MI 3132 EV Tester
Instruction manual
Ver.1.2.2, code no. 20753309

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1 General description

1.1 **Warnings and notes**

1.1.1 Safety warnings

In order to reach high level of operator safety while carrying out various measurements using the instrument, as well as to keep the test equipment undamaged, it is necessary to consider the following general warnings.

- Read this instruction manual carefully, otherwise use of the instrument may be dangerous for the operator, for the instrument or for the equipment under test!
- Consider warning markings on the instrument!
- If the test equipment is used in manner not specified in this instruction manual the protection provided by the equipment may be impaired!
- Use only *Metrel* standard or optional test accessories!
- Only adequately trained and competent persons may operate the equipment.
- Do not use the instrument and accessories if any damage is noticed!
- Regularly check the instrument and accessories for correct functioning to avoid hazard that could occur from misleading results.
- Do not touch any conductive parts of equipment under test during the test, risk of electric shock!
- Consider all generally known precautions in order to avoid risk of electric shock while dealing with hazardous voltages!
- Instrument servicing and calibration is allowed to be carried out only by a competent authorized person!
- *Metrel* Auto Sequences® are designed as guidance to tests in order to significantly reduce testing time, improve work scope and increase traceability of the tests performed. *Metrel* assumes no responsibility for any Auto Sequence by any **means. It is the user's responsibility, to check adequacy for the purpose of use of** the selected Auto Sequence. This includes type and number of tests, sequence flow, test parameters and limits.
- In case a fuse has blown refer to the chapter <u>Maintenance</u>.

- Maximum allowed input voltage between any terminals on test connector (C1, C2,P1,P2) is 1000 V! (CAT III 1000 V)

1.1.2 Warnings related to batteries

- Use only batteries provided by the manufacturer.
- Do not attempt to disassemble, crush or puncture the batteries in any way.
- Do not use a damaged battery.
- If a battery has leaking fluids, do not touch any fluids.
- In case of eye contact with fluid, do not rub eyes. Immediately flush eyes thoroughly with water for at least 15 minutes, lifting upper and lower lids, until no evidence of the fluid remains. Seek medical attention.

1.1.3 Warnings related to safety of measurement functions

<table>
<tr><td>

WARNING

Measurements are performed on energized conductors, or test leads can be accidentally connected to them.
Risk of electric shock!
Always consider precautions against electric shock!

</td></tr>
</table>

Insulation resistance	Do not touch the test object during the measurement or before it is fully discharged! Risk of electric shock! Conditions for starting the test (in regard to external voltage on test terminals): U < 50V: test will start normally U = 50 V to 200 V: test will start, noise icon will lit. Results may be impaired. U > 200 V: a check of the current capability / resistance of the external voltage source will be performed. If current capability is below 3 mA the test will start, noise icon will lit. Results may be impaired. If current capability is above 3 mA the test will not start, notification will be displayed. At the end of test, capacitive objects are discharged to 35 V.

1.1.4 Note related to measurement procedure

- In general, the procedure for measurement consists of the following steps in exact order:
    1. Select measurement function
    2. Connect test leads / accessories to the test instrument and to the device under test
    3. Start and stop the measurement
    4. Disconnect device under test from the test instrument

1.1.5 General notes

- LCD screenshots in this document are informative only. Screens on the instrument may be slightly different.
- *Metrel* reserve the right to make technical modifications without notice as part of the further development of the product.

1.1.6 Markings on the instrument

⚠	Read the Instruction manual with special care to safety operation«. The symbol requires an action!
CE	Mark on your equipment certifies that it meets requirements of all subjected EU regulations.
UKCA	Mark on your equipment certifies that it meets requirements of all subjected UK regulations.
🗑	This equipment should be recycled as electronic waste.

1.2 **Battery and charging of Li-ion battery pack**

1.2.1 Battery and charging characteristics

Battery type	18650T22A2S2P 18650T22A2S4P (optional)
Rated capacity	4400 mAh (type: 18650T22A2S2P) 8800 mAh (type: 18650T22A2S4P)
Typical charging time	3 hours (type: 18650T22A2S2P) 4.5 hours (type: 18650T22A2S4P)

1.2.2 Li – ion battery pack guidelines

Li – ion rechargeable battery pack requires routine maintenance and care in their use and handling. Read and follow the guidelines in this Instruction manual to safely use Li – ion battery pack and achieve the maximum battery life cycles.

Do not leave batteries unused for extended periods of time – more than 6 months (self – discharge). Rechargeable Li – ion battery pack has a limited life and will gradually lose their capacity to hold a charge. As the battery loses capacity, the length of time it will power the product decreases.

Storage:

- Charge or discharge the instruments battery pack to approximately 50% of capacity before storage.
- Charge the instrument battery pack to approximately 50% of capacity at least once every 6 months.

1.3 **Standards applied**

The instrument is manufactured and tested according to the following regulations, listed below.

Electromagnetic compatibility (EMC)

EN 61326-1	Electrical equipment for measurement, control and laboratory use - EMC requirements – Part 1: General requirements
EN 61326-2-2	Electrical equipment for measurement, control and laboratory use - 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

Safety (LVD)

EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
EN 61010-2-030	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits
EN 61010-031	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test
EN 61557	Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures Instrument complies with all relevant parts of EN 61557 standards.

Functionality

UNECE R100	Regulation No. 100 – Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electrical power train
ISO 6469-3	Electrically propelled road vehicles – Safety specification – Part 3: Electrical safety

2 Instrument set and accessories

2.1 Standard set of the instrument

- Instrument MI 3132 EV Tester
- Soft carrying bag and set of carrying straps
- 4-wire test lead, 2 x 2 m + 2 x 5 m, (A 1782)
- 3-wire test lead, 3 x 1.5 m, (A 1781)
- 2-wire test lead, 2 x 1.5 m, (A 1780)
- Test tip, 4 pcs, (red, black, brown, grey)
- Alligator clips, 5 pcs, (2 x black, 2 x red, 1 x green)
- USB cable
- Li-ion battery pack, 7.2 V, 4400 mAh (Type: 18650T22A2S2P)
- Power supply adapter 12 V, 3 A
- Short form instruction manual (Quick guide)
- PC SW Metrel ES Manager, Instruction manual: download from WebCD page (link included)

See the attached sheet "Included in the Set".

2.2 Optional accessories

For a list of optional accessories, approved with this test instrument, visit www.metrel.si/.

3 Instrument description

3.1 Front panel
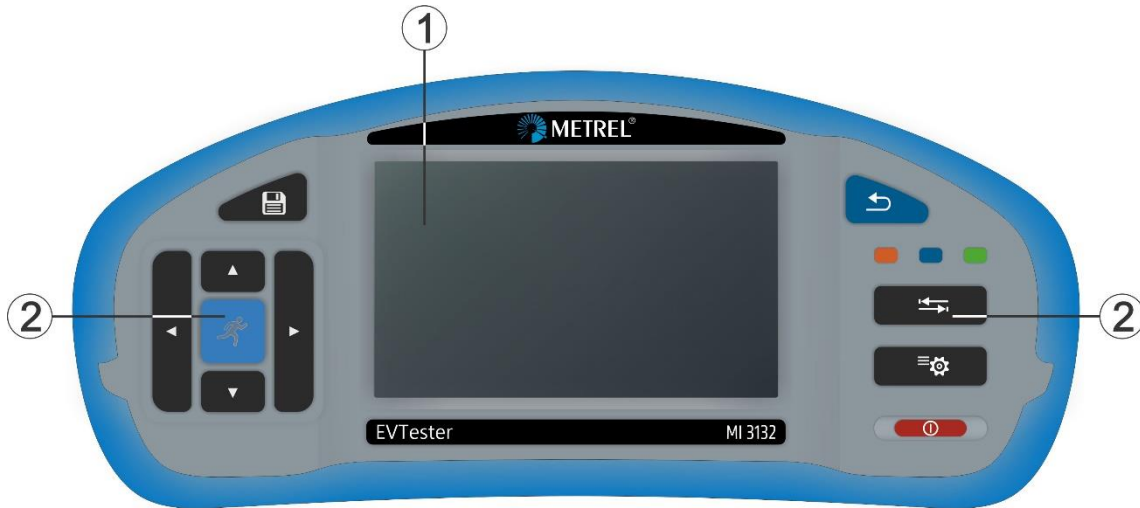
1	Colour TFT display with touch screen
2	Keypad

3.2 Connector panel
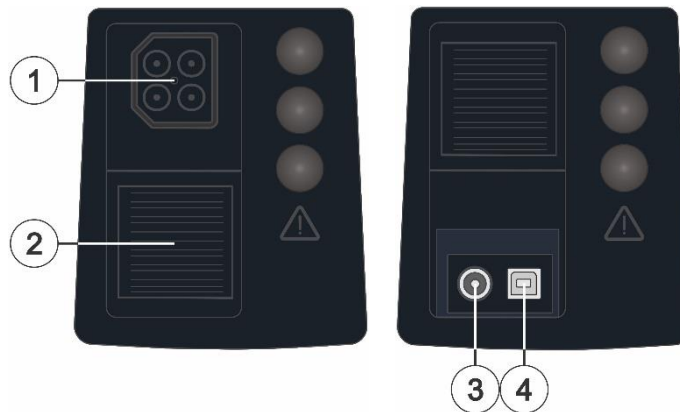
1	4-pole test connector
2	Protection cover
3	Charger socket
4	USB communication port

3.2.1 Designation of the 4 – pole test connector terminals

Voltage Meter	C1, C2
μΩ - Meter	P1, C1, C2, P2
Ω - Meter	P1, C1, C2, P2
Insulation Resistance	C1, C2
Continuity	C1, C2
ISO EV R100	C1, C2, P2

3.3 **Back side**

1	Battery / fuse compartment cover
2	Fixing screws for battery / fuse compartment cover
3	Back panel information label

3.3.1 Battery / fuse compartment
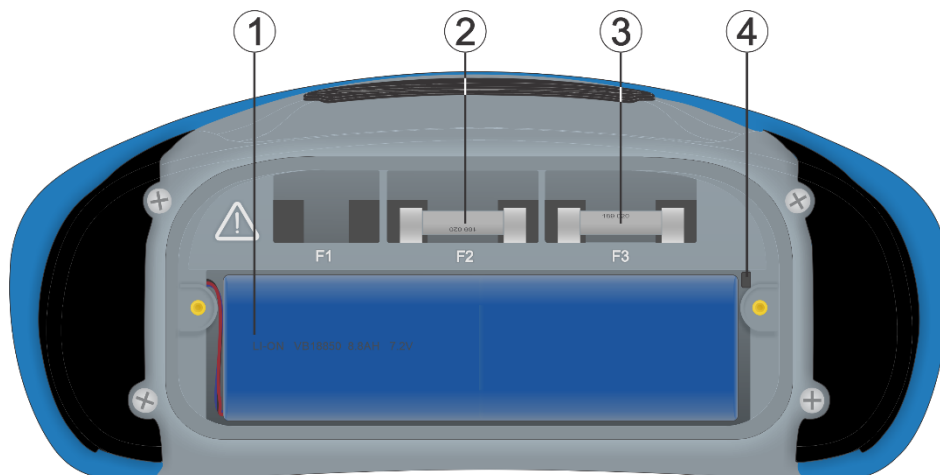
1	Li-ion battery pack
2	Fuse, FF 2 A / 1000 V, 32 × 6.3 mm (breaking capacity: 30 kA)

| 3 | Fuse, FF 100 mA / 1000 V, 32 × 6.3 mm (breaking capacity: 30 kA) |
| 4 | SD card slot |
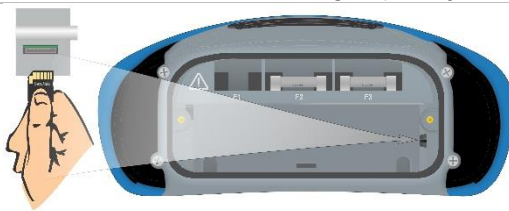
3.4 **Bottom**
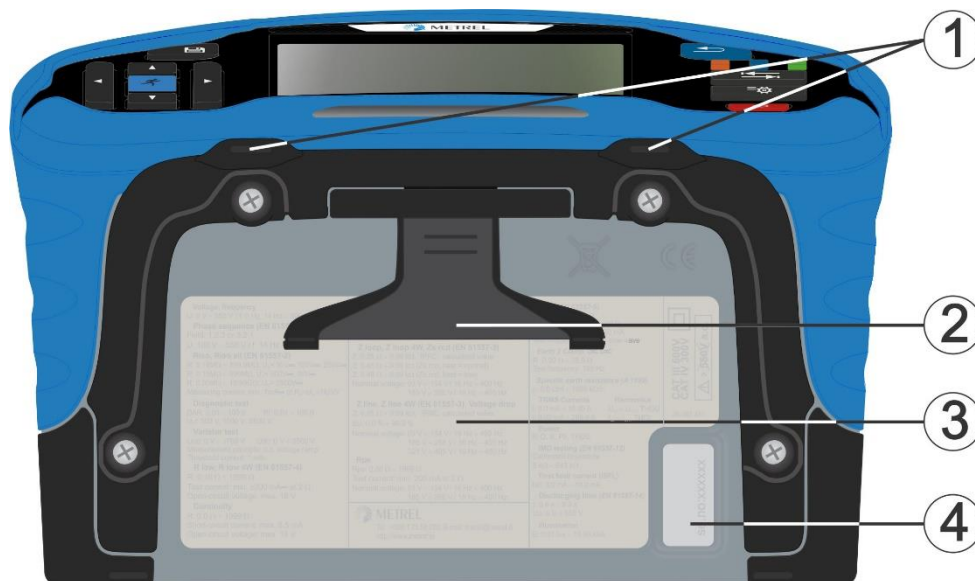
1	Neck belt openings
2	Stand for desktop use
3	Bottom information label
4	Serial number label

3.4.1 Secure attachment of the strap

Please perform a periodical check of the attachment.

4 Instrument operation

The instrument can be manipulated via a keypad or touch screen.

4.1 **General meaning of keys**
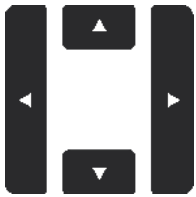
	Cursor keys are used to: • select appropriate option; • Left, right, up, down; • In some functions: page up, page down.
	Run key is used to: • confirm selected option; • start and stop measurements.
	Escape key is used to: • return to previous menu without changes; • abort measurements.
	Option key is used to: • expand column in control panel; • Show detailed view of options.
	Save key is used to: • store test results.
	Auto Sequences® key is used as: • shortcut key to enter Auto Sequences® menu.
	Single Tests key is used as: • shortcut key to enter Single Tests menu.
	Memory Organizer key is used as: • shortcut key to enter Memory Organizer menu.
	General Settings key is used to: • enter General Settings menu.
	On / Off key is used to: • switch On / Off the instrument; • switch Off the instrument if pressed and held for 5 s.

4.2 **General meaning of touch gestures**

	Tap (briefly touch surface with fingertip) is used to: • Select appropriate option. • Confirm selected option. • Start and stop measurements.
	Swipe (press, move, lift) up/ down is used to: • Scroll content in same level. • Navigate between views in same level.
  long	Long press (touch surface with fingertip for at least 1 s) is used to: • Select additional keys (virtual keyboard).
	Tap Escape icon is used to: • Return to previous menu without changes. • Abort / stop measurements.

4.3 **Virtual keyboard**
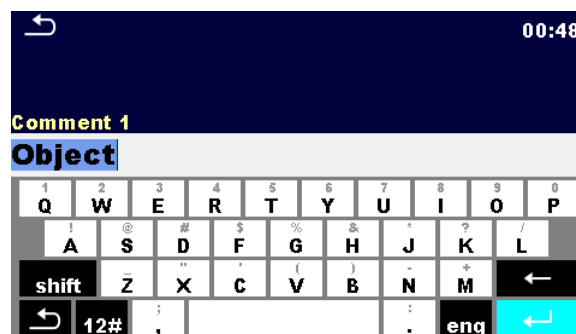
Note
• If Backspace is held for 2 s, all characters will be selected.   • Set English, Greek, Russian, Hebrew character set: eng, GR, RU, HEB.

Hint
Long press on some keys opens additional keys.

4.4 **Safety checks, symbols, messages**

At start up and during operation the instrument performs various safety checks to ensure safety and to prevent any damage. If a safety check fails, an appropriate warning message will be displayed and safety measures will be taken.

4.4.1 Terminal voltage monitor

The terminal voltage monitor displays conditions on the active test terminals.
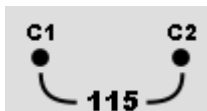
     Voltages on the active terminals

     Polarity of output signal on active terminals

4.4.2 Battery

The battery indication indicates the charge condition of battery and connection of external charger.

	Battery capacity indication.
	Low battery. Recharge the battery cells.
	Battery is full.
	Battery fault indication.
	Charging in progress (if power supply adapter is connected and battery inserted).

4.4.3 Messages

In the message field warnings and messages are displayed.

	Voltage higher than 1000 V is detected on test terminals. Immediate action is needed!
	Check the reason and safely remove the test leads from the voltage source.

Notification

External voltage is detected on test terminals.

OK
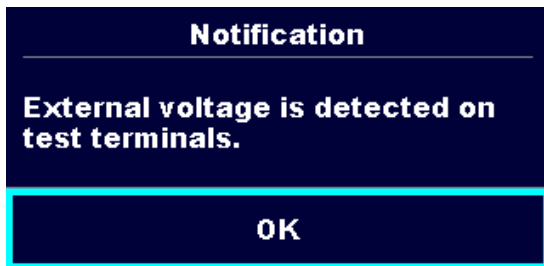
Test is blocked, because an external voltage with too high current capability was detected. See *Warnings related to safety of measurement functions*.

▶	Conditions on the input terminals allow starting the measurement; consider other displayed warnings and messages.
▶	Conditions on the input terminals do not allow starting the measurement, consider displayed warnings and messages.
⚡	Warning! High voltage is applied to the test terminals. Limit [> 50 Vrms on test terminals].
∿	High electrical noise was detected during measurement. Results may be impaired.
↻	Wrong polarity for the test. Change C1 and C2 test leads.
∿	AC voltage detected. Test cannot be carried out.
⧗	Measurement is running, consider displayed warnings.
CAL✗	Test leads resistance in Ω - Meter and Continuity measurement is not compensated. Limit [Lead compensation < 5 Ω].
CAL✓	Test leads resistance in Ω - Meter and Continuity measurement is compensated.
✗	Improper connection of measuring leads. Check connection of test leads.
✔	Test passed. Result is inside predefined limits.
✘	Test failed. Result is out of predefined limits.
🚫	Measurement is aborted. Consider displayed warnings and messages.

	Bluetooth communication inactive.
	Bluetooth communication active.

Hint
For some icons more information is displayed if on icon.

4.5 **Instrument main menu**

From the instrument Main Menu four main operation menus can be selected.
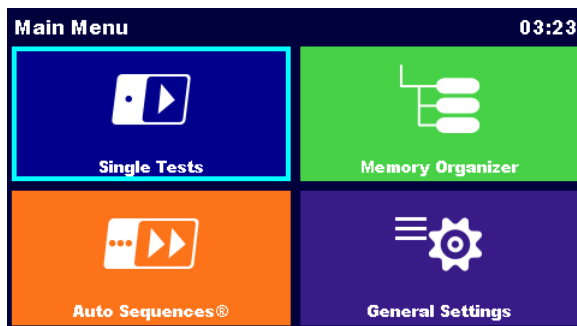
Single Test	Menu for selecting single tests
Auto Sequences®	Menu for selecting Auto sequence®
Memory Organizer	Menu for working with structured test objects and measurements
General Settings	Menu for setup of the instrument

4.6 **General settings menu**

In the General Settings menu general parameters and settings of the instrument can be viewed or set.
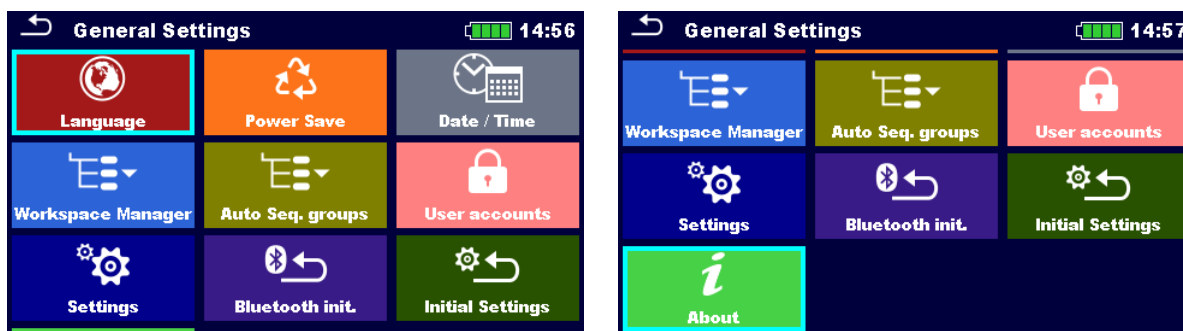
Language	Language selection
Power Save	Brightness of LCD, enabling/disabling Bluetooth communication
Date / Time	Setting date and time
Workspace Manager	Managing project files

Auto Sequence® groups	Managing lists of Auto Sequences®
User accounts	Managing user accounts
Profiles	Instrument profiles (This setting is visible only if more than one profile is available.)
Settings	Setting different system and measuring parameters
Bluetooth initialization	Bluetooth module initialization
Initial Settings	Factory settings
About	Instrument data

4.6.1 Power Save

In this menu different options for decreasing power consumption can be set.
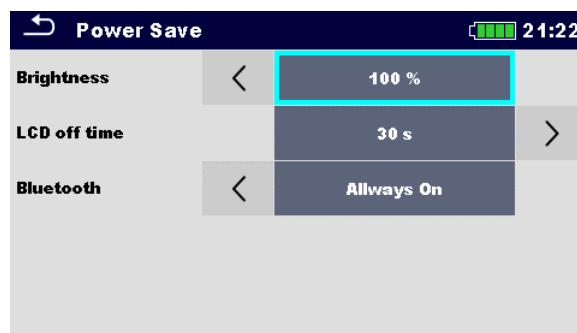
Brightness	Setting level of LCD brightness level.
LCD off time	Setting LCD off after set time interval. LCD is switched on after pressing any key or touching the LCD.
Bluetooth	Always On: Bluetooth module is ready to communicate. Save mode: Bluetooth module is set to sleep mode and is not functioning.

4.6.2 Settings
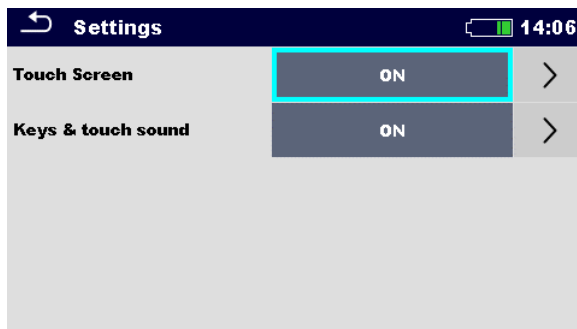
Touch screen	Set Touch screen on / off.
Keys & touch sound	Set key touch sound on / off.

4.6.3 Bluetooth initialization

In this menu the Bluetooth module is reset.
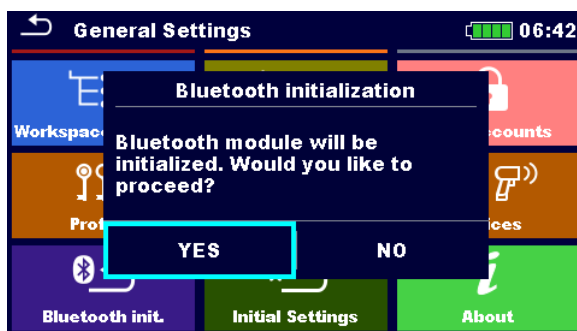
4.6.4   Initial Settings

In this menu internal Bluetooth module will be initialized and the instrument settings, measurement parameters and limits will be set to initial (factory) values.

WARNING

Following customized settings will be lost when setting the instruments to initial settings:
- Measurement limits and parameters.
- Global parameters, System settings and Devices in General settings menu.
- Opened Workspace and Auto Sequence® group will be deselected.
- User will be signed out.

Note

Following customized settings will stay:
- Profile settings
- Data in memory (Data in Memory organizer, Workspaces, Auto Sequence® groups and Auto Sequences®)
- User accounts

4.6.5 About

In this menu instrument data (name, serial number, FW (firmware) and HW (hardware) version, profile code, HD (hardware documentation) version, and date of calibration) can be viewed.

About	14:59
Name	MI 3132 EV Tester
S/N	22320637
FW version	1.0.5.53db6ca2
FW Profile	CDAB
HW version	1
HD version	1

4.6.6 User Accounts

The instrument has an User Accounts system. Following actions can be managed:
- Setting if signing in to work with the instrument is required or not.
- Adding and deleting new users, setting their user names and passwords.
- Setting the password for allowing Black Box operation.

Default passwords

'ADMIN'	The default account manager password
Second account manager password	This password is delivered with the instrument and always unlocks the Account manager
	By default, no password needs to be entered for Black Box operation

Note
• If a user account is set and the user is signed-in, the user's name will be stored for each measurement.

	Sign in as user: Select User, Sign in, change user Password. Sign in as administrator: Select Account manager, set account manager Password.
	User sign out: select Sign out Change user password (individual users can change their password): Select Change password, set new password. Account manager sign out: is automatic by exiting the Account manager menu.
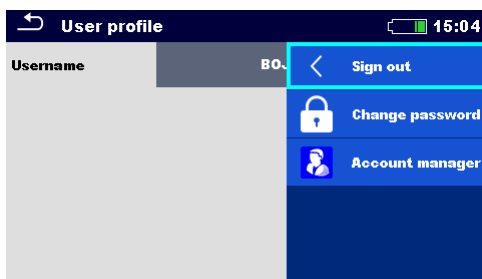
4.6.7 Managing accounts

User Accounts can be managed by the Account manager.
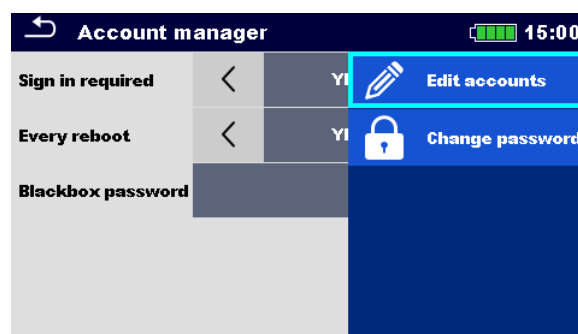
Sign in required	Require signing in
Every reboot	Sign in is required once, or at each reboot of the instrument
Change password	Change account manager password. Password is case sensitive.
Blackbox password	Set Black Box password (same password is valid for all users)

Edit accounts
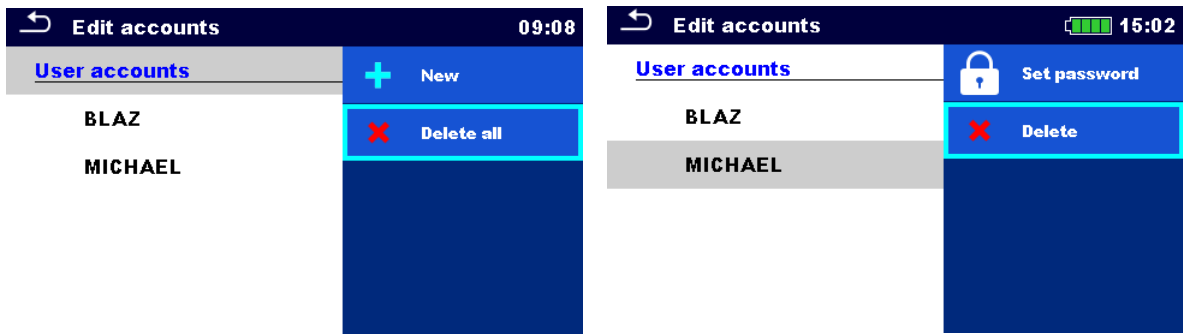
Add new user	Header line (User accounts), New, add name and password
Delete all users	Header line (User accounts), Delete all
Delete user	Select user, Delete
Change user's password	Select user, Set password

4.7 **Instrument profiles**

The instrument uses specific system and measuring settings in regard to the scope of work or country it is used. These specific settings are stored in instrument profiles. By default, each instrument has at least one profile activated. Proper licence keys must be obtained to add more profiles to the instrument. See *Appendix B - Profile Notes* for more information about functions specified by profiles.
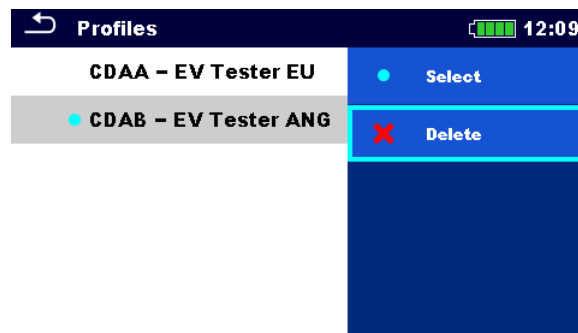
Select	Select profile
Delete	Delete profile

Note
• This menu is visible only if more than one profile is available.

4.8 **Workspace Manager**

The Workspace Manager is intended to manage with different Workspaces and Exports stored on the microSD card.

4.8.1 Workspaces and Export

The works can be organized with help of Workspaces and Exports. Both Exports and Workspaces contain all relevant data (measurements, parameters, limits, structure objects) of an individual work.
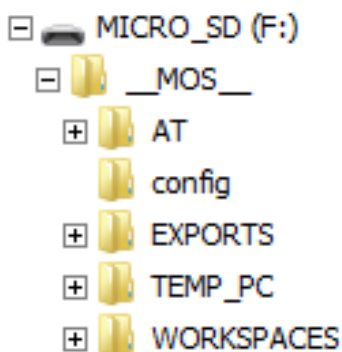
Workspaces are stored on microSD card on directory WORKSPACES, while Exports are stored on directory EXPORTS. Export files can be read by Metrel applications that run on other devices. Exports are suitable for making backups of important works or can be used for storage of works if the removable microSD card is used as a mass storage device. To work on the instrument an Export should be imported first from the list of Exports and converted to a Workspace. To be stored as Export data a Workspace should be exported first from the list of Workspaces and converted to an Export. In the Workspace manager menu Workspaces and Exports are displayed in two separated lists.
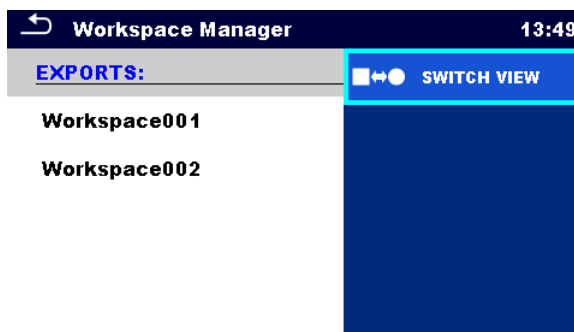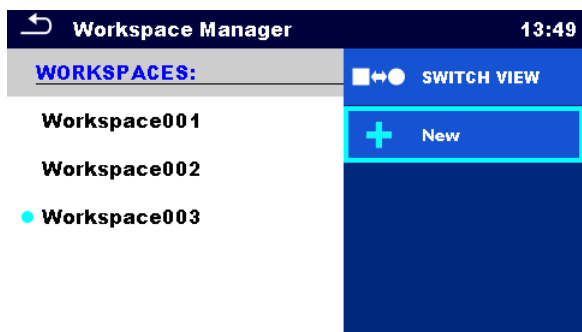
Header line (Workspaces, Exports), Switch View	Switch between Exports and Workspaces
Header line (Workspaces), New	Add new Workspace
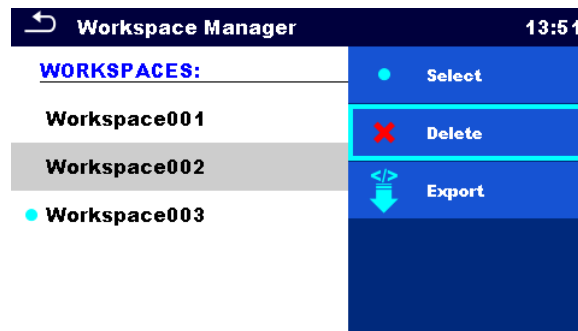
Select	Open selected Workspace in Memory Organizer
Delete	Delete selected Workspace
Export	Export selected Workspace into an Export
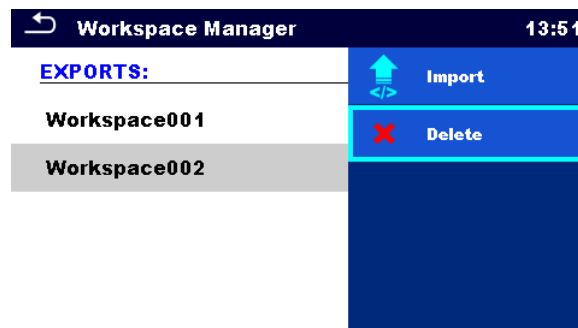
Import	Import selected Export to a Workspace
Delete	Delete selected Export

4.9 **Auto Sequence® groups**

The Auto Sequences in the instrument can be organized by using lists. In a list a group of similar Auto Sequences is stored. The Auto Sequence® groups menu is intended to manage with different lists. Folders with lists of Auto Sequences are stored in *Root__MOS__\\AT* on the microSD card.

In Auto Sequence® groups menu lists of Auto Sequences® are displayed.
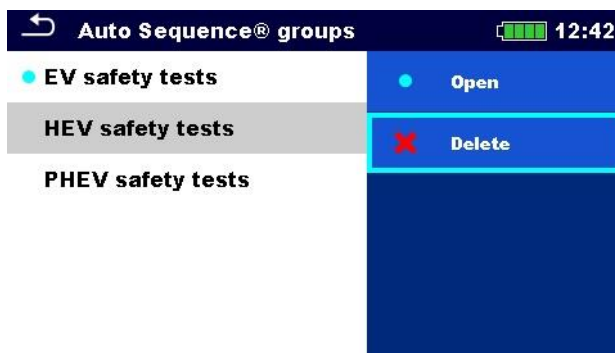
Open	Open the selected Auto Sequence® group in the Auto Sequences® main menu.
Delete	Delete the selected Auto Sequence® group.

5 Memory Organizer

Memory Organizer is an environment for storing and working with test data. The data is organized in a multilevel tree structure with Structure objects and Measurements. For a list of available structure objects see *Appendix A - Structure objects.*

5.1 **Operations in Memory Organizer**

5.1.1 Operations on Workspace

Header line (Workspace), Workspaces	Go to Workspace Manager from Memory Organizer
Header line (Workspace), Search	Search for structure elements

Node:
Node is the highest-level structure element. One Node is a must; others are optional and can be created or deleted freely.

Add a new node	Header line (Workspace), Add structure

5.1.2 Operations on measurements

Start Test	Start a new measurement
Clone	Copy selected measurement as an empty measurement under the same Structure object
Copy, Paste	Copy a selected measurement as an empty measurement to any location in structure tree
Add Measurement	Add an empty measurement
Comment	Add / view a comment to the measurement
Delete	Delete a measurement

View	Enter menu for viewing details of test
Parameters	View / edit parameters
Retest	Run a new measurement with same settings as selected measurement

5.1.3 Measurement statuses

Measurement statuses indicate the status of a measurement or a group of measurements in the Memory Organizer.

Statuses of Single tests

🟢	Passed finished single test with test results
🔴	Failed finished single test with test results
🔵	Finished single test with test results and no status
⭕	Empty single test without test results

Overall statuses of Auto Sequence

🟢 or ✔	At least one single test in the Auto Sequence passed and no single test failed
🔴 or ✖	At least one single test in the Auto Sequence failed
🔵 or ▬	At least one single test in the Auto Sequence was carried out and there was no other passed or failed single tests
⭕ or ▬	Empty Auto Sequence with empty single tests

Overall status of measurements under structure elements
Overall status of measurements under each structure element gives a fast information on tests without expanding tree menu.

	There are no measurement result(s) under selected structure object. Measurements should be made.
	One or more measurement result(s) under selected structure object has failed. Not all measurements under selected structure object have been made yet.
	All measurements under selected structure object are completed but one or more measurement result(s) has failed.
	No status indication if all measurement results under each structure element / sub-element have passed or are without measurements.

5.1.4 Operations on Structure objects
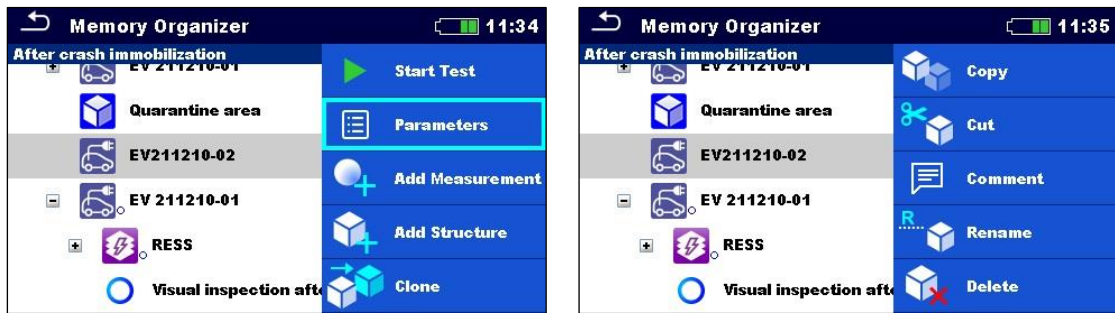
Start Test	Start a new measurement (proceeds to menus for selection of measurement).
Parameters	View / edit parameters.
Add Measurement	Add a new empty measurement. Menu for adding new measurement will open.
Add Structure	Add a new structure object. Menu for adding new structure object will open.
Clone	Copy selected element as to same level in the structure tree.
Copy, Paste	Copy selected element to any allowed location in structure tree. Menu for selecting inclusions (parameters, attachments, sub structures, sub measurements) of copy command is opened.
Cut, Paste	Move selected Structure with child items (sub-structures and measurements) to any allowed location in structure tree.
Comment	View/edit/add a comment to the structure element.
Rename	Rename the structure element.
Delete	Delete the structure element.
Attachment	View link of attachment.

5.1.5 Searching in Memory Organizer

In Memory organizer it is possible to search for different structure objects and their parameters.
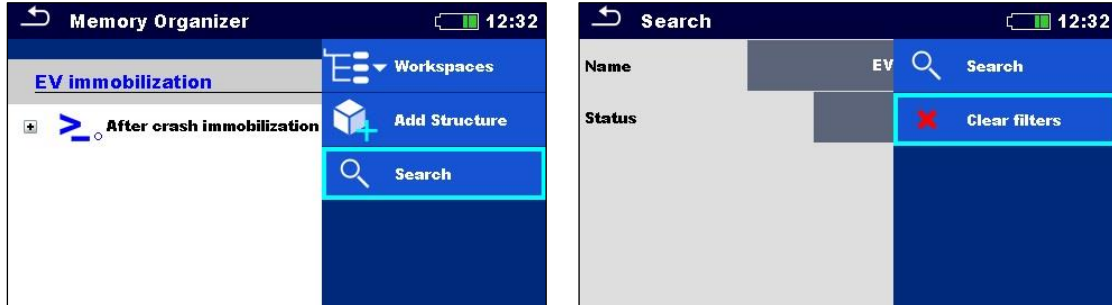
Header line (Workspace), Search	Enter Search menu
Search	**Search according to parameter, status…**
Clear filters	Clear set filters in Search menu

Operations on found structure objects

Header line (Page x/y), Next Page, Previous Page	Go Page Up / Down
Go to location	Jump to selected location in Memory organizer
Parameters	View/edit parameters
Rename	Rename the found object

6 Single tests

There are different modes for selecting single tests available.

6.1 Selection modes

In Single tests main menu four modes for selecting single tests are available.

Groups	View groups of similar tests
Last used	View last made measurements
Cross selector	Selection mode optimized for working with keypad
All	View all measurements

6.2 Single test screens

In the Single test screens main measuring results, sub-results, limits and parameters of the measurement are displayed. In addition, on-line statuses, warnings and other information are displayed.
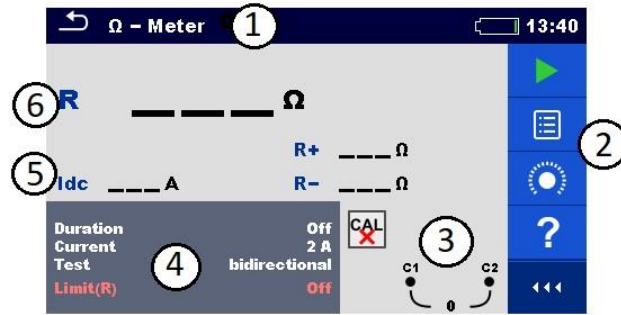
1	Name of function
2	Options
3	Statuses, infos, warnings
4	Parameters (white) and limits (red)
5	Sub-result
6	Main result

6.2.1 Single test start screen
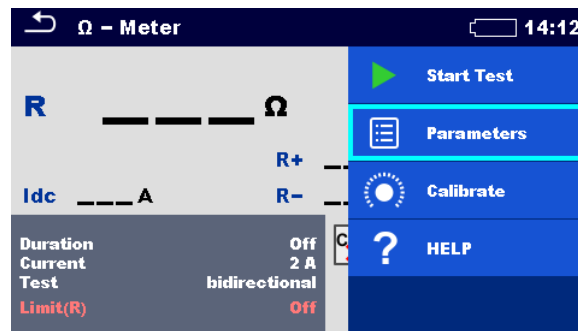
Start test	Start single test
Parameters, or tap on Parameters field	Set parameters/ limits of single test
Calibrate	Compensate test leads (option)
Help	View help screens

Add comments before the test: In the Parameters menu comments can be stored as a part of the single test Parameters, Comment 1, Comment 2.

6.2.2 Single test screen during test
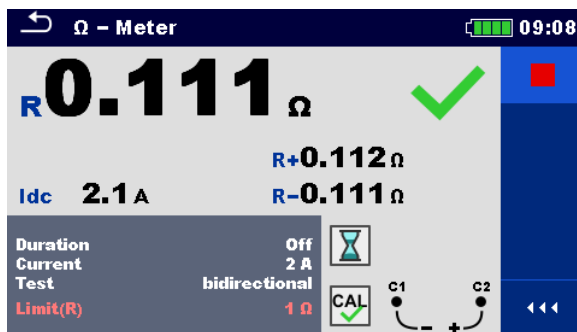
	End single test

Testing procedure (during the test)
Observe the displayed results and statuses
Check for eventual messages, warnings

6.2.3 Single test result screen
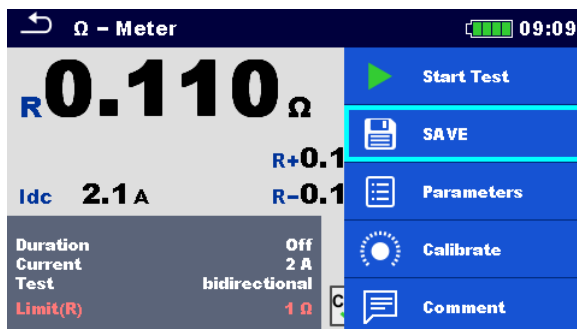
Start test	Start a new single test
Save	Save the result

A new measurement was started from a Structure object in the structure tree	The measurement will be saved under the selected Structure object
A new measurement was started from the Single test main menu	Saving under the last selected Structure object will be offered by default. The user can select another Structure object or create a new Structure object. By pressing the Save key in Memory organizer menu the measurement is saved under selected location.

An empty measurement was selected in Memory Organizer and started	The result(s) will be added to the measurement. The measurement will **change its status from 'empty' to 'finished'.**
An already carried out measurement was selected in Memory Organizer, viewed and then restarted	A new measurement will be saved under the selected Structure object.
Comment	Add comment to the measurement

6.3 **Single test (inspection) screens**

Visual and Functional inspections are a special type of single tests. Items to be visually or functionally checked are displayed. Appropriate statuses can be applied.
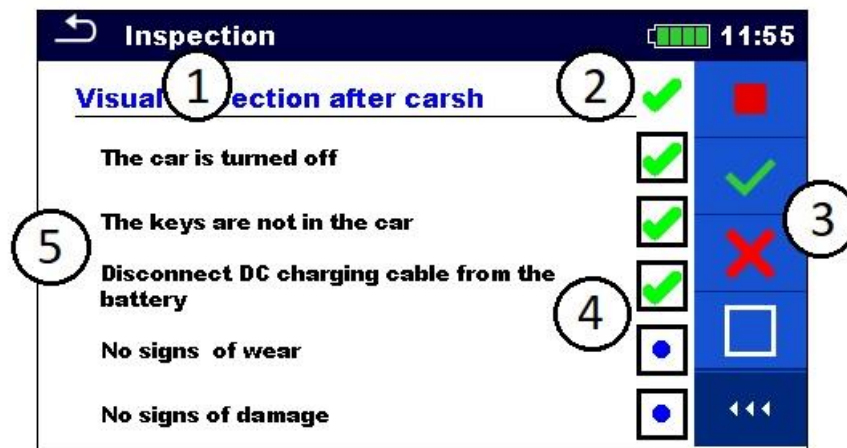
	1	Selected inspection
	2	Overall status
	3	Options
	4	Status fields
	5	Items

6.3.1 Single test (inspection) start screen
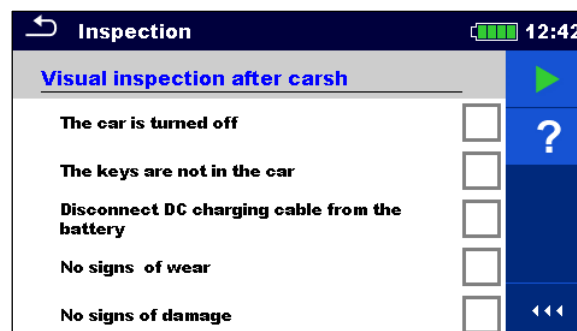
Start test	Start the inspection
Help	View help screens

6.3.2 Single test (Inspection) screen during test
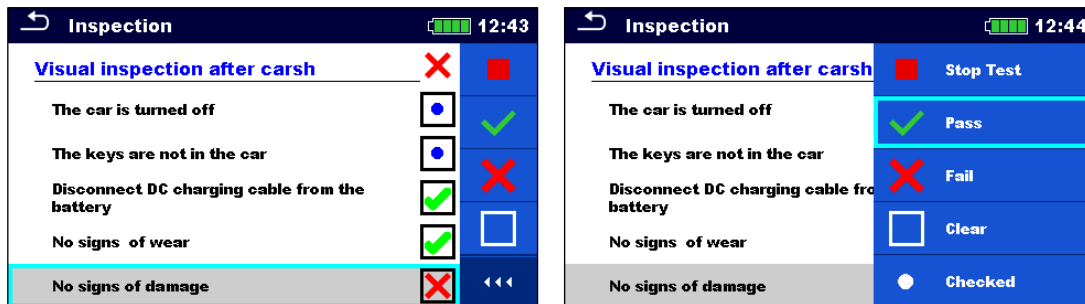
Header line (name of inspection), apply Pass or Fail or Checked or Clear	Apply or clear the overall status to complete inspection
Select items, apply Pass or Fail or Checked or Clear	Apply or clear the status of an individual item

---

Hint

Tap on ☐ or use [🏃] key to set status.

Rules for automatic applying of statuses

The parent items will automatically get a status on base of statuses in child items	• The fail status has highest priority. A fail status for any item will result in a fail status in all parent items and an overall fail result. • If there is no fail status in child items the parent item will get a status only if all child items have a status. • Pass status has priority over checked status.
The child items will automatically get a status on base of status in the parent item	All child items will get the same status as applied to the parent item

---

Note

- Inspections and even inspection items inside one inspection can have different **status types. For example, some inspections don't have the 'checked' status.**
- Only inspections with an overall status can be saved.

6.3.3 Single test (Inspection) result screen

Start test	Start a new inspection
Save results	Save the result
Comment	Add comment to the inspection
Help	View help screens

|	
A new inspection was started from a Structure object in the structure tree	The inspection will be saved under the selected Structure object.
A new inspection was started from the Single test main menu	Saving under the last selected Structure object will be offered by default. The user can select another Structure object or create a new Structure object. By pressing the Save key in Memory organizer menu the inspection is saved under selected location.
An empty inspection was selected in Memory Organizer and started	The result(s) will be added to the inspection. The inspection will change its status from **'empty' to 'finished'.**
An already carried out inspection was selected from Memory Organizer, viewed and then restarted	A new inspection will be saved under the selected Structure object.

6.3.4 Help screens

Help screens contain diagrams for proper connection of the instrument.
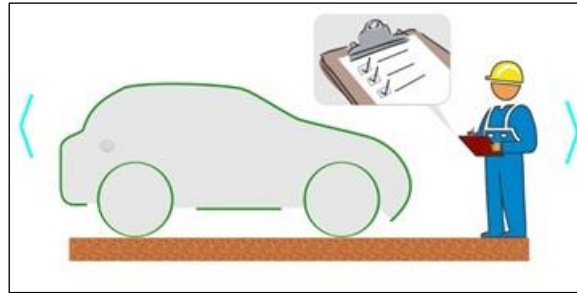
Help	Open help screen
👆 on 〈 〉 , ◀ ▶	Go to other help screens
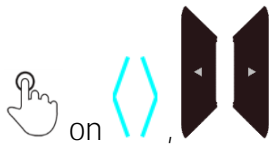
6.4 **Single test measurements**

6.4.1 Visual inspection after crash
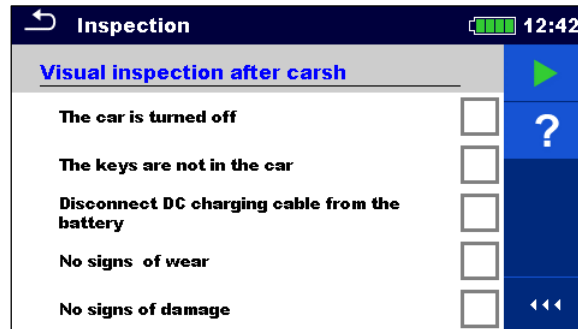
Test results / sub-results

✔............Pass
✘............Fail
●............Checked

Test circuit
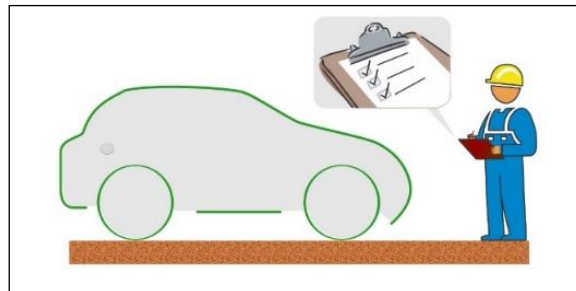
6.4.2Voltage and Frequency
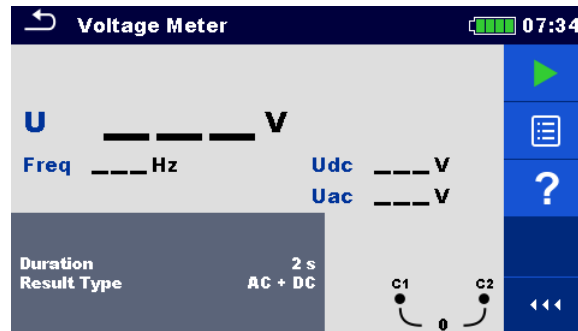
Test results / sub-results
U ....Voltage
Udc............Voltage (DC portion)
Uac............Voltage (AC portion)
Freq...........Frequency

Test parameters

Duration	Test duration: [Off, 2 s … 180 s]
Result Type	Type of main result: [AC, DC, AC+DC]

Test circuits

6.4.3 **µΩ** - Meter

Test results / sub-results
R ....Resistance
Idc ....Test current
R+ ....Resistance (positive direction)
R- ....Resistance (negative direction)

Test parameters

Duration	Test duration: [Off, 2 s ... 180 s]
Current	Test current: [10 mA, 100 mA, 200 mA, 1 A, 2 A]
Test	Test polarity: [unidirectional, bidirectional]

Test limits

Limit	Limit(R): [Off, Custom, 1 m**Ω** ... 100 **Ω**]

Additional options

Lim. Calculator	Limit Calculator – see Limit calculator

Test circuits

6.4.4 **Ω** - Meter

Test results / sub-results
R ....Resistance
Idc ....Test current
R+ ....Resistance (positive direction)
R- ....Resistance (negative direction)

Test parameters

Duration	Test duration: [Off, 2 s ... 180 s]
Current	Test current: [10 mA, 100 mA, 200 mA, 1 A, 2 A]
Test	Test polarity: [unidirectional, bidirectional]

Test limits

Limit	Limit(R): [Off, Custom, 1 mΩ ... 100 Ω]

Additional options

Calibrate	Calibrate – see Compensation of test lead(s)
Lim. Calculator	Limit Calculator – see Limit calculator
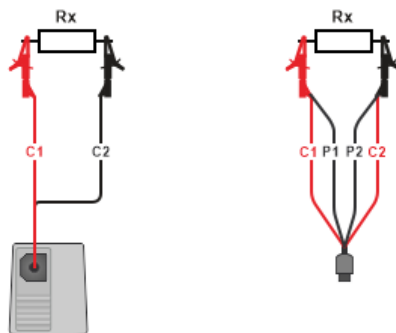
Test circuits

6.4.5**Continuity**
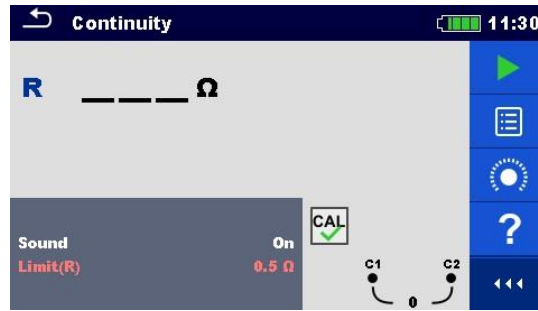
Test results / sub-results
R ....Resistance

Test parameters

Sound	Test sound: [Off, On]

Test limits

Limit	Limit(R): [Off, Custom, 0,05 Ω ... 20 Ω]

Test circuits
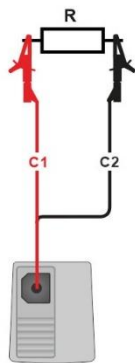
6.4.6   Compensation of test lead(s)

Resistance of test lead(s) can be compensated. Compensation is possible in following functions:
- **Ω** - Meter
- Continuity

Connections for compensating the resistance of test lead(s)
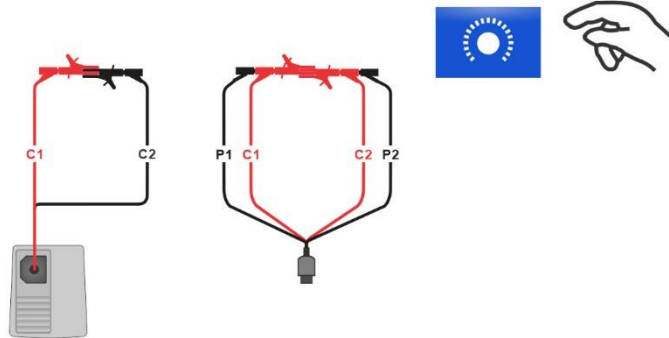
Compensation of test lead(s) procedure

Select single test and its parameters.

Connect test lead to the instrument. Make a short between C1 and C2 terminals.

Calibrate: Compensate test lead(s)

Symbol ![CAL] is displayed if the compensation was carried out successfully.
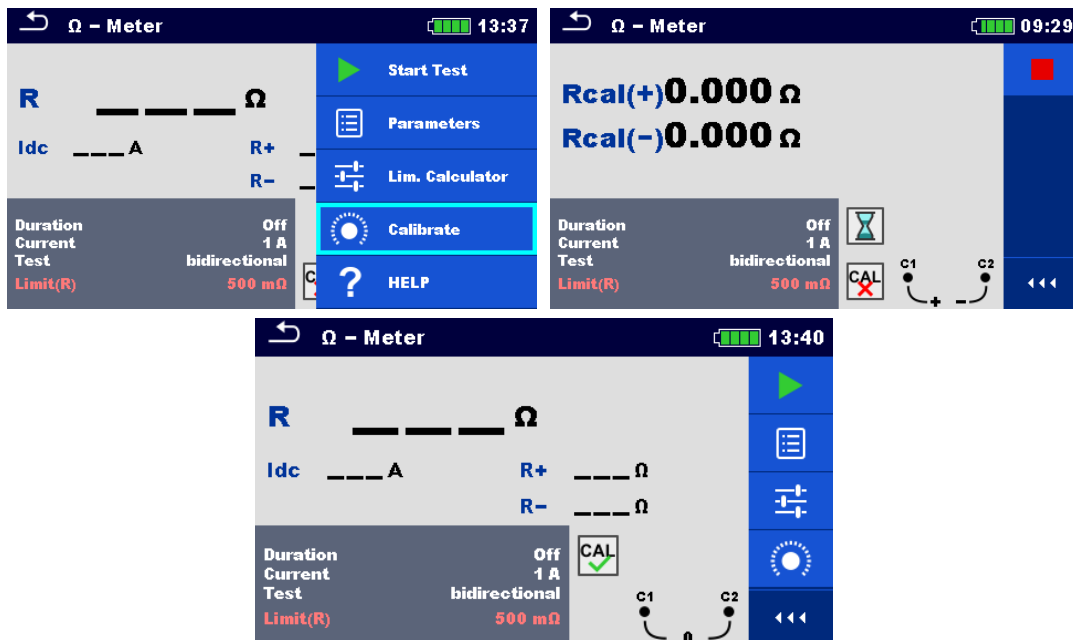
Note
- Consider firm connection of shorted test tips / crocodiles
- Consider correct connection of crocodiles (see connection diagram above)
- Calibrations for Continuity and Ω-Meter have to be done separately.

6.4.7 Limit calculator
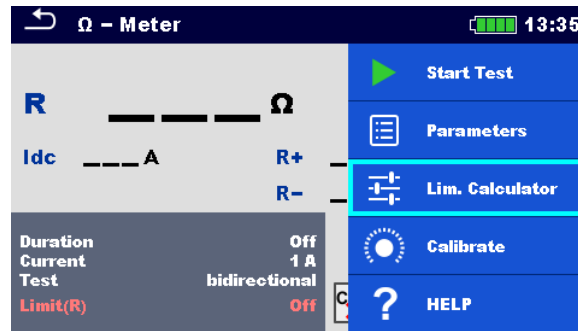
Limit calculator is a tool for determining the resistance high limit.

Open Limit calculator	Lim. Calculator
Define the limit value	Set Length & Cross-section, or custom entry

Calculator

Resistance limit is calculated by the formula:

$$R = \rho\,\frac{L}{A} + 0.1\Omega$$

ρ	Specific resistance of copper $1.68{\times}10^{-8}$ Ωm
L	Wire length selected from a list **(1 m, 2 m, 3 m, … ,100 m) or custom numeric entry**
A	Wire cross section selected from a list (0.50 mm^2, 0.75 mm^2, 1.00 mm^2, 1.50 mm^2, 2.5 mm^2, 4.0 mm^2, 10.0 mm^2) or custom numeric entry

Custom
Resistance limit is directly selected from a list (Off, 1 mΩ … 100 Ω) or set via keypad (Custom).

6.4.8 Insulation resistance (Riso)
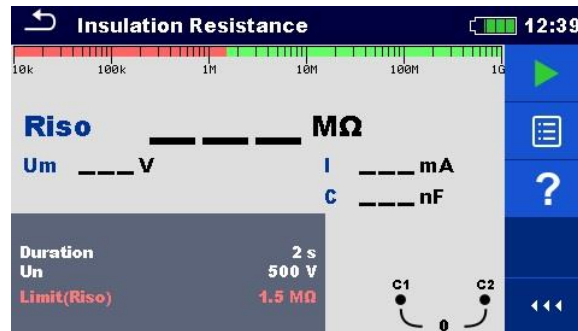
Test results / sub-results

Riso	Insulation resistance
Um	Measured voltage
I	Measured current
C	Capacitance

Test parameters

Duration	**Test duration [Off, 2 s … 180 s]**
Un	Test voltage [50 V … 1500 V]

Test limits

Limit(Riso)	Low Limit Riso: [Off, Custom, 1 MΩ … 500 MΩ]

Test circuits
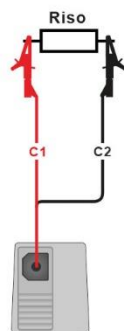
6.4.9ISO EV R100
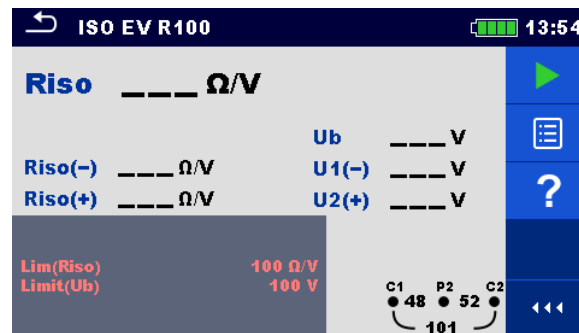
Test results / sub-results

Riso	Insulation resistance active conductor and chassis
Riso (-)	Insulation resistance between (-) and chassis
Riso (+)	Insulation resistance between (+) and chassis
Ub	Bus voltage
U1(-)	Voltage between (-) and chassis
U2(+)	Voltage between (+) and chassis

Test limits

Lim(Riso)	Low Limit Riso: [100 Ω/V, 500 Ω/V]
Limit(Ub)	Low limit bus voltage [Custom, 100 V ... **990 V**]

Test circuits
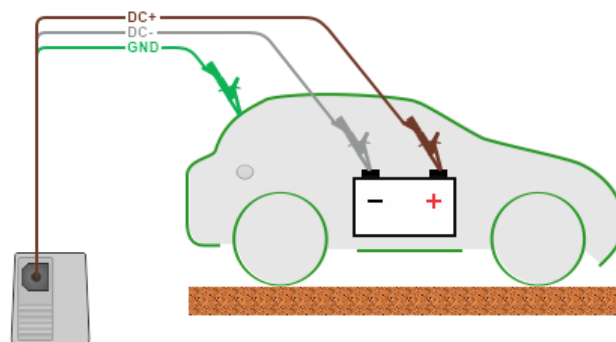
7 Auto Sequences®

Auto Sequences® are pre-programmed sequences of measurements. The Auto Sequences® can be pre-programmed on PC with the Metrel ES Manager software and uploaded to the instrument. On the instrument parameters and limits of individual single test in the Auto Sequence® can be changed / set.

7.1 Selection and searching of Auto Sequences
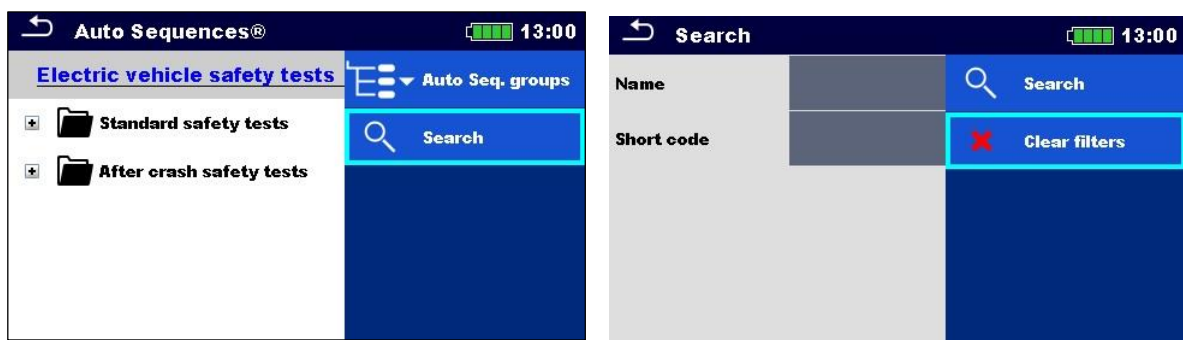
Selecting an Auto Sequence® list in Auto Sequence® groups menu

Go to Auto Sequence® groups menu	Header line (Auto Sequence list), Auto Seq. groups

Searching of Auto Sequences®

Search for Auto Sequence®	Header line (Auto Sequence® list), Search, set filters (Name or Short code)
Clear filters	Clear filters

Operations on found Auto Sequences®

Page x/y, Next Page, Previous Page	To jump Page Up/Down
Go to location	Go to location in Auto Sequences® menu

Start Test	Start Auto Sequence
View	View Auto Sequence

7.1.1 Organization of Auto Sequences® in Auto Sequences® menu

The Auto Sequence® menu can be organized in a structural manner with folders, sub-folders and Auto Sequences®. Auto Sequence® in the structure can be the original Auto Sequence® or a shortcut to the original Auto Sequence®.

Originals and shortcuts
Auto Sequences® marked as shortcuts and the original Auto Sequences® are coupled. Changing of parameters or limits in any of the coupled Auto Sequences® will influence on the original Auto Sequence® and all its shortcuts.

▐▶▶ Periodic test PHEV	The original Auto Sequence®.
▐▶▶ Periodic test PHEV_Shortcut	A shortcut to the original Auto Sequence®.
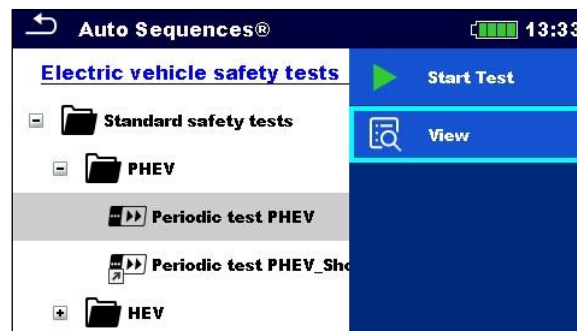
Start Test	Start of Auto Sequence®
View	Detailed view of Auto Sequence®

7.2 **Auto Sequence® execution**

Carrying out Auto Sequences® step by step

Before starting, the Auto Sequence® view menu is shown, (unless it was started directly from the Main Auto Sequences® menu). Before the test, parameters and limits of individual measurements can be edited.

During the execution phase of an Auto Sequence®, pre-programmed single tests are carried out. The sequence of single tests is controlled by pre-programmed flow commands.

After the test sequence is finished, the Auto Sequence® result menu is shown. Details of individual tests can be viewed and the results can be saved to Memory organizer.

7.2.1 Auto Sequence® view menu
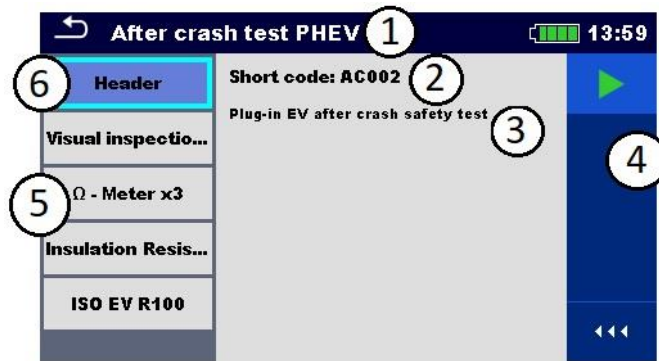
Header is selected:

1	Auto Sequence® name
2	Short code
3	Description
4	Options
5	Single tests
6	Header

Options:

Start Test	Start of Auto Sequence®
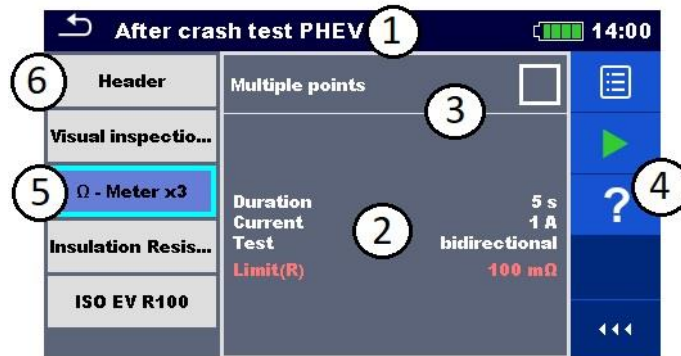
Single test is selected

1	Auto Sequence® name
2	Parameters / limits of selected single test
3	Multiple points selected
4	Options
5	Single tests
6	Header

Options:

Start Test	Start of Auto Sequence®
Parameters	View/edit parameters
Help	View help screens

Enable multiple points testing: set Multiple points, see <u>Managing multiple points.</u>

7.2.2 Indication of Loops

The attached 'x3' at the end of single test name indicates that a loop of single tests is programmed. This means that the marked single test will be carried out as many times as the **number behind the 'x' indicates. It is possible to exit the loop before, a**t the end of each individual measurement.

7.2.3 Managing multiple points

If the test object has more than one test point for an individual single test and the selected Auto Sequence® predicts only one test point (one single test) it is possible to change the Auto Sequence® appropriately. Single tests with enabled Multiple points ticker will be executed in a continuous loop. It is possible to exit the loop anytime at the end of each individual measurement.

The Multiple points setting is valid only for the actual Auto Sequence®. If the user often tests objects with more than one test points it is recommended to program a special Auto Sequence® with pre-programmed loops.

7.2.4 Step by step execution of Auto Sequences®

While the Auto Sequence® is running, it is controlled by pre-programmed flow commands.

Examples of actions controlled by flow commands
Pauses during the Auto Sequence (texts, warnings, pictures)
Buzzer sound On / Off mode
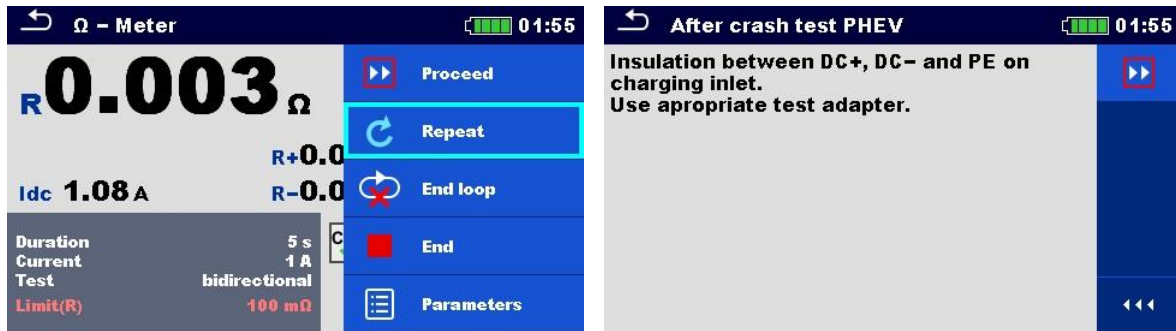
The offered options in the control panel depend on the selected single test, its result and the programmed test flow.

Proceed	Proceeds to the next step in the test sequence.
Repeat	Repeat the measurement.
End loop	Exit the loop of single tests and proceeds to the next step.
End	End the Auto Sequence® and go to result screen.
Parameters	View parameters/limits of single test.
Comment	Add comment

7.2.5 Auto Sequence result screen

After the Auto Sequence® is finished the result screen is displayed. At the left side of the display the single tests and their statuses in the Auto Sequence® are shown. In the middle of the display the header of the Auto Sequence® with Short code and description are displayed. At the top the overall Auto Sequence® result status is displayed. For more information see Measurement statuses.
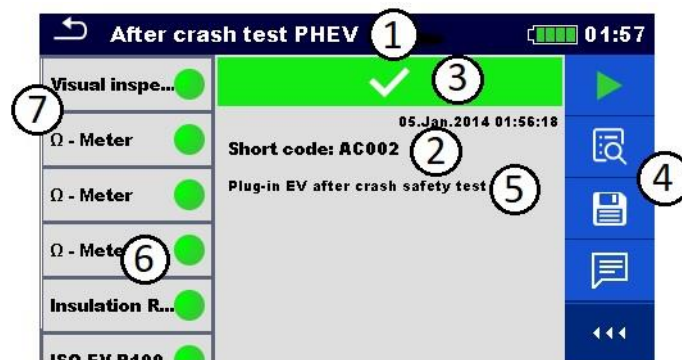
1	Auto Sequence name
2	Short code
3	Overall status

4	Options
5	Description
6	Status of single test
7	Single tests

Result screen options:

Start Test	Start a new Auto Sequence®
View	View results, parameters and limits of individual measurements.
Comment	Add comment to Auto Sequence
Tap on Single test	Viewing details of individual single tests, add comment on individual single test
Save results	Save the Auto Sequence® results
A new Auto Sequence® was selected and started from a Structure object in the structure tree	The Auto Sequence® result will be saved under the selected Structure object
A new Auto Sequence® was started from the Auto Sequence® main menu	Saving under the last selected Structure object will be offered by default. The user can select another Structure object or create a new Structure object. By pressing Save in Memory organizer menu the Auto Sequence result is saved under selected location.
An empty measurement was selected in structure tree and started	The result(s) will be added to the Auto Sequence. The Auto Sequence® will change its overall status from 'empty' to 'finished'.
An already carried out Auto Sequence® was selected in structure tree, viewed and then restarted	A new Auto Sequence® result will be saved under the selected Structure object.

8 Maintenance

8.1 **Periodic calibration**

It is essential that all measuring instruments are regularly calibrated in order for the technical specification listed in this manual to be guaranteed. We recommend an annual calibration.

8.2 **Fuses**

There are two fuses under the battery panel: intended for instrument protection. For position of fuses see Battery / fuse compartment.

F2	FF 2 A / 1000 V, (32 × 6.3) mm, (breaking capacity: 30 kA)
F3	FF 100 mA / 1000 V, (32 × 6.3) mm, (breaking capacity: 30 kA)
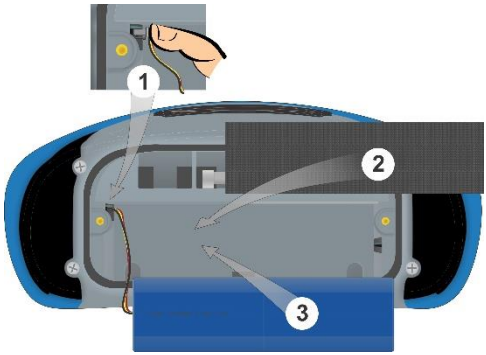
WARNING
• Switch off the instrument and disconnect all test accessories and mains cord before opening the back cover. • Replace blown fuses with the same type as defined in this document.

8.3 **Battery pack insertion / replacement**

Procedure:

①	Remove the battery pack from battery compartment.	
②	Remove foam if were inserted under the battery pack.	
③	Press to unlock the connector (1) and pull the wires (2) to disconnect the battery pack from the instrument.	

①	Connect the new battery pack to the instrument.
②	For standard capacity pack use a foam (2) to fill empty space.
③	Insert the battery pack in battery compartment and close the battery / fuse compartment cover. Note: When placing high-capacity battery pack make sure that protection circuit module of the battery pack is placed at top inner side of the compartment.

WARNING

- Switch off the instrument and disconnect all test accessories and mains cord before opening the back cover.
- Replace battery pack with original type only, otherwise the instrument may be **damaged and / or operator's safety impaired!**

8.4 **Service**

For repairs under or out of warranty please contact your distributor for further information. Unauthorized person is not allowed to open the instrument. There are no user replaceable parts inside the instrument, except fuses and battery.

8.5 **Cleaning**

Use a soft, slightly moistened cloth with soap water or alcohol to clean the surface of the instrument. Leave the instrument to dry totally before using it.

WARNING

- Do not use liquids based on petrol or hydrocarbons!
- Do not spill cleaning liquid over the instrument!

9 Communications

The instrument can communicate with the Metrel ES Manager PC software. Available communication modes on the instrument are USB and Bluetooth. Instrument is also future-ready to communicate with **various external devices (Android devices, …).**

9.1 **USB communication with PC**

The instrument automatically selects the communication mode according to detected interface.

How to establish an USB:
- USB communication: connect a PC USB port to the instrument USB connector using the USB interface cable.
- Switch on the PC and the instrument.
- Run the Metrel ES Manager software.
- Select communication port (COM port for USB communication is identified as "**Measurement Instrument USB VCom Port**").
- The instrument is prepared to communicate with the PC.

10 Technical specifications

10.1 **μΩ - Meter**

	Test current	Range	Resolution	Accuracy	
				Bidirectional mode	Unidirectional mode
R	1 A, 2 A	0.000 mΩ … 1.999 mΩ	1 μΩ	±(1 % of rd + 5 D)	±(1 % of rd + 50 D)
		2.00 mΩ … 19.99 mΩ	10 μΩ	±(0.5 % of rd + 2 D)	±(0.5 % of rd + 5 D)
		20.0 mΩ … 199.9 mΩ	100 μΩ	±(0.5 % of reading + 1 D)	
		200 mΩ … 499 mΩ	1 mΩ	±0.5 % of reading	
	1 A	0.500 Ω … 1.999 Ω	1 mΩ	±0.5 % of reading	

	Test current	Range	Resolution	Accuracy	
				Bidirectional mode	Unidirectional mode
R	100 mA, 200 mA	0.00 mΩ … 19.99 mΩ	10 μΩ	±(0.5 % of rd +5 D)	±(0.5 % of rd + 50 D)
		20.0 mΩ … 199.9 mΩ	100 μΩ	±(0.5 % of rd + 2 D)	±(0.5 % of rd + 5 D)
		200 mΩ … 1999 mΩ	1 mΩ	±(0.5 % of reading + 1 D)	
		2.00 Ω … 19.99 Ω	0.01 Ω	±(0.5 % of reading + 1 D)	
		20.0 Ω … 199.9 Ω	0.1 Ω	±1 %	
		200 Ω … 1999 Ω	1 Ω	±2 %	

Test current drops below 200 mA above R = 15 Ω
Test current drops below 100 mA above R = 30 Ω

	Test current	Range	Resolution	Accuracy	
				Bidirectional mode	Unidirectional mode
R	10 mA	0.0 mΩ … 199.9 mΩ	100 μΩ	±(2 % of rd + 5 D)	informative
		200 mΩ … 1999 mΩ	1 mΩ	±2 % of reading	±(2 % of rd + 5 D)
		2.00 Ω … 19.99 Ω	0.01 Ω	±2 % of reading	
		20.0 mΩ … 199.9 Ω	0.1 Ω	±2 % of reading	
		200 Ω … 1999 Ω	1 Ω	±2 % of reading	

Test current drops below 10 mA above R = 300 Ω

Operating range acc. to EN 61557-4:

Test current	Bidirectional mode	Unidirectional mode
2 A	0.018 mΩ … 499 mΩ	0.173 mΩ … 499 mΩ
1 A	0.018 mΩ … 1.999 Ω	0.173 mΩ … 1.999 Ω
200 mA	0.17 mΩ … 1999 Ω	1.70 mΩ … 1999 Ω

DC Current

	Range	Resolution	Accuracy
Idc	0.01 mA ... 2.9 A	0.01 mA ... 0.1 A	±(2 % of reading + 2 D)

Open-terminal test voltage .... >5 Vdc
Test current direction .... bidirectional, unidirectional
Test current accuracy .... ±10 % (smoothed DC)
Maximum lead resistance .... 200 mΩ total (Rlead C1 + C2) and
                                                  100 Ω total (Rlead P1 + P2)
Test method 4-wire
Automatic connection test .... yes [C1, P1, P2, C2]

Current waveform shape (μΩ - Meter)
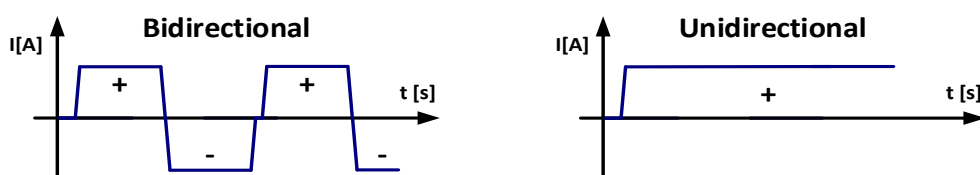
10.2 Ω - Meter

	Test current	Range	Resolution	Accuracy
R	1 A, 2 A	0.000 Ω ... 0.499 Ω	1 mΩ	±(0.5 % of reading + 10 D)
	1 A	0.500 Ω ... 1.999 Ω	1 mΩ	±1 % of reading

	Test current	Range	Resolution	Accuracy
R	100 mA, 200 mA	0.000 Ω ... 1.999 Ω	1 mΩ	±(1 % of reading + 10 D)
		2.00 Ω ... 19.99 Ω	10 mΩ	±1 % of reading
		20.0 Ω ... 199.9 Ω	100 mΩ	±1 % of reading
		200 Ω ... 1999 Ω	1 Ω	±2 % of reading

Test current drops below 200 mA above R = 15 Ω
Test current drops below 100 mA above R = 30 Ω

	Test current	Range	Resolution	Accuracy
R	10 mA	0.00 Ω ... 19.99 Ω	10 mΩ	±(1 % of reading + 10 D)
		20.0 Ω ... 199.9 Ω	100 mΩ	±1 % of reading
		200 Ω ... 1999 Ω	1 Ω	±2 % of reading

Test current drops below 10 mA above R = 300 Ω

Operating range acc. to EN 61557-4:

Test current	Bidirectional mode / Unidirectional mode
2 A	0.034 Ω … 0.499 Ω
1 A	0.034 Ω … 1.999 Ω
200 mA	0.035 Ω … 1999 Ω

DC Current

	Range	Resolution	Accuracy
Idc	0.01 mA … 2.9 A	0.01 mA … 0.1 A	±(2 % of reading + 2 D)

Open-terminal test voltage .... >5 Vdc
Test current direction .... bidirectional, unidirectional
Test current accuracy .... ±10 % (smoothed DC)
Maximum lead resistance .... 200 mΩ total (Rlead C1 + C2) and
                                                                        100 Ω total (Rlead P1 + P2)
Test method 2-wire
Automatic connection test .... yes [C1, P1, P2, C2]

Current waveform shape (Ω - Meter)
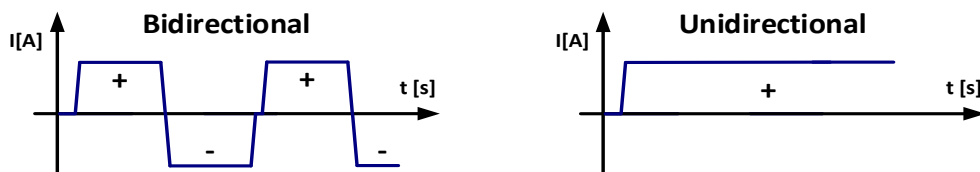
10.3 **Continuity**

	Range	Resolution	Accuracy
R	0.0 Ω … 199.9 Ω	0.1 Ω	±(3 % of reading + 2 D)
	200 Ω … 1999 Ω	1 Ω	±3 % of reading
	2.00 kΩ … 19.99 kΩ	10 Ω	±5 % of reading
	20.0 kΩ … 199.9 kΩ	100 Ω	±10 % of reading

Test mode .... continuous
Open-terminal test voltage .... > 6 Vdc
Test current .... cca 3 mA
Test current direction .... unidirectional

Current waveform shape (Continuity)
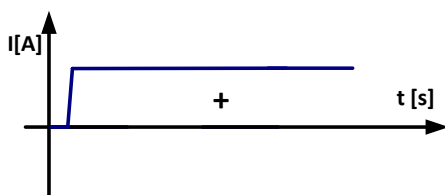
10.4 **Insulation Resistance**

Uiso < 250 V

	Range	Resolution	Accuracy*
	0.000 MΩ ... 1.999 MΩ	1 kΩ	±(3 % of reading + 3 D)
Riso	2.00 MΩ ... 19.99 MΩ	10 kΩ	±3 % of reading
	20.0 MΩ ... 199.9 MΩ	100 kΩ	±5 % of reading

Operating range (acc. to EN 61557-2): 0.08 MΩ ... 199.9 MΩ

Uiso ≥ 250 V

	Range	Resolution	Accuracy*
	0.000 MΩ ... 1.999 MΩ	1 kΩ	±(3 % of reading + 5 D)
	2.00 MΩ ... 19.99 MΩ	10 kΩ	±3 % of reading
Riso	20.0 MΩ ... 199.9 MΩ	100 kΩ	±3 % of reading
	200 MΩ ... 999 MΩ	1 MΩ	±5 % of reading
	1.00 GΩ ... 2.99 GΩ*	10 MΩ	±10 % of reading

Operating range (acc. to EN 61557-2): 0.019 MΩ ... 2.99 GΩ

*Specified accuracy is valid up to 1 GΩ if relative humidity is > 85 %.

DC Voltage

	Range	Resolution	Accuracy
Um	0 V ... 999 V	1 V	±(1 % of reading + 3 D)
	1.00 kV ... 2.00 kV	10 V	

DC Current

	Range	Resolution	Accuracy
	2.0 mA ... 5.0 mA	0.1 mA	
	0.20 mA ... 1.99 mA	10 µA	
I	20 µA ... 199 µA	1 µA	±(1 % of reading + 3 D)
	2.0 µA ... 19.9 µA	0.1 µA	
	0.20 µA ... 1.99 µA	10 nA	±(5 % of reading + 3 D)
	20 nA ... 199 nA	1 nA	±(15 % of reading + 1 D)

Capacitance

	Range	Resolution	Accuracy
	10 nF ... 999 nF	1 nF	
C	1.00 µF ... 9.99 µF	10 nF	±(10 % of reading + 3 D)
	10.0 µF ... 50.0 µF	100 nF	

Nominal voltages Un ....50 V ... 1500 V (- 0 %, + 10 %)
Current capability of test generator........> 1 mA for Un set ≥ 350 V
Short circuit current..............................max. 2.5 mA

10.5 **Voltage**

	Range	Resolution	Accuracy
Uac	**0.000 V ... 9.999 V**	0.001 V	**Freq. range: 15 Hz ... 99 Hz** ±(0.5 % of reading + 3 D)
	10.00 V ... 99.99 V	0.01 V	**Freq. range: 100 Hz ... 399 Hz** ±(1 % of reading + 3 D)
	100.0 V ... 749.9 V	0.1 V	**Freq. range: 400 Hz ... 1200 Hz** ±(10 % of reading + 3 D)

	Range	Resolution	Accuracy
Udc	**0.000 V ... 9.999 V**	0.001 V	±(0.5 % of reading + 3 D)
	10.00 V ... 99.99 V	0.01 V	
	100.0 V ... 999.9 V	0.1 V	

	Range	Resolution	Accuracy
U	**0.000 V ... 9.999 V**	0.001 V	Freq. range: DC, **15 Hz ... 99 Hz** ±(0.5 % of reading + 3 D)
	10.00 V ... 99.99 V	0.01 V	**Freq. range: 100 Hz ... 399 Hz** ±(1 % of reading + 3 D)
	100.0 V ... 999.9 V	0.1 V	**Freq. range: 400 Hz ... 1200 Hz** ±(10 % of reading + 3 D)

	Range	Resolution	Accuracy
f	**15.00 Hz ... 99.99 Hz**	0.01 Hz	±(0.2 % of reading + 1 D)
	100.0 Hz ... 999.9 Hz	0.1 Hz	
	1.000 kHz ... 1.200 kHz	1 Hz	

Test mode ....continuous
Result type..AC, DC, AC + DC
Nominal frequency range ....DC, 15.00 Hz **...** 1.200 kHz
Input resistance ....48 MΩ ± 5 %
Measuring refresh rate ....typical 1 s
Automatic range selection ....yes

10.6 **RISO EV R100**

	Range	Resolution	Accuracy
Riso, Riso(-) Riso (+) (lower result)	0 Ω/V ... 999 Ω/V	1 Ω/V	±(3 % of reading + 2 D)
	1.00 Ω/V ... 4.99 kΩ/V	10 Ω/V	±5 % of reading
	5.0 kΩ/V ... 19.9 kΩ/V	100 Ω/V	±10 % of reading
	20.0 kΩ/V ... 49.9 kΩ/V		±20 % of reading

	Range	Resolution	Accuracy

Riso, Riso(-) Riso (+) (higher result)	0 Ω/V ... 999 Ω/V	1 Ω/V	Indicative*
	1.00 Ω/V ... 4.99 kΩ/V	10 Ω/V	
	5.0 kΩ/V ... 19.9 kΩ/V	100 Ω/V	
	20.0 kΩ/V ... 49.9 kΩ/V		

*Accuracy of the higher result depend on the ratio of Riso(-) and Riso(+). A ratio higher than 100 can result in a high measurement error of the higher result.

	Range	Resolution	Accuracy
Ub, U1(-), U2(+)	**100.0 V ... 999.9 V**	0.1 V	±(0.5 % of reading + 3 D)

Operation: ....100 V_{DC} ≥ Ub ≥ 1000 V_{DC}
Voltmeter input resistance ....48 MΩ
Test method..acc. to Addendum 99 – UN Regulation No. 100
Test resistors (Ro)................................20 kΩ, 40 kΩ, 80 kΩ, 100 kΩ

10.7 **General data**

Battery power supply ....7.2 V DC (4.4 Ah or 8.8 Ah Li-ion pack)
Charger socket input voltage..................12 V ± 10 %
Charger socket input current ....3.0 A max.

Auto - off timer.....................................10 min (idle state)

Typical battery operation time:

Measurement	Load conditions	The number of possible tests or time (continuous testing), with a fully charged battery.	
		4400 mAh Li-ion pack	8800 mAh Li-ion pack
Idle state	Brightness = 100 %	> 10 h	> 20 h
	2.5 MΩ load @ 2.5 kV (EN 61557-2)	> 600 tests	> 1200 tests
Ω - Meter (200mA)	R= 1 Ω (EN 61557-4)	> 1000 tests	> 2000 tests

Protection classification.........................reinforced insulation 回

Measuring category:
@ (Altitude ≤ 2000 m):...........................1000 V CAT III, max. input voltage = 1000 V
@ (Altitude ≤ 3000 m):...........................1000 V CAT II, max. input voltage = 1000 V
@ (Altitude ≤ 4000 m):...........................600 V CAT III / 1000 V CAT II,
                                       max. input voltage = 800 V

Pollution degree 2
Degree of protection..............................IP 54 (with protective covers on USB, Charger)
Operation ....Outdoor use
Dimensions (w × h × d)..........................25 cm x 11 cm x 16 cm

Weight ....1.6 kg (with 4400 mAh Li-ion battery pack)
                                                      1.8 kg (with 8800 mAh Li-ion battery pack)
Sound / Visual warnings ....yes
Display ....4.3'' (10.9 cm) 480 × 272 pixels TFT colour display
                                                      withtouch screen

EMC:
Emission ....Class B
Immunity ....Portable test and measurement equipment

Reference conditions:
Reference temperature range ....25 °C ± 5 °C
Reference humidity range ....**40 %RH ... 60 %RH**
Operation conditions:
Working temperature range ....**-10 °C ... 50 °C**
Maximum relative humidity ....**90 %RH (0 °C ... 40 °C), non**-condensing
Storage conditions:
Temperature range................................**-10 °C ... 70 °C**
Maximum relative humidity ....90 %RH (-10 °C ... **40** °C)
                                                      80 %RH (40 °**C** ... **60** °C)

USB communication:
USB ....USB 2.0 Hi speed interface
Connector..standard USB connector - type B

Bluetooth communication:
Baud rate:..115200 bit/s
Bluetooth module ....class 2

Data:
Data storage capacity............................8 GB SD memory card
PC software..yes

Specifications are quoted at a coverage factor of k = 2, equivalent to a confidence level of approximately 95 %.
Accuracies apply for 1 year in reference conditions. Temperature coefficient outside these limits is 0.2 % of measured value per °C, and 1 digit.

Appendix A   Structure objects

Structure elements used in Memory Organizer may be instrument's Profile dependent.

Symbol	Default name	Description
	Node	Node
	Object	Object
	Vehicle	Vehicle under test
	Equipotential bonding	Equipotential bonding
	RESS	Rechargeable energy storage system
	Circuit	High voltage electronic circuit

Appendix B   Profile Notes

So far there are no specific profile notes for this instrument.

Appendix C   Programming of Auto Sequences® on Metrel ES Manager

The Auto Sequence® Editor is a part of the Metrel ES Manager software. In Auto Sequence® Editor an Auto Sequence® can be pre-programmed and organized in groups, before uploaded to the instrument.

C.1   **Auto Sequence® Editor workspace**

To enter Auto Sequence® Editor's workspace, select Auto Sequence® Editor in Home Tab of Metrel ES Manager PC SW. Auto Sequence® Editor workspace is divided in four main areas.

On the left side **❶** ,structure of selected group of Auto Sequence® is displayed. In the middle part of the workspace **❷** , the elements of the selected Auto Sequence® are shown. On the right side, list of available single tests **❸** and list of flow commands **❹** are shown.
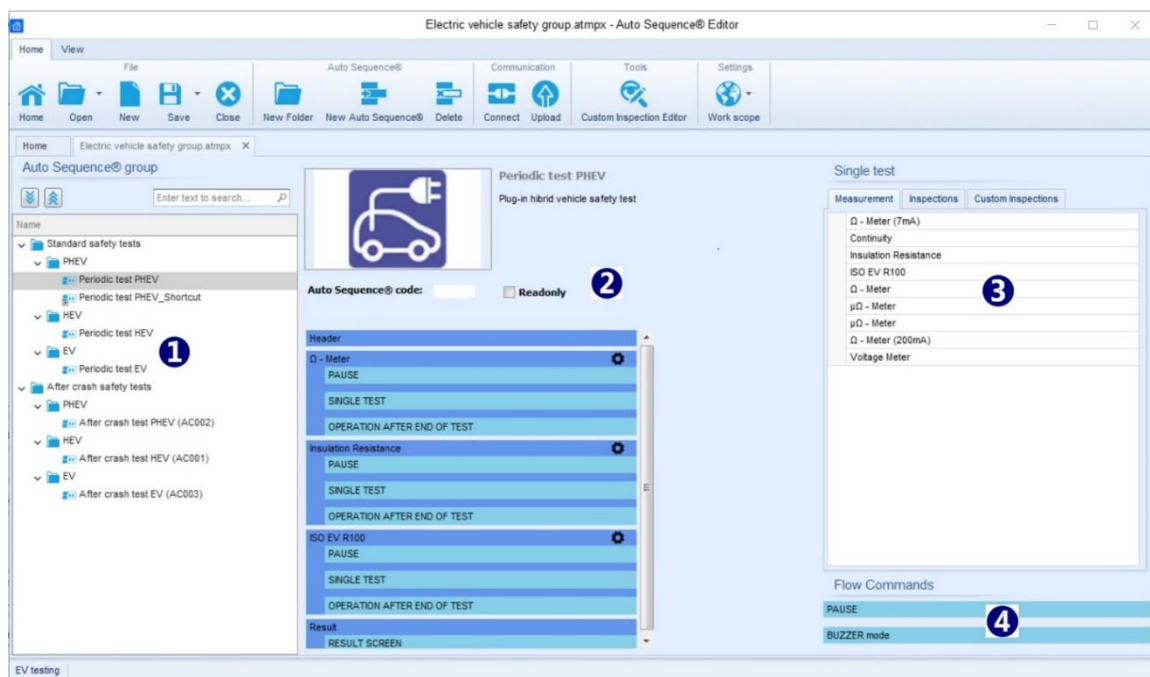

Auto Sequence® Editor workspace

An Auto Sequence® **❷** begins with Name, Description and Image, followed by the first step (Header), one or more measuring steps and ends with the last step (Result). By inserting appropriate Single tests (measurements, inspections and custom inspections) **❸** and Flow commands **❹** and setting their parameters, arbitrary Auto Sequences® can be created.
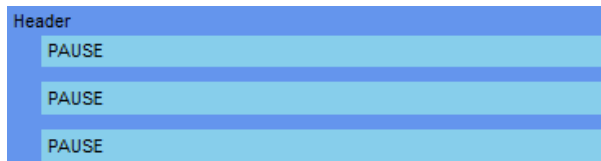
Example of an Auto Sequence® header
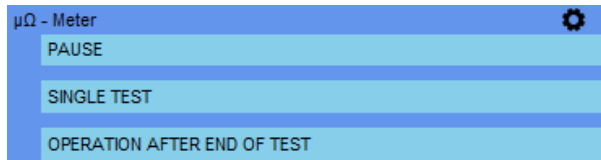
Example of a measurement step

Example of an Auto Sequence® result part

C.2 **Managing groups of Auto Sequences®**

The Auto Sequences® can be divided into different user defined groups of Auto Sequences®. Each group of Auto Sequences® is stored in a file. More files can be opened simultaneously in Auto Sequence® Editor.
Within Group of Auto Sequences®, tree structure can be organized, with folders / subfolders containing Auto Sequences®. The three structure of currently active Group is displayed on the left side of the Auto Sequence® Editor workspace.
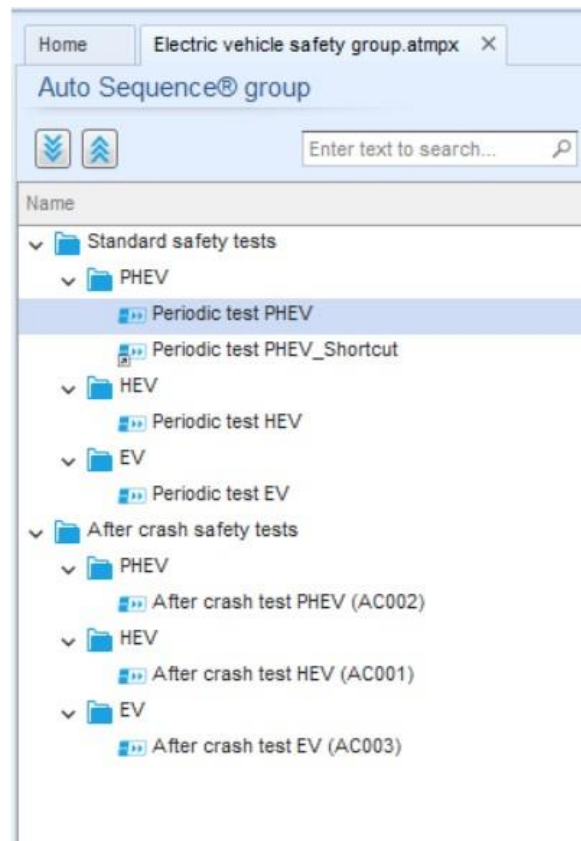
Group of Auto Sequences® tree organization

Operation options on Group of Auto Sequences® are available from menu bar at the top of Auto Sequence® Editor workspace.

File operation options:

🏠	Opens starting Auto Sequence® Editor screen.
📂 ▾	Opens a file (Group of Auto Sequences®).
📄	Creates a new file (Group of Auto Sequences®).
💾 ▾	Saves / Saves as the opened Group of Auto Sequences® to a file.
❌	Closes the file (Group of Auto Sequences®).

Group of Auto Sequence® view options:

⏬	Expand all folders / subfolders / Auto Sequences®.
⏫	Collapse all folders / subfolders / Auto Sequences®.
🔍	Search by name within Auto Sequence® group. See Appendix C.2.2 Search within selected Auto sequence® group for details.

Group of Auto Sequences® operation options (also available by right clicking on Folder or Auto Sequence®):

📁	Adds a new folder / subfolder to the group
🔲	Adds a new Auto Sequence® to the group
🔲	Deletes: -the selected Auto Sequence® -the selected folder with all subfolders and Auto Sequences®

Right click on the selected Auto Sequence® or Folder opens menu with additional possibilities:

	Auto Sequence®: Edit Name, Description and Image Folder: Edit folder name
	Auto Sequence®: Copy to clipboard Folder: Copy to clipboard including subfolders and Auto Sequences®
	Auto Sequence®: Paste it to selected location Folder: Paste it to selected location
	Auto Sequence®: Creates shortcut to selected Auto Sequence®

Double click on the object name allows name edit:

DOUBLE CLICK	Auto Sequence® name: Edit Auto Sequence® name Periodic test EV Folder name: Edit folder name Standard safety tests

Drag and drop of the selected Auto Sequence® or Folder / Subfolder moves it to a new location:

DRAG & DROP	**"Drag and drop" functionality is equivalent to "cut" and "paste" in a single move.** move to folder insert

C.2.1 Auto Sequences® Name, Description and Image editing

When EDIT function is selected on Auto Sequence®, menu for editing appear on the screen. Editing options are:
Name: Edit or change the name of Auto Sequence®.
Description: Any text for additional description of Auto Sequence® can be entered.
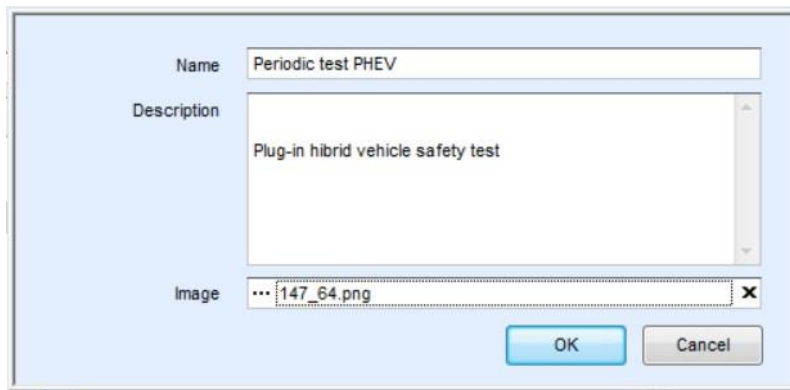Image: Image presenting Auto sequence® measuring arrangement can be entered or deleted.

|	
...	Enters menu for browsing to Image location.
✗	Deletes the Image from Auto Sequence®.

Editing the Auto Sequence® header

C.2.2 Search within selected Auto sequence® group

By entering the text into search box and click on the search 🔍 icon, found results are highlighted with orange background and first found result (Folder or Auto Sequence®) is focused. Click on the Search icon 🔍 again focus next search result. Search functionality is implemented in Folders, Subfolders and Auto Sequences® of selected Auto Sequence® Group.

Search text can be cleared by selecting the Clear ⊗ button.
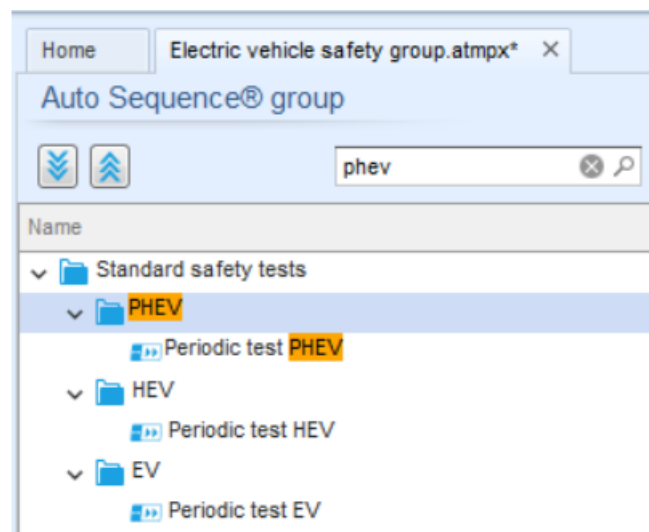
Example of Search result within Auto Sequence® group

C.3 **Elements of an Auto Sequence®**

C.3.1 Auto Sequence® steps

There are three kinds of Auto Sequence® steps.

Header
The Header step is empty by default. Flow commands can be added to the Header step.

Measurement step

The Measurement step contains a Single test and the Operation after end of test flow command by default. Other Flow commands can also be added to the Measurement step.

Result

The Result step contains the Result screen flow command by default. Other Flow commands can also be added to the Result step.

C.3.2 Single tests

Single tests are the same as in Metrel ES Manager Measurement menu.
Limits and parameters of the measurements can be set. Results and sub-**results can't be set.**

C.3.3 Flow commands

Flow commands are used to control the flow of measurements. Refer to chapter C.5 Description of flow commands for more information.

C.3.4 Number of measurement steps

Often the same measurement step has to be performed on multiple points on the device under test. It is possible to set how many times a Measurement step will be repeated. All carried out individual Single test results are stored in the Auto Sequence® result as if they were programmed as independent measuring steps.

C.4 **Creating / modifying an Auto Sequence®**

If creating a new Auto Sequence® from scratch, the first step (Header) and the last step (Result) are offered by default. Measurement steps are inserted by the user.

Options:

Adding a measurement step	By double clicking on a Single test a new measurement step will appear as the last of measurement steps. It can also be dragged and dropped on the appropriate position in the Auto Sequence®.
Adding flow commands	Selected flow command can be dragged from the list of Flow commands and dropped on the appropriate place in any Auto Sequence® step.
Changing position of flow command inside one step	By a click on an element and use of keys.
Viewing / changing parameters of flow commands or single tests.	By a double click on the element.
Setting number of measurement steps	By setting a number in the field.

Right click on the selected measurement step / flow command
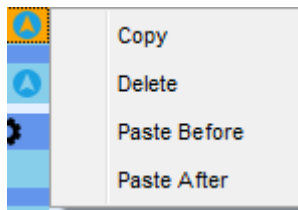
	Copy – Paste before A measurement step / flow command can be copied and pasted above selected location on the same or on another Auto Sequence®. Copy – Paste after A measurement step / flow command can be copied and pasted under selected location on the same or on another Auto Sequence®. Delete Deletes the selected measurement step / flow command.

C.5 **Description of flow commands**

Double click on inserted Flow Command opens menu window, where text or picture can be entered, external commands can be activated and parameters can be set.

Flow commands Operation after end of test and Results screen are entered by default, others are user selectable from Flow Commands menu.

Pause

A Pause command with text message or picture can be inserted anywhere in the measuring steps. Warning icon can be set alone or added to text message. Arbitrary text message can be entered in prepared field Text of menu window.

Parameters:

Pause type	Show text and/or warning (check ☑ to show warning icon) Show picture (⋯ browse for image path)
Duration	Number in seconds, infinite (no entry)

Buzzer mode

Passed or failed measurement is indicated with beeps.
- ❑ Pass – double beep after the test
- ❑ Fail – long beep after the test

Beep happens right after single test measurement.

Parameters:

State	On – enables Buzzer mode Off – disables Buzzer mode

Operation after end of test

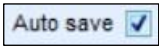This flow command controls the proceeding of the Auto Sequence® in regard to the measurement results.

Parameters:

Operation after end of test – pass – fail – no status	The operation can be individually set for the case the measurement passed, failed or ended without a status.	
	Manual –	The test sequence stops and waits for appropriate command (Enter key) to proceed.
	Auto –	The test sequence automatically proceeds.

Result screen

This flow commands control the proceeding after the Auto Sequence® has ended.
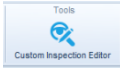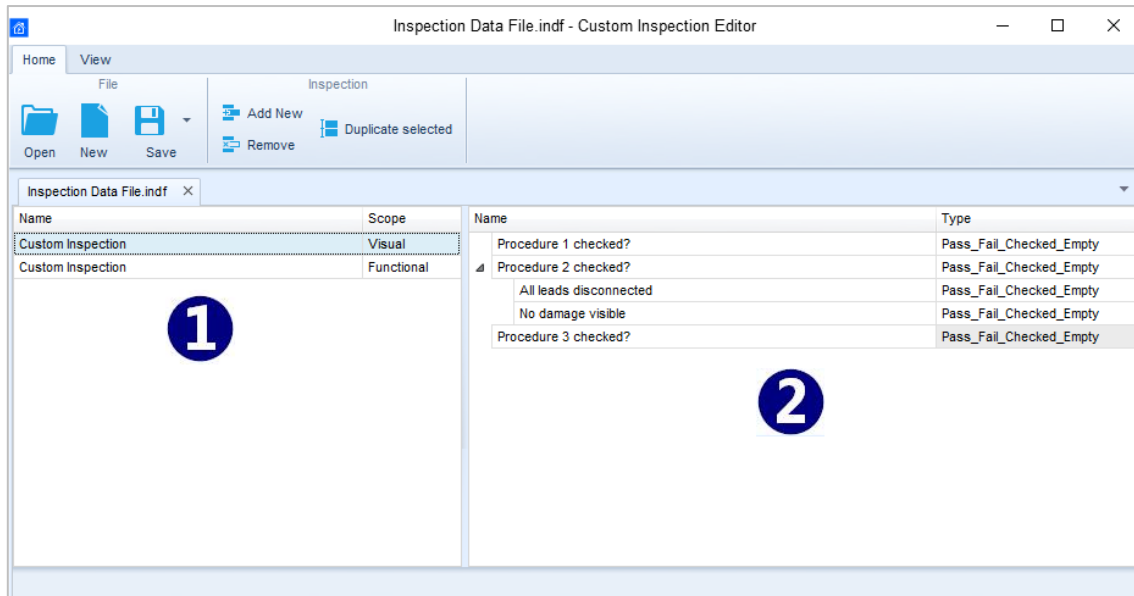
Parameters:

	Auto Sequence® results are stored in the momentary workspace.
	A new Node with the date and time will be created. Under the Node, Auto Sequence® results will be stored.
	Up to 100 Auto Sequence® results can be automatically stored under the same node. If more results are available, they are split to multiple nodes. Auto save Flow setting is disabled by default.
	Note: This flow command is active only if Auto Sequence® is started from the Auto Sequence® Main menu (not from the Memory organizer).

C.6 **Custom Inspection programming**

Arbitrary set of tasks dedicated to specific user defined Inspections can be programmed with application of Custom Inspection Editor Tool, accessible from Auto Sequence® Editor workspace. Custom Inspections are stored in dedicated file *.indf with user defined name. For application of Custom Inspections as a single test within Auto Sequence® group, appropriate file containing specific Custom Inspection should be opened first.

C.6.1 Creating and editing Custom Inspections

Custom Inspection Editor workspace is entered by selecting [Custom Inspection Editor] icon from Auto Sequences® main menu. It is divided in two main areas, as presented on figure below.

Custom Inspection Editor Workspace

Custom Inspection Editor Main menu options:

	Opens existing Custom Inspection Data file. By selecting, menu for browsing to location of *.indf file containing one or more Custom Inspections data appear on the screen. Selected file is opened in dedicated tab marked with file name.
	Creates a new Custom Inspection Data file. New tab with empty workspace is opened. Default name of the new tab is Inspection Data File; it could be renamed during Save procedure.
	Save / Save as Custom Inspection Data file opened on active tab. Menu for browsing to the folder location and editing of file name is opened. Browse to the location, confirm overwriting, if file already exists or edit file name to save it as a new Custom Inspection Data file.
	Add New Custom Inspection. New inspection with default name Custom Inspection and default scope Visual appear on the editor workspace. It contains one Item task with default name Custom Inspection and default Type Pass_Fail_Checked_Empty. Default Name and Type can be edited – changed.
	Remove selected custom inspection. To select inspection, click to the inspection Name field. To remove it, select icon from editor main menu. Before removal, user is asked to confirm deletion.
	Duplicates selected Custom Inspection.

Selected Custom Inspection including Scope and all Custom Inspection items and sub-items, or only selected Custom Inspection Item or sub-item including Type can be duplicated.
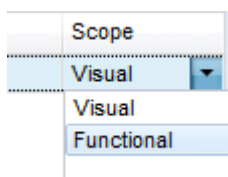
Edit Name and Scope of Inspection
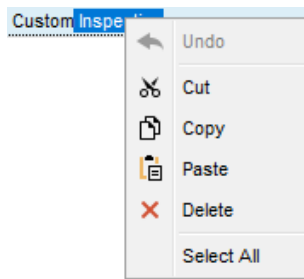
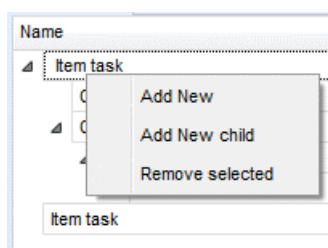|	
	Inspection Name edit: Click to the Inspection Name field to start editing it. Drag cursor, with left mouse button pressed, to select letters and words. Position cursor and double-click to select word of the name. Actions could be performed with keyboard also. Press right mouse button to activate Edit menu and select appropriate action as presented on the left figure. Menu is case sensitive; options currently not available are greyed out.
	Inspection Scope edit: Click to Inspection Scope field to open selection menu presented on left figure. Options: Visual is intended for observation of test object Functional allows functional test of observed object

Edit Item task structure of Inspection
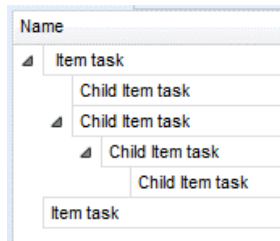
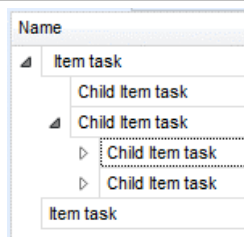|	
	Item tasks of the selected Inspection are listed in Name column on the right side of Editor workspace. Each Item task can have Child Item tasks, Child Item can have its own Child Item tasks and so on. Arbitrary tree structure of Item tasks and subtasks can be built as presented on left figure.
	ADD New Item task procedure: Position cursor above Item task Name and apply right mouse click to select Item task and open menu with options: Add New: new Item task is added on the top tree level Add New Child: new child Item task is added under selected Item Remove selected: delete selected Item task with all subtasks Default Name of New Item task is Custom Inspection, default Type Pass_Fail_Checked_Empty and both can be edited – changed.
	Item tasks containing Child Item tasks are marked with triangle in front of their Name. Click on triangle mark: ◢ collapse Item task tree structure ▷ expands Item task tree structure

Edit Name and Type of Item task
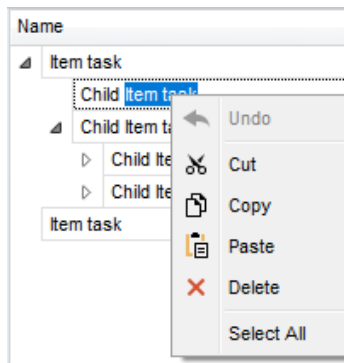
Edit Name of Item task:
Click to the Item task Name field to start editing it.
Drag cursor, with left mouse button pressed, to select letters and words. Position cursor and double-click to select word of the name. Actions could be performed with keyboard also. Press right mouse button to activate Edit menu and select appropriate action as presented on the left figure. Menu is case sensitive; options currently not available are greyed out.
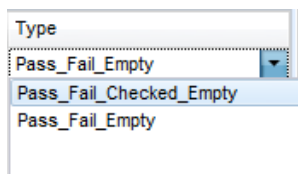
Edit Type of Item task:
Click to Item Type field to open selection menu presented on left figure. Selectable checkbox status assignment options are:
Pass_Fail_Checked_Empty: Pass, Fail, Checked, Empty (default)
Pass_Fail_Empty: Pass, Fail selection, Empty (default) value

C.6.2 Applying Custom Inspections

Custom inspections can be applied in Auto Sequences®. Direct assignment of Custom inspection to the Metrel ES manager structure objects is not possible.
After custom created Inspection Data file is opened, available inspections are listed in Custom Inspections tab of Single test area of Auto Sequence® Editor, see chapter C.1 Auto Sequence® Editor workspace for details.
Custom Inspection is added to Auto sequence as a Single test, see chapter *C.4 Creating / modifying an Auto Sequence®* for details.
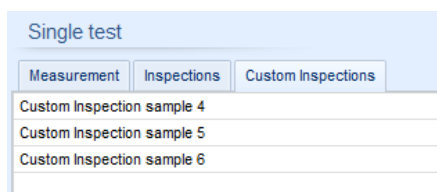
Opening / changing Inspection Data File
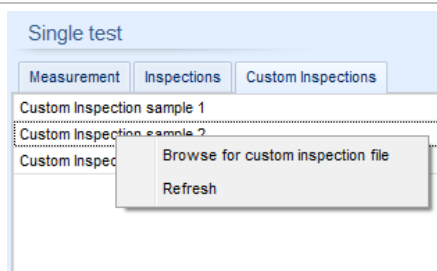
Position cursor within Custom inspections List area and apply mouse right click to open Option menu:
Refresh: Refresh content of already opened Inspection Data file.
Browse for custom Inspection file:
Menu for browsing to folder location of new Inspection Data file is opened.

After confirmation of selection, new Inspection Data file is opened and list of available Custom Inspections is changed.
Note:
If Metrel ES Manager Work scope is changed, opened Inspection Data file remains active and available Custom Inspections remains the same.