop |
| 2.00...19.99 A  | 0.01 A     |                                                        |
| 20.0...199.9 A  | 0.1 A      |                                                        |
| 200...9999 A    | 1 A        |                                                        |

- Prospective fault current calculated and displayed by the meter may slightly differ from the value calculated by the user with a calculator, basing on the displayed value of the impedance, because the meter calculates the current from unrounded value of fault loop impedance (which is used for displaying). As the correct value, consider  $I_k$  current value, displayed by the meter or by firmware.



## 12.1.5 Measurement of $Z_{L-PE[RCD]}$ fault loop impedance (without tripping the RCD) – EV type RCD

### $Z_s$ fault loop impedance measurement

Measuring range according to EN IEC 61557: **0.5...1999  $\Omega$**  for the 1.2 m leads and **0.51...1999  $\Omega$**  for the 5 m, 10 m and 20 m leads and EV CAB 2.2 m

| Display range         | Resolution    | Accuracy                                    |
|-----------------------|---------------|---------------------------------------------|
| 0...19.99 $\Omega$    | 0.01 $\Omega$ | $\pm(6\% \text{ m.v.} + 10 \text{ digits})$ |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  | $\pm(7\% \text{ m.v.} + 5 \text{ digits})$  |
| 200...1999 $\Omega$   | 1 $\Omega$    | $\pm(7\% \text{ m.v.} + 5 \text{ digits})$  |

- Does not trip the EV type RCDs with  $I_{\Delta n} \geq 15 \text{ mA}$
- Rated operating voltage  $U_n$ : 220 V, 230 V, 240 V
- Voltage operating range: 180...270 V
- Mains rated frequency  $f_n$ : 50 Hz, 60 Hz
- Frequency operating range: 45...65 Hz
- Check of PE terminal connection correctness with the contact electrode

### Readings of fault loop impedance $R_s$ and fault loop reactance $X_s$

| Display range         | Resolution    | Accuracy                                      |
|-----------------------|---------------|-----------------------------------------------|
| 0...19.99 $\Omega$    | 0.01 $\Omega$ | $\pm(6\% + 10 \text{ digits})$ of $Z_s$ value |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  | $\pm(7\% + 5 \text{ digits})$ of $Z_s$ value  |

- Calculated and displayed for  $Z_s$  values  $< 200 \Omega$

### Readings of short-circuit current $I_k$

Measurement ranges according to EN IEC 61557 can be calculated from the measurement ranges  $Z_s$  and rated voltages.

| Display range   | Resolution | Accuracy                                               |
|-----------------|------------|--------------------------------------------------------|
| 0.110...1.999 A | 0.001 A    | Calculated on the basis of accuracy for the fault loop |
| 2.00...19.99 A  | 0.01 A     |                                                        |
| 20.0...199.9 A  | 0.1 A      |                                                        |
| 200...9999 A    | 1 A        |                                                        |

- Prospective fault current calculated and displayed by the meter may slightly differ from the value calculated by the user with a calculator, basing on the displayed value of the impedance, because the meter calculates the current from unrounded value of fault loop impedance (which is used for displaying). As the correct value, consider  $I_k$  current value, displayed by the meter or by firmware.

### 12.1.6 Measurement of earth resistance – 3-pole method ( $R_E3P$ )

The measurement method: 3-pole, in accordance with EN IEC 61557-5.

Measuring range according to EN IEC 61557-5: **0.85  $\Omega$ ...1999  $\Omega$**  for  $U_n = 50$  V.

| Display range         | Resolution    | Accuracy                                   |
|-----------------------|---------------|--------------------------------------------|
| 0.00...19.99 $\Omega$ | 0.01 $\Omega$ | $\pm(3\% \text{ m.v.} + 5 \text{ digits})$ |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  |                                            |
| 200...1999 $\Omega$   | 1 $\Omega$    | $\pm 5\% \text{ m.v.}$                     |

- Measuring current at the short circuit: 15 mA
- Measuring frequency: 125 Hz or 150 Hz
- Selected test voltage: 25 V or 50 V
- Maximum interference voltage for the  $R_E$  measurement: 24 V
- Maximum resistance of auxiliary earth electrodes: 2 k $\Omega$

### Measurement of resistance of auxiliary earth electrodes $R_H$ , $R_S$

| Display range          | Resolution      | Accuracy                                        |
|------------------------|-----------------|-------------------------------------------------|
| 0...999 $\Omega$       | 1 $\Omega$      | $\pm(5\% (R_S + R_E + R_H) + 8 \text{ digits})$ |
| 1.00...1.99 k $\Omega$ | 0.01 k $\Omega$ |                                                 |

### 12.1.7 Measurement of the RCD parameters

- Measurement of RCDs type: AC, A, B, B+, F, EV
- Rated operating voltage  $U_n$ : 220 V, 230 V, 240 V
- Voltage operating range: 180...270 V
- Mains rated frequency  $f_n$ : 50 Hz, 60 Hz
- Frequency operating range: 45...65 Hz

### RCD tripping test and $t_A$ tripping time measurement (for $t_A$ measurement function)

Measuring range according to EN IEC 61557-6: **10 ms ... to the upper limit of displayed value**

| RCD type                               | Multiplication factor setting    | Display range | Resolution | Accuracy                            |  |  |
|----------------------------------------|----------------------------------|---------------|------------|-------------------------------------|--|--|
| General type and short-time delay type | 0.5 I <sub>Δn</sub>              | 0...300 ms    | 1 ms       | ±(2% m.v. + 2 digits) <sup>1)</sup> |  |  |
|                                        | 1 I <sub>Δn</sub>                |               |            |                                     |  |  |
|                                        | 2 I <sub>Δn</sub>                | 0...150 ms    |            |                                     |  |  |
|                                        | 5 I <sub>Δn</sub>                | 0...40 ms     |            |                                     |  |  |
| Selective                              | 0.5 I <sub>Δn</sub>              | 0...500 ms    |            |                                     |  |  |
|                                        | 1 I <sub>Δn</sub>                |               |            |                                     |  |  |
|                                        | 2 I <sub>Δn</sub>                | 0...200 ms    |            |                                     |  |  |
|                                        | 5 I <sub>Δn</sub>                | 0...150 ms    |            |                                     |  |  |
| ▪ EV 6 mA DC<br>▪ RCM                  | 1 I <sub>Δn</sub>                | 0.0...10.0 s  | 0.1 s      | ±(2% m.v. + 3 digits)               |  |  |
|                                        | 10 I <sub>Δn</sub>               | 0...300 ms    | 1 ms       |                                     |  |  |
|                                        | 33 I <sub>Δn</sub> <sup>2)</sup> | 0...100 ms    |            |                                     |  |  |
|                                        | 50 I <sub>Δn</sub> <sup>3)</sup> | 0...40 ms     |            |                                     |  |  |

<sup>1)</sup> for  $I_{\Delta n} = 10$  mA and 0.5  $I_{\Delta n}$  accuracy is  $\pm(2\% \text{ m.v.} + 3 \text{ digits})$

<sup>2)</sup> for measurements acc. to IEC 62955

<sup>3)</sup> for measurements acc. to IEC 62752

- Accuracy of differential current setting:

- for 1  $I_{\Delta n}$ , 2  $I_{\Delta n}$ , 5  $I_{\Delta n}$  ..... 0...8%
- for 0.5  $I_{\Delta n}$  ..... -8...0%

**Effective value of forced leakage current at measurement of RCD disconnection time (does not apply to RCD EV 6 mA DC and RCM) [mA]**

| $I_{\Delta n}$ | Multiplication factor setting                                                     |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |
|----------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|                | 0.5                                                                               |                                                                                   |                                                                                   | 1                                                                                 |                                                                                   |                                                                                   | 2                                                                                 |                                                                                   |                                                                                   | 5                                                                                 |                                                                                   |                                                                                   |
|                |  |  |  |  |  |  |  |  |  |  |  |  |
| 10             | 5                                                                                 | 3.5                                                                               | 5                                                                                 | 10                                                                                | 20                                                                                | 20                                                                                | 20                                                                                | 40                                                                                | 40                                                                                | 50                                                                                | 100                                                                               | 100                                                                               |
| 15             | 7.5                                                                               | 5.25                                                                              | 7.5                                                                               | 15                                                                                | 30                                                                                | 30                                                                                | 15                                                                                | 60                                                                                | 60                                                                                | 75                                                                                | 150                                                                               | 150                                                                               |
| 30             | 15                                                                                | 10.5                                                                              | 15                                                                                | 30                                                                                | 42                                                                                | 60                                                                                | 60                                                                                | 84                                                                                | 120                                                                               | 150                                                                               | 210                                                                               | 300                                                                               |
| 100            | 50                                                                                | 35                                                                                | 50                                                                                | 100                                                                               | 140                                                                               | 200                                                                               | 200                                                                               | 280                                                                               | 400                                                                               | 500                                                                               | —                                                                                 | —                                                                                 |
| 300            | 150                                                                               | 105                                                                               | 150                                                                               | 300                                                                               | 420                                                                               | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 |
| 500            | 250                                                                               | 175                                                                               | 250                                                                               | 500                                                                               | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 | —                                                                                 |

**Effective value of forced leakage current at measurement of RCD disconnection time (applies to RCD EV 6 mA DC and RCM) [mA]**

| $I_{\Delta n}$            | Multiplication factor setting |    |     |     |
|---------------------------|-------------------------------|----|-----|-----|
|                           | 1                             | 10 | 33  | 50  |
| 6 mA DC acc. to IEC 62955 | 6                             | 60 | 200 | —   |
| 6 mA DC acc. to IEC 62752 | 6                             | 60 | —   | 300 |

**R<sub>E</sub> – protective conductor resistance for RCD**

| Selected RCD rated current | Measurement range                  | Resolution      | Test current | Accuracy                      |
|----------------------------|------------------------------------|-----------------|--------------|-------------------------------|
| 10 mA                      | 0.01 k $\Omega$ ...5.00 k $\Omega$ | 0.01 k $\Omega$ | 4 mA         | 0....+10% m.v. $\pm 8$ digits |
| 15 mA                      | 0.01 k $\Omega$ ...3.33 k $\Omega$ |                 | 5.3 mA       | 0....+10% m.v. $\pm 5$ digits |
| 30 mA                      | 0.01 k $\Omega$ ...1.66 k $\Omega$ |                 | 12 mA        |                               |
| 100 mA                     | 1 $\Omega$ ...500 $\Omega$         | 1 $\Omega$      | 40 mA        | 0....+5% m.v. $\pm 5$ digits  |
| 300 mA                     | 1 $\Omega$ ...166 $\Omega$         |                 | 120 mA       |                               |
| 500 mA                     | 1 $\Omega$ ...100 $\Omega$         |                 | 200 mA       |                               |

**Measurement of touch voltage U<sub>B</sub> referred to rated residual current**

Measuring range according to EN IEC 61557: **10...50 V**

| Measurement range | Resolution | Test current       | Accuracy                    |
|-------------------|------------|--------------------|-----------------------------|
| 0...9.9 V         | 0.1 V      | 0.4 $I_{\Delta n}$ | 0...10% m.v. $\pm 5$ digits |
| 10.0...99.9 V     |            |                    | 0...15% m.v.                |

**RCD I<sub>A</sub> tripping current measurement for sinusoidal residual current**

Measuring range according to EN IEC 61557: **(0.3...1.0)  $I_{\Delta n}$**

| Selected RCD rated current | Measurement range | Resolution | Test current                               | Accuracy            |
|----------------------------|-------------------|------------|--------------------------------------------|---------------------|
| 10 mA                      | 3.0...10.0 mA     | 0.1 mA     | 0.3 I <sub>Δn</sub> ...1.0 I <sub>Δn</sub> | ±5% I <sub>Δn</sub> |
| 15 mA                      | 4.5...15.0 mA     |            |                                            |                     |
| 30 mA                      | 9.0...30.0 mA     |            |                                            |                     |
| 100 mA                     | 30...100 mA       | 1 mA       |                                            |                     |
| 300 mA                     | 90...300 mA       |            |                                            |                     |
| 500 mA                     | 150...500 mA      |            |                                            |                     |

- It is possible to start the measurement from positive or negative half-period of forced residual current
- Test current flow time: max. 3200 ms

**Measurement of RCD disconnection current  $I_{\Delta}$  for differential unidirectional pulsed current and unidirectional pulsed current with 6 mA direct current offset**

Measuring range according to EN IEC 61557: **(0.4...1.4) $I_{\Delta n}$**  for  $I_{\Delta n} \geq 30$  mA and **(0.4...2) $I_{\Delta n}$**  for  $I_{\Delta n} = 10$  mA

| Selected RCD rated current | Measurement range | Resolution | Test current                                | Accuracy             |
|----------------------------|-------------------|------------|---------------------------------------------|----------------------|
| 10 mA                      | 3.5...20.0 mA     | 0.1 mA     | 0.35 I <sub>Δn</sub> ...2.0 I <sub>Δn</sub> | ±10% I <sub>Δn</sub> |
| 15 mA                      | 5.3...21.0 mA     |            | 0.35 I <sub>Δn</sub> ...1.4 I <sub>Δn</sub> |                      |
| 30 mA                      | 10.5...42.0 mA    |            | 0.35 I <sub>Δn</sub> ...1.4 I <sub>Δn</sub> |                      |
| 100 mA                     | 35...140 mA       | 1 mA       |                                             |                      |
| 300 mA                     | 105...420 mA      |            |                                             |                      |

- Measurement may be performed for positive or negative half-periods of forced leakage current
- Test current flow time: max. 3200 ms

**Measurement of RCD disconnection current  $I_{\Delta}$  for differential direct current**

Measuring range according to EN IEC 61557: **(0.2...2) $I_{\Delta n}$**

| Selected RCD rated current | Measurement range | Resolution | Test current | Accuracy |
|----------------------------|-------------------|------------|--------------|----------|
|----------------------------|-------------------|------------|--------------|----------|

|                    |               |        |                                                |                      |
|--------------------|---------------|--------|------------------------------------------------|----------------------|
| 6 mA <sup>1)</sup> | 1.0...6.0 mA  | 0.1 mA | 1.0...6.0 mA                                   | ±6% I <sub>Δn</sub>  |
| 10 mA              | 2.0...20.0 mA | 0.1 mA | 0.2 x I <sub>Δn</sub> ...2.0 x I <sub>Δn</sub> | ±10% I <sub>Δn</sub> |
| 15 mA              | 3.0...30 mA   |        |                                                |                      |
| 30 mA              | 6...60 mA     | 1 mA   |                                                |                      |
| 100 mA             | 20...200 mA   |        |                                                |                      |
| 300 mA             | 60...600 mA   |        |                                                |                      |

- Measurement can be performed for positive or negative forced leakage current
- Test current flow time (does not apply to RCD EV and RCM): max. 3200 ms

- <sup>1)</sup> Test current flow time (applies to RCD EV and RCM)
- acc. to IEC 62955.....30 s
  - acc. to IEC 62752.....40 s

## 12.1.8 Measurement of insulation resistance

Measuring range according to EN IEC 61557-2 for  $U_N = 50 \text{ V}$ : **50 k $\Omega$ ...49.9 M $\Omega$**

| Display range for<br>$U_N = 50 \text{ V}$ | Resolution      | Accuracy                                   |
|-------------------------------------------|-----------------|--------------------------------------------|
| 0...1999 k $\Omega$                       | 1 k $\Omega$    | $\pm(5\% \text{ m.v.} + 8 \text{ digits})$ |
| 2.00...19.99 M $\Omega$                   | 0.01 M $\Omega$ |                                            |
| 20.0...49.9 M $\Omega$                    | 0.1 M $\Omega$  |                                            |

Measuring range according to EN IEC 61557-2 for  $U_N = 100 \text{ V}$ : **100 k $\Omega$ ...99.9 M $\Omega$**

| Display range for<br>$U_N = 100 \text{ V}$ | Resolution      | Accuracy                                   |
|--------------------------------------------|-----------------|--------------------------------------------|
| 0...1999 k $\Omega$                        | 1 k $\Omega$    | $\pm(5\% \text{ m.v.} + 8 \text{ digits})$ |
| 2.00...19.99 M $\Omega$                    | 0.01 M $\Omega$ |                                            |
| 20.0...99.9 M $\Omega$                     | 0.1 M $\Omega$  |                                            |

Measuring range according to EN IEC 61557-2 for  $U_N = 250 \text{ V}$ : **250 k $\Omega$ ...199.9 M $\Omega$**

| Display range for<br>$U_N = 250 \text{ V}$ | Resolution      | Accuracy                                   |
|--------------------------------------------|-----------------|--------------------------------------------|
| 0...1999 k $\Omega$                        | 1 k $\Omega$    | $\pm(5\% \text{ m.v.} + 8 \text{ digits})$ |
| 2.00...19.99 M $\Omega$                    | 0.01 M $\Omega$ |                                            |
| 20.0...199.9 M $\Omega$                    | 0.1 M $\Omega$  |                                            |

Measuring range according to EN IEC 61557-2 for  $U_N = 500 \text{ V}$ : **500 k $\Omega$ ...599.9 M $\Omega$**

| Display range for<br>$U_N = 500 \text{ V}$ | Resolution      | Accuracy                                   |
|--------------------------------------------|-----------------|--------------------------------------------|
| 0...1999 k $\Omega$                        | 1 k $\Omega$    | $\pm(5\% \text{ m.v.} + 8 \text{ digits})$ |
| 2.00...19.99 M $\Omega$                    | 0.01 M $\Omega$ |                                            |
| 20.0...599.9 M $\Omega$                    | 0.1 M $\Omega$  |                                            |

Measuring range according to EN IEC 61557-2 for  $U_N = 1000 \text{ V}$ : **1000 k $\Omega$ ...599.9 M $\Omega$**

| Display range for<br>$U_N = 1000 \text{ V}$ | Resolution      | Accuracy                                   |
|---------------------------------------------|-----------------|--------------------------------------------|
| 0...1999 k $\Omega$                         | 1 k $\Omega$    | $\pm(8\% \text{ m.v.} + 8 \text{ digits})$ |
| 2.00...19.99 M $\Omega$                     | 0.01 M $\Omega$ |                                            |
| 20.0...599.9 M $\Omega$                     | 0.1 M $\Omega$  |                                            |

- Type of test voltage: DC
- Test voltage: 50 V, 100 V, 250 V, 500 V, 1000 V
- Accuracy of generated voltage ( $R_{LOAD} [\Omega] \geq 1000 \cdot U_N [\text{V}]$ ): -0+10% from the set value
- Detection of a dangerous voltage before commencing a measurement
- Discharging the tested object
- Measurement of voltage on OUT1 terminals within the range of: 0...440 V
- Test current: <2 mA



Long-term exposure to moisture will impair the performance of the OUT1 socket. If the meter is stored and/or operated in humidity conditions other than those specified in **section 12.2**, the measurement accuracy may be reduced.



For insulation resistance below  $R_{ISOmin}$  there is no accuracy specified because the meter works with the adjustable current limit in accordance with the following formula:

$$R_{ISOmin} = \frac{U_{ISO nom}}{I_{ISO nom}}$$

where:

$R_{ISOmin}$  — minimum insulation resistance measured without limiting the converter current

$U_{ISO nom}$  — nominal test voltage

$I_{ISO nom}$  — nominal converter current (1.6 mA)

## 12.1.9 Low-voltage measurement of continuity and resistance

### Measurement of continuity of protective conductors and equipotential bondings with $\pm 200$ mA current

Measuring range according to EN IEC 61557-4: **0.12...400  $\Omega$**

| Display range         | Resolution    | Accuracy                                   |
|-----------------------|---------------|--------------------------------------------|
| 0.00...19.99 $\Omega$ | 0.01 $\Omega$ | $\pm(2\% \text{ m.v.} + 3 \text{ digits})$ |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  |                                            |
| 200...400 $\Omega$    | 1 $\Omega$    |                                            |

- Voltage at open terminals: 4...20 V
- Output current at  $R < 2 \Omega$ :  $I_{SC} = 200...250$  mA
- Compensation of test leads resistance
- Measurements for both current polarizations

### Continuity testing of EV cable wires (wires: L1, L2, L3, N, PE, CP) with $\pm 200$ mA

Measuring range according to EN IEC 61557-4: **0.20...400  $\Omega$**

| Display range         | Resolution    | Accuracy                                   |
|-----------------------|---------------|--------------------------------------------|
| 0.00...19.99 $\Omega$ | 0.01 $\Omega$ | $\pm(3\% \text{ m.v.} + 5 \text{ digits})$ |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  |                                            |
| 200...400 $\Omega$    | 1 $\Omega$    |                                            |

- Voltage at open terminals: 4...20 V
- Output current at  $R < 2 \Omega$ :  $I_{SC} = 200...250$  mA
- Measurements for both current polarizations

## 12.1.10 Phase sequence

- Phase sequence indication: correct, incorrect
- Range of mains voltage  $U_{L-L}$ : 100...440 V (45...65 Hz)
- Display of phase-to-phase voltages

## 12.1.11 Resistance of coding resistor

### Measurement of $R_C$ resistors (PP-PE) – IN PEop socket and OUT PEpp

Measuring range according to EN IEC 61557-4: **0.32...6000  $\Omega$**

| Display range         | Resolution    | Accuracy                                   |
|-----------------------|---------------|--------------------------------------------|
| 0.00...19.99 $\Omega$ | 0.01 $\Omega$ | $\pm(3\% \text{ m.v.} + 8 \text{ digits})$ |
| 20.0...199.9 $\Omega$ | 0.1 $\Omega$  |                                            |
| 200...6000 $\Omega$   | 1 $\Omega$    |                                            |

- Voltage at open terminals: 4...20 V
- Output current at  $R < 2 \Omega$ :  $I_{SC} = 200...250$  mA
- Measurements for both current polarizations

### 12.1.12 Simulation of PP cable parameters

| Display range | Value         | Accuracy  |
|---------------|---------------|-----------|
| NC            | Open circuit  | -         |
| 13 A          | 1500 $\Omega$ | $\pm 2\%$ |
| 20 A          | 680 $\Omega$  | $\pm 2\%$ |
| 32 A          | 220 $\Omega$  | $\pm 2\%$ |
| 63 A          | 100 $\Omega$  | $\pm 2\%$ |
| 80 A          | 56 $\Omega$   | $\pm 3\%$ |

### 12.1.13 Simulation of CP communication

| Display range                                             | Value         | Accuracy  |
|-----------------------------------------------------------|---------------|-----------|
| State A – vehicle not connected                           | Open circuit  | -         |
| State B – vehicle connected, not charging                 | 2740 $\Omega$ | $\pm 1\%$ |
| State C – vehicle connected, charging without ventilation | 882 $\Omega$  | $\pm 1\%$ |
| State D – vehicle connected, charging with ventilation    | 246 $\Omega$  | $\pm 1\%$ |

### 12.1.14 EVSE<sub>DIAG</sub> diagnostics

#### Voltage measurement for CP (PWM) and PP signals

| Display range     | Resolution | Accuracy                                    |
|-------------------|------------|---------------------------------------------|
| -19.99... 19.99 V | 0.01 V     | $\pm (1\% \text{ m.v.} + 8 \text{ digits})$ |

- Separate positive and negative voltage amplitude for CP (CP+, CP-)

#### Measurement of frequency f (PWM) for CP signal

Measuring range according to EN IEC 61557-4: **950...1050 Hz**

| Display range | Resolution | Accuracy              |
|---------------|------------|-----------------------|
| 800...1200 Hz | 1 Hz       | $\pm 1 \text{ digit}$ |

- Voltage range: 3...20 V

#### Measurement of duty cycle (D) for CP signal (PWM)

Measuring range according to EN IEC 61851-1: **3.0...97.0%**

| Display range | Resolution | Accuracy               |
|---------------|------------|------------------------|
| 1.0...99.0%   | 0.1%       | $\pm 3 \text{ digits}$ |

- Voltage range: 3...20 V

#### Maximum charging current I<sub>MAX</sub>

| Display range | Resolution | Accuracy |
|---------------|------------|----------|
| 0...80 A      | 1 A        | -        |

- Voltage range: 3...20 V
- Determined based on the "Measurement of the duty cycle (D) for the CP (PWM) signal" section according to EN IEC 61851-1

12.1.15 EVSE<sub>ERR</sub> station error simulation

OUT station error simulation

| Error type                       | Display range | Resolution | Accuracy              |
|----------------------------------|---------------|------------|-----------------------|
| Short circuit of CP to PE (CPsh) | 0...3100 ms   | 1 ms       | ±(3% m.v. + 3 digits) |
| Diode short circuit (Dsh)        |               |            |                       |
| Interruption in PE (PEop)        | 0...1000 ms   |            |                       |

IN station error simulation

| Error type                                 | Display range              | Resolution                 | Accuracy                   |
|--------------------------------------------|----------------------------|----------------------------|----------------------------|
| Interruption in phase L1 (L/L1op)          | as in EVSE <sub>DIAG</sub> | as in EVSE <sub>DIAG</sub> | as in EVSE <sub>DIAG</sub> |
| Interruption in phase L2 (L/L2op)          |                            |                            |                            |
| Interruption in phase L3 (L/L3op)          |                            |                            |                            |
| Interruption in N (Nop)                    |                            |                            |                            |
| Interruption in PE (PEop)                  |                            |                            |                            |
| Interchanged L1 and PE wires (L1↔PE)       |                            |                            |                            |
| Interchanged L2 and PE wires (L2↔PE)       |                            |                            |                            |
| Interchanged L3 and PE wires (L3↔PE)       |                            |                            |                            |
| Voltage on PE wire (U <sub>EXT</sub> (PE)) |                            |                            |                            |

- Voltage range: 3...20 V
- Determined based on the “Measurement of the duty cycle (D) for the CP (PWM) signal” section according to EN IEC 61851-1

12.1.16 Transition time between states

Measurement of the transition time for the charger (ICCB, EVCS)

| Transition between states | Display range | Resolution | Accuracy              |
|---------------------------|---------------|------------|-----------------------|
| A→C, B→C, A→D, B→D        | 0...3100 ms   | 1 ms       | ±(3% m.v. + 3 digits) |
| C→A, C→B, D→A, D→B        | 0...1000 ms   |            |                       |



## 12.2 Operating data

|    |                                                                                                                     |                                                                                    |
|----|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| a) | type of insulation acc. to EN 61010-1 and EN IEC 61557 .....                                                        | double                                                                             |
| b) | measurement category acc. to EN IEC 61010-2-030 .....                                                               |                                                                                    |
|    | ▪ rated operating altitude $\leq 2000$ m .....                                                                      | CAT III 300 V                                                                      |
|    | ▪ rated operating altitude $\leq 3000$ m .....                                                                      | CAT II 300 V                                                                       |
| c) | ingress protection acc. to EN 60529 .....                                                                           |                                                                                    |
|    | ▪ open enclosure .....                                                                                              | IP20                                                                               |
|    | ▪ closed enclosure .....                                                                                            | IP54                                                                               |
| d) | power supply .....                                                                                                  |                                                                                    |
|    | ▪ mains .....                                                                                                       | 220...240 V / 380...415 V, 50...60 Hz                                              |
|    | ▪ rechargeable battery .....                                                                                        | Li-Ion 7.2 V 9.8 Ah                                                                |
| e) | dimensions .....                                                                                                    | 429 x 328 x 236 mm                                                                 |
| f) | weight .....                                                                                                        | ca. 8.7 kg                                                                         |
| g) | storage temperature .....                                                                                           | -20...+70°C                                                                        |
| h) | operating temperature .....                                                                                         | -10...+45°C                                                                        |
| i) | humidity .....                                                                                                      | 20...90%                                                                           |
| j) | reference temperature .....                                                                                         | +23°C $\pm$ 2°C                                                                    |
| k) | reference humidity .....                                                                                            | 40%...60%                                                                          |
| l) | display .....                                                                                                       | LCD, color capacitive touchscreen 5"                                               |
|    | ..... resolution 1280x720 dots, max brightness 700 cd/m <sup>2</sup>                                                |                                                                                    |
| m) | number of R <sub>ISO</sub> measurements acc. to EN IEC 61557-2 with battery power supply .....                      | min. 600                                                                           |
| n) | time of operation on a single battery charge .....                                                                  |                                                                                    |
|    | ▪ for R <sub>ISO</sub> =1 M $\Omega$ , U <sub>ISO</sub> =500 V, T=(23 $\pm$ 5)°C, screen backlight 50% .....        | approx. 3 h                                                                        |
|    | ▪ under conditions according to EN IEC 61557-2 p. 6.7, screen backlight 50% .....                                   | approx. 7 h                                                                        |
| o) | memory of measurement results .....                                                                                 | 9999 results                                                                       |
| p) | transmission of results – wired .....                                                                               | USB-B, RJ-45                                                                       |
| q) | transmission of results – wireless .....                                                                            |                                                                                    |
|    | ▪ interface .....                                                                                                   | Bluetooth, Wi-Fi                                                                   |
|    | ▪ range .....                                                                                                       | up to 10 m                                                                         |
| r) | communication with external device – wired .....                                                                    | USB-A                                                                              |
| s) | Wi-Fi band frequency .....                                                                                          | 2.4 GHz, 5 GHz                                                                     |
| t) | quality standard .....                                                                                              | development, design and manufacturing are ISO 9001, ISO 14001, ISO 45001 compliant |
| u) | the device meets the requirements of .....                                                                          | EN 61010-1, EN IEC 61557, EN IEC 61010-2-030                                       |
| v) | the product meets EMC requirements (immunity for industrial environment) according to the following standards ..... |                                                                                    |
|    | .....                                                                                                               | EN IEC 61326-1, EN IEC 61326-2-2                                                   |



### NOTE!

The meter is classified in terms of Electromagnetic Compatibility (EMC) as instruments of Class A (for use in industrial environments – according to EN 55011). Interferences, impacting the operation of other devices must be taken into account when the meters are used in other environments (e.g. domestic).



SONEL S.A. hereby declares that the radio device type EVSE-100 complies with Directive 2014/53/EU. The full text of the EU Declaration of Conformity is available at the following website address: <https://sonel.pl/en/download/declaration-of-conformity/>

## 12.3 Bluetooth specification

|    |                                  |                                  |
|----|----------------------------------|----------------------------------|
| a) | version .....                    | v4.2 Classic, BLE                |
| b) | frequency range .....            | 2400 MHz...2483.5 MHz (ISM band) |
| c) | frequency response .....         | 1 MHz < f < 3.5 MHz              |
| d) | modulation method .....          | GFSK/ $\pi$ /4DQPSK/8DPSK/LE     |
| e) | receiver sensitivity .....       | -89 dBm                          |
| f) | minimum transmission power ..... | -3...-7 dBm                      |

## 12.4 Additional data

Data on additional uncertainties are useful mainly when the meter is used in non-standard conditions and for metrological laboratories for the purpose of calibration.

### 12.4.1 Additional uncertainties according to EN IEC 61557-3 (Z)

| Significant parameter                                   | Designation      | Additional uncertainty                                                                                        |
|---------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------|
| Position                                                | E <sub>1</sub>   | 0%                                                                                                            |
| Supply voltage                                          | E <sub>2</sub>   | 0% (1% not displayed)                                                                                         |
| Temperature 0°C...35°C                                  | E <sub>3</sub>   | 1.2 m lead – 0 Ω<br>5 m lead – 0.011 Ω<br>10 m lead – 0.019 Ω<br>20 m lead – 0.035 Ω<br>EVCAB 2.2 m – 0.015 Ω |
| Phase angle 0°...30° at the bottom of measurement range | E <sub>6.2</sub> | 0.6%                                                                                                          |
| Frequency 99%...101%                                    | E <sub>7</sub>   | 0%                                                                                                            |
| Mains voltage 85%...110%                                | E <sub>8</sub>   | 0%                                                                                                            |
| Harmonics                                               | E <sub>9</sub>   | 0%                                                                                                            |
| DC component                                            | E <sub>10</sub>  | 0%                                                                                                            |

### 12.4.2 Additional uncertainties according to EN IEC 61557-4 (R ±200 mA)

| Significant parameter  | Designation    | Additional uncertainty |
|------------------------|----------------|------------------------|
| Position               | E <sub>1</sub> | 0%                     |
| Supply voltage         | E <sub>2</sub> | 0% (1% not displayed)  |
| Temperature 0°C...35°C | E <sub>3</sub> | 1.5%                   |

### 12.4.3 Additional uncertainties according to EN IEC 61557-6 (RCD)

I<sub>A</sub>, t<sub>A</sub>, U<sub>B</sub>

| Significant parameter    | Designation    | Additional uncertainty |
|--------------------------|----------------|------------------------|
| Position                 | E <sub>1</sub> | 0%                     |
| Supply voltage           | E <sub>2</sub> | 0% (1% not displayed)  |
| Temperature 0°C...35°C   | E <sub>3</sub> | 0%                     |
| Electrodes resistance    | E <sub>5</sub> | 0%                     |
| Mains voltage 85%...110% | E <sub>8</sub> | 0%                     |

### 12.4.4 Influence of serial interference voltage on the resistance measurements for function R<sub>E</sub>3P

| R <sub>E</sub> | U <sub>N</sub> | Additional uncertainty [Ω]         |
|----------------|----------------|------------------------------------|
| 0.00...10.00 Ω | 25 V           | $\pm(0.001R_E+0.01)U_Z+0.007U_Z^2$ |
|                | 50 V           | $\pm(0.001R_E+0.01)U_Z+0.004U_Z^2$ |
| 10.01...1999 Ω | 25 V, 50 V     | $\pm(0.001R_E+0.01)U_Z+0.001U_Z^2$ |

### 12.4.5 Influence of the auxiliary electrodes on earth resistance measurements for function R<sub>E</sub>3P

| R <sub>H</sub> , R <sub>S</sub>                      | Additional uncertainty [%]                                                           |
|------------------------------------------------------|--------------------------------------------------------------------------------------|
| R <sub>H</sub> ≤ 1.99 kΩ<br>R <sub>S</sub> ≤ 1.99 kΩ | $\pm \left( \frac{R_S}{R_S + 100000} \cdot 150 + \frac{R_H \cdot 0.17}{R_E} \right)$ |

R<sub>E</sub>[Ω], R<sub>S</sub>[Ω] and R<sub>H</sub>[Ω] are values displayed by the device.

### 12.4.6 Additional uncertainties according to EN IEC 61557-5 (R<sub>E</sub>3P)

| Significant parameter              | Designation    | Additional uncertainty                                                            |
|------------------------------------|----------------|-----------------------------------------------------------------------------------|
| Position                           | E <sub>1</sub> | 0%                                                                                |
| Supply voltage                     | E <sub>2</sub> | 0% (1% not displayed)                                                             |
| Temperature                        | E <sub>3</sub> | ±0.2 digit/°C for R < 1 kΩ<br>±0.07%/°C ± 0.2 digit/°C for R ≥ 1 kΩ               |
| Serial interference voltage        | E <sub>4</sub> | According to the formulas shown in sec. 12.4.4<br>(U <sub>N</sub> = 3 V 50/60 Hz) |
| Resistance of auxiliary electrodes | E <sub>5</sub> | According to the formula in sec. 12.4.5                                           |

## 12.5 Prospective short-circuit current

The device always measures impedance, and the short-circuit current displayed is calculated from the formula:

$$I_k = \frac{U_n}{Z_s}$$

where:

U<sub>n</sub> – rated voltage of the network being tested,

Z<sub>s</sub> – impedance measured.

In a case when the installation voltage is outside of tolerance, the meter will not be able to determine the rated voltage for the short-circuit current calculation. In such event the display will show horizontal dashes instead of the short-circuit current value. The figure below shows the voltage ranges for which the short-circuit current is calculated.



Relationship between the network voltage and the ability to calculate the short-circuit current

Blue bar – the U<sub>L-N</sub> voltage ranges, for which the short-circuit current is calculated

Orange bar – the U<sub>L-L</sub> voltage ranges, for which the short-circuit current is calculated

198 V...440 V – the voltage range for which the impedance measurement is performed

## 13 Manufacturer

The manufacturer of the device and provider of guarantee and post-guarantee service:

**SONEL S.A.**

Wokulskiego 11

58-100 Świdnica

Poland

tel. +48 74 884 10 53 (Customer Service)

e-mail: [customerservice@sonel.com](mailto:customerservice@sonel.com)

web page: [www.sonel.com](http://www.sonel.com)



### NOTE!

Service repairs must be performed only by the manufacturer.

## NOTES

## NOTES





## ———— TROUBLE WITH MEASUREMENTS? ————



You can find all the information about the desired test in the help menu of the respective measurement function.



Download the user manual for the **Sonel MeasureEffect™** platform and find information on the test in it. To do so, visit:

- the Sonel MeasureEffect™ platform web page,
- the web page of your instrument.

### **SONEL S.A.**

Wokulskiego 11  
58-100 Świdnica  
Poland

### **Customer Service**

tel. +48 74 884 10 53

e-mail: [customerservice@sonel.com](mailto:customerservice@sonel.com)

**[www.sonel.com](http://www.sonel.com)**