CST-222

Charging Station Digital Multimeter

User Manual

SPEKTER

Today's Innovations for Tomorrow's Precision

Made in Slovenia

CST-222

Charging Station Digital Multimeter

User Manual

2025 MI SPEKTER

Tabel of contents

Version changes

Version	Changes	Chapter
1.0	First version of the document.	-

List of Abbreviations

CAT II	Overvoltage Category II
PC II	Protection class II (appliances with double/reinforced insulation)
CP	Control Pilot
PP	Proximity Pilot
DUT	Device Under Test
EVSE	Electric Vehicle Supply Equipment or Charging Station
EV	Electric Vehicle
MFT	Multifunction Installation Tester
DMM	Digital Multimeter

1 Introduction

CST-222 is a Charging Station Digital Multimeter (EVSE DMM), manufactured by MI SPEKTER. This Instrument is designed for stand-alone functionality testing of Mode 2 and Mode 3 EVSE with Type 2 cable or socket in accordance with IEC 61851-1 standard. It can measure:

- Phase to neutral voltages U_{L1-N}, U_{L2-N}, U_{L3-N}
- Neutral to PE voltage U_{N-PE}
- Frequency of mains voltage
- Phase sequence
- Maximum current (Imax)
- Control Pilot (CP) signal voltage (CP+ and CP-)
- CP signal frequency and duty cycle

Instrument also supports safety testing of EVSE through its L1, L2, L3, N, PE and CP 4-mm test sockets and Mains socket on the rear. Through these sockets additional instruments like Multifunction Installation Tester (MFT), Oscilloscope or Digital Multimeter (DMM) can be connected.

2 Safety Information, Warnings

Testing of EVSEs should only be carried out by properly trained and competent personnel! Carefully read this document before using the Instrument.

Symbols used on the Instrument or in this User Manual:

	Warning of a potential danger, comply with this User Manual.
	**Do not touch, hazardous voltage, risk of electric shock.**
	**Reference, please pay utmost attention.**
	**Earth (ground) terminal**
	**Double insulation**
	**Read this User Manual.**
	**Note**
	**Symbol for marking of electrical and electronic equipment (WEEE Directive).**
	**Conformity symbol, confirms compliance with the applicable European directives. The requirements of the Low Voltage Directive with the relevant regulations Standards are also fulfilled.**

WARNING

- **The User Manual contains information and references, necessary for safe operation and maintenance of the Instrument. Prior to using the Instrument, user must thoroughly read the User Manual and comply with it in all sections.**
- **If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.**
- **Failure to read this User Manual or to comply with the warnings and references contained herein can result in serious bodily injury or equipment damage.**
- **Do not alter the Instrument and use it only as specified, or the protection supplied by the Instrument can be compromised.**
- **Do not use the Instrument if it operates incorrectly.**
- **Do not touch voltages >30 V ac rms, 42 V ac peak, or 60 V dc.**
- **Limit operation to the specified measurement category, voltage, or amperage ratings.**
- **Do not exceed the Measurement Category (CAT) rating of the lowest-rated individual component of the Instrument.**
- **Comply with local and national safety codes. Use personal protective equipment (face protection, and flame-resistant clothes) to prevent shock and arc blast injury where hazardous live conductors are exposed.**
- **Do not use the Instrument around explosive gas, vapor, or in damp or wet environments.**

3 Safety Measures

Instrument has been built and tested in compliance with valid safety regulations and left the factory in safe and perfect condition. In order to maintain this condition and to ensure safe operation, the user must pay attention to the references and warnings contained within this User Manual.

WARNING, DANGER OF ELECTRICAL SHOCK

- ☞ The respective accident prevention regulations established by the national health & safety board for electrical systems and equipment must be strictly met at all times.
- ☞ Prior to any operation, ensure that the Instrument including cables is in perfect condition.
- ☞ Tested EVSE (DUT) may only be connected to the Instrument as indicated in the technical specification section.
- ☞ The Instrument may only be used within the operating ranges as specified in the technical specification section.
- ☞ The Instrument may only be used in dry and clean environments. Dirt and humidity reduce insulation resistance and may lead to electrical shocks, in particular for high voltages.
- ☞ Never use the Instrument in precipitation such as dew or rain. In case of condensation due to temperature jumps, the Instrument may not be used.
- ☞ Accurate tests and measurements may only be ensured within the temperature range of -10 to +40 °C.
- ☞ Unauthorized personnel are prohibited from opening the Instrument. It can be done only by properly trained service technicians authorized by the manufacturer.
- ☞ Always use only original accessories supplied by the manufacturer.
- ☞ If the user's safety is no longer guaranteed, the Instrument is to be put out of service and protected against use. The safety can no longer be guaranteed if the Instrument including cables:
    - shows obvious damage
    - does not carry out desired tests or measurements
    - has been stored for too long under unfavourable conditions
    - has been subjected to mechanical stress during transport

4 Available Functionalities

With the CST-222, user can perform following measurements:

- Phase to neutral voltages U_{L1-N}, U_{L2-N}, U_{L3-N}
- Neutral to PE voltage U_{N-PE}
- Frequency of mains voltage
- Phase sequence
- Presence of phase to PE voltages U_{L1-PE}, U_{L1-PE}, U_{L1-PE}
- Maximum current (Imax)
- CP signal voltage (CP+ and CP-)
- CP signal frequency and duty cycle
- Indication of CP signal states
- PE PRE-TEST (LED indicator for hazardous voltages)

User can also simulate following:

- EV CP states: A, B, C, D and E,
- Charging cable ampacities (PP states): NC (not connected), 13 A, 20 A, 32 A, 63 A and Error (short circuit from PP to PE),
- CP error (short circuit from CP to PE)
- PE error (disconnected PE)
- Diode short error

Additional measurements can be performed via the 4-mm test sockets, which are designed for connection to MFT, oscilloscope or DMM. The rear of the Instrument also features a Mains socket for connecting MFT or external mains load up to 10 A.

5 Scope of Supply

1 pc CST-222 Instrument with fixed cable and Type 2 connector

1 pc Safety information (Warranty card included)

1 pc Quick reference guide

1 pc Calibration certificate

1 pc Soft carrying bag

6 Transport and Storage

The Instrument must be stored in dry and closed areas. In case it is being transported in extreme conditions (outside storage temperature range), a recovery time of minimum 2 hours is required prior to any operation.

7 Description of Warning Marks

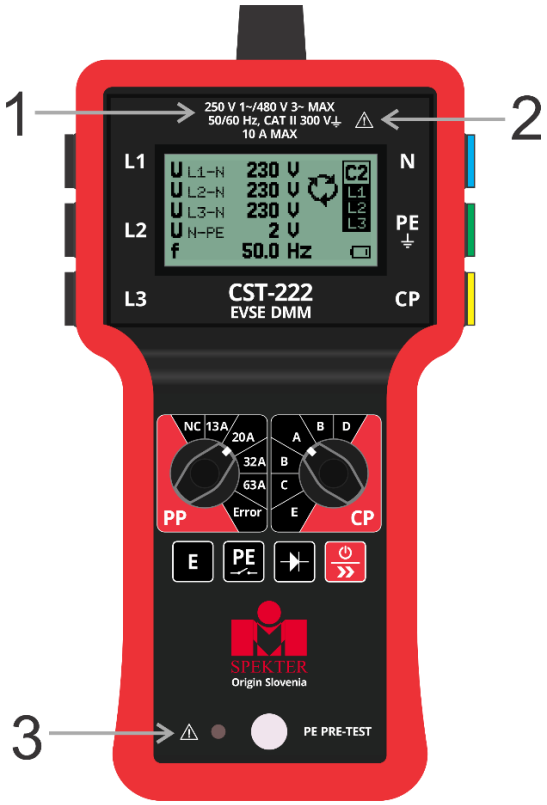


Figure 1: Location of warning marks on the Instrument.

⚠ Warning 1

Rating of input voltage and current.

⚠ Warning 2

Dangerous voltages may be present at the L1, L2, L3, N, PE and CP 4-mm test sockets while the Instrument is connected to the EVSE.
The CP test socket carries a low-voltage signal (approx. ±12 V in reference to PE) supplied by EVSE.
4-mm test sockets are intended for testing purposes only and allow a **maximum current of 1 A!** Higher current is permissible for measurements, done with MFT that complies with IEC 61557.
In the event of incorrect wiring or a fault in the EVSE, hazardous voltages may also appear on N, PE or CP. **Use PE PRE-TEST to check against presence of dangerous voltage on PE conductor!**

⚠ Warning 3

High danger of electric shock is present (hazardous voltage is potentially present on PE conductor and EVSE housing) when PE PRE-TEST indicator lights up during the PE PRE-TEST. See test instructions in chapter 10.2.2 PE PRE-TEST. In this case further testing must be stopped immediately! Ensure to ground your body sufficiently while performing this test!

8 Operation Elements and Connectors

8.1 Front panel

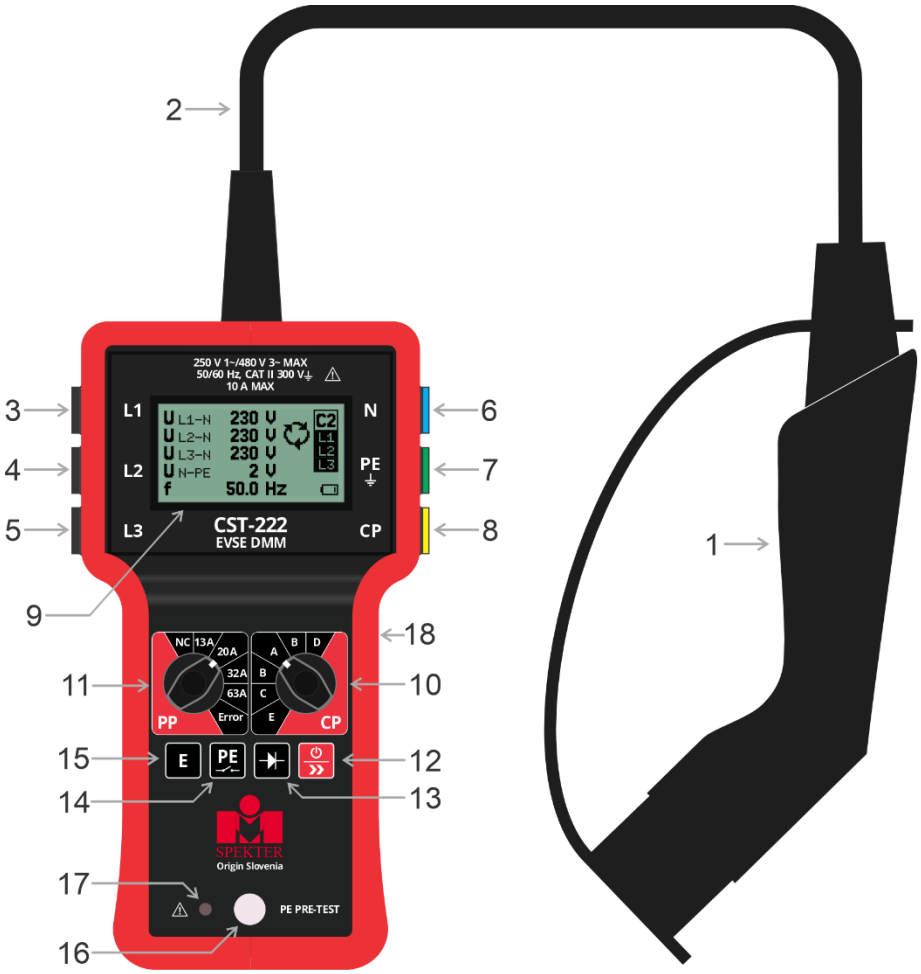


Figure 2: Operation elements and connectors, visible from the front.

1	Type 2 connector (EV socket)	11	PP state rotary switch
2	7-pole fixed cable	12	ON/NEXT/OFF button
3	L1 4-mm test socket	13	Diode Short button
4	L2 4-mm test socket	14	PE Error button
5	L3 4-mm test socket	15	CP Error button
6	N 4-mm test socket	16	PE PRE-TEST touch electrode
7	PE 4-mm test socket	17	PE PRE-TEST indicator
8	CP 4-mm test socket	18	Protection rubber (removable)
9	2,4'' reflective LCD		
10	CP state rotary switch		

8.2 Back panel

Figure 3: Operation elements and connectors, visible from the back (protection rubber removed).

1	Mains socket
2	Fuse for Mains socket protection
3	Instrument and fuse information lable
4	Instrument serial number lable
5	Battery compartment door (fastened with two countersunk screws)
6	Battery replacement warning lable

9 Basic Instrument usage

9.1 Powering on, off and switching between measurements

By pressing the ON/NEXT/OFF button, the Instrument powers up. It initially displays Mains measurements screen. By pressing this button again, it will switch to CP measurements screen. With yet another press it will go back to Mains measurement screen (and so on). By long-pressing ON/NEXT/OFF button (for at least 2 seconds), the Instrument will turn off. Refer to Figure 4.

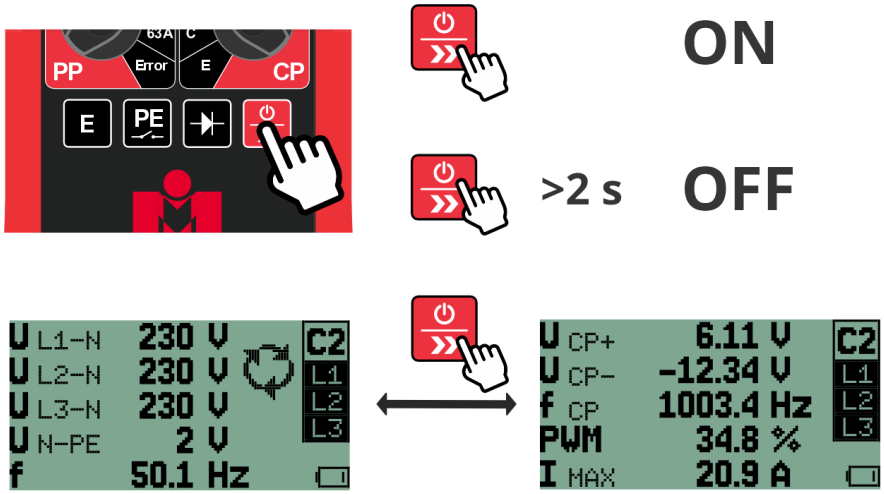


Figure 4: Principle of using ON/NEXT/OFF button.

9.2 Battery status indicator

In the bottom right corner of the screen, a battery status icon appears if battery capacity is low. The indicator operates in two stages as follows:

1. **First Warning Level – Low Battery**

When the battery voltage drops below a certain threshold, a “Low Battery” icon appears. The Instrument continues to operate, but user is recommended to have a spare pair of AA batteries with him while using the instrument.

2. **Second Warning Level – Empty Battery**

If the battery reaches a critically low level, the “Empty Battery” icon will start blinking instead and the device will automatically shut down after 10 seconds. After turning the Instrument back on, if battery voltage level will still be critically low, either a Dead Battery screen will be displayed and after 3 seconds the Instrument will turn off or the Instrument will not even power on (if battery capacities are too low to power the Instrument on). At this point, user should replace the batteries (or charge them if he is using NiMH). Refer to chapter 11.3 on how to replace them.

Figure 5: Dead Battery screen

9.3 Auto Power Off function

To reduce power consumption, the Instrument turns off automatically after 5 minutes of not being used. 10 seconds before turning off, an “Auto Power Off” icon will start blinking.

Any of the following actions will reset the timer which causes Instrument to turn off:

- ON/NEXT/OFF button is pressed
- CP Error “E” button is pressed
- PE Error button is pressed

NOTE: The Auto Power Off function will not trigger in case any phase-to-PE voltages are present (equal or above 100 V).

10 Testing

WARNING

☞Before starting the tests, you must familiarize yourself with the EN/IEC 61851-1 standard "Electric vehicle conductive charging system - Part 1: General requirements" and with the documentation of the EVSE.

☞Before commencing the tests, you are strongly advised to make reference to the local regulations and standards for safety at works regulations and any relevant publications from the Health and Safety Executive.

☞Tests should only be performed by competent personnel who are familiar with the requirements of the type of tests suitable for installations.

☞It is potentially hazardous for both user and the EVSE (DUT) if the wrong type of tests is undertaken or if testing is carried out in an incorrect sequence.

☞It is important that you fully understand the various tests required and how they should be performed.

☞The appliance must have passed the PE PRE-TEST prior to any other test. If this test fails further testing must be stopped and the fault must be removed. In case of error, all metal parts of the EVSE including output terminals and PE may carry hazardous voltage. In this case there is a high risk of electric shock to the user and other people nearby.

10.1Purpose and Operation

There are three main purposes of the Instrument:

1) Simulate electrical vehicle (EV)

The Instrument simulates and behaves like an Electric Vehicle (EV). When properly connected and configured, it initiates the charging process in connected EVSE. By adjusting the rotary switches, the EVSE can be set to all possible CP states (A, B, C, D, E) initiated by EV with CP state switch and to one of six different charging cable states/ampacities (NC, 13 A, 20 A, 32 A, 63 A, Error) with PP state switch.

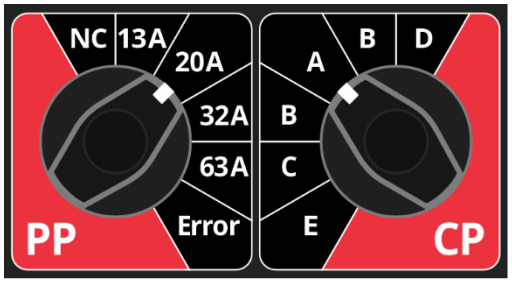


Figure 6: CP and PP state switches used to configure EV states and cable settings.

2) Easy access to EVSE output terminals

Output terminals L1, L2, L3, N, PE and CP of EVSE can be accessed through conveniently located 4-mm test sockets on both sides of the Instrument, enabling easy connection of external measuring devices for extended testing procedures.

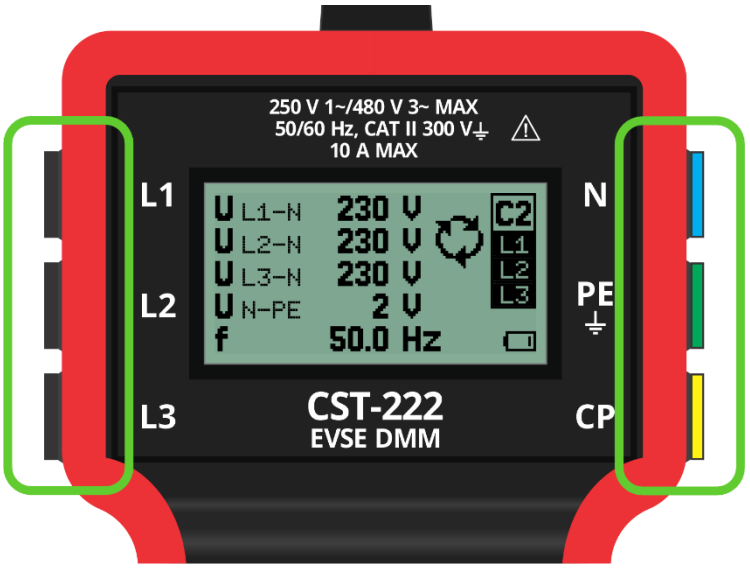


Figure 7: Access to EVSE output terminals.

3) Monitoring of Mains values and CP signal characteristics

Upon connecting the Instrument to EVSE, two display modes are available. First provides real-time monitoring of Mains voltages ($U_{Lx\text{-}N}$, $U_{N\text{-}PE}$), frequency and phase sequence, while the second shows CP+ and CP– voltages, frequency, duty cycle (PWM) and the maximum current (Imax). The right side of the display continuously shows the status of each phase and the current CP state of the CP signal based on Table A.4 of IEC 61851-1:2017.

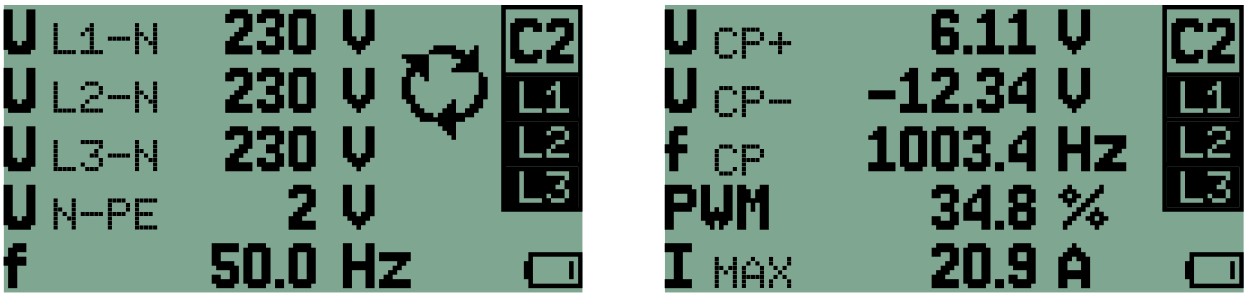


Figure 8: Display of Mains and CP measurements.

10.2How to test EVSE

Testing an EVSE would normally be done in the following steps:

1. set CP state switch to A and PP switch to NC,
2. connect Instrument to EVSE,
3. confirm safety of PE terminal by performing PE PRE-TEST,
4. execute required tests for non-energized EVSE (if testing EVSE with MFT), for example:
    a. Visual inspection,
    b. Resistance of PE conductor,
    c. Insulation resistance between terminals L1, L2, L3, N and PE/CP,
5. energize EVSE by correctly setting PP and CP state switches,
6. reconfirm safety of PE terminal by performing PE PRE-TEST again,
7. execute required tests for energized EVSE, for example:
    a. check Mains and CP parameters on EVSE output terminals,
    b. check if EVSE correctly responds to fault conditions,
    c. if testing EVSE with MFT:
        i. Loop / Line impedance,
        ii. RCD test,
        iii. RDC-DD 6 mA test,
8. deenergize EVSE by setting CP state switch to A and PP switch to NC,
9. disconnect Instrument from EVSE.

Refer to following points for thorough explanation of these steps.

10.2.1 Connection to EVSE

Prior to connecting Instrument to an EVSE, make sure the rotary switch is in position A. Check that the connection between the Instrument and the EVSE is secure and correct. The Instrument is compatible with the following EVSE:

- Mode 2 EVSE with Type 2 cable
- Mode 3 EVSE with Type 2 socket
- Mode 3 EVSE with Type 2 cable

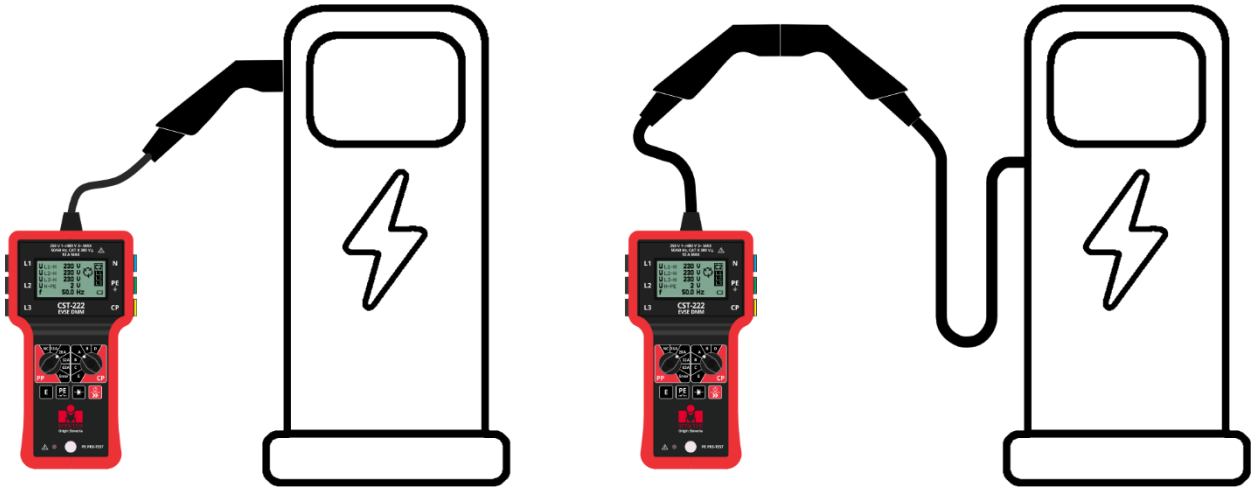


Figure 9: Connection of the Instrument to EVSE with socket or cable.

10.2.2PE PRE-TEST

PE PRE-TEST is a safety function of the Instrument. It allows the user to check the PE (protective earth) terminal of EVSE for the presence of potentially dangerous voltage relative to ground. Under normal conditions, the PE terminal is properly grounded and should not carry any voltage with respect to ground. However, if the PE terminal is not grounded — for example, if it is mistakenly connected to a phase voltage or if the connection is interrupted — this creates a highly hazardous situation where PE terminal or any exposed metal part (especially on EVSE housing) are potentially dangerous to touch.

⚠ WARNING

☞ In the event of this error, **the PE terminal (and potentially any exposed metal/conductive part) carries a hazardous voltage**, posing a serious risk of electric shock to the user and anyone nearby. Possible causes include:

- PE interrupted / not connected.
- PE carries hazardous voltage (for example connected to phase)

☞ Perform this test with bare hands to allow proper detection of voltage through the touch probe. Ensure a solid ground connection and do not touch any exposed metal parts while the test is in progress!

☞ In case your body is not properly grounded—for example, if you are standing on an insulated surface—the test result may not be valid. Do not trust the outcome under these conditions!

Instructions:

1. Connect the Instrument to the EVSE without touching any exposed metal parts apart from PE PRE-TEST touch electrode on the Instrument.

2. Touch the PE PRE-TEST touch electrode (position 16 in Figure 2) with a bare finger and inspect PE PRE-TEST indicator (position 17 in Figure 2)

If PE PRE-TEST indicator lights up, this indicates a fault on PE terminal. **Immediately stop testing, don't touch any exposed metal/conductive parts and check the PE wiring for possible faults!!!** Refer to Figure 10 for more intuitive instructions.

The PE PRE-TEST must also be repeated when the EVSE activates mains supply to the Instrument.

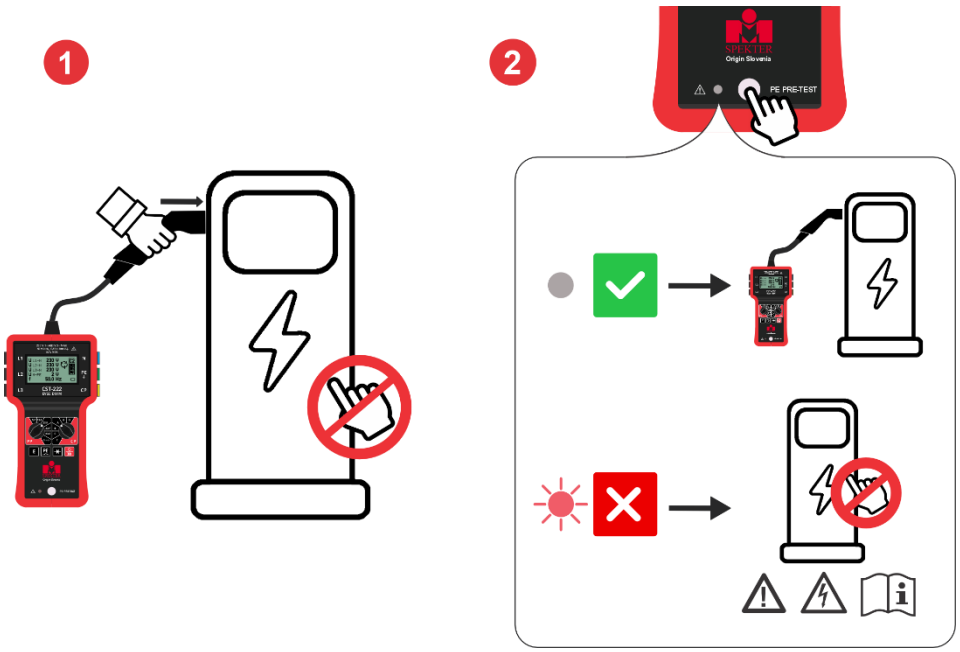


Figure 10: PE PRE-TEST instructions.

10.2.3Proximity pilot state

The PP state rotary switch (position 11 in Figure 2) allows simulation of different charging cable options. This is achieved by connecting specific resistances between the PP and PE terminals. Table below outlines the correspondence between resistance values and the simulated cable ampacities.

Table 1: Correlation between resistance and ampacity of charging cables

Cabel ampacity	Resistance between PP and PE
No cable	Open (∞, calibrated to >100 kΩ)
13 A	1,5 kΩ
20 A	680 Ω
32 A	220 Ω
63 A	100 Ω
Error	< 30 Ω

This function is primarily used for EVSEs with a socket. Before enabling the charging process, EVSEs with a socket need to check encoded ampacities of connected charging cables to determine maximum allowed charging current. If there is no cable connected (PP state switch on the Instrument is set NC), EVSE should not start the charging sequence. PP Error state is also only relevant for EVSE with socket. For safety purposes a current limiting device is used for PP Error.

EVSEs with a fixed cable generally don't check this since they already have information regarding its fixed cable ampacity. Construction of Type 2 connector also doesn't allow stacking of cables. That is why user can leave PP state switch set to NC when testing EVSEs with a fixed cable.

In case that an EVSE with a fixed cable wouldn't start the charging sequence when PP state switch is set to NC, try switching it to some other value (13A, 20A, 32A or 63A) and repeat test sequence.

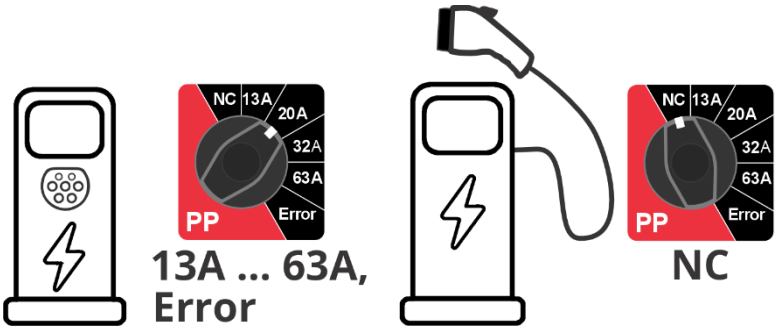


Figure 11: Set PP state switch to 13A, 20A, 32A or 63A for EVSE with socket and to NC for EVSE with cable.

10.2.4Control pilot state

The CP state switch (position 10 in Figure 2) allows the simulation of different EV charging states during connection to an EVSE. These states are represented by specific voltage drops between CP and PE output terminal of EVSE.

EVSE will generate a square wave with voltages +/- 12 V and frequency of 1 kHz. It will supply this voltage through a 1 kΩ resistor to CP output terminal (in reference to PE). Then a voltage drop will be caused by resistances and a diode, placed between CP and PE terminals inside the EV (due to the diode, voltage drop will only occur in the positive part of square wave).

Table below shows resistances used in the Instrument on CP state switch to generate specific states. These resistance values are all placed after the diode. That goes for state E as well. User should use CP Error "E" to test EVSE in accordance with IEC 61851-1 but can use state E on CP state switch for additional troubleshooting.

Table 2: Correlation between resistances used for CP state switch and caused voltage drops.

CP state	Vehicle State	Resistance between CP and PE	Voltage at CP terminal
A	Electric vehicle (EV) not connected	> 1 MΩ	12 1 kHz
B	EV connected, not ready to charge	2,74 kΩ	+9 V / -12 V 1 kHz

C	EV connected, ventilation not required, ready to charge	882 Ω	+6 V / -12 V 1 kHz
D	EV connected, ventilation required, ready to charge	246 Ω	+3 V / -12 V 1 kHz
E	EV connected, CP signal short-circuited after diode, EVSE should disable charging	< 30 Ω	+0,7 V / -12 V 1 kHz

10.2.5Simulation of fault conditions

Three buttons allow the simulation of specific fault conditions that the EVSE is required to detect and handle correctly. The simulated errors include:

CP Error “E”

- Pressing the "E" button grounds the CP terminal through a current limiting device, simulating Error State E
- EVSE must respond by switching to an error state and disconnecting all phase voltages
- **This is not the same as state E on CP state switch** (refer to Figure 12)

PE Error

- Pressing PE button disconnects PE terminal from CP state simulator, simulating a protective earth fault
- EVSE is required to stop charging in 100 ms (according to IEC 61851-1) and block any further reinitialization of the charging process

Diode Short error

- Pressing Diode Short button bypasses the diode in the CP signal path of the Instrument
- This tests EVSE’s ability to identify an invalid EV connection
- EVSE must respond by displaying an error and disabling charging

To properly do the Diode Short test:

1. press and hold the Diode Short button with the CP rotary positioned in A,
2. try to energize EVSE by setting CP to state C,
3. mains voltage should not appear on the output and EVSE should display an error.

NOTE: Some EVSE with sockets will go into error state after applying the error. In the error state they wait for the cable to be disconnected. User can simulate the disconnection of the cable by rotating the PP rotary to NC and CP rotary to A. After that the EVSE should continue to operate normally.

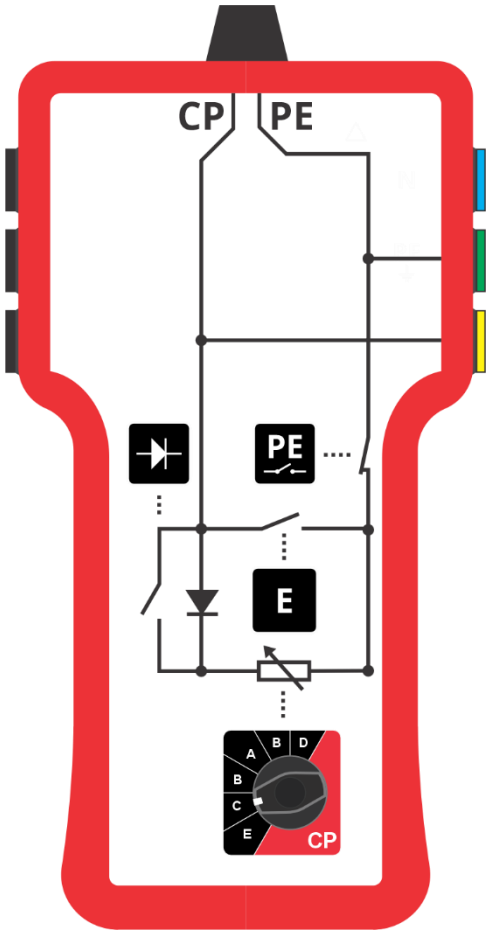


Figure 12: CP state switch and error buttons inside the Instrument.

10.2.6Mains measurements screen

It provides real-time monitoring of Mains voltages (U_{Lx-N}, U_{N-PE}), frequency and phase sequence.

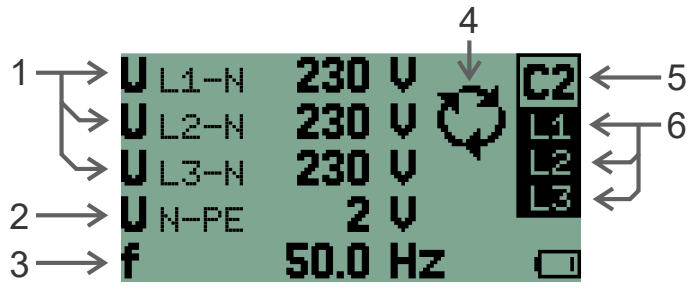


Figure 13: Mains measurement screen

1 → Phase to neutral voltages U_{L1-N}, U_{L2-N} and U_{L3-N}

2 → Neutral to PE voltage U_{N-PE}

3 → Phase frequency

4 → Mains state indication

5 → CP voltage state

6 → Phase presence indicators for U_{L1-PE}, U_{L2-PE} and U_{L3-PE}

Frequency is measured on the first present U_{Lx-N} voltage (equal or above 100 V); U_{L1-N} will be checked first and U_{L3-N} will be checked last.

"Unable to measure" icon (_ _ _) will be displayed for frequency if conditions for measurement are not met (no U_{Lx-N} is present).

Mains state indication will be evaluated as "Right", "Left" or "Undefined" if all of the voltages U_{Lx-N} and U_{Lx-PE} are present (equal or above 100 V), U_{Lx-N} are not above measuring range and their frequencies are within specified measuring range (40.0 to 70.0 Hz), otherwise "Not determined" icon (▬▬▬) will be displayed.

Mains state indication will be evaluated as "Undefined" if phase shift between voltages is not 120° ± 10° and voltage imbalance between U_{Lx-N} is more than 20% of lowest voltage.

If all voltages U_{Lx-N} and U_{N-PE} are present (equal or above 100 V) but no voltages U_{Lx-PE} are present, "L and N switched" icon will be displayed. Figure 14 shows example of detected "L and N switched" state.

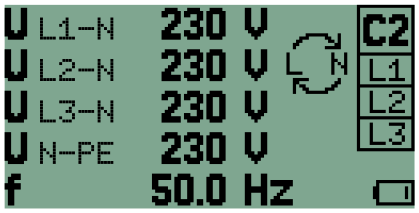


Figure 14: Example of L and N switched.

"L and N switched" icon indicates that L1 and N output terminals are most likely switched. This will mostly happen if single-phase EVSE is being tested and its Mains plug is reversed. User should be able to correct this by re-plugging EVSE into Mains in reverse.

Table 3: Possible states on position 4 of Figure 13.

State	Description	Icon
RIGHT	Phase sequence is L1 -> L2 -> L3	
LEFT	Phase sequence is L1 -> L3 -> L2	
Undefined	Phase shift between voltages is not within specified range	
Not determined	Mains state is not determined	▬▬▬
L and N switched	L1 and N output terminals are switched	

Common measurements to both screens

The right side of the screen continuously indicates the presence of each phase (U_{Lx-PE}) and the current CP state of the signal, calculated based on Table A.4, IEC 61851-1:2017.

For example, in Figure 13 all $U_{Lx\text{-}PE}$ are present (equal or above 100 V) while in Figure 14 none of them are present.

10.2.7CP measurements screen

It displays CP+ and CP– voltages, CP square wave frequency, duty cycle (labelled PWM), and the maximum current (Imax) based on Table A.8, IEC 61851-1:2017.

Same “Unable to measure” icon as before (_ _ _) will be displayed for measurements if they cannot be evaluated due to conditions not being met.

CP+ voltage will be evaluated if positive DC voltage is applied or if CP signal square wave frequency and duty cycle are measuring range.

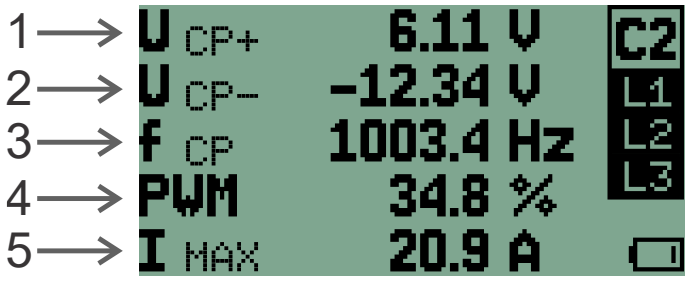
CP- voltage will be evaluated if negative DC voltage is applied or if CP signal square wave frequency and duty cycle are measuring range.

Frequency will be evaluated if square wave signal is applied.

Duty cycle will be evaluated if CP signal square wave frequency is within range.

Maximum current will be calculated from duty cycle. If duty cycle will be within 3 to 7%, “Digital” icon ( ) will be displayed. This indicates that the EVSE is attempting to establish digital communication over CP terminal (Power Line Communication; normally compliant with ISO 15118 for AC charging) with the Instrument. This Instrument itself does not support digital communication and will not establish this communication channel with the EVSE by itself. Normally the EVSE should reach a timeout in a few seconds and automatically continue with analogue communication over CP terminal.

This screen also displays $U_{Lx\text{-}PE}$ voltage presence and current CP state.



1 → CP+ voltage

2 → CP- voltage

3 → CP signal frequency

4 → CP signal duty cycle

5 → Maximal current

Figure 15: CP measurement screen

10.2.8Test sockets

The 4-mm test sockets (position 3 to 8 in Figure 2) are directly connected to the EVSE output terminals.

!!!These sockets are intended for measurement purposes only!!!

The maximum allowed current is 1 A. Higher currents can be drawn when doing measurements with appropriate MFT that complies with IEC 61557 (for some measurements, like loop/line impedance, MFT will momentarily draw higher currents). Drawing current continuously or using these sockets to power other devices is strictly prohibited. By using an appropriate MFT the following tests are possible:

- Visual inspection
- Resistance of PE conductor
- Insulation resistance in all combinations between terminals L1, L2, L3, N and PE/CP
- Loop / Line impedance
- RCD test
- RDC-DD 6 mA test

Figure 16 shows how MFT can be connected to the Instrument in order to execute measurements, mentioned above.

NOTE: The list above is only an example! This Instrument will help you to conduct the tests mentioned above.

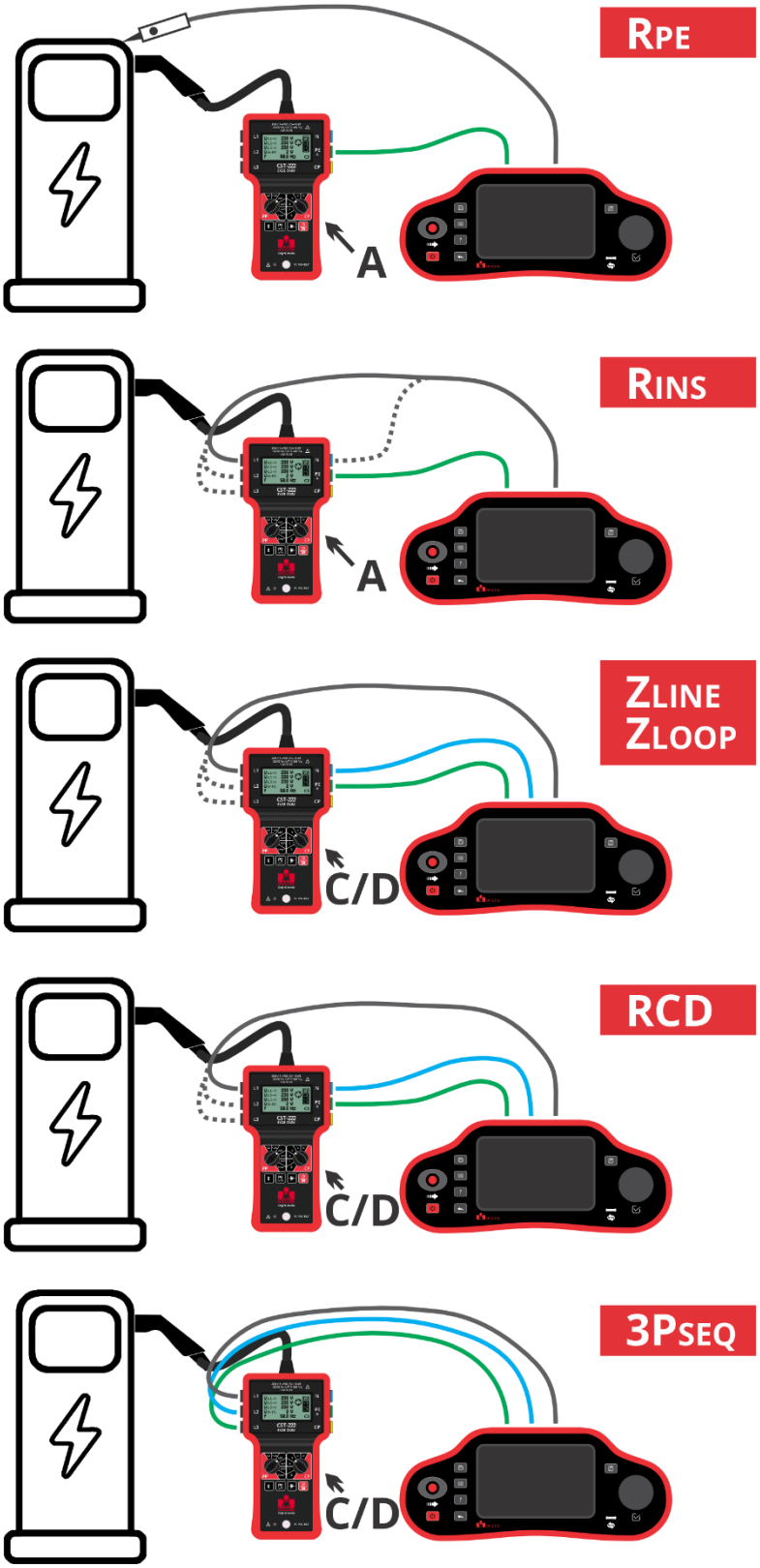


Figure 16: MFT connection to the Instrument.

10.2.9Mains socket

The Mains socket (position 1 in Figure 3) is connected to the L1, N, and PE terminals. This output is intended for measurement purposes only. It allows the connection of MFT or an external mains load. An external load can be used to verify whether the energy meter in the EVSE is functioning correctly, or in some cases, to simulate the presence of a connected EV.

NOTE: When using an external load, follow the intermittent usage guidelines as specified in the technical section of this User Manual. Maximum allowed current is 10 A. In case of misuse the socket is protected by a T10A/250V fuse (5×20 mm), located at position 2 in Figure 3.

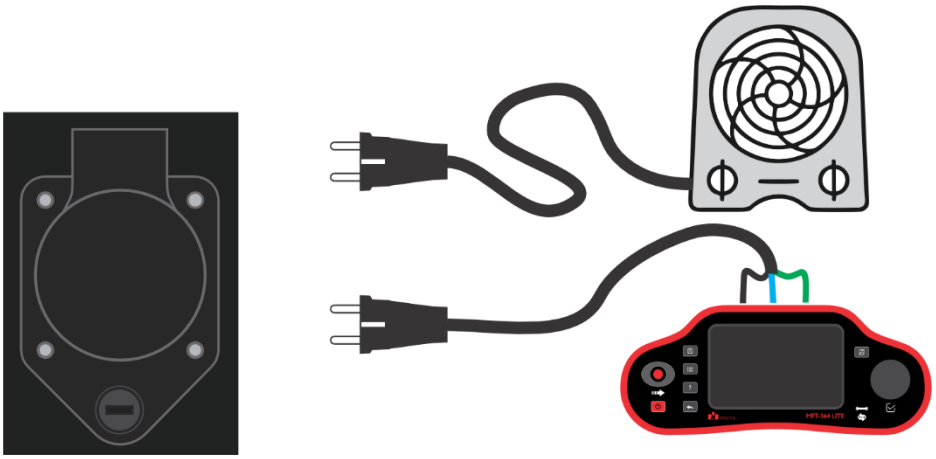


Figure 17: Load or MFT connection to the Mains socket on the Instrument.

11 Maintenance

When the Instrument is used in accordance with the User Manual, no special maintenance is required apart from battery replacement. However, if any functional issues arise during normal operation, our after-sales service will promptly repair your Instrument.

11.1Cleaning

If the Instrument requires cleaning after daily use, it is recommended to use a damp cloth and a mild household detergent.

Before cleaning, make sure to disconnect the Instrument from all measurement circuits.

Never use acid-based cleaners or solvent-based liquids for cleaning.

Do not use the Instrument again until it is completely dry.

11.2Calibration interval

We suggest a calibration interval of 1 year. If the Instrument is rarely used the calibration interval can be extended on up to 2 years.

11.3Battery replacement

If the Instrument is indicating empty batteries (refer to chapter 9.2), please follow the instructions below for proper replacement.

WARNING

- ☞ Before replacing depleted batteries, ensure that the Tester is fully disconnected from all measurement circuits.
- ☞ Use only batteries specified and rated in technical specification!
- ☞ Use of unspecified batteries is strictly prohibited!
- ☞ Spare batteries can be obtained in electric supply wholesale shops.

To replace the batteries, proceed as follows:

1) ensure that the Instrument is fully disconnected from any measurement circuit before proceeding,
2) carefully remove the protective rubber from the Instrument (position 18 in Figure 2),
3) use a suitable cross-head screwdriver to unscrew battery compartment door (position 5 in Figure 3),
4) carefully remove the used batteries by pulling the red ribbon and insert new ones of the specified type; make sure to position the red ribbon underneath them so that next battery replacement will be easier (refer to Figure 18),
5) screw back the battery compartment door and put the protective rubber back on the Instrument.

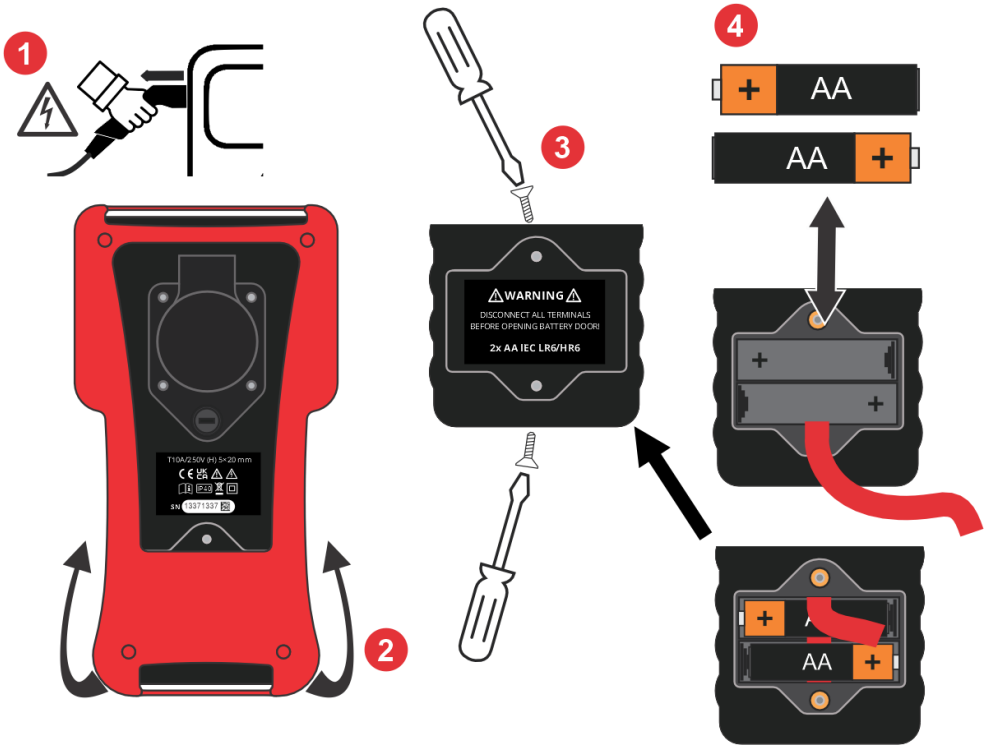


Figure 18: Battery replacement procedure.

11.4Fuse Replacement

If a fuse for Mains socket blows due to overload or improper operation, please follow the instructions below for proper replacement.

Signs of a blown fuse: no voltage is present at the Mains socket even if the connected EVSE is in “charging mode” and U_{L1-N} voltage is measured by the Instrument.

WARNING

- ☞ Prior to replacement of blown fuse, the Instrument must be disconnected from all measuring circuits.
- ☞ Use only fuse specified and rated in technical specifications; using alternative fuses may cause a safety risk!
- ☞ Use of unspecified fuses and in particular shorting fuse-holders is prohibited!
- ☞ Spare fuses can be obtained in electric supply wholesale shops or in our factory service.
- ☞ If the fuse blows several times while Instrument is being used within the specifications (for example in case of operating error) the Instrument must be sent in to the service department in order to be checked.

To replace the blown fuse, proceed as follows:

1) disconnect the Instruments from all measuring circuits,
2) unscrew fuse holder cap by using an appropriate flat-head screwdriver (position 2 in Figure 3),
3) replace the defective fuse with a new one and screw fuse holder cap back on.

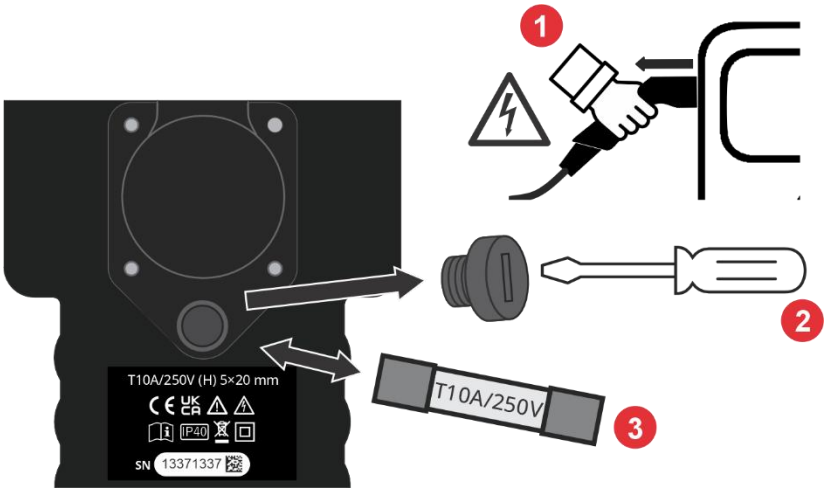


Figure 19: Fuse replacement procedure.

12 Tehnical Specifications

Accuracies defined in these specifications are valid for 1 year inside reference temperature range. Temperature coefficient outside these limits is ±0.05%/K.

General Features

Power supply	2x AA Battery Alkaline (LR6) 1.5 V or NiMH (HR6) 1.2 V
Battery life (typical)	>100 h
Input test voltage	Max. 250 VAC (single-phase system) / 480 VAC (three-phase system), 50/60 Hz, max. load current 1 A if not otherwise specified (higher load currents are allowed when doing measurements with MFT that complies with IEC 61557)
EV Connector	IEC 62196-2 plug, 16 A (Type 2, 7P three-phase), cable length 0.5 m
Housing	Plastic handheld with protective rubber
Dimensions (width × length × height)	117 × 210 × 45 mm (without cable and connector)
Weight	1.12 kg
Ingress protection class	IP40
Functional standards	IEC/EN 61851-1:2017 (Electric vehicle conductive charging system - Part 1: General requirements)
CE directive	Low Voltage Directive LVD 2014/35/EU Electromagnetic Compatibility EMC 2014/30/EU RoHS Directive 2011/65/EU WEEE Directive 2012/19/EU
Safety standards	EN/IEC 61010-1:2010+A1:2019 (Safety requirements for electrical equipment for measurement, control and laboratory use - General requirements) EN / IEC 61010-2-030:2021 (Safety requirements for electrical equipment for measurement, control and laboratory use - Particular requirements for equipment having testing or measuring circuits)
EMC standards	EN IEC 61326-1:2021 (Electrical equipment for measurement, control and laboratory use. EMC requirements - General requirements)
Reference temperature range	+23 °C (± 5 °C)
Working temperature range	-10 … 40 °C
Storage temperature range	-20 … 50 °C
Referential humidity range	30 … 50 %
Working humidity range	5 … 85 % (w/o condensation)
Storage humidity range	< 85 % (w/o condensation)
Pollution degree	2
Protection class	Class II
Measurement category	CAT II 300 V
Maximum altitude	2000 m
Display	2.4-inch reflective LCD, 128x64 pixels
Auto Power Off	5 min

Outputs

L1, L2, L3, N and PE output terminals	4-mm test sockets, max. 250/480 V, CAT II 300 V, max. 1 A
CP signal output terminal	4-mm test socket, approx. +/-12 V in reference to PE under normal conditions (in case of wrong wiring or error of the EVSE, it may become hazardous => up to max. CAT II 300 V)
Mains socket (for connection of MFT or external load)	Max. 250 V, CAT II 300 V, allowed current max. 10 A ⚠ **Warning** ⚠ **Intermittent use should be respected. Max. ratio**

	(current on time) / (current off time) = 1 / 3, max. on time = 0.5 h.
Mains socket protection	Fuse T10A/250V, breaking capacity 1500 A, size 5×20 mm

PE PRE-TEST

Indicator of present voltage on PE	>50V (user must be properly grounded; indicator is not discrete but becomes brighter with higher voltage applied)

Mains voltage presence detection (phase voltages U_{L1-PE}, U_{L2-PE}, U_{L3-PE})

Indication of present voltage	>100 V
Connection to mains	AC Coupled
Input impedance	4 MΩ

Mains voltage measurement (phase voltages U_{L1-N}, U_{L2-N}, U_{L3-N} and neutral voltage U_{N-PE})

Display/measuring range	0 … 280 V within 40.0 … 70.0 Hz
Connection to mains	AC Coupled
Resolution	1 V
Accuracy	± (2% + 3D)
Max. crest factor	2.0
Input impedance	4 MΩ from L1/L2/L3/N to PE 8 MΩ from L1/L2/L3 to N

Mains frequency measurement

Display/measuring range	40.0 … 70.0 Hz
Voltage condition	100 … 280 V (on any phase to N)
Resolution	0.1 Hz
Accuracy	± 2D

Mains state indication

Display values	Not determined Three-phase sequence - left orientation Three-phase sequence - right orientation Three-phase sequence - undefined orientation L and N switched
Three-phase sequence left/right voltage condition	100 … 280 V on all Lx to N
Three-phase sequence left/right phase imbalance	120° ± 10°
Three-phase sequence left/right voltage imbalance	< ± 20 % voltage difference between Lx/N
Lx and N switched voltage condition	100 ... 280 V on any Lx to N 100 ... 280 V on N to PE <100 V on all Lx to PE (mains voltage presence indicators all OFF)

CP Voltage

Display/measuring range (positive and negative voltage measurements separated)	± (0.50 ... 15.00 V)
Resolution	0.01 V
Accuracy (0.50 … 2.00)	± (0.5 % + 3 D)
Accuracy (2.01 … 15.00)	± 0.5 %
Frequency condition	DC or 900.0 … 1100.0 Hz
Duty cycle condition	DC or 3.0 … 97.0 %

CP Frequency

Display/measuring range	900.0 … 1100.0 Hz
Resolution	0.1 Hz
Accuracy	± 0.1 %

CP Duty Cycle

Display range	2.0 … 98.0 %
Measuring range	3.0 … 97.0 %
Resolution	0.1 %
Accuracy	± 5D
Frequency condition	900.0 … 1100.0 Hz

CP Maximum current

Calculated from **CP Signal Duty Cycle**	Based on Table A.8, IEC/EN 61851-1:2017

CP Voltage state indication

Calculated from **CP Voltage**	Based on Table A.4, IEC 61851-1:2017

“CP state” switch positions – voltage at 12V source with 1 kΩ internal resistance

A – EV in standby (EV not connected)	12 V (>1 MΩ)
B – EV connected, not ready to charge	9 V (2740 Ω)
C – EV ready to charge, no ventilation	6 V (882 Ω)
D – EV ready to charge, ventilation required	3 V (246 Ω)
E – Error state (on diode’s cathode)	0 V (<30 Ω)

“PP state” switch positions (cable ampacity selection)

NC – EV not connected	>100 kΩ
13 A	1500 Ω ± 2 %
20 A	860 Ω ± 2 %
32 A	220 Ω ± 2 %
63 A	100 Ω ± 2 %
Error	<30 Ω

Error simulations

E button – CP error state (on diode’s anode)	<30 Ω from CP to PE when pressed
PE button – PE open error	Open circuit from CP to PE when pressed
Diode short button	Short circuit over diode when pressed

13 Limited Warranty and Limitation of Liability

It is guaranteed that this MI Spekter product is free of material and manufacturing damages for the time period of 24 months starting from the date of purchase. This warranty does not include damages caused by accidents, negligence, misuse, unauthorised modifications, improper transport packaging, abnormal operating conditions or improper handling. The sales offices do not have the right to extend the warranty on behalf of MI Spekter. The supplied fuse and batteries are not covered by the warranty.

14 Service

All products that are sent in for repair or calibration within or beyond the warranty period must contain the following data: Name of the client, name of the company, address, contact telephone number and a proof of purchase. Please enclose also a short description (or a service form) of the problem detected or of desired maintenance.

Service address:

MI SPEKTER d.o.o.

Podpeška cesta 67

SI-1351 Brezovica pri Ljubljani

Slovenia

Phone: +386 (0) 7509 708

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Subject to technical changes without notice!

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