

OPERATING MANUAL

SEFELEC 1500-M



Reference: PENT6570

(ENGLISH)

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1. INTRODUCTION

General points

These instructions present the SEFELEC1500M device, designed for taking measurements of high-value electrical resistance, as well as its electrical and mechanical specifications.

In addition, the information required for usage in accordance with the rules in effect for safe operation, commissioning and maintenance of devices is provided.

Since 1965, the mission of our teams has been the designing and manufacturing of electrical resistance measuring devices, dielectric strength test stations and cable testers.

Our experience in these areas has been recognised by most of the companies that make use of cutting-edge technologies, whether military, aeronautical, railway or civil.



1.1. WARRANTY

EATON guarantees that this device is free from any defect in the construction and packaging thereof. EATON also guarantees that in the framework of correct use, the device will comply with the characteristics mentioned in this document.

If within the year following its first delivery, the device does not comply with its specifications, it will be repaired free of charge at our location in Lognes.

Any modifications made to the device or to one of its accessories that are not approved by EATON shall void this warranty.

EATON is not liable for any indirect damage consecutive to the use of the device.

1.2. PICTOGRAMS USED

Warnings are used in these instructions with symbols that must be complied with in order to guarantee safe operation of the devices.

The warnings and symbols used are:



DANGER

Indicates imminent danger.

Death or very serious injury may occur, if suitable safety measures are not taken.



WARNING

Indicates imminent danger.

Death or very serious injury may occur, if suitable safety measures are not taken.



CAUTION

Indicates a situation which may be dangerous.

Slight injury may occur, if suitable precautionary measures are not taken.



IMPORTANT

Indicates a situation which may be dangerous.








Damage to equipment or to parts of the installation may occur, if suitable precautionary measures are not taken.



NOTE

Indicates important information on the device.

The following symbols may appear on the devices:

| | | | |
|---|--|---|---|
|  | <p>Direct current.</p> |  | <p>Warning (See accompanying documents).</p> |
|  | <p>Direct current and alternating current.</p> |  | <p>Warning, risk of electric shock.</p> |
|  | <p>Alternating current.</p> |  | <p>falls under a WEEE recycling procedure</p> |
|  | <p>Earth terminal.</p> | | |

1.3. WARNING AND SAFETY INSTRUCTIONS

The SEFELEC 1500-M Megohmmeter & Pico-ammeter is designed to take measurements of high-value resistances and of low-value currents.

Warning:



IMPORTANT

- The measuring device must be used only in compliance with the provisions mentioned hereinabove.
- Correct usage of the measuring device assumes transport, installation, handling and maintenance according to the instructions.
- The admissible environmental conditions must also be complied with.

Safety instructions before use:



WARNING

- Before using the measuring device, check the integrity of the power cord and more particularly that the latter has not been subjected to any mechanical damage that can render a wire directly accessible and/or a connection cut-off.
- Before using the measuring device, check the integrity of the measuring cords and more particularly that the latter have not been subjected to any mechanical damage that can render a wire directly accessible and/or a connection cut-off.
- Before using the measuring device, check the connection of the latter with a ground cable directly connected via the stud bolt at the rear of the measuring device.
- Before using the measuring device, check that none of the vents of the measuring device are obstructed and that they allow air to flow freely.
- Before using the measuring device, check that the connectors on the front panel of the latter are not damaged and/or not locked.
- Use the ON/OFF push-button to turn the measuring device on and check the lighting of the blue indicator light of the push-button on the front panel.

Safety instructions after use:



WARNING

- After using the measuring device, before any action on the measuring device, check that the red indicator light is not lit and the lighting of the green indicator light on the front panel of the measuring device.
- Use the ON/OFF push-button to turn the measuring device off and check that the blue indicator light of the push-button is not lit on the front panel of the measuring device.
- Disconnect the tested product.

1.4. DECLARATION OF CONFORMITY

SEFELEC 1500-M measuring devices are compliant with the regulatory provisions defined by:

European directives

- | | |
|-------------|--|
| 2006/95/EC | Covering the safety of electrical equipment intended for use within certain voltage limits (LVD) |
| 2004/108/EC | covering electromagnetic compatibility (EMC) |

Harmonised standards

- | | |
|--------------------------------------|--|
| IEC 61010-2-034 January 2017 edition | Safety requirements for electrical equipment for measurement, control, and laboratory use. |
| EN61326 -1 01/07/2006 edition | Electrical equipment for measurement, control and laboratory use. EMC requirements. |

A copy of the Declaration of Conformity document can be found at the end of this notice..

1.5. QUALIFICATION OF THE PERSONNEL

These instructions are intended for qualified persons, who have received instructions prior to using the device and who have had training authorising work on electrical devices. The instructions provide the information required for mounting and correctly using devices of the SEFELEC1500M series.

The instructions for use and the corresponding technical documents must be read and understood before using the device and the instructions must be observed.

1.6. EXCLUSION OF LIABILITY

This documentation presents the devices in their standard version.

Despite in-depth verification of the content of the instructions, we cannot guarantee that there are absolutely no errors. The manufacturer assumes no liability for any inaccuracies or omissions.

In case of doubt or for technical questions, please contact your technical representative.

1.7. AFTER-SALES SERVICE

For any technical questions you may have, please contact your technical representative or the after-sales service at the following addresses:

EATON

Sefelec SAS

19 rue des Campanules

F-77185 - LOGNES

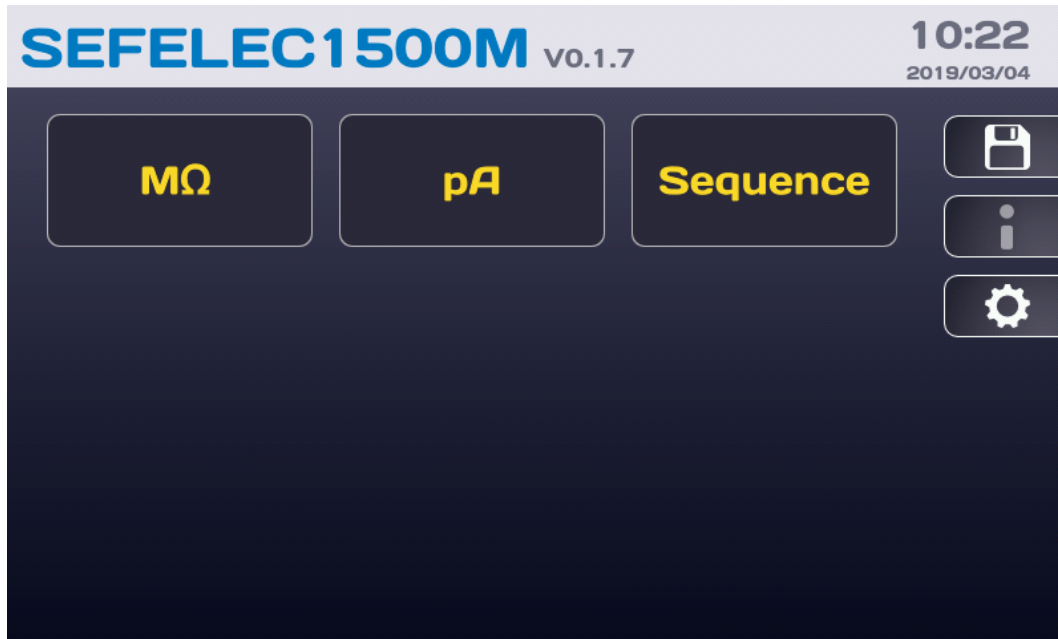
FRANCE

Tel.: +33 (0)1 64 11 83 40

Web: www.sefelec.com

2. PRESENTATION OF THE DEVICE

2.1. SEFELEC 1500-M



- The device includes in the same compact unit the functions for measuring insulation resistance and low currents. Its colour LCD touchscreen graphic display makes it easy to use.
- Measuring insulation resistance is done under DC from 1 to 1,500 volts.
- The measurement range of the resistance is from 100 Ω to 2,000 T Ω .
- The current is measured either by using the variable internal voltage source or by using an external voltage source.
- The current measurement range is from 0.01 pA (resolution) to 20 mA.

2.2. OPTIONAL FUNCTIONS

| Reference | Description |
|----------------------|---|
| SEFO-IEEE488 | IEEE488-2 Interface |
| SEFO-CO160 | red/green light to indicate HV presence |
| SEFO-1500REAR | HV rear panel output |
| SEFO-153MA | short-circuit current limitation <3mADC |

2.3. ACCESSORIES (TO ORDER SEPARATELY)

| Reference | Description |
|-----------------------|---|
| SEFA-KR | 19" rack mounting |
| SEFA-HV15 | HT 1500VDC L=1.5 meters lead |
| SEFA-SE15 | Shielded high insulation probe, L=1.5 meters |
| SEFA-HVSE15-10 | set of a HV lead and a shielded lead without ending for system integration, L=10 meters |
| SEFE-RE15 | set of 2 leads to connect on REMA series standard |
| SEFA-SRE24 | shielded ring probe for surface insulation resistance measurement |

-

3. SPECIFICATIONS

3.1. OVERVOLTAGE CATEGORY

CAT II overvoltage category device, making it possible to take measurements on specific terminals of a piece of equipment being tested, powered by the low voltage network (mains) and having regulatory overcurrent protection systems.

3.2. POLLUTION DEGREE

Pollution 2: temporary conductivity pollution caused solely by condensation.

3.3. SAFETY CLASS

Safety class I: device with a protective earth incorporated in the power cord.

Earth < 3 Ω , interruptions < 10 ms

3.4. ENVIRONMENT

High insulation resistance measurements must be carried out in humidity controlled conditions (< 50% at 20°C) both for the measurement instrument and for the equipment to be tested.

The tester should be cleaned regularly to remove dust.

For optimum operation of the electronics, the tester should be used in an ambient temperature range of 15°C to 35°C. The tester air inlets must be kept clear.

The tester must be used indoors, in a horizontal position or it may be tilted using the feet.

3.5. MEASUREMENT SPECIFICATIONS

| General Specification | | | |
|----------------------------|---|------------------|--------|
| Mains : | 100-240Vac $\pm 10\%$ 50 to 60Hz / single phase | | |
| Mains Protection : | Temporized double fuse T10AH 250V | | |
| Input Power : | 700 VA max. | | |
| Temperature range : | <i>Storage</i> | <i>Operation</i> | |
| | -10°C to +60°C | 0°C to +45°C | |
| | Specified accuracy after 1/2-hour warm-up, RH<50%, temperature within 15-35°C | | |
| Altitude : | Up to 2 000 meters | | |
| Relative Humidity : | 80% max. @ 31°C | | |
| Acoustic pressure: | Max. 80 dBA @ 1 meter | | |
| Weight : | approx. 15 kg | | |
| Dimensions : | Height | Width | Depth |
| | 131 mm | 440 mm | 455 mm |

| Output voltage | | | |
|---|---|--------------------------|----------------------------|
| Voltage adjustable: | volt by volt from 1VDC to 1500VDC | | |
| Generation accuracy | $\pm (0.5\% + 0.5V)$ read value | | |
| Reading accuracy | $\pm (0.5\% + 0.5V)$ read value | | |
| Short circuit current : | 20 mA ($\pm 10\%$) can be limited to 3 mA (in option) | | |
| Dynamic stability | $> 1.10^{-6}$ for mains variation of $\pm 15\%$ | | |
| Nominal current : | <i>from 1V to 10V</i> | <i>from 11V to 1000V</i> | <i>from 1000V to 1500V</i> |
| | 1 mA / V ($\pm 0.5mA$) | 10 mA ($\pm 10\%$) | 5 mA ($\pm 10\%$) |
| Polarity : | Positive pole to HV terminal, Negative pole to guard terminal Possibility to ground positive or negative HV pole | | |
| Voltage Ripple : | ± 100 mV peak to peak for 10mA output current | | |
| Noise 0.01Hz à 10Hz: | 100 μ V max (20°C) | | |
| Temperature coefficient : | 0.001%/°C | | |
| Max D.U.T. Capacitance : | < 1mFarad (discharge time < 10sec.) | | |
| Discharge resistance : | 2.2 k Ω | | |
| Test time | | | |
| Temporization for slopes and plateau : | Adjustable from 0.1 to 9999 sec. or permanent mode | | |
| Measurement speed | | | |
| 3 speeds selectable from front panel : | <i>Slow</i> | <i>Normal</i> | <i>Fast</i> |
| | 1 reading/sec | 3 reading/sec | 10 reading/sec |

| Tera-Ohmmeter specification | | | |
|--|--|--|--|
| Measurement range : | 0.1 kΩ to 2000 TΩ (1.10 ² Ω to 2.10 ¹⁵ Ω) | | |
| | 10 measurement current ranges | | |
| Temperature coefficient : | ± 0.1%/°C | | |
| Display resolution : | 2 000 digits | | |
| Test Voltage (ex.) | 10 V | 100 V | 1 500V |
| | from 10 ³ to 2.10 ¹³ Ω | from 10 ⁴ to 2.10 ¹⁴ Ω | from 3.10 ⁵ to 2.10 ¹⁵ Ω |
| Accuracy : | ±[current range accuracy+(50/Test Voltage)% +1 digit] of read value | | |
| Threshold : | High and low from 0.1 kΩ to 2000TΩ | | |
| Pico-Ammeter specification | | | |
| Measurement range from : | 500 fA to 20 mA in 10 ranges / Automatic or manual range selection | | |
| <i>Range</i> | <i>Minimum value</i> | <i>Resolution</i> | <i>Accuracy @25°C</i> |
| 20.00 pA | 0.50 pA | 10 fA | 0.3% reading + 500 fA |
| 200.0 pA | 19.8 pA | 100 fA | 0.2% + 0.6 pA |
| 2.000 nA | 0.198 pA | 1 pA | 0.2% + 2 pA |
| 20.00 nA | 1.98 nA | 10 pA | 0.2% + 20 pA |
| 200.0 nA | 19.8 nA | 100 pA | 0.2% + 200 pA |
| 2.000 μA | 0.198 μA | 1 nA | 0.2% + 2 nA |
| 20.00 μA | 1.98 μA | 10 nA | 0.2% + 20 nA |
| 200.0 μA | 19.8 μA | 100 nA | 0.2% + 200 nA |
| 2.000 mA | 0.198 mA | 1 μA | 0.2% + 2 μA |
| 20.00 mA | 1.98 mA | 10 μA | 0.2% + 20 μA |
| Nota : 1 pA = 0.001 nA = 0.000 001μA = 0.000 000 001 mA = 1x10⁻¹²A | | | |
| Temperature coefficient : | ± 0.1%/°C | | |
| Display resolution : | 2 000 digits | | |
| Range Selection : | Automatic or manual range selection | | |
| Input Impedance : | <i>Range</i> | <i>Impedance</i> | |
| | 20 mA | 9 Ω 1% | |
| | 2 mA | 90 Ω 1% | |
| | Others | 9 kΩ 1% | |
| Threshold : | High and low from 00.50pA to 20.00mA | | |
| External Voltage Source : | up to 100kVDC with BAPA options and RLHT50 or RLHT70 limitation resistors for sources > 10kVDC | | |

4. SAFETY

4.1. SAFETY WHEN WORKING WITH ELECTRICAL EQUIPMENT



WARNING

Risk of electric shock!

- All precautions for using equipment connected to the mains must be taken when it is used.
- In particular, the equipment must be earthed.
- Always ensure that the high voltage presence light is off before connecting or disconnecting a wired assembly to be tested.

4.2. SAFETY MEASURES

- Disconnection of the equipment via the power cord.
- The testers have a double safety circuit.



WARNING

Risk of electric shock!

- If possible, the test zone should be protected by safety circuits to prevent the access of unauthorised personnel.



WARNING

Disconnection device

- The power cord is the disconnection device for the equipment. After installation, ensure that the latter remains accessible.

4.2.1. SAFETY CIRCUIT

The voltages and currents generated by the SEFELEC1500M measurement devices can create a risk of electric shock by contact. Protection for the personnel is the responsibility of the management of the site where the measuring device is installed.

EATON can only provide recommendations. The "safety" manager of the company using the device is responsible for ensuring compliance with the safety measures.

The devices have a **double safety circuit** to meet the requirements of CEI 61010-2-034, EN60591, either intrinsically or by the addition of external accessories (emergency stop buttons, light curtains, beacons, safety cages, etc.).

This double safety circuit has electromechanical relays to cut the high voltage generators as soon as one of the circuits is open. The test software raises an alarm message and stops the test. The circuits must be re-established and an operator command given before the test can continue.

The indicators on the front panel and an optional beacon show that the measuring device is on (green) and that the measuring device is testing (red).

Connecting the safety circuits

The device has a double "safety circuit" available on points 1-9 and 2-10 of the rear socket C5. The latter must be connected in order to authorise the execution of a test.

Note: it is recommended that you place in these connections dry contacts in series subject to safety conditions (closed door, cover lowered, etc.).

It is possible to connect a red/green signal lamp (SEF-CO160) on terminal plug C5 in order to visibly indicate at a distance the presence or absence of voltage on the output terminals of the device.



NOTE

the connection of the connector C5 is given in paragraph 17.1.1:
SAFETY CONNECTOR C5

Reminder of the standard: Contact with live parts

The effects of a current passing through the human body have been studied and are covered in NF EN 50191 of 20 January 2003, available from AFNOR. It applies to "*the installation and operation of electronic test equipment*".

It is considered that the human body presents a non-inductive resistance of about 2 k Ω .

Case with alternating current

For voltages greater than 25 V: A current of 3 mA (RMS)

Case with direct current

For voltages greater than 60 V: A current of 12 mA

In any case, the discharge energy must not exceed 350 mJ

NOTE: *A peak current of 0.7 mA can be felt by some people even though it does not present a risk.*

4.2.2. OPTIMISING THE SAFETY

In any case, a properly used safety circuit offers the best protection.

This safety system protects the wired assembly being tested as well as the operator. It is independent of the voltage applied and current injected for the measurements.



WARNING

Risk of electric shock!

- Access to the device must be reserved for personnel who have received training in electrical hazards.
- The wired assembly being tested should not be handled during the test (risk of measurement errors and electric shock).

A double safety circuit is provided as standard.

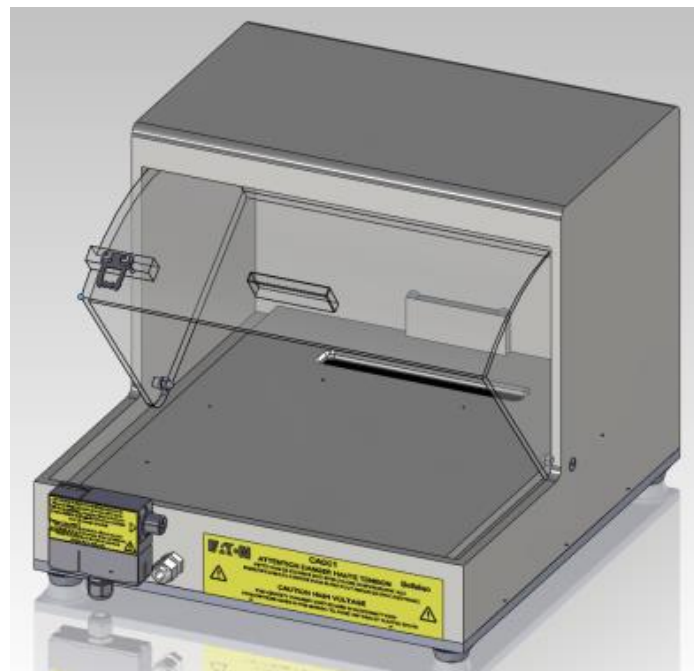


WARNING

High voltage!

- For dangerous voltages, signalling using a suitable Red/Green lamp (Option **SEFO-CO160**) must be implemented.

EATON on request can supply a locking system used during the test to control a type CA001, CA002 (image below) or CA003 safety cage in order to conduct the tests in complete safety.



4.3. PRECAUTIONS FOR USE



IMPORTANT

The measuring device must not be used to switch or handle external sources of energy that are not controlled by its system software. These power sources include relay solenoids, inductors without flyback diodes and undischarged capacitors.



IMPORTANT

During insulation measurements on capacitance > 1 mF, setting up a discharge system that makes it possible to ensure that the capacitor is discharged is mandatory.

The DISCHARGE command makes it possible to check the discharge level of the capacitor.

If this instruction is not complied with, the measuring device can be damaged.



NOTE

As the SEFELEC1500M is a measuring instrument, EATON cannot be held liable for any equipment faults or loss of production resulting from damage to the tester by failure to comply with the operating conditions set out above (environment, mains power supply and operation).

5. COMMISSIONING



WARNING

Risk of electric shock!

- The equipment must be commissioned, used and maintained by qualified personnel.
- All precautions for using equipment connected to mains supplies must be taken when it is used.
- In particular, the equipment must be earthed through the power cord and through the dedicated earth connection on the rear panel (see 16.1 section Z2 note)
- Always ensure that the high voltage presence light is off before connecting or disconnecting a wired assembly to be tested.

5.1. CONTENT WHEN DELIVERED

When the measuring device is delivered, the package should contain the following items:

- SEFELEC1500M megohmmeter device
- 1 x 2P+E 16 A power cord, 1.5 m in length.
- 4 x 10-points plugs of the screw terminal type with green cover
- 1 x printed Complete user manual for the device.
- 1 x printed guide for safety rules in high voltage test
- 1 x CE mark conformity certificate (included at the end of this manual)

And according to your order:

- The SEFA-SE15, SEFA-HV15, ...measuring accessories
- WinPass-MX software.
- Measurement data document

Please contact EATON if any items are missing. See the chapter [After-sales service](#).

5.2. SETTING UP THE VARIOUS CONNECTORS AND CORDS

Before turning the measuring device on, check that the following connectors and accessories are correctly connected and locked in position:

- The 10-pin C5 safety circuit plug should be connected to the 10-pin safety circuit socket (note that these sockets are keyed)
- Power cord on the rear panel and on a 16A mains socket with earth connection.



If the mains power cord is replaced, be sure to always use a mains cord suitable for the power and CE certified.

IMPORTANT

5.3. INSTRUCTIONS FOR FITTING IN THE BAY

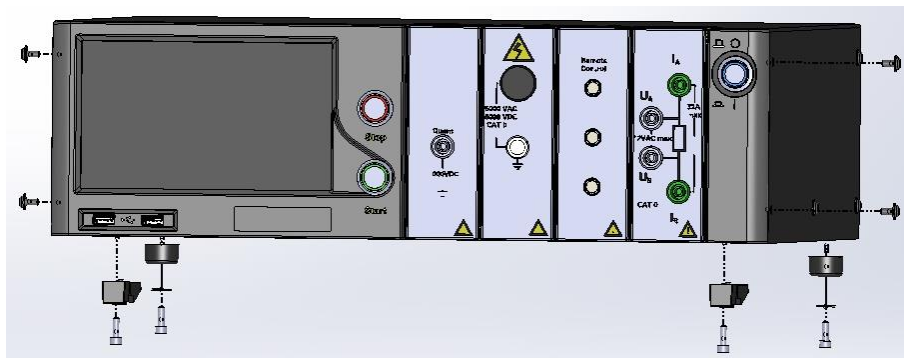
In cases when the SEFELEC 5x range device needs to be fitted in a bay, follow the instructions below:

The dimensions of the device are: height 3U, width to the 19" standard, depth 520 mm with the connectors. Use bays to the 19" standard with a depth of 600 mm minimum.

1 - Take the references of the bay and use the in-bay mounting kit supplied by the brand. For a device with a height = 3U the kit is usually composed of 2 runners and 4 screws (Caution: take the runners to suit the depth of the bay).

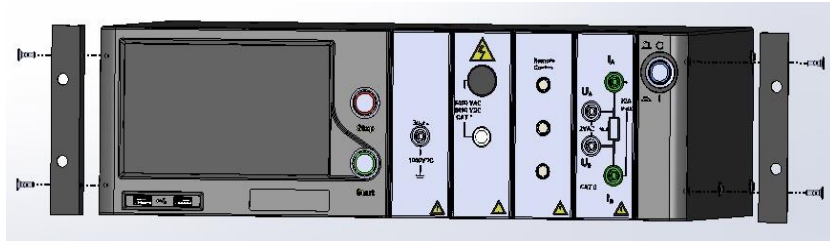
2 - Preparation of the device: Remove the 4 feet by unscrewing the 4 screws (hexagon socket head cap screws). Then remove the 2 screws on each side that hold the cover on the front of the device (Torx socket head cap screws).

See below:



3- Equip the device of the SEFELEC 5x range with the kit: SEFA-KR. It consists of 2 brackets and 4 screws (countersunk torx head).

Position the brackets on each side of the device as in the drawing and secure with the 4 screws. See below:



4 - Fitting the bay kit: Fit the 2 runners, adjust them in height according to the equipment to be installed in the bay.

5 - Install the device on the runners and slide it so that the 2 brackets on the rails of the bay on the front panel are abutting. Then fix the device to the bay with the screws in the kit.

In the case of a device with the outputs in the rear face. Provide a deeper bay of 800 mm minimum.



NOTE

The air inlets of the device must be clear. The dimensions of the bay as well as the mounting of the device must allow the movement of air around it in order to ensure a maximum operating temperature of 45°C.

5.4. TURNING ON THE DEVICE

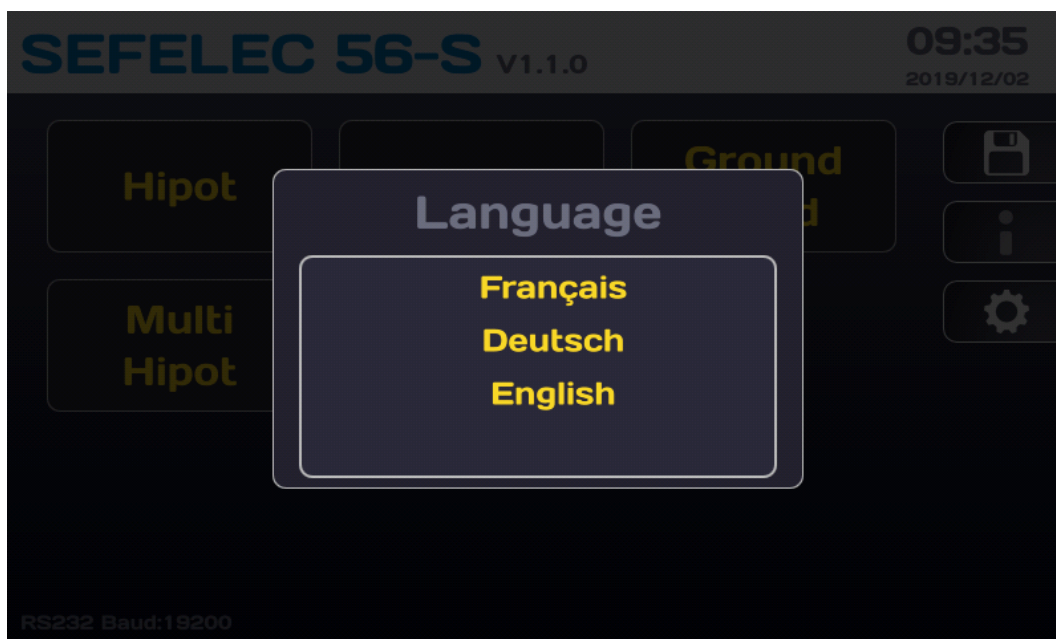
Turn on the device by pressing the ON/OFF push-button on the right side of the device:



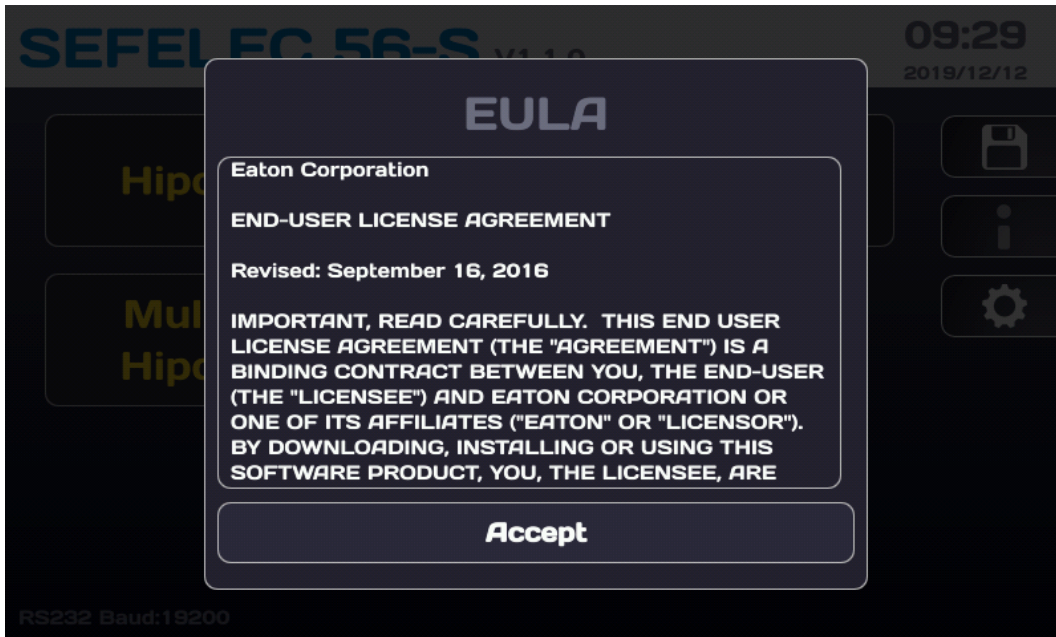
IMPORTANT

After turning off the unit, wait 2 seconds before turning it back on.

When switching on the power to the device after receipt, it displays a pattern with the EATON logo and then after approximately 17 seconds, the subsequent screen to ask for the language of use:

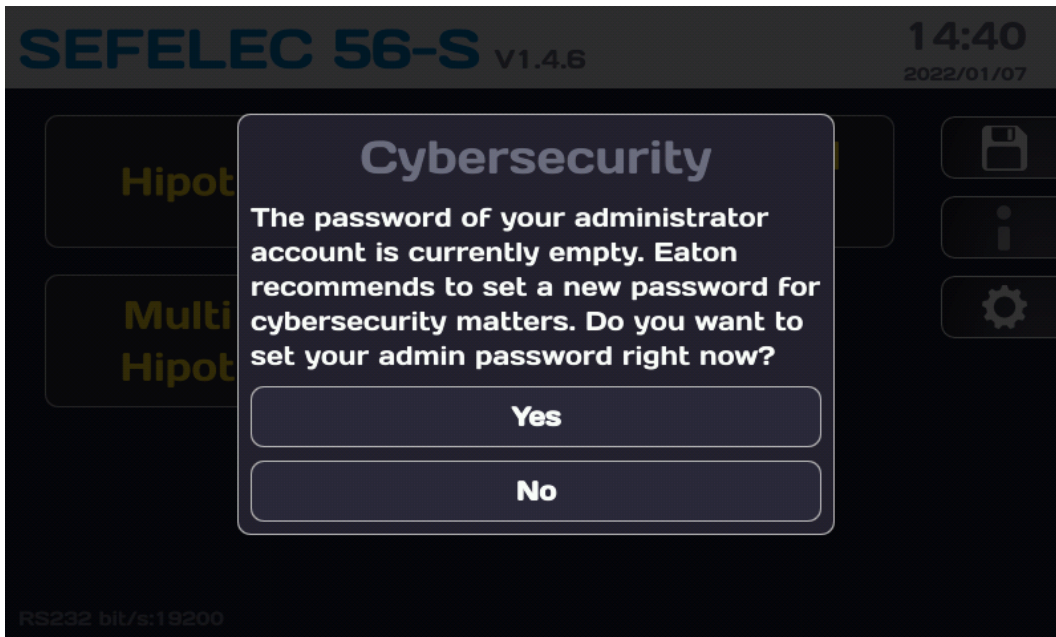


Choose the language; the device then displays the conditions for the use of the embedded software and asks you to accept the end user license agreement:



Accept the text to be able to use the device. The full text can be found in the appendix chapter 19 of this leaflet.

Once accepted the license agreement will no longer be displayed and the LCD will display the following Cybersecurity menu:



The SEFELEC 1500-M was designed with cybersecurity as an important consideration. The product offers a number of features to reduce cybersecurity risks. These cybersecurity recommendations provide information to help users deploy and maintain the product in a way that minimizes cybersecurity risks.

Eaton is committed to reducing cybersecurity risk in its products and deploying cybersecurity best practices in its products, making them more secure, reliable and competitive for its customers.

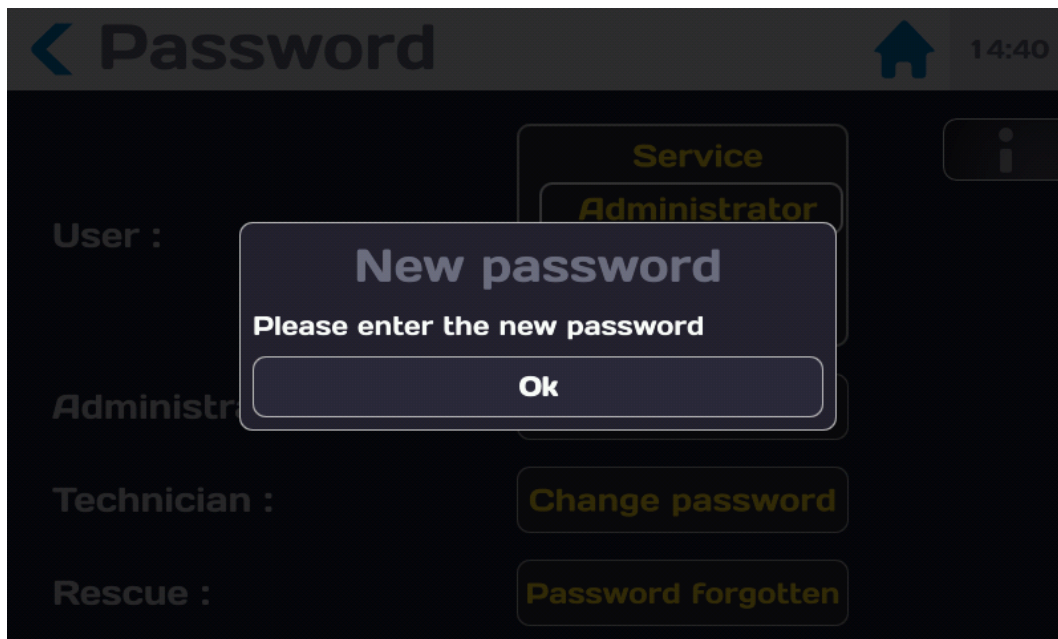
Press YES to enter your password.

If you decide not to use a password for Cybersecurity reasons, the ETHERNET interface will not be available on the device.

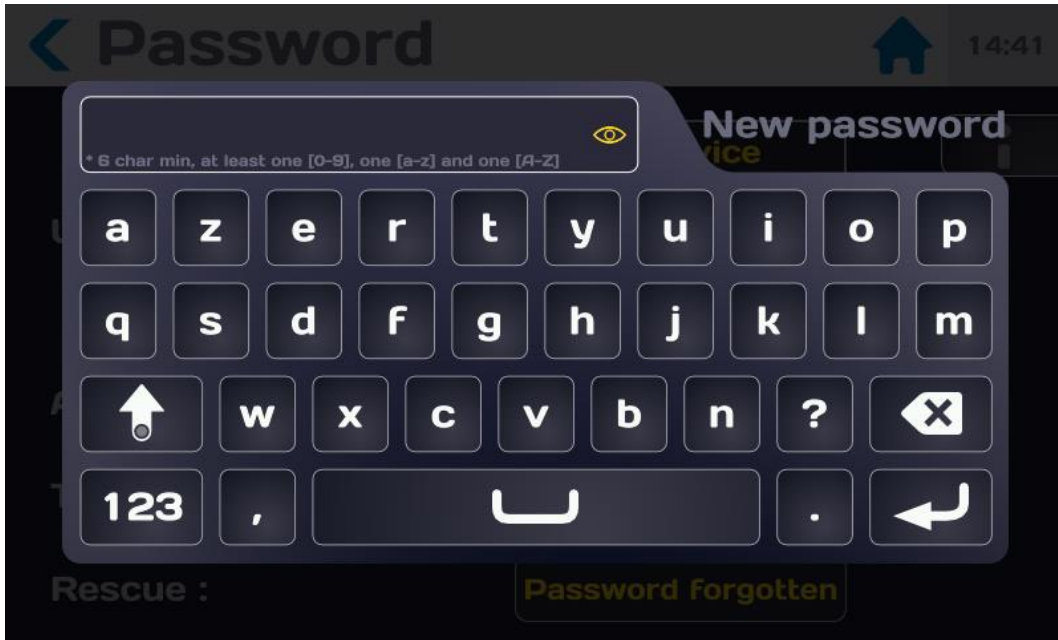


To use the ETHERNET interface it is necessary to enter an Administrator password

IMPORTANT



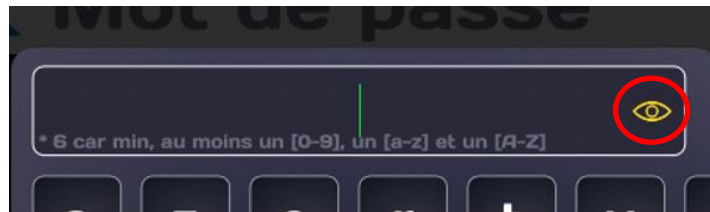
Press OK to display a virtual keyboard for entering the password:



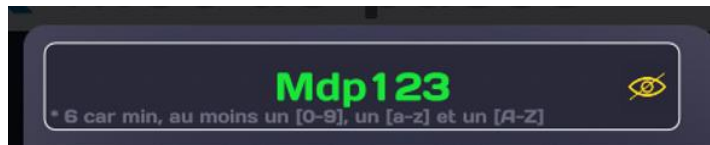
Enter the password according to the following rules:

- 6 characters minimum
- At least 1 digit
- At least 1 lowercase character
- At least 1 uppercase character

It is possible to view the entered password by pressing the eye icon:



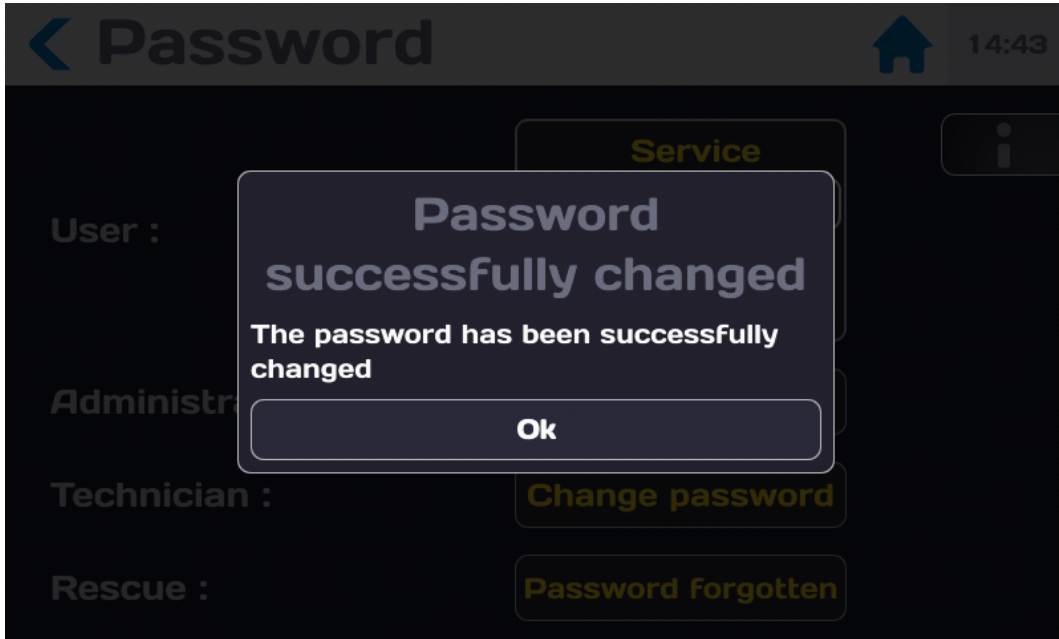
When the password entered complies with the above rules, the input area turns green:



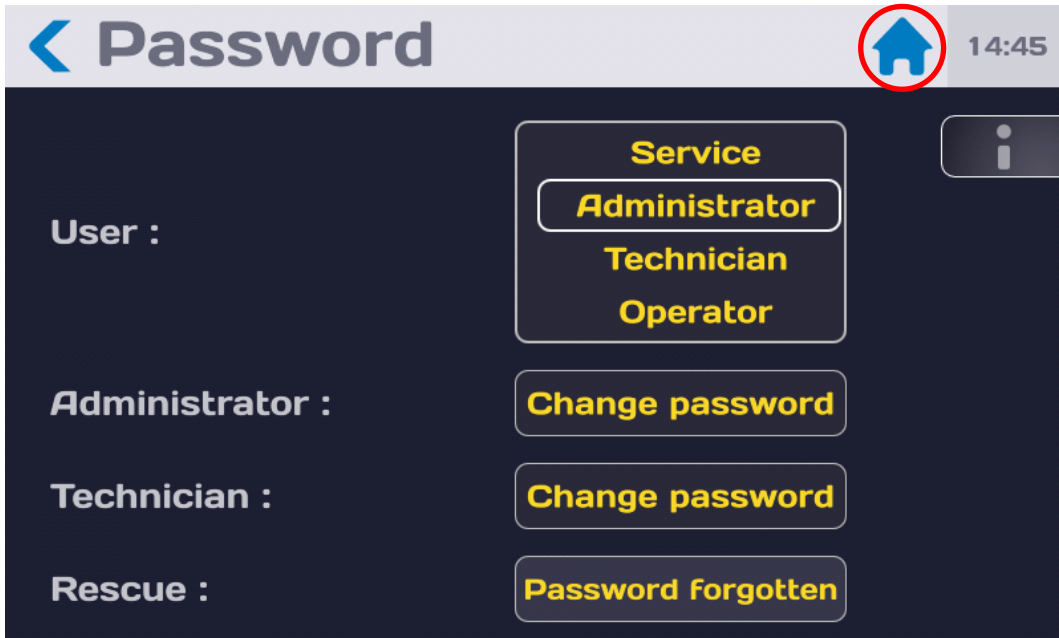
Validate the entry by pressing the character entry arrow. A new password entry screen will be offered to confirm your password.

Enter the same password, be careful it will not turn green.

Validate your entry, the following message will be displayed if the operation was successful:

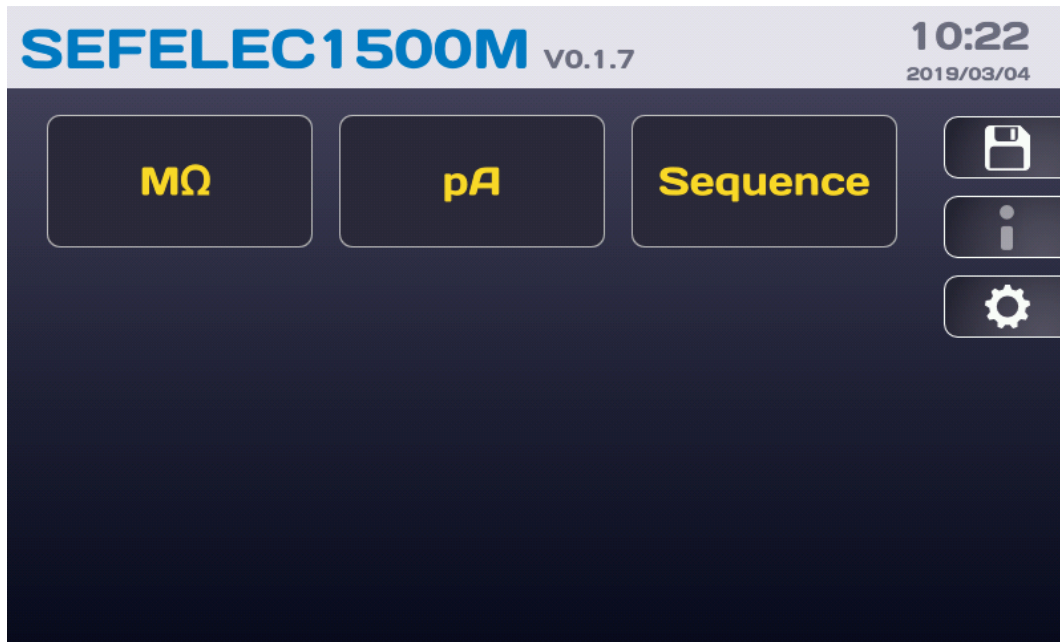


Press OK to reach the following screen :



You are at an administrator level of the 5x series device which gives you access to all the functions allowing the use of the device.

To return to the start menu press the House icon.



The upper banner indicates:

- the reference of the device: SEFELEC1500M
- the software version V0.1.7
- the time 10:22 and the date 2019/03/04

The date and time parameters can be changed in the "General parameters" menu which can be accessed by pressing the gear icon on the screen.

The communication interface selected is displayed in the lower left corner (e.g.: API, RS232 Baud: 9600, Ethernet, etc.):

Ethernet Ip:192.168.44.181 Mask:255.255.255.0

The colour LCD screen is touch sensitive allowing for navigation through the various menus of the device. For proper operation of the touchscreen, do not use gloves, a stylus or any other sharp object. After initial delivery please remove the protective plastic film from the LCD screen.

The function keys are delimited by a graphic zone, for example:



Pressing a key for longer than one second makes it possible to display a help screen that briefly describes the function. Press anywhere outside the help window to return to the previous screen.

Some screens require scrolling up or down through the information displayed in order to display all of the parameters. This possibility is indicated by the display of a scrollbar on the left side of the screen.



To scroll the screen down, place your finger towards the bottom of the screen and while remaining in contact with the screen, swipe towards the top of the screen with your finger; swipe in the opposite direction to scroll the screen up.

Active areas of the touchscreen are usually yellow.



Pressing the icon in the shape of a house in the upper banner returns you to the on/off menu.



Pressing the icon with the < shape allows you to return to the previous menu.

Entering numerical values for the parameters or filenames is done with the virtual keyboard that is displayed on the screen.

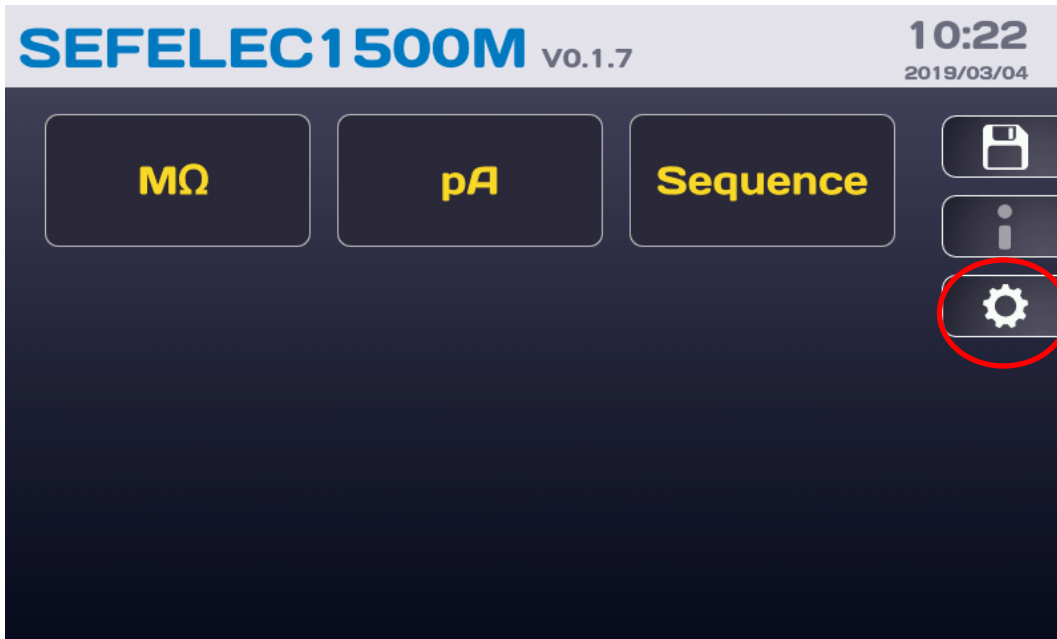


To facilitate key-entry, an AZERTY keyboard and mouse can also be plugged into the USB ports on the front of the device under the LCD screen.

Connect the keyboard and mouse with the USB, they will work immediately.

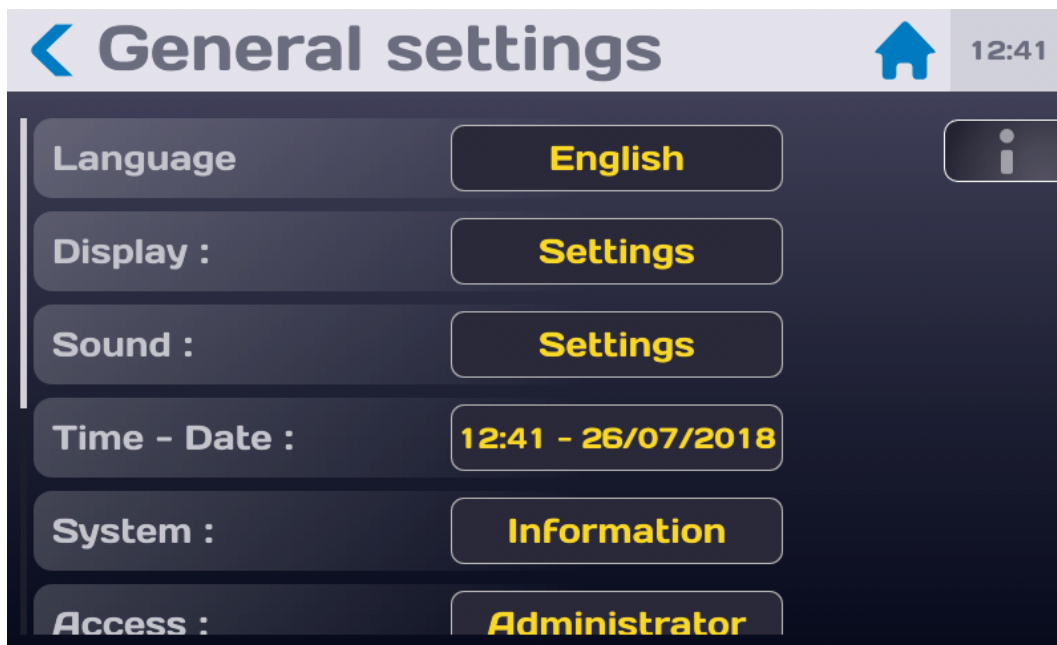
6. CONFIGURATION OF THE DEVICE

After turning on the device or when returning to the start-up menu, the home screen indicates:



press the configuration button (gear)

The LCD screen then displays the following information:



6.1. LANGUAGE SELECTION

The messages displayed on the screen can be in French, English, German and several other languages. To choose a language, make the selection by pressing on the area indicating the selected language

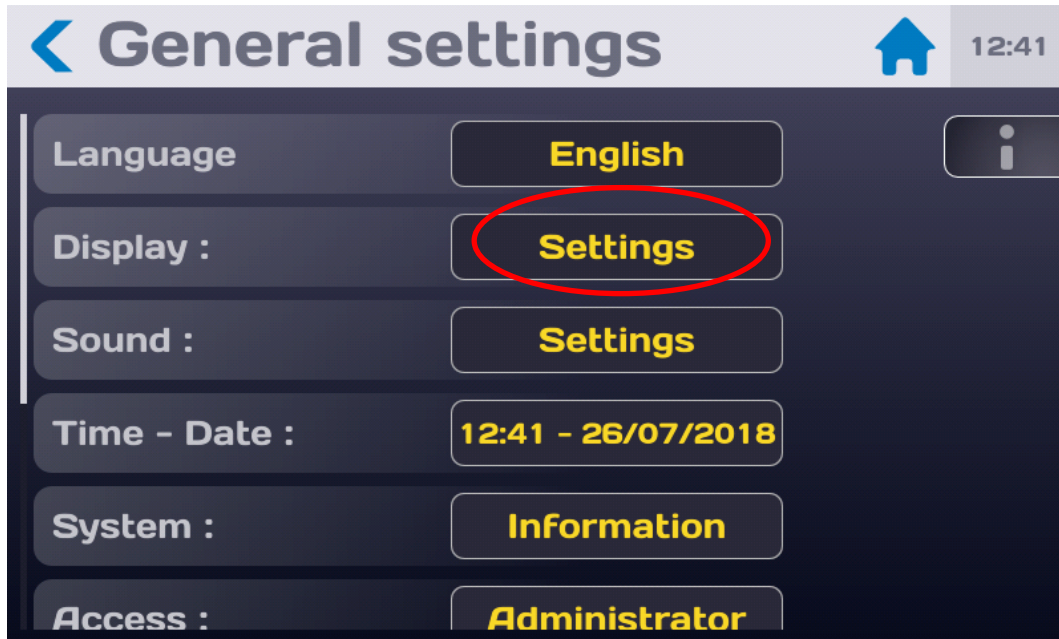


then scroll through the various languages and select the new language by pressing the area again.

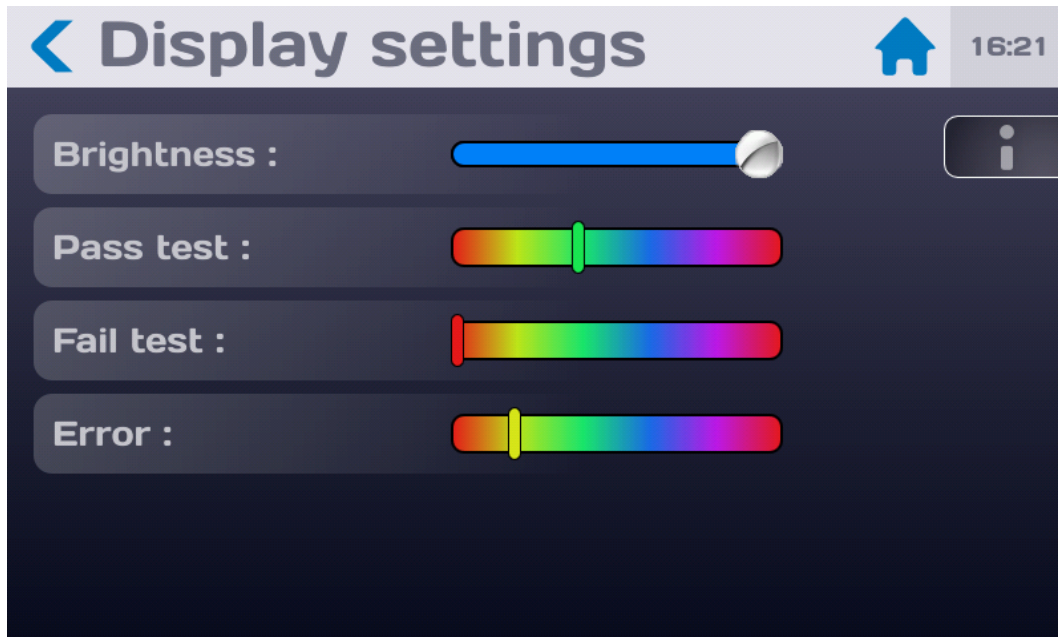


6.2. DISPLAY PARAMETERS

From the "**General settings**" menu, press the Parameter area of the "Display" line:



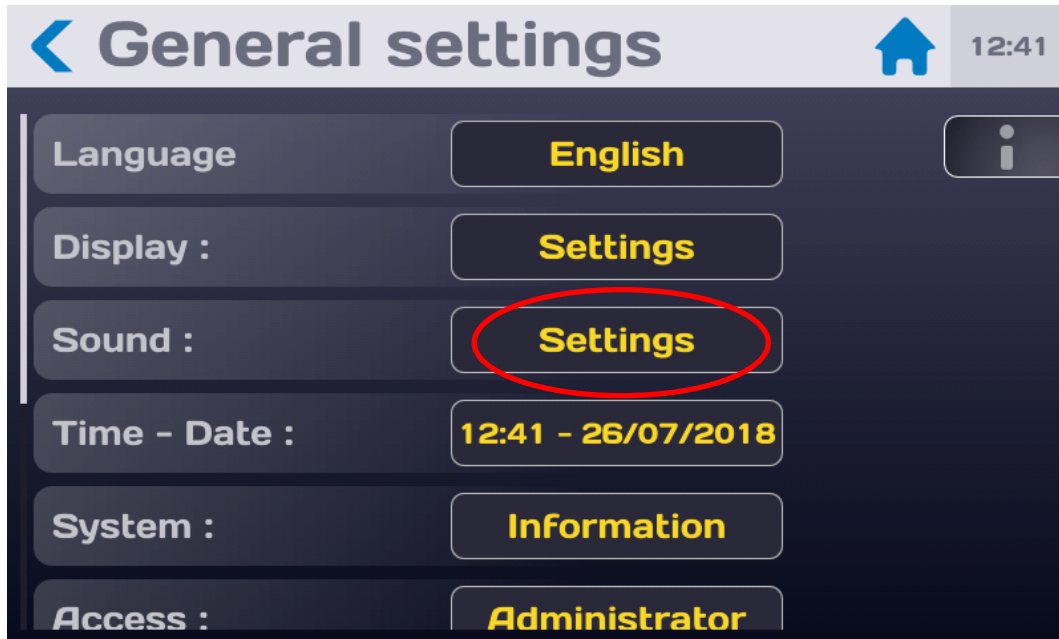
To obtain the following screen:



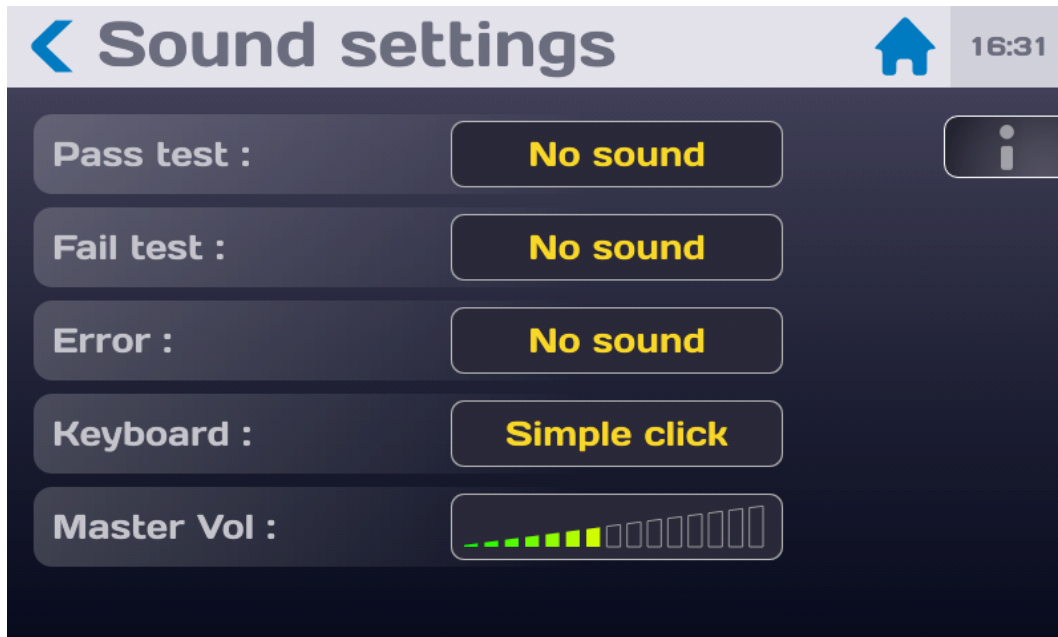
Adjust the Brightness and the colours by moving the various cursors, keeping your finger pressed on the touchscreen and sliding from right to left or the other way.

6.3. SOUND PARAMETERS

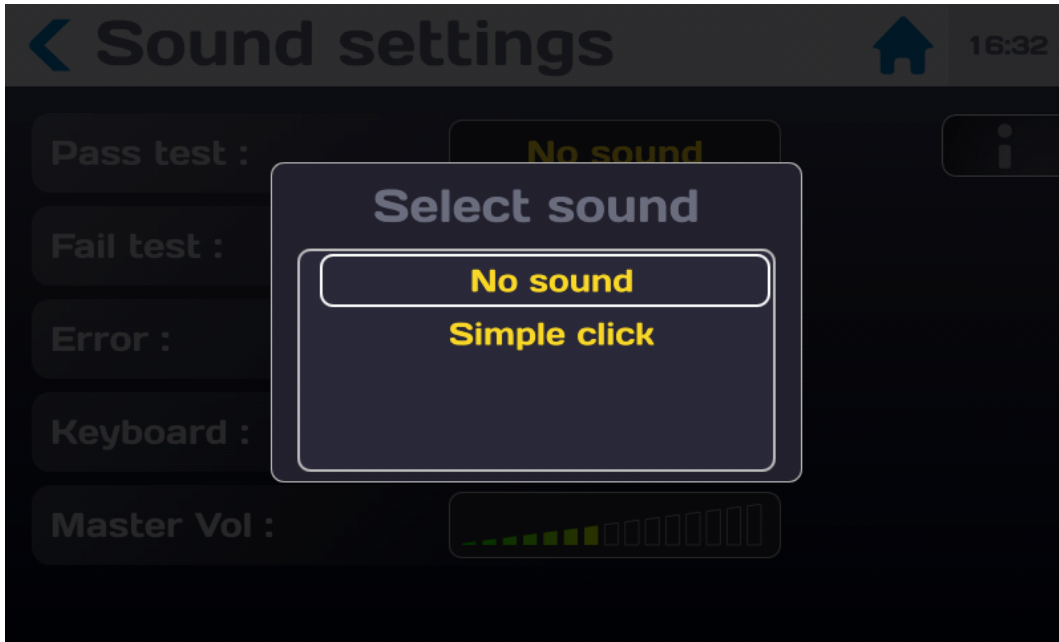
From the "**General settings**" menu, press the Parameter area of the "Sound" line:



To obtain the following screen:



Choose the various sound possibilities for the actions proposed.

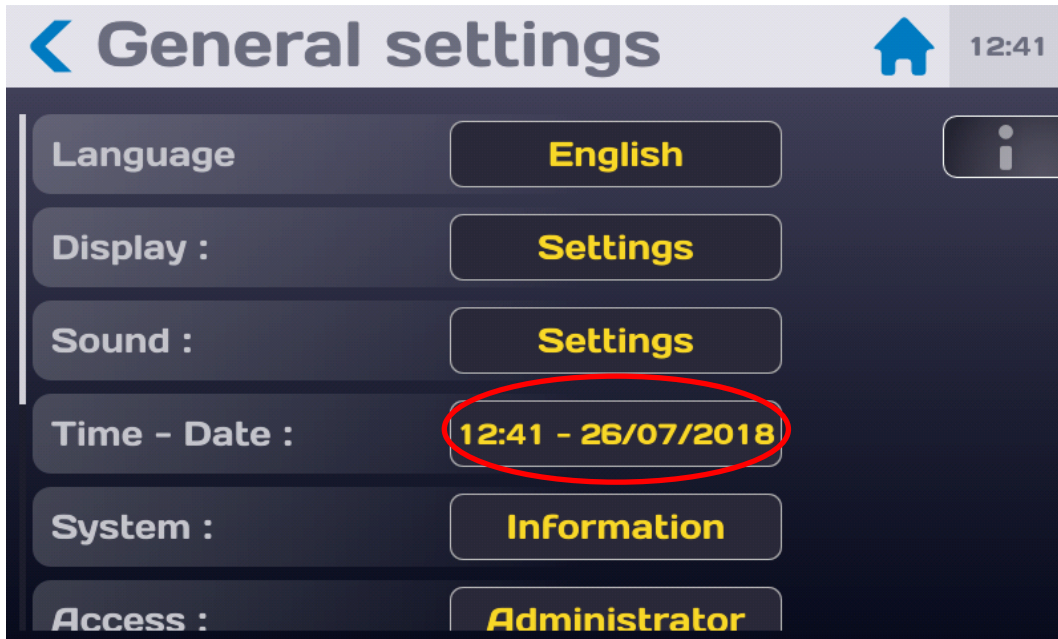


To adjust the volume of the sound, place your finger on the bar graph and slide your finger to the right maintaining contact with the screen in order to increase the volume and to the left to decrease the volume.

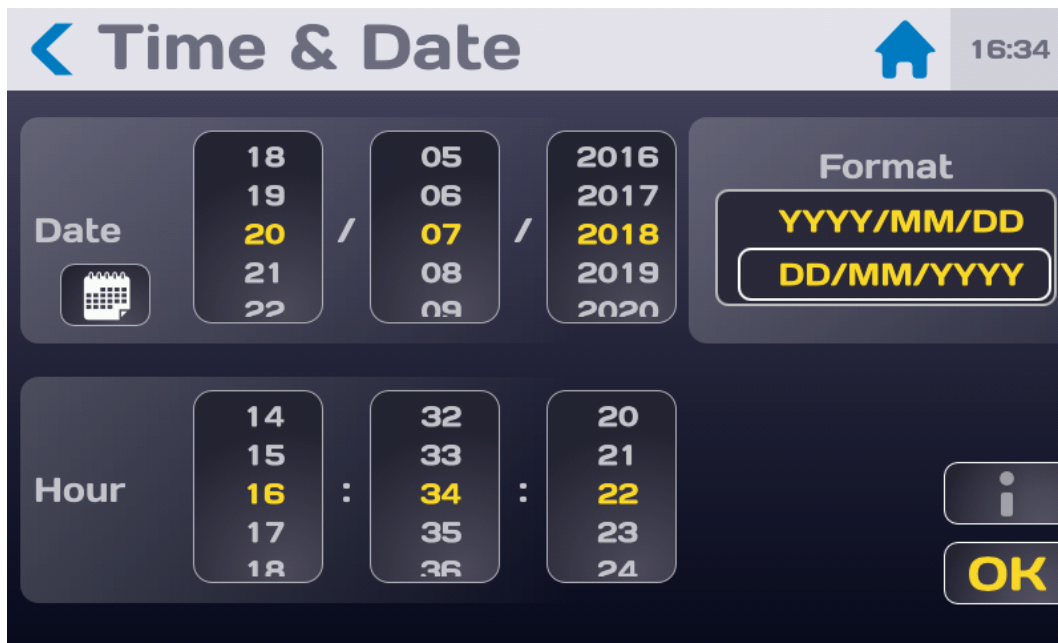
Return to the previous menu with the symbol <

6.4. TIME-DATE PARAMETERS

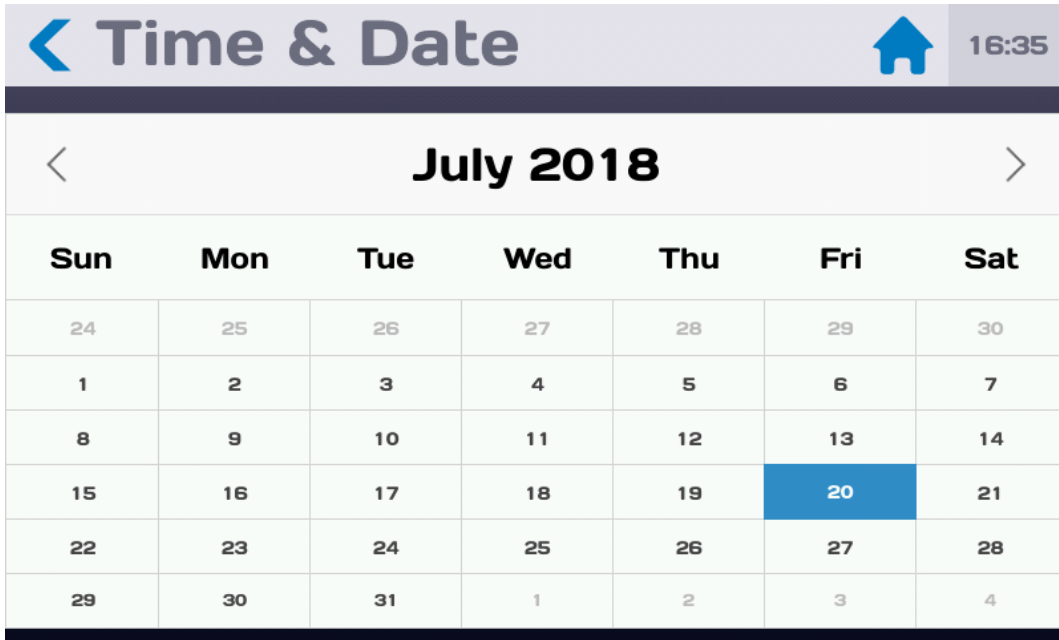
From the "**General settings**" menu, press the area indicating the time and the date of the "Time-Date" line:



To obtain the following screen:



Select the date format YYYY/MM/DD or DD/MM/YYYY then set the date using the drop-down windows or press the icon symbolising a calendar to select a date directly.



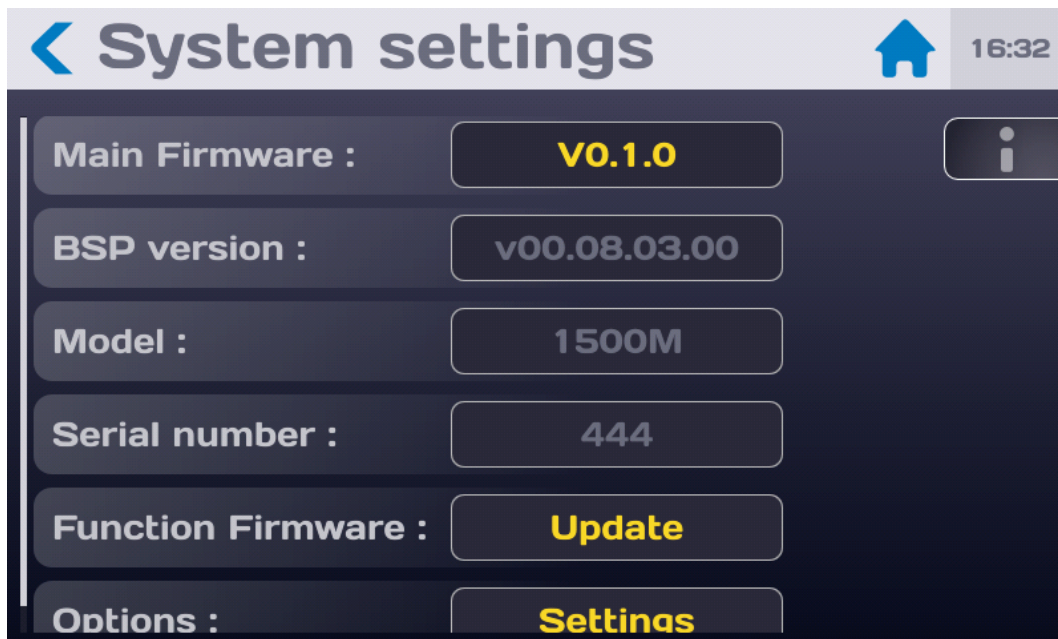
Continue in the same way to set the time and validate with **OK**

6.5. SYSTEM PARAMETERS

From the **"General settings"** menu, press the Information area of the "System" line:



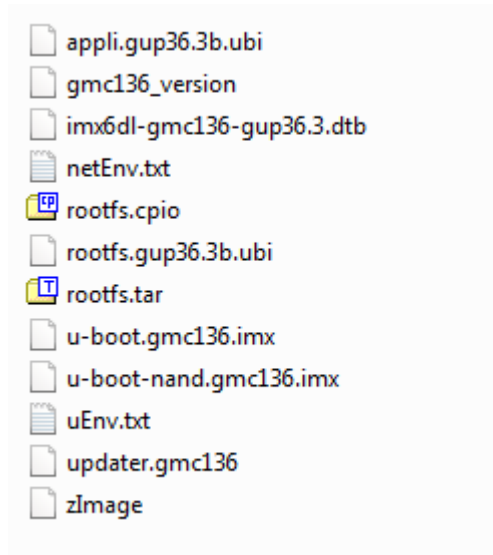
To obtain the following screen:



6.5.1. UPDATING THE OPERATING SYSTEM AND DRIVERS (BSP):

Updating the Operating System and its drivers can be done with a set of files. Contact our after-sales service or visit our website to obtain the latest available version of the BSP (Board Support Package) running on SEFELEC 5x devices.

The update files must be added to the root of the USB key used for the update:



Once the files are in the root of your USB drive, plug the drive into the front of your device. Restart the device using the ON/OFF button.

The update will be launched automatically during the restart if the key is detected correctly. The update starts shortly after the black “EATON” splash screen. The screen remains black and information about the update is displayed.

At the end of the update, you are prompted to remove the USB key. The device will restart again but with the new version of the BSP.



NOTE

It is possible that the USB drive is not detected fast enough during startup, causing the device to restart normally without any updates. If this happens, try the procedure again. If it still does not work, you can try another USB key before contacting our services.



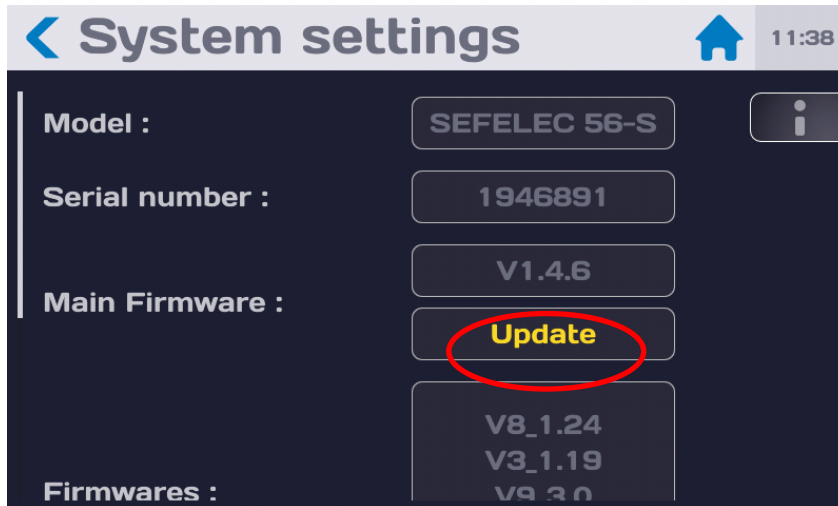
NOTE

It is recommended that you delete the update files from your USB drive after the update is complete to ensure that your device does not accidentally launch an update to its operating system during a normal restart .

6.5.2. UPDATING THE MAIN FIRMWARE OF THE HMI (HUMAN MACHINE INTERFACE):

Updating the main firmware of the HMI can be done with an update file **eaton-maj.zip** (do not unzip and consult our after-sales service or our website to obtain the latest version available) and which will be saved at the root of a USB key.

Then on the following screen:



Press the field showing the Update of the main firmware to obtain the following screen:



Press the "Cancel" key if you do not want to do the update.

Insert the USB key with the update file.

Then press the "Update" key and follow the instructions

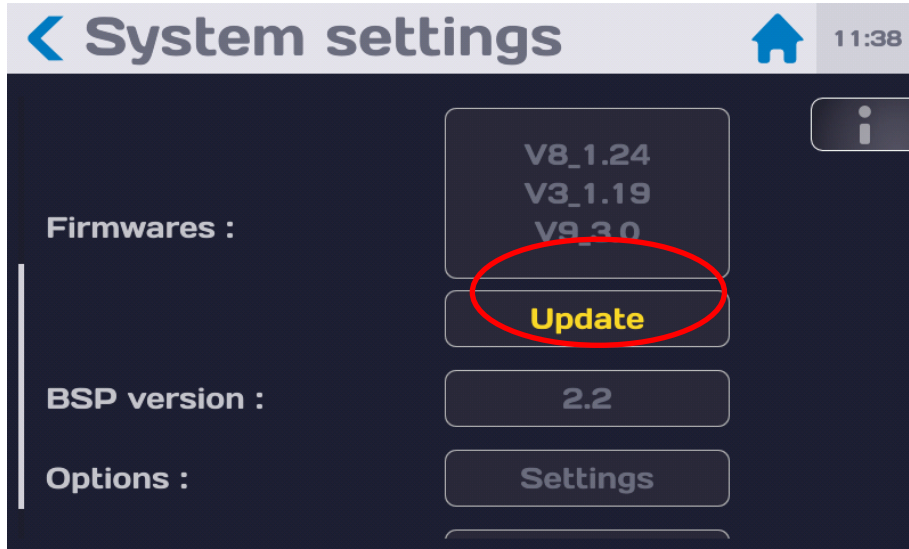


IMPORTANT

It is important not to turn off the device during the update

6.5.3. UPDATE OF THE FIRMWARE OF THE FUNCTION BOARDS:

Updating the Firmware of the function cards can be done from the update file eaton-maj-fct.zip (do not unzip and consult our after-sales service or our website to obtain the latest version available) which will be saved on the root of a USB key.
Then on the following screen:



Press the area indicating the Update of the function board Firmware to get the following screen:



Press the "Cancel" key if you do not want to do the update.
Insert the USB key with the update file.
Then press the "Update" key and follow the instructions



IMPORTANT

**Do not turn off the device during the update.
Please restart the device after the update is complete**

6.6. ACCESS PARAMETERS

The SEFELEC 1500-M has been designed with cybersecurity in mind as an important element. The product offers a number of features to reduce cybersecurity risks. These cybersecurity recommendations provide information to help users deploy and maintain the product in a way that minimizes cybersecurity risks.

Eaton is committed to reducing cybersecurity risk in its products and deploying cybersecurity best practices in its products, making them more secure, reliable and competitive for its customers.



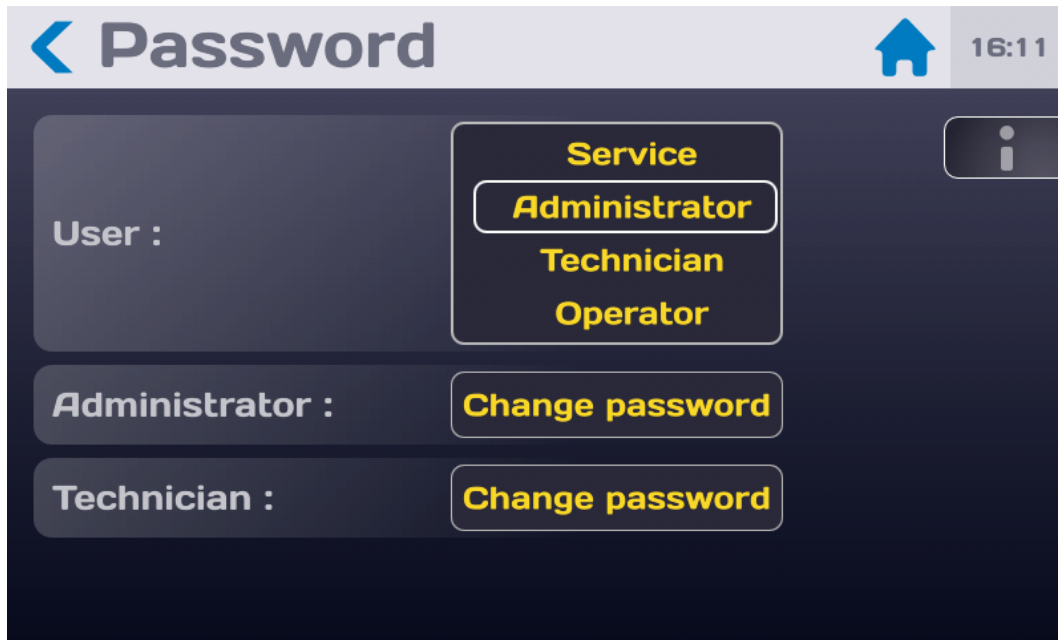
If you decide not to use a password for Cybersecurity reasons, the ETHERNET interface will not be available on the device.

IMPORTANT

In the "**General settings**" menu press the active area of the "Access" line:



To obtain the following screen:



Choose the user level and enter the corresponding password to validate the change in user level.

- The **Administrator** level has no limitation on the access to the different menus and functions of the device.
- The **Technician** level can only recall files previously configured.
- The **Operator** level cannot change the settings or load a new test file.
- The **Service** level has no limitation in the access to the different menus and functions of the device with an additional access to the calibration of the device. The **Service** level is only accessible to EATON technicians.

6.6.1. NEW PASSWORD OR PASSWORD CHANGE:

Rules concerning the password:

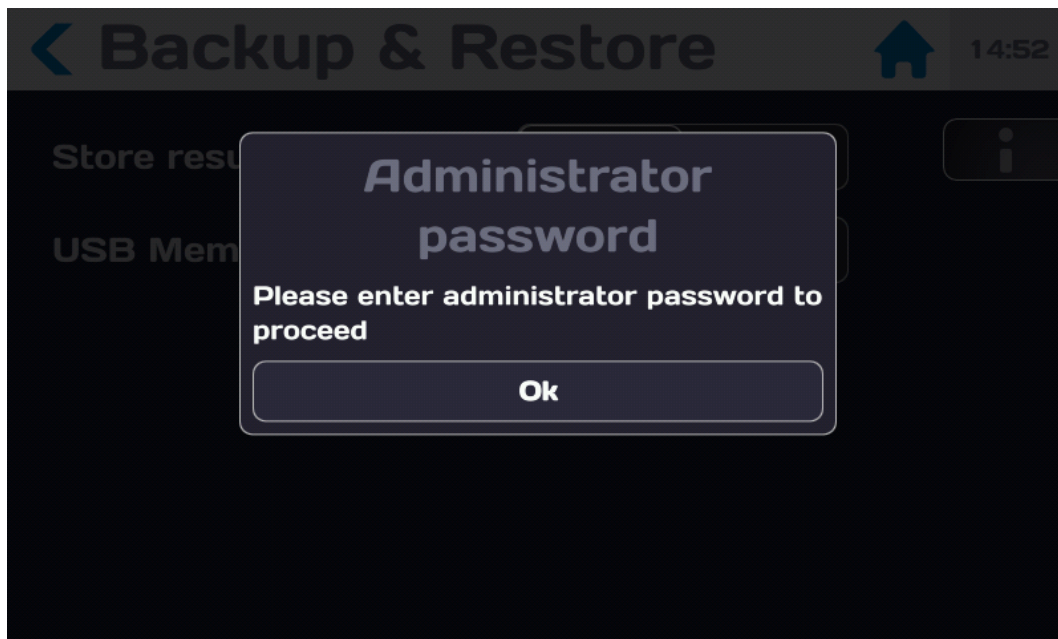
When changing the password, enter the old password and then the new one. There is no limitation in the number of characters which are those available on the virtual keyboard, but it should include:

- 6 characters minimum
- At least 1 digit
- At least 1 lowercase character
- At least 1 uppercase character



IMPORTANT

By default, when the device is delivered, the Administrator mode password is empty, press "Enter" to validate it.



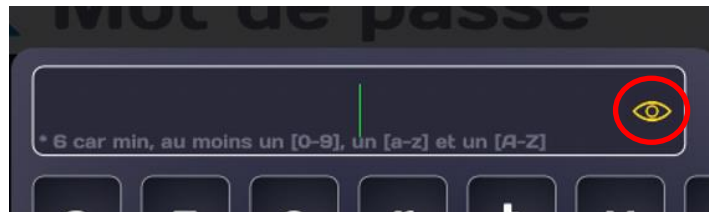
Press OK to display a virtual keyboard for entering the password:



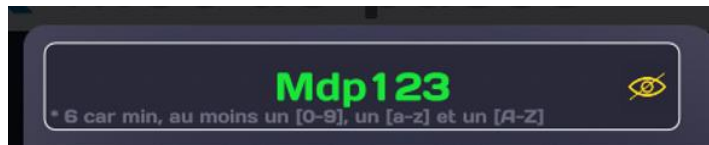
Enter the password according to the following rules:

- 6 characters minimum
- At least 1 digit
- At least 1 lowercase character
- At least 1 uppercase character

It is possible to view the entered password by pressing the eye icon:



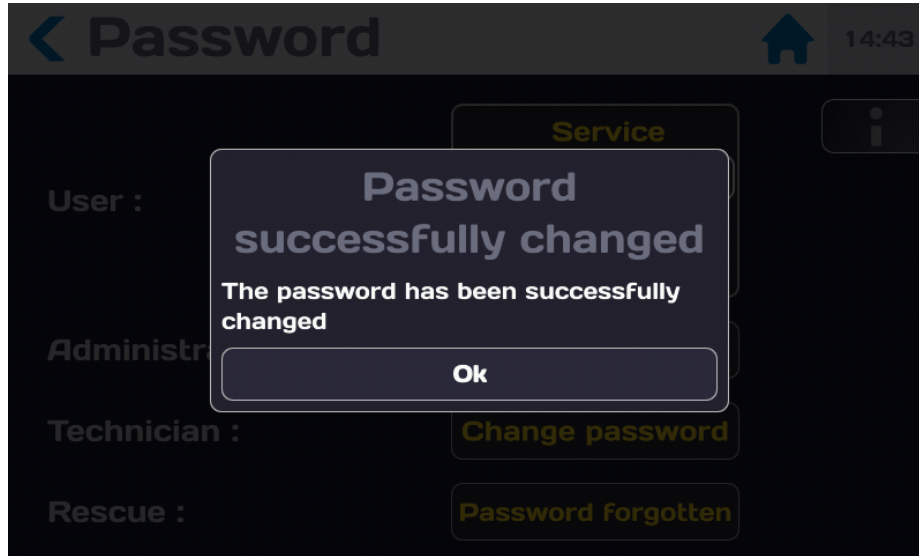
When the password entered complies with the above rules, the input area turns green:



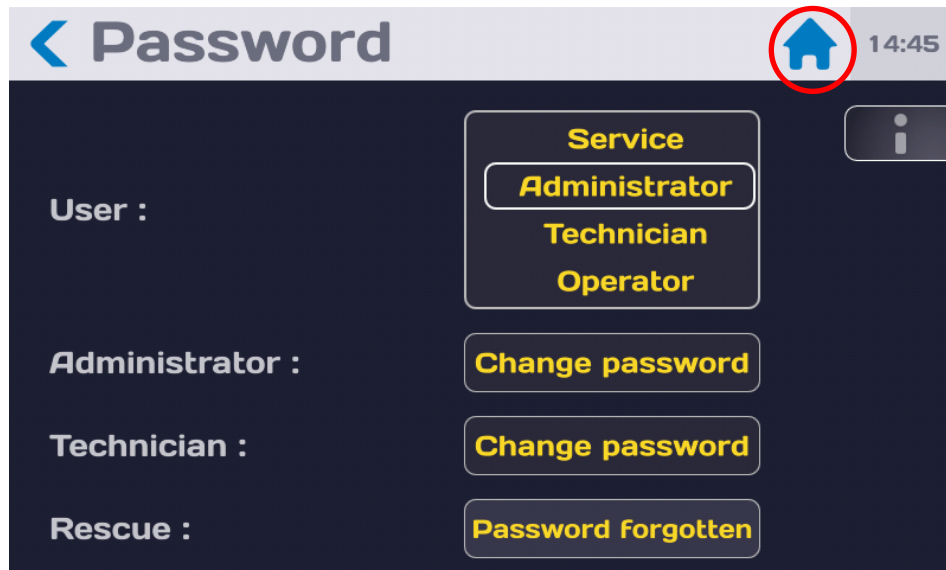
Validate the entry by pressing the character entry arrow. A new password entry screen will be offered to confirm your password.

Enter the same password, be careful it will not turn green.

Validate your entry, the following message will be displayed if the operation was successful:



Press OK to reach the following screen:



You are at an administrator level of the 5x series device which gives you access to all the functions allowing the use of the device.

To return to the start menu press the House icon.

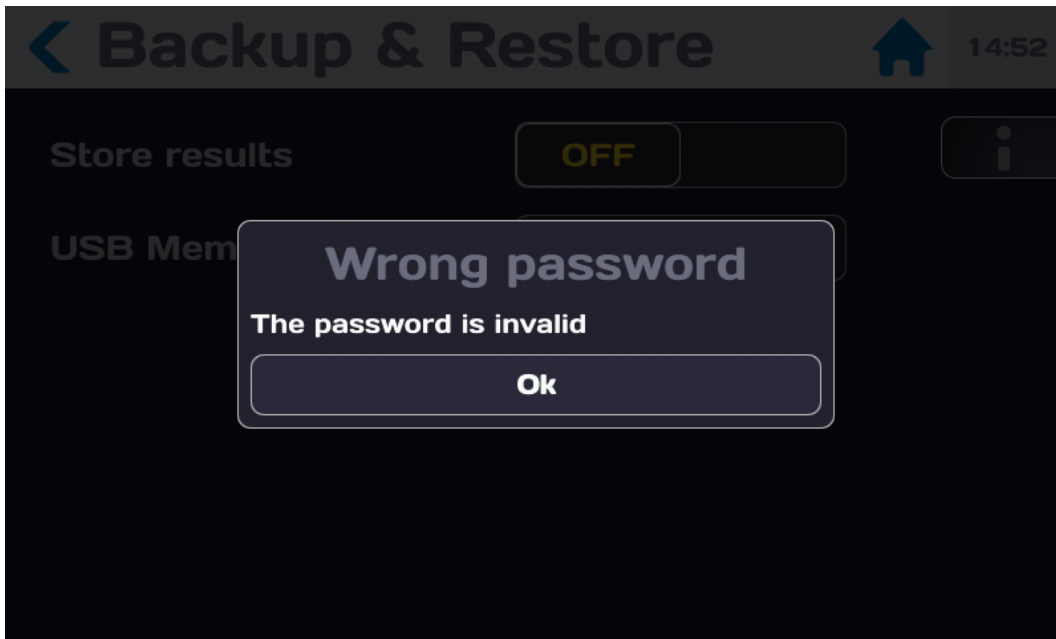


IMPORTANT

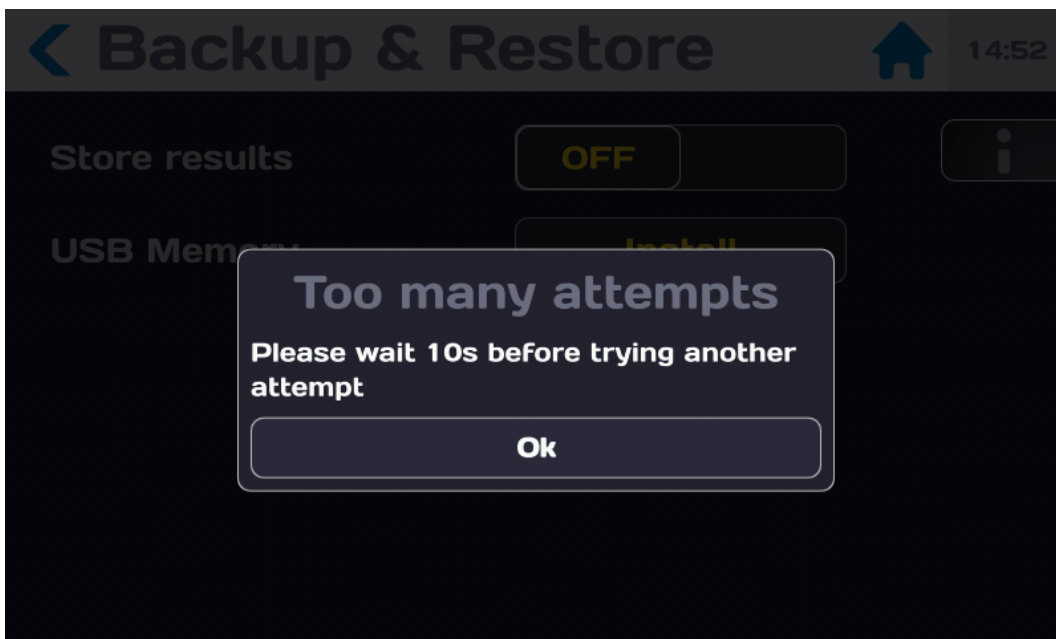
**Remember to keep passwords in a safe place.
In the event of loss, contact our after-sales service by following the procedure in paragraph 6.6.3.**

6.6.2. INCORRECT PASSWORD

If the password is entered incorrectly, the following message will be displayed:



After several incorrect attempts the following message will be displayed:



You will have to wait the time indicated between 2 password entries.

6.6.3. PROCEDURE FOR RECOVERING A FORGOTTEN PASSWORD

If the password is forgotten, it can be reset by following the following procedure:

Send an email to servicesefelec@eaton.com indicating:

- the device model (e.g.: Sefelec 56-H, etc.)
- the serial number of the device accessible in the menu:

GENERAL PARAMETERS

SYSTEM

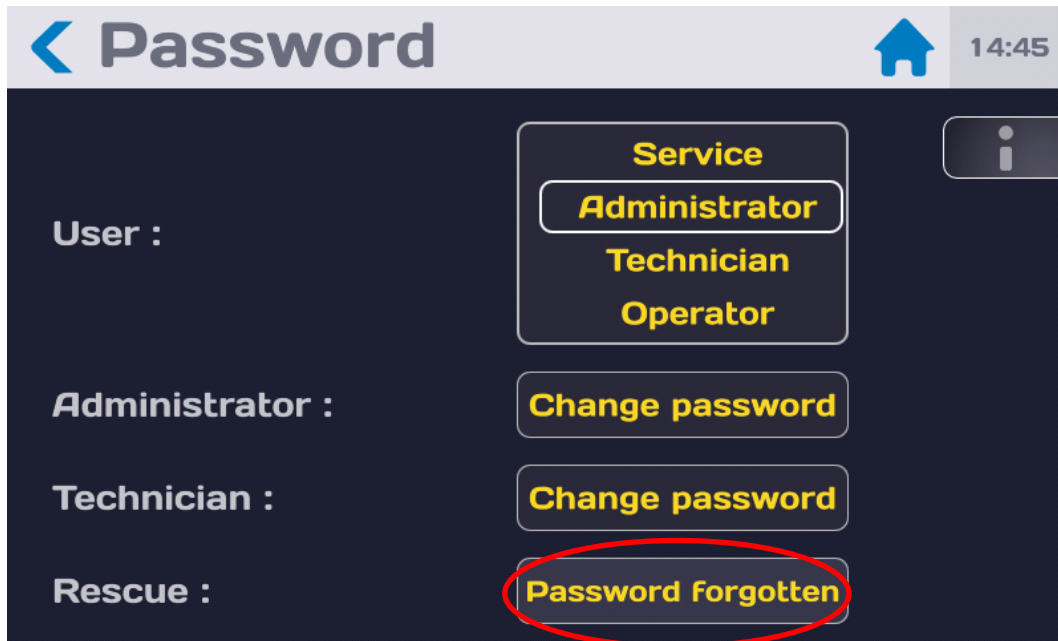
ABOUT

Serial number: 2149463

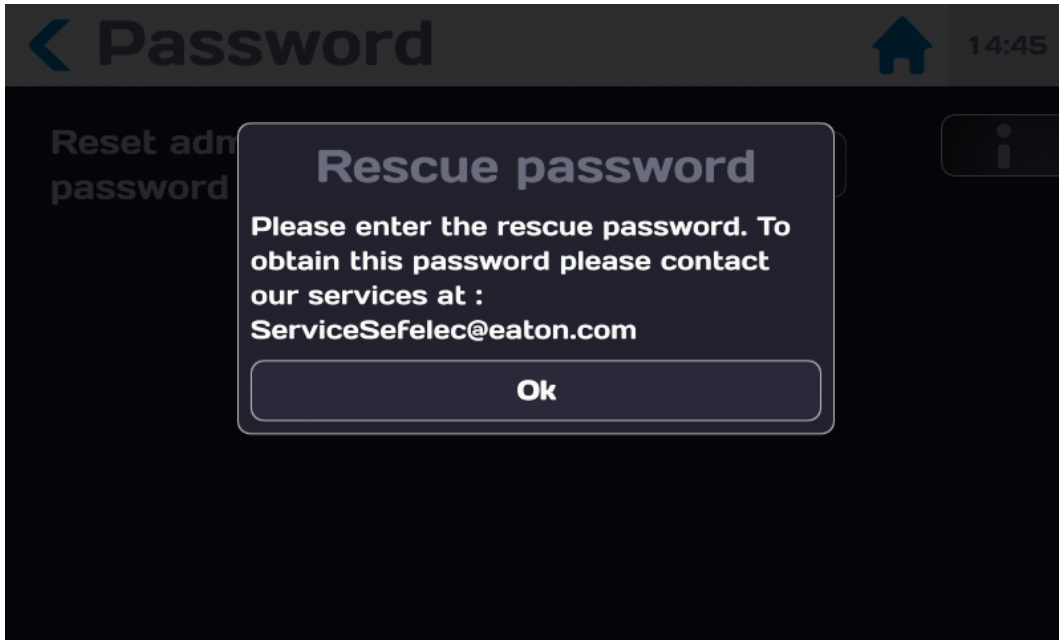
- your name
- the name of your company
- your phone number.

Upon receipt of your message and within 48 working hours, you will receive a code allowing you to reset your password.

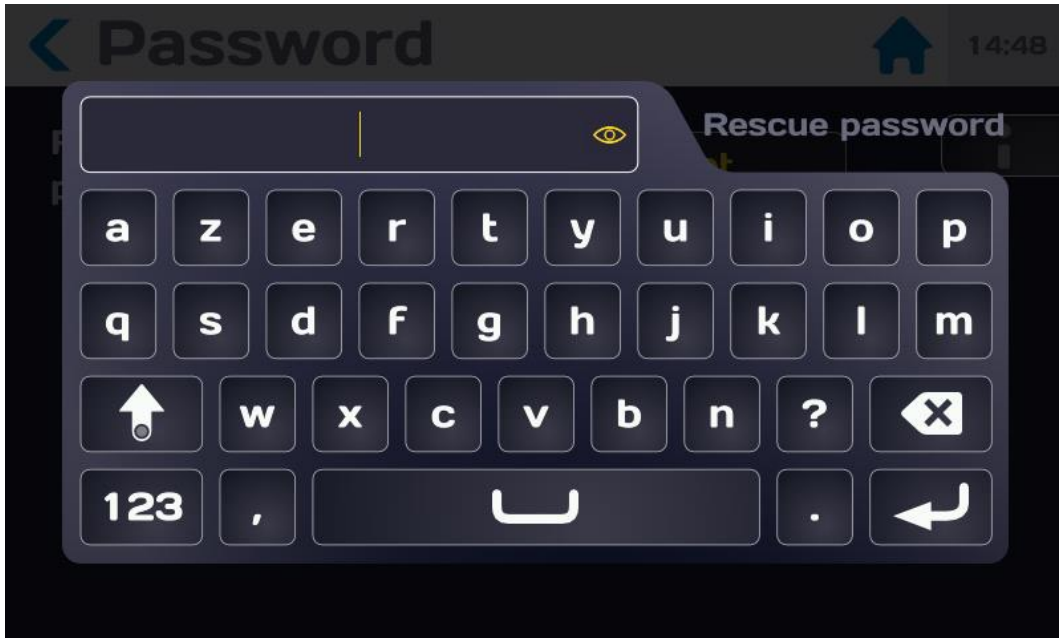
When you have received the new password, from the Password menu, press the active area of the line Help Forgotten password



Press on the active area Reset to validate the action.



Enter the rescue password with the keyboard:



A POPUP window asks you to confirm the reset, press the active area YES to continue or NO to stop the process. Enter a new password following the procedure described in paragraph 6.6.1

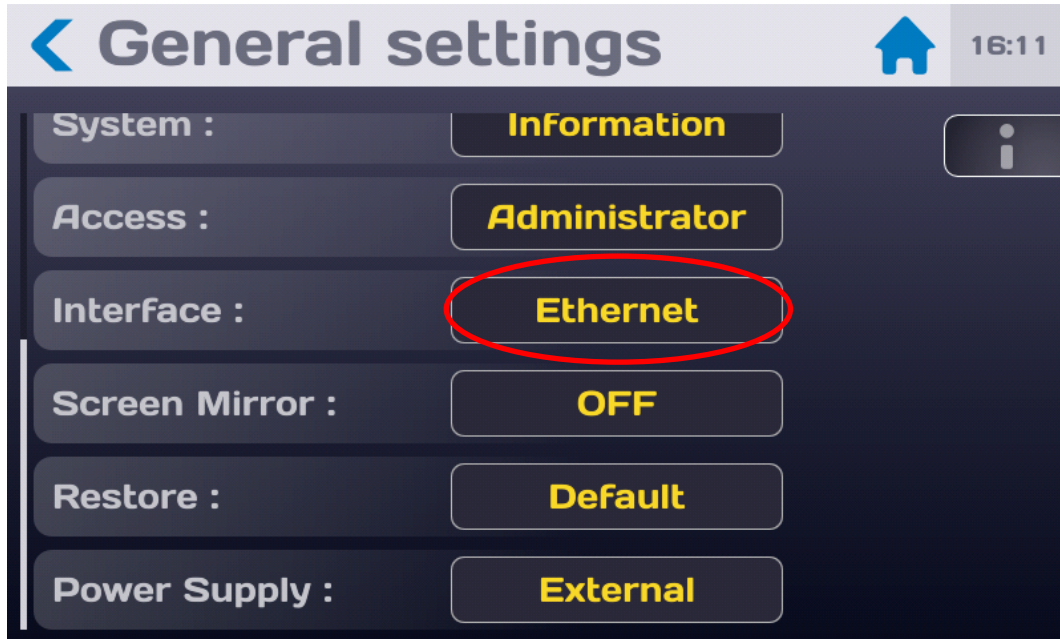


Remember to keep passwords in a safe place.

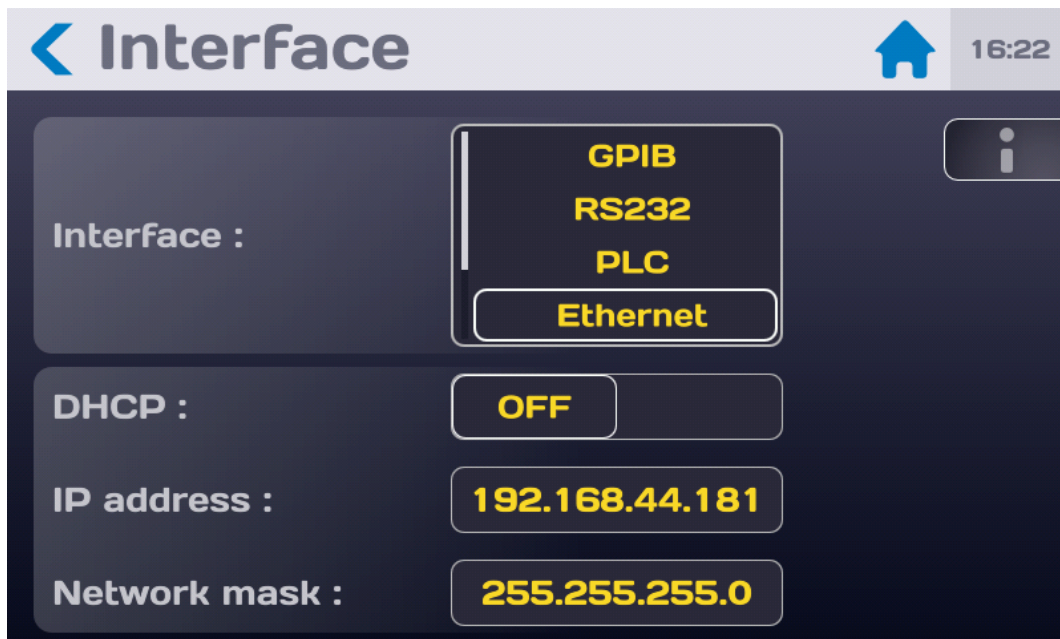
IMPORTANT

6.7. SELECTING THE TYPE OF INTERFACE

Scroll the general settings screen down to obtain the following screen:



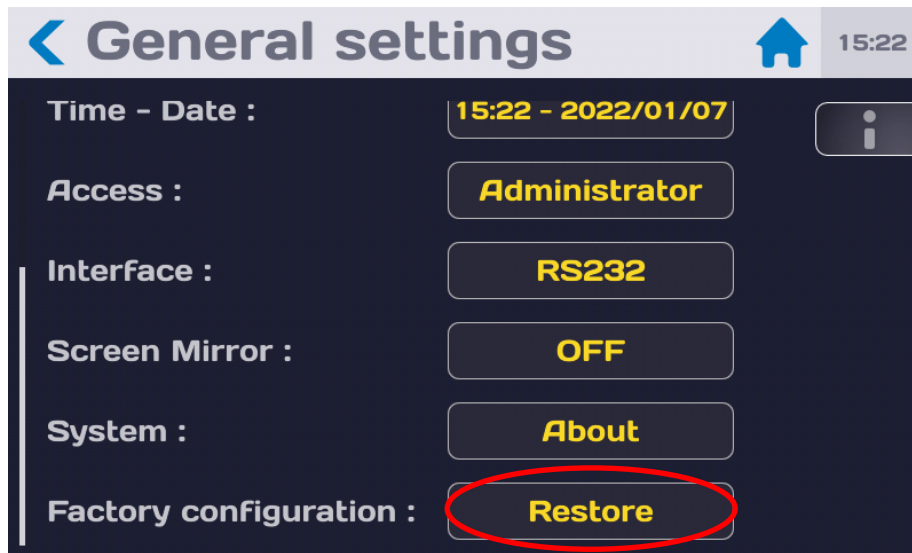
Press the selection area for the "Interface" line to obtain the following screen:



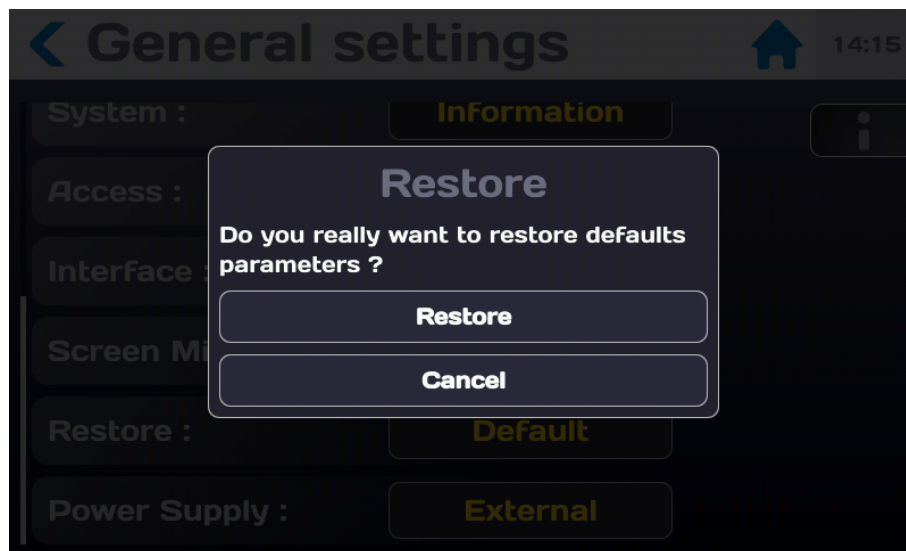
Select the desired type of interface and set the communication parameters according to the indications provided in the paragraph that describes the selected interface.

6.8. RESTORATION OF THE FACTORY SETTINGS

The device offers to restore the factory settings. This operation will erase all the files stored in the device. If you wish to keep them, follow the backup procedure with the instructions in paragraph 6.9.2. Scroll through the "General settings" screen downwards to obtain the following screen:



Press the active area of the "Factory configuration" line to display:

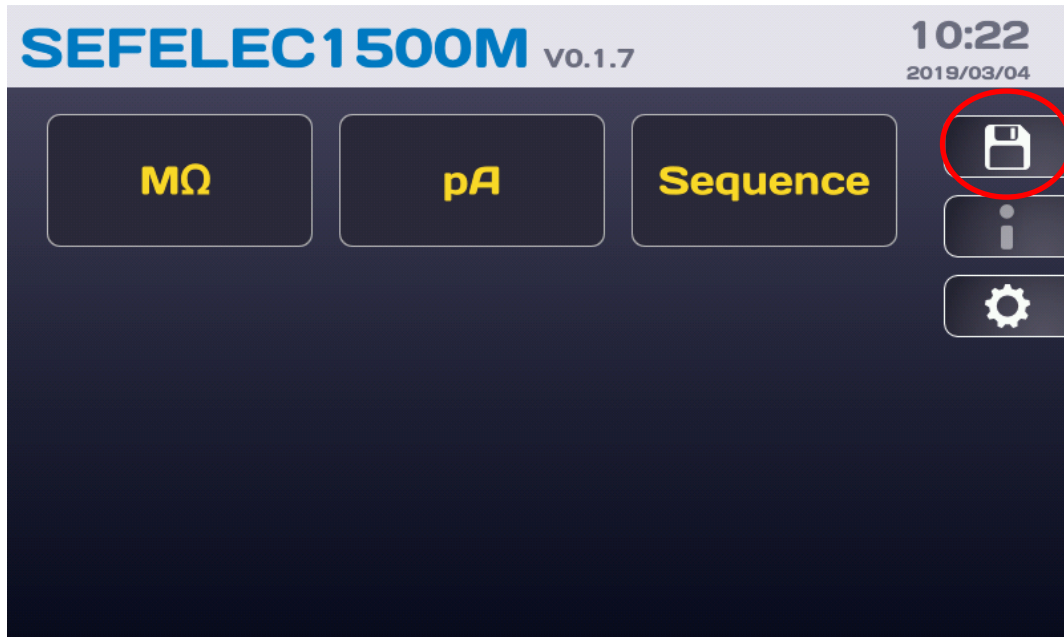


If you do not want to restore, press the "Cancel" key to restore, press the "Restore" key.

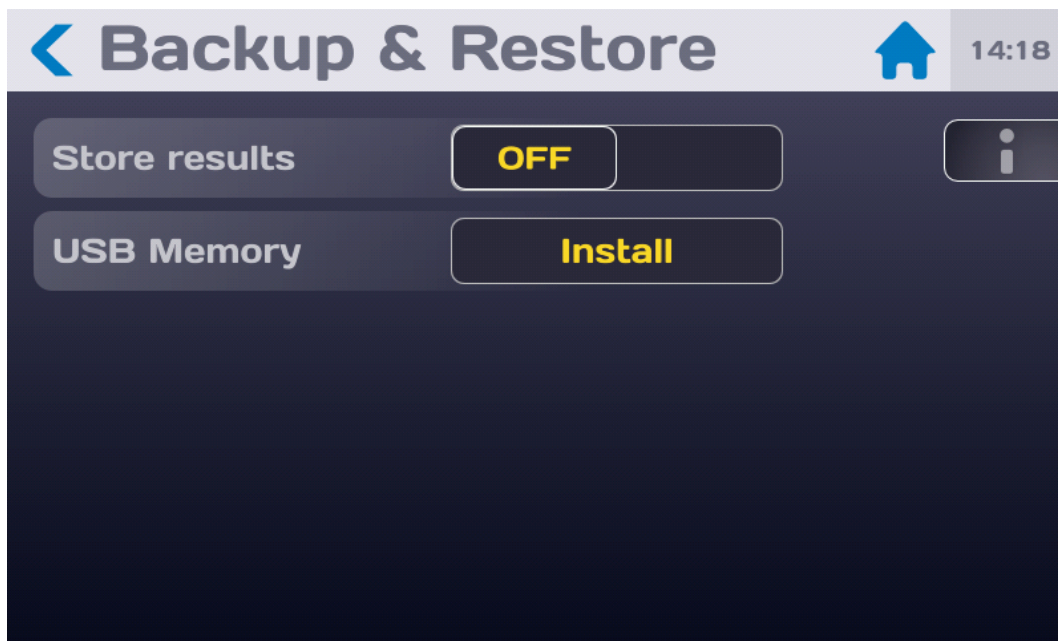
If the Password function is active, you will be asked to enter the Administrator password before authorizing the restoration of factory settings. At the end of the restoration of the factory settings, the device restarts and offers a choice of language and acceptance of the End User License Agreement as described in paragraph 5.4.

6.9. STORING THE RESULTS

In order to provide traceability for the measurements taken it is possible to save the test parameters as well as the measurement results to the internal memory of the device
To activate this function after turning on the device or returning to the start-up menu, when the home screen indicates:



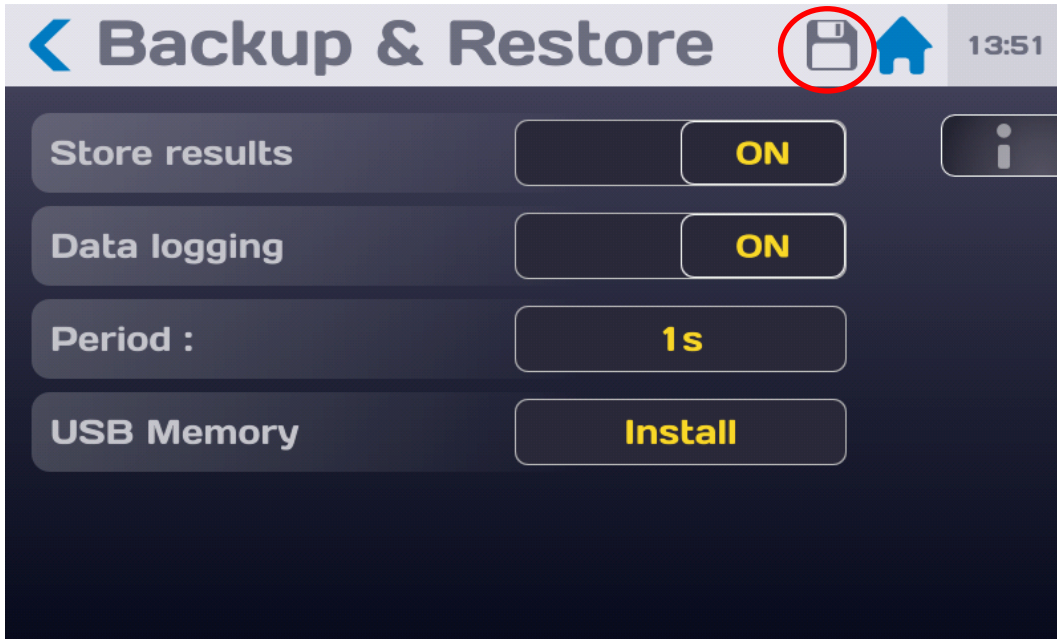
press the access button for the results storage menu (diskette)
The LCD screen then displays the following information:



Activate the saving of measurement results by pressing on the right of the Store results area, ON is displayed.

Deactivate the saving of measurement results by pressing on the left of the Store results area, OFF is displayed.

It is possible to activate an automatic measurement storage by defining a periodic time to store the measurement. Set the line data storage to ON and select a periodic time with 1 second step between 2 records:

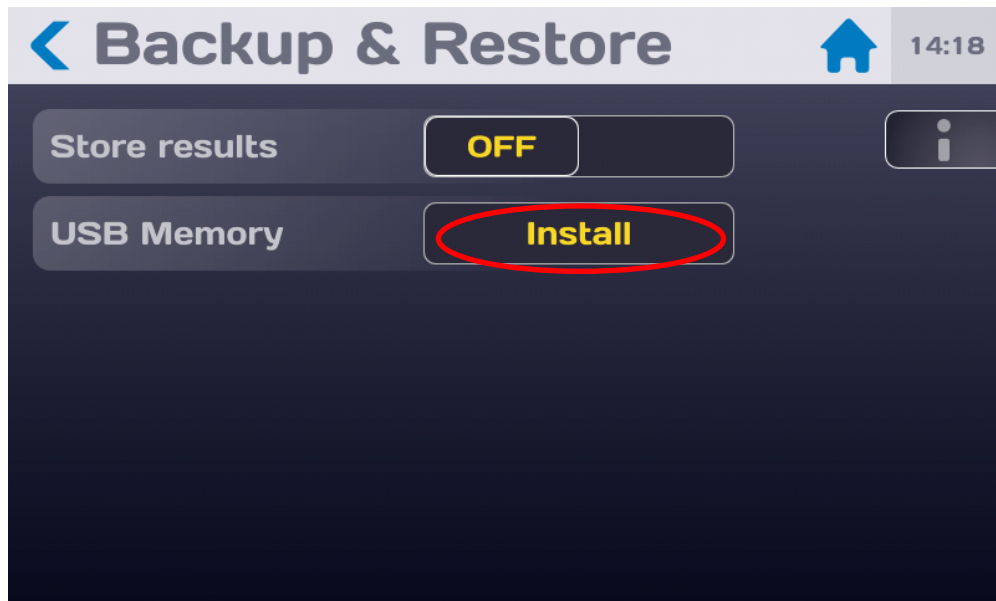


IMPORTANT

Do not activate this function if it is not used because the internal memory fills up with each measurement.

6.10. SAUVEGARDE DES FICHIERS SUR CLE USB

For the purpose of making a backup or to copy the settings from one device to another, it is possible to export and import the device settings files to a USB key. The measurement results stored in the device can also be exported to a USB key for archiving or processing. Connect a USB key to one of the USB ports available under the LCD screen.



Then press on the Install active zone of the USB Memory line, if the Password function is active, the entry of the Administrator password will be necessary to obtain the following display:



Choose the settings or measurement results for import/export on the USB key by pressing the active area of the corresponding line.

The LCD screen shows the following display:



Choose the file by pressing on its name and drag it from the Device column to the USB Key column or vice versa depending on the desired operation. A message confirming if the copy operation has been successful is displayed briefly.

Return to the previous menu by pressing at the top left on the icon: 

Proceed in the same way for the other settings files or measurement results files



NOTE

Settings files are saved with the extension .JSON

Measurement results files are saved in .CSV format

They can be read by an Excel spreadsheet, but they cannot be modified from Excel and then imported into a device.



IMPORTANT

Uninstall the USB key before removing it from the device and wait for the message authorizing the disconnection.

On the USB memory stick, there is a « horus_backup » directory with the following sub-directories :

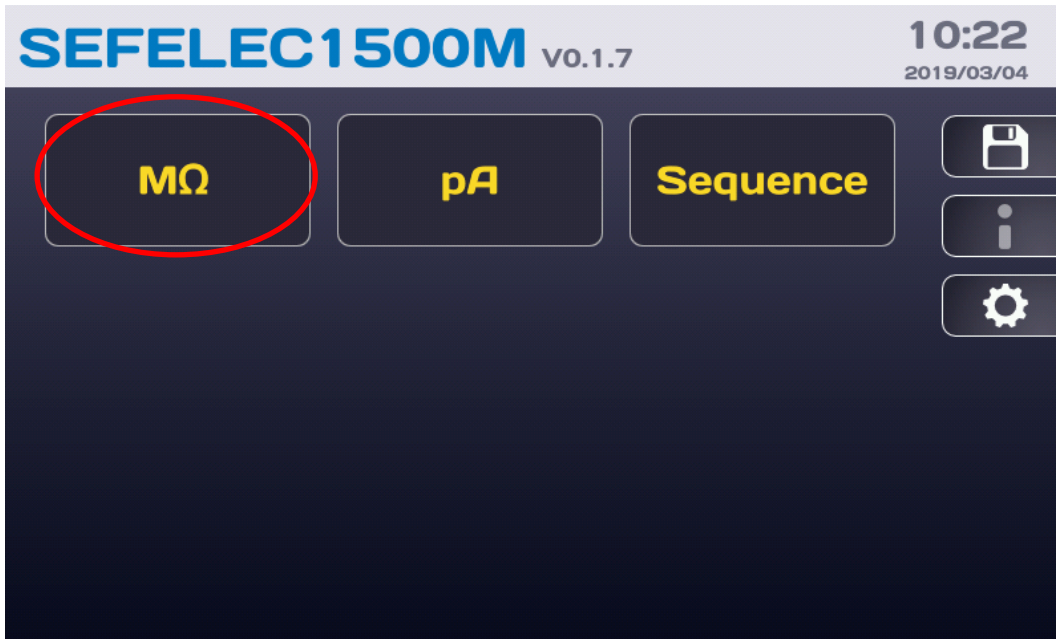
- ▼ horus_backup
 - > global
 - > megohmmeter
 - > picoammeter
 - > **sequence**

Select the required directory and open with EXCEL the CSV result file:

| | A | B | C | D | E | F | G | |
|----|----------------|----------------------------------|------------|----------|----------|---------------|-----|--|
| 22 | | | | | | | | |
| 23 | IDN: | EATON,SEFELEC1500M,1842466,0.1.7 | | | | | | |
| 24 | Parameters: | megohmmeter: file: isol-100 | | | | | | |
| 25 | START SEQUENCE | | | | | | | |
| 26 | | | | | | | | |
| 27 | Parameters: | Tension= | 1.000E+02 | V | Rmax= | 2.0000E+1 | Ohm | |
| 28 | | | | | | | | |
| 29 | START MEG | | | | | | | |
| 30 | Date | Time | VOLT | AMP | OHM | Result | | |
| 31 | 20/02/2019 | 16:33:45 | 2.590E+00 | 5.00E-13 | 0.0E+00 | | | |
| 32 | 20/02/2019 | 16:33:46 | 1.0000E+02 | 2.12E-11 | 4.72E+12 | | | |
| 33 | 20/02/2019 | 16:33:47 | 1.0010E+02 | 2.03E-11 | 4.94E+12 | | | |
| 34 | 20/02/2019 | 16:33:48 | 0.000E+00 | 0.0E+00 | 0.0E+00 | | | |
| 35 | 20/02/2019 | 16:33:48 | 0.000E+00 | 0.0E+00 | 0.0E+00 | BON | | |
| 36 | END MEG | | | | | | | |
| 37 | | | | | | | | |
| 38 | 20/02/2019 | 16:33:48 | | | | Sequence PASS | | |
| 39 | | | | | | | | |
| 40 | END SEQUENCE | | | | | | | |

7. CONFIGURING THE INSULATION RESISTANCE MEASUREMENT

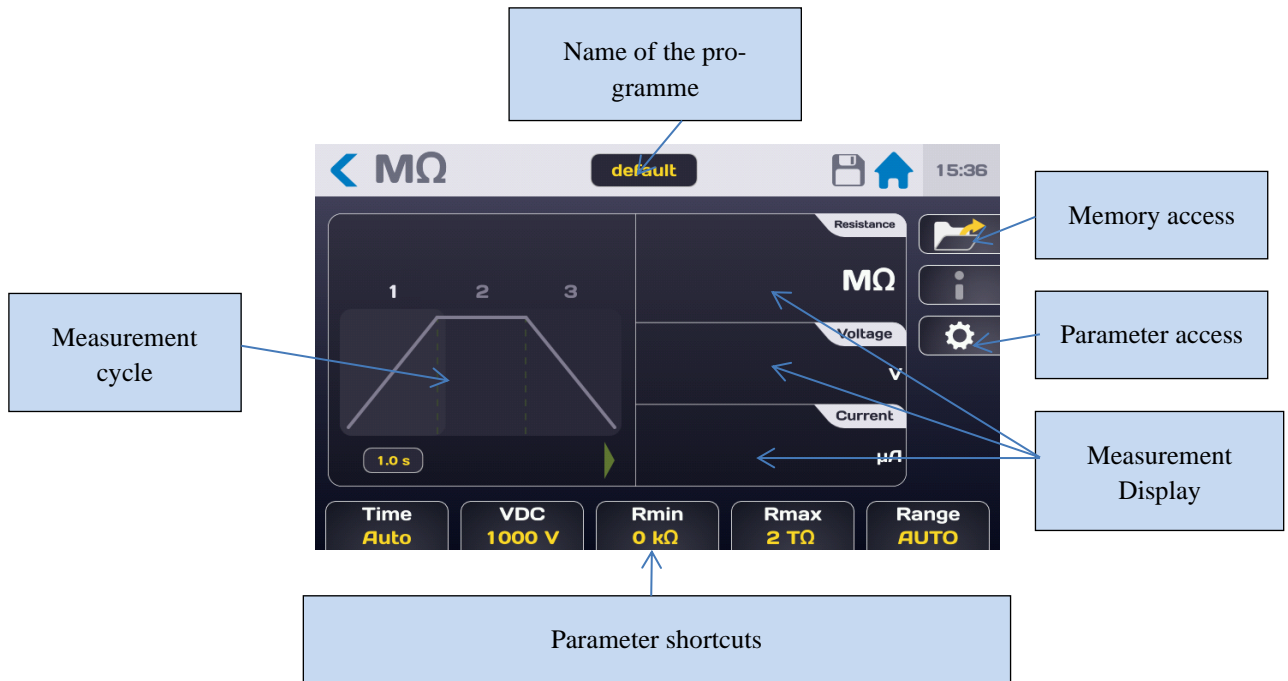
After turning on the device or returning to the start-up menu, the home screen indicates:



press the **MΩ** button to access the following measurement screen:



Description of the measurement screen:



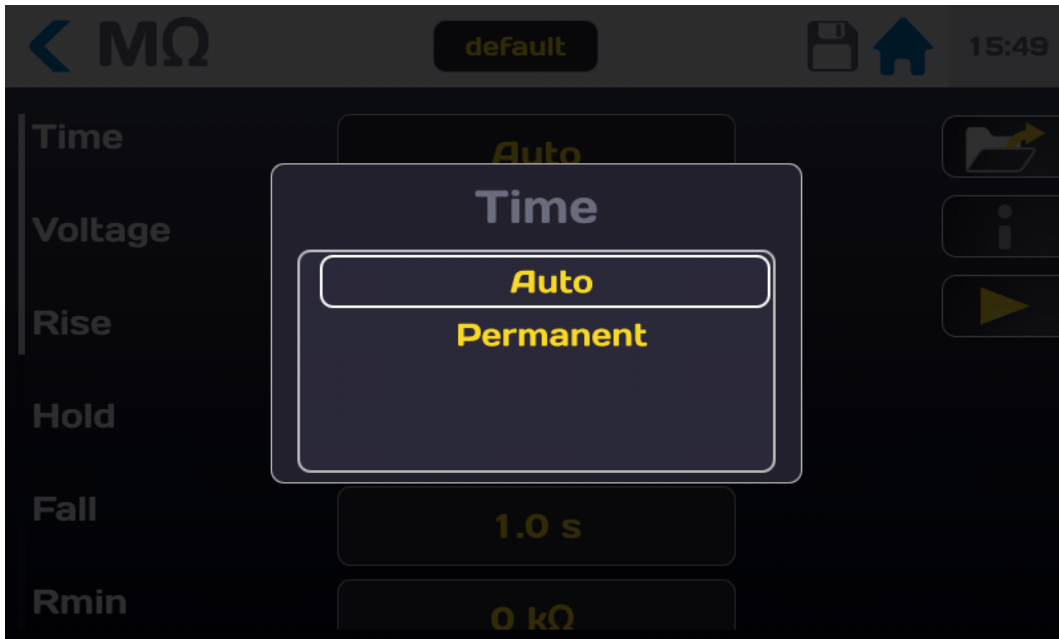
The measurement is displayed over 3 screens (Current, Voltage, Resistance) of which the order can be changed by pressing one of the 3 areas. Access to the measurement parameters can be done from the shortcut buttons located at the bottom of the measurement screen or from the button with the gear icon which displays the following menu:



Choose the parameter to be modified by pressing the active area (yellow) of the line of the parameter.

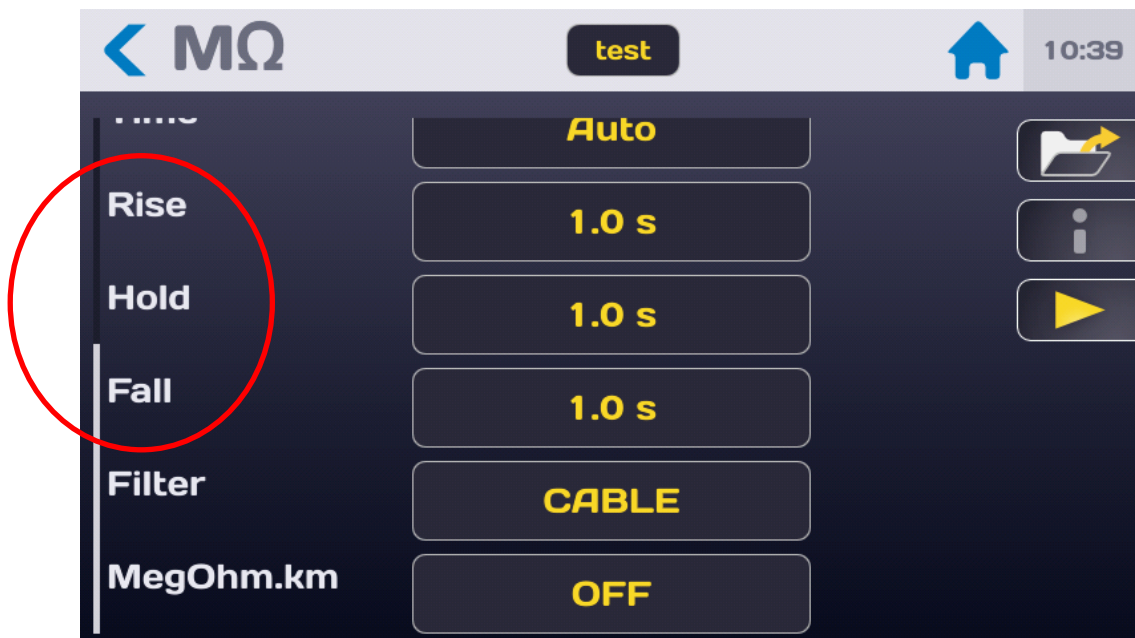
7.1. SETTING THE MEASUREMENT TIME

To change the measurement time, press the active area of the "Time" line to obtain:



The Permanent mode does not use the internal timer of the device and the measurement will be taken by pressing the START push-button until the STOP push-button is pressed.

To use the internal timer select AUTO mode and set the Rise, Hold and Fall times from the configuration menu (values between 0.1 and 9,999 sec.):



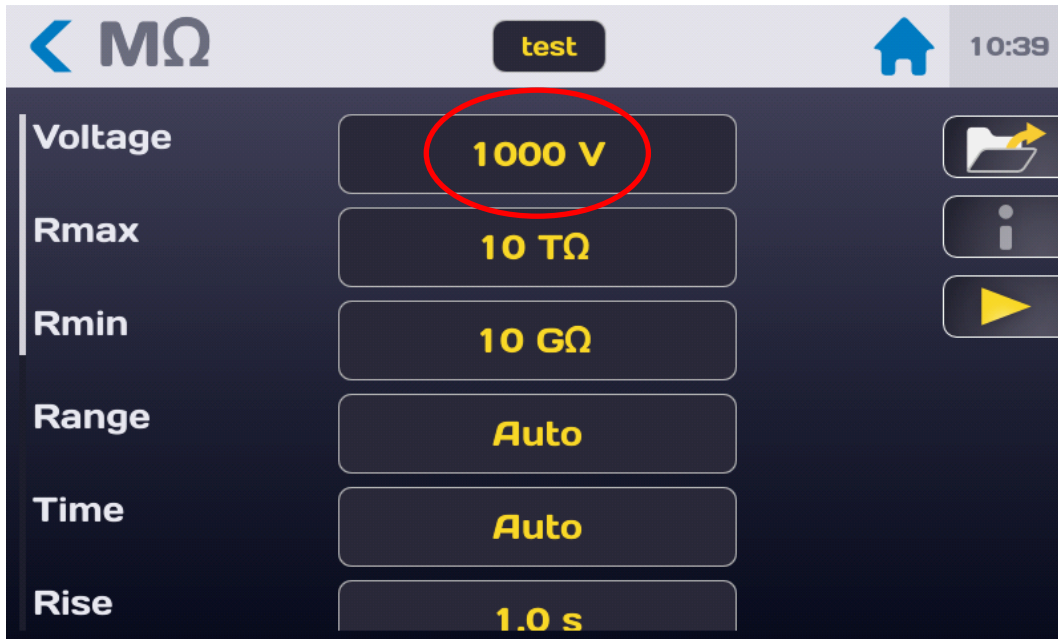
To set one of the measurement cycle times, press the active area of the corresponding parameter line:



Enter the value of the time in seconds: if the value entered is outside of the minimum and maximum limits it will be displayed in red. Press the Arrow validation button to confirm the entry and return to the configuration menu.

7.2. SETTING THE MEASUREMENT VOLTAGE

From the configuration menu or from the Voltage shortcut button at the bottom of the measurement screen, press the active area of the Voltage line:



To obtain the following screen:



Enter a voltage value between 1 and 1,500 VDC, if the value entered is outside of the authorised limits it will turn red. Press the Arrow validation button to confirm the new value and return to the previous menu.

7.3. SETTING THE COMPARISON THRESHOLDS

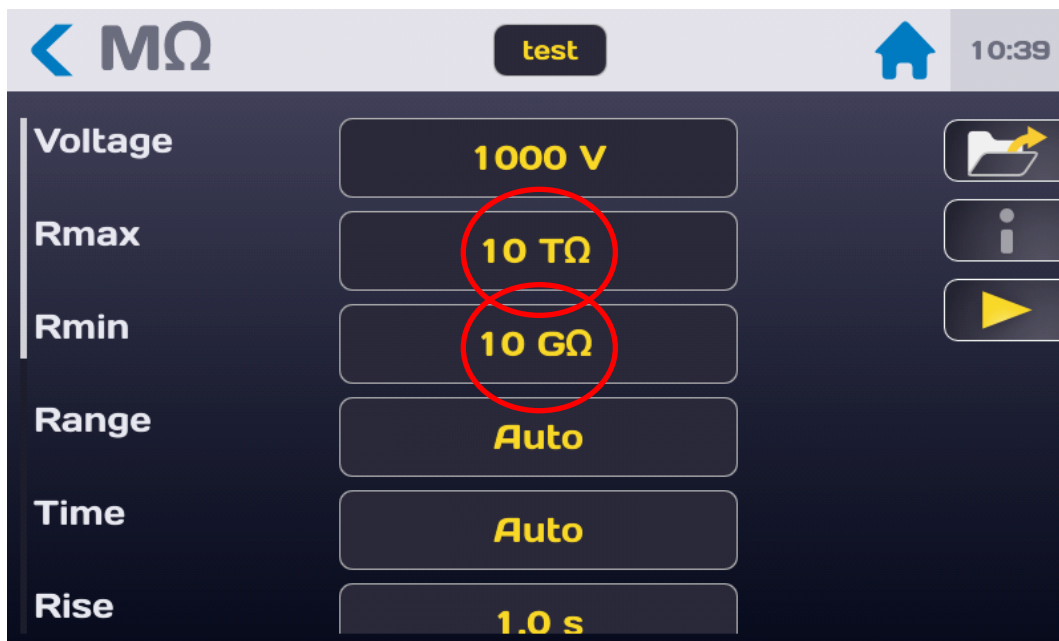
The device offers two comparison thresholds Rmin and Rmax.

The main threshold for insulation resistance measurement is the Rmin threshold, if the resistance measured is less than the Rmin threshold the result is FAIL, if the resistance measured is greater than Rmin the result is PASS.

The Rmax threshold makes it possible if needed to detect an incorrect connection on the tested sample which would then have an abnormally high insulation resistance value.

The value of Rmax must always be higher than the value of Rmin.

To access the settings for Rmin and Rmax scroll the insulation parameters screen to display:



And press the active area of the threshold to be modified in order to obtain the following key-entry menu:



Enter the threshold value by using the Tera, Mega, Giga or kilo Ω units.

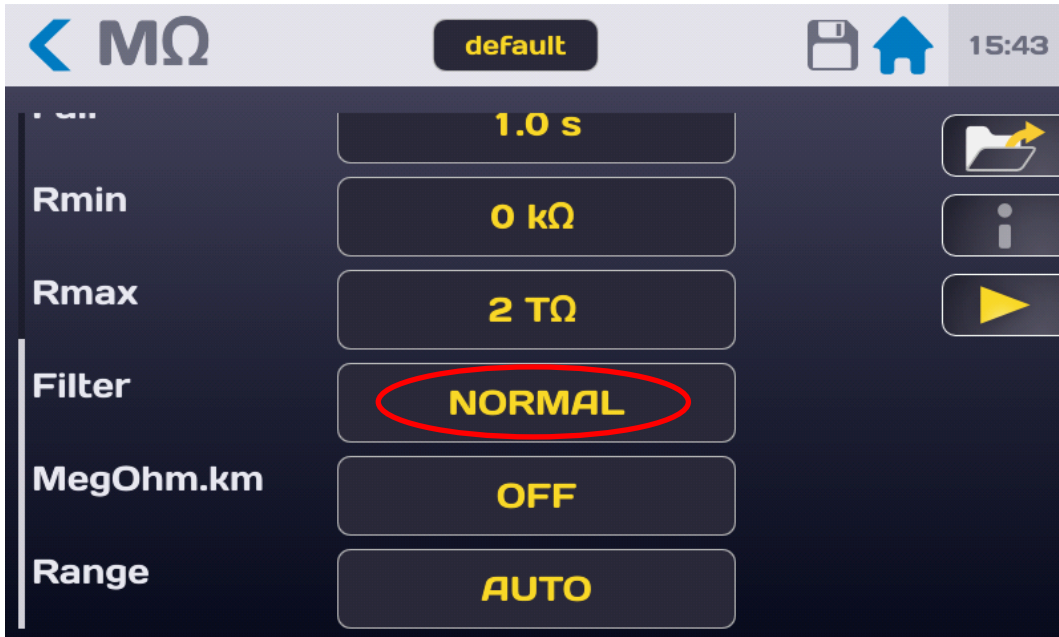
If the value entered is outside of the limits, it turns red. Confirm the threshold by pressing on the key-entry arrow.

Continue in the same way to set the other threshold.

7.4. SELECTING THE FILTERING MODE

The SEFELEC1500M offers various filtering modes that make it possible to stabilise the measurement according to the components and the measuring environment.

Press the active area of the "Filter" line to select the mode that is best suited:



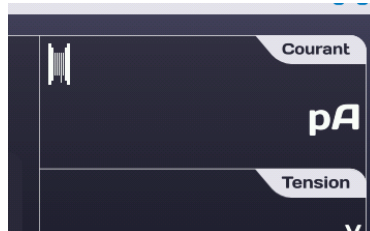
To display the various modes like this:



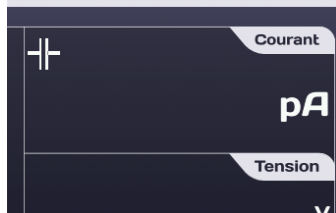
The device proposes three measurement speeds and two measurement configurations for capacitive circuits:

- **NORMAL**: 5 measurements are averaged for each display with 3 displays per second
- **SLOW**: 15 measurements are averaged for each display with 1 display per second.
- **FAST**: 1 measurement for each display with 10 displays per second.
- **CABLE** and **CAPACITOR**: these measurement modes have the same speed characteristics as in normal mode but they make use of analogue and software processing in order to allow for stable measurements on highly capacitive circuits.
 - In both **CABLE** and **CAPACITOR** modes the measurement range will be limited from 0.010 nA to 20.00 mA
 - Selection of the **CABLE** or **CAPACITOR** modes is indicated by a cable reel or a capacitor symbol in the main measurement window left hand side corner.

CABLE icon:



CAPACITOR icon:



- The **CABLE** mode is more particularly intended for capacitance measurements in disturbed environments (cable reels, machines in workshops, etc.).
- The **CAPACITOR** mode is intended for measurements on capacitive components in the laboratory environment. In this mode, the automatic searching range function will start from the 20mA to the 2nA ranges but it will not go back unless a short-circuit on the high voltage generator output. It is mandatory to go in discharge mode by pressing the STOP button before disconnecting the DUT.

7.5. SELECTING THE MEGOHM PER KILOMETER MODE

The SEFELEC1500M proposes to indicate cable resistance values expressed as insulation per kilometre, with this formulation generally being that specified in the manufacturer's specifications or the standards. Cables can be comprised of several independent conductors connected together in parallel for the measurement and the device will recalculate the value for 1 conductor.

The insulation value displayed is the result of the following calculation:

$$R_{\text{displayed}} = (R_{\text{measured}} \times \text{Length in metres} \times \text{Number of wires}) / 1,000$$

Press the active area of the "Megohm.km" line to activate and configure this mode:



Activate or deactivate the Megohm.km mode by selecting ON or OFF.

Then enter the cable length in metres and the number of cables in parallel.

For example:

A cable 100 metres long with 5 conductors in parallel gives an insulation value of 500 MΩ in normal mode.

If the Megohm.km function is activated we then obtain a displayed value of:

$$R_{\text{display}} = (500 \text{ M}\Omega \times 100 \text{ m} \times 5) / 1,000 = 2,500 \text{ M}\Omega.\text{KM} = 2.5 \text{ G}\Omega.\text{KM}$$

7.6. SELECTING THE MEASUREMENT RANGE

The SEFELEC1500M has an automatic measurement range search mode.

This is the most practical operating mode for the user. It is however possible in the case where it is sought to increase the rapidity of the measurement to block the device in a range (range change time: 150 msec. per range)

Press the active area of the "Range" parameters line:



Select the resistance range, the max. value indicated is equal to: Voltage / Imin and the min. value is equal to Voltage / Imax.

With the following current ranges:

| N° | Range | N° | Range | N° | Range | N° | Range |
|----|----------|----|----------------|----|-----------|----|-----------|
| 0 | AUTO | 3 | 20-200 μ A | 6 | 20-200 nA | 9 | 20-200 pA |
| 1 | 2-20 mA | 4 | 2-20 μ A | 7 | 2-20 nA | 10 | 2-20 pA |
| 2 | 0.2-2 mA | 5 | 0.2-2 μ A | 8 | 0.2-2 nA | | |

In example, resistance ranges for a voltage of 100 VDC:

| N° | Range | N° | Range | N° | Range | N° | Range |
|----|--------------------------------|----|--------------------------------|----|--------------------------------|----|-------------------------------|
| 0 | AUTO | 3 | 500 k Ω – 5 M Ω | 6 | 500 M Ω – 5 G Ω | 9 | 500 G Ω – 5 T Ω |
| 1 | 5 k Ω – 50 k Ω | 4 | 5 M Ω – 50 M Ω | 7 | 5 G Ω – 50 G Ω | 10 | 5 T Ω – 50 T Ω |
| 2 | 50 k Ω – 500 k Ω | 5 | 50 M Ω – 500 M Ω | 8 | 50 G Ω – 500 G Ω | | |

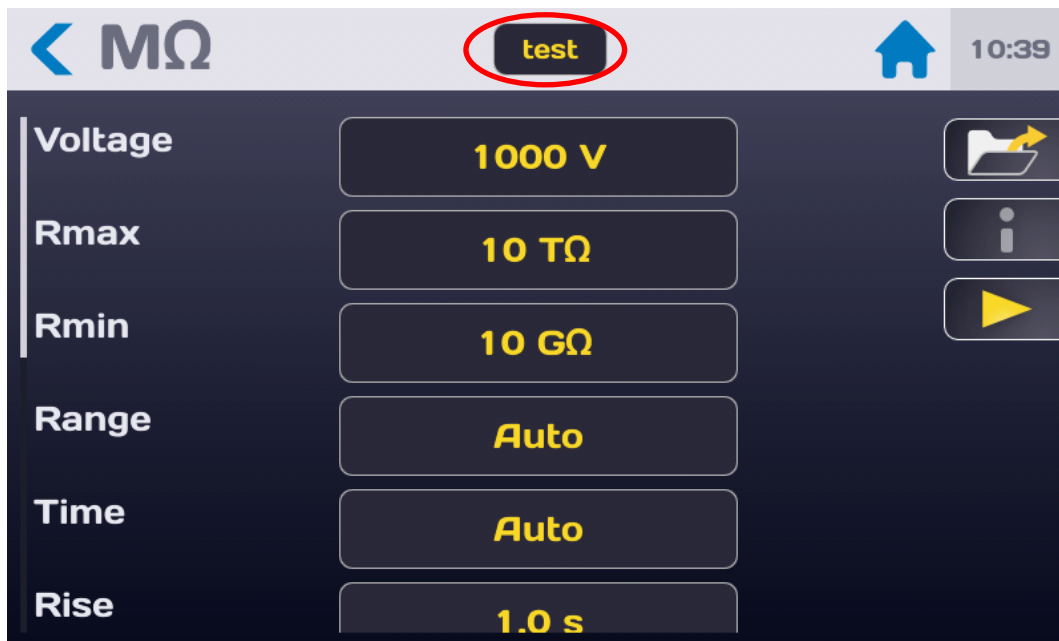
Below the min. value the display will indicate a "**UNDER RANGE**" message and - - - -

Beyond the max. value, the display will indicate a "**OVER RANGE**" message and will take correct measurements up to 10 times the maximum value of the range.

7.7. SAVING THE MEASUREMENT PARAMETERS UNDER A FILE NAME

All of the insulation resistance measurement parameters can be saved under a filename which will make it possible to find the configuration easily.

After having set all of the parameters the latter are found under the filename mentioned in the zone herein below:



To change the filename press the area with the filename in order to display a virtual keyboard and enter the new name.

Spaces are not allowed in the filename, use the dash (-) or underscore (_) as a separator.

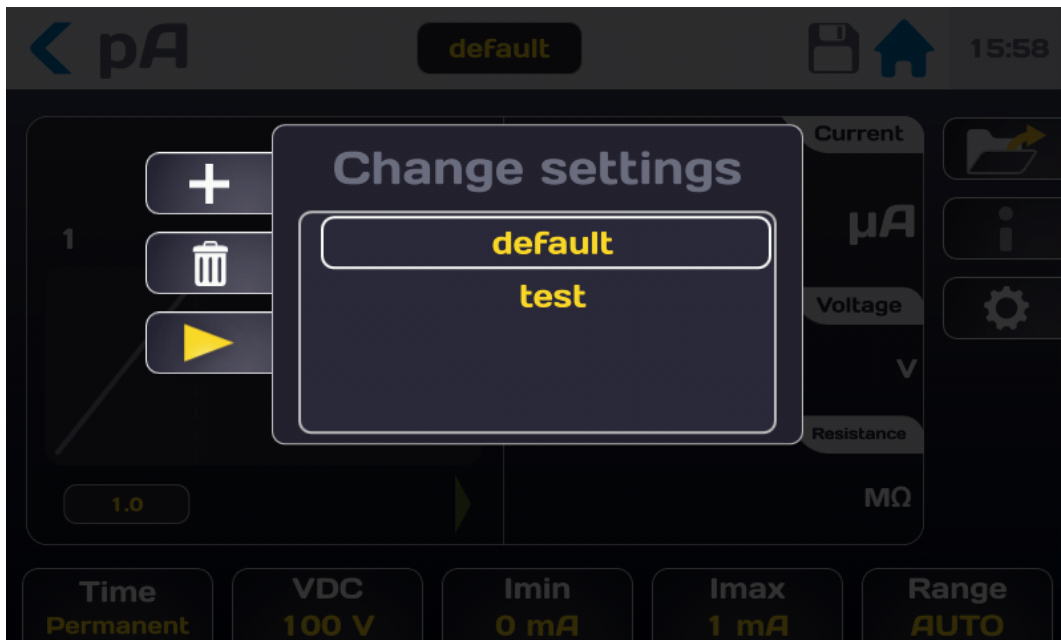
The special characters @, €, £, \$, &, μ, (), {}, ... are not allowed in filenames. The filename can comprise at most 50 characters.

When confirming, you are allowed to keep the old file and duplicate it or to rename the file without keeping the original version.

To recall a filename press the function button with the folder icon:



To obtain the following screen:



Search for the filename by scrolling up or down in the list of files. Press the desired filename then press outside of the file list display area or on the button with the yellow Arrow.

This window also allows you to delete a filename. Select the filename to be deleted then press the button in the shape of a Trash bin. A deletion confirmation window is displayed, confirm or cancel the deletion.

From this window it is also possible to create a new file with the + button which generates a file which self-increments from a file named: file1



WARNING: any modification of a parameter of a file is automatically saved in the file

NOTE

8. INSULATION RESISTANCE MEASUREMENT

8.1. CONNECTING THE COMPONENT TO BE MEASURED



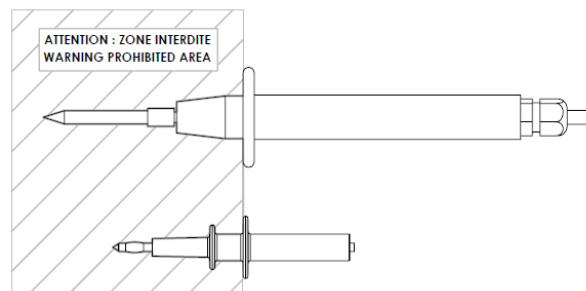
WARNING

Danger of electric shock!

WARNING: The accessories must only be handled by qualified personnel.

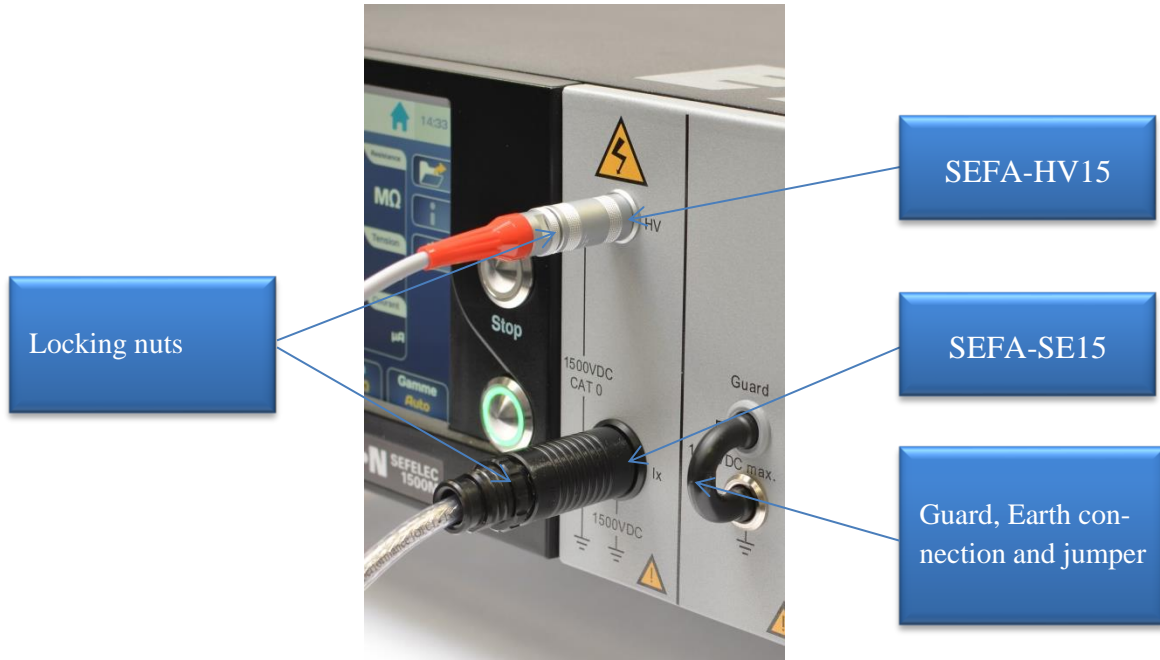
Essential recommendations for user safety:

- **Use accessories with the device or devices provided only. The operator safety and the proper operation of the equipment used depend on the compliance with this rule.**
- **Do not attempt to modify an accessory.**
- **The measurement accessories may contain elements limiting and protection it is forbidden to modify them without written permission of the company SEFELEC-EATON.**
- **In the case of use in conditions other than those specified in the manual of the device, potential risks may occur for the safety of the user.**
- **ALWAYS follow safety rules relating to the use of high voltage equipment**
- **Do not touch the metal tip of an accessory when connected to a device.**
- **Do not use accessory poor, incomplete or defective.**
- **Comply with the conditions of use specified in the manual of the associated measuring devices.**
- **Do not use an accessory to replace another just because it looks like another to another. Each accessory is designed for a specific use and in strict association with a measuring device.**
- **Never be several people manipulating a same accessory**



Connect the measuring lead SEFA-SE15 to the **Ix** terminal provided for this purpose, the lead is locked by inserting the plug until it clicks. Continue in the same way with the lead SEFA-HV15 on the **HV** terminal.

WARNING: connectors are equipped with locking nut to avoid unwanted disconnection. If necessary screw the nut and unscrew the nut to allow terminal removing.



For measurements with the guard potential connected to the ground, leave the black jumper isolated on the front panel. For floating measurements or with High Voltage connected to the ground remove the jumper and use a cord of the laboratory type with safety banana plugs of a diameter of 4 mm to connect the guard to the guard planes of the measurement mounting.



Risk of electric shock!

In the case where the High Voltage is connected to the ground the guard potential will be brought to - Utest (maximum value of 1,500 VDC)

To disconnect the measurement leads, unscrew the locking nut, grasp the plug of the accessory by its striated ring and pull to take the plug out of the terminal.

8.2. PRECAUTIONS TO OBSERVE DURING A MEASUREMENT:

To take a resistance measurement beyond a Teraohm, use an effective shielding connected to the guard terminal (grey terminal on the front panel for a floating measurement or ground terminal on the rear panel for a measurement with the guard connected to the ground). Erroneous measurements due to the presence of parasitic leakage currents or to introductions of mains fields are as such prevented.

The proximity of an operator bringing his hand close to the tested sample can distort the measurement. Care should be taken not to wear nylon lab coats and to avoid insulating objects which may create high static electricity fields which could affect the operation of the device at very low levels of current. A measurement of 10 Teraohm under 10 volts corresponds to a measurement of a current of 1 pA.

When measuring capacitive circuits (use the CABLE or CAPACITOR mode, chapter 7-4) never take measurements by decreasing the voltage measurement at each test but always by increasing it; the phenomena of hysteresis and polarisation presented by the dielectric would distort the results. In this case the device will tend to indicate the maximum and will take a long time to fall to the real value to be measured.

Never disconnect a capacitive sample without switching to DISCHARGE mode with the STOP push-button and waiting for the time required for the capacitance of the sample to discharge into the 2.2 kΩ resistor of the discharge circuit.

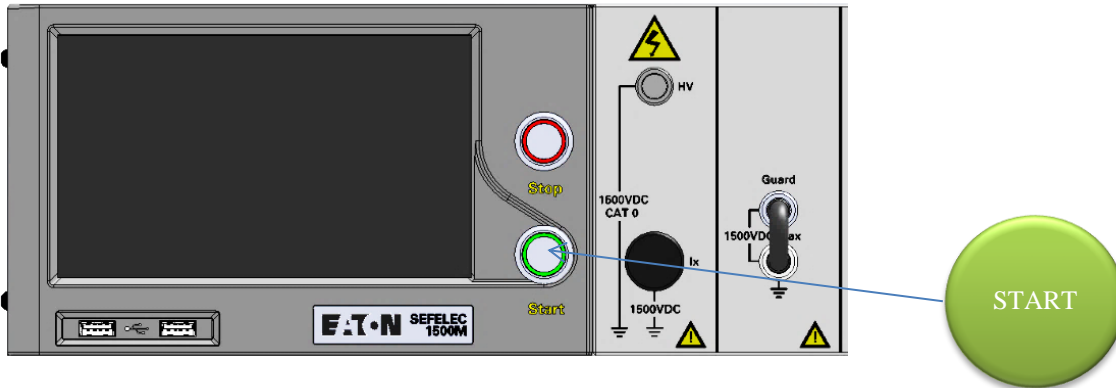
After connecting the component to be measured with the precautions described hereinabove and selecting the required measuring parameters, return to the measuring screen hereinbelow:





NOTE

Press the START push-button. For safety reasons, it is necessary to press for a time > 1 second in order for the device to switch to MEASUREMENT mode, in the event the pressing is too short an information message will be displayed briefly on the LCD screen.



The measuring cycle unfolds according to the rise, hold and fall time with the following screen:



| Display | Rise | Hold | Fall | End of test |
|------------|------|------|------|-------------|
| Voltage | yes | yes | yes | no |
| Current | yes | yes | yes | no |
| Resistance | no | yes | no | yes |
| PASS/FAIL | no | no | no | yes |

At the end of the test the display indicates the last value measured before the falling of the voltage and if the measurement is between Rmin and Rmax, i.e. considered as PASS.



If the measurement is < Rmin or > Rmax, it will be considered as FAIL:

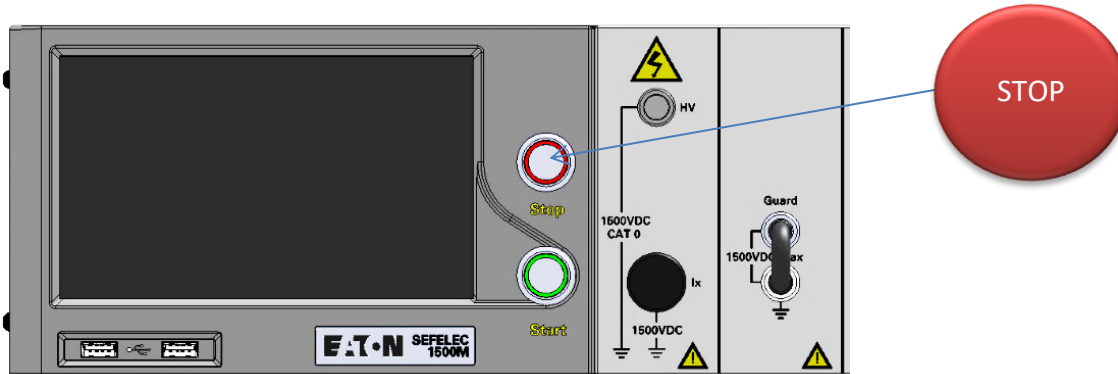


The coloured parameter shortcut button will indicate the parameter which causes the FAIL result for the measurement.



IMPORTANT

Before disconnecting the measured component, press the **STOP** push-button to confirm the stopping of the High Voltage generation and discharge the component: the device then checks the residual voltage down to a value of 30VDC



This action makes it possible to return to the initial measuring screen either to change the parameters or to run another measurement by pressing the **START** push-button.

8.3. ERROR MESSAGES:

- **"SAFETY LOOP WAS OPENED"**: the safety loop is not closed, there is no connection between the points 1-9 or 2-10 of connector C5 on the rear panel of the device. Front panel START and STOP pushbuttons are not illuminated. Press OK to acknowledge the message and check the safety loop connection

- **"OVER RANGE"**: the insulation resistance of the sample being tested is greater than the measuring possibilities of the device ($> 2,000 \text{ T}\Omega$) or of the measuring range in manual mode.

- **"UNDER RANGE"**: the insulation resistance of the sample being tested is less than the measuring possibilities of the device ($< 100 \Omega$) or of the measuring range in manual mode.

- **"CHARGING...."**: the measurement voltage has not reached its final value. The voltage generator charges the capacitor of the sample being tested. This message must appear in a fleeting manner when switching to Measurement mode. If the message persists, this means that the measurement voltage requested cannot be supplied to the resistance measured.

Check with respect to the characteristics of the voltage generator.

- **"VOLTAGE ERROR"**: when a measurement time is defined, if during the test the message **"CHARGING..."** is constantly displayed, at the end of the measurement time the test will be declared as FAIL and the **"VOLTAGE ERROR"** message will indicate the cause of it.

If needed see the information on the message **"CHARGING..."**



IMPORTANT

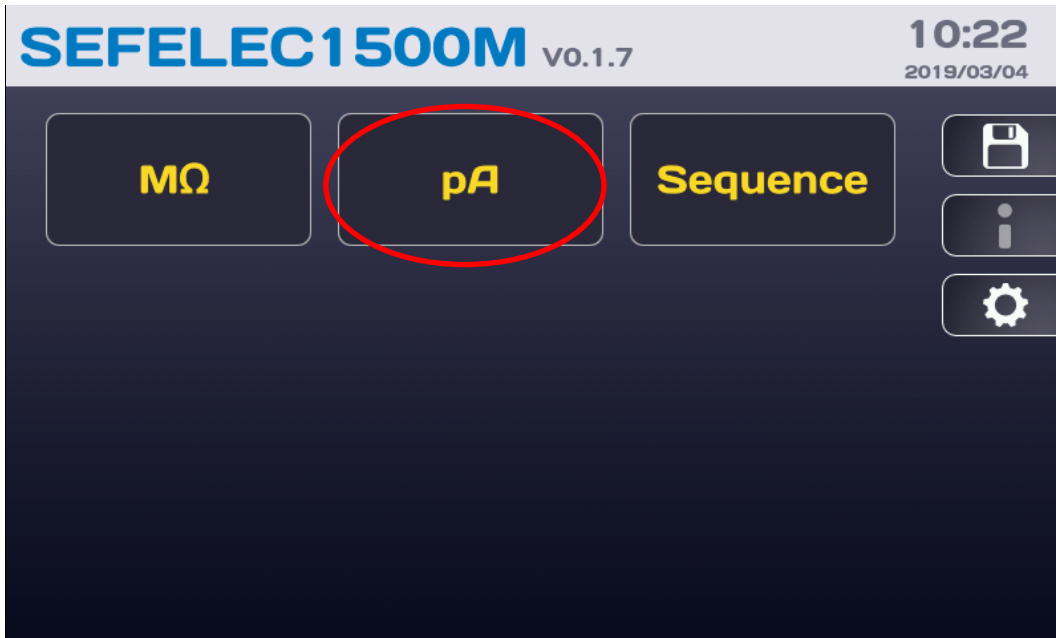
The device is equipped with a thermal protection system. In case of prolonged use of the High Voltage generator on a short circuit, the protection system will be activated.

In this case the message **"OVERHEAT"** will be displayed constantly on the LCD screen.

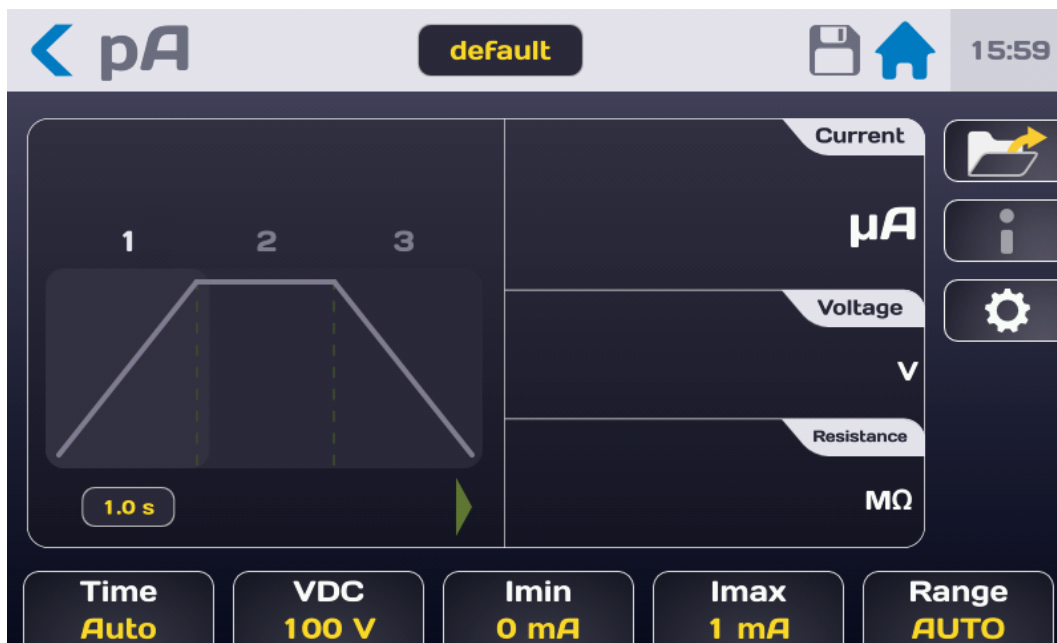
Turn off the device and allow it to cool down for 10 minutes before using it again.

9. CONFIGURING THE CURRENT MEASUREMENT

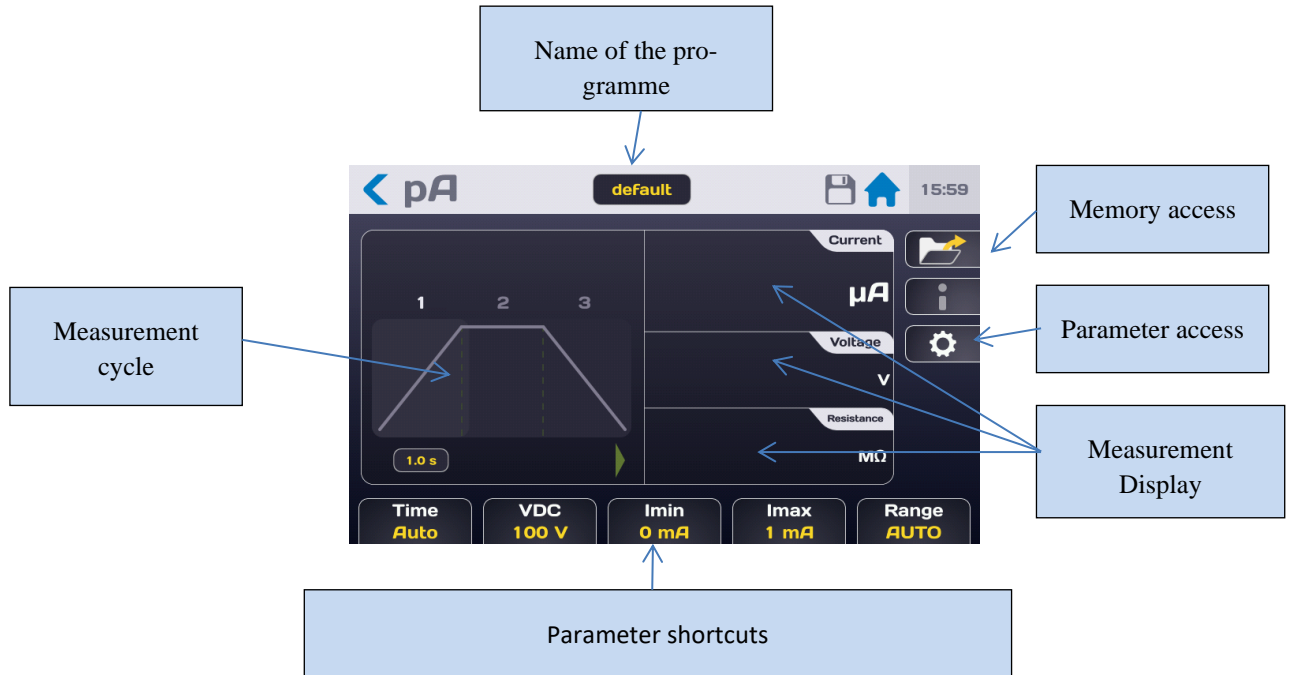
After turning on the device or returning to the start-up menu, the home screen indicates:



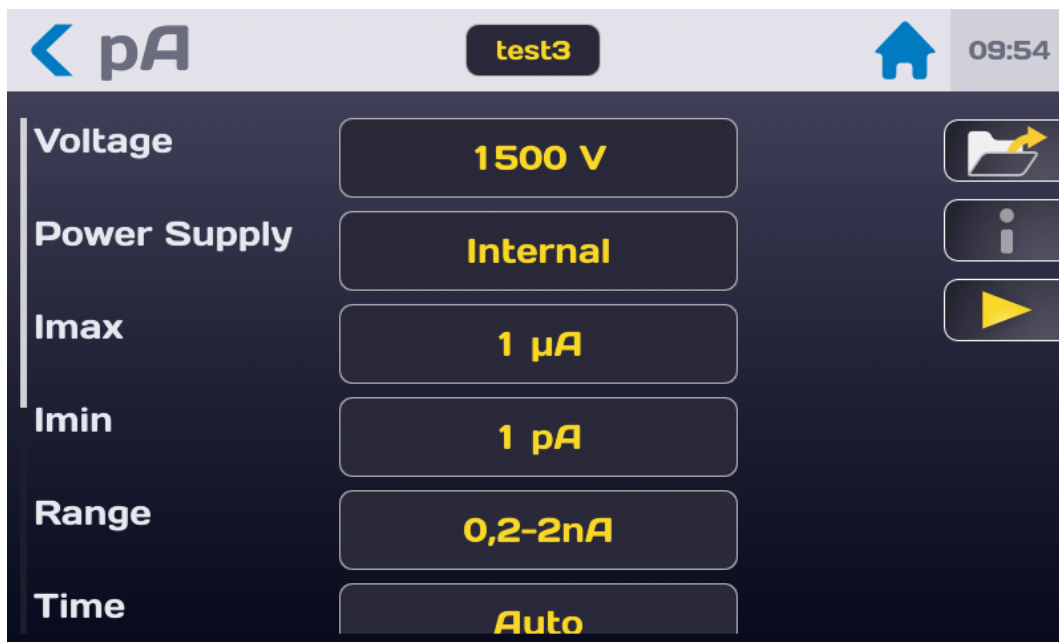
press the **pA** button to access the following measurement screen:



Description of the measurement screen:



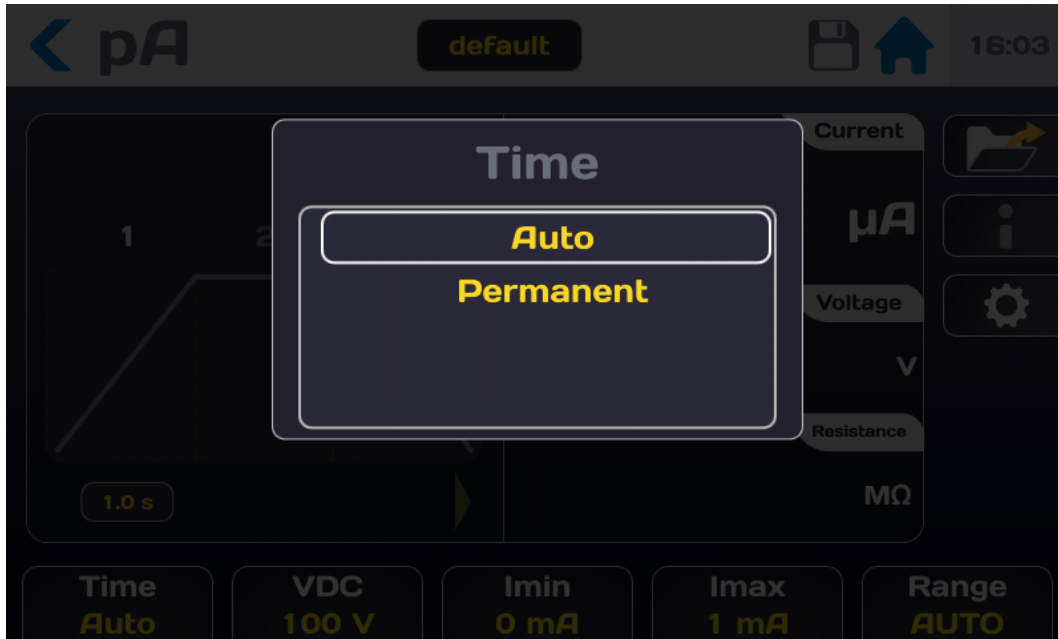
The measurement is displayed over 3 screens (Current, Voltage, Resistance) of which the order can be changed by pressing one of the 3 areas. Access to the measurement parameters can be done from the shortcut buttons located at the bottom of the measurement screen or from the button with the gear icon which displays the following menu:



Choose the parameter to be modified by pressing the active area (yellow) of the line of the parameter.

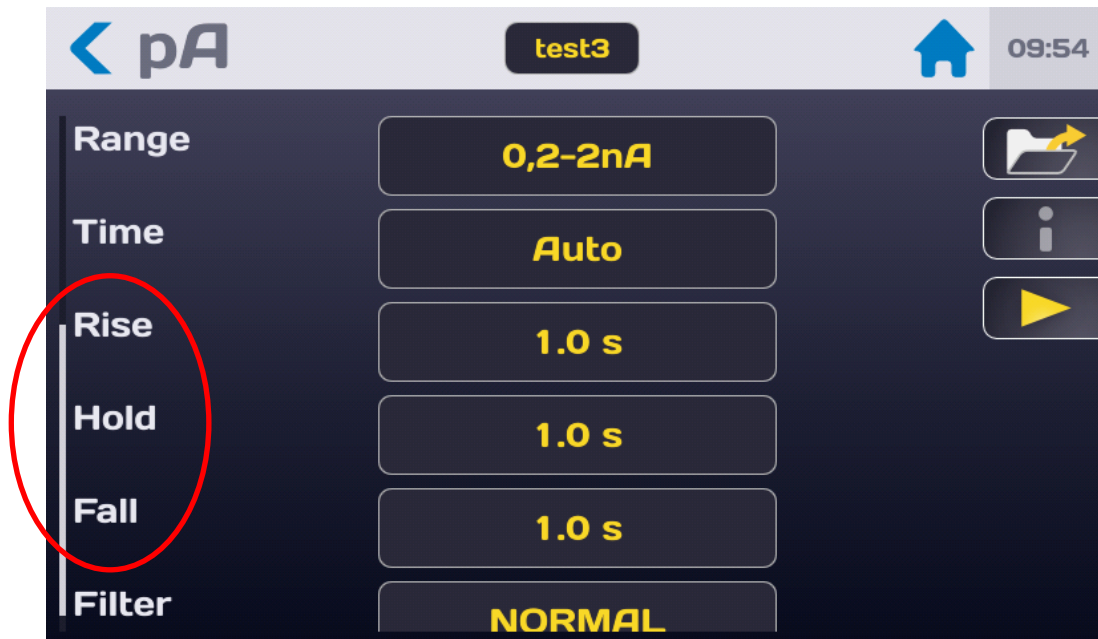
9.1. SETTING THE MEASUREMENT TIME

To change the measurement time, press the active area of the "Time" line to obtain:



The Permanent mode does not use the internal timer of the device and the measurement will be taken by pressing the START push-button until the STOP push-button is pressed.

To use the internal timer select AUTO mode and set the Rise, Hold and Fall time from the configuration menu (values between 0.1 and 9,999 sec.):



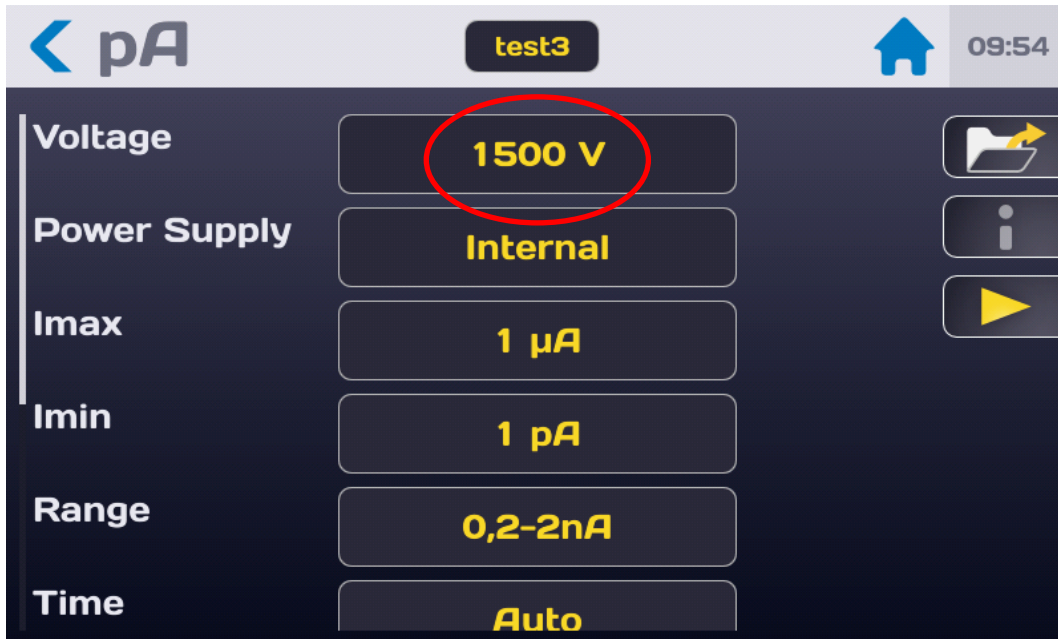
To set one of the measurement cycle times, press the active area of the corresponding parameter line:



Enter the value of the time in seconds: if the value entered is outside of the minimum and maximum limits it will be displayed in red. Press the Arrow validation button to confirm the entry and return to the configuration menu.

9.2. SETTING THE MEASUREMENT VOLTAGE

From the configuration menu or from the Voltage shortcut button at the bottom of the measurement screen, press the active area of the Voltage line:



To obtain the following screen:



Enter a voltage value between 1 and 1,500 VDC, if the value entered is outside of the authorised limits it will turn red.

9.3. USING EXTERNAL POWER SUPPLY WITH THE PICOAMMETER

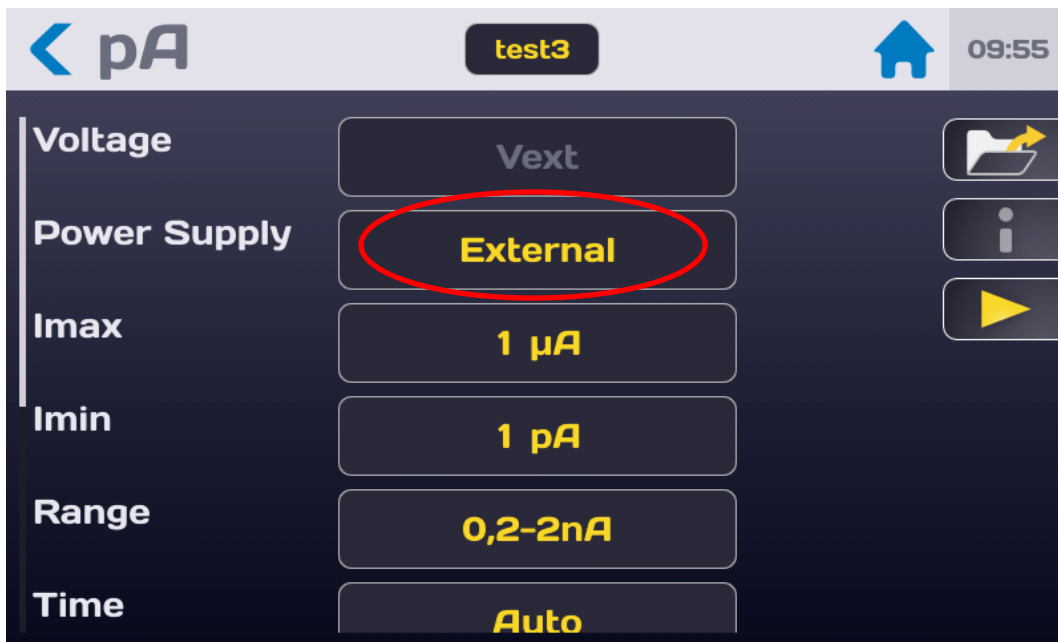
The device provides the possibility of using an external power supply for measuring currents



IMPORTANT

In the case of an external source > 1,500 VDC it is necessary to use a protective box and for voltages > 10,000 VDC a protective resistor of the RLHT series must be added. Please contact our sales department for more information.

To set up an operating mode with an external voltage press on the active area on the Power Supply line :




Select the Internal or External mode. With the External mode the build in generator will not operate.



IMPORTANT

The device cannot measure currents > 20 mA

Press the  symbol to return to the previous screen.

9.4. SETTING THE COMPARISON THRESHOLDS

The device offers two comparison thresholds I_{min} and I_{max} .

The main threshold for current measurement is the I_{max} threshold, if the current measured is greater than the I_{max} threshold the result is FAIL, if the current measured is less than I_{min} the result is PASS.

The I_{min} threshold makes it possible if needed to detect an incorrect connection on the tested sample which would then have an abnormally low current value.

The value of I_{max} must always be higher than the value of I_{min} .

To access the settings for I_{min} and I_{max} scroll the measurement parameters screen to display:



And press the active area of the threshold to be modified in order to obtain the following key-entry menu:



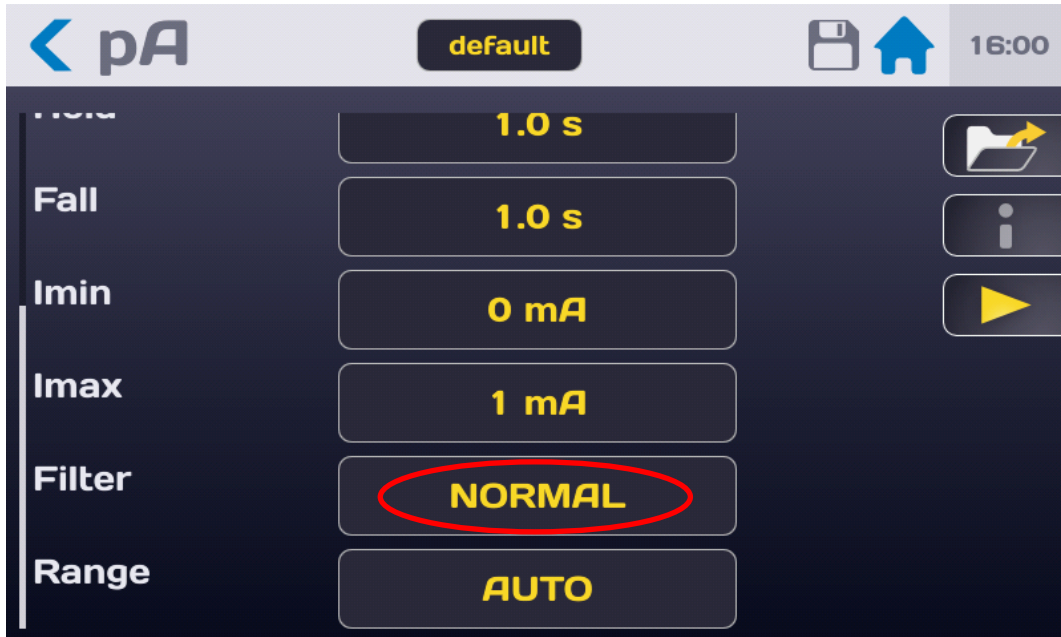
Enter the threshold value by using the Pico, Nano, Micro, Milli ampere units.

If the value entered is outside of the limits, it turns red. Confirm the threshold by pressing on the key-entry arrow.

9.5. SELECTING THE FILTERING MODE

The SEFELEC1500M offers various filtering modes that make it possible to stabilise the measurement according to the components and the measuring environment.

Press the active area of the "Filter" line to select the mode that is best suited:



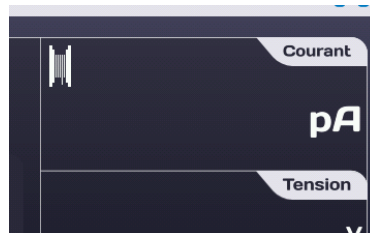
To display the various modes like this:



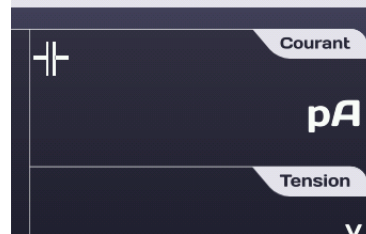
The device proposes three measurement speeds and two measurement configurations on capacitive circuits:

- **NORMAL**: 5 measurements are averaged for each display with 3 displays per second
- **SLOW**: 15 measurements are averaged for each display with 1 display per second.
- **FAST**: 1 measurement for each display with 10 displays per second.
- **CABLE** and **CAPACITOR**: these measurement modes have the same speed characteristics as in normal mode but they make use of analogue and software processing in order to allow for stable measurements on highly capacitive circuits.
 - In both **CABLE** and **CAPACITOR** modes the measurement range will be limited from 0.010 nA to 20.00 mA
 - Selection of the **CABLE** or **CAPACITOR** modes is indicated by a cable reel or a capacitor symbol in the main measurement window left hand side corner.

CABLE icon:



CAPACITOR icon:



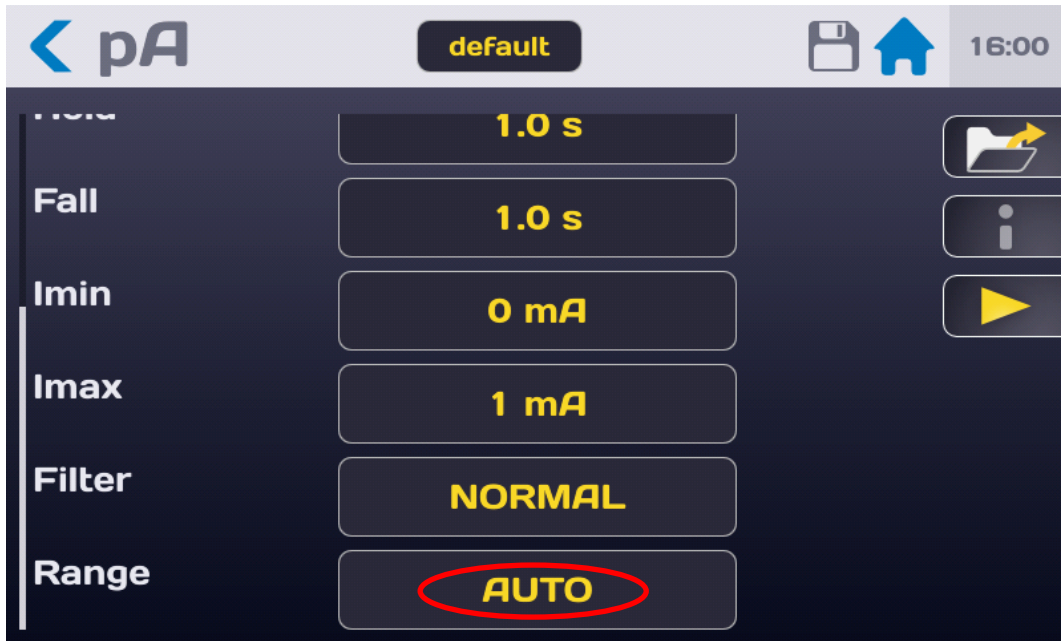
- The **CABLE** mode is more particularly intended for capacitance measurements in disturbed environments (cable reels, machines in workshops, etc.).
- The **CAPACITOR** mode is intended for measurements on capacitive components in the laboratory environment. In this mode, the automatic searching range function will start from the 20mA to the 2nA ranges but it will not go back unless a short-circuit on the high voltage generator output. It is mandatory to go in discharge mode by pressing the STOP button before disconnecting the DUT.

9.6. SELECTING THE MEASUREMENT RANGE

The SEFELEC1500M has an automatic measurement range search mode.

This is the most practical operating mode for the user. It is however possible in the case where it is sought to increase the rapidity of the measurement to block the device in a range (range change time: 150 msec. per range)

Press the active area of the "Range" parameters line:



scroll through the various possible ranges:

| N° | Range | N° | Range | N° | Range | N° | Range |
|----|----------|----|----------------|----|-----------|----|-----------|
| 0 | AUTO | 3 | 20-200 μ A | 6 | 20-200 nA | 9 | 20-200 pA |
| 1 | 2-20 mA | 4 | 2-20 μ A | 7 | 2-20 nA | 10 | 2-20 pA |
| 2 | 0.2-2 mA | 5 | 0.2-2 μ A | 8 | 0.2-2 nA | | |

Select the range by pressing the range value.

The measurements will be taken between 10% and 100% of the range (for example between 2.00 mA and 20.00 mA)

Below this value of the minimum value the display will indicate a message

"OVER RANGE"

Beyond this maximum value, the display will indicate: -----, with the message

"UNDER RANGE".

9.7. SAVING CURRENT MEASUREMENT PARAMETERS UNDER A FILE NAME

All of the current measurement parameters can be saved under a filename which will make it possible to find the configuration easily.

After having set all of the parameters the latter are found under the filename mentioned in the zone hereinbelow:



To change the filename, press the area with the filename in order to display a virtual keyboard and enter the new name.

Spaces are not allowed in the filename, use the dash (-) or underscore (_) as a separator.

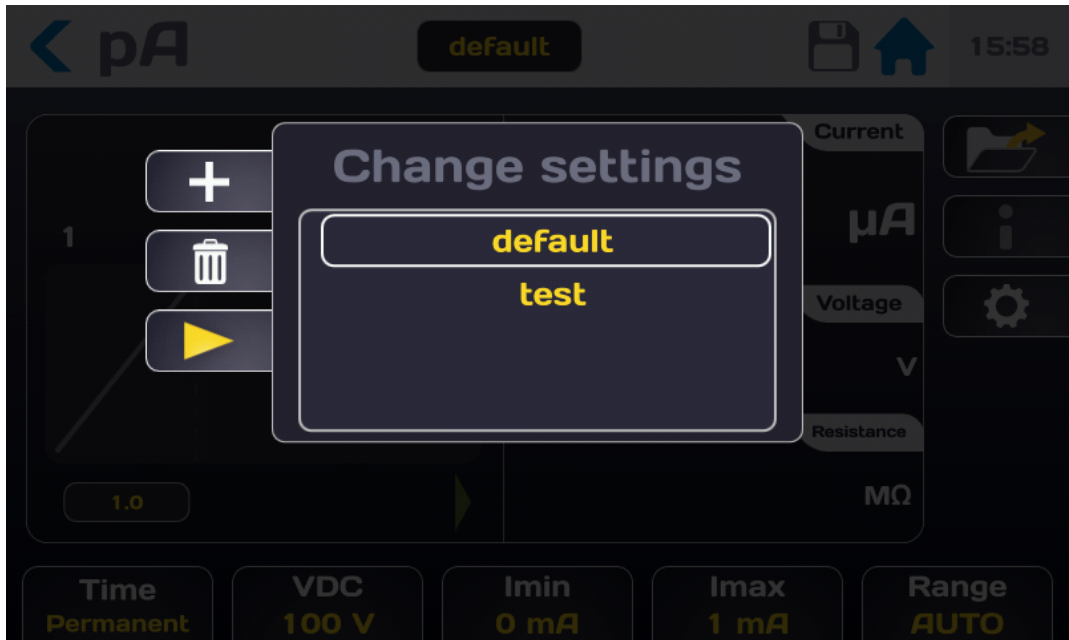
The special characters @, €, £, \$, &, μ, (), {}, ... are not allowed in filenames. The filename can comprise at most 50 characters.

When confirming, you are allowed to keep the old file and duplicate it or to rename the file without keeping the original version.

To recall a filename press the function button with the folder icon:



To obtain the following screen:



Search for the filename by scrolling up or down in the list of files. Press the desired filename then press outside of the file list display area or on the button with the yellow Arrow.

This window also allows you to delete a filename. Select the filename to be deleted then press the button in the shape of a Trash bin. A deletion confirmation window is displayed, confirm or cancel the deletion.

From this window it is also possible to create a new file with the + button which generates a file which self-increments from a file named: file1



WARNING: any modification of a parameter of a file is automatically saved in the file

NOTE

10. CURRENT MEASUREMENT

10.1. CONNECTING THE COMPONENT TO BE MEASURED



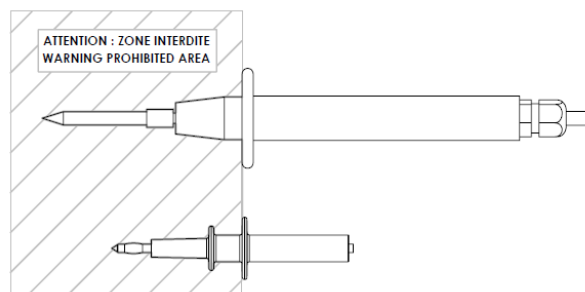
WARNING

Danger of electric shock!

WARNING: The accessories must only be handled by qualified personnel.

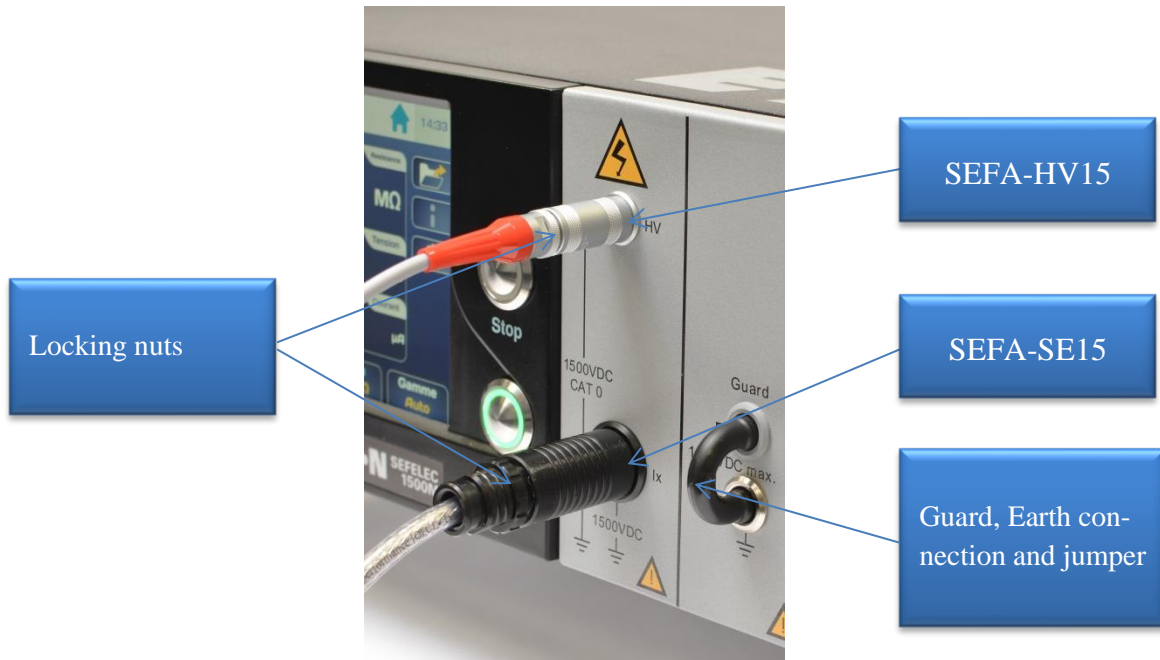
Essential recommendations for user safety

- Use accessories with the device or devices provided only. The operator safety and the proper operation of the equipment used depend on the compliance with this rule.
- Do not attempt to modify an accessory.
- The measurement accessories may contain elements limiting and protection it is forbidden to modify them without written permission of the company SEFELEC-EATON.
- In the case of use in conditions other than those specified in the manual of the device, potential risks may occur for the safety of the user.
- **ALWAYS** follow safety rules relating to the use of high voltage equipment
- Do not touch the metal tip of an accessory when connected to a device.
- Do not use accessory poor, incomplete or defective.
- Comply with the conditions of use specified in the manual of the associated measuring devices.
- Do not use an accessory to replace another just because it looks like another to another. Each accessory is designed for a specific use and in strict association with a measuring device.
- Never be several people manipulating a same accessory



Connect the measuring cord **SEF-SE15** to the base **Ix** provided for this purpose, the cord is locked by inserting the plug until it clicks. Continue in the same way with the cord **SEF-HV15** on the **HV** terminal.

WARNING: connectors are equipped with locking nut to avoid unwanted disconnection. If necessary screw the nut and unscrew the nut to allow terminal removing.



For measurements with the guard potential connected to the ground, leave the black jumper isolated on the front panel. For floating measurements or with High Voltage connected to the ground remove the jumper and use a cord of the laboratory type with safety banana plugs of a diameter of 4 mm to connect the guard to the guard planes of the measurement mounting.



Risk of electric shock!

In the case where the High Voltage is connected to the ground the guard potential will be brought to - Utest (maximum value of 1,500 VDC)

To disconnect the measurement leads, unscrew the locking nut, grasp the plug of the accessory by its striated ring and pull to take the plug out of the terminal.

10.2. PRECAUTIONS TO OBSERVE DURING A MEASUREMENT:

To take a current measurement less than the μA , use an effective shielding connected to the guard terminal (grey terminal on the front panel for a floating measurement or ground terminal on the rear panel for a measurement with the guard connected to the ground). Erroneous measurements due to the presence of parasitic leakage currents or to introductions of mains fields are as such prevented.

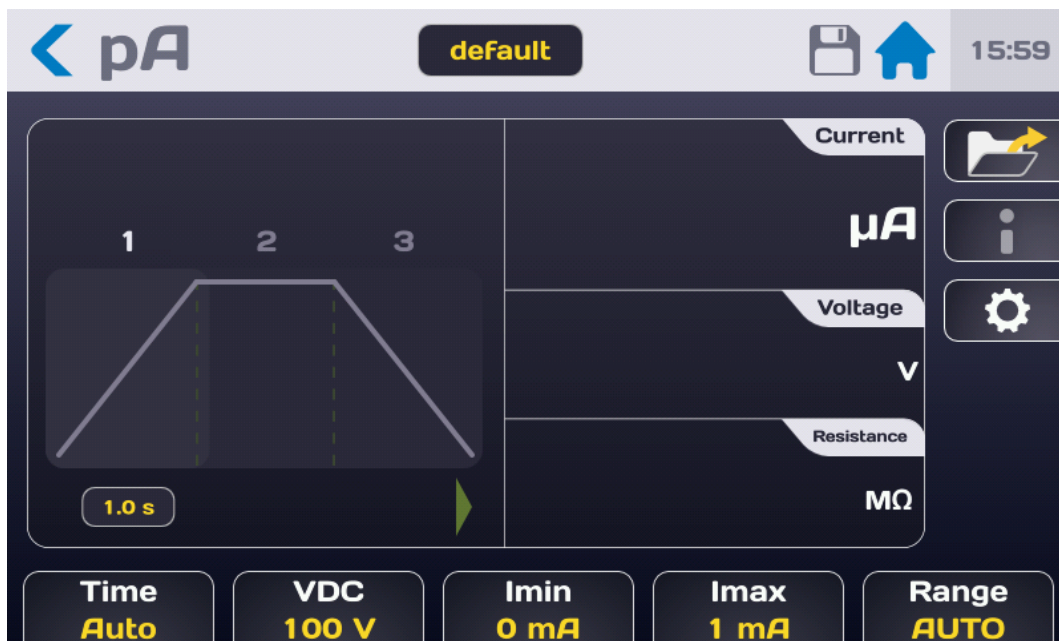
The proximity of an operator bringing his hand close to the tested sample can distort the measurement. Care should be taken not to wear nylon lab coats or insulating objects which may create high static electricity fields which could affect the operation of the device at very low current levels.

A measurement of 10 Teraohm under 10 volts corresponds to a measurement of a current of 1 pA.

When measuring capacitive circuits (use the CABLE or CAPACITOR mode, see chapter 9-4) never take measurements by decreasing the measuring voltage at each test but always by increasing it; the phenomena of hysteresis and polarisation presented by the dielectric would distort the results. In this case the device will tend to indicate the maximum and will take a long time to fall to the real value to be measured.

Never disconnect a capacitive sample without switching to DISCHARGE and waiting for the time required for the capacitance of the sample to discharge into the 2.2 k Ω resistor of the discharge circuit.

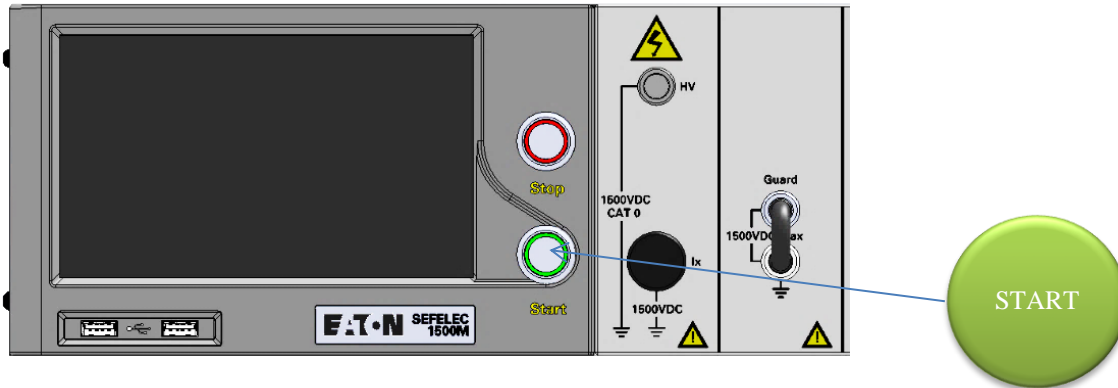
After connecting the component to be measured with the precautions described hereinabove and selecting the required measuring parameters, return to the measuring screen hereinbelow:





NOTE

Press the START push-button. For safety reasons, it is necessary to press for a time > 1 second in order for the device to switch to MEASUREMENT mode, in the event the pressing is too short an information message will be displayed briefly on the LCD screen.



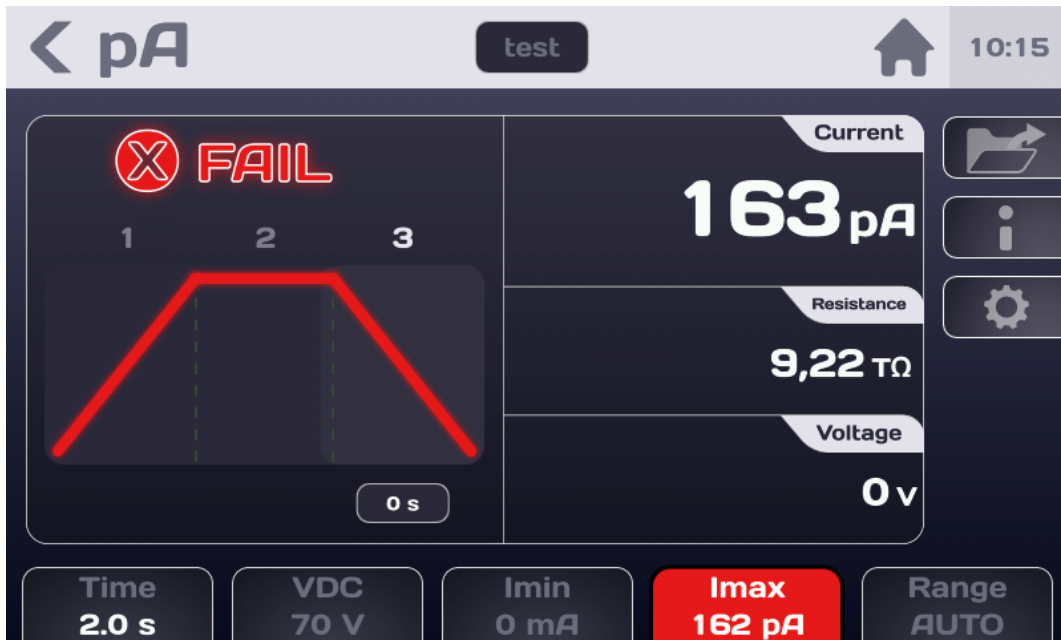
The measuring cycle unfolds according to the time for rising, maintaining and falling with display of the resistance, voltage and current according to the following screen:



At the end of the test the display indicates if the measurement is between Imin and Imax, i.e. considered as PASS.



If the measurement is $< I_{min}$ or $> I_{max}$, it will be considered as FAIL:

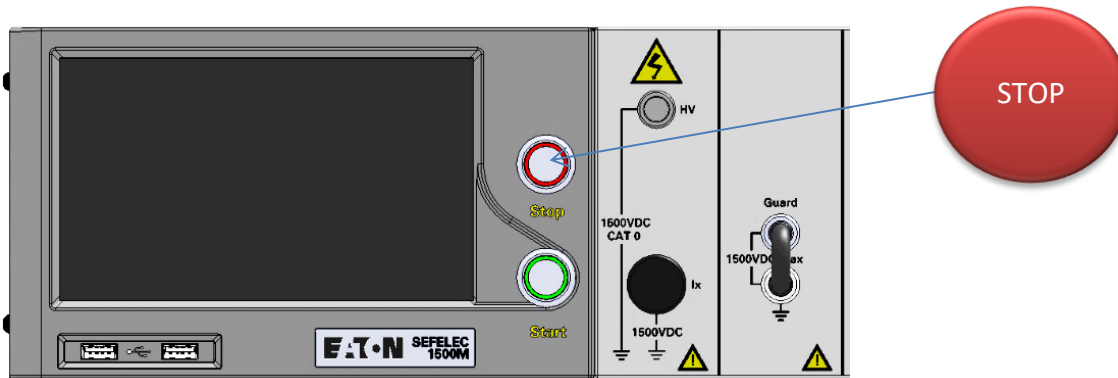


The coloured parameter shortcut button will indicate the parameter which causes the FAIL result for the measurement.



WARNING

Before disconnecting the measured component, press the STOP push-button to confirm stoppage of the generating of High Voltage and discharge the component:



This action makes it possible to return to the initial measuring screen either to change the parameters or to run another measurement by pressing the START push-button.

10.3. ERROR MESSAGES:

- **"SAFETY LOOP WAS OPENED"**: the safety loop is not closed, there is no connection between the points 1-9 or 2-10 of connector C5 on the rear panel of the device. Front panel START and STOP pushbuttons are not illuminated. Press OK to acknowledge the message and check the safety loop connection.

- **"OVER RANGE"**: the leakage current in the sample being tested is greater than the measuring possibilities of the device ($> 20 \text{ mA}$) or of the measuring range in manual mode.

- **"UNDER RANGE"**: the leakage current in the sample being tested is less than the measuring possibilities of the device ($< 0.5 \text{ pA}$) or of the measuring range in manual mode.

- **"CHARGING..."**: the measurement voltage has not reached its final value. The voltage generator charges the capacitor of the sample being tested. This message must appear in a fleeting manner when switching to Measurement mode. If the message persists, this means that the measurement voltage requested cannot be supplied to the resistance measured.

Check with respect to the characteristics of the voltage generator.

- **"VOLTAGE ERROR"**: when a measurement time is defined, if during the test the message "CHARGING..." is constantly displayed, at the end of the measurement time the test will be declared as FAIL and the **"VOLTAGE ERROR"** message will indicate the cause of it.

If needed see the information on the message **"CHARGING..."**



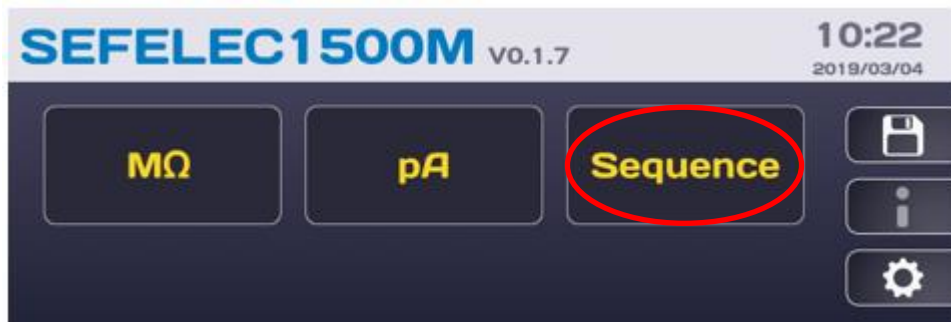
IMPORTANT

The device is equipped with a thermal protection system. In case of prolonged use of the High Voltage generator on a short circuit, the protection system will be activated. In this case the message **"OVERHEAT"** will be displayed constantly on the LCD screen. Turn off the device and allow it to cool down for 10 minutes before using it again.

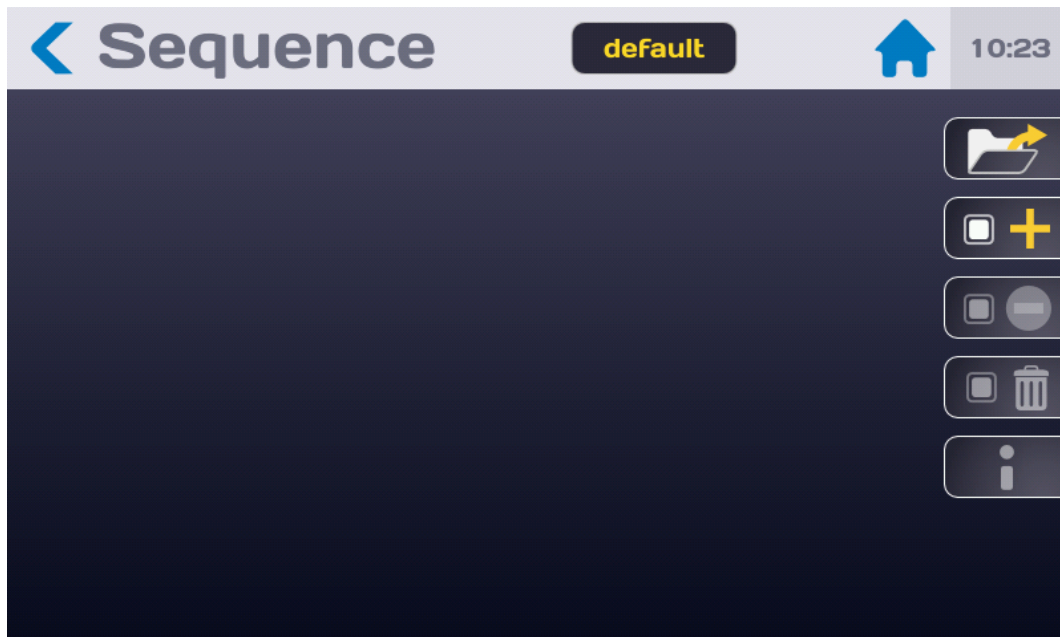
11. SEQUENCE MODE

The SEQUENCE mode is a very complete operating mode that allows you to create measurement programs that use different parameter files, different measurement functions, messages giving information or instructions for the operators as well as possibilities for displaying photos or plans. A set of instructions allows a rolling of each sequence according to the measurement results, conditional looping as well as jumps at certain stages of the sequence.

After turning on the power or returning to the boot menu, press the Sequence key:



To reach the next screen:



11.1. LIST OF AVAILABLE FUNCTIONS IN SEQUENCE

From the SEQUENCE mode screen, press on the following function key :



To display the scrolling list of available functions:

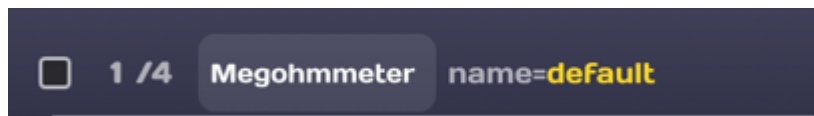
A SEQUENCE is made of a consists of a series of steps, each step being able to be one of the following functions:

- **Megohmmeter**
- **Picoammeter**
- **Text message**
- **Picture Message**
- **PDF message**
- **Condition**
- **Repetition**
- **Pause**
- **Keyboard Input**

Press the desired function to add a step in the sequence.

General rules of the Sequence mode:

Each step consists of a line comprising:

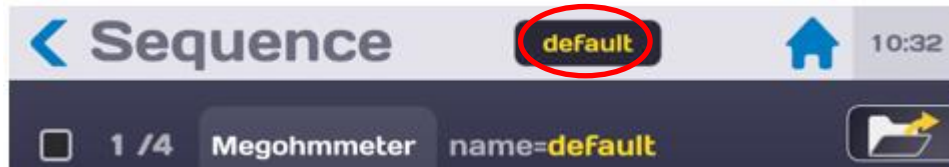


- a tick box allowing the selection of the step to delete it (trash icon), to put it in standby or to reactivate it (icon NO ENTRY). It is possible to make a multiple selection of multiple lines to delete them or put them to sleep. Disabled lines are completely grayed out
- an order number in the format x / n which gives the rank x of the step on a total of n steps
- the name of the function
- the associated parameter file. A press on the name of the file (in yellow) gives access to a list of available files or to the entry of titles and texts.

A long press on a step will highlight the line and move it by dragging the screen up or down.

The parameter files of the measurement functions called by the Sequence mode must not use the PERMANENT mode of the timer.

Each addition, deletion, modification of a step line is automatically saved under the name of the Sequence file, "default" in the example below:



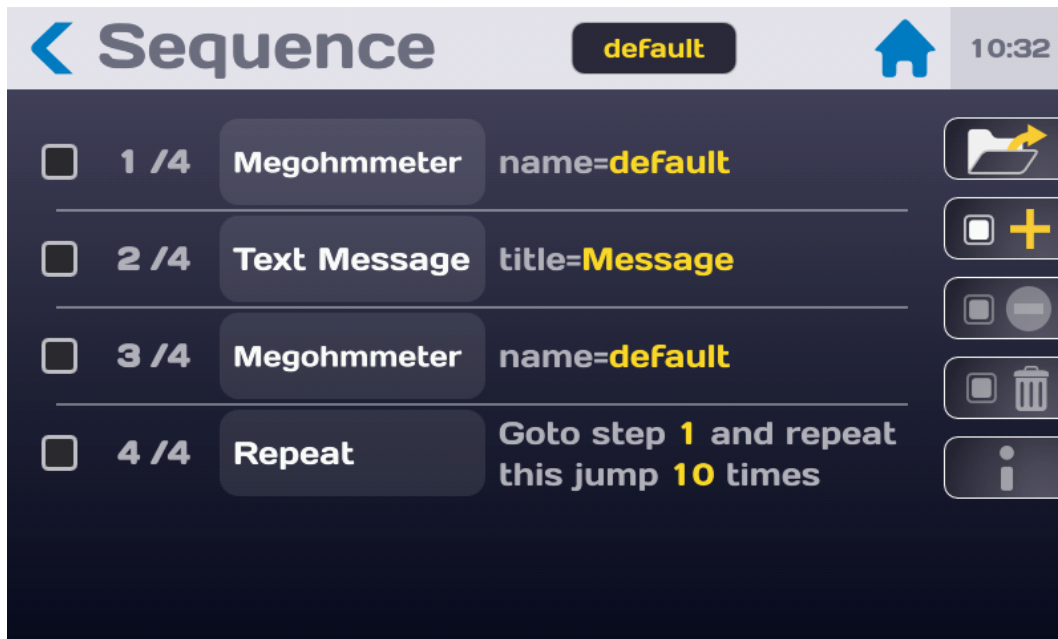
It is possible to change the name of the Sequence file by pressing the name and entering the new name.

Space is not allowed in the file name, use dash (-) or Under score (_) as separator.

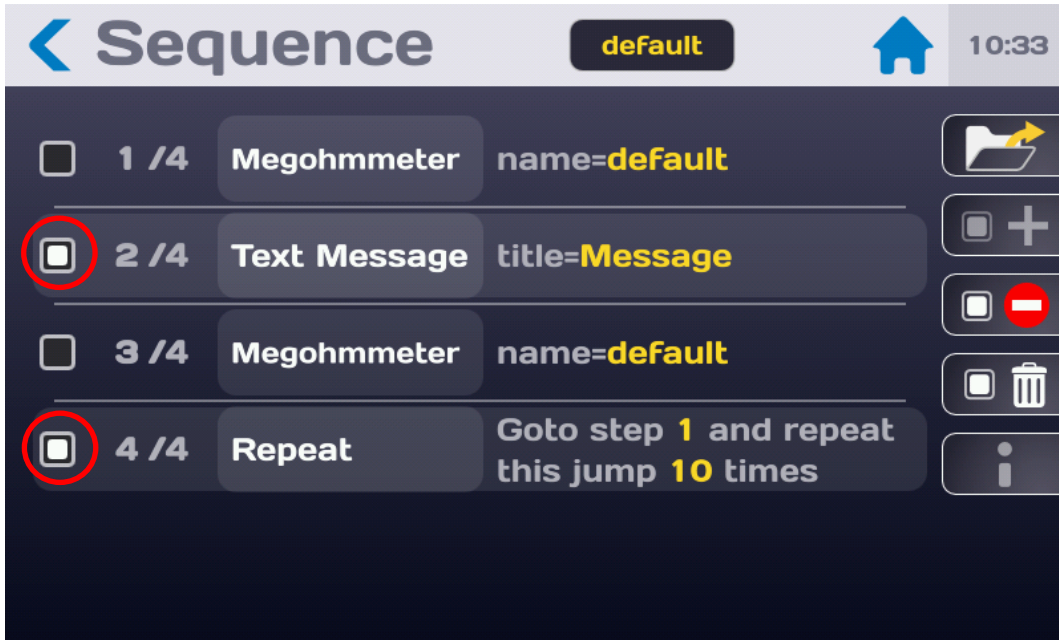
Special characters @, €, £, \$, &, μ, (), {}, ... are not allowed in file names. The file name can be at least 50 characters long.

During the validation it is proposed to you to keep the old file and to duplicate it or to rename it without keeping the original version.

Exploring all the lines of steps is done by placing your finger on the LCD screen and dragging it up (to go towards the end) or down (to go to the beginning)



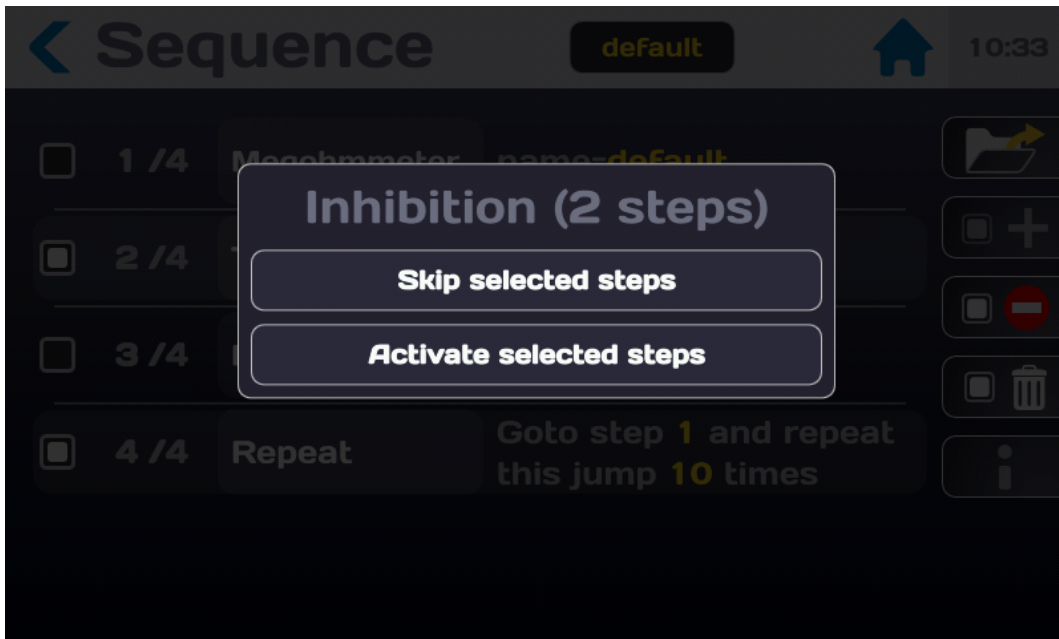
It is possible to inhibit a step in a sequence without completely deleting it. This allows easier editing of the sequences. Select the step line (s) to be inhibited by checking the selection box:



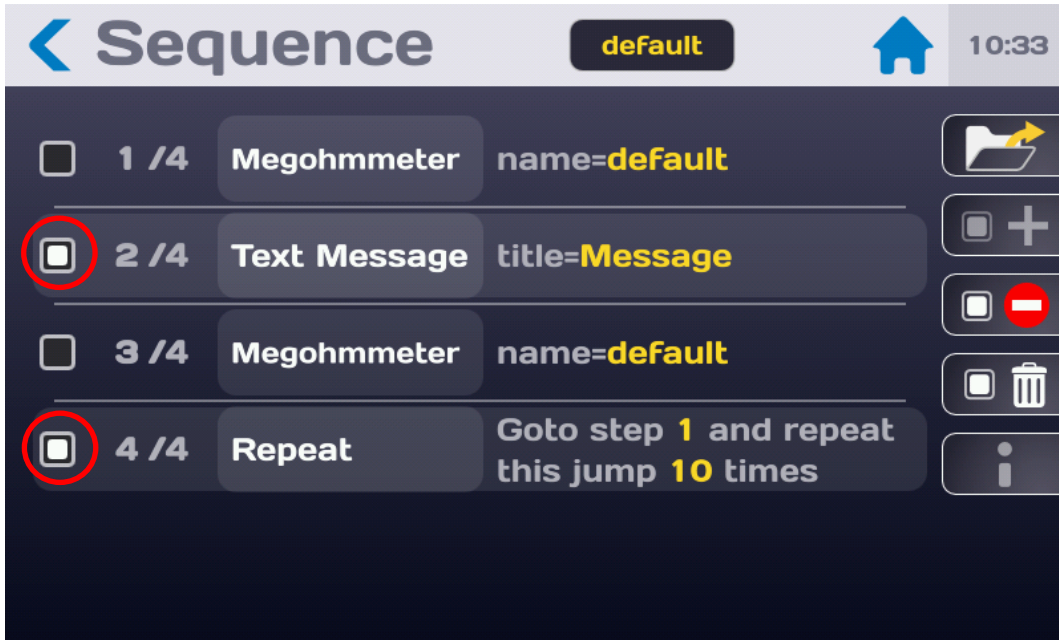
Then press the icon NO ENTRY:



Choose to skip these steps or activate them:



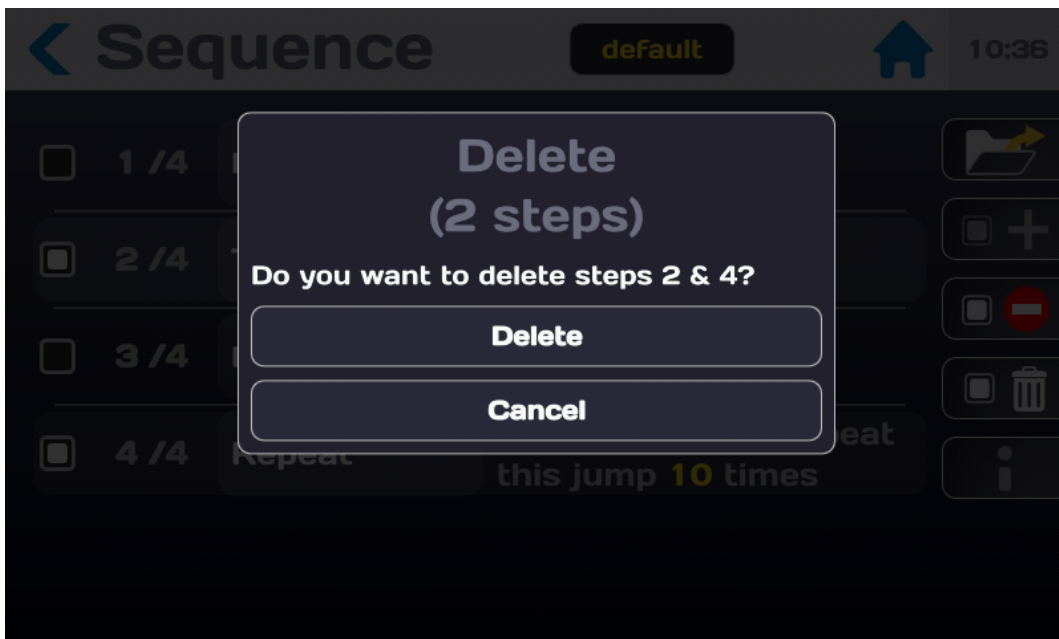
To delete a step from a sequence, select the step line (s) to delete by checking the selection box:



Then press the Trash icon:



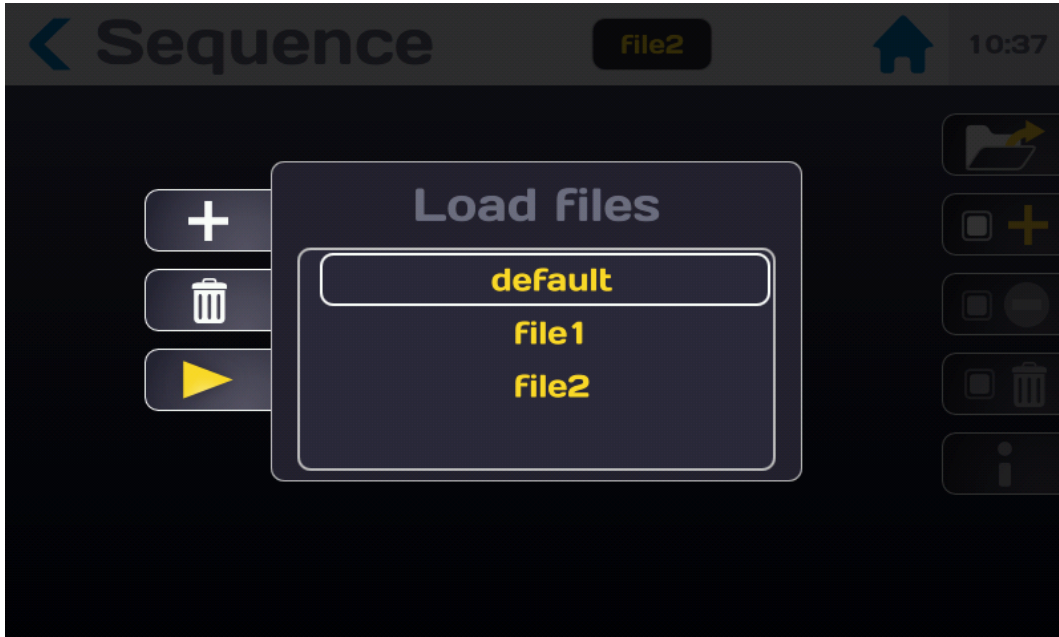
Confirm (Delete) or not (Cancel) the deletion of these steps:



To recall an existing Sequence file, press the icon:



to view the list of available files:



The keys :



Allow to add or delete files.

To load a Sequence file, select it from the drop-down list and press the key:

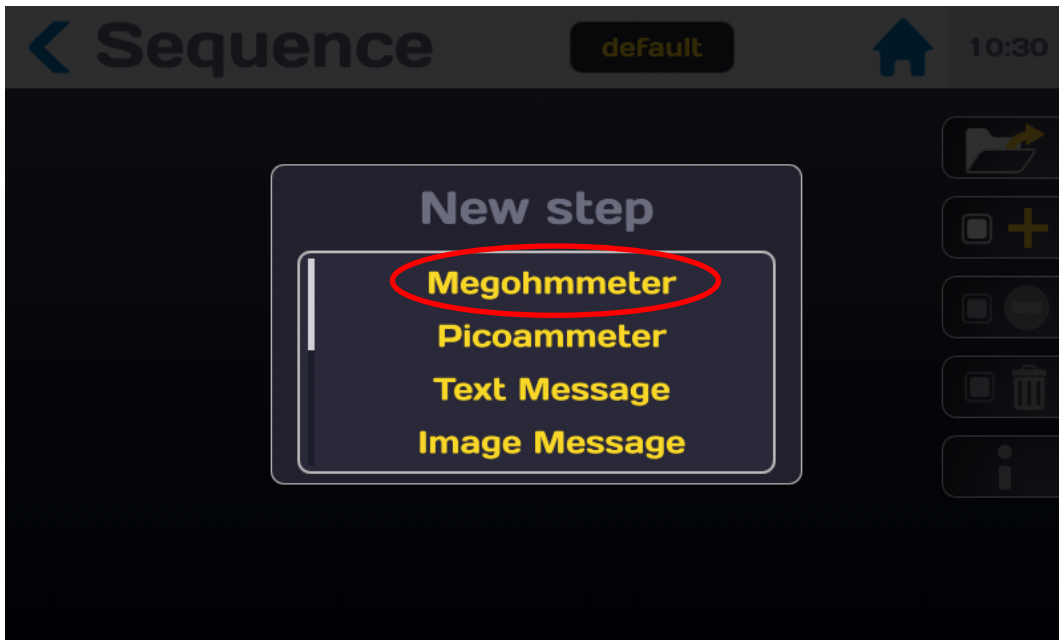


11.1.1. MEGOHMMETER STEP:

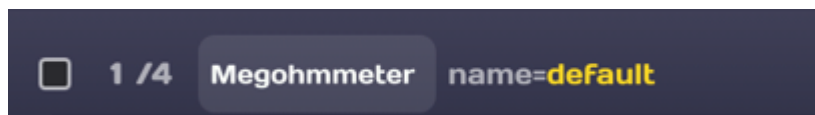
The Megohmmeter step is used to perform an isolation resistance measurement with a chosen parameter file. To display the drop-down list of steps, click on the icon:



Choose from the list of steps the Megohmmeter function:



It is displayed as follows:



See Sequence General rules in 11-1.

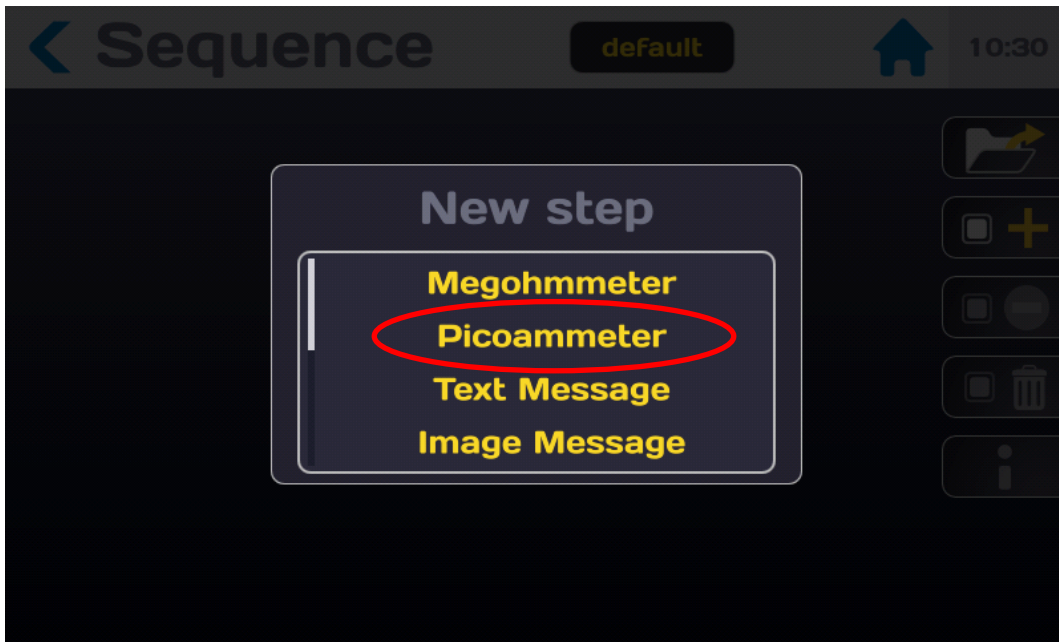
Select the desired parameter file for this test step by pressing the yellow area. If the file does not exist, create it by going to the Megohmmeter function from the home menu.

11.1.2. PICOAMMETER STEP:

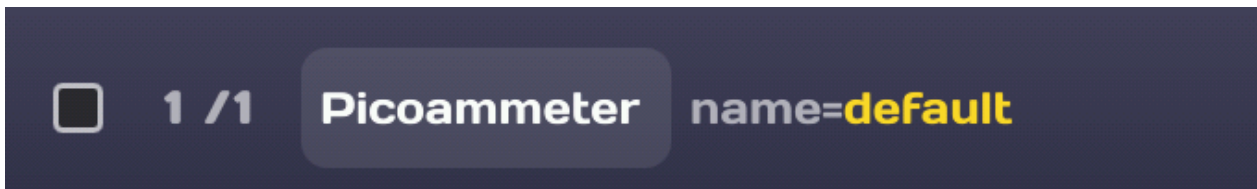
The Picoammeter step is used to perform a current measurement with a chosen parameter file. To display the drop-down list of steps, click on the icon:



Choose from the list of steps the Picoammeter function:



It is displayed as follows:



See Sequence General rules in 11-1.

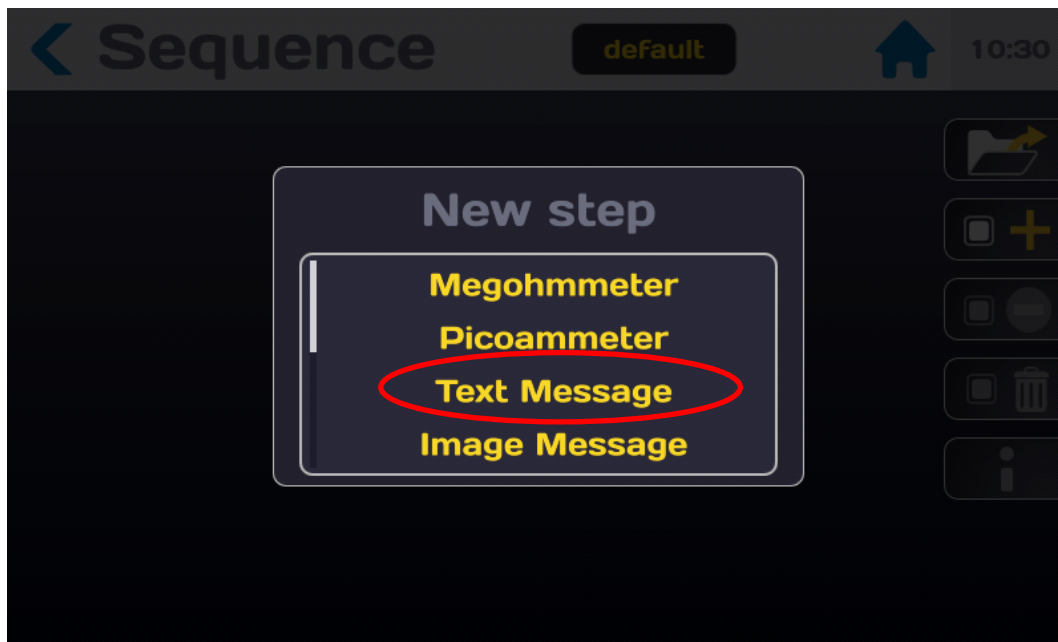
Select the desired parameter file for this test step by pressing the yellow area. If the file does not exist, create it by going to the Picoammeter function from the home menu.

11.1.3. TEXT MESSAGE STEP:

The text message step is used to insert a text message to inform or guide the operator. To display the drop-down list of steps press the icon:



Choose from the list of steps the Text message function:

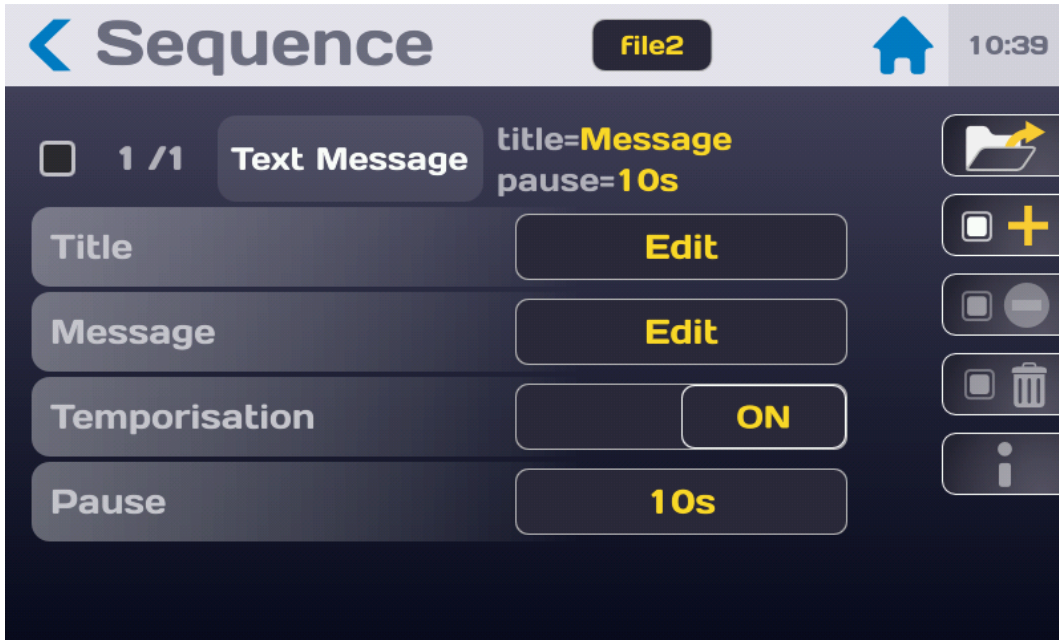


It is displayed as follows:

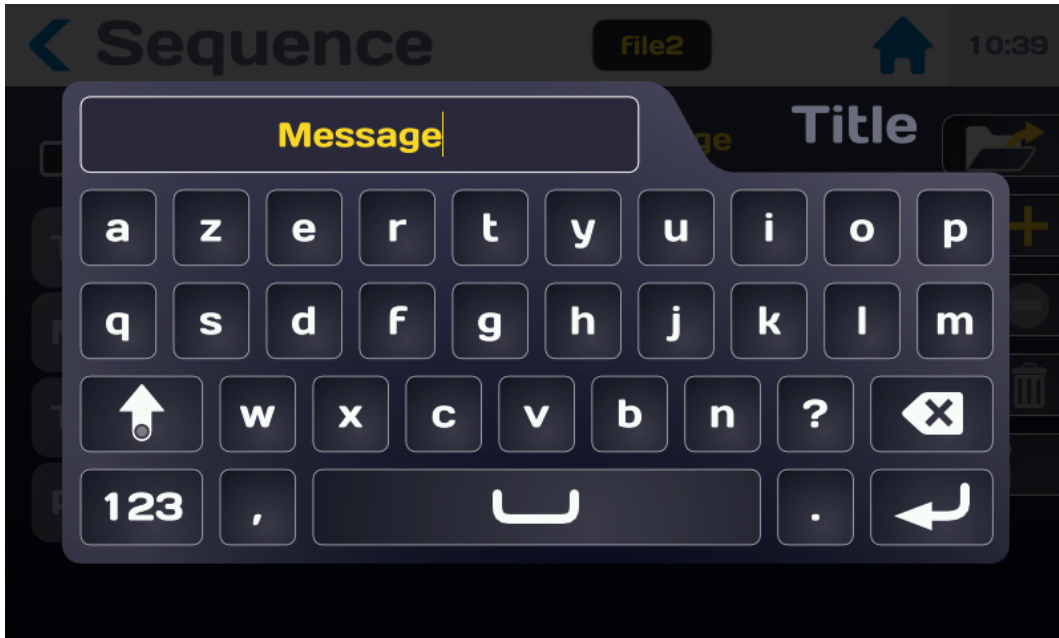


See Sequence General rules in 11-1.

Touching the Text Message field in Yellow, you can enter a text for the message title, for the message itself and to activate a display timeout (Pause). In the OFF mode, the message must be acknowledged by pressing the OK button. In the event of the ON mode, the message will disappear after the indicated time.



Press Edit Title to access an input keyboard to give a title to the message.



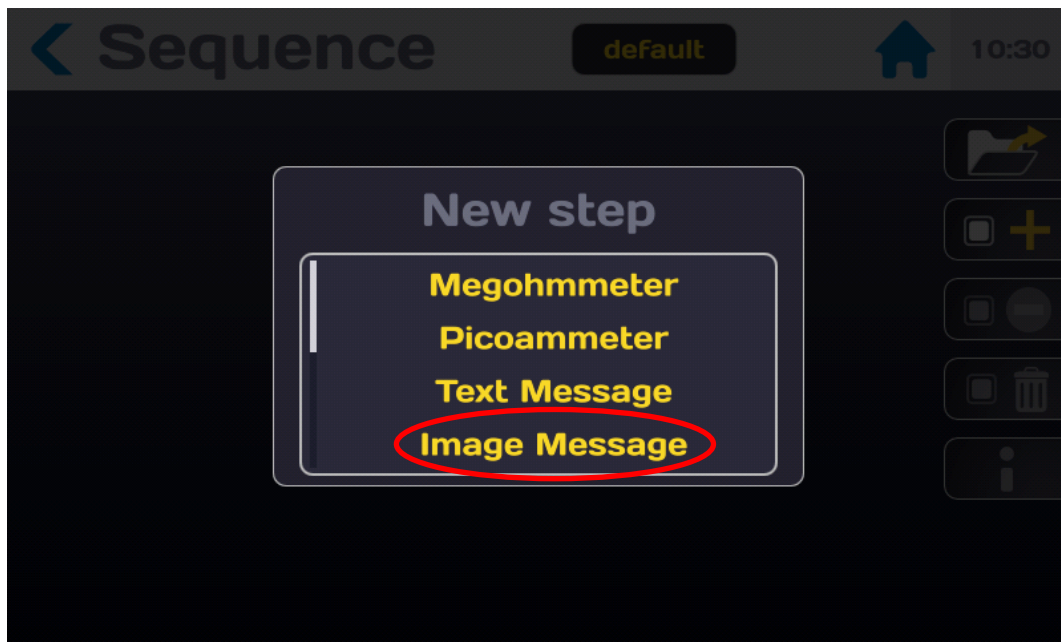
Proceed in the same way for the text of the message. It is necessary to enter a text, otherwise a sequence error message will be displayed.

11.1.4. IMAGE MESSAGE STEP:

The Image Message step is used to insert an image to inform or guide the operator. To display the drop-down list of steps, click on the icon:



Choose from the list of steps the Image message function:



It is displayed as follows:



See Sequence General rules in 11-1.

Press the yellow field Message, it is possible to enter a text for the title of the photo. Press Edit Title to access an input keyboard to give a title to the photo. In the OFF mode, the picture must be acknowledged by pressing the OK button. In the case of the ON mode, the picture will disappear after the specified time.

On the Image line press Edit to display the image list. Scroll through the list of available images and select by pressing the name of the image.



If there are no images in the device or to import new ones:

- Copy image files in JPEG or PNG format from a PC to a USB flash drive. It is recommended to limit the size of images <1MB.
- Eject the USB key from the PC
- Put the USB key containing the images in one of the USB connectors on the front of the device
- Go to the home menu (House icon)
- Press the key with the Floppy Disk icon
- On the USB memory line press Install
- Tap the House icon
- Return to Sequence mode
- Click on the Message area of the Message Image line
- Image Line press Edit
- Press Add to Library ...
- The list of available images on the USB flash drive is displayed in the Image window
- Scroll through the names and select the file by pressing its name
- If the image file already exists, you will be offered to replace it or cancel the operation



NOTE

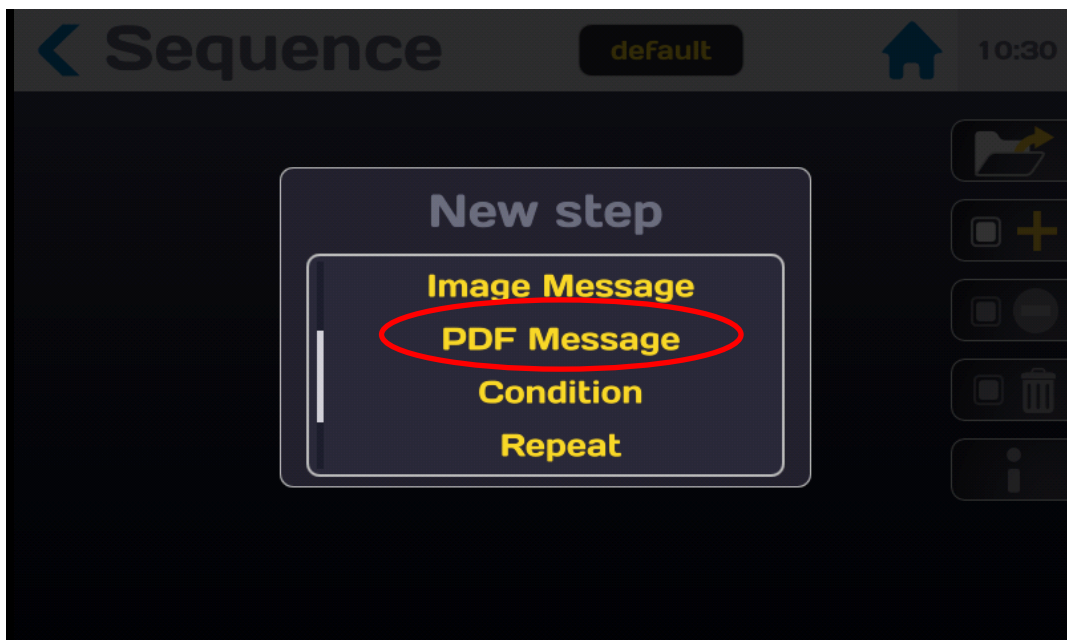
Before removing the USB flash drive from the device, go back to the Home menu, then the Floppy disk menu and eject the USB flash drive.

11.1.5. PDF MESSAGE STEP:

The PDF Message step allows you to insert a file in PDF format to inform or guide the operator. To display the drop-down list of steps, click on the icon:



Choose from the list of steps the PDF message function:



It is displayed as follows:



See Sequence General rules in 11-1.

It is possible to enter a text for the title of the PDF file. Press Edit Title to access an input keyboard for giving a title to the file.

On the PDF line press Edit to display the list of PDF files. Scroll through the list of available files and select by pressing the file name.

If there are no PDF files in the device or to import new ones:

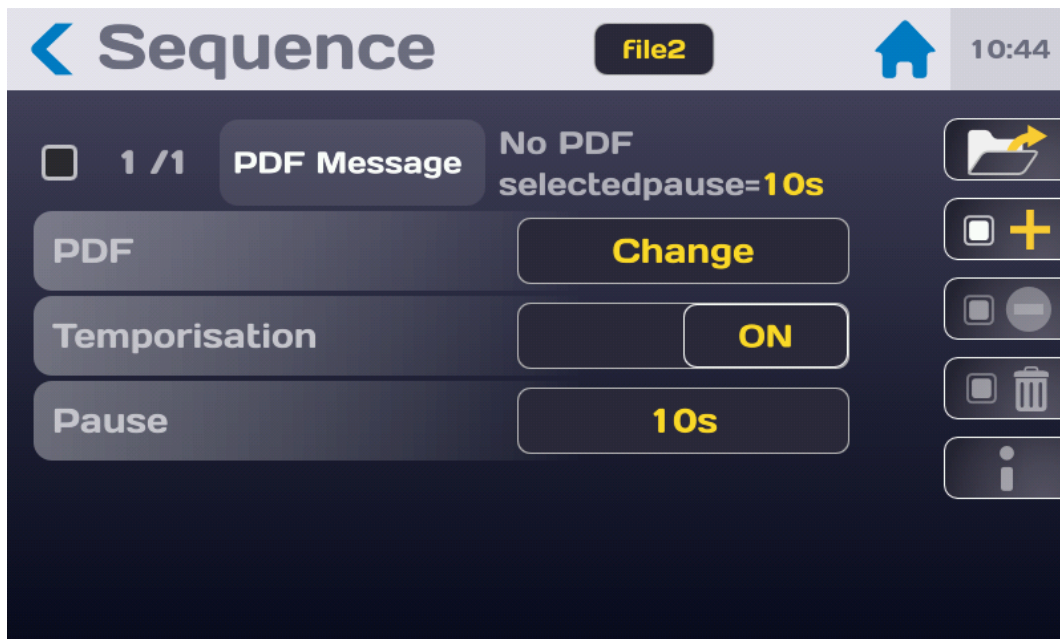
- Copy PDF files from a PC to a USB flash drive. It is recommended to limit the size of files <1MB.
- Eject the USB key from the PC
- Put the USB key containing the PDF file in one of the USB connectors on the front of the device
- Go to the home menu (House icon)
- Press the key with the Floppy Disk icon
- On the USB memory line press Install
- Tap the House icon
- Return to Sequence mode
- Click on the Message area of the PDF Message line
- PDF Line press Edit
- Press Add to Library ...
- The list of available PDF files on the USB flash drive is displayed in the Image window
- Scroll through the names and select the file by pressing its name
- If the PDF file already exists, you will be offered to replace it or cancel the operation



Before removing the USB flash drive from the device, go back to the Home menu, then the Floppy disk menu and eject the USB flash drive.

NOTE

In the timer OFF mode, the PDF file must be operator acknowledged by pressing the OK. In the case of the timer ON mode, the PDF file will disappear after the specified time.

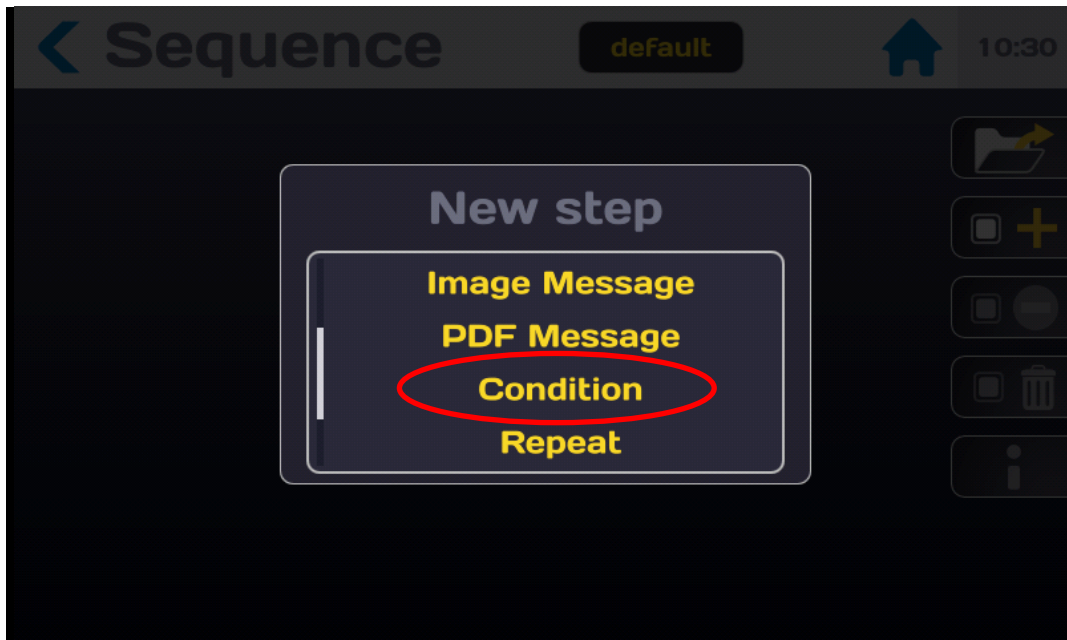


11.1.6. CONDITION STEP:

The Condition step allows you to insert a condition in the sequence of the various steps. To display the drop-down list of steps, click on the icon:



Choose from the list of steps the Condition function:

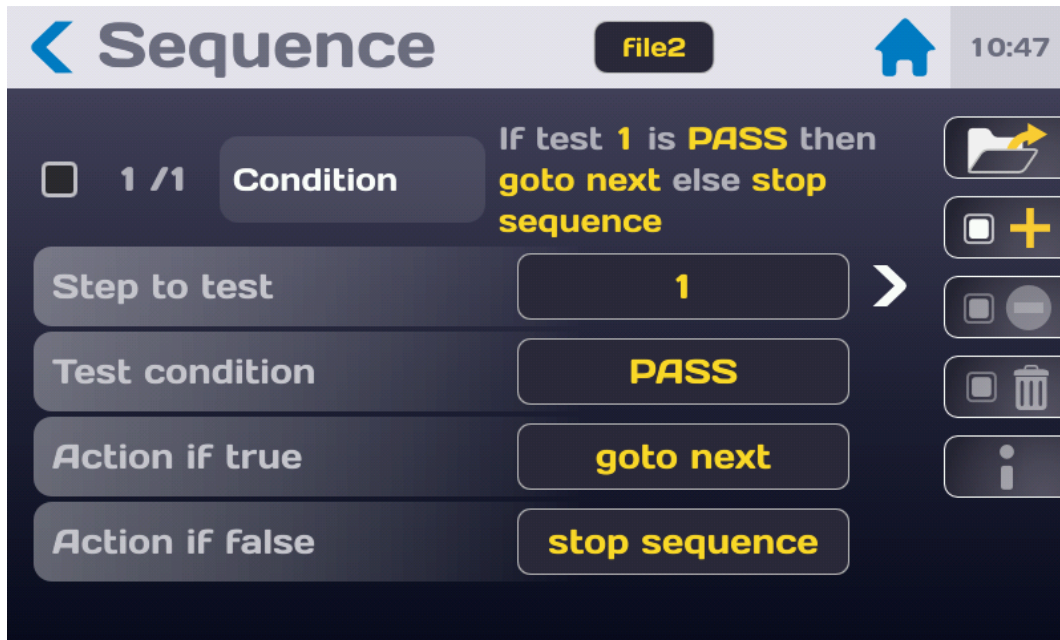


It is displayed as follows:



See Sequence General rules in 11-1.

Press the yellow zone to set the condition:



The condition function requires the following information:

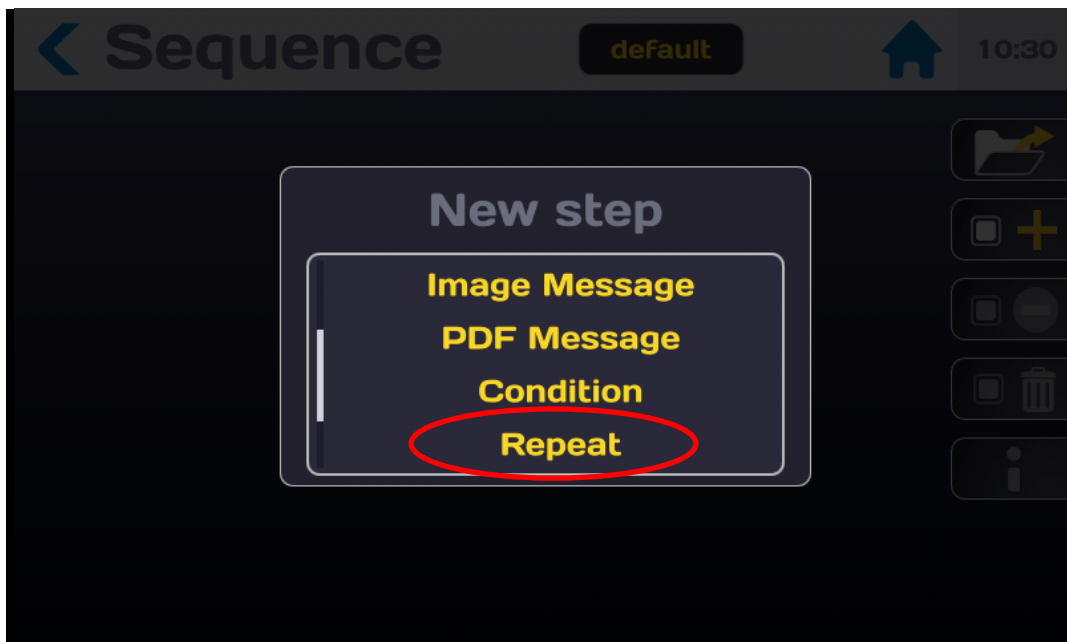
- The number of the step to which the condition relates
Enter a step number corresponding to a measurement function. In the case of a step number that does not correspond to a measurement function, the result of the step will always be GOOD and will make a non-conditional jump.
- The condition of the chosen step
Choose the result of the step: Good, Bad, Error, Bad or Error, Not yet tested
- The action to be taken if the condition is fulfilled
Choose: Stop Sequence, goto next (go to next step), goto xx (go to step xx)
- The action to be taken if the condition is not fulfilled
Choose: Stop Sequence, goto next (go to next step), goto xx (go to step xx)

11.1.7. REPETITION STEP:

The Repetition step is used to insert an iterative loop in the sequence of the various steps of a sequence. To display the drop-down list of steps, click on the icon:



Choose from the list of steps the Repetition function:



It is displayed as follows:



See Sequence General rules in 11-1.

Repetition requires the following information:

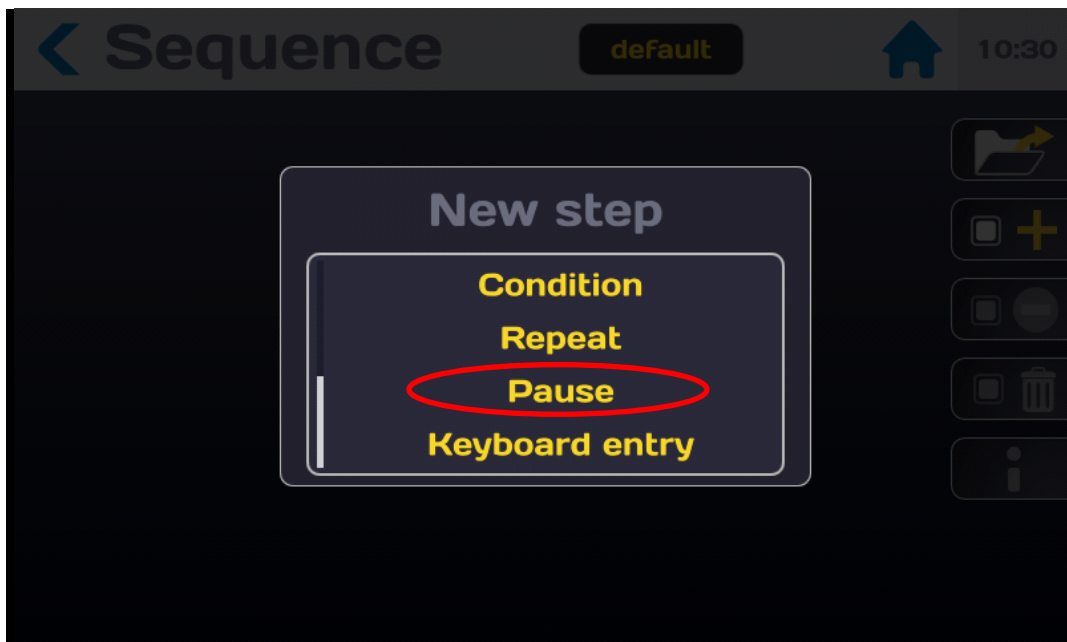
- The number of the step on which the repetition is
 - o Enter a valid step number
- The number of repetitions
 - o Choose the number of occurrences of the repetition

11.1.8. PAUSE STEP:

The Pause step is used to insert a timed pause in the sequence of the various steps of a sequence. To display the drop-down list of steps, click on the icon:



Choose from the list of steps the Pause function:



It is displayed as follows:



See Sequence General rules in 11-1.

The Pause requires the following information:

- Pause time
 - o Enter the time in seconds with a resolution of 0.1 second

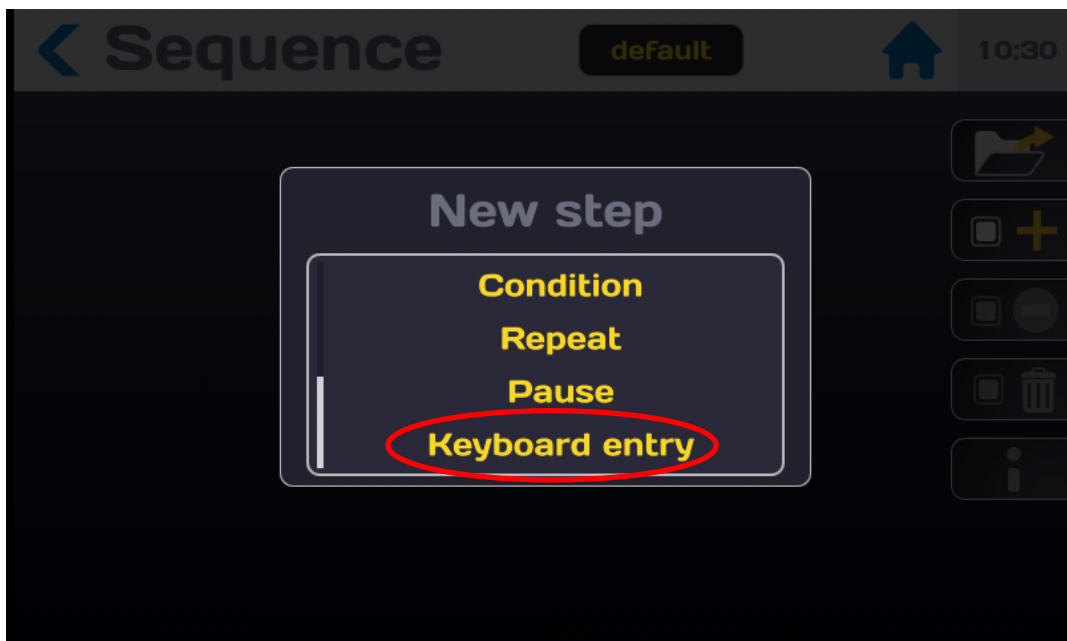
11.1.9. ENTER KEYBOARD STEP:

The Enter Keyboard step is used to insert an information entry in the sequence of the various steps of a Sequence, for example the name of an operator or a batch number of parts or any other information. The entered text will be saved in the result file.

To display the drop-down list of steps, click on the icon:



Choose from the list of steps the Enter keyboard function:



It is displayed as follows:



See Sequence General rules in 11-1.

It is possible to give a title to keyboard input

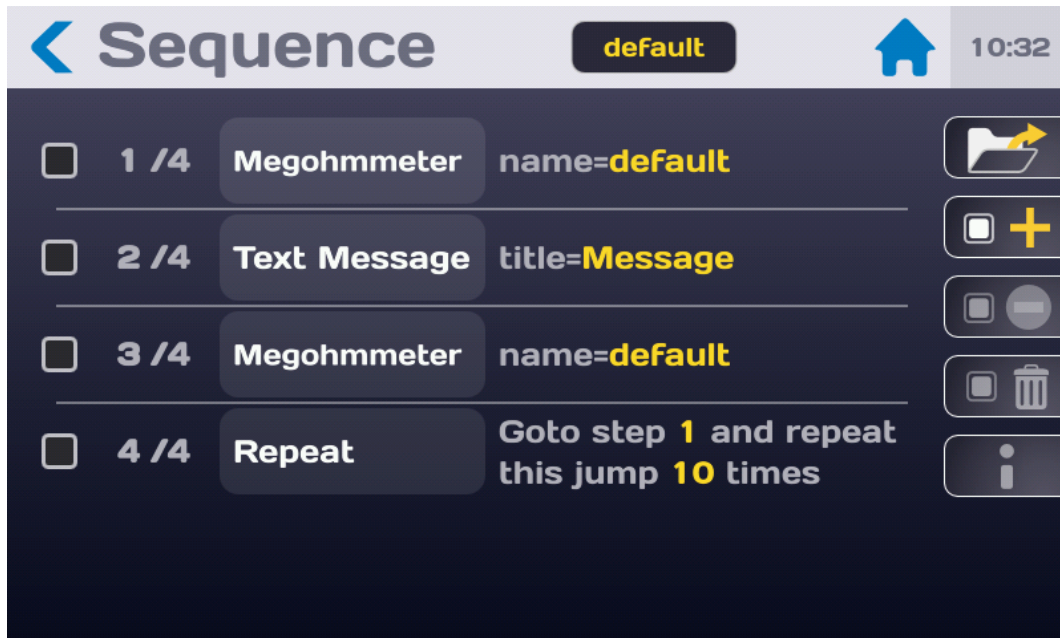
- Tap on the yellow zone of the keyboard entry line
- Press the Edit title field
- A keyboard is displayed
- Enter the title of the keyboard entry, eg Operator name:

When running the Sequence in the Key Input step, the input keyboard will be displayed with the title of the input allowing the operator to enter the requested data.

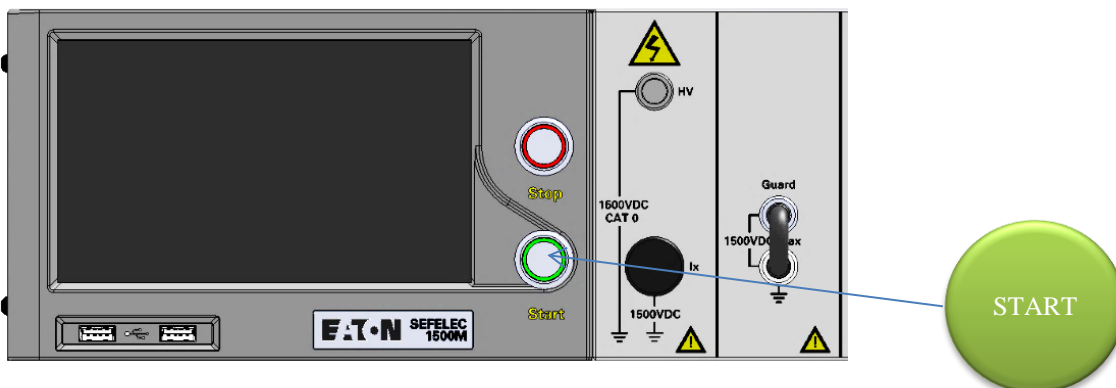
11.2. RUNNING A SEQUENCE

Either a "default" name sequence calling a megohmmeter function with a parameter set called "default" followed by a text message and a call to a megohmmeter function with a set of parameters called "default" and a loopback 100 times.

This corresponds to the following sequence:



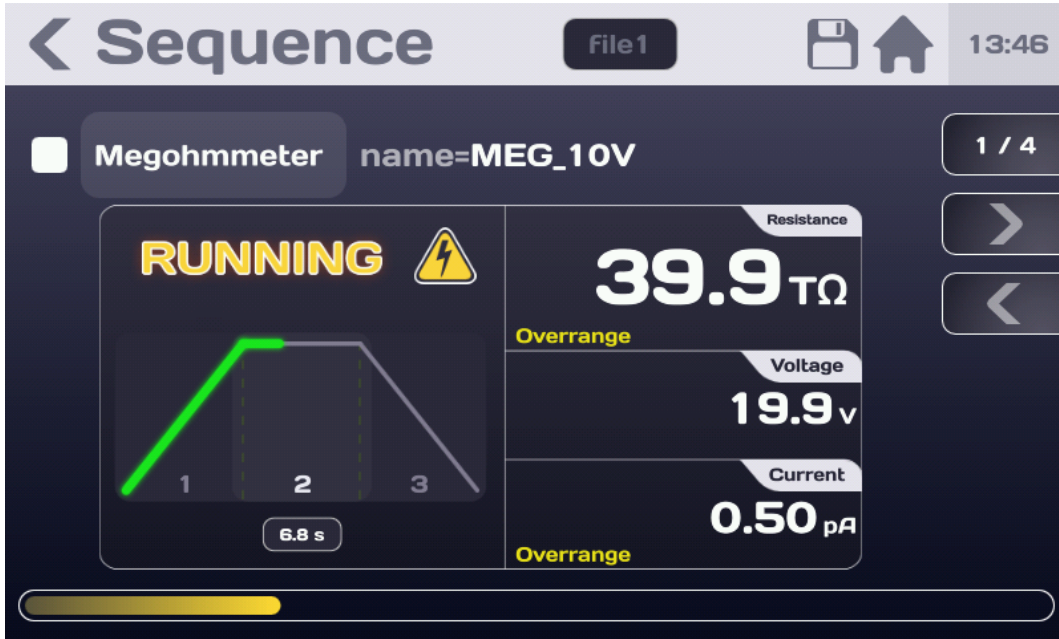
When the START button on the front panel of the device is lit in green, it is then possible to start the sequence



NOTE

Press the START pushbutton. For security reasons, it is necessary to press for a time > 1 second for the device to enter the MEASURE mode, in case of too brief press an information message will be displayed momentarily on the LCD screen.

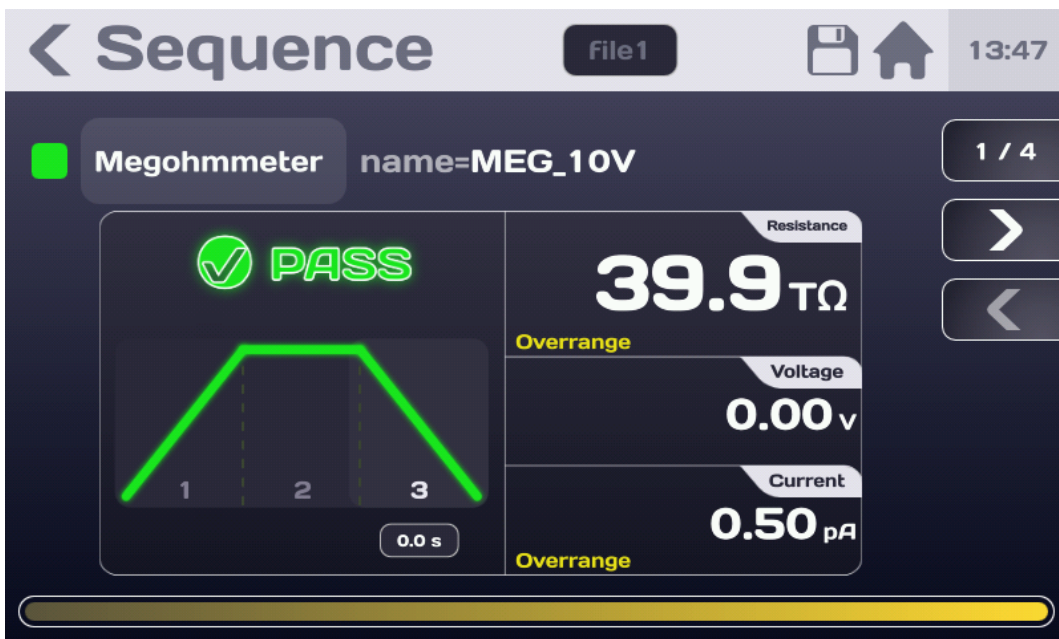
The first step of the sequence will execute by displaying a measurement screen in Megohmmeter mode:



The yellow progress bar at the bottom of the screen indicates the relative position of the step in the sequence.

At the end of the measurement, the next step will display a text message

Then the sequence will go to the second measurement in Megohmmeter mode:

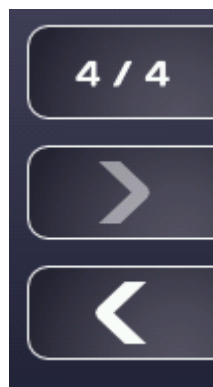


At the end of the n times repetition, the sequence will be finished with a synthesis of the measurement results:

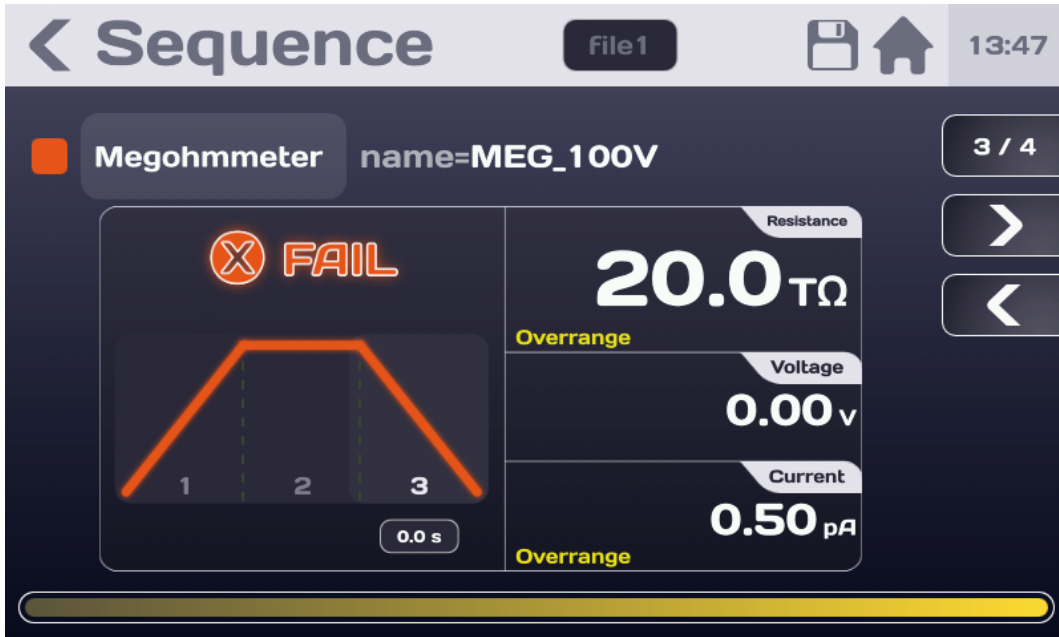


In this example, the result of the sequence is BAD because of step 3/3 measurement in Megohmmeter mode with the parameter file "MEG_100V".

It is possible to review the screens of the different steps with the navigation keys:

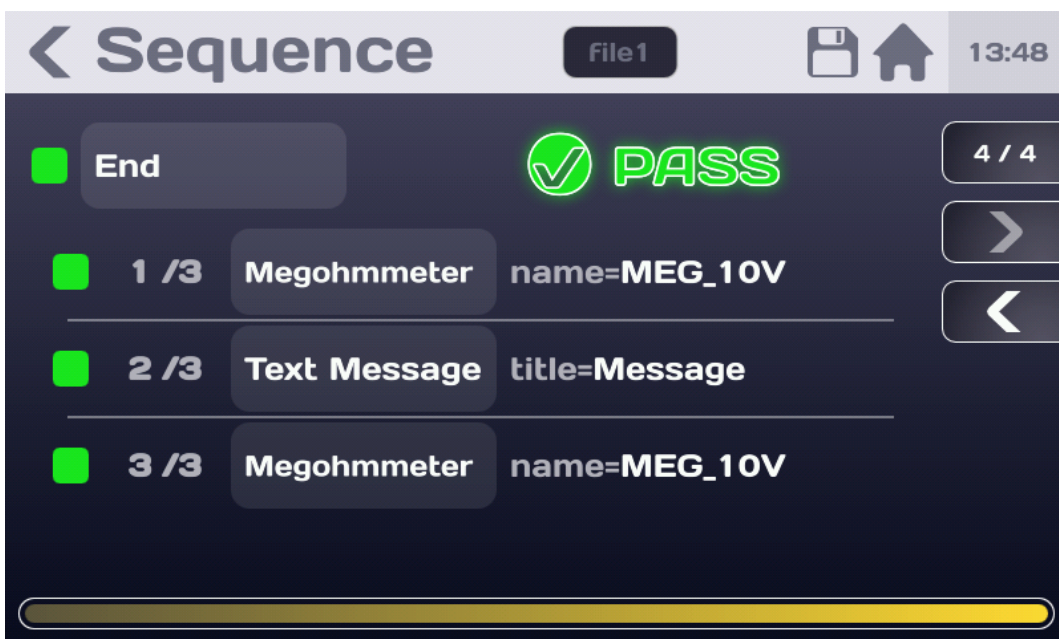


Press the Left arrow key to display the screen for the last step:



With the arrow keys to the right and to the left it is possible to display all the steps of the sequence.

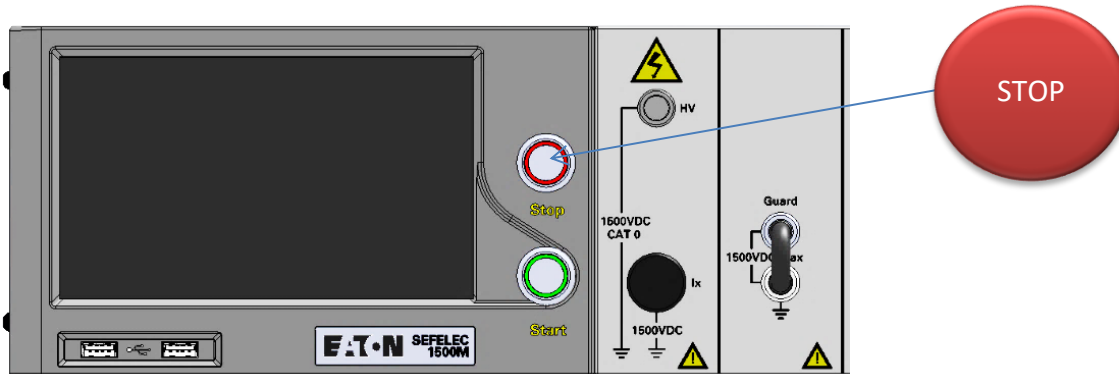
Case of a PASS sequence result:



To finish the sequence completely, press the STOP button illuminated in red



Before disconnecting the measured component, press the STOP push-button to confirm the stop of the high-voltage generation and discharge the component.



This action makes it possible to return to the initial Sequence screen either to change parameters or to redo a new measurement sequence by pressing the START pushbutton.

12. PLC INTERFACE (PROGRAMMABLE LOGIC CONTROLLER)



The PLC function (Programmable Logic Controller) must be selected in the configuration menu (INTERFACE: PLC).

NOTE



The role of the programmable logic controller (PLC) is to allow for the control of the measuring instrument by a system of the programmable logic controller type.



Implementing the safety loop circuit is indispensable. Controlling the device via PLC and therefore generating a dangerous voltage can be done from a point where visual control on the device is not possible.

IMPORTANT

12.1. ELECTRICAL CHARACTERISTICS OF THE SIGNALS

INPUTS:

- Number: 11
- Type: Optoelectronic
- Input resistance: 2.2 k Ω
- Uminimum: 11 VDC
- Umaximum: 43 VDC

OUTPUTS

- Number: 9
- Type: Photo relay
- Maximum voltage: 48 VDC
- Maximum current / output: 100 mADC
- Resistance in closed state < 1.2 Ω

12.2. LOGIC STATE CONVENTIONS

INPUT

Logic high is defined by the presence of DC voltage between Umin and Umax.
Logic low is defined by the absence of voltage.

OUTPUT

Logic high is defined as a closed contact.
Logic low is defined as an open contact.

12.3. CONNECTIONS

The input-output signals can be accessed on the rear panel of the device on terminal blocks C6, C7 and C8



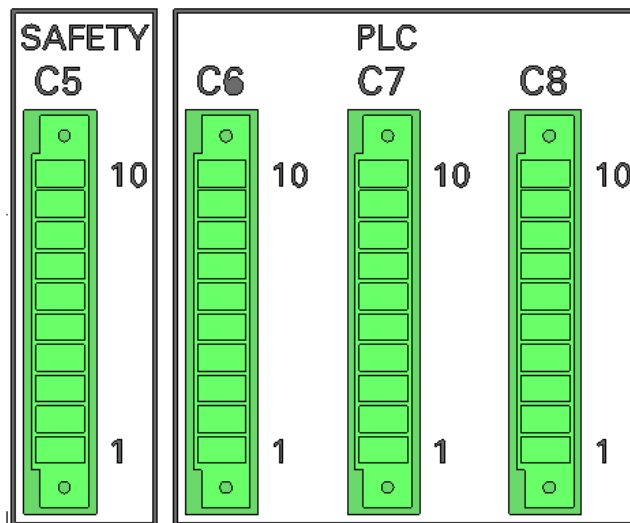
Each terminal block has a mechanical coding device

NOTE

| Connector C6 | | Connector C7 | | Connector C8 | |
|--------------|-----------------------|--------------|------------|--------------|-------------------|
| 1 | IN_OUT_0-10V_0 | 1 | TYPE | 1 | N4 |
| 2 | IN_OUT_0-10V_1 | 2 | MESDCH | 2 | N5 |
| 3 | GND10V | 3 | IN_0-10V_3 | 3 | N6 |
| 4 | +24VDC ⁽¹⁾ | 4 | COMOUT | 4 | N7 |
| 5 | COMIN | 5 | CTRLOUT | 5 | SR0 |
| 6 | CTRLIN | 6 | PLCFAIL | 6 | SR1 |
| 7 | N0 | 7 | EOT | 7 | SR2 |
| 8 | N1 | 8 | PLCPASS | 8 | SR3 |
| 9 | N2 | 9 | ERROR | 9 | IN_0-10V_2 |
| 10 | N3 | 10 | GND | 10 | NC ⁽²⁾ |

(1) Internal unregulated 24VDC power supply protected by a PTC resettable fuse, maximal current 1 A

(2) NC: not connected



12.4. DEFINITION OF THE INPUT-OUTPUT SIGNALS

COMIN (C6-5)

Electric common for the input signals.

COMOUT (C7-4)

Electric common for the output signals.

CTRLIN (Input C6-6)

Request to take control of the measuring instrument by the PLC.

MES_DCH (Input C7-2)

Switch to measurement or discharge.

- At logic high: Measurement.
- At logic low: Discharge.

TYPE (Input C7-1)

This input corresponds to the old selection of the XS series measurement function, with the Sefelec series:

- At logic low : shifts 256-position memory numbers (256-512)
- Logically high : does not shift memory numbers. (0-256)

N0, N1, N2, N3 (Input C6-7,8,9,10)

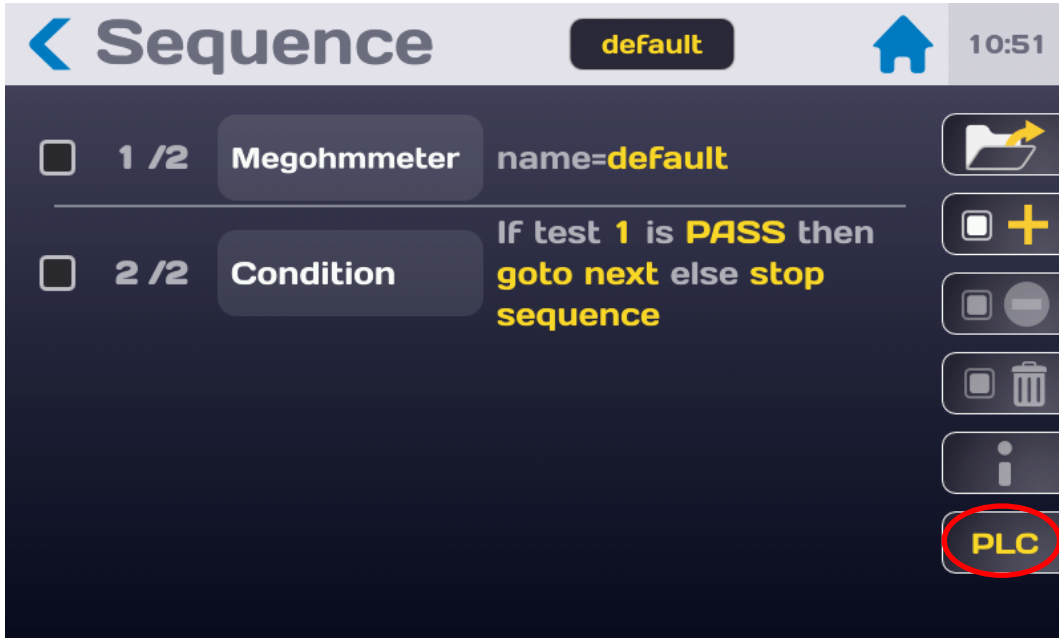
N4, N5, N6, N7 (Input C8-1,2,3,4)

Binary coding making it possible to select a parameter memory number and an associated file.

| N7 | N6 | N5 | N4 | N3 | N2 | N1 | N0 | Memory | Filename |
|------|------|------|------|------|------|------|------|--------|----------|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Nom1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | Nom2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | Nom3 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | Nom4 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | Nom5 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 5 | ... |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 6 | |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 7 | |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 8 | |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 9 | |
| | | | | | | | | | |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 255 | Nom256 |

The file names only correspond to Sequence files. To run a measurement function only, put only one call line of the desired function in the Sequence.

To match the memory numbers and Sequencing file names, go to the Sequence menu (refer to chapter 11 Sequence mode) and press the PLC key (the PLC interface must be selected in the General Settings menu):



To display the following correspondence table:

The screenshot shows the 'PLC Memory' screen with a home icon and the time 10:51. A table displays the correspondence between memory addresses and file names:

| Memory | File name |
|--------|-----------|
| 0 | file1 |
| 1 | file2 |
| 2 | default |
| 3 | No File |
| 4 | No File |
| 5 | file1 |

A red oval highlights the left side of the table, indicating the memory numbers.

View the memory number by swiping the screen up or by pressing the elevator area on the left of the screen. On the line of the selected memory number, press the yellow File Name box to display the list of Sequence File names available. Choose the file by pressing on its name. It is now associated with the memory number.

CTRLOUT (Output C7-5)

Validation contact for taking control of the device by the PLC.

EOT (Output C7-7)

End of test contact

PLCPASS (Output C7-8)

Test result contact: pass

PLCFAIL (Output C7-6)

Test result contact: fail

ERROR (Output C7-9)

Indicates if an error occurred during the test , the SR0 to SR3 outputs provide the error type.

SR0 à SR3 (Output C8-5,6,7,8)

Error type coding :

| SR3 | SR2 | SR1 | SR0 | Error type |
|-----|-----|-----|-----|------------------|
| 0 | 0 | 0 | 0 | SAFETY LOOP OPEN |
| 0 | 0 | 0 | 1 | UNDER RANGE |
| 0 | 0 | 1 | 0 | OVER RANGE |
| 0 | 0 | 1 | 1 | CHARGING |
| 0 | 1 | 0 | 0 | VOLTAGE ERROR |
| - | - | - | - | ... |
| 1 | 1 | 1 | 1 | |

IN_OUT_0-10V_0 (Output C6-1)

0-10VDC analog output - configurable

IN_OUT_0-10V_1 (Output C6-2)

0-10VDC analog output - configurable

IN_0-10V_2 (Input C8-9)

0-10VDC analog input - configurable

IN_0-10V_3 (Input C7-3)

0-10VDC analog input – configurable

12.5. MEASUREMENT-DISCHARGE CYCLE



NOTE

The PLC function (Programmable Logic Controller) must be selected in the configuration menu (INTERFACE : PLC).

To take a measurement (See diagram no. 2)

- Activate the CTRLIN signal (logic High).
- The PLC must specify the measurement function on the TYPE input.
- The PLC must select a parameter number which will be binary encoded on inputs N0 to N7, N0 being the least significant bit and N7 being the most significant bit.
- Set the MES_DCH signal to logic high to start the measurement. Note: the state of the inputs CTRLIN, TYPE, N0 to N7 are taken into account only on a rising front of the MES_DCH signal. This signal must be at logic high during the measurement.
- As soon as the first measurement is taken, the device sends a CTRLOUT signal that remains stable until validation (by a rising front of the MES_DCH signal) of the setting to logic low of the CTRLIN signal. Other signals can appear according to the unfolding of the test: an error signal (ERROR), and end of test signal (EOT), and a signal that indicates if the test is good or bad (PLCPASS or PLCFAIL). All of these signals are active at logic high.

To switch to discharge, simply set the MES_DCH signal to a low level. To return control to the device, delete the logic high on the CTRLIN signal, activate a logic high on MES_DCH, and deactivate it (see diagram no. 1).

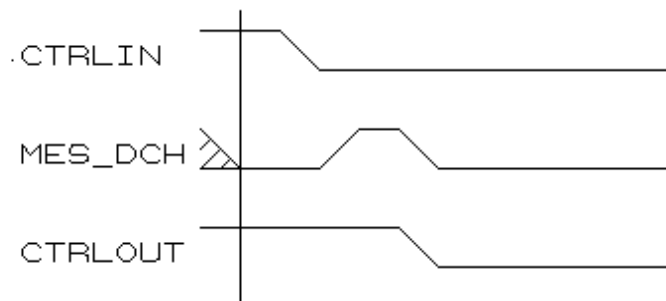


Diagram no. 1: Deactivation of the CTRLOUT signal

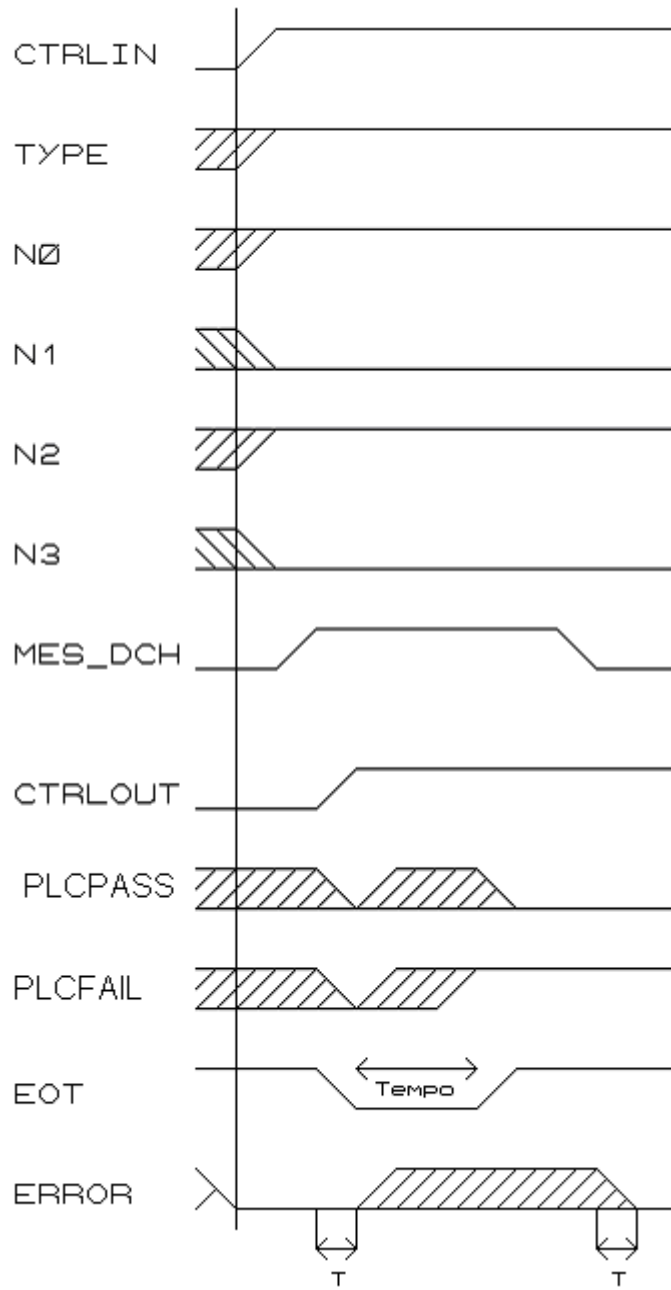


Diagram no. 2: Running an insulation test

Memory 5 - Test result fail.

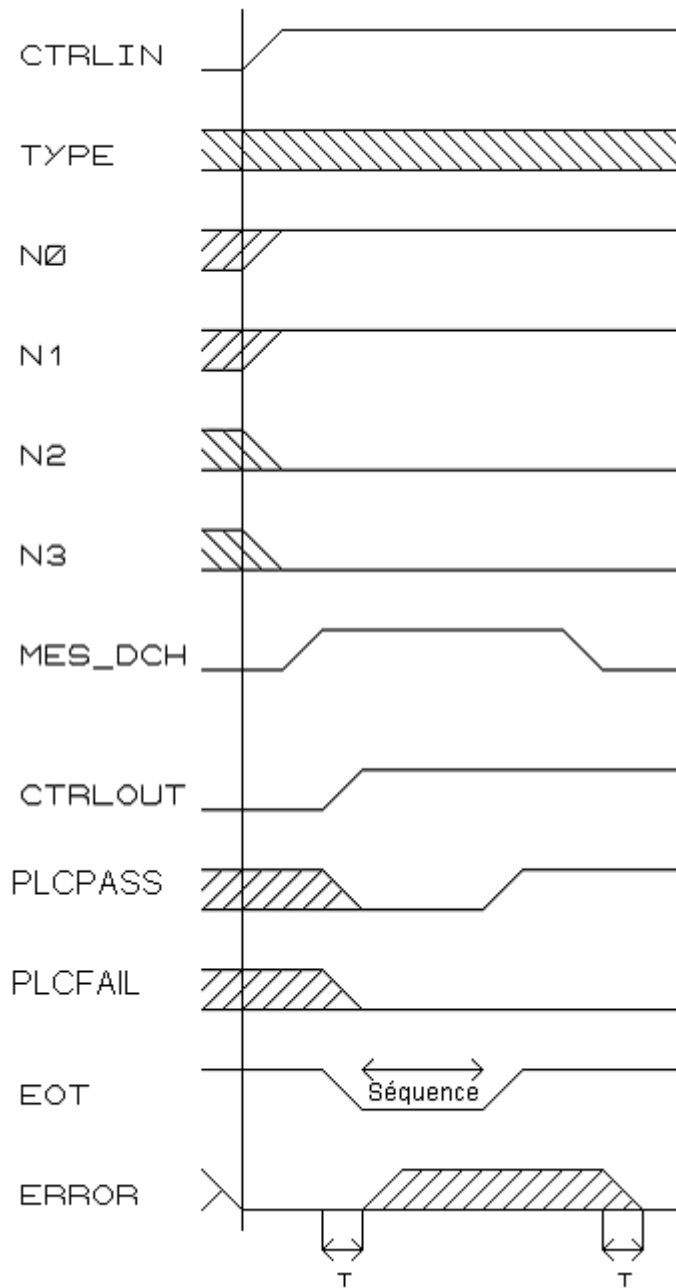


Diagram no. 3: Execution of a sequence.

Memory 3 - Result pass.

PLC SYSTEM

DEVICE

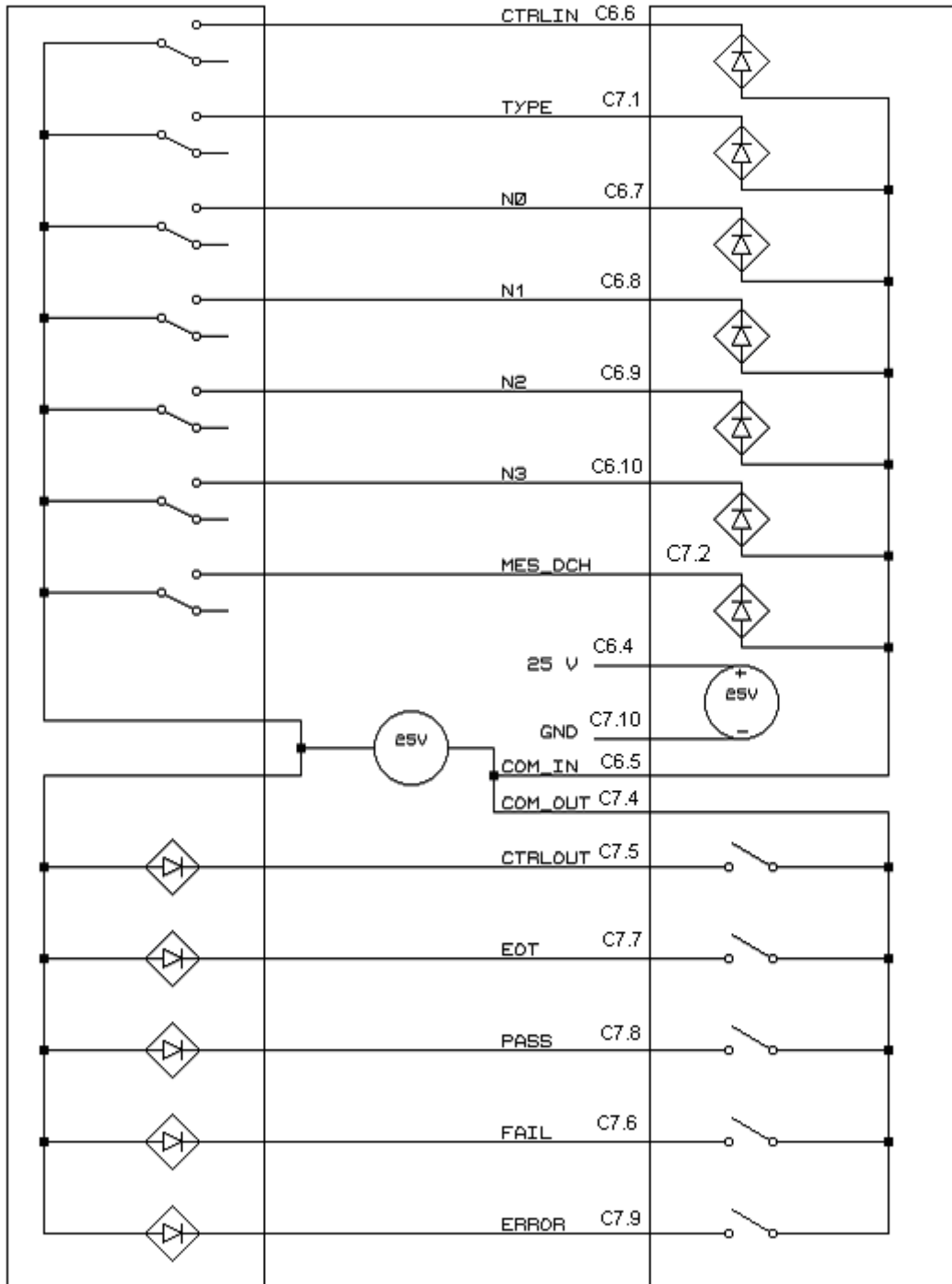


Diagram no. 4: Wiring of the PLC option with an external power supply.

PLC SYSTEM

DEVICE

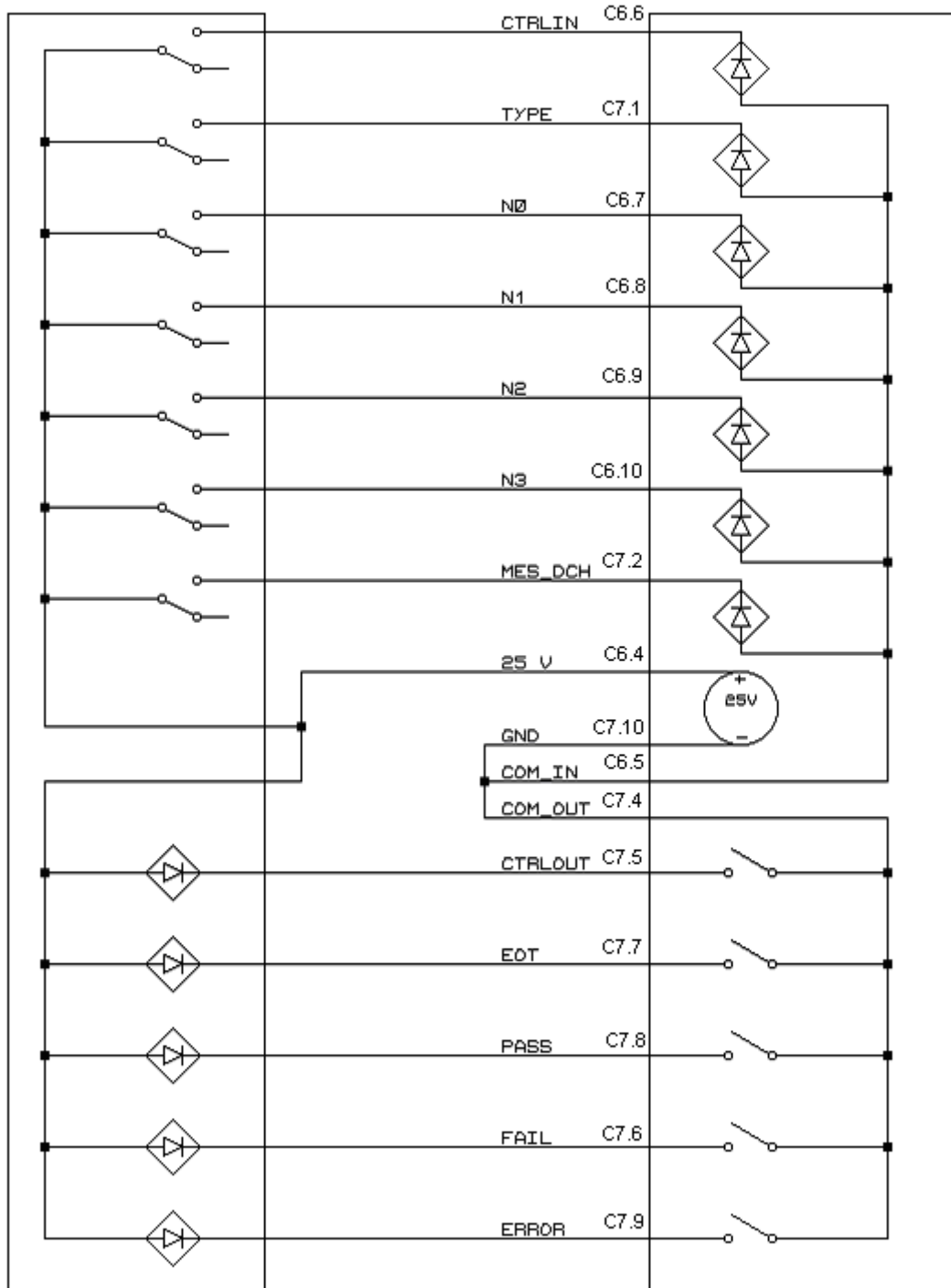


Diagram no. 5: Wiring of the PLC option with the internal power supply of the measuring device.

13. 0-10VDC INPUT -OUTPUT – OPTION SEFO-5X0-10V

This function allows the device to deliver an analog voltage proportional to the measurements displayed on the LCD screen (insulation resistance or leakage currents). This voltage can be connected to a multimeter or to a plotter to monitor and record the evolution of the measurement.

A configuration of the analog outputs by menu allows the selection of the different operating modes.

| | | Sefelec 1500-M | | | |
|------|----------------|----------------|-----------|-----------|-----------|
| | | Tera Ohm | Tera Ohm | pA | pA |
| | | 1 x OUT | 2 x OUT | 1 x OUT | 2 x OUT |
| C6-1 | IN_OUT_0-10V_0 | Out R log | Out R lin | Out I log | Out I lin |
| C6-2 | IN_OUT_0-10V_1 | | Out range | | Out range |

13.1. TERAOHMMETER AND PICOAMMETER MODE

- Output voltage: From 0 to 10 V dc in steps of 10 mV.
- Input voltage: 0 to 10 V dc
- Output impedance: 1 k Ω at +/- 5%.
- Insulation: Not isolated, the mass is connected to the earth.
- Accuracy of the output voltage in relation to the displayed value:
 - in linear mode : +/- (0.1% + 20 mV)
 - in logarithmic mode : +/- (0.1% + 20 mV)

Connection (C6 connector on the rear panel)

| Connecteur C6 | |
|----------------------|-----------------------|
| 1 | IN_OUT_0-10V_0 |
| 2 | IN_OUT_0-10V_1 |
| 3 | GND10V |
| 4 | +24VDC ⁽¹⁾ |
| 5 | COMIN |
| 6 | CTRLIN |
| 7 | N0 |
| 8 | N1 |
| 9 | N2 |
| 10 | N3 |

13.1.1.1. LINEAR MODE ET TERAOHMMETER CONFIGURATION 2 OUTPUTS :

From 0 to 10 VDC per decade of measurement for insulation values ranging from 200.0kΩ to 2000TΩ.

Point 1 of connector C6 gives the measured resistance range (V0).

Point 2 of connector C6 gives the resistance value in the range (V1).

- V1 (C6-2): value in the range: from 0 to 10 V depending on the mantissa of the displayed value.

| Displayed value | Output voltage |
|-----------------|----------------|
| 0.201 M Ω | 1.000 VDC |
| 2.000 M Ω | 10.00 VDC |
| 02.01 M Ω | 1.000 VDC |
| 20.00 M Ω | 10.00 VDC |
| ----- | ----- |

- V0 (C6-1) : value in the range :

| Range | Min. | Max. | Voltage |
|-------|-----------|-----------|---------|
| 0 | 0.200 M Ω | 2.000 M Ω | 0 VDC |
| 1 | 02.00 M Ω | 20.00 M Ω | 1 VDC |
| 2 | 020.0 M Ω | 200.0 M Ω | 2 VDC |
| 3 | 0.200 G Ω | 2.000 G Ω | 3 VDC |
| 4 | 02.00 G Ω | 20.00 G Ω | 4 VDC |
| 5 | 020.0 G Ω | 200.0 G Ω | 5 VDC |
| 6 | 0.200 T Ω | 2.000 T Ω | 6 VDC |
| 7 | 02.00 T Ω | 20.00 T Ω | 7 VDC |
| 8 | 020.0 T Ω | 200.0 T Ω | 8 VDC |
| 9 | 0200 T Ω | 2000 T Ω | 9 VDC |

The resistor value is given by the following formula:

$$R = 2 \times V1 \times 10^{(V0+2)} \text{ k}\Omega$$

In example: If $V1 = 5.2 \text{ V}$ and $V0 = 1.0 \text{ V}$ then $R = 10.4 \text{ M}\Omega$

Accuracy of the 0-10V output voltage:

- V1 versus display: $\pm(0.1\% + 20 \text{ mV})$ versus the displayed value.
- V0 versus display: $\pm(0.1\% + 200 \text{ mV})$ versus the displayed value.

13.1.2. LINEAR MODE AND PICOAMMETER CONFIGURATION 2 OUTPUTS :

From 0 to 10 VDC per decade of measurement for current values ranging from 0.50pA to 20.00mA (3.00mA if limitation option)

Point 1 of connector C6 gives the measured current range (V0).

Point 2 of connector C6 gives the current value in the range (V1).

- V1(C6-2): value in the range: from 0 to 10 V depending on the mantissa of the displayed value.

| Displayed value | Output voltage |
|-----------------|----------------|
| 0.201 μ A | 1.000 VDC |
| 2.000 μ A | 10.00 VDC |
| 02.01 μ A | 1.000 VDC |
| 20.00 μ A | 10.00 VDC |
| ----- | ----- |

- V0(C6-1): range value.

| Range | Min. | Max. | Voltage |
|-------|---------------|---------------|---------|
| 0 | 02.00pA | 20.00pA | 0 VDC |
| 1 | 020.0pA | 200.0pA | 1 VDC |
| 2 | 0.200nA | 2.000nA | 2 VDC |
| 3 | 02.00nA | 20.00nA | 3 VDC |
| 4 | 020.0nA | 200.0nA | 4 VDC |
| 5 | 0.200 μ A | 2.000 μ A | 5 VDC |
| 6 | 02.00 μ A | 20.00 μ A | 6 VDC |
| 7 | 020.0 μ A | 200.0 μ A | 7 VDC |
| 8 | 0.200mA | 2.000mA | 8 VDC |
| 9 | 02.00mA | 20.00mA | 9 VDC |

13.1.3. LOGARITHMIC MODE AND THERAOHMMETER CONFIGURATION 1 OUTPUT :

From 0 to 10 VDC per decade of measurement for insulation values ranging from 200.0kΩ to 2000TΩ with a logarithmic progression of the voltage.

Insulation resistance values as a function of analog voltage in logarithmic mode:

Each measurement range corresponds to a voltage according to table TB1 below:

| Range | Min. | Max. | Voltage |
|-------|-----------|-----------|---------|
| 0 | 0.200 M Ω | 2.000 M Ω | 0 VDC |
| 1 | 02.00 M Ω | 20.00 M Ω | 1 VDC |
| 2 | 020.0 M Ω | 200.0 M Ω | 2 VDC |
| 3 | 0.200 G Ω | 2.000 G Ω | 3 VDC |
| 4 | 02.00 G Ω | 20.00 G Ω | 4 VDC |
| 5 | 020.0 G Ω | 200.0 G Ω | 5 VDC |
| 6 | 0.200 T Ω | 2.000 T Ω | 6 VDC |
| 7 | 02.00 T Ω | 20.00 T Ω | 7 VDC |
| 8 | 020.0 T Ω | 200.0 T Ω | 8 VDC |
| 9 | 0200 T Ω | 2000 T Ω | 9 VDC |

A value corresponding to the following formula should be added to each of these voltages:

Log10 (Number of displayed points / 200)

For example, the measurement of a resistance of 100 MΩ :

The display will give: 100.0 MΩ which will correspond to range 2 of table TB1.

The analog output voltage will be equal to: 2 VDC + Log (1000/200) = 2.6989 VDC

Conversely, to find the display from the analog voltage, proceed as follows:

- measure the output voltage with a multimeter, for example 2.6989 VDC
- subtract the number of volts, i.e. 2 VDC in our example, which gives us the display format of the range according to table TB1: xxx.x MΩ
- Calculate the number of display points according to the formula:

$$\begin{aligned}
 200 \times 10^{(U_{\text{measured}} - U_{\text{range}})} &= 200 \times 10^{(2.6989 - 2)} = 200 \times 10^{(0.6989)} \\
 &= 200 \times 5 = 1000 \text{ points of display on a format: xxx.x M}\Omega \\
 &= 100.0 \text{ M}\Omega
 \end{aligned}$$

13.1.4. LOGARITHMIC MODE PICOAMMETER CONFIGURATION 1 OUTPUT :

From 0 to 10 VDC per decade of measurement for current values ranging from 2.00pA to 20.00mA with a logarithmic progression of the voltage, for example:

Current values as a function of analog voltage in logarithmic mode:

Each current measurement range corresponds to a voltage according to the table [TB2] below:

| Range | Min. | Max. | Voltage |
|-------|---------|---------|---------|
| 0 | 02.00pA | 20.00pA | 0 VDC |
| 1 | 020.0pA | 200.0pA | 1 VDC |
| 2 | 0.200nA | 2.000nA | 2 VDC |
| 3 | 02.00nA | 20.00nA | 3 VDC |
| 4 | 020.0nA | 200.0nA | 4 VDC |
| 5 | 0.200μA | 2.000μA | 5 VDC |
| 6 | 02.00μA | 20.00μA | 6 VDC |
| 7 | 020.0μA | 200.0μA | 7 VDC |
| 8 | 0.200mA | 2.000mA | 8 VDC |
| 9 | 02.00mA | 20.00mA | 9 VDC |

A value corresponding to the following formula should be added to each of these voltages:

Log10 (Number of displayed points / 200)

As an example, the measurement of a current of 100 nA:

The display will give: 100.0 nA which corresponds to range 4 of table TB2.

The analog output voltage will be equal to: 4 VDC + Log (1000/200) = 4.6989 VDC

Conversely, to find the display from the analog voltage, proceed as follows:

- measure the output voltage with a multimeter: 4.6989 VDC

- subtract the number of volts, i.e. 4 VDC in our example, which gives us the display format of the range according to table TB2: xxx.x nA

- Calculate the number of display points according to the formula:

$$200 \times 10^{(U_{\text{measured}} - U_{\text{range}})} = 200 \times 10^{(4,6989 - 4)}$$

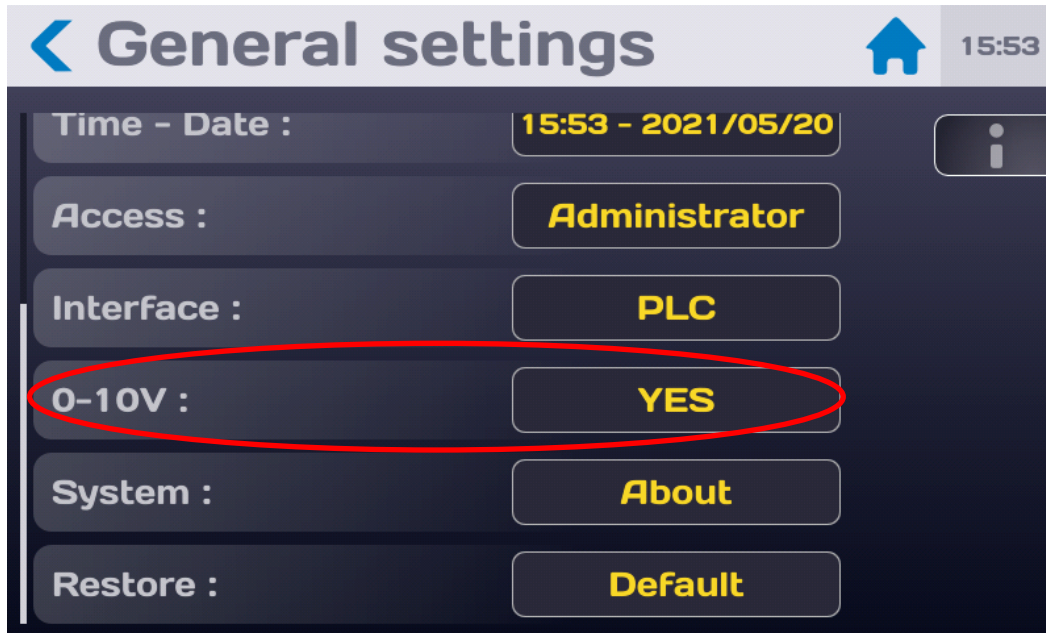
$$= 200 \times 10^{(0,6989)}$$

$$= 200 \times 5 = 1000 \text{ points of display on a format : xxx.x nA}$$

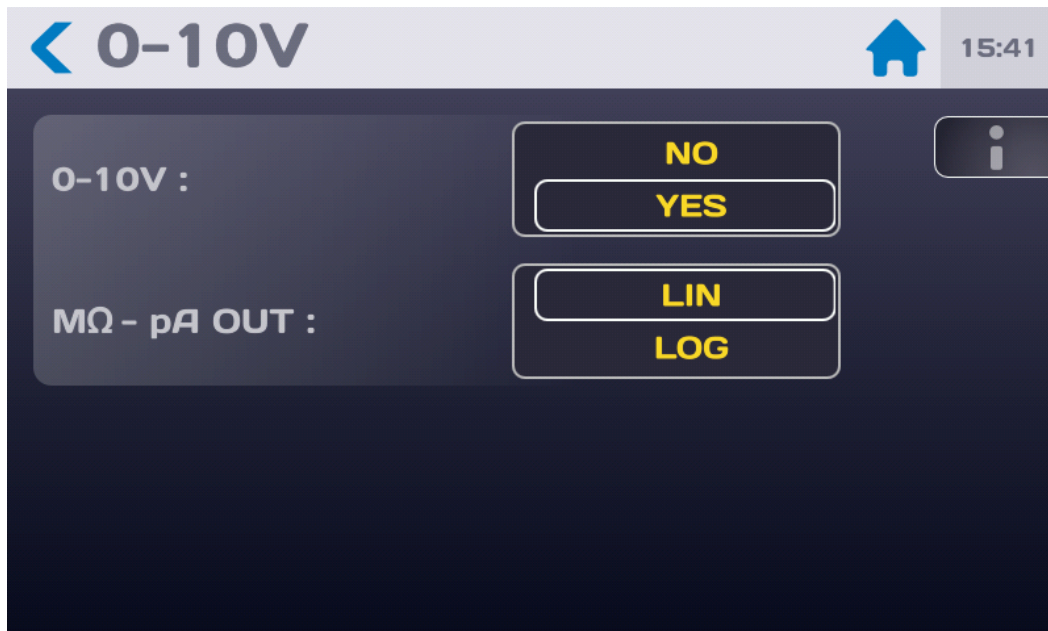
$$= 100.0\text{nA}$$

13.2. OPERATING MODE

The configuration of the analog inputs-outputs is done from the General Settings menu (gear wheel) accessible from the device start screen.



To modify the parameters of the 0-10VDC function, press the key marked in yellow on the 0-10V line to access the following menu:



Select the activation of the 0-10V function by YES or NO.

Select linear (LIN) or logarithmic (LOG) mode. See the operation of these modes in paragraphs 1.1.1 to 1.1.4

The activation of the 0-10V function is recalled in the measurement screens in Megohm-meter and Picoammeter mode by a green icon as below:

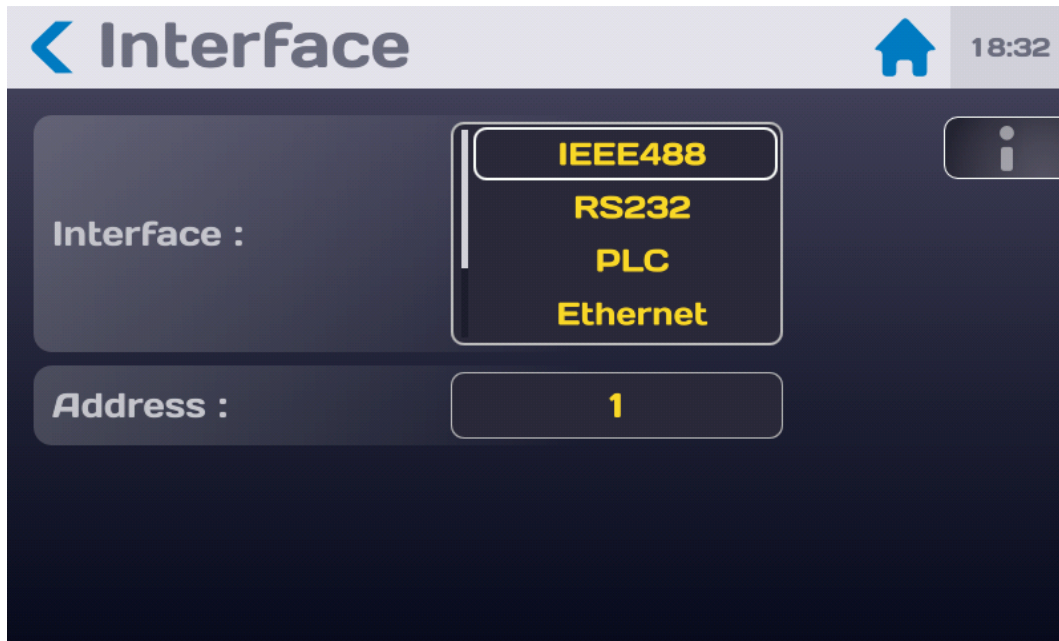


14. IEEE488-2 (GPIB) INTERFACE



NOTE

The IEEE488-2 function must be selected in the configuration menu, INTERFACE line: IEEE488. Enter the value of the address of the device between 0 and 30.



SEFELEC1500M test and measuring instruments can be equipped with an interface of the IEEE488 type. It allows all of the instruments in the range to be integrated into an automatic test or measuring system, whether intended for manufacturing control or for input control. The interface can be accessed through a connector located on the rear panel of the device.



IMPORTANT

Implementing the safety loop circuit is indispensable. Controlling the device via IEEE488-2 and therefore generating a dangerous voltage can be done from a point where visual control on the device is not possible.

14.1. SYNTAX RULES

A command intended for the device preferably ends with the character: **LF** (hexadecimal **0A**, decimal **10**).

Codes can be sent in upper or lower case. The maximum number of commands in the same block cannot exceed 15 instructions. **Be careful not to associate standard commands or requests with other types of commands.**

The events that occur during the measurement can be reported to the computer through emitting a **SRQ** (format error, end of test, open safety circuit, etc.). To activate this function, the code **SRQ** must be sent after the device has initialised. When such an event occurs, the internal registers of the IEEE controller (**STB,SRE...**) must be checked in order to obtain more precision on the reasons for the event.

In the case of incorrect syntax the message **DIALOGUE ERROR: 1** is displayed. In the case of a code that is out of context the message **DIALOGUE ERROR: 2** is displayed (specific code for a function when we are not in this function, or numerical value out of bounds).

14.2. SUPPORTED IEEE-488-1 FUNCTIONS

SH1,AH1,T6,L4,SR1,RL1,PP0,DC1,DT0,C0

14.3. LIST OF IEEE488 COMMANDS

The syntax of the commands sent over the **IEEE-488** connection was made compliant with the **IEEE488-2** standard (1992 revision).

Reminder of the numerical formats according to standard **IEEE488-2**:

Format **NR1**: +/-<digit>...<digit>

Format **NR2**: +/-<digit>...<digit>.<digit>...<digit>

Format **NR3**: +/-<digit>...<digit>.<digit>...<digit>E+/-<digit>...<digit>

NOTE: The code in parentheses are the expanded codes that can be interpreted by the device.

The command set of the **IEEE488** option is the same as that for the **RS232** interface. It is described in detail in the paragraph **RS-232C Interface**.

15. ETHERNET INTERFACE



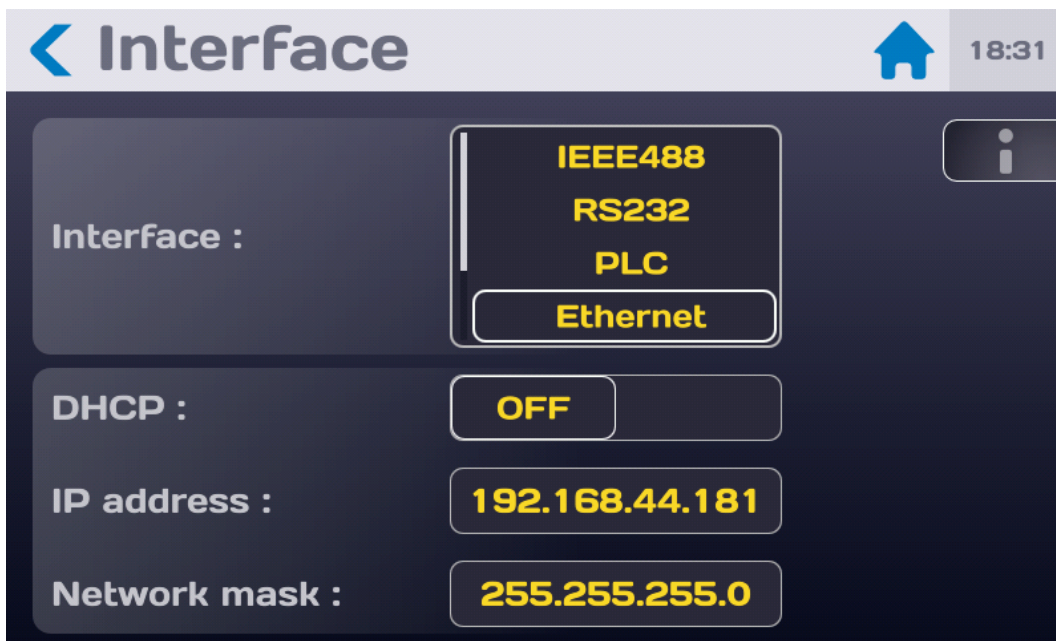
NOTE

The ETHERNET function must be selected in the configuration menu, INTERFACE line: ETHERNET



IMPORTANT

To enable the ETHERNET interface, it is mandatory to enter an Administrator password.



The test and measuring instruments of the SEFELEC series can be equipped with an interface of the Ethernet type. It allows all of the instruments in the range to be integrated into an automatic test or measuring system, whether intended for manufacturing control or for input control.

The interface can be accessed through a RJ45 connector located at the rear of the device.



Implementing the safety loop circuit is indispensable. Controlling the device via Ethernet and therefore generating a dangerous voltage can be done from a point where visual control on the device is not possible.

15.1. CYBER SECURITY RECOMMENDATIONS

SEFELEC 1500-M unit has been designed with cyber security as a major consideration. A number of features are offered in the product to address cyber security risks. These Cybersecurity Recommendations provide information to help users to deploy and maintain the product in a manner that minimizes the cybersecurity risks. These Cybersecurity recommendations are not intended to provide a comprehensive guide to cybersecurity, but rather to supplement customers' existing cybersecurity programmes.

EATON is committed to minimizing the cybersecurity risk in its products and deploying cybersecurity best practices in its products and solutions, making them more secure, reliable and competitive for customers.

15.1.1. ASSET MANAGEMENT:

Keeping track of software and hardware assets in your environment is a pre-requisite for effectively managing cybersecurity. EATON recommends that you maintain an asset inventory that identifies each important component individually. To facilitate this, SEFELEC 5x Range supports the following identifying information:

- Manufacturer, Type, serial number, F/W version number, and location. Most of this information is shown on a sticker at the back of the unit.

For the Firmware revision refer to Section 6.5 of the operating manual.

15.1.2. RISK ASSESSMENT:

EATON recommends conducting a risk assessment to identify and assess reasonably foreseeable internal and external risks to confidentiality, availability and integrity of the System | Device and its environment. This exercise should be conducted in accordance with applicable technical and regulatory frameworks such as IEC 62443. The risk assessment should be repeated periodically.

15.1.3. PHYSICAL SECURITY:

An attacker with unauthorized physical access can cause serious disruption to device functionality. Additionally, Industrial Control Protocols do not offer cryptographic protections, making ICS and SCADA communications especially vulnerable to threats to their confidentiality. Physical security is an important layer of defence in such cases. SEFELEC 5x is designed to be deployed and operated in a physically secure location.

Following are some best practices that EATON recommends to physically secure your device:

- Secure the facility and equipment rooms or closets with access control mechanisms such as locks, entry card readers, guards, man traps, CCTV, etc. as appropriate.
- Restrict physical access to cabinets and/or enclosures containing SEFELEC 5x and the associated system.

- Physical access to the telecommunication lines and network cabling should be restricted to protect against attempts to intercept or sabotage communications. It's a best practice to use metal conduits for the network cabling running between equipment cabinets

- SEFELEC 5x supports the following physical access ports: RS232C, USB, IEEE488-2, Ethernet, PLC. Refer to section 12 to 15 of the operating manual.

Access to these ports should be restricted.

- Do not connect removable media (e.g., USB devices) for any operation (e.g., firmware upgrade, configuration change, or boot application change) unless the origin of the media is known and trusted.

- Before connecting any portable device through a USB port, scan the device for malware and viruses.

15.1.4. ACCOUNT MANAGEMENT

Logical access to the device should be restricted to legitimate users, who should be assigned only the privileges necessary to complete their job roles/functions. Some of the following best practices may need to be implemented by incorporating them into the organization's written policies:

- Ensure default credentials are changed upon first login. SEFELEC 5x should not be deployed in production environments with default credentials, as default credentials are publicly known.
- No Account Sharing - Each user should be provisioned a unique account instead of sharing accounts and passwords. Security monitoring/logging features in the product are designed based on each user having a unique account. Allowing users to share credentials weakens security.
- Administrative restrict privileges - attackers seek to gain control of legitimate credentials, especially those for highly privileged accounts. Administrative privileges should be assigned only to accounts specifically designated for administrative duties and not for regular use.- Leverage the roles / access privileges, refer to Section 6.6 of the Manual of use to provide users with access in several levels depending on the needs of the business. Follow the principle of least privilege (Assign the minimum level of authority and access the system resources required for the role).
- Leverage the roles / access privileges, refer to section 6.6 of the operating manual to provide tiered access to the users as per the business /operational need. Follow the principle of least privilege (allocate the minimum authority level and access to system resources required for the role).
- Perform periodic account maintenance (remove unused accounts).
- Ensure password length, complexity and expiration requirements are appropriately set, particularly for all administrative accounts
- Enforce session time-out after a period of inactivity.

15.1.5. NETWORK SECURITY:

SEFELEC 5x supports network communication with other devices in the environment. This capability can present risks if it's not configured securely. Following are EATON recommended best practices to help secure the network.

EATON recommends segmentation of networks into logical enclaves, denying traffic between segments except that which is specifically allowed, and restricting communication to host-to-host paths (for example, using router ACLs and firewall rules). This helps to protect sensitive information and critical services and creates additional barriers in the event of a network perimeter breach. At a minimum, a utility Industrial Control Systems network should be segmented into a three-tiered architecture for better security control.

Communication Protection: -SEFELEC 5x provides the option to encrypt its network communications. Please ensure that encryption options are enabled. You can secure the product's communication capabilities by taking the following steps:

EATON recommends opening only those ports that are required for operations and protect the network communication using network protection systems like firewalls and intrusion detection systems / intrusion prevention systems.

15.1.6. REMOTE ACCESS:

Remote access to devices creates another entry point into the network. Strict management and validation of termination of such access is vital for maintaining control over overall ICS security. Refer to sections 12 to 15 of the operating manual for Remote access

15.1.7. LOGGING AND EVENTS MANAGEMENT

- EATON recommends logging all falling within system and application events, including all administrative and maintenance activities.

- Logs should be protected from tampering and other risks to their integrity (for example, by restricting permissions to access and modify logs, transmitting logs to a security information and event management system, etc.).

- Ensure that logs are retained for a reasonable and appropriate length of time.

- Review the logs regularly. The frequency of review should be reasonable, taking into account the sensitivity and criticality of the System | Device and any data it processes

15.1.8. MALWARE DEFENCES:

EATON recommends deploying adequate malware defences to protect the product or the platforms used to run the EATON product.

15.1.9. SECURE MAINTENANCE:

Best Practices

Update device firmware prior to putting the device into production. Thereafter, apply firmware updates and software patches regularly.

EATON publishes patches and updates for its products to protect them against vulnerabilities that are discovered. EATON encourages customers to maintain a consistent process to promptly monitor for and install new firmware updates.

Please check EATON's cybersecurity website for information bulletins about available firmware and software updates

15.1.10. BUSINESS CONTINUITY/ CYBERSECURITY DISASTER RECOVERY:

Plan for Business Continuity / Cybersecurity Disaster Recovery

EATON recommends incorporating SEFELEC 5x into the organization's business continuity and disaster recovery plans. Organizations should establish a Business Continuity Plan and a Disaster Recovery Plan and should periodically review and, where possible, exercise these plans. As part of the plan, important system | device data should be backed up and securely stored, including:

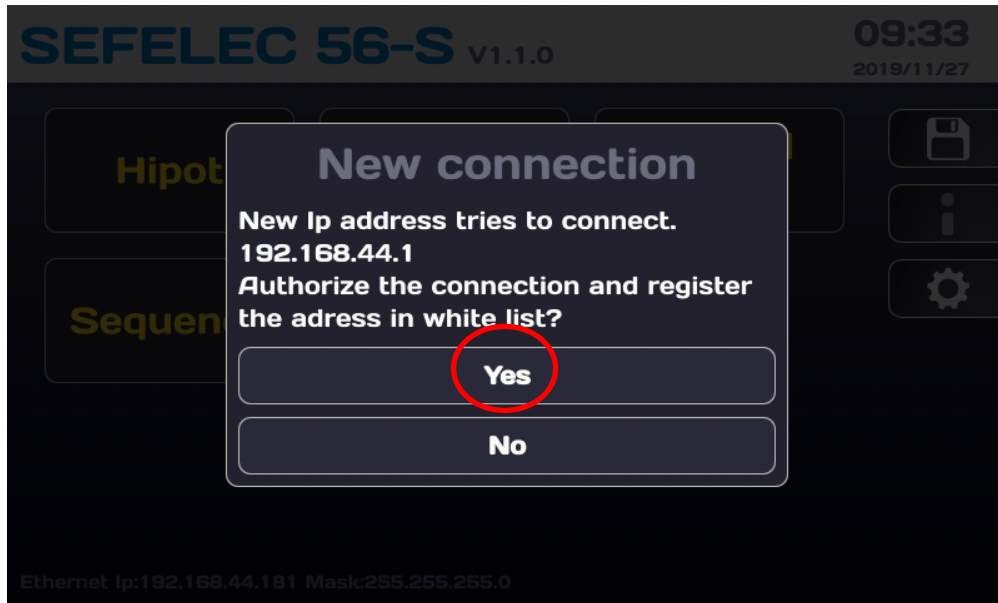
- Updated firmware for SEFELEC 5x. Make it a part of standard operating procedure to update the backup copy as soon as the latest firmware is updated.

- The current configuration.

- Documentation of the current permissions / access controls, if not backed up as part of the configuration.

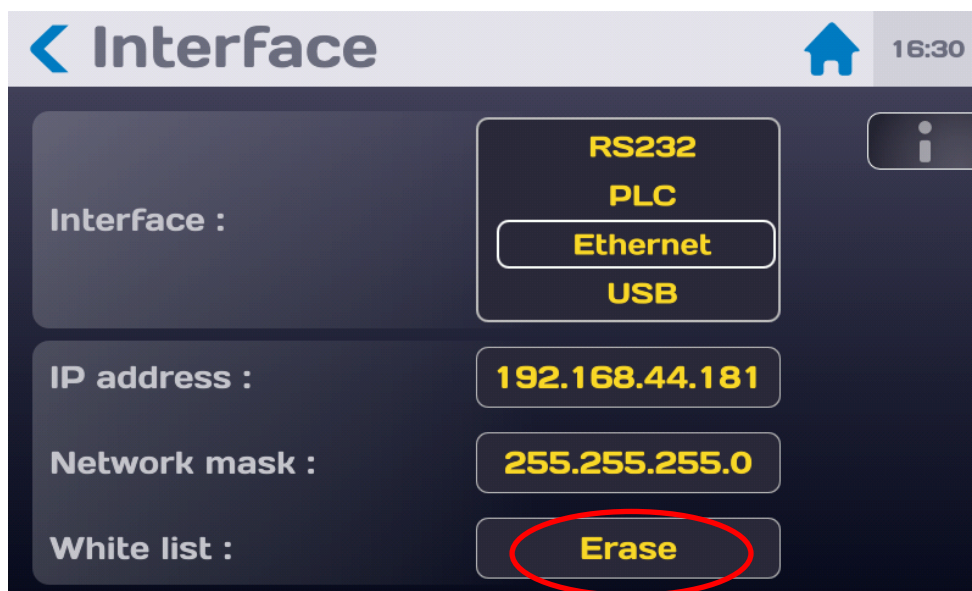
15.2. FIRST TIME CONNECTION - WHITE LIST

In order to reduce the risks of remote piracy of the devices of the SEFELEC 5x range, on first connection between a PC and the device, the following window will be displayed:



If the IP address is a known address, then validate the connection request by pressing YES to add the IP address into the list of permitted addresses (white list), if not press NO. Then repeat a connection attempt which will be accepted by the device without repeating the question.

It is possible to clear the list of permitted addresses (White list). From the Ethernet Interface menu, on the White list line, press Delete and confirm or not to the deletion of the all the authorised IP addresses.



15.3. CONNECTION EXAMPLES

15.3.1. SIMPLE CONNECTION BETWEEN A PC AND A DEVICE WITH A FIXED IP ADDRESS

In this configuration an **Ethernet crossover cable** must be used. In order to clearly identify the SEFELEC1500M device you will need to determine a fixed IP address for your device and for your PC.

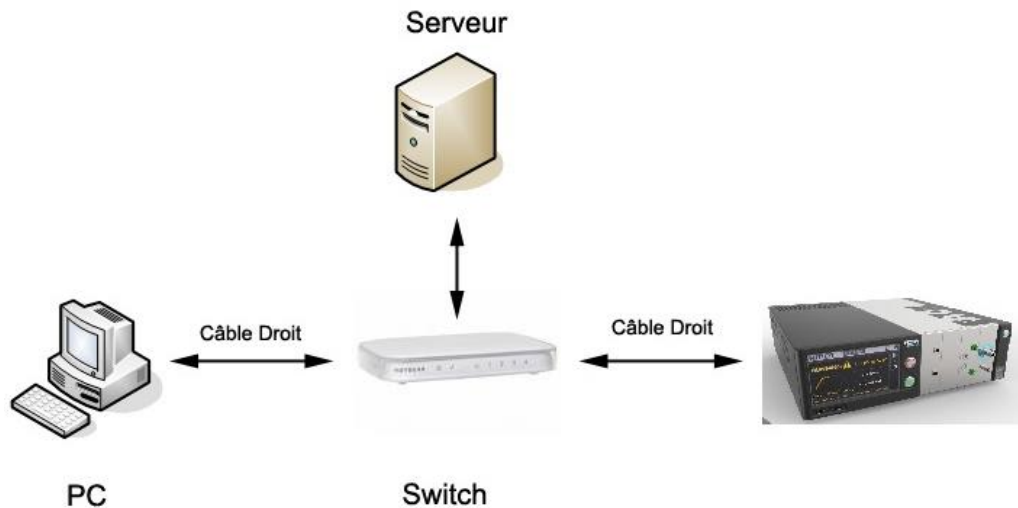


Example of IP addresses for this application:

| | PC | 5x range device |
|--------------|---------------|------------------------|
| IP Address | 192.168.0.1 | 192.168.0.2 |
| Network mask | 255.255.255.0 | 255.255.255.0 |

15.3.2. CONNECTION BETWEEN A PC AND A DEVICE THROUGH A NETWORK

In this configuration a **straight Ethernet cable (not crossed)** must be used. Check with your network administrator for the choice of the parameters for the device (IP address, Network mask, etc.)



Note

Most of the current switches are of the "auto sense" type. The connection to the switch can be done indifferently with a "straight" or "crossed" cable.

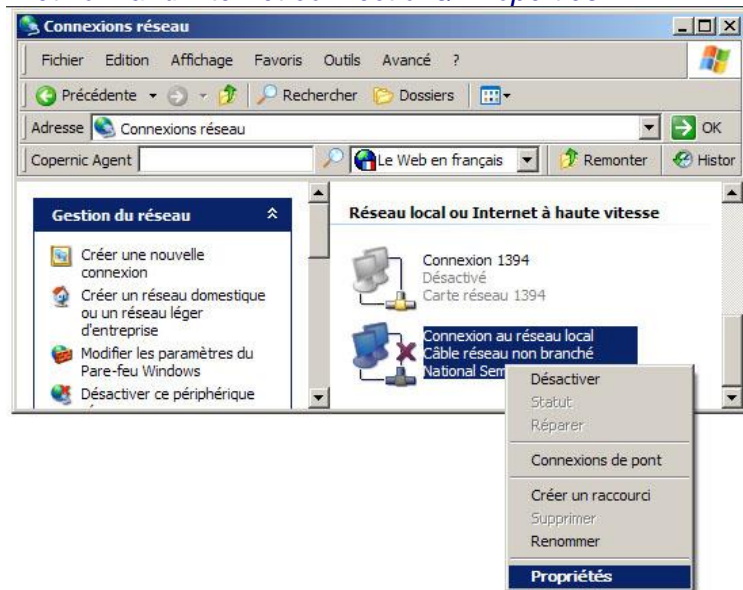
15.4. SETTING UP THE PC ETHERNET CARD UNDER WINDOWS

This paragraph relates only to the case of connection no. 1 and is of no use for case no. 2 since the device is inserted into a network.

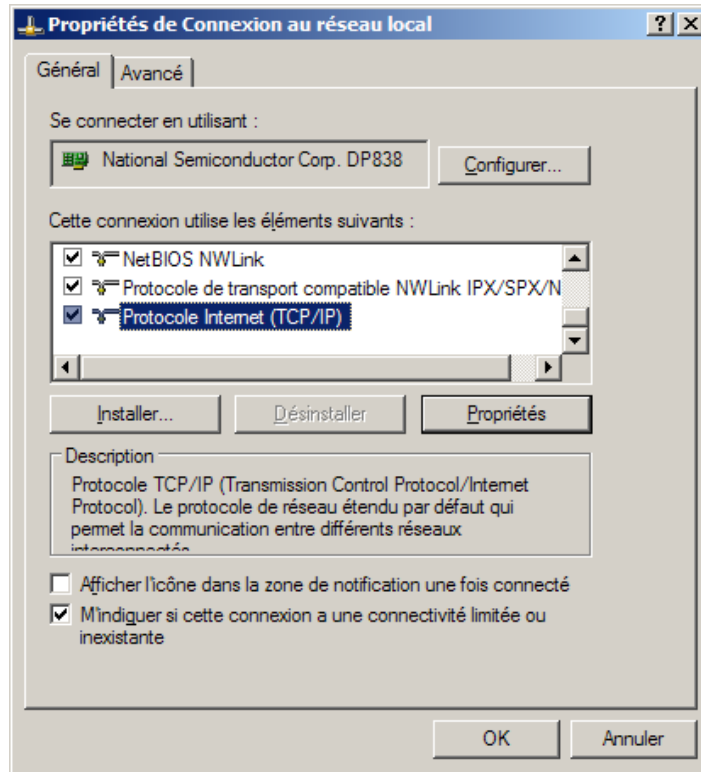
In case no. 1 one device and only one is connected to the network card and forms a small local network with only one node (device).

15.4.1. PROCEDURE TO FOLLOW

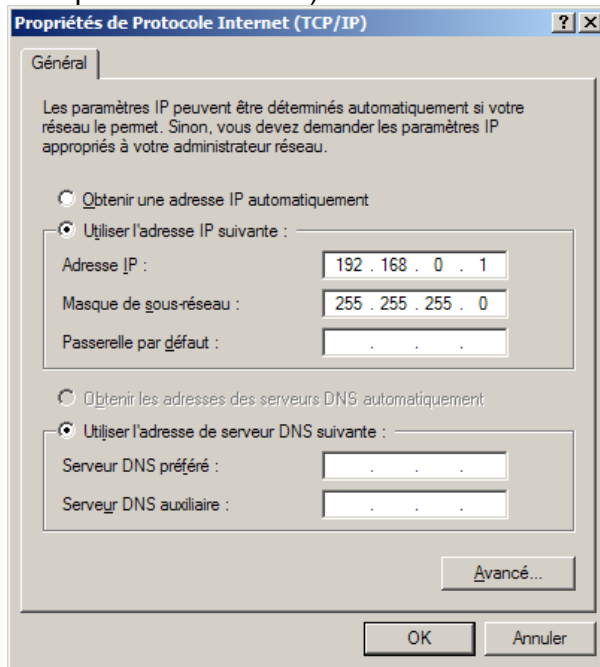
Go to *Control panel/ Network and internet connections/ Properties*



- Select *Internet Protocol (TCP/IP)* in the field "This connection uses the following items: " then click on Properties
-

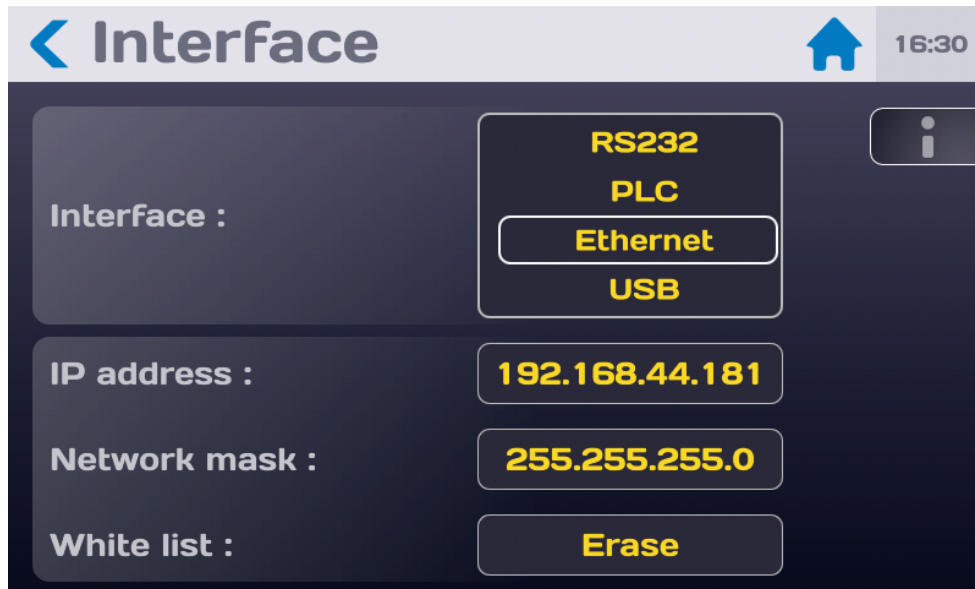


Select: Use the following IP address:
Enter the IP address of the network card (PC) (Example 192.168.0.1)
Enter your Subnet mask (Example 255.255.255.0)



In the last two windows opened, click on OK.

15.5. CONFIGURING THE ETHERNET CONNECTION



15.5.1. IP ADDRESS

Select the **IP ADDRESS** line and confirm, wait a few moments.

15.5.2. NETWORK MASK

Recall: In order to be able to manually enter an IP address, DHCP = OFF.

Select the **NETWORK MASK** line and confirm.
Enter your network mask, confirm and wait a few moments.

15.5.3. COMMUNICATION PORT AND PROTOCOL

Our interface works according to the **TCP/IP** protocol.
The control device (Supervision software) must use port **TCP no. 2001**

15.5.4. SYNTAX RULES

A command intended for the device preferably ends with the character: LF (hexadecimal 0A, decimal 10).

Codes can be sent in upper or lower case. The maximum number of commands in the same block cannot exceed 15 instructions. **Be careful not to associate standard commands or requests with other types of commands.**

The events that occur during the measurement can be reported to the computer through emitting a SRQ (format error, end of test, open safety circuit, etc.). To activate this func-

tion, the code **SRQ** must be sent after the device has initialised. When such an event occurs, the internal registers of the IEEE controller (STB,SRE...) must be checked in order to obtain more precision on the reasons for the event.

In the case of incorrect syntax the message **DIALOGUE ERROR: 1** is displayed. In the case of a code that is out of context the message **DIALOGUE ERROR: 2** is displayed (specific code for a function when we are not in this function, or numerical value out of bounds).

15.5.5. LIST OF ETHERNET COMMANDS

The syntax of the commands sent over the **ETHERNET** connection is compliant with the **IEEE488-2** standard (1992 revision).

Reminder of the numerical formats according to standard **IEEE488-2**:

Format **NR1**: +/-<digit>...<digit>

Format **NR2**: +/-<digit>...<digit>.<digit>...<digit>

Format **NR3**: +/-<digit>...<digit>.<digit>...<digit>E +/-<digit>...<digit>

NOTE: The code in parentheses are the expanded codes that can be interpreted by the device.

15.5.6. COMMANDS

The command set of the **ETHERNET** option of the **SEFELEC** range is the same as that of the **RS232** interface. It is described in detail in the paragraph **RS-232C Interface**.

15.5.7. ERROR MESSAGE

the message **CONNECTION IMPOSSIBLE** appears, two cases are to be considered:

- The device has not been identified, press **ETHERNET** again
- You left a communication session open with the device, close the connection and press **ETHERNET** again

15.5.8. MALFUNCTION

In the event the Ethernet connection does not operate as described in this manual, check the following points:

Absence of a reaction of the device when sending commands:

- The devices in the SEFELEC series have several possible types of interfaces, check in the configuration menu that the ETHERNET mode was selected on the INTER-FACE line.
- Check if your device's IP address and that of your control device (PC) are in the same network. (Modify the network mask if necessary)
- The end of message character must be the LF character (hexadecimal: 0A, decimal: 10). If this character is not sent, the SEFELEC1500M device does not process the command received.
- Check that the **LF** character is indeed added to the characters of the command sent.
- The first command that must be sent is the REM command, the latter results in the display of the icon of the links of a chain on the left hand side corner of the LCD screen, the device is then ready to process the other commands.
Warning: the first REM command must not wait for the Xon character before it is sent.

The device switches to REMOTE then seems to be blocked

Before sending another command, it is imperative to wait for the device in the SEFELEC series to report that it is available by the sending of the Xon character. If a code arrives during the processing of the preceding code, it can cause incoherent operation of the device or block it.

16. USB INTERFACE



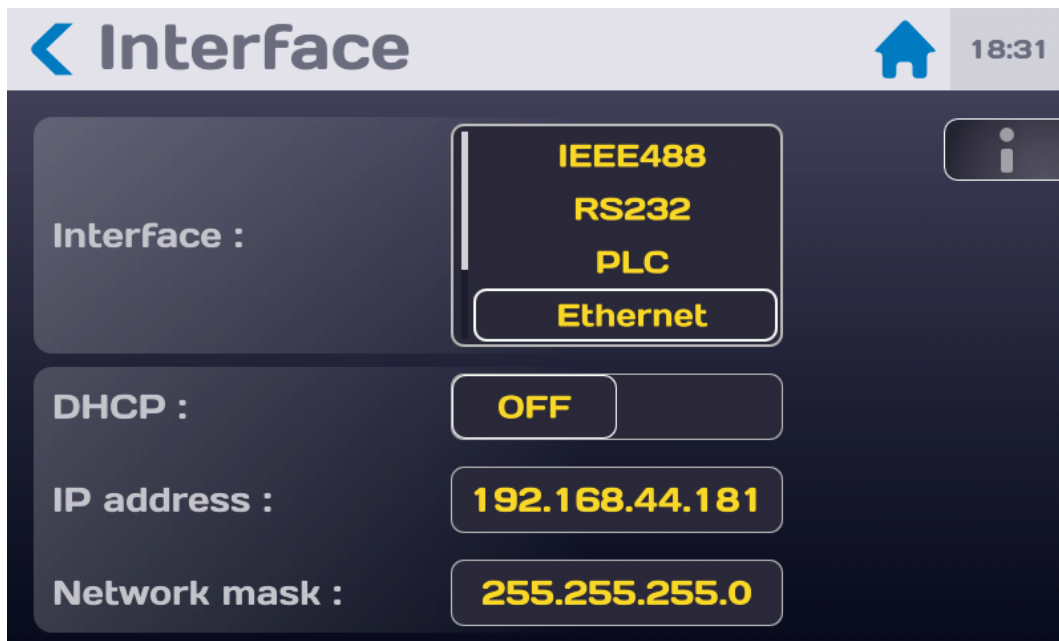
IMPORTANT

To enable the USB interface, it is mandatory to enter an Administrator password.



NOTE

IMPORTANT: The USB function must be selected in the configuration menu, interface line: USB



The test and measurement instruments of the SEFELEC 1500-M series are equipped with a USB type interface.

It allows the integration of all the instruments of the range in an automatic test or measurement system whether intended for manufacturing control or input control.

The interface is accessible via a mini-USB connector (type B) located at the back of the device. The USB connection is managed by an RNDIS/Gadget driver which converts the USB connection so that it is perceived by the PC as an ethernet connection.

However, on some PCs (especially under Windows 10) the driver is not installed automatically when connecting the USB connection and it is seen as a COM port.

To remedy this, it is necessary to force Windows to install the correct RNDIS/Gadget driver.

16.1. HOW TO GET THE RNDIS/GADGET DRIVER

The driver is available on the following website :

<https://www.driverscape.com/download/usb-ethernet-rndis-gadget>

Download the appropriate driver for your PC configuration.

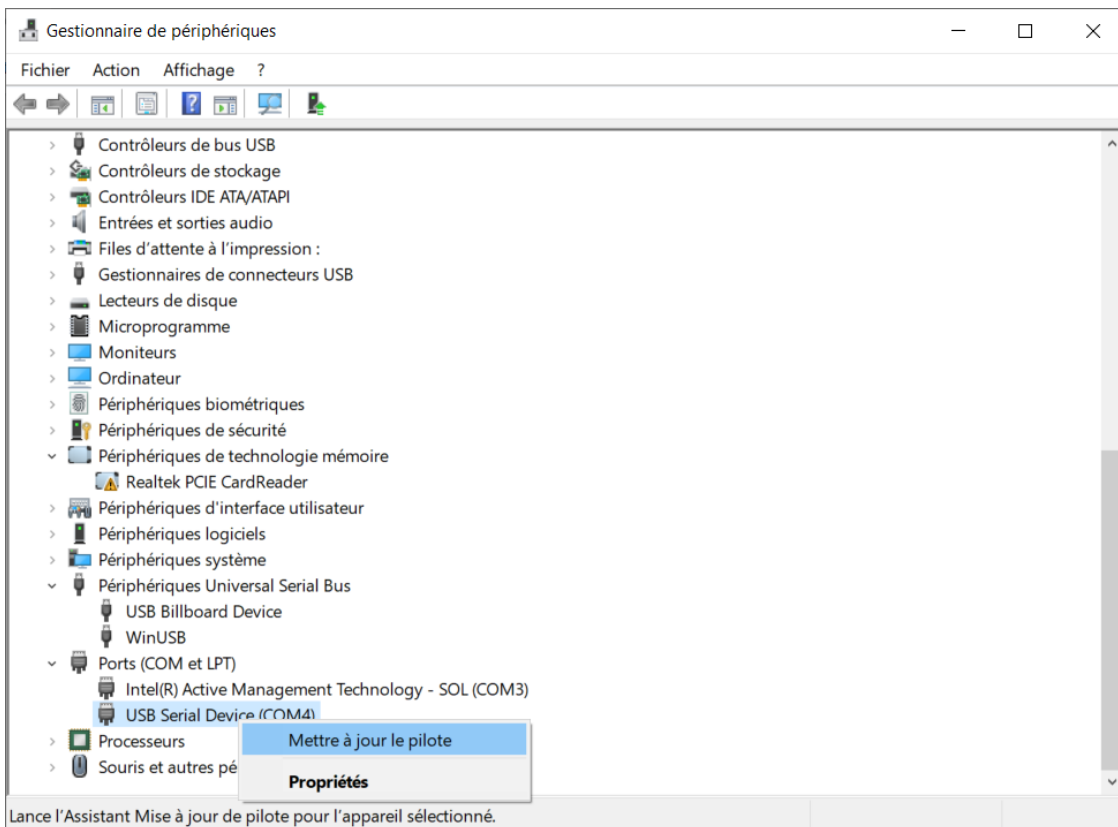
You will get a compressed file with the “.zip” extension that you will have to extract on your computer.

Now you must force Windows to point to this driver for the USB connection.

16.2. HOW TO FORCE THE RNDIS/GADGET DRIVER

Access Device Manager by typing its name in the Windows search bar.

The USB connection can be found in the “Ports (COM and LPT)” tab.



Right-click on the identified COM port and click on “Update driver”.

←  Mettre à jour les pilotes - USB Serial Device (COM4)

Comment voulez-vous rechercher les pilotes ?

→ **Rechercher automatiquement le logiciel de pilote à jour**

Windows va rechercher sur votre ordinateur et sur Internet le logiciel de pilote le plus récent pour votre appareil, sauf si vous avez désactivé cette fonctionnalité dans les paramètres d'installation de votre appareil.

→ **Parcourir mon ordinateur à la recherche du logiciel de pilote**

Localisez et installez le logiciel de pilote manuellement.

Then click on “Browse my computer for driver software”.

←  Mettre à jour les pilotes - USB Serial Device (COM4)

Rechercher des pilotes sur votre ordinateur

Rechercher les pilotes à cet emplacement :

Inclure les sous-dossiers

→ **Choisir parmi une liste de pilotes disponibles sur mon ordinateur**

Cette liste affichera les pilotes disponibles compatibles avec l'appareil, ainsi que tous les pilotes dans la même catégorie que l'appareil.

Click on “Choose from the list of drivers available on my computer”.

← Mettre à jour les pilotes - USB Serial Device (COM4)

Choisissez le pilote de périphérique à installer pour ce matériel.



Sélectionnez le fabricant et le modèle de votre périphérique matériel et cliquez sur Suivant. Si vous avez un disque qui contient le pilote que vous voulez installer, cliquez sur Disque fourni.

Afficher les matériels compatibles

Modèle

USB Serial Device



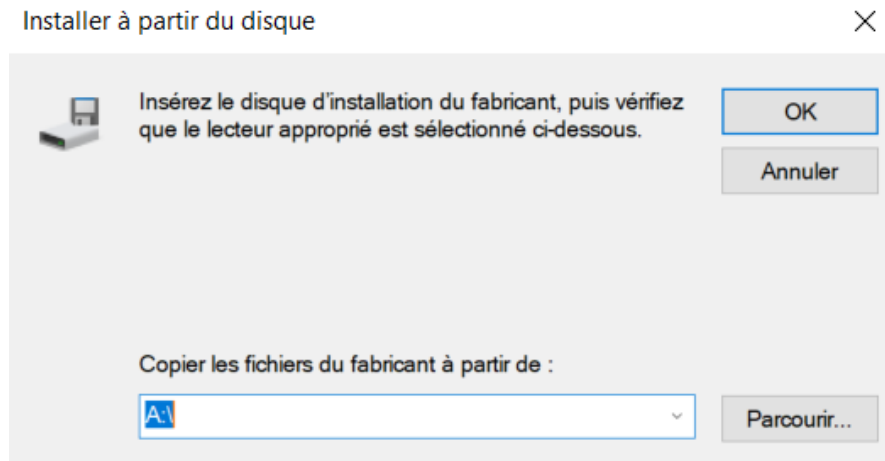
Ce pilote a été signé numériquement.

[Pourquoi la signature du pilote est-elle importante ?](#)

Disque fourni...

Click here on “Have disk...” at the bottom left.

The following pop-up appears:



Click on “Browse...”. Then go and point to the previously extracted file. The file in question is the extension file “.inf” here “rndis.inf”.

Click on “OK”. Then on “Next”. The driver is installed.



IMPORTANT

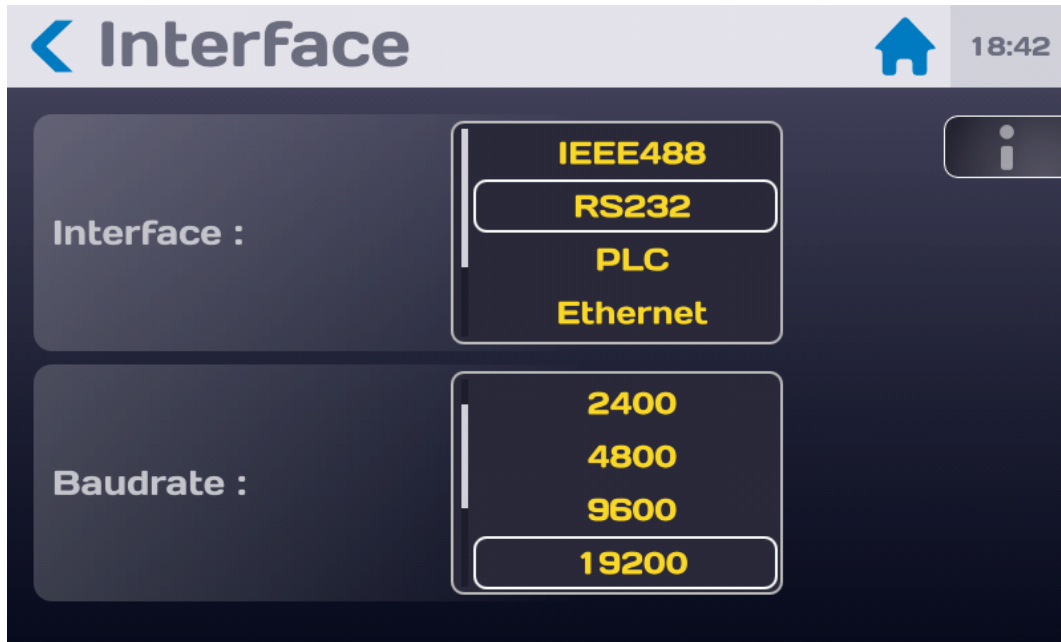
For the use of the USB interface, please refer to the information given in paragraph ‘18 ETHERNET interface’

17. RS232C INTERFACE



IMPORTANT: The RS232C function must be selected in the configuration menu, interface line: RS232

Note:



SEFELEC 5x range test and measurement instruments are fitted with a RS232C interface working in the speak and listen mode. It enables the integration of all the instruments of the range in an automatic test or measurement system whether it is intended for production control or entry control.



IMPORTANT

The implementation of the safety loop is essential. The control of the device and therefore the generation of a dangerous voltage by RS232C can be done from a point where visual inspection of the device is not possible.



IMPORTANT

Use a series DB9 male - DB9 standard female non-crossover and shielded connection cord to connect the device to the PC. The SEFELEC CO179 cord is not compatible with this device.

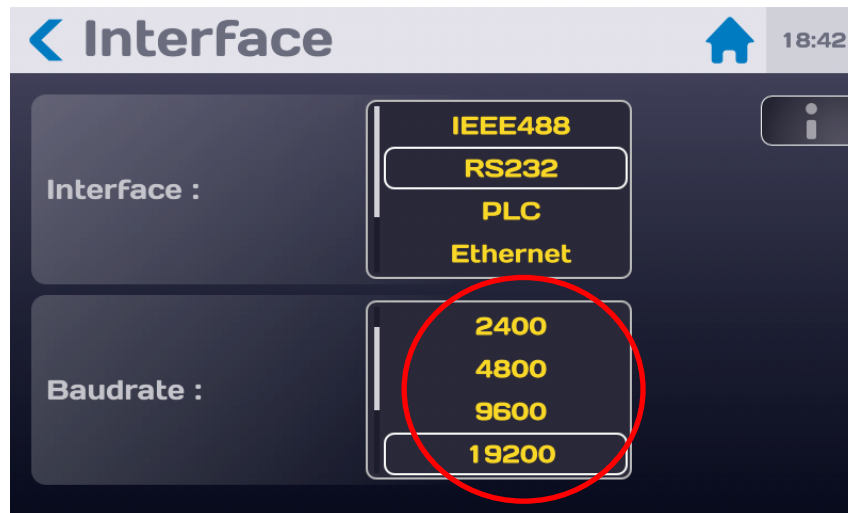
The interface is accessible via a 9-pin connector on the rear of the device. The RS232C standard describes the hardware aspects for series data transmission. It requires five lines which are:

- Data reception RXD
- Data transmission TXD
- Terminal ready to receive DTR
- Data ready to be sent DSR
- Signal ground GND

The transmission settings are not modifiable and are:

- Parity: Without
- Format: 8 bits
- Stop bit: 1

To change the speed of transmission, go into the Config menu, on the interface line and select RS232. In the Bit/s area choose the flow by scrolling through the values between 1.2 kbauds and 115.2 kbauds. Validate by pressing the desired digit.



A command destined for the device must end with the character: LF (hexadecimal 0A, decimal 10). The codes can be sent in upper case or lower case. The maximum number of commands in the same block must not exceed 15 instructions. Take care not to associate normalized orders or queries with other types of commands.

The end of the execution of a block of commands by the device is reported by the issuance of the XON character (hexadecimal 11, decimal 17) and allows us to synchronize the communication with the computer which must wait for the XON character before sending the next blocks.

Events occurring during the measurement can be reported to the computer by the issuance of a character Z (format errors, end of test, safety loop open, etc.). To activate this function, it is necessary to send the SRQ code after initialization of the device. On receipt of the character Z, a special command allows the computer to recognise the event precisely (see Commands *STB? and *ESR?).

In the case of incorrect syntax, the message: dialogue error 1 is displayed. In the case of a code out of context the message: dialogue error 2 is displayed (a code specific to a function when we are not in this function, or a digital value outside the limits).

17.1. LIST OF RS232C COMMANDS

The syntax of the commands sent over the **RS232C** connection was made compliant with the **IEEE488-2** standard (1992 revision).

Reminder of the numerical formats according to standard **IEEE488-2**:

Format **NR1**: +/-<digit>...<digit>

Format **NR2**: +/-<digit>...<digit>.<digit>...<digit>

Format **NR3**: +/-<digit>...<digit>.<digit>...<digit>E+/-<digit>..<digit>

NOTE: The code in parentheses are the expanded codes that can be interpreted by the device.

17.1.1. GENERAL COMMANDS

REM (REMOte)

Passage into the remote mode.



WARNING: To be sent before any other command.
For security reasons, this command is only valid during the starting test pattern (screen displayed at power on).

Note:

GTL (GoToLocal)

Return to Local mode.

LLO (LocalLockOut)

Return to local mode locked.

17.1.2. STANDARDISED COMMANDS

*SRE <NR1>

(*Service Request Enable Register*). Activates according to NR1 the corresponding indicators of the "status byte register" (STB). In this way, the user can select the reasons for which a SRQ is emitted (Z character). See *STB? code.

*ESE <NR1>

(*Standard Event Enable Status*). Selects the event bits that can activate the global event indicator (ESB) in the "Event register" register. By using these event indicators, the user can control the scope of the active events.

*CLS

Positions all of the standardised registers to the state in which the user finds them when the device is turned on.

*RST

- *ESR register reset to 0x00
- *STB register reset to default value 0x41 and safety loop bit updated
- Reset to default values of the two masks SRE (0x0A) and ESE (0x30)
- All the tests that can be launched via remote (all except the sequence therefore) are setup with the "default" file (the "default" file is not overwritten and contains the parameters chosen by the user)

Return to the starting pattern but without losing the connection with the device
Standardised requests

*STB?

Returns in NR1 format and in hexadecimal the value of the "STB" register (e.g.: "#H80").

| | |
|-----------|--|
| b0 | 0 = Safety loop open 1 = Safety loop closed |
| b1 | 0 = No error 1 = Error (Test error, Communication error, safety loop error on MEAS command, fan error) |
| b2 | 0 = End of test 1 = Test in progress |
| b3 | 0 = Test Bad 1 = Test Good |
| b4 | Not used |
| b5 | Logical OR of ESR register bits and filtered by ESE mask |
| b6 | 0 = No bit of the *STB register filtered by the SRE mask has changed since it was last read 1 = At least one bit of the *STB register filtered by the SRE mask has changed since it was last read |
| b7 | Not used |

*SRE?

Returns in NR1 format and in hexadecimal the value of the SRE register (mask of the STB register).

***ESR?**

Returns to the NR1 format and in the hexadecimal base the value of the register "ESR"

| | |
|---------|--|
| b0 à b3 | Not used |
| b4 | 1 = Type 2 dialog error (numeric value out of range, command out of context) |
| b5 | 1 = Dialog error type 1 (incorrect syntax) |
| b6 | Not used |
| b7 | 1 = Power On |



The bits are reset after reading by the *ESR? command.

Note:

***ESE?**

Returns in NR1 format and in hexadecimal the value of the ESE register (mask of the ESR register).

***LRN?**

This request allows the programmer to receive a "response message" sequence informing him of the status of the device (function and active parameters). The latter can be reused as is in order to put the instrument at a later time back into the state that it was in when the request was emitted.

***IDN?**

Allows the device to be identified. The message returned by the device is in the following form: <field1>, <field2>, <field3>, <field4> with

- field1: Name of the manufacturer (e.g.: EATON)
- field2: type of device (e.g.: SEFELEC1500M...)
- field3: Serial number
- field4: Software version (e.g.: 1.60)

***TST?**

Allows the operation of the device to be verified. The message returned obeys the following syntax: #H<NR1> with

| | b3 | b2 | b1 | b0 | result |
|----------------|----|----|----|----|--------|
| | X | X | X | 1 | #H01 |
| Megohm missing | X | X | 1 | X | #H02 |
| | X | 1 | X | X | #H04 |

With X = 0 or 1



IMPORTANT: This function must be used before selecting a function (from the start test pattern of the device).

Note

17.1.3. DEVICE-DEPENDENT COMMANDS

MEG (MEGohmeter)

Activates the megohmmeter function. Must be sent from the starting pattern.

PIC (PICOammeter)

Activates the current measurement function. Must be sent from the starting pattern.

SEQ (SEQuence)

Activates the sequence function. Must be sent from the starting pattern.

CONF (CONFig)

Activates the configuration function. Must be sent from the starting pattern.

PAR (PARAmeter) <NR1>

Selects the parameter set for the active function. E.g.: `MEG:PAR 1`

DCV (DCVoltage) <NR1>

Changes the value of the test voltage of the current parameter set for the active function and switches to DC voltage if the option is present in strength. E.g.: `DCV 500`

HTIM (HTIMe) <NR1> or <NR2>

Changes the value of the maintaining time in seconds of the current parameter set for the active function. Values between 0.1 and 9,999 E.g.: `HTIM 3`

RTIM (RTIMe) <NR1> or <NR2>

Changes the value of the rising time in seconds of the current parameter set for the active function. Values between 0 and 9,999 E.g.: `RTIM 10`

FTIM (FTIMe) <NR1> or <NR2>

Changes the value of the falling time in seconds of the current parameter set for the active function. Values between 0 and 9,999 E.g.: `FTIM 5`

HLIM (HLIMit) <NR3>

Changes the value of the upper threshold of the current parameter set for the active function.

E.g.:

`MEG:HLIM 2.0E+6` (new value in Ohms)

`PIC:HLIM 1.45E-6` (new value in Amperes)

The unit is automatically expressed in Volts, Ohms or Amperes and depends on the function.

CBHLIM <NR3>

Same as HLIM but resetting of the lower threshold before loading the value of the upper threshold.

LLIM (LLIMit) <NR3>

Changes the value of the lower threshold of the current parameter set for the active function.

E.g.:

MEG:LLIM 1.0E+6 (new value in Ohms)
PIC:LLIM 1.50E-3 (new value in Amperes)

The unit is automatically expressed in Volts, Ohms or Amperes and depends on the function.

TIM (TIME) AUT / PERM

Selects the **AUT** timer modes for automatic, **PERM** for permanent

FILT (FILTer) NOR / SLO / FAS / CAP1 / CAP2 /

Activates the measuring modes **NORMAL**, **SLOW**, **FAST**, **CABLE** and **CAPACITOR**

E.g.:

CONF:FILT NOR
CONF:FILT CAP1

RANGE <NR1>

with <NR1> between 0 and 10, 0 corresponding to AUTO range, refer to 7.6 and 9.6 section for current or resistance correspondence.

MKM ON / OFF

Allows to activate or deactivate the Megohm.km mode
(Extended version « MEGOHMKM »)

MKMLEN <NR1>

with <NR1> cable length (1 to 16000 meters) in Megohm.km mode
(Extended version « MEGOHMKMLENGTH »)

MKMCOUNT <NR1>

with <NR1> number of wires (0 to 999) in Megohm.km mode
(Extended version « MEGOHMKMCOUNT »)

MEAS (MEASure)

Switches to measuring mode in the active function.

STOP

Interrupts the test in progress.

QUIT

Exits the active function.

SRQ

Through analogy with the Service Request command of the **IEEE488** bus, this code authorises the sending of a **Z** character for reporting the events (end of test, format error, safety circuit open...). This code must be sent at the beginning of the program after switching to **REMOTE** mode.

17.1.4. DEVICE-DEPENDENT REQUEST

MEAS?

Returns one or several measurement results at the time the request is launched.

Formats the response in a function

- Insulation: OHM 1.100E+08 VOLT 9.900E+02 AMP 9.000E-06
- Current: OHM 1.100E+08 VOLT 9.900E+02 AMP 9.000E-06

17.1.5. OPERATING FAULT ON THE RS232C SERIAL LINK

In the event the **RS232C** connection does not operate as described in this manual, please check the following points:

Absence of a reaction of the device when sending commands

- The connection cord between the device of the **SEFELEC** series and the computer must be connected correctly at the two ends and be of uncrossed type. The Sefelec CO179 cord is not compatible with the device.
- The devices in the SEFELEC series have several possible types of interfaces, check in the configuration menu that the **RS232** mode was selected on the **INTERFACE** line.
- The end of message character must be the LF character (hexadecimal: **0A**, decimal: **10**). If this character is not sent, the device of the **SEFELEC** series does not process the command received.
- Check that this character is indeed added to the characters of the command sent.
- The first command that must be sent is the REM command, the latter results in the display of the icon of the links of a chain on the left hand side corner of the LCD screen, the device is then ready to process the other commands.
Warning: the first REM command must not wait for the Xon character before it is sent.

The device switches to REMOTE then seems to be blocked

Before sending another command, it is imperative to wait for the device in the SEFELEC series to report that it is available by the sending of the **Xon** character. If a code arrives during the processing of the preceding code, it can cause incoherent operation of the device or block it.

17.1.6. RS232 / IEEE488-2 COMMANDS

| Code | Menu Init | Config | MΩ | pA |
|----------|-----------|--------|----|----|
| REM | X | X | X | X |
| *CLS | X | X | X | X |
| *ESE | X | X | X | X |
| *ESE? | X | X | X | X |
| *ESR? | X | X | X | X |
| *IDN? | X | X | X | X |
| *LRN? | | | X | X |
| *RST | X | X | X | X |
| *SRE | X | X | X | X |
| *SRE? | X | X | X | X |
| *STB? | X | X | X | X |
| *TST? | X | | | |
| GTL | X | X | X | X |
| LLO | X | X | X | X |
| CONF | X | X | | |
| DCV | | | X | X |
| FILT | | | X | X |
| HLIM | | | X | X |
| CBHLIM | | | X | X |
| HTIM | | | X | X |
| LLIM | | | X | X |
| MEAS | | | X | X |
| MEAS? | | | X | X |
| MEG | X | | X | |
| MKM | | | X | |
| MKMLN | | | X | |
| MKMCOUNT | | | X | |
| PIC | | | | X |
| PAR | | | X | X |
| QUIT | X | X | X | X |
| RTIM | | | X | X |
| RANGE | | | X | X |
| SRQ | X | X | X | X |
| STOP | | | X | X |
| TIM | | | X | X |

18. APPLICATION NOTES

18.1. PURPOSE OF THE DIELECTRIC TESTS

The purpose of the dielectric strength tests is to:

- Detect the manufacturing defects of a piece of electrical equipment,
- Check the quality of the insulators of a piece of electrical equipment,
- Check that the electrical installation was carried out correctly,
- Check the insulation resistance of a piece of equipment or of an installation in order to following the changes and the ageing of it.

These are based on insulation resistance measurements and on dielectric strength tests.

18.2. TERMINOLOGY

MINIMUM CONDUCTOR SPACING

the smallest spacing, measured across the surface of an insulator between two conductors, required to prevent tracking.

LEAKAGE CURRENT

current across or through an insulating medium or at a given voltage. The leakage current is used to establish the insulation resistance of an insulating material.

BREAKDOWN

an instantaneous failure of the insulating properties of the insulating material. Breakdown results in more or less serious damage to the material. Breakdown tests can be destructive or non-destructive.

INSULATION RESISTANCE

characteristic of an insulator that, subjected to a given voltage, has a resistance such that the value of the leakage current that passes through it remains permissible.

DIELECTRIC STRENGTH

ratio between the voltage at which a dielectric rupture of the insulator occurs and the distance between the two points where the voltage is applied (generally expressed in kV/cm). Depending on the nature of the insulator (solid, liquid or gas), dielectric rupture may be caused by perforation, tracking or arcing.

18.3. INFLUENCE OF THE ENVIRONMENTAL CONDITIONS

Temperature, pressure and humidity affect the results of dielectric tests.

18.3.1. TEMPERATURE

As temperature affects the density of gases, it will modify the insulation properties of these gas and liquid insulators. The oils often used as insulators are never pure and the amount of dissolved gas increases with temperature which will adversely affect the insulating properties of the oil. So many different types of material are used as solid insulators that it is impossible to define a general law on their behaviour with temperature (with the insulating properties tending to degrade as the temperature increases).

18.3.2. PRESSURE

The voltage resistance of gases changes according to the pressure according to the PASCHEN law. This law presents a minimum breakdown voltage at a particular value of the product of the pressure by the distance, otherwise, the higher the pressure, the higher the breakdown voltage. The liquids used as dielectric insulators are influenced by pressure, the rigidity increases monotonically with pressure. Solid insulators are, in theory, unaffected by pressure as this does not substantially change either their thickness or their internal composition.

18.3.3. HUMIDITY

The voltage resistance of gases changes according to the presence of water vapour. For air, for example, and for relative humidity values greater than 80%, the dielectric strength increases slightly with increasing the humidity (the water molecules are denser than the gas and inhibit the avalanche effect). Water in a liquid insulator such as an oil degrades the dielectric strength by electrolysis of the water (forming gases leading to partial discharges inducing a breakdown). Under the combined effect of high humidity (> 95%) and temperature (> 100°C) most polymer insulators are degraded. Water can make the insulators swell and fissure, providing paths for electric arcs.

18.4. INSULATION RESISTANCE MEASUREMENT

The insulation resistance is measured to ensure that the various components and sub-assemblies in an electrical assembly have sufficiently high insulation resistance to ensure that the leakage currents do not reach unacceptable values.

The principle is to apply a given stable direct voltage (there are various standard voltages) between predefined points, for a time that is usually specified, and then measuring the current passing through the material under test. Ohm's law (Resistance = Voltage / Current) is used to calculate the insulation resistance. This value is tested against the minimum threshold specified in the standard used for the test.

18.4.1. PRECAUTIONS

The equipment under test must be connected in such a way as to minimise the parasitic leakage caused by the measurement technique.

The accessories supplied have shielding that is connected to a guard voltage to provide a high immunity to parasitic leakage currents and mains fields.

If extensions are used for the basic accessories, care should be taken to not introduce any measurement error (short leads, leads kept clear of metal parts or even insulating parts, etc.).

For very high resistance measurements ($> 100 \text{ G}\Omega$), an operator putting his hand close to the equipment under test could reduce the measurement accuracy or make the measurement unstable. Care should be taken not to wear nylon lab coats or insulating objects which may create high static electricity fields which could affect the measurement of high resistances. ($100 \text{ G}\Omega$ at $100 \text{ V} = 1 \text{ nA}$ measured current).

18.4.2. CAPACITANCE MEASUREMENT

Recall that many pieces of modern electrical equipment have mains filters including capacitors to meet EMC standards. During measurement on capacitors it is recommended to use the **CAPACITOR** measuring mode in order to stabilise the values measured.

With these capacitors, even the smallest fluctuation in or interference on the measurement voltage will pass directly into the current measurement system which has a very high gain and will amplify these fluctuations. The **CAPACITOR** mode implements circuits which will limit the instability of the values measured.

Always carry out insulation resistance measurements on capacitive circuits at increasing test voltages. Hysteresis and polarisation effects in the dielectrics will give false measurements if reducing test voltages are used between each test. If reducing test voltages are used, the device will over-estimate the insulation resistance and will take a long time to fall to the real value.

The contribution of the capacitance to the measured leakage current decreases exponentially with time. It is, therefore, important to specify the time taken for the test in order for the result to be significant. SEFELEC1500M devices can satisfy this requirement thanks to the built-in timer, able to time from 0.1 s to nearly 3 hours.

Never disconnect a capacitive sample without switching to DISCHARGE and waiting for the time required for the capacitance to discharge into the resistor of 2.2 kΩ built into the device (allow about 1s per 100 μF).

18.4.3. CABLE MEASUREMENTS

Measurement on cables is similar to the measurement on capacitor samples (see the preceding paragraph for the basic precautions).

The configurations for measurements on cables are very diverse. The measurements must be taken either between conductors for multi-core cables, or between the core and the shielding for shielded cables, or between the cable and its environment for single-conductor wires.

In this latter case, the method that is generally used is to plunge the cable reel into a reservoir of water (called POOL), allow the water to penetrate to the core of the reel, then take the insulation resistance measurement between the conductor and the water. For construction and safety reasons, the reservoir is grounded. The insulation resistance measurement device must therefore be able to measure a sample of which one of its points is the ground. SEFELEC1500M devices are able to take this type of measurement very easily since the top point of the voltage generator can be connected to the ground. Simply connect the input of the measuring device (with the high voltage accessory) to the conductor to be measured and trigger the measurement.

Another specificity when measuring insulation resistance on cables is that the manufacturers' characteristics give resistance values for a standardised cable length of 1 km (kilometre).

On the platform when controlling cable reels, the latter are never exactly the standardised length, which requires the operators to perform a calculation that is a function of the length of the cable and of the number of conductors in parallel for multi-core cables. On the other hand the comparators built into the measuring devices can no longer be used, since they compare with respect to the global insulation value, not with respect to the standardised value.

SEFELEC1500M devices can display insulation resistance measurements brought to a length of 1 km and with 1 conductor, which also allows for the use of built-in comparators. The operator has the possibility to enter in a menu on the device the length of the cable being tested as well as the number of conductors that it is comprised of. The result is then expressed in MΩ per km.

For example: the device measures a value of 10 MΩ for a single-core cable 10 km long. Its value brought to 1 km would therefore be:

$(R_{total}/1 \text{ km}) \times \text{Length} = 100 \text{ M}\Omega \cdot \text{km}$

For the same cable with 10 conductors, the value for 1 conductor will be 1,000 MΩ.km.

The contribution of the cable to the measured leakage current decreases exponentially with time. It is, therefore, important to specify the time taken for the test in order for the result to be significant. SEFELEC1500M devices can satisfy this requirement thanks to the built-in timer, able to time from 0.1 s to nearly 3 hours.

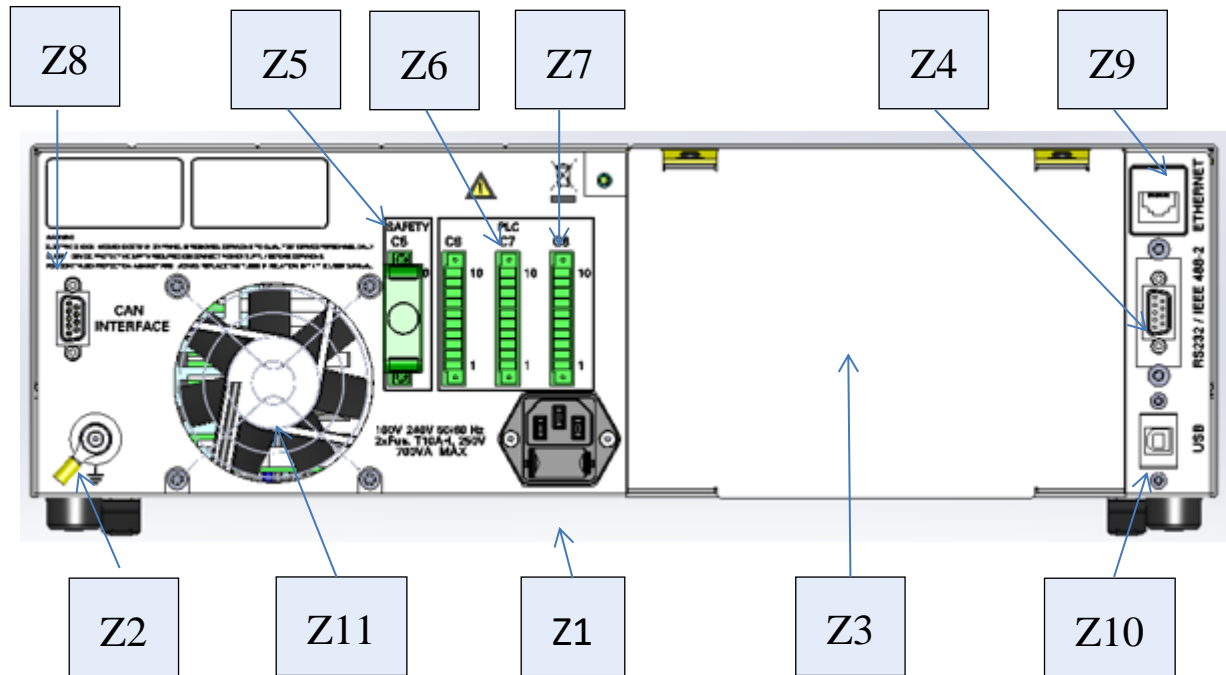
18.4.4. TEST VOLTAGE FOR MEASUREMENT

Insulation resistance measurements are used to check that materials or equipment meet defined standards; it is important to refer to these standards when choosing the test voltage. Standard test voltages are usually: 50, 100, 250 and 500 DC volts. If there is no recommended test voltage, choose a voltage of 100 volts for the measurements.

Where measurements are made on capacitive devices and when the insulation resistance is to be measured at different voltages, always start from the lowest test voltage and increase the voltage for subsequent measurements. Reducing the test voltage may give inconsistent results.

19. LAYOUT OF SOCKETS ON THE REAR PANEL

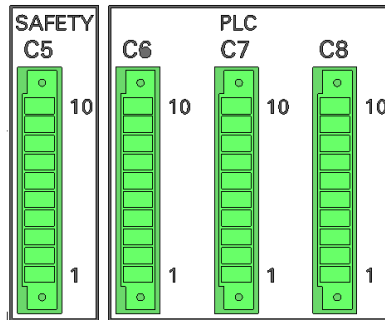
19.1. DESCRIPTION OF THE REAR PANEL



The rear panel includes the following elements:

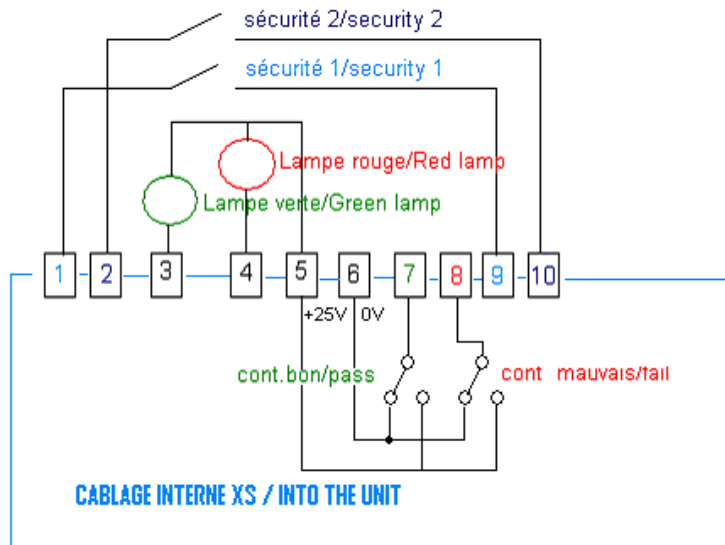
- **Z1** Mains socket with Fuses
- **Z2** Ground connection stud bolt
- **Z3** Measurement cable output area in the case of the REAR PANEL OUTPUT option.
- **Z4** 24-point RIBBON connector for the IEEE-488-2 connector.
- **Z5** 10-pole terminal block for the safety circuit.
- **Z6** 10-pole terminal block for the PLC control.
- **Z7** 10-pole terminal block for the PLC control.
- **Z8** 9-point sub-D connector for CAN bus for controlling an external matrix
- **Z9** RJ45 terminal for the ETHERNET connection.
- **Z10** Mini USB terminal for the USB connection.
- **Z11** Fan

19.1.1. SAFETY CONNECTOR C5



| | |
|----|---|
| 1 | Safety loop circuit contact: to connect with 9 |
| 2 | Safety loop circuit contact: to connect with 10 |
| 3 | Green lamp |
| 4 | Red lamp |
| 5 | +25V common red-green lamps |
| 6 | 0V – ground |
| 7 | Contact PASS (GOOD) (= +25 V) |
| 8 | Contact FAIL (BAD) (= +25 V) |
| 9 | Safety loop circuit contact: to connect with 1 |
| 10 | Safety loop circuit contact: to connect with 2 |

Connection example of the red/green lamps, of the contacts of the safety circuit and of the pass/fail contacts



NOTE

The contacts of the safety circuit must be free of any potential (24 VDC, 230 VAC, Ground, etc.) They are protected by thermal fuses, in the event of overcurrent wait 15 seconds before trying again.

20. MAINTENANCE AND CALIBRATION

20.1. GENERAL

Our warranty (see beginning of this manual) guarantees this equipment against manufacturing and packaging defects. If the equipment does not appear to be operating correctly, or if you require further information about using our equipment, please contact our technical service on +33 (0)1 64 11 83 40 if you are in France. For other countries, please contact your local representative.



WARNING

**There may be dangerous voltages present within these devices.
Repairs must only be carried out by the manufacturer or qualified personnel.**

20.2. EQUIPMENT RETURNS

Before returning equipment to our after-sales service, please contact the service on the telephone number provided hereinabove for details of the procedure.

Use original packaging or otherwise packaging that guarantees protection for the equipment during transport.

20.3. MAINTENANCE



WARNING

**Risk of electric shock!
The equipment must be commissioned, used and maintained by qualified personnel.**

Our devices do not require any particular maintenance, other than calibration. In case of problems, please follow the simplified check-list. In the case non-operation were to persist, contact our after-sales service.

Cleaning the device

Clean the equipment only with a soft cloth which may be slightly damp with water. For the LCD screen, use a microfiber cloth.

Calibration

We recommend that our equipment should be calibrated once a year. The calibration period depends on how often the measuring device is used (the EATON technical service can advise on the recommended calibration period). The testers must be calibrated by qualified personnel who are fully familiar with the procedure using calibration equipment that has been certified. Our after sales service can carry out this annual calibration promptly and at competitive rates.

Maintenance

Our departments are particularly authorised to carry out regular inspections and maintenance of the measuring device.

However, the customer's maintenance services must ensure that the testers are kept dust free, that dust filters are changed (depending on the model) and the ventilation kept clear. If used in a dusty environment, the inside of the measuring device should be vacuumed (compressed air should not be used).

In workshops with floors that are cold or washed with water, the measuring device should be installed on a stand in order to limit condensation.

We recommend:

checking or having the measurement functions checked at least once a year. Beyond this timeframe, we no longer guarantee the accuracy of measurements and correct operation of the equipment.

Maintenance periods:

| | |
|----------|-------------------|
| Monthly | Clean filters |
| Annually | Check measurement |
| Annually | Remove dust |

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EATON Home,
30 Pembroke Road,
Dublin 4,
D04 Y0C2,
Ireland

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EATON EULA

22. EU DECLARATION OF CONFORMITY

EU Declaration of Conformity

We,
Sefelec sas Eaton groupe
19 rue des campanules
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France

declare under our sole responsibility as the manufacturer of Electrical measurement units, that

Sefelec series
Types within the range on page 2,

provided that if it is installed, maintained and used in the application intended for, with respect to the relevant manufacturer instructions, installation standards and "good engineering practices",

complies with the provisions of Union harmonisation legislation

| | |
|------------|--|
| 2014/35/EU | LVD – Low Voltage Directive |
| 2014/30/EU | EMC – Electromagnetic Directive |
| 2011/65/EU | RoHS – Restriction of Hazardous Substances |

based on compliance with European standards:

IEC 61010-2-034: 2017; IEC 61010-1: 2010 (3rd edition) + Am1:2016
Safety requirements for electrical equipment for measurement, control and laboratory use.

EN61326 -1 edition of 01/07/2006
Measurement, control and laboratory electrical devices – EMC related instructions.

EN 50581 : 2012
Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Date : 08 March 2019



Didier Delacourt
Engineering Director

Types within the range

The declaration of conformity applies to the following types within the product family:

Description

Megohmmeter Picoammeter 2000Tohm@1500VDC
Shielded lead with measurement probe L=1.5m
High voltage 1500VDC lead L=1.5m
High voltage and shielded measurement leads L=10m

Part number

Sefelec1500M
SEFA-SE15
SEFA-HV15
SEFA-HVSE15-10

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