

**SEFELEC 56-S/D/H**  
**SEFELEC 506-S/D/H**  
**SEFELEC 1000-M**  
**SEFELEC 32-C**



**PENT6833 – version 1.08**  
(English)

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## 1. INTRODUCTION



### General information

This manual presents instruments in the SEFELEC 5x range designed for testing dielectric strength, high electrical resistances and ground continuity, as well as their electrical and mechanical specifications.

It also contains the information necessary for their use in accordance with the applicable rules for safe operation, commissioning and maintenance of the equipment.

Since 1965, the vocation of our teams has been the design and manufacture of electrical resistance measurement instruments, dielectric strength testing stations and cable testers.

Our experience in these fields is recognized by most firms using advanced technology whether in the military, aerospace, railway or civilian fields.

### List of models in the SEFELEC 5x range:

Reference		
Sales	Order	Description
SEFELEC 56-H	+SEFELEC56H	Dielectric strength tester - 5 kVAC - 6 kVDC 50 VA
SEFELEC 56-D	+SEFELEC56D	Dielectric strength tester - 5 kVAC - 6 kVDC 50 VA Megohmmeter - 200 Gohm @1,000 VDC
SEFELEC 56-S	+SEFELEC56S	Dielectric strength tester - 5 kVAC - 6 kVDC 50 VA Megohmmeter - 200 Gohm @1,000 VDC Ground continuity - 1,000 mOhm @32 AAC
SEFELEC 506-H	+SEFELEC506H	Dielectric strength tester - 5 kVAC - 6 kVDC 500 VA
SEFELEC 506-D	+SEFELEC506D	Dielectric strength tester - 5 kVAC - 6 kVDC 500 VA Megohmmeter - 200 Gohm @1,000 VDC
SEFELEC 506-S	+SEFELEC506S	Dielectric strength tester - 5 kVAC - 6 kVDC 500 VA Megohmmeter - 200 Gohm @1,000 VDC Ground continuity - 1,000 mOhm @32 AAC
SEFELEC 1000-M	+SEFELEC1000M	Megohmmeter - 200 Gohm @1,000 VDC
SEFELEC 32-C	+SEFELEC32C	Ground continuity 1,000 mOhm @32 AAC

#### 1.1. WARRANTY

EATON guarantees that its devices are free of manufacturing and packaging faults. EATON also guarantees that, if used correctly, the device will comply with the specifications in this document.

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

Modifications to the device or any of its accessories not approved by EATON cancel this warranty.

EATON is not responsible for any indirect damage resulting from the use of the device.

## 1.2. PICTOGRAMS USED

Warnings with symbols are used in this manual; they must be respected to ensure safe operation of the devices.

**The warnings and symbols used in this manual are:**



**WARNING**

**Indicates imminent danger.**

**Death or very serious injury can be caused if appropriate safety measures are not taken.**



**CAUTION**

**Indicates a situation which can be dangerous.**

**Minor injuries can be caused if appropriate safety measures are not taken.**



**IMPORTANT**

**Indicates a situation which can be dangerous.**

**Damage can be caused to equipment or parts of the installation if appropriate safety measures are not taken.**










**NOTE**


**Indicates important information about the device.**



The following symbols may appear on the devices:

	Direct current.		Warning (see accompanying documents).
	Direct and alternating current.		Warning, Risk of electric shock.
	Alternating current		Is covered by a WEEE recycling procedure
	Ground terminal.		



When the symbol  is placed on the device or on one of its accessories it is imperative to refer to this manual find out the nature of the potential dangers and all actions to be taken to avoid them.

### 1.3. WARNING AND SAFETY INSTRUCTIONS

The devices in the SEFELEC 5x range are intended for testing dielectric strength, and high or low resistances.

#### **Warning:**



#### **IMPORTANT**

- The measurement device must only be used in conformity with the provisions mentioned above.
- Correct use of a measurement device implies transport, installation, handling and maintenance according to the instructions in this manual.
- It is also necessary to comply with the required conditions for the operating environment.

#### **Safety instructions before use:**



#### **WARNING**

- Before using the measurement device, check the integrity of the power cord, and especially check that it has not suffered mechanical damage that could cause a wire to be directly accessible and/or cause an open circuit.
- Before using the measurement device, check the integrity of the measurement wires, and especially check that they have not suffered mechanical damage that could cause a wire to be directly accessible and/or in open circuit.
- Before using the measurement device, check its connection by a ground cable connected directly via the stud at the rear of the measurement device.
- Before using the measurement device, check that none of its air vents are obstructed and that they allow air to circulate freely.
- Before using the measurement device, check that the connectors on its front panel are not damaged and/or unlocked.
- Using the ON/OFF button, turn on the measurement device and check that the blue light on the front panel goes on.

#### **Safety instructions after use:**



#### **WARNING**

- After using the measurement device, and before any action on the measurement device, check that the red light on its front panel is OFF and the green light ON.
- Using the ON/OFF button, turn the measurement device off and check that the blue light on the front panel of the measurement device goes off.
- Disconnect the product tested.

## 1.4. DECLARATION OF CONFORMITY

The SEFELEC 5x range measuring devices marketed by the EATON Corporation comply with the requirements of:

### **European Directives**

2014/35/EU	covering the safety of electrical equipment intended to be used within certain voltage limits. (Low Voltage Directive)
2014/30/EU	covering Electromagnetic Compatibility (EMC)

### **Harmonized standards**

EN 61010-1:2010/A1:2019/AC:2019-04	Safety rules for electrical equipment for measurement, control and laboratory use.
IEC 61010-2-034 Edition January 2017	
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use - requirement relating to EMC

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

## 1.5. QUALIFICATION OF PERSONNEL

This manual is intended for persons qualified for work on electrical devices and having received prior training on the use of the device. The manual gives the information necessary for the proper assembly and use of devices in the SEFELEC 5x range.

The operation manual and the corresponding technical documents must be studied 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 thorough checking of the content of this document, we cannot exclude possible errors. The manufacturer does not accept responsibility for inaccuracies or omissions.

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

## 1.7. AFTER-SALES SERVICE

For all technical questions contact your technical representative or our service department at the following address:

**EATON**

SEFELEC SAS

19 rue des Campanules

F-77185 - LOGNES

FRANCE

Phone: +33 (0)1 64 11 83 40

Website: [www.sefelec.com](http://www.sefelec.com)

## 2. PRESENTATION OF THE DEVICE

### 2.1. MODELS FROM THE 5X SERIES



The SEFELEC 5x range is a range of products for performing dielectric tests and ground continuity measurements very simply and in a comprehensive way.

The SEFELEC 56-H and SEFELEC 506-H are used to perform tests of dielectric strength at powers of 50 VA and 500 VA respectively. The SEFELEC 56-D and the SEFELEC 506-D are combinations of a 50 VA or 500 VA dielectric strength tester and a Megohmmeter. The SEFELEC 56-S and SEFELEC 506-S combine the functions of insulation measurement, dielectric strength testing and ground continuity measurement in a single device.

The SEFELEC 5x range devices allow the user to do the tests and measurements referred to above on all types of insulation, such as resin, porcelain, oil or plastic, as well as on finished products such as capacitors, transformers, switches, cables, connectors or electrical devices connected to the mains or powered by batteries. They allow the user to make ground continuity measurements in compliance with most of the existing standards in the fields of measurement devices, medical equipment, office equipment, machinery, etc.

The SEFELEC range devices include a high-resolution graphic colour display with a touch screen for easier use. A single output for dielectric strength tests and insulation resistance measurements facilitates connection to the elements to be tested. Messages in colour indicate the outcome of the tests visually, simply and without any possibility of error.

The dielectric strength tests are performed at voltages adjustable from 100 VAC to 5,000 VAC and 100 VDC to 6,000 VDC. The rated current is 10 mA for the 50 VA models and 100 mA for 500 VA models. Breakdown voltages and currents are stored after circuit break and cut-off of the high voltage.

The insulation resistance is measured at voltages of -20 VDC to -1,000 VDC. The device gives, in direct readings with display of the units, resistance values of 100 k $\Omega$  to 200 G $\Omega$  (2 T $\Omega$  on option).

The ground continuity resistance is measured at currents of 5 to 32 A AC (50 A AC on option) with open circuit voltages of 6 or 8 V. The device gives, in direct readings with display of the units, resistance values of 1 m $\Omega$  to 1,000 m $\Omega$ ,

The devices in the SEFELEC 5x range are equipped as standard to communicate with any system provided with an API, RS232, USB, Ethernet or even IEEE 488 (optional) interface.

## 2.2. OPTIONS (TO BE ORDERED ACCORDING TO THE REQUIREMENT)

Option reference	Description
<b>SEFO-IEEE488</b>	IEEE488-2 interface
<b>SEFO-5XREAR</b>	HV and/or Ground continuity rear panel outputs
<b>SEFO-5X3MA</b>	Short circuit limitation to <3mAAC and <5mADC 50VA Hipot
<b>SEFO-5X2TO</b>	100 k $\Omega$ to 2 T $\Omega$ insulation
<b>SEFO-5X500M</b>	10 - 500VDC voltage in insulation
<b>SEFO-5X50A</b>	5 to 50A AC for ground continuity
<b>SEFO-5X4WHV</b>	4 wires detection mode in Hipot
<b>SEFO-5XRC</b>	Module for remote control accessories

## 2.3. ACCESSORIES (TO BE ORDERED ACCORDING TO THE REQUIREMENT)

References	Descriptions
SEFA-KR	19" rack mounting
SEFA-TE65-02	HV/Insul. measurement probe. Length 2 m
SEFA-TE65-05	HV/Insul. measurement probe. Length 5 m
SEFA-TE65-10	HV/Insul. measurement probe. Length 10 m
SEFA-CO175-02	4mm return cord HV/Insul. Length 2 m
SEFA-CO175-05	4mm return cord HV/Insul. Length 5 m
SEFA-CO175-10	4mm return cord HV/Insul. Length 10 m
SEFA-CO180-02	HV cable/Insul. Without probe Length 2 m
SEFA-CO180-05	HT Cable/Insul. Without probe Length 5 m
SEFA-CO180-10	HT Cable/Insul. Without probe Length 10 m
SEFA-TE58-02	HV/Insul. probe With remote control Length 2 m
SEFA-TE58-05	HV/Insul. probe With remote control Length 5 m
SEFA-TE58-10	HV/Insul. probe With remote control Length 10 m
SEFA-PI001-502	Set of 2 guns HV/Insul. remote control 2 m
SEFA-PI001-0002	HV gun with remote control, cable 2 m
SEFA-PI001-0005	HV gun with remote control, cable 5 m
SEFA-PI001-0010	HV gun with remote control, cable 10 m
SEFA-PI001-0302	HV return gun, cable 2 m
SEFA-PI001-0305	HV return gun, cable 5 m
SEFA-PI001-0310	HV return gun, cable 10 m
SEFA-CO183-5002	2-wire power cord 50 A, Lemo/Croco. Length 2 m
SEFA-CO183-5005	2-wire power cord 50 A, Lemo/Croco. Length 5 m
SEFA-CO183-5010	2-wire power cord 50 A, Lemo/Croco. Length 10 m
SEFA-CO183-3202	2-wire power cord 32 A, 4mm Croco. Length 2 m
SEFA-CO183-3205	2-wire power cord 32 A, 4mm Croco. Length 5 m
SEFA-CO183-3210	2-wire power cord 32 A, 4mm Croco. Length. 10 m
SEFA-CO184-3202	Retractable 2-wire probe, 4 mm 32 A Length 2 m
SEFA-CO184-3205	Retractable 2-wire probe, 4 mm 32 A Length 5 m
SEFA-CO184-3210	Retractable 2-wire probe, 4 mm 32 A Length 10 m
SEFA-TE81-5002	2-wire probe 50A remote control Length 2 m
SEFA-TE81-5005	2-wire probe 50A remote control Length 5 m
SEFA-TE81-5010	2-wire probe 50A remote control Length 10 m
SEFA-TE81-3202	2-wire probe 32A remote control Length 2 m
SEFA-TE81-3205	2-wire probe 32A remote control Length 5 m
SEFA-TE81-3210	2-wire probe 32A remote control Length 10 m
SEFA-EMBUNIV	External universal base test unit
SEFA-AO10	2 hands control - cable 2 m
SEFA-AO11	Remote control pedal - 2.5 m
SEFA-5XGUARD	Guard connection cord Length 2 m
SEFA-CO160	Red/Green lamp for High Voltage presence

## 2.4. INTERNAL SCANNER REFERENCES SEFM-XXXX

Internal scanner references	Description
<b>SEFM-4IHC</b>	4-channel module Earth continuity internal scanner
<b>SEFM-4IHV</b>	4-channel module Strength-Insulation internal scanner
<b>SEFM-4IHVHC</b>	4-channel module Strength-Insulation and 4-channel Earth continuity
<b>SEFM-8IHC</b>	8-channel module Earth continuity internal scanner
<b>SEFM-8IHV</b>	8-channel module Strength-Insulation internal scanner
<b>SEFA-SCHV4-02</b>	4-channel cord Strength-Insulation L=2 metres
<b>SEFA-SCHV4-05</b>	4-channel cord Strength-Insulation L=5 metres
<b>SEFA-SCHC4-02</b>	4-channel cord Earth continuity L=2 metres
<b>SEFA-SCHC4-05</b>	4-channel cord Earth continuity L=5 metres
<b>SEFA-SCHV8-02</b>	8-channel cord Strength-Insulation L=2 metres
<b>SEFA-SCHV8-05</b>	8-channel cord Strength-Insulation L=5 metres
<b>SEFA-SCHC8-02</b>	8-channel cord Earth continuity L=2 metres
<b>SEFA-SCHC8-05</b>	8-channel cord Earth continuity L=5 metres
<b>SEFA-SCHVHC4-02</b>	4-channel HV cord and 4-channel Earth continuity L=2 metres
<b>SEFA-SCHVHC4-05</b>	4-channel HV cord and 4-channel Earth continuity L=5 metres



**Rear view of a 5x series device equipped with an SEFM-xx option**

The internal scanner option allows switching from 4 to 8 channels for insulation, dielectric rigidity or mass continuity measurements. For a larger number of channels (up to 512 channels) please choose the Sefelec 64-SC external scanner.



### REMARQUE

See the PENT7761 manual for complete information on the internal and external scanners. Available on the website: [Download \(sefelec.com\)](http://sefelec.com)



### IMPORTANT

The installation of an internal scanner is not compatible with the use of an external SEFELEC 64-SC scanner.



### 3. SPECIFICATIONS

#### 3.1. OVERVOLTAGE CATEGORY

Supply to the device by a **CAT II** mains network

#### 3.2. POLLUTION DEGREE

**Pollution 2:** occasional conductive pollution by condensation only.

#### 3.3. SAFETY CLASS

**Class I:** device connected to the protective ground by the power cord, Ground < 3  $\Omega$ , power line disturbance < 10 ms

#### 3.4. ENVIRONMENT

Regular dusting of the device is recommended. For optimal operation of the electronics, an ambient temperature range of 15°C to 35°C is required. The air inlets of the device must be clear. The device must be used indoors, in a horizontal position or tilted on its legs.

### 3.5. GENERAL CHARACTERISTICS


Mains	100-240VAC ±10% 50/60Hz single phase		
	230VAC ±10% 50/60Hz single phase (SEFELEC 506-H/D/S)		
Power	950 VA max.		
Mains protection	Double timed fuse T10AH 250 V		
Temperature Range	Storage	Operation	
	-10°C to +60°C	0°C to +45°C	
	Specified accuracy 1/2 hour after of powering and HR < 50%		
Altitude	Up to 2,000 meters		
Relative humidity	80% max. @ 31°C - linear decrease to 50%RH @40°C		
Sound pressure	Max. 80 dBA @ 1 meter		
	SEFELEC 56-H	SEFELEC 56-D	SEFELEC 56-S
Weight	16 kg	18 kg	25 kg *
	SEFELEC 506-H	SEFELEC 506-D	SEFELEC 506-S
Weight	20 kg	23 kg	28 kg *
	SEFELEC 1000-M	SEFELEC 32-C	
Weight	12 kg	14 kg	
	* 2 people required for handling weights > 25 kg		
Cartoon weight	add 2.5 kg		
Mini pallet weight	add 5 kg		
Dimensions	Height	Width	Depth
	131 mm	440 mm	455 mm

### 3.6. MEASUREMENT SPECIFICATIONS

## Dielectric strength, 50 VA (SEFELEC 56-H/D/S)

<b>Output voltage</b>	
Adjustable from	0.100 to 5.000 kV in AC
Sinusoidal alternating with frequency of	50 Hz or 60 Hz
Adjustable from	0.100 to 6.000 kV in DC
(+) pole in DC	to ground
Residual ripple factor in DC according IEC61180	< 3% for a current < 3 mA @6000VDC
Stability	< ±3% for mains ΔV of ±10%
Accuracy of the generation in relation to the set point for voltages between 100 and 5,000 V AC (6,000 V DC) and a current flow less than 3 mA	± (2%+5 V)
Maximum capacity of the sample measured	< 1 μF (discharge time < 10 sec.)
Discharge of the element tested and internal capacitors	1.5 MΩ in DC
<b>Voltage reading</b>	
By a voltmeter connected directly to the output terminals.	
Accuracy	± (1.5% +5 V)
Resolution	6,000 points
<b>Nominal current</b>	
from 800VAC to 5000VAC	<10mAAC – if option SEFO 5X3MA: <1,5mAAC
from 400VDC to 6000VDC	< 8mADC – if option SEFO 5X3MA: <1,5mADC
<b>Short-circuit current</b>	
For the adjustment of the maximum voltage in AC	< 20mAAC – if option SEFO 5X3MA: <3mAAC
For the adjustment of the maximum voltage in DC	< 20mADC – if option SEFO 5X3MA: <5mADC
<b>Fault detection:</b>	
<b>In current variation ΔI</b>	
The ΔI (delta I) sensor automatically performs the subtraction between the current flowing normally in the sample under test ( $I = U/Z$ ) and the one that occurs suddenly when a fault occurs: ( $I' = I + I_{\text{fault}}$ ).	
DELTA-I detector factory setting = 1mA	
Standard HV probe length 2 meters connected on the device	
Amplitude adjustable from	from 1 mA to 10mA ± (10%+0,5mA) in steps of 100μA from 100 μA to 900 μA ± 10% in steps of 100 μA* * AC only (100VAC to 2500VAC)
Pulse width of	10 μS ±20%.

## Dielectric strength, 50 VA

<b>At current threshold I<sub>MAX</sub></b>	
Amplitude adjustable from	0.001 mA to 10.000 mA in steps of 0.001 mA.
The device continuously measures the total current and the real current (AC) circulating through the sample under test and compares the latter according to two possibilities:	
The high threshold > 0.000 mA, the low threshold is fixed at 0.000 mA	If the measured current is greater than or equal to the threshold, the test is declared FAIL: Circuit break; if the current is < high threshold the test is declared PASS
The low threshold > 0.000 mA and the high threshold is > low threshold	If the current measured is inside the range defined by the thresholds, the test is PASS, if it is outside the test is declared FAIL: Circuit break
<b>Min. current limit I<sub>MIN</sub></b>	
In the sensing modes above, it is possible to specify a minimum value of current flowing in the sample under test. The value of I <sub>MIN</sub> is adjustable from 0.000 mA to 10.000 mA. The use of I <sub>MIN</sub> ensures that the test sample is correctly connected to the device	
<b>Without sensing</b>	
In this case no current monitoring is performed.	
<b>There is no adjustment of the output voltage in relation to the load</b>	
 <b>Warning: Permanent use of the device on a low-impedance charge can result in overheating of the amplification stage, with consequent stoppage of the generator for safety reasons.</b>	
<b>Measurement of the TOTAL permanent current</b>	
The reading of the total current (resistive and capacitive) is obtained through a shunt located directly in the test circuit	
Resolution	10,000 points
Accuracy	
0.001 mA 9.999 mA AC	±(1.5% + 2 µA)
0.001 mA to 9.999 mA DC	±(1.5% + 2 µA)
In DC the accuracy is guaranteed for charging resistances > 1 MΩ.	


## Dielectric strength, 50 VA

<b>Measurement of the real alternating current</b>	
The reading of the real current, linked to the resistance, is obtained through a shunt located directly in the test circuit	
Resolution	10,000 points
Accuracy	
0.001 mA to 9.999 mA AC	$\pm(3\% + 100 \mu\text{A})$
<b>Signalling of a fault</b>	
By a PASS or FAIL colour message on the LCD display and an audible signal	
With memory of	Breakdown voltage.
	Current in case of a fault (IMAX mode)
<b>In the event of a fault, the high voltage cut occurs without overvoltage.</b>	
<b>Time delay</b>	
<b>MANUAL</b>	
No time is applied to the test or the measurement. The control of the voltage is manual by action on the up and down arrows of the LCD screen. The test or the measurement is stopped only if a fault occurs or if the user requests to stop the test by pressing the red button on the front panel.	
<b>PERMANENT</b>	
A rise time is applied to the test and then the output voltage is equal to the set point. The test or the measurement is stopped only if a fault occurs or if the user requests to stop the test by pressing the red button on the front panel.	
<b>AUTO</b>	
In AUTO mode: The test consists of 3 successive phases (7 phases in multi-slope mode) during which the voltage increases linearly up to the desired value (Rise), is maintained at the programmed value (Hold) and is then gradually reduced to 0 (Fall)	
Rise and Fall programmable from	0.0 to 9999.0 sec. in steps of $> 0.1$ s.
Hold programmable from	0.1 to 9999.0 sec. in steps of $> 0.1$ s.
Accuracy	$\pm 20$ msec.

## Dielectric strength, 500 VA (SEFELEC 506-H/D/S)

<b>Output voltage</b>	
Adjustable from	0.100 to 5.000 kV in AC
Sinusoidal alternating with frequency of	50 Hz or 60 Hz
Adjustable from	0.100 to 6.000 kV in DC
(+) pole in DC	to ground
Residual ripple factor in DC according IEC61180	< 3% for a current < 3 mA @6000VDC
Stability	< ±3% for mains ΔV of ±10%
Accuracy of generation in relation to the set point for voltages between 100 and 5,000 V AC (6,000 V DC) and a current flow less than 10 mA	± (3%+5 V)
Maximum capacity of the sample measured	< 1 μF (discharge time < 10 sec.)
Discharge of the element tested and internal capacitors	1.5 MΩ in DC
<b>Voltage reading</b>	
By a voltmeter connected directly to the output terminals.	
Accuracy	± (1.5% +5 V)
Resolution	6,000 points
<b>Nominal current</b>	
from 800VAC to 5000VAC on capacitive load	>100 mA
from 1500VAC to 5000VAC on resistive load	>100 mA
from 400VDC to 6000VDC	>20 mA
<b>Short-circuit current</b>	
For adjustment of the maximum voltage in AC	≥ 200 mA
For adjustment of the maximum voltage in DC	≥ 100 mA
<b>Fault detection:</b>	
<b>In current variation ΔI</b>	
The ΔI (delta I) sensor automatically performs the subtraction between the current flowing normally in the sample under test ( $I = U/Z$ ) and the one that occurs suddenly when a fault occurs: ( $I' = I + I_{\text{fault}}$ ).	
DELTA-I detector factory setting = 1mA Standard HV probe 2 meters connected on the device	
Amplitude adjustable from	1 mA to 100 mA ± (10%+0.5mA) in steps of 1 mA DC : range 1mA-5mA only for U<3000VDC
Pulse width of	10 μS ±20%.

## Dielectric strength, 500 VA

<b>At current threshold IMAX</b>	
Adjustable amplitude of from	0.01 mA to 110 mA in steps of 0.01 mA.
The device continuously measures the current flowing in the sample under test and compares it according to two possibilities:	
The high threshold > 0.01 mA; the low threshold is fixed at 0.00 mA	If the measured current is greater than or equal to the threshold, the test is declared NG: Circuit break; if the current is < high threshold the test is declared PASS
The low threshold > 0.01 mA and the high threshold is > low threshold	If the current measured is inside of the range defined by the thresholds, the test is PASS, if it is outside the test is declared FAIL: Circuit break
<b>Min. current limit IMIN</b>	
In the sensing modes above, it is possible to specify a minimum value of current flowing in the sample under test. The value of IMIN is adjustable from 0.0 mA to 109 mA. The use of IMIN ensures that the test sample is correctly connected to the device	
<b>Without sensing</b>	
In this case no current monitoring is performed.	
<b>There is no adjustment of the output voltage in relation to the load</b>	
	<b>Warning: Permanent use of the device on a low-impedance charge can result in overheating of the amplification stage, with consequent stoppage of the generator for safety reasons.</b>
<b>Measurement of the permanent current</b>	
The current reading is obtained through a shunt located directly in the test circuit	
Resolution	11,000 points
Accuracy	
0.01 mA to 110.00 mA AC	±(2.5% + 20 µA)
0.01 mA to 110.00 mA DC	±(2.5% + 20 µA)
The message 'POWER CURRENT' as well as the "value" '- - - mA' are displayed on the LCD screen when the current exceeds 110 mA AC or DC.	
<b>The DC current displayed is the real RMS current. I.e. it is calculated according to the formula:</b> $\sqrt{I_{ac}^2 + I_{dc}^2}$	

## Dielectric strength, 500 VA

<b>Measurement of the ACTUAL permanent current</b>	
The reading of the real current, linked to the resistance, is obtained through a shunt located directly in the test circuit	
Resolution	11,000 points
Accuracy	
0.01 mA to 110.00 mA AC	$\pm(3\% + 1 \text{ mA})$
<b>Signalling of a fault</b>	
By a PASS or FAIL colour message on the LCD display and an audible signal	
With memory of	Breakdown voltage.
	Current in case of a fault (IMAX mode)
<b>In the event of a fault, the high voltage cut occurs without overvoltage.</b>	
<b>Time delay</b>	
<b>MANUAL</b>	
No time is applied to the test or the measurement. The control of the voltage is manual by action on the up and down arrows of the LCD screen. The test or the measurement is stopped only if a fault occurs or if the user requests to stop the test by pressing the red button on the front panel.	
<b>PERMANENT</b>	
A rise time applies to the test and then the output voltage is equal to the setpoint. The test or the measurement is stopped only if a fault occurs or if the user requests to stop the test by pressing the red button on the front panel.	
<b>AUTO</b>	
In AUTO mode: The test consists of 3 successive phases during which the voltage increases linearly up to the desired value (Rise), is maintained at the programmed value (Hold) and is then gradually reduced to 0 (Fall)	
Rise and Fall times programmable from	0.0 to 9999.0 sec. in steps of $> 0.1 \text{ s.}$
Hold programmable from	0.1 to 9999.0 sec. in steps of $> 0.1 \text{ s.}$
Accuracy	$\pm 20 \text{ msec.}$



## Insulation resistance (SEFELEC 1000-M; SEFELEC 56/506-D/S)

<b>Measurement specifications</b>	
Programmable volt per volt from	20 to 1,000 VDC
Generation accuracy	$\pm(1\% + 1 \text{ V})$
(+) pole of the generator	to ground
Dynamic stability for mains $\Delta V = \pm 10\%$ : Variation of the voltage measured	$< \pm 1\%$ .
Maximum current in the measurement circuit:	2 mA - 20% +0%
Maximum capacity of the sample measured	$< 100 \mu\text{F}$ (discharge time $< 10 \text{ sec.}$ )
Discharge resistance	2.2 k $\Omega$
<b>Resistance measurement range</b>	
Measurement scope	(Generator $U_{\text{test}}/U_{\text{max}}$ ) x 200 G $\Omega$ (or 2 T $\Omega$ )
<b>Standard version</b>	
Voltage	Measurement scope
100 V	100 k $\Omega$ to 20 G $\Omega$
250 V	250 k $\Omega$ to 50 G $\Omega$
500 V	500 k $\Omega$ to 100 G $\Omega$
1,000 V	1 M $\Omega$ to 200 G $\Omega$
<b>Optional 2T<math>\Omega</math> version</b>	
Voltage	Measurement scope
100 V	100 k $\Omega$ to 200 G $\Omega$
250 V	250 k $\Omega$ to 500 G $\Omega$
500 V	500 k $\Omega$ to 1 T $\Omega$
1,000 V	1 M $\Omega$ to 2 T $\Omega$
<b>Measurement accuracy in NORMAL mode</b>	
Display with indication of the units k $\Omega$ , M $\Omega$ , G $\Omega$ and T $\Omega$	2,000 points
Accuracy (in % of the reading, 1U = 1 point of display):	
200 G $\Omega$ , basic version	$\pm(1.5\% + 1U) *$
Option - 2 T $\Omega$ and $U \leq 200 \text{ Vdc}$	$\pm(2\% + 1U) *$
Option - 2 T $\Omega$ and $U > 200 \text{ Vdc}$	$\pm(1\% \times U_{\text{test}} / 100 + 1U) *$
*Accuracies are given for $R < 10 \text{ G}\Omega$	Hold Time $> 1 \text{ second}$
$R > 10 \text{ G}\Omega$	Hold Time $> 5 \text{ seconds}$
<b>CAPACITOR mode</b>	
	1.00 M $\Omega$ at 200 G $\Omega$
Accuracy	Precision mode NORMAL $\pm 100 \text{ k}\Omega$
Input impedance	10 M $\Omega \pm 1\%$

## Insulation resistance (SEFELEC 1000-M; SEFELEC 56/506-D/S + SEFO-5X500M option)

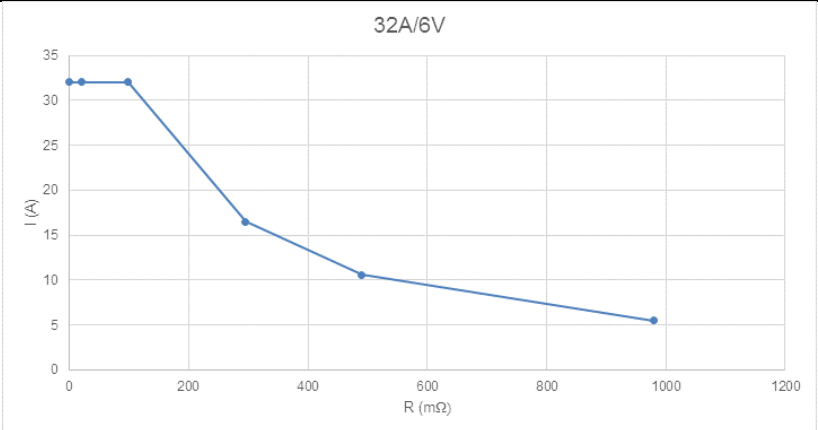
Measurement specifications	
Programmable volt per volt from	10 to 500 VDC
Generation accuracy	$\pm(1\% + 1 \text{ V})$
(+) pole of the generator	to ground
Dynamic stability for mains $\Delta V = \pm 10\%$ : Variation of the voltage measured	$< \pm 1\%$ .
Maximum current in the measurement circuit:	2 mA - 20% +0%
Maximum capacity of the sample measured	$< 100 \mu\text{F}$ (discharge time $< 10 \text{ sec.}$ )
Discharge resistance	2.2 k $\Omega$
Resistance measurement range	
Measurement scope	(Generator $U_{\text{test}}/U_{\text{max}}$ ) x 200 G $\Omega$ (or 2 T $\Omega$ )
Standard version	
Voltage	Measurement scope
50V	50k $\Omega$ to 20G $\Omega$
100V	100k $\Omega$ to 40G $\Omega$
250V	250k $\Omega$ to 100G $\Omega$
500V	500k $\Omega$ to 200G $\Omega$
Optional 2T $\Omega$ version	
Voltage	Measurement scope
50V	50k $\Omega$ to 200G $\Omega$
100V	100k $\Omega$ to 400G $\Omega$
250V	250k $\Omega$ to 1 T $\Omega$
500V	500k $\Omega$ to 2 T $\Omega$
Measurement accuracy in NORMAL mode	
Display with indication of the units k $\Omega$ , M $\Omega$ , G $\Omega$ and T $\Omega$	2,000 points
Accuracy (in % of the reading, 1U = 1 point of display):	
200 G $\Omega$ , basic version	$\pm(1.5\% + 1U) ^*$
Option - 2 T $\Omega$ and $U \leq 200 \text{ Vdc}$	$\pm(2\% + 1U) ^*$
Option - 2 T $\Omega$ and $U > 200 \text{ Vdc}$	$\pm(1\% \times U_{\text{test}} / 100 + 1U) ^*$
*Accuracies are given for $R < 10 \text{ G}\Omega$	Hold Time $> 1 \text{ second}$
$R > 10 \text{ G}\Omega$	Hold Time $> 5 \text{ seconds}$
CAPACITOR mode	
	1.00 M $\Omega$ at 200 G $\Omega$
Accuracy	Precision mode NORMAL $\pm 100 \text{ k}\Omega$
Input impedance	10 M $\Omega \pm 1\%$

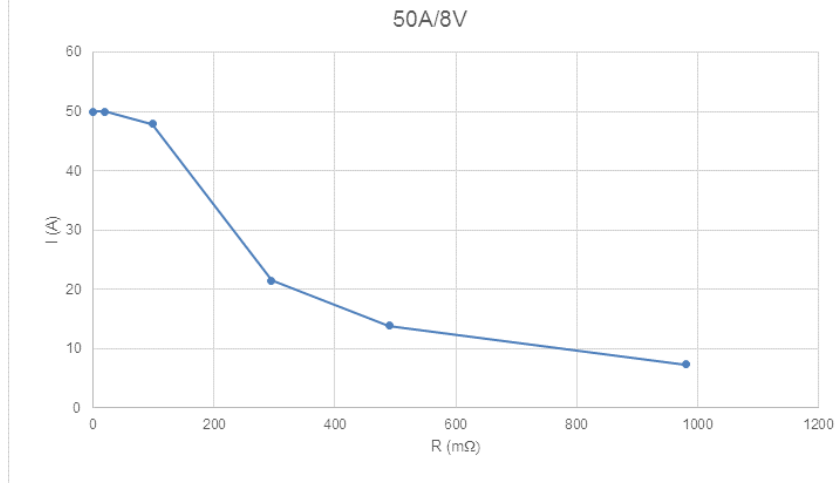
## Insulation resistance

Current measurement accuracy (automatic range):						
Version	Range	I Min	I Max	Accuracy	Voltage	Min. time
200 GΩ	1	0.100 mA	1.000 mA	+/- ( 1% +0.001 mA)	≤ 1000VDC	1 sec.
	2	010.0 μA	100.0 μA	+/- ( 1% +000.1 μA)	≤ 1000VDC	1 sec.
	3	01.00 μA	10.00 μA	+/- ( 1% +00.01 μA)	≤ 1000VDC	1 sec.
	4	0.100 μA	1.000 μA	+/- ( 1% +0.001 μA)	≤ 1000VDC	1 sec.
	5	010.0 nA	100.0 nA	+/- ( 1% +000.1 nA)	≤ 1000VDC	1 sec.
	6	01.00 nA	10.00 nA	+/- ( 1% +00.02 nA)	≤ 1000VDC	5 sec.
2TΩ	7	0.100 nA	1.000 nA	+/- ( 2% + 0.005 nA)	≤ 200VDC	10 sec.
				+/- ( 1% x U/100 + 0.005 nA)	>200VDC	10 sec.

Measurement thresholds	
Two measurement thresholdadjustable from	100 kΩ to 200 GΩ (or 2 TΩ)
Measurement results according to the thresholds	Low threshold / R.measured / High threshold
PASS: R.measured >= SB and SH disabled	10 MΩ / 15.4 MΩ/ <b>200 GΩ</b>
PASS: R.measured between SB and SH	55 kΩ / 63.2 MΩ/ 80 MΩ
FAIL: R.measured higher than SH	45 kΩ / 110 MΩ/ 75 MΩ
Time delay	
PERMANENT	
A rise time applies to the test and then the output voltage is equal to the setpoint. The test is stopped if the user requests to stop the test by pressing the red button on the front panel.	
AUTO	
In AUTO mode: The test consists of 3 successive phases during which the voltage rises linearly up to the desired value (Rise), is maintained at the programmed value (Hold) and is then gradually reduced to 0 (Fall)	
Rise and Fall programmable from	0.0 to 9999.0 sec. in steps of 0.1 s.
Hold programmable from	0.1 to 9999.0 sec. in steps of 0.1 s.
Accuracy	+/- 20 msec.

## Ground continuity 32 A AC (SEFELEC 32-C; SEFELEC 56/506-S)

<b>Measurement current</b>													
Sinusoidal alternating with frequency of	50 Hz or 60 Hz depending on the mains												
Adjustable in steps of	0.5 A												
	5.0 to 32.0 A AC												
option	5.0 to 50.0 A ac												
Generation and measurement accuracy	$\pm(1\% + 0.1 \text{ A})$												
option	$\pm(1\% + 0.2 \text{ A})$												
<b>Maximum open circuit voltage</b>													
32 A generator	6 VAC $\pm 10\%$												
50 A generator	8 VAC $\pm 10\%$												
<b>Voltage drop measurement</b>													
Measurement scope	0.01 to 9.99 V												
Resolution	0.01 V												
Accuracy (% of reading)	$\pm(1.5\% + 0.03 \text{ V})^*$												
<b>Ground continuity measurement</b>													
This function calculates the value of the resistive circuit from the current generated and the voltage at the terminals of the sample													
Measurement scope	0.1 to 1,000.0 m $\Omega$												
Resolution	0.1 k $\Omega$												
Indication of the unit	m $\Omega$ = 0.001 $\Omega$												
Accuracy (% of the reading)	$\pm(1.5\% + 0.5 \text{ m}\Omega)^*$												
*Accuracies are given for	Hold time > 1 second												
<b>Resistance measurement range</b>													
According to the graph below:													
 <table border="1"> <caption>Data points from the 32A/6V graph</caption> <thead> <tr> <th>R (m<math>\Omega</math>)</th> <th>I (A)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>32</td> </tr> <tr> <td>100</td> <td>32</td> </tr> <tr> <td>300</td> <td>16</td> </tr> <tr> <td>500</td> <td>10</td> </tr> <tr> <td>1000</td> <td>5</td> </tr> </tbody> </table>		R (m $\Omega$ )	I (A)	0	32	100	32	300	16	500	10	1000	5
R (m $\Omega$ )	I (A)												
0	32												
100	32												
300	16												
500	10												
1000	5												



### Measurement thresholds in resistance or voltage drop

The device offers high and a low measurement thresholds expressed either in continuity resistance or in voltage drop.

Resistance measurement thresholds adjustable from	0.1 mΩ to 1,000.0 mΩ
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Voltage drop measurement thresholds adjustable from	0.01 to 9.99 V
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### Timer

#### PERMANENT

A rise time applies to the test and then the output current is equal to the set point. The test is stopped if the user requests to stop the test by pressing the red button on the front panel.

#### AUTO

In AUTO mode: The test consists of 3 successive phases during which the current increases linearly up to the desired value (Rise), is maintained at the programmed value (Hold) and is then gradually reduced to 0 (Fall)

Rise and Fall programmable from	0.0 to 9999.0 sec. in steps of 0.1 s.
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Hold programmable from	0.1 to 9999.0 sec. in steps of 0.1 s.
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Accuracy	+/- 20 msec.
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### Measurement cycle

If the current generated is high (greater than or equal to 25 A), it may cause overheating of the current transformer and trigger its protection.

The information below indicates the maximum time of use of the ground continuity function according to the cycle of use (one ½ cycle represents an application of the current for one second for a cycle with a total duration of 2 seconds). Note: All these times are given for a current of 32 A. For lower currents these times are longer.

Cycle	Permanent / 0.5 / 0.3
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Maximum time of use	25 minutes / 5 hours/ infinity
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**Using the SEFA-TE81-32 or 50 accessory adds a residual resistance of around 5 mΩ. This value can be canceled with the zero function.**

### REMARQUE

## 4. SAFETY

### 4.1. SECURITY WHEN WORKING ON ELECTRICAL DEVICES



**WARNING**

#### **Danger of electric shock!**

- All precautions related to the use of equipment connected to the electrical network must be taken when using it.
- In particular, it is absolutely necessary to connect the equipment to the ground by the power cord and via the ground pin provided for this purpose on rear face of the unit (see paragraph 20.1 item Z2)
- Always be sure that the high voltage light is turned off before connecting or disconnecting an element to be tested.

### 4.2. SAFETY ARRANGEMENTS

- Sectioning of the equipment by the power cord.
- The devices are equipped with a double safety loop.



**WARNING**

#### **Danger of electric shock!**

- **To prevent access by unauthorized persons, the test area must be secured by a safety loop.**



**WARNING**

#### **Sectioning device!**

- **The power cord is the device for sectioning the equipment. After installation, make sure that it remains accessible. In case of replacement of the mains power cord, be sure to always use a mains cord suitable for the power and CE certified.**

#### 4.2.1. SAFETY LOOPS

The voltages and currents applied by the measuring devices in the SEFELEC 5x range can be dangerous to the touch. The protection of personnel is the responsibility of the management of the site where the measurement device is installed.

EATON can only give advice; the respect of the conditions of safety is the responsibility of the user company's safety manager.

A **double safety loop** is integrated in the devices; it makes it possible to respect the IEC 61010-2-034 and IN60591 standards, either directly or by the addition of external accessories (emergency stop button, safety gate, light signalling, safety cage, etc.).

This double loop acts, by electromechanical cut-off of the high voltage generators, as soon as one of the loops is opened. The software responds by an alarm message and by stopping the test. The test cannot restart unless the loops are closed, and on an order from the operator.

The lights on the front panel (and optionally a light column) allow the user to see that the measurement device is powered (green), and that it is testing (red).

#### Connection of the safety loops

The device has a double "safety loop" available at points 1-9 and 2-10 of the rear connection C5. They must be linked to allow a test to be performed.

**Note:** We recommended fitting in series with these connections dry contacts subject to safety conditions (door closed, cover lowered, etc.).

It is possible to connect a red/green signalling light (SEFA-CO160) on terminal C5 to indicate visibly from a distance the presence or absence of potential on the output terminals of the device.



#### NOTE

The connection of connector C5 can be found in paragraph 20.1.1:  
**Safety Connector C5**

#### Reminder of the standard: Parts that are dangerous to the touch

The effects of a current passing through the human body were the subject of work recorded in NF EN 50191 of 20 January 2003, available from the AFNOR. It applies to "*the installation and operation of electronic test equipment of test*".

It is considered that the human body is similar to a non-inductive resistor close to 2 kΩ.

#### Situation of alternating currents

For voltages higher than 25 VAC: A current of 3 mA (rms)

#### Situation of direction currents

For voltages higher than 60 VDC: A current of 12 mA

In any event the discharge energy must not exceed 350 mJ

**Note:** A maximum current of 0.7 mA peak, enters the perception range of certain persons, although it does not present a danger.

#### 4.2.2. SAFETY OPTIMIZATION

In all cases, a safety loop used properly is the best protection.

The system of protection is ideal for the equipment under test and for the operator; it is independent of the voltage applied and the current injected for measurement.



**WARNING**

**Danger of electric shock!**

**Access to the device must be limited to personnel "informed about electrical hazards".**

**We strongly advise against handling equipment under test (risk of faults and electric shock).**

A double safety loop is offered as the basic equipment.



**WARNING**

**High voltage!**

**For dangerous voltages, signalling by a suitable Red/Green light (SEFA-CO160) must be put in place.**



**IMPORTANT**

**The safety loop and the proper functioning of the danger warning lamps (SEFA-CO160) must be checked each time the device is switched on by trying to launch a test with the safety loop open and by checking the green lighting: no danger and red: presence of danger. A check of each associated safety device: Emergency Stop Button, door safety, etc. in detail once a year.**

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





#### 4.3. PRECAUTIONS OF USE



**IMPORTANT**

In no circumstances must the measurement device switch or receive external electrical supplies which it does not control with its own software. In these power supplies we include relay coils, chokes not fitted with "free-wheeling diodes" or non-discharged capacitors.



**IMPORTANT**

During measurement of the insulation on capacities  $> 100 \mu\text{F}$ , the installation of a discharge system able to guarantee the discharge of the capacity is mandatory.

In the case of non-respect of this set point the measurement device may be damaged.



**IMPORTANT**

To maintain the protection provided by the equipment, it is mandatory that all of the electrical circuits at very low voltage which are connected to it (USB output, Ethernet, CAN, etc.) have double or reinforced insulation in relation to any circuit operating at a dangerous voltage.



**NOTE**

During the use of the devices of the SEFELEC 5x range, the non-respect of the conditions of operation listed above (condition of the environment, mains supply and of use) release EATON from any warranty and any production following degradation of the device.

## 5. COMMISSIONING



### NOTE

The device must be used indoors, in a horizontal position or tilted on its legs. The hardware must be installed on a horizontal plane that supports its weight, in a space that is sufficiently light and is not humid. The air inlets of the device must be clear.



### WARNING

#### **Danger of electric shock!**

- Commissioning, use and maintenance of the equipment must be carried out by qualified personnel.
- All precautions related to the use of equipment connected to the electrical network must be taken when using it.
- It is absolutely necessary to connect the equipment to the ground by the power cord and via the ground pin provided for this purpose on rear face of the unit (see paragraph 20.1 item Z2)
- Always be sure that the high voltage light is turned off before connecting or disconnecting an element to be tested.

### 5.1. DELIVERY CONTENT

On delivery of the measurement device, the packaging box must contain the following articles as standard:

- 1 measuring device from the SEFELEC 56/506-H/D/S, 1000-M or 32-C range
- 1 AC Power Cord 2P+G, 16 A of length 1.5 m
- 4 x 10-pin plugs of the screw terminal type provided with a green cover
- 1 Quick Start guide. The complete Operating Manual of the device is accessible via a link on our Internet website: [www.sefelec.com](http://www.sefelec.com)
- 1 manual of safety rules for high-voltage tests
- 1 CE certificate of conformity (included at the end of this manual)

And depending on your order:

- The measurement accessories
- WINPASS\_MX software
- 1 calibration report with the measurement readings.

If any item is missing, contact EATON. See chapter entitled [After-sales service](#).

## 5.2. INSTALLATION OF THE DIFFERENT CONNECTORS AND CORDS

Before powering the measurement device, ensure that the following accessories are installed, and their plugs locked:

- The C5 safety plug (10 points) must be installed on the socket marked C5 (caution, there is mechanical fool-proofing on the sockets)
- Connect the mains power cord to the rear panel and to a 16A wall socket with ground



**IMPORTANT**

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

## 5.3. INSTRUCTIONS FOR FITTING IN THE BAY

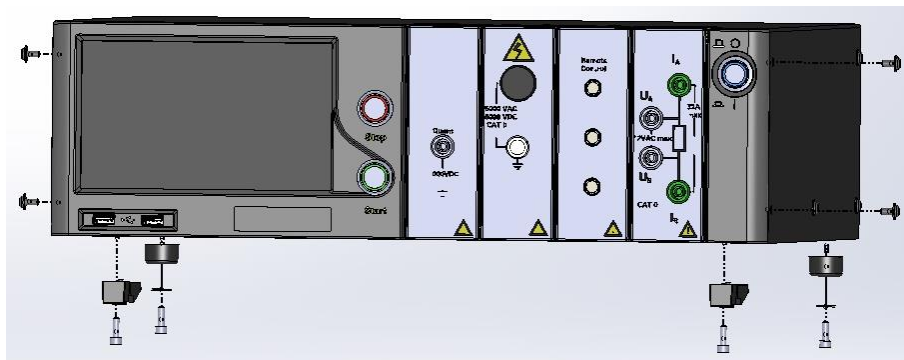
In cases when the SEFELEC 5x range device needs to be fitted in a bay, follow the instructions below:

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).

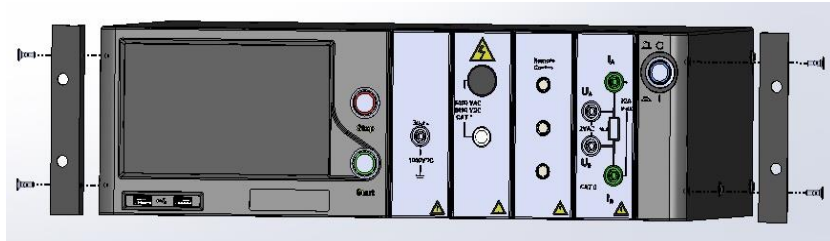
2 - Preparation of the device: Remove the 4 feet by unscrewing the 4 screws (hexagon socket head cap screws). Then remove the 2 screws on each side that hold the cover on the front of the device (Torx socket head cap screws).

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. SWITCHING ON THE POWER TO THE DEVICE

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



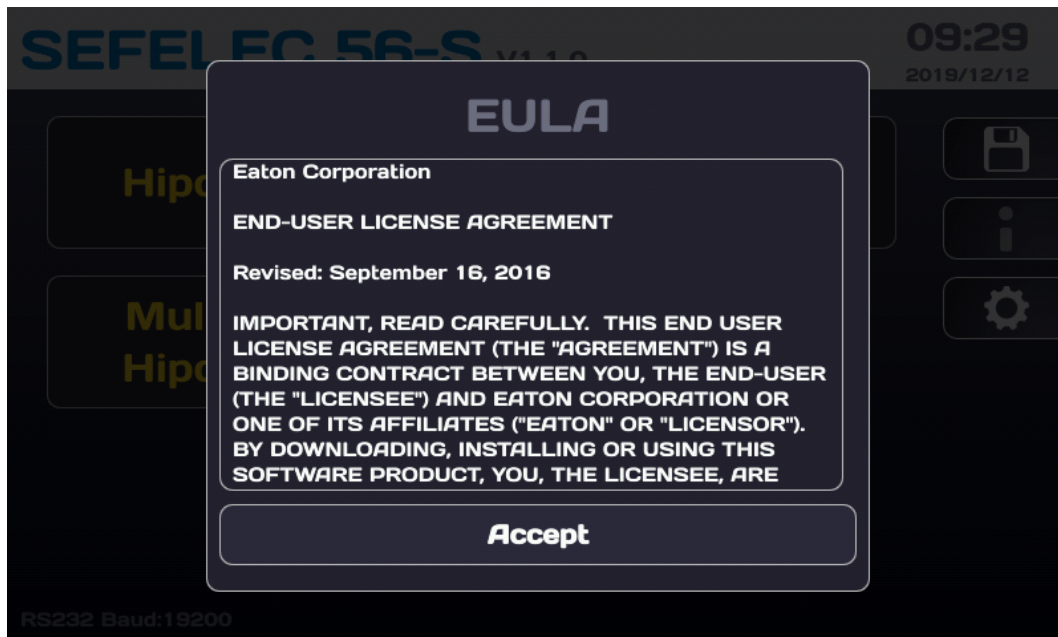
### IMPORTANT

After switching off the power to the device, 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:

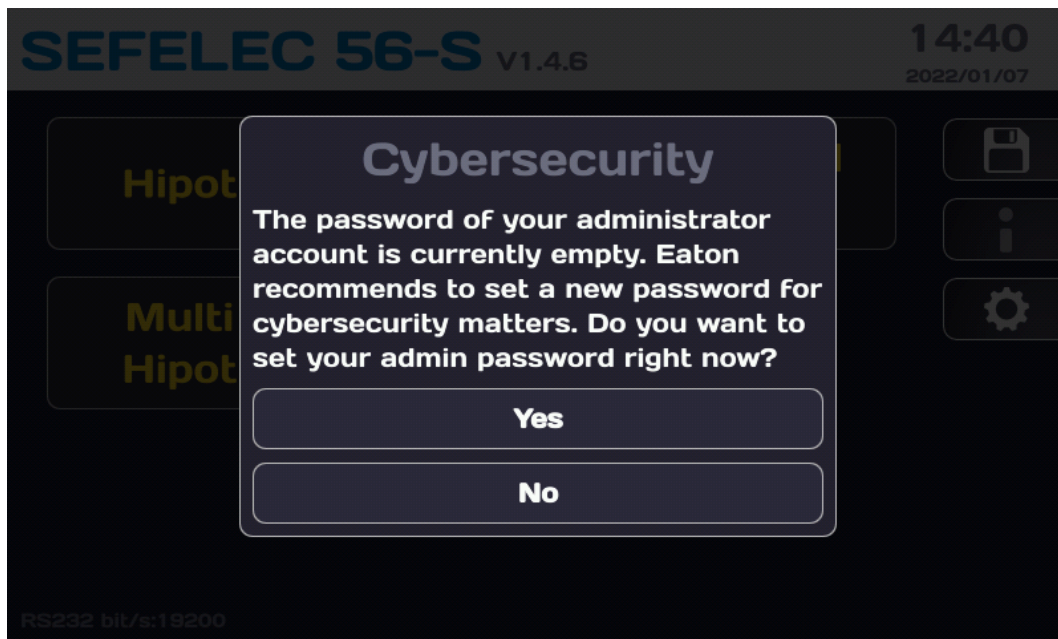


Choose the language; the device then displays the conditions for the use of the embedded software and asks you to accept the end user license agreement:



Accept the text to be able to use the device. The full text can be found in the appendix chapter 24 of this leaflet.

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



The SEFELEC 5x series 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.

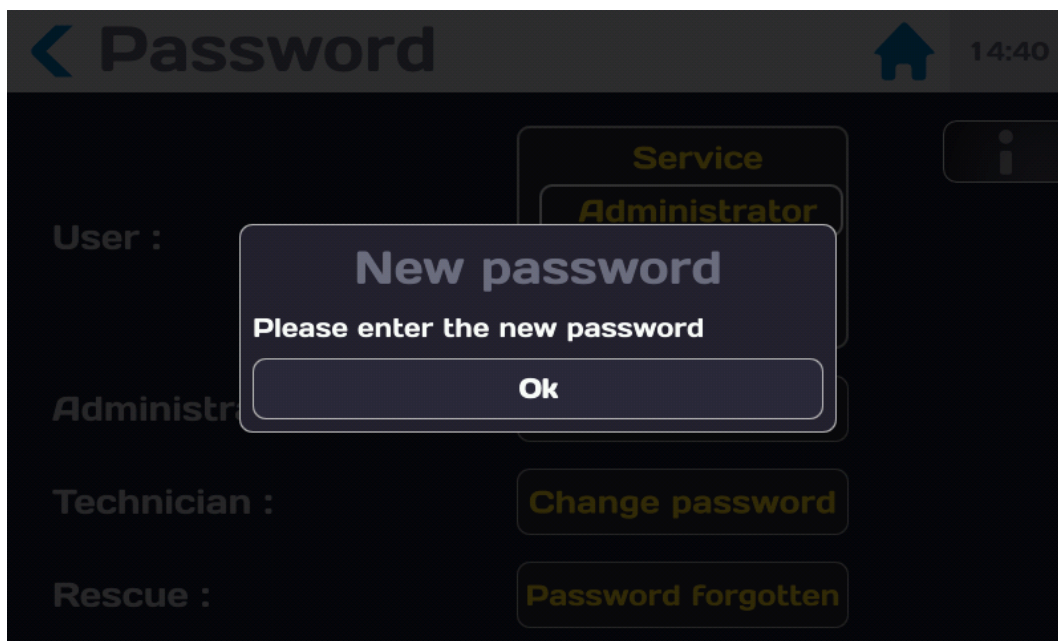
Press YES to enter your password.

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:



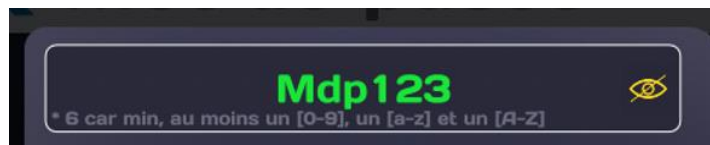
Enter the password according to the following rules:

- 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:



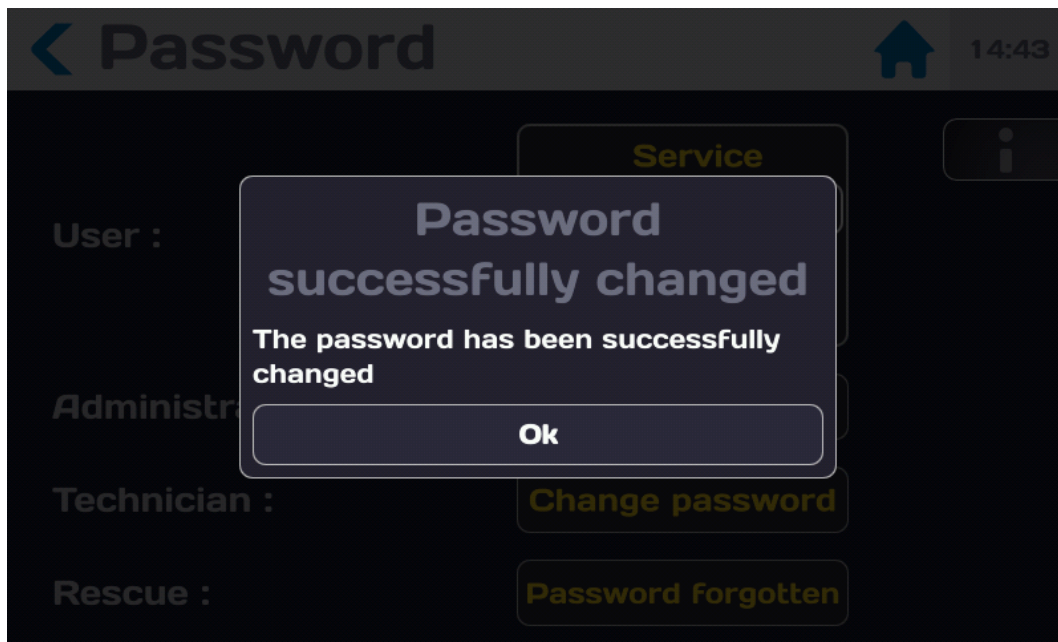
When the password entered complies with the above rules, the input area turns green:



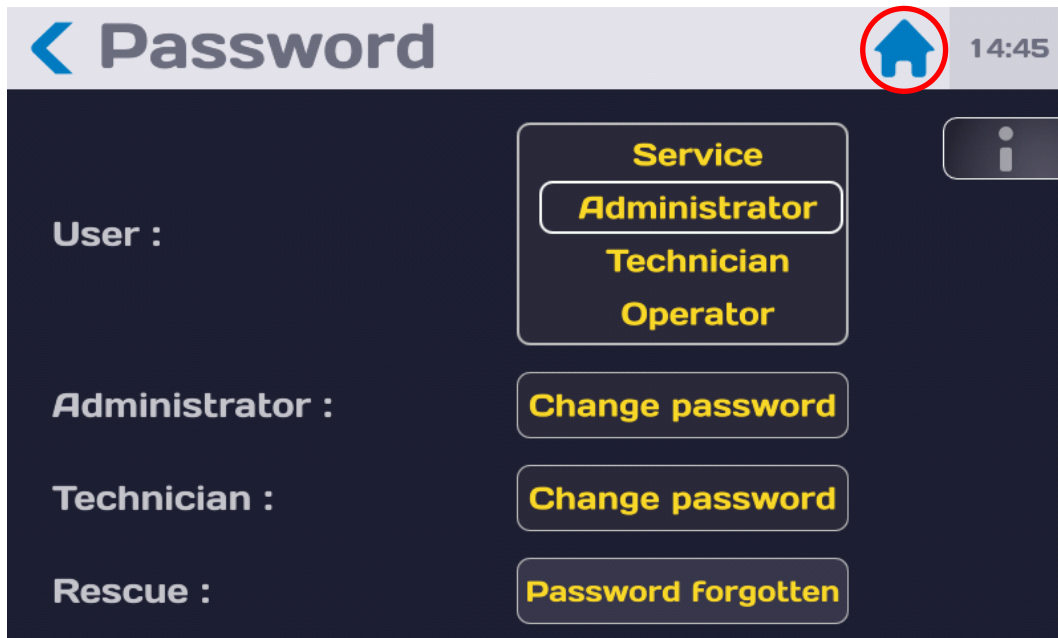
Validate the entry by pressing the character entry arrow. A new password entry screen will be offered to confirm your password.  
Enter the same password, be careful it will not turn green.



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 top banner indicates:

- The reference of the device: SEFELEC 56-S
- The software version V1.1.0
- The time 10:53 and the date 2019/12/12

The date and time settings can be changed in the "General settings" menu accessible by pressing on the area of the screen with the toothed wheel icon.

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

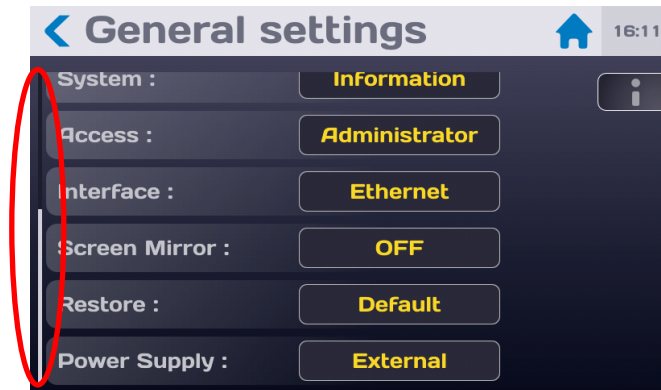
The colour LCD is equipped with a touch screen allowing navigation in the different menus of the device. For the proper functioning of the touch screen do not use gloves, pens or any other sharp object. On first delivery remove the protective plastic film from the LCD screen.

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



Pressing a key for more than one second allows the user to display a help window briefly describing the function. Press outside of the Help window to return to the previous screen.

Some screens require scrolling through the information displayed upwards or downwards to view all the settings. This possibility is indicated by the display of a scroll box on the left of the screen.



To scroll to the bottom of the screen, place your finger towards the bottom of the screen and while keeping it in contact with the screen, swipe to the top of the screen with your finger, and vice versa to scroll the screen to the top.

The active fields of the touch screen are usually yellow in colour.



Pressing the icon in the form of a home in the banner at the top allows you to return to the power-on menu.



Pressing the icon in the form of < allows you to return to the previous menu.

The entry of the numerical values of the parameters or names of files is done using a virtual keyboard displayed on the screen.



To facilitate entry it is also possible to connect a QWERTY keyboard and a mouse on the USB ports on the front panel of the device under the LCD screen.

Connect the keyboard and the mouse via the USB connections; they are functional immediately.

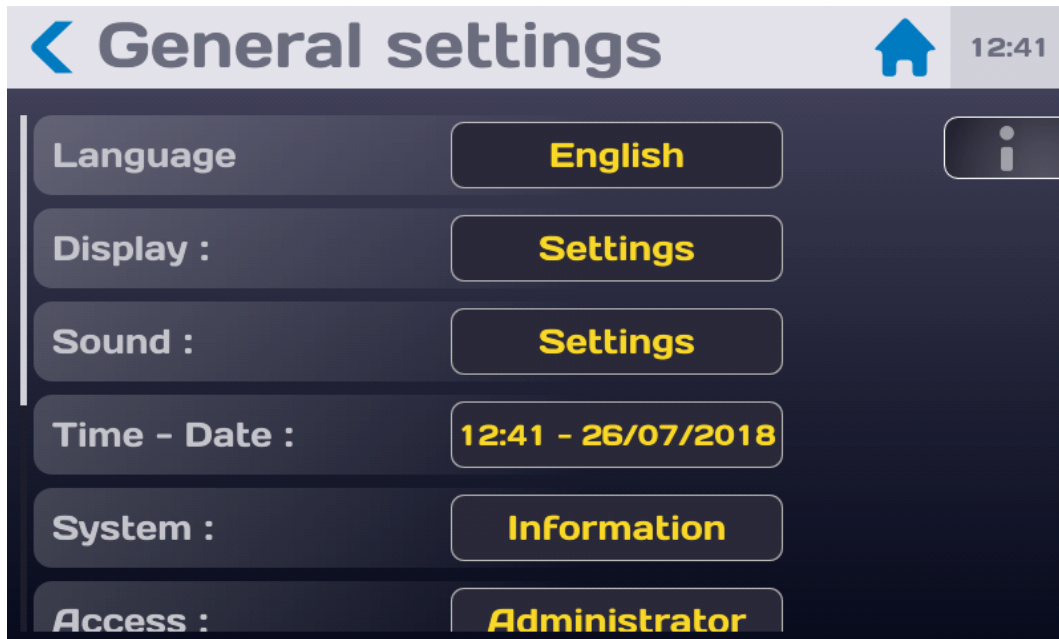
## 6. CONFIGURATION OF THE DEVICE

After switching on the device or the return to the Start menu, the Home screen shows:



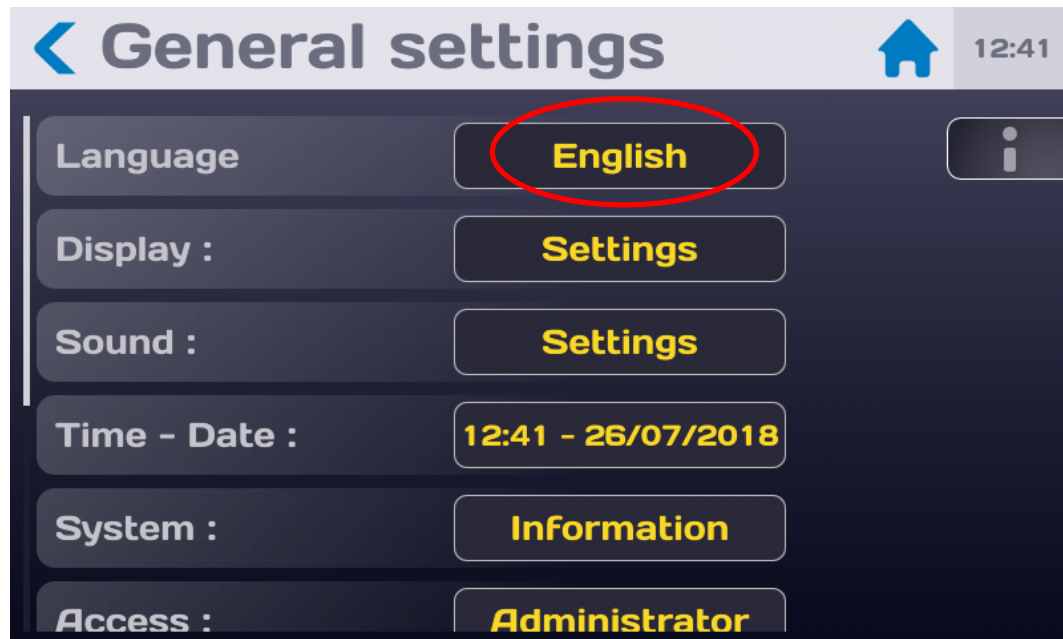
press the Setup key (gear wheel)

The LCD screen displays the following information:



## 6.1. LANGUAGE SELECTION

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



Then scroll through the different languages and select the new language by pressing again on the field.



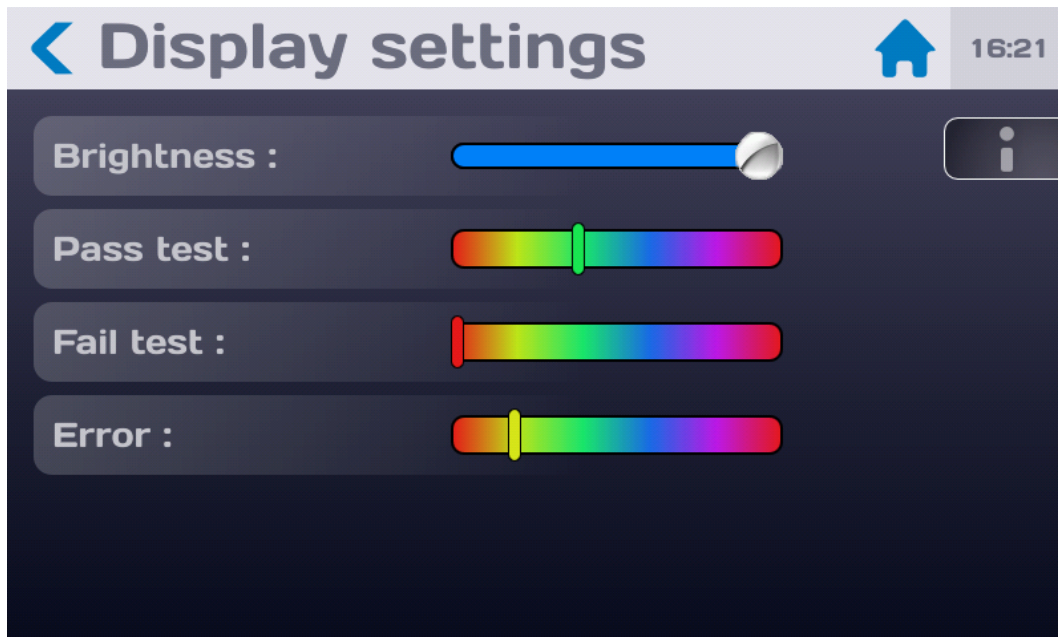


## 6.2. DISPLAY SETTINGS

In the "**General settings**" menu press the "Settings" area of the "Display" line:



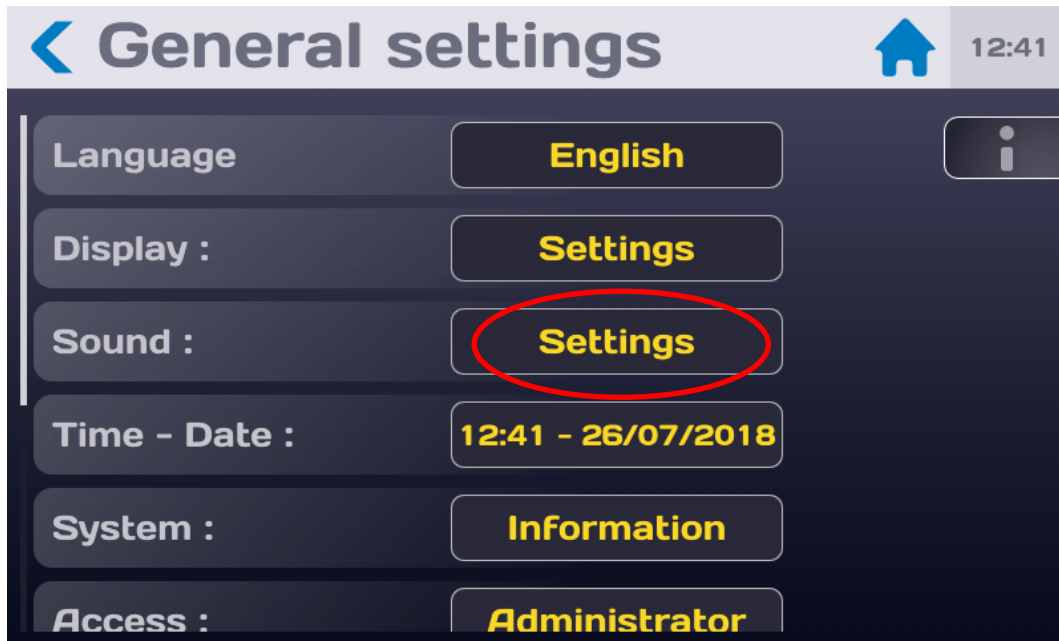
To obtain the following screen:



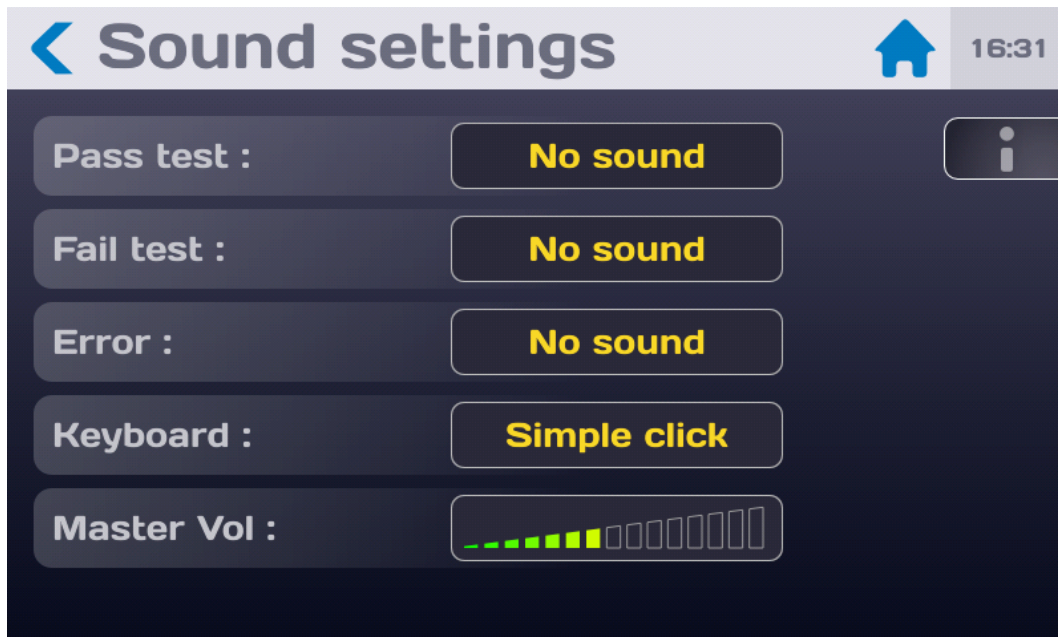
Adjust the brightness and colours by moving the different cursors by holding your finger on the touch pad and dragging it from right to left or vice versa.

### 6.3. SOUND SETTINGS

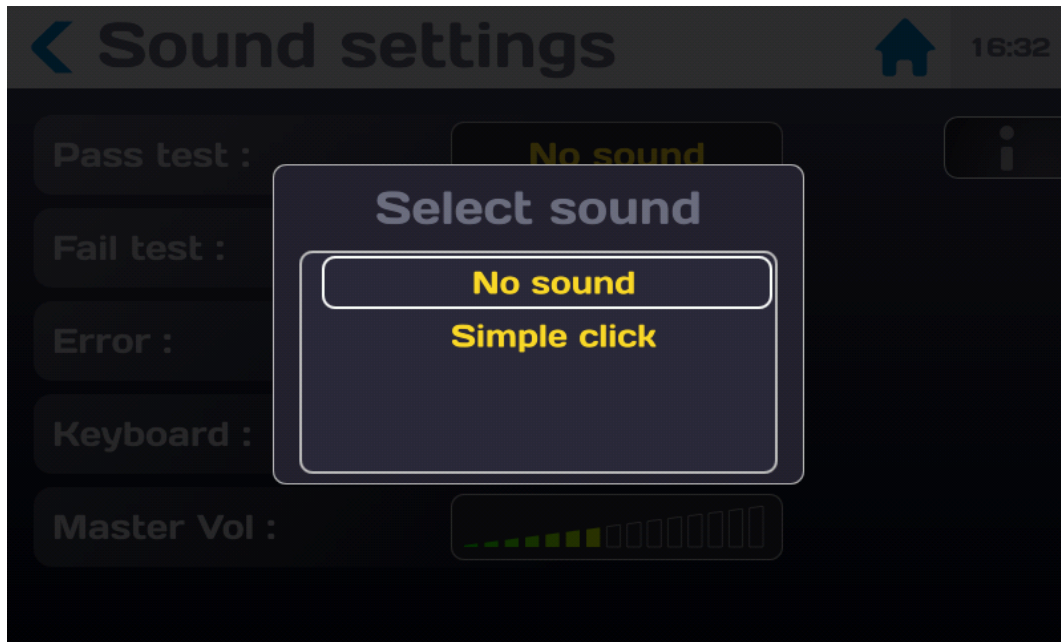
In the "**General settings**" menu press the "Settings" area of the "Sound" line:




To obtain the following screen:



Choose the different sound possibilities for the proposed actions.



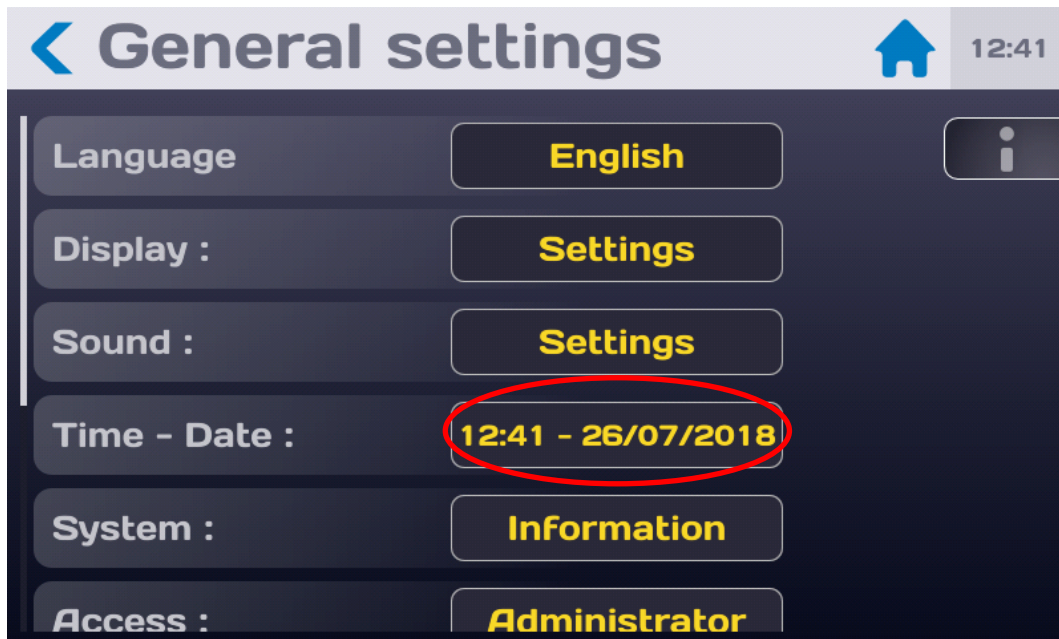
To adjust the sound volume place your finger on the graphic bar and drag it to the right while remaining in contact with the screen to increase the volume, and to the left to decrease the volume.

Return to the previous menu with the symbol: 



## 6.4. TIME-DATE SETTINGS


In the "**General settings**" menu press the "Settings" field indicating the time and date of the "Time – Date" line:





To obtain the following screen:




Choose the YYYY/MM/DD or DD/MM/YYYY date format, and then set the date using the drop-down windows or press the icon symbolizing a calendar to choose a date directly.


**Time & Date**


16:35



**July 2018**



Sun	Mon	Tue	Wed	Thu	Fri	Sat
24	25	26	27	28	29	30
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

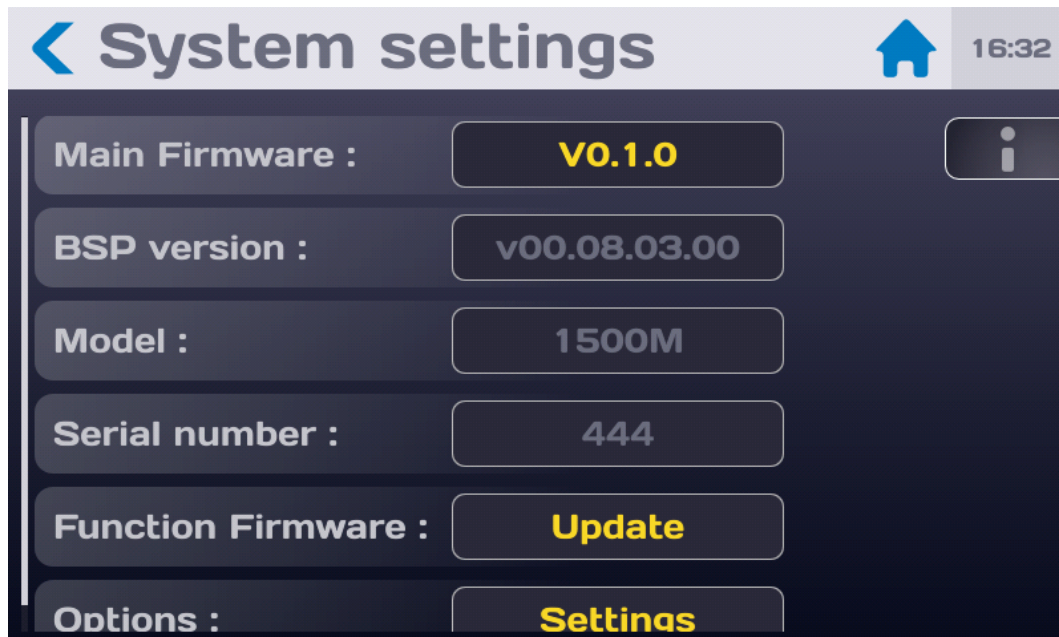
Proceed in the same way for setting the time and validate by **OK**

## 6.5. SYSTEM SETTINGS

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



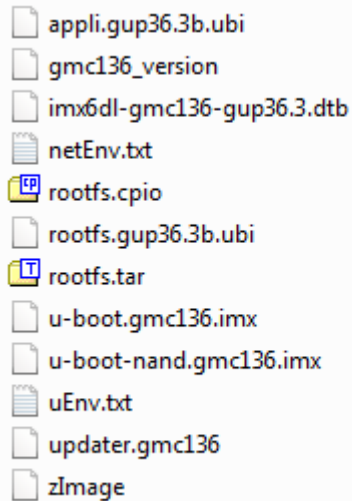
To obtain the following screen:



### 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 (32Gb max. capacity) used for the update:



- appli.gup36.3b.ubi
- gmc136\_version
- imx6dl-gmc136-gup36.3.dtb
- netEnv.txt
- rootfs.cpio
- rootfs.gup36.3b.ubi
- rootfs.tar
- u-boot.gmc136.imx
- u-boot-nand.gmc136.imx
- uEnv.txt
- updater.gmc136
- zImage

Once the files are in the root of your USB key, plug the key 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 key (32Gb max. capacity) 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.**



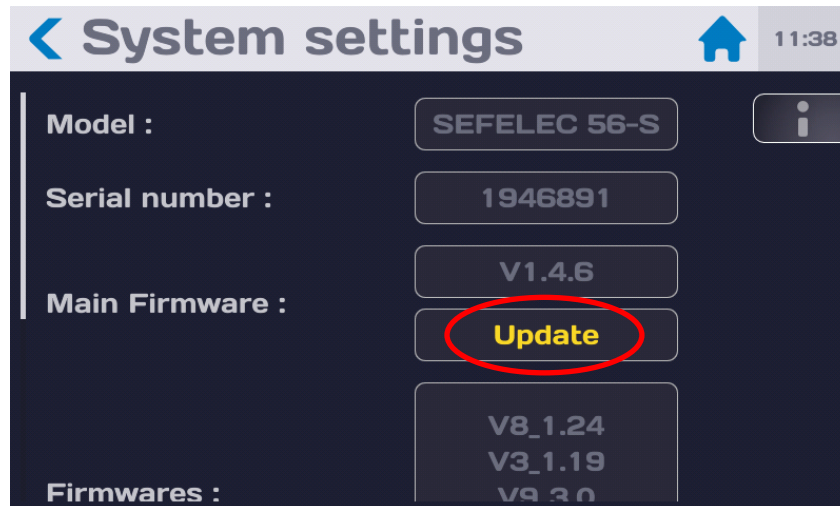
**NOTE**

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

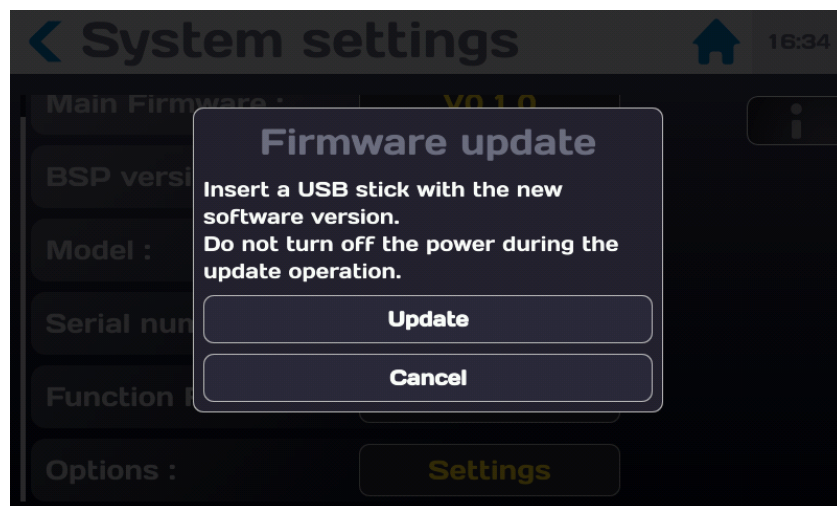
## 6.5.2. UPDATING THE MAIN FIRMWARE OF THE HMI (HUMAN MACHINE INTERFACE):

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 (32Gb max. capacity).

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

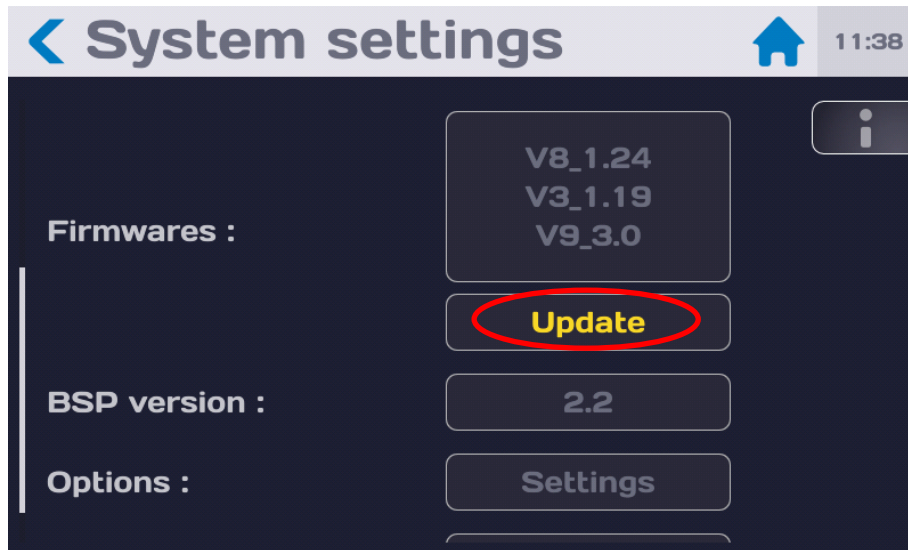


**IMPORTANT**

**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 (32Gb max. capacity).  
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 SETTINGS

The SEFELEC 5x series 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:

The screenshot shows a mobile application interface titled "Password" with a back arrow on the left and a home icon and time "16:11" on the right. The interface is divided into three main sections. The top section has a "User :" label and a selection box containing "Service", "Administrator", "Technician", and "Operator", with "Administrator" highlighted. The middle section has an "Administrator :" label and a "Change password" button. The bottom section has a "Technician :" label and a "Change password" button. A small information icon is visible in the top right corner of the main content area.

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. The **Service** level is only accessible to EATON technicians.



### 6.6.1. NEW PASSWORD OR PASSWORD CHANGE:

#### Rules concerning the password:

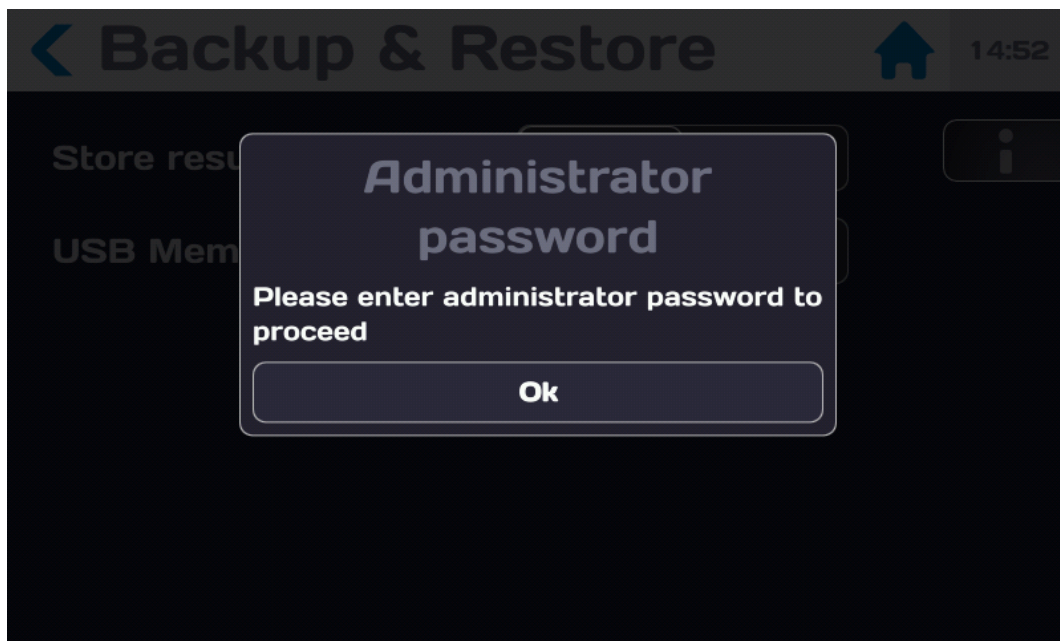
When changing the password, enter the old password and then the new one. There is no limitation in the number of characters which are those available on the virtual keyboard, but it should include:

- 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:



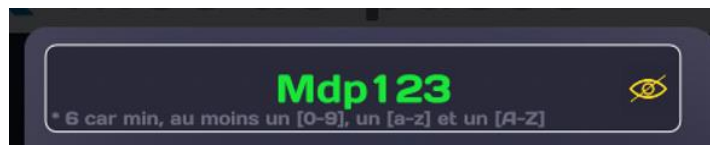
Enter the password according to the following rules:

- 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:



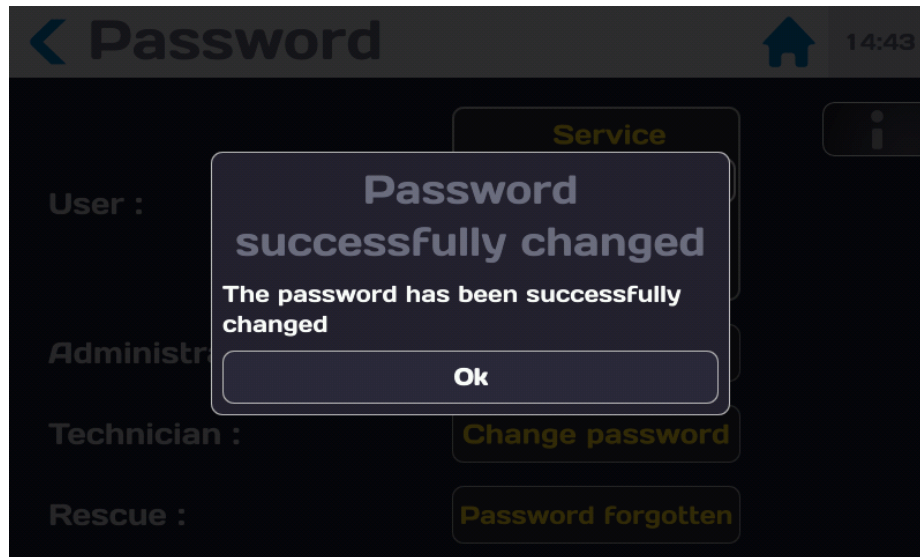
When the password entered complies with the above rules, the input area turns green:



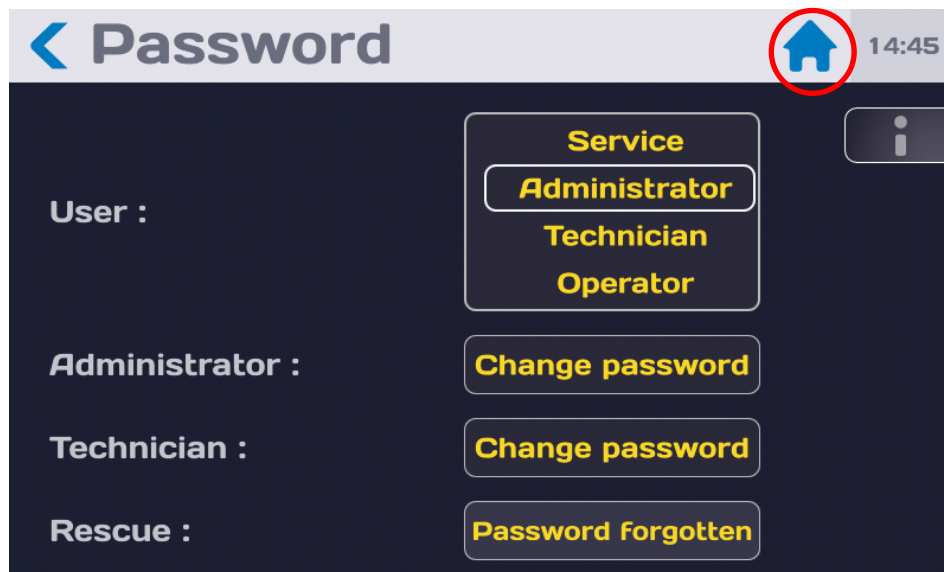
Validate the entry by pressing the character entry arrow. A new password entry screen will be offered to confirm your password.

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.

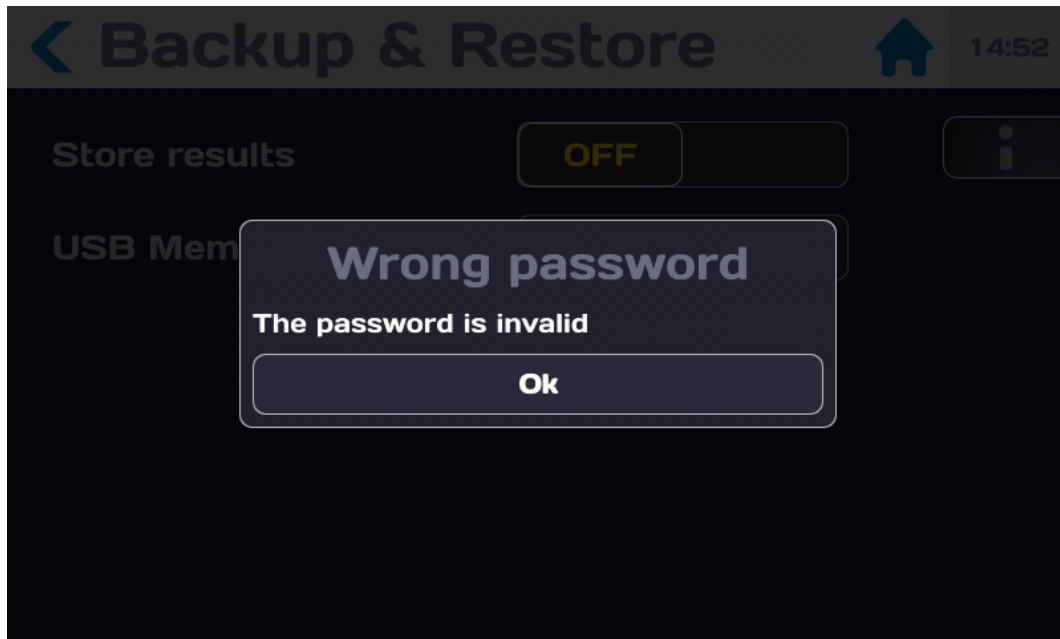


**IMPORTANT**

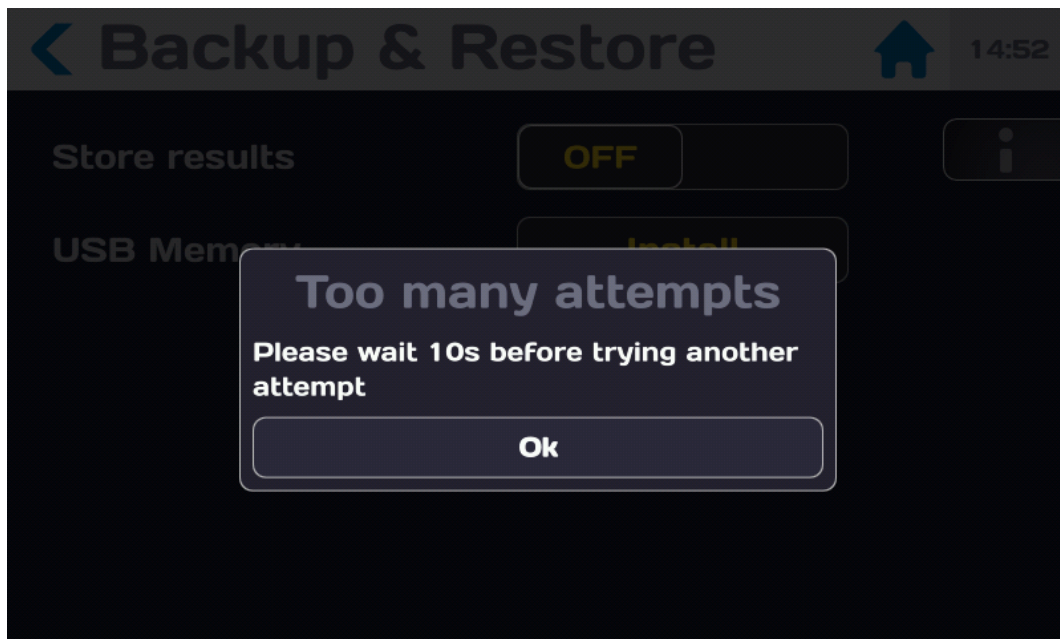
**Remember to keep passwords in a safe place.  
In the event of loss, contact our after-sales service by following the procedure in paragraph 6.6.3.**

## 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](mailto: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

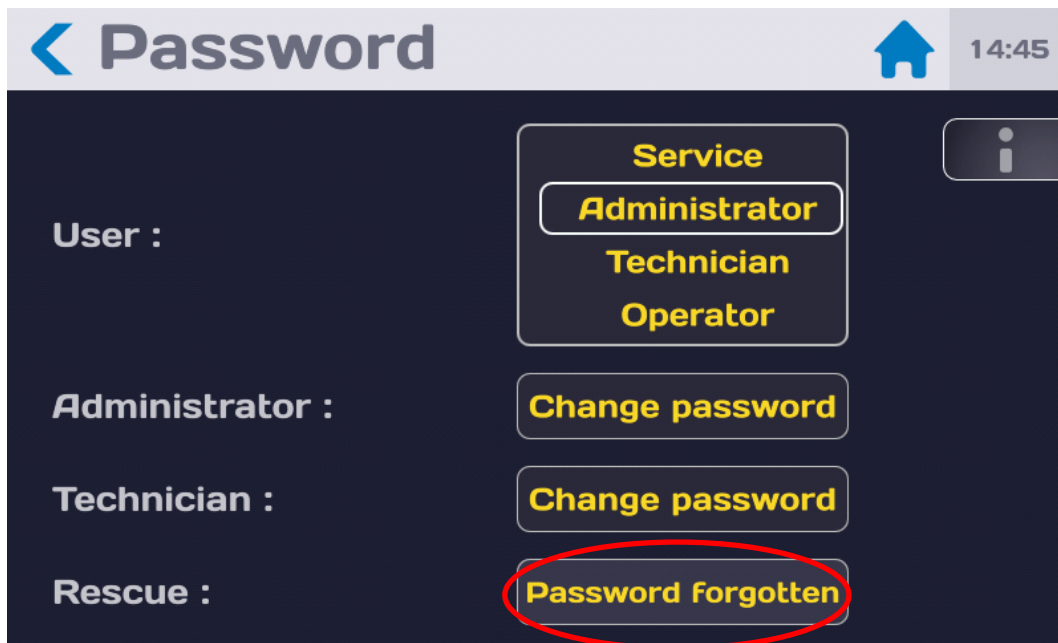
ABOUT

Serial number: 2149463

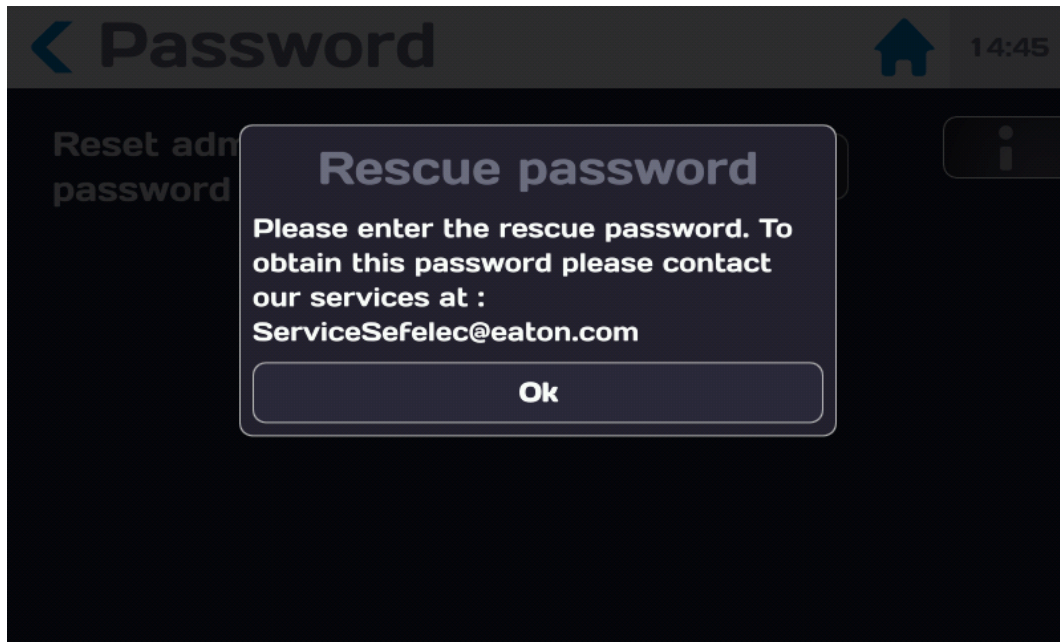
- your name
- the name of your company
- your phone number.

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

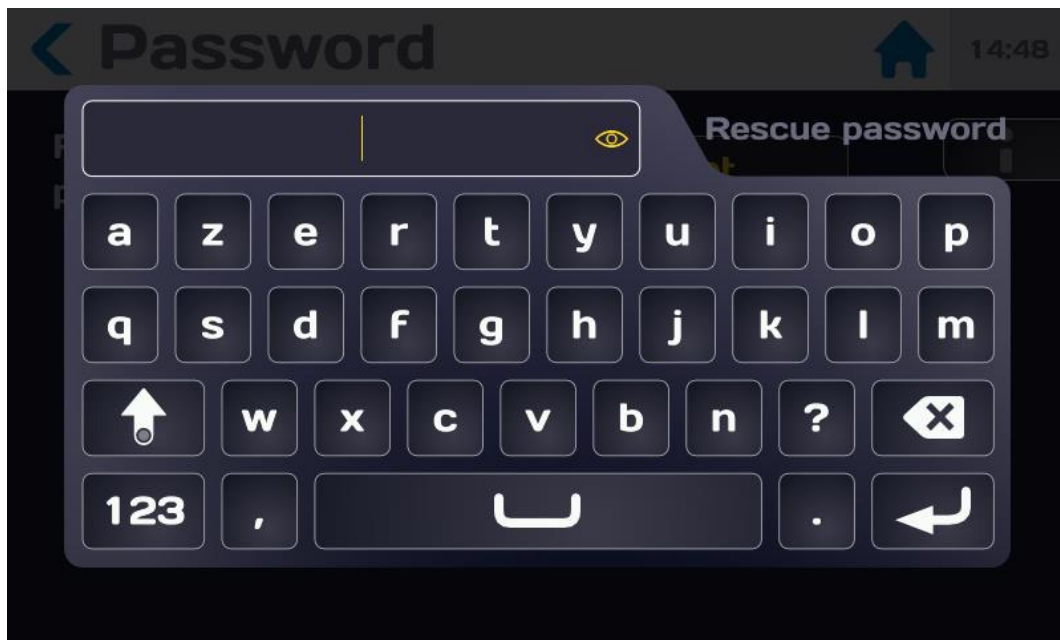
When you have received the new password, from the Password menu, press the active area of the line Help Forgotten password



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



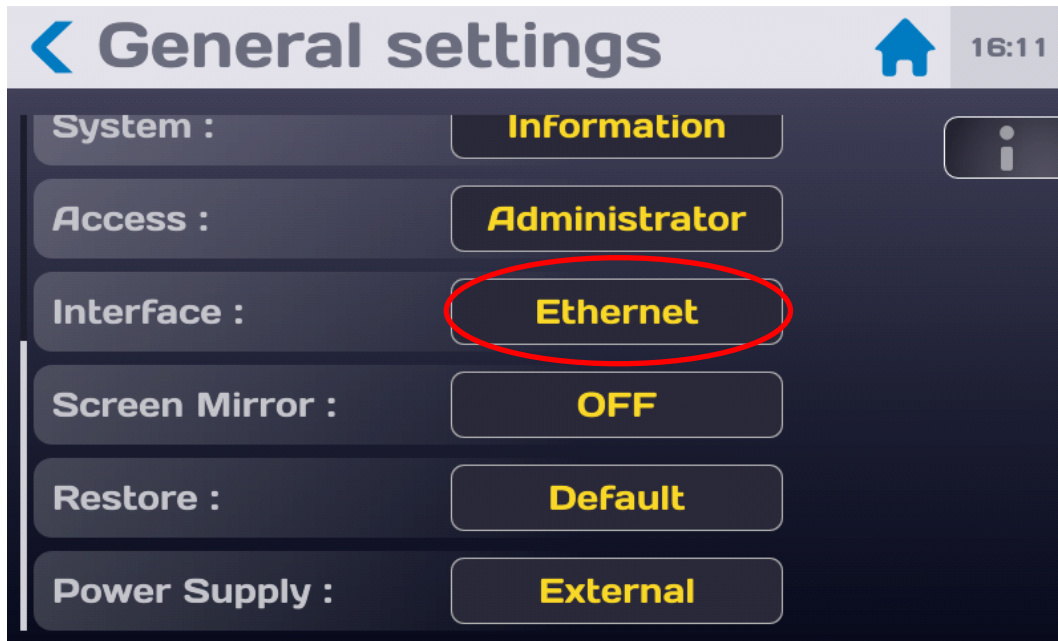
**Remember to keep passwords in a safe place.**

**IMPORTANT**

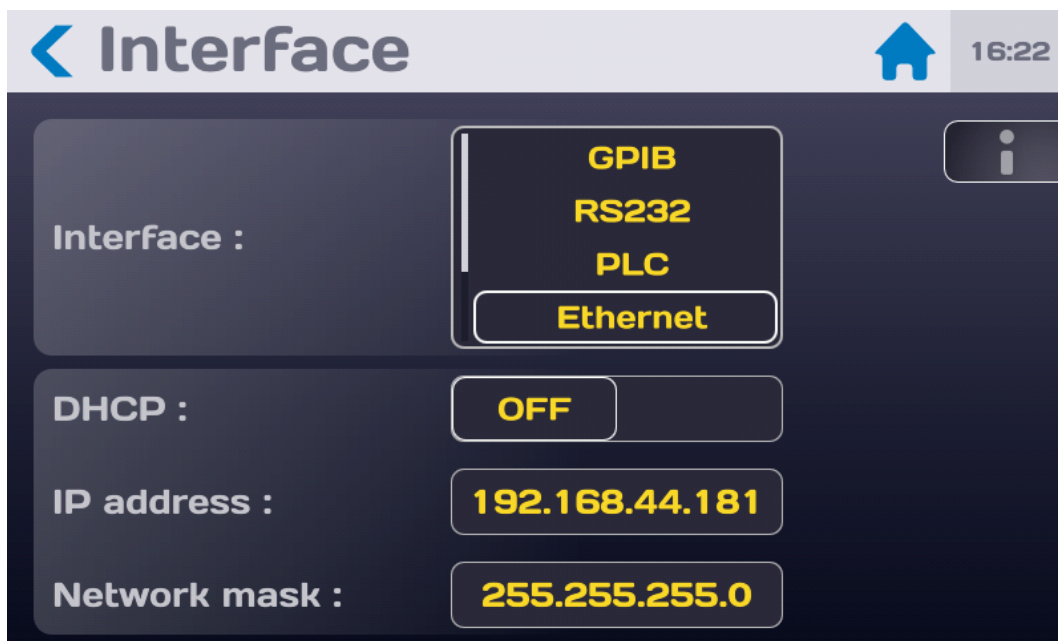


## 6.7. SELECTION OF THE TYPE OF INTERFACE

Scroll through the "General settings" screen downwards to obtain the following screen:



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



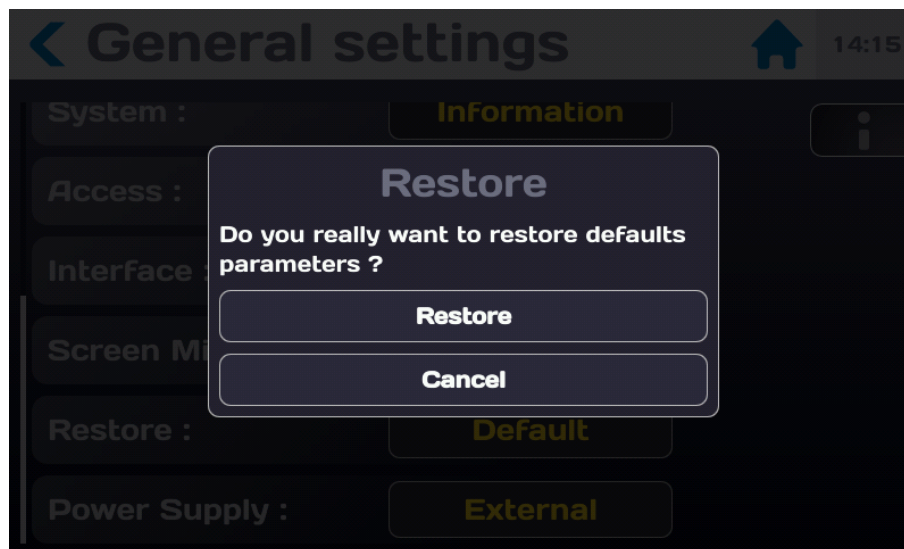
Select the type of interface you want and set the communication settings according to the indications provided in the paragraph describing the selected interface.

## 6.8. RESTORATION OF THE DEFAULT 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.



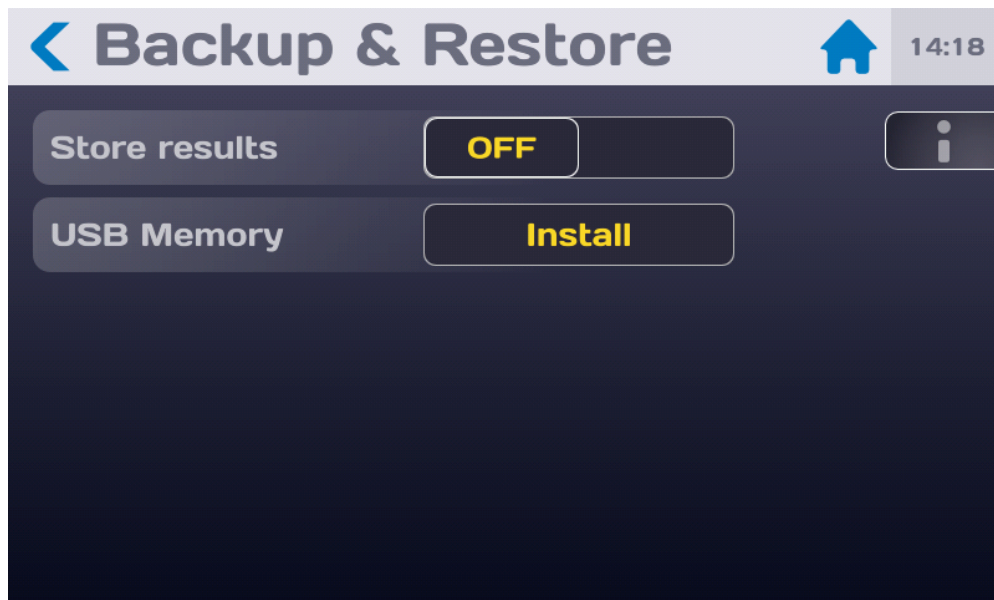
## 6.9. STORAGE OF MEASUREMENT RESULTS IN INTERNAL MEMORY

To ensure traceability of measurements taken it is possible to store the test settings as well as the measurement results in the internal memory of the device

To activate this function, after switching on the device or returning to the Start menu, the Home screen shows:



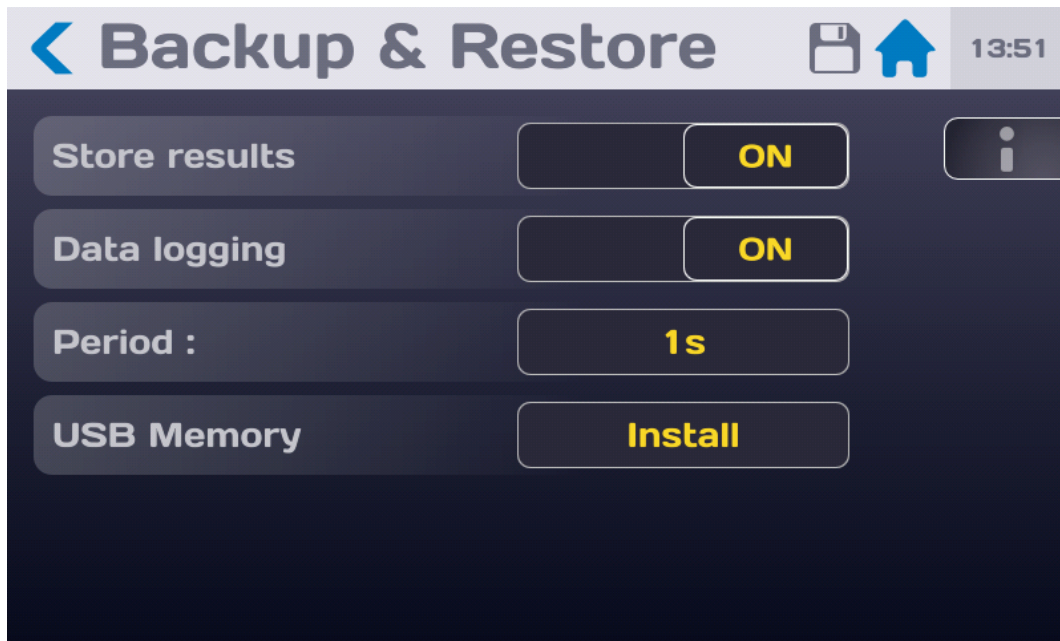
Press the key to access the results storage menu (floppy) The LCD screen displays the following information:



Activate recording of measurement results in internal memory (Value at end of test, GOOD/BAD, etc.) by pressing on the right of the Save results area, display of ON and display of a gray diskette to the left of the house icon.

Deactivate the recording of measurement results by pressing on the left of the Save results zone, display of OFF and disappearance of the gray diskette on the left of the house.

It is possible to activate automatic measurement recording by defining a measurement storage period by setting the Data recording line to ON and selecting the time between 2 recordings in steps of 1 second:

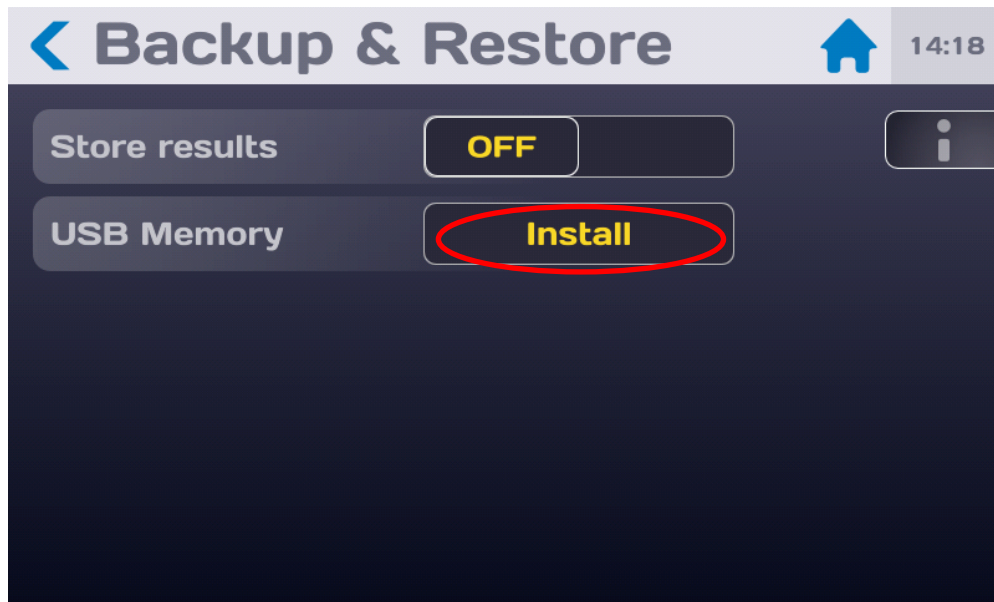


**IMPORTANT**

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

## 6.10. SAVING FILES ON USB KEY

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 (32Gb max. capacity). 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 key there is a "HORUS\_BACKUP" directory with the following sub-directories:

- ▼  horus\_backup
  - >  global
  - >  megohmmeter
  - >  picoammeter
  - >  sequence

Go to the desired directory and open the results file in .CSV format with Excel:

IDN:	EATON,SEFELEC 56-S,1900607,1.1.0.22						
Parameters:	Tension=	2.00E+01	V	Temps=	Auto	Montée=	0,00E+00
START ISOL							
Date	Time	VOLT	AMP	OHM	Result		
22/11/2019	15:40:38	0.0E+00	4.70E+00	4.54E+00	ERREUR Surtension		
END MEG							
IDN:	EATON,SEFELEC 56-S,1900607,1.1.0.22						
Parameters:	Tension=	2.000E+02	V	Temps=	Auto	Montée=	0,00E+00
START ISOL							
Date	Time	VOLT	AMP	OHM	Result		
22/11/2019	15:40:49	2.0E+02	4.58E+00	4.37E+01			
22/11/2019	15:40:50	2.0E+02	4.52E+00	4.43E+01			
22/11/2019	15:40:51	2.0E+02	4.49E+00	4.46E+01			
22/11/2019	15:40:52	2.0E+02	4.47E+00	4.47E+01			
22/11/2019	15:40:53	2.0E+02	4.46E+00	4.48E+01			
22/11/2019	15:40:54	2.0E+02	4.46E+00	4.49E+01			
22/11/2019	15:40:55	2.0E+02	4.45E+00	4.50E+01			
22/11/2019	15:40:56	2.0E+02	4.44E+00	4.51E+01			
22/11/2019	15:40:57	2.0E+02	4.44E+00	4.51E+01			
22/11/2019	15:40:58	2.0E+02	4.43E+00	4.51E+01			
22/11/2019	15:40:58	0.0E+00	4.43E+00	4.51E+01	BON		

## 7. SETTING THE MEASUREMENT OF INSULATION RESISTANCE

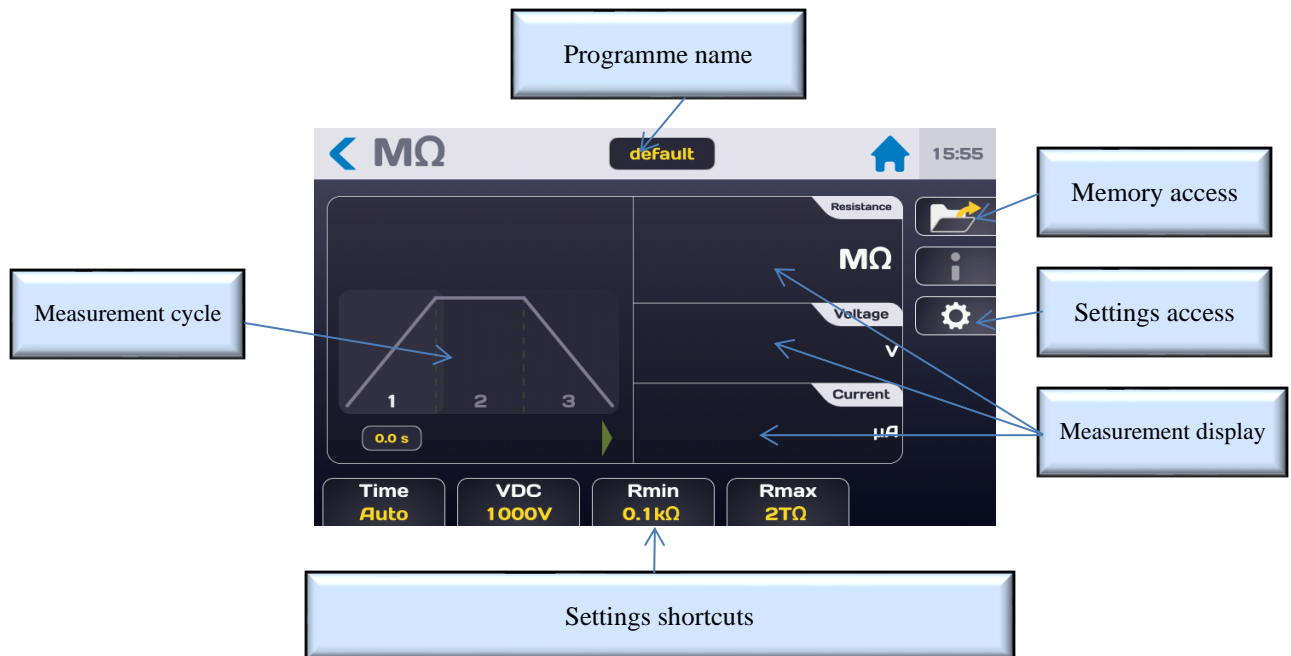
After switching on the device or returning to the Start menu, the Home screen shows:




press the **MΩ** key to access the measurement screen:



Description of the measurement screen:



The measurement display is done on 3 screens (current, voltage and resistance) the order of which can be changed by pressing one of the 3 areas and dragging up or down.

Access to the measurement settings can be from the shortcut keys located on the bottom of the measurement screen or from the key with the gear wheel icon  which displays the following menu:

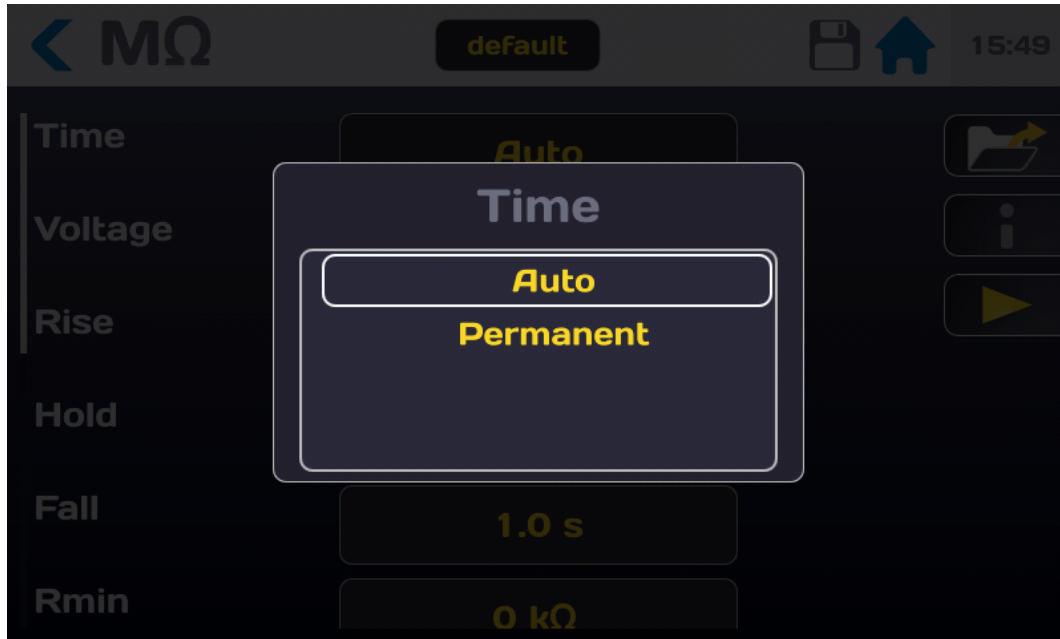


Select the setting to be changed by pressing the active area (yellow) of the line of the setting.



## 7.1. ADJUSTING THE MEASUREMENT TIME

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



The **Permanent** mode: after pressing on the START green lighted push button, a rise time applies to the test and then the output voltage is equal to the set point. The test is stopped if the user requests to stop the test by pressing the STOP red lighted button on the front panel.

In **Auto** mode, it is possible to set the RISE, HOLD and FALL times from the settings menu (values between 0.1 and 9999 sec.):





To adjust the measurement time press the active area of the line of the corresponding setting:



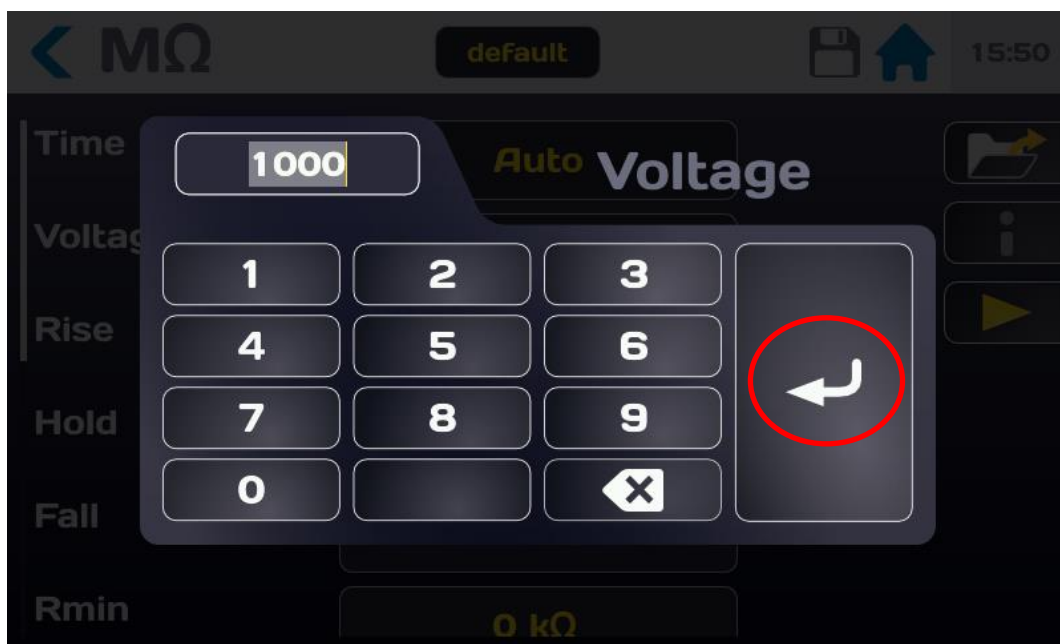
Enter the time in seconds, if the value entered is outside the minimum and maximum limits it will be displayed in red. Press the arrow key to validate the entry and return to the Settings menu.

## 7.2. ADJUSTING THE MEASUREMENT VOLTAGE

From the settings menu or by the voltage shortcut key at the bottom of the measuring screen press the active area of the voltage line:



To obtain the following screen:



Enter a voltage between 20 and 1,000 VDC (or 10 to 500VDC with SEFO-5X500VDC option) if the value entered is outside the permitted limits it is shown in red. Press the enter key to validate the entry and return to the previous menu.

### 7.3. ADJUSTMENT OF THE COMPARISON THRESHOLDS

The device offers two comparison thresholds Rmin and Rmax.

The main threshold in the measurement of the insulation resistance 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 serves to detect a poor connection on the test sample which would then have an abnormally high insulation resistance.

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

To access the Rmin and Rmax settings scroll through the insulation settings screen to display them:



Then press the active area of the threshold to be changed to obtain the following input menu:



Enter the value of the threshold using Tera, Mega, Giga or kilo  $\Omega$  units.

If the value entered is beyond the limits, it is displayed in red. Validate the threshold by pressing the enter key.

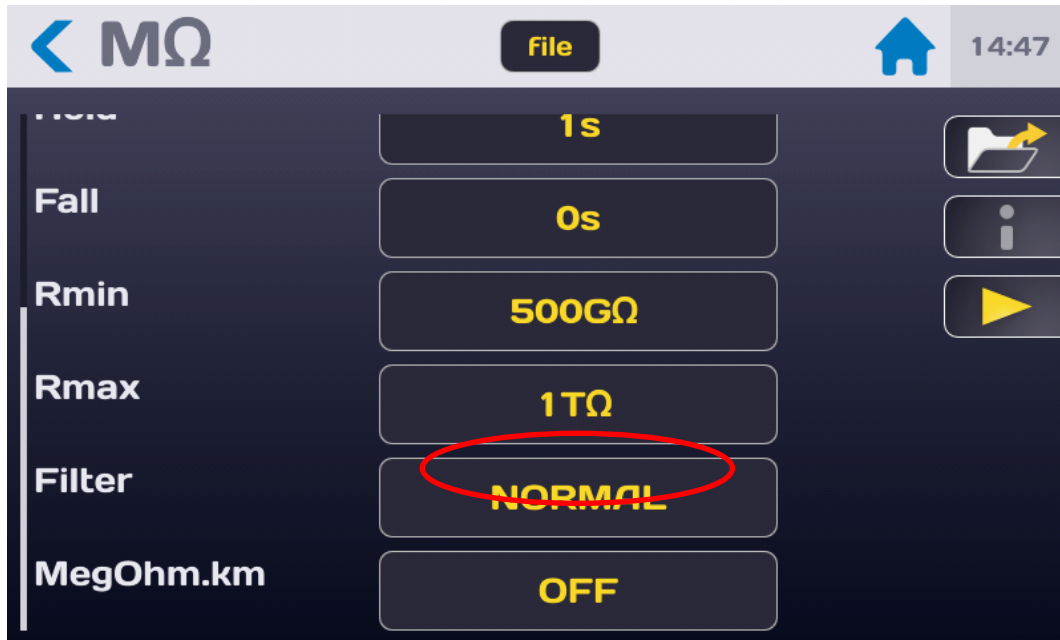
Proceed in the same way to adjust the other threshold.

## 7.4. SELECTION OF THE FILTER MODE

The device offers a filtering mode to stabilize the measurement on the capacitive components. This filtering uses software but also hardware functions to stabilize the insulation measurement on capacitors.

The input impedance of the measurement circuit goes to a value of 10MΩ which can significantly reduce the measurement voltage at the terminals of the sample for insulation values less than 1000MΩ

Press the active area of the "Filter" line to activate the filter mode:



The device offers a measurement configuration for resistive circuit with the **NORMAL** mode or for capacitive circuits with the **CAPACITOR** mode.

**CAPACITOR**: this measurement mode implements analogue treatments and software to provide stable measurements on highly capacitive circuits.

The activation of the **CAPACITOR** mode is materialised by the symbol of a capacitor in the top left of the main measurement window.

CAPACITOR mode icon:



**IMPORTANT**

**In CAPACITOR mode the input impedance is 10 MΩ. This mode is not suitable for insulation resistance measurements < 1000MΩ**

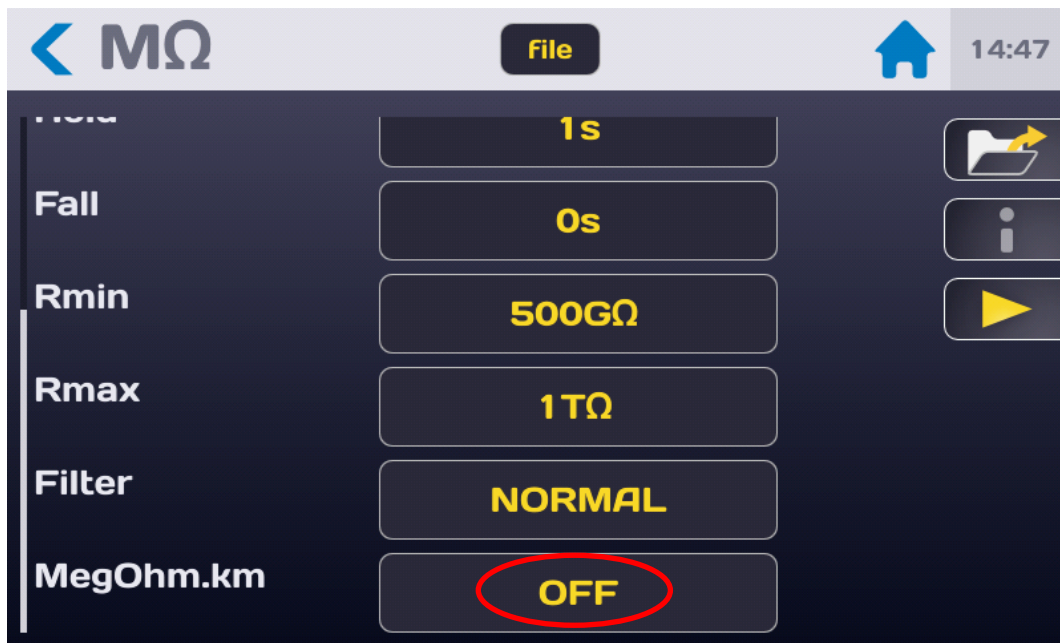
## 7.5. SELECTION OF THE MEGOHM PER KILOMETRE MODE

The device proposes to indicate values of resistance of cables expressed in insulation per kilometre, as this formulation is the one generally used in manufacturers' specifications or standards. The cables can be comprised of several independent conductors connected in parallel for the measurement; the device recalculates the value for 1 conductor.

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

$$\mathbf{R.displayed = (R.measured \times Length \text{ in metres} \times no. \text{ of conductors}) / 1,000}$$

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



Enable or disable the Megohm x km mode by selecting ON or OFF.

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

For example:

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

If we activate the Megohms per kilometre function, we obtain a displayed value of:

$$\mathbf{R.displayed = (500 \text{ M}\Omega \times 100 \text{ m} \times 5) / 1,000 = 2,500 \text{ M}\Omega.\text{km} = 2.5 \text{ G}\Omega.\text{km}}$$

## 7.6. SAVE UNDER A FILE NAME THE MEASUREMENT SETTINGS

All the settings of the insulation resistance measurement can be saved under a file name allowing the setting to be found easily.

After you have set all the settings, they are located under the file name specified in the field below:



To change the name of the file press the field with the name of the file to show a virtual keyboard and enter the new name.

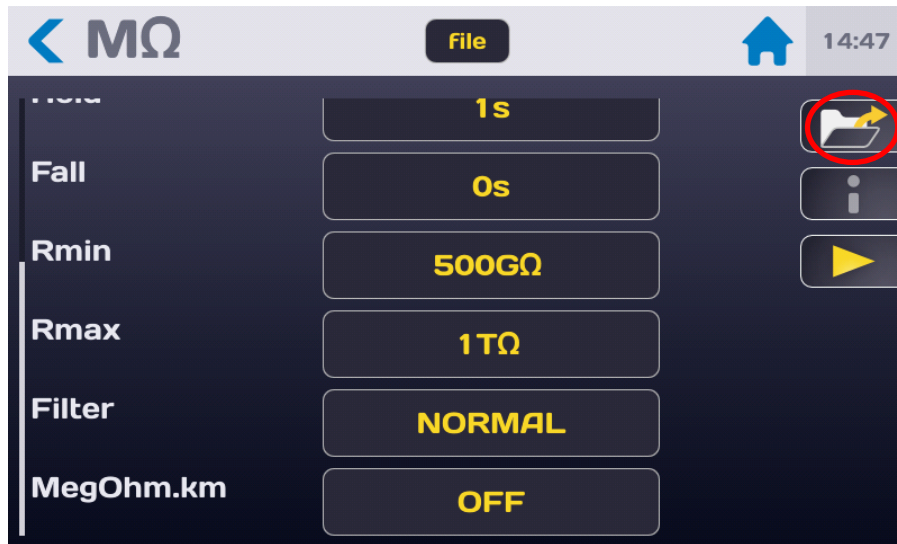
Spaces are not allowed in the file name, use the dash (-) or the underscore (\_) as a separator.

Special characters such as @, €, £, \$, &, μ, (), {}, etc. are not allowed in the file names. The file name can contain at least 50 characters.

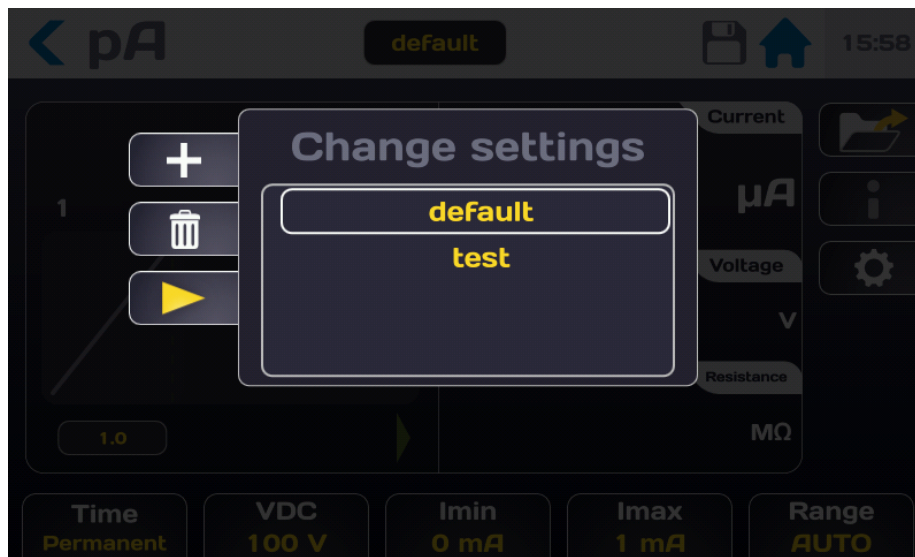
When validating the machine proposes to keep the old file and to duplicate or rename it without keeping the original version.



To recall a file name press the function key with a folder icon:



To obtain the following screen:



Find the name of the file by scrolling the list of files to the bottom or to the top. Press the desired file name then press outside the area of the display of the list of files or on the button with the yellow arrow.

This window also allows you to delete a file name. Select the name of the file to delete and then press the button in the form of bin. A Delete Confirmation window appears; confirm or cancel the deletion.

From this window it is also possible to create a new file with the (+) key which generates a file that auto-increments from a file named: file1



**NOTE**

**WARNING: Any change of a file setting is automatically saved in the file**

## 8. MEASUREMENT OF INSULATION RESISTANCE

### 8.1. CONNECTION OF THE COMPONENT TO BE MEASURED

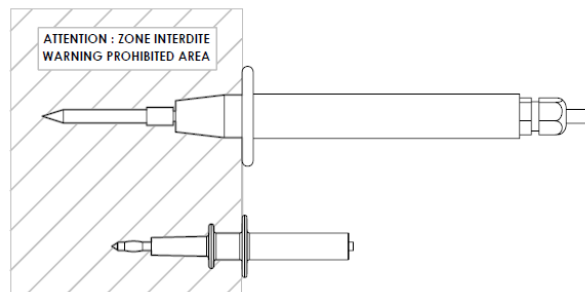


**Danger of electric shock!**

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

#### **WARNING**

- Only use accessories with the device or devices for which they are intended. The safety of the operator and the proper functioning of the device used depend on the respect of this rule.
- Do not try to modify an accessory; measurement accessories may contain imitation and protection elements. It is forbidden to modify the accessories without written agreement from SEFELEC-EATON.
- If the device is used in conditions other than those specified in the manual of the device, potential risks may occur for the safety of the user.
- **ALWAYS** observe the safety rules relating to the use of High Voltage equipment.
- Never touch the metal tip of an accessory connected to a device.
- Do not use accessories that are in poor condition, incomplete or defective. Check the integrity of the accessory before every use.
- Respect the conditions of use specified in the instructions of the associated measurement devices.
- Do not use an accessory in the place of another, just because it looks the same. Each accessory is designed for a specific use and in strict association with a measurement device.
- More than one person should never use the same measurement accessories at the same time.

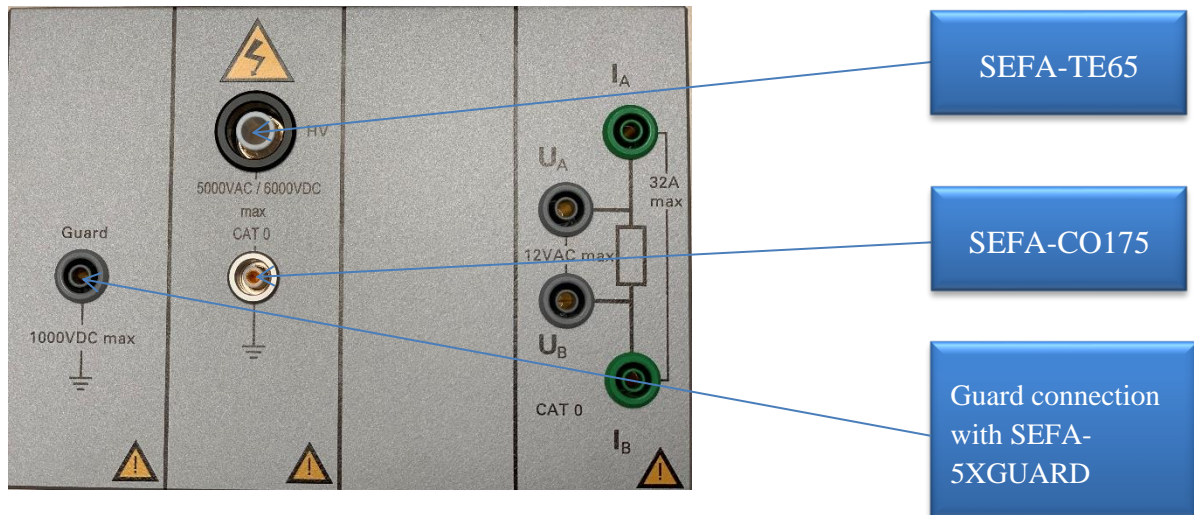


Connect the **SEFA-TE65** measurement cord to in the **HV** socket provided; to lock the cord push the plug until you hear a click. Proceed in the same way with the **SEFA-CO175** return cord on the socket connected to the ground.



**IMPORTANT**

The connectors are fitted with a thumb wheel at the back preventing their extraction. Tighten the thumb wheel if necessary and loosen it to disconnect the plug from the socket.



**IMPORTANT**

To disconnect the cords, make sure that there is no voltage and then unscrew the rear thumb wheel, grasp the plug of the accessory by its ribbed ring and pull to remove the plug from the socket.

## 8.2. PRECAUTIONS TO BE OBSERVED DURING MEASUREMENT:

To perform a measurement of resistance above 100 Gohm, use effective shielding connected to the guard terminal (grey terminal on the front panel). This avoids erroneous measurements due to the presence of leakage currents or the introduction of alternating residues.

The proximity of an operator approaching his/her hand to a sample under test can distort the measurement. It is important to beware of nylon laboratory coats or objects made from insulating materials likely to generate, by static electricity, significant fields that can disrupt the operation of the device at very low currents. A measurement of 100 GOhm at 100 volts devolves to measure a current of 1 nA.

During measurements on capacitive circuits (use the CAPACITOR mode, see paragraph 7-4) never perform measurements by reducing the measurement voltage at each test but always increasing it; the hysteresis and polarisation phenomena of the dielectric would distort the results. In this case the device has a tendency to indicate the maximum and takes a very long time to return down to the real value to be measured.

Never disconnect a capacitive sample without passing through the discharge mode with the Stop push button and waiting the time required for the capacity of the sample to be discharged into the resistance of 2.2 kΩ of the discharge circuit.



**It is recommended to check the proper functioning of the device regularly by connecting an element of known value to the measurement output and performing a measurement. In the absence of an element of known value, it is possible to make a measurement on an open circuit and on a short-circuit to confirm the consistency of the indications of the device.**

After having connected the component for measurement applying the precautions described above and selected the measurement settings required, return to the measurement screen:



**NOTE**

Press the Start button. For safety reasons, it is necessary to press the button for > 1 second for the device to switch into measurement mode. If the button is pressed for too short a time a message will be displayed momentarily on the LCD screen.



The measurement cycle takes place according to the Rise, Hold and Fall times with the following screen:



Display	Rise	Hold	Fall	End of test
Voltage	Yes	Yes	Yes	No
Current	No	Yes	Yes	Yes
Resistance	No	Yes	No	Yes
PASS/FAIL	No	No	No	Yes

At the end of the test the display shows the last value measured before the reduction of the voltage and if the measurement is between Rmin and Rmax i.e. considered PASS



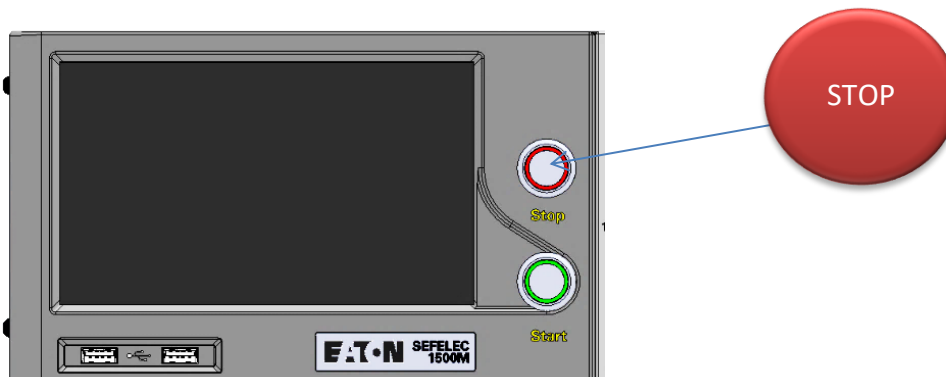
If the measurement is  $< R_{min}$  or  $> R_{max}$ , it will be regarded as FAIL:



The coloured function key indicates the setting that caused the FAIL sanction of the measurement.



**Before disconnecting the measured component, press the Stop button to confirm the stoppage of the high voltage generation and discharge the component: the device then performs a check of the residual voltage up to a value of 30 VAC or DC**



This action returns you to the initial measurement screen either to change the settings or to perform a new measurement by pressing the Start button.



### 8.3. THE FOLLOWING 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 under test is higher than the measurement possibilities of the device ( $> 2 \text{ T}\Omega$  or other value according to the measurement voltage)
- **"SATURATION"**: the insulation resistance of the sample under test is lower than the measurement possibilities of the device ( $< 100 \text{ k}\Omega$ )
- **"CHARGE..."**: The measurement voltage has not reached its final value. The voltage generator charges the capacity of the sample under test. This message should appear momentarily when switching to measuring mode. If this message persists the measurement voltage requested cannot be supplied to the resistance measured.

Check the characteristics of the voltage generator.

- **"VOLTAGE ERROR"**: If a measurement time is defined, and during the test the message: **"Charge..."** is displayed permanently, at the end of the measurement time the test is declared NG and the message: **"Voltage error"** indicates the cause.

If necessary, refer to the information on the message: **"Charge..."**

## 9. DIELECTRIC STRENGTH TEST SETTINGS

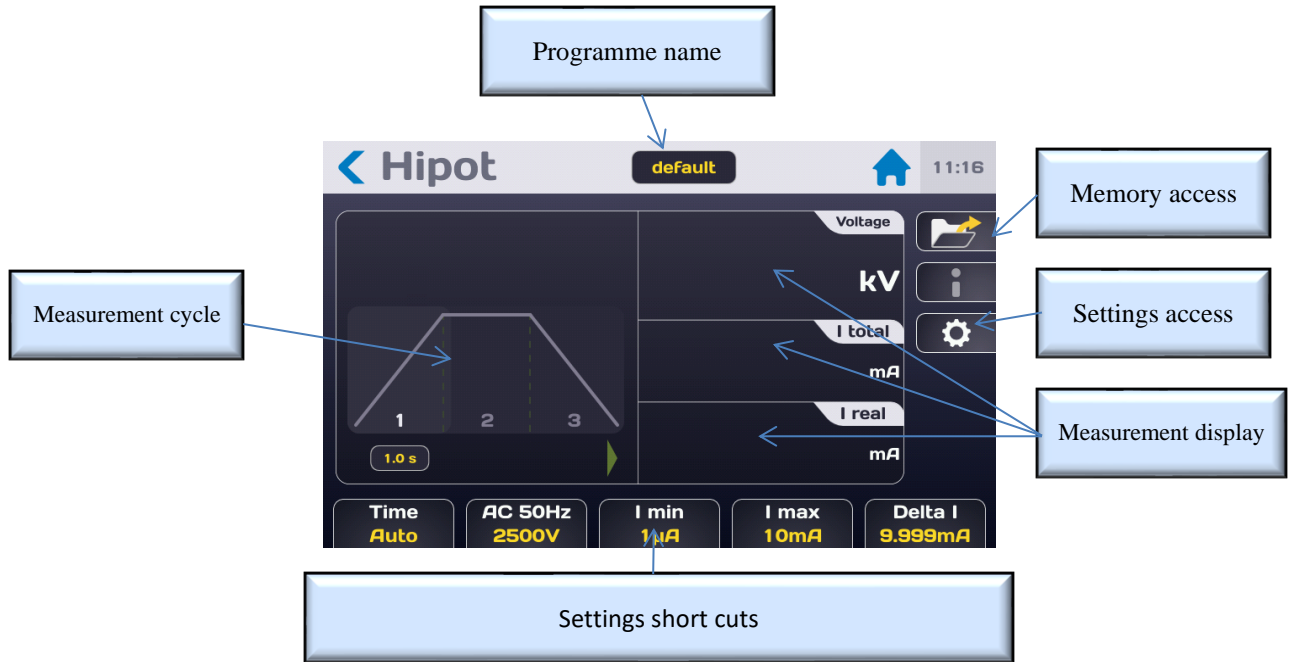
After switching on the device or returning to the Start menu, the Home screen shows:



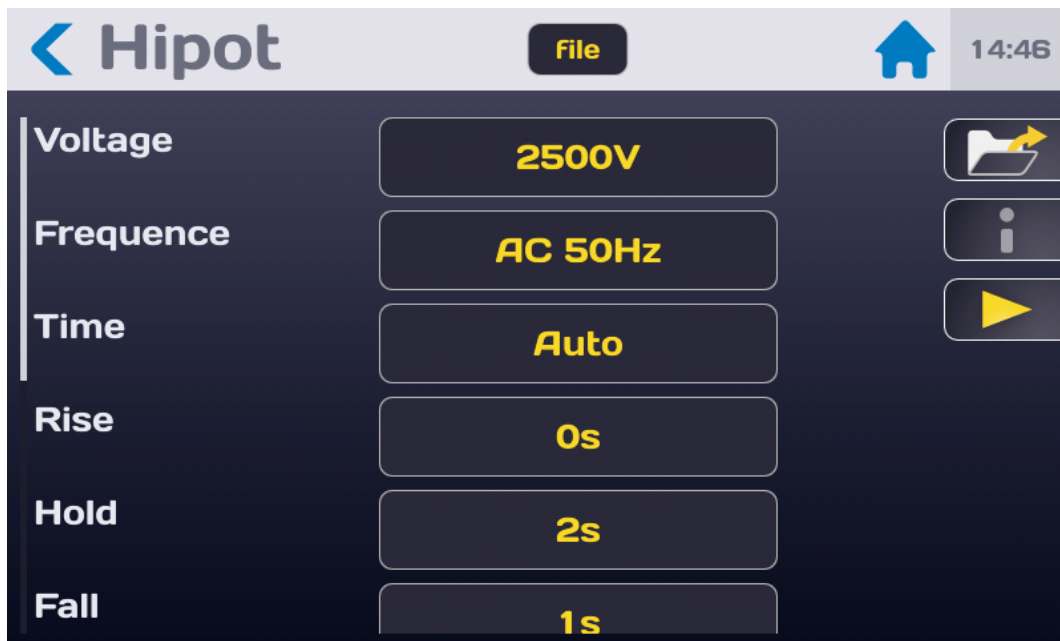
press the **Hipot** (Dielectric Strength test) key to access the measurement screen:



Description of the measurement screen:



The measurement display is shown on 3 screens (Voltage, Total current and Real current) the order of which can be changed by pressing one of the 3 fields and dragging up or down. Access to the measurement settings can be from the shortcut keys located on the bottom of the measurement screen or from the key with the gear wheel icon which displays the following menu:



Select the setting to be changed by pressing the active area (yellow) of the line of the setting.

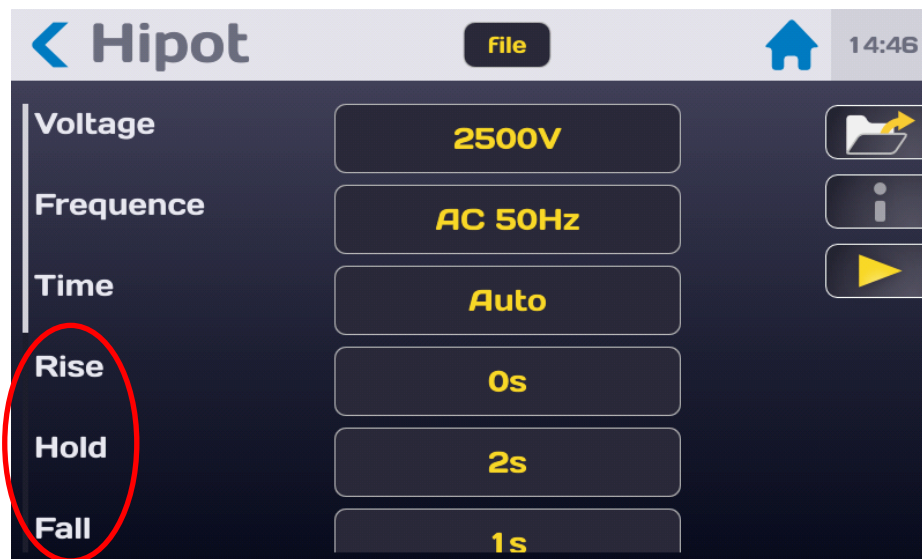
## 9.1. ADJUSTING THE MEASUREMENT TIME

The dielectric strength test measurement time can be set from one of the following modes: **AUTO**, **PERMANENT** or **MANUAL**.

Press the active area of the "Time" line to obtain:



In **Auto** mode, the value of the Rise, Hold and finally of Fall are decremented every 0.1 second. When the Fall time displayed reaches 0, the output voltage is automatically cut off. Depending on the value of the leakage current during the test in relation to the IMAX and IMIN thresholds, the PASS or FAIL indication is displayed on the LCD screen.



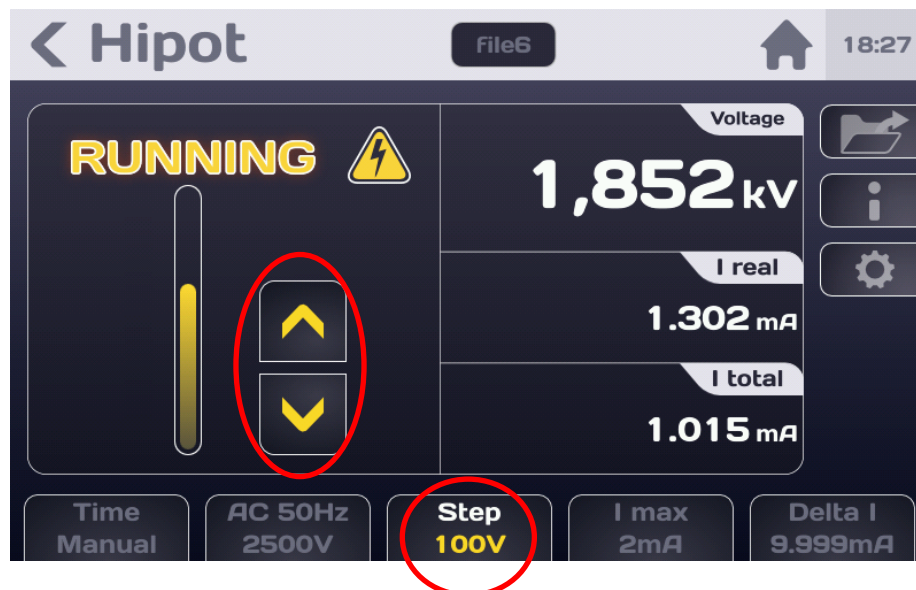
To adjust the measurement time press the active area of the line of the corresponding setting:



Enter the time in seconds, if the value entered is outside the minimum and maximum limits it will be displayed in red. Press the arrow key to validate the entry and return to the Settings menu.

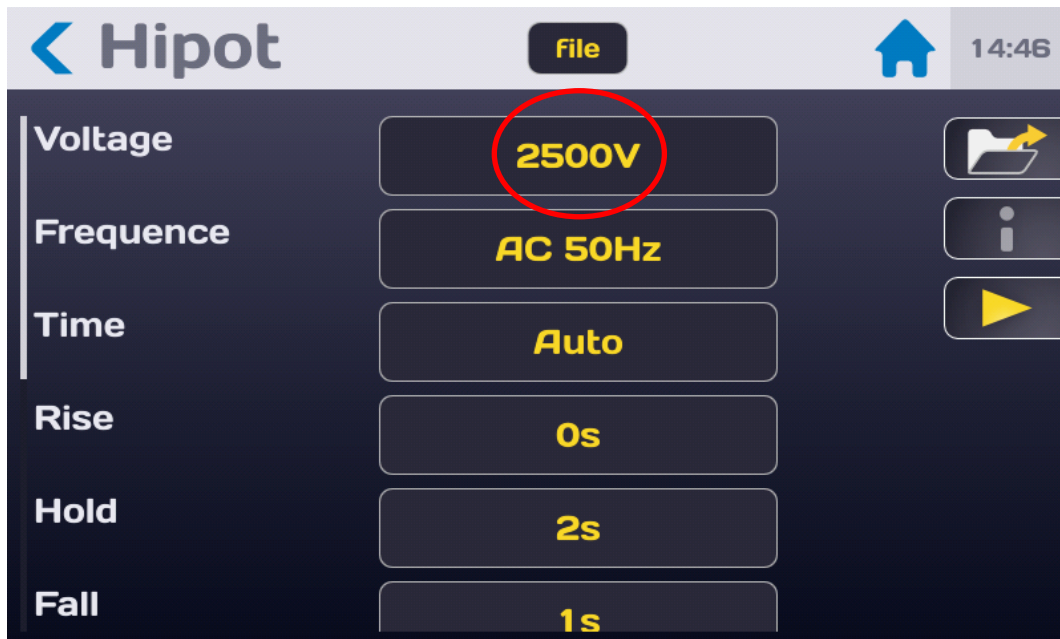
The **Permanent** mode does not use the internal timer of the device and the measurement takes place from when the Start button is pressed to when the Stop button is pressed. The Permanent mode allows the setting of a voltage Rise time.

In **Manual** mode, the device remains in Measurement until the Stop button is pressed, and the Up arrow allows the user to increase the voltage of the test value specified on the Step key (this value can be adjusted between 100 and 1,000 V) while the Down arrow allows to decrease it. The maximum voltage that can be reached is that shown in the setting line: Voltage. However, depending on the charge represented by the element under test, the voltage reached may be lower; the voltage regulation function is disabled in this mode.



## 9.2. ADJUSTING THE MEASUREMENT VOLTAGE

From the settings menu or by the voltage shortcut key at the bottom of the measuring screen press the active area of the voltage line:

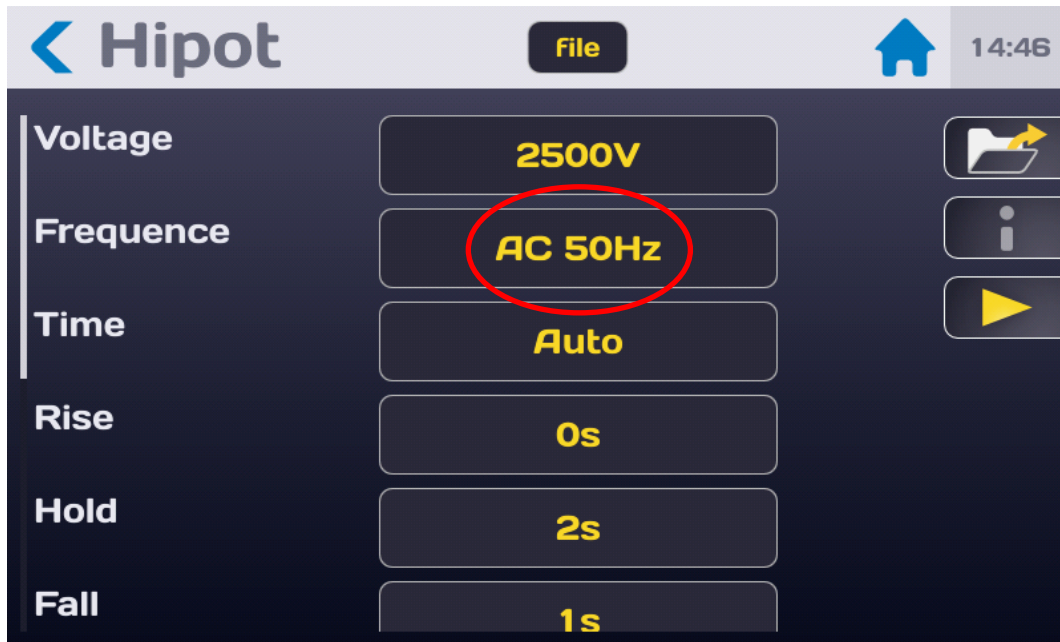


To obtain the following screen:



Enter a voltage between 100 V and 5,000 VAC or 6,000 VDC in steps of 1 V; if the value entered is outside the permitted limits it is shown in red.

From the settings menu or by the voltage short cut key at the bottom of the measuring screen press the active area of the "Frequency" line:



Choose the frequency of the voltage:

- AC 50 Hz
- AC 60 Hz
- DC



### 9.3. SELECTION OF THE MODE OF CUT-OUT FAULT DETECTION

The device offers the possibility to choose between several modes of cut-out Fault detection

#### In the Delta I detection mode:

The  $\Delta I$  (delta I) sensor automatically performs the subtraction between the current flowing normally in the sample under test ( $I = U/Z$ ) and the one that occurs suddenly when a fault occurs: ( $I' = I + I \text{ fault}$ ).

#### In the IMAX detection mode:

The device continuously measures the current flowing in the sample under test and compares it according to two possibilities:

- The high threshold (threshold IMAX) > 0, the low threshold (threshold IMIN) is set to 0
  - o If the measured current is greater than or equal to the threshold, the test is declared FAIL (cut-out):
- The low threshold (IMIN threshold) > 0, the high threshold (threshold IMAX) is > low threshold (IMIN threshold)
  - o If the current measured is inside of the range defined by the thresholds, the test is PASS, if it is outside the range the test is declared FAIL (cut-out or  $I < IMIN$ ).

The IMAX threshold may apply to the total current (capacitive and resistive) circulating in the sample under test or only to the real current (resistive). The real current gives an indication of the quality of the insulant tested without considering the current consumed by the capacity of this insulation.

The total current and the real current are linked by the formula:

$$I_{total} = \sqrt{I_{real}^2 + I_{capa}^2}$$

#### In the Delta I + IMAX detection modes:

In this case the IMAX and  $\Delta I$  detection modes are active simultaneously

**In the mode WITHOUT detection:** In this case no current monitoring is performed. And there is no adjustment of the output voltage in relation to the load. In case of breakdown, the high voltage stays ON.



**In the without detection mode there is no adjustment of the output voltage in relation to the load**

IMPORTANT

## 9.4. ADJUSTMENT OF IMAX, IMIN AND DELTA I DETECTION THRESHOLDS

The device comprises two thresholds, IMAX and IMIN, used for the comparison with the value of the measurement of current flowing in the equipment under test and to decide whether the result of the test is PASS or FAIL.

The IMIN threshold sets the minimum limit of current flowing into the element tested to detect a possible poor connection to the device.

The IMAX threshold defines the maximum value of current that can circulate in the element being tested. During a test with an AC voltage, the IMAX threshold may apply to the total current (capacitive and resistive) or only to the real current (resistive).

Depending on the sensing mode chosen, an element tested is declared PASS if the current flowing is less than the IMAX threshold and greater than the IMIN threshold; if not the element is declared FAIL.

The IMIN and IMAX thresholds can be adjusted between

- 0.001 mA and 9.999 mA for a 50VA model
- 0.01 mA and 110 mA for a 500VA model

An IMIN threshold with a value of 0.000 mA disables the minimum current test.

The Delta I current cut-out value can be adjusted between:

- 0.1 mA/10  $\mu$ s and 10 mA/10  $\mu$ s in steps of 0.1 mA/10  $\mu$ s for a 50VA model,
- 1 mA/10  $\mu$ s at 100 mA/10  $\mu$ s in steps of 1 mA/10  $\mu$ s for a 500VA model,



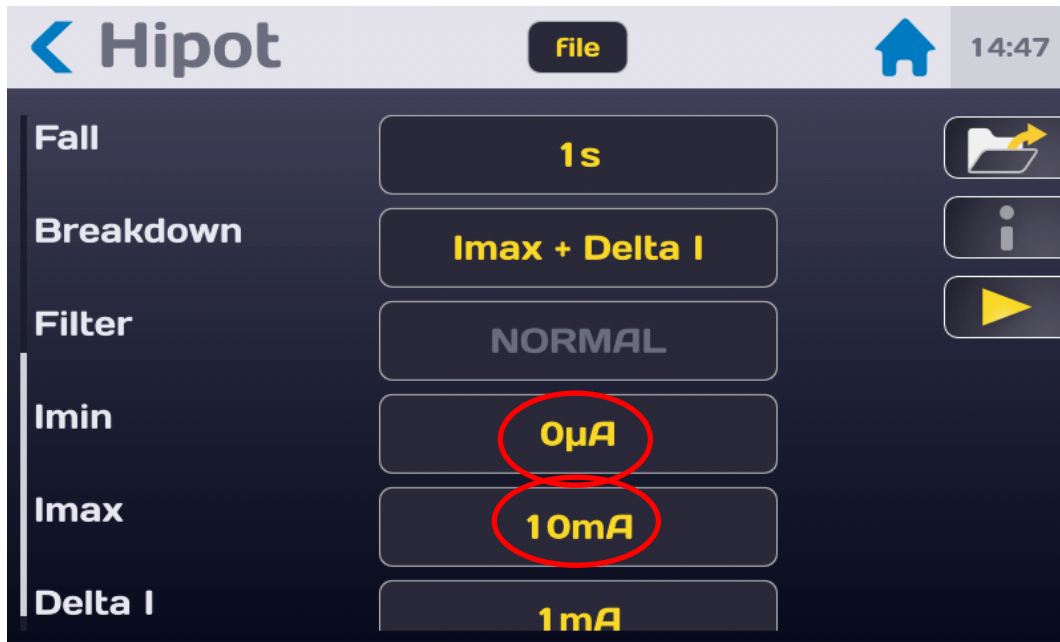
### NOTE

**To adjust the thresholds:** Preferably start by adjusting the high threshold, as the IMAX threshold must always be greater than the IMIN threshold, if not, and depending on which threshold you adjust the error message High threshold < Low threshold or Low threshold > High threshold is displayed.



### NOTE

**If an AC voltage has been selected, choose the Total or Real cut-out current mode. In the case of a DC voltage only the Total cut-out mode is available**



Then press the active area of the threshold to be changed to obtain the following input menu:

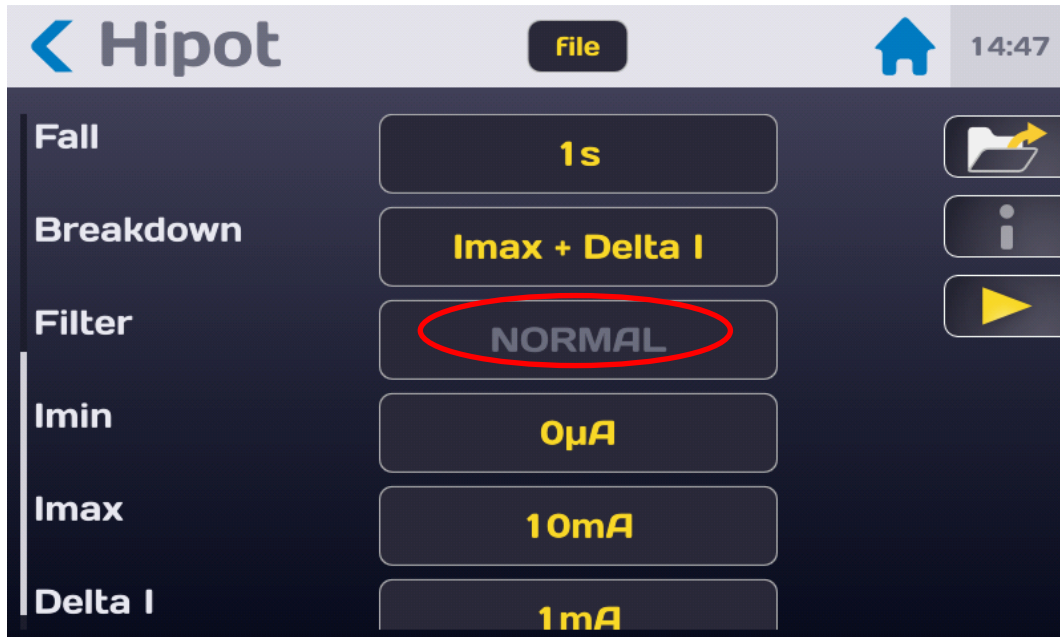


Enter the threshold value using μA or mA units.

If the value entered is beyond the limits, it is displayed in red. Validate the threshold by pressing the enter key.

## 9.5. SELECTION OF THE FILTER MODE

The device offers a filter mode to stabilize the measurement on capacitive components. Press the active area of the "Filter" line to choose the most suitable NORMAL, CAPACITOR or R//C mode:



- **NORMAL:** this measurement mode does not activate software processing
- **CAPACITOR:** this measurement mode activates software processing in order to allow stable measurements on capacitive circuits ( $C > 50\text{nF}$ ).  
In DC voltage, the **CAPACITOR** mode does not control the output voltage in relation to the setpoint voltage in order to avoid overvoltage.  
In AC voltage, the **CAPACITOR** mode modifies its control algorithm to take into account the effects related to the capacity of the sample under test.

The activation of **CAPACITOR** mode is indicated by the symbol of a capacitor in the top left of the main measurement window.

Capacitor icon:



- **R//C**: this measurement mode implements software processing in order to allow stable measurements on capacitive circuits in parallel with resistive circuits ( $I_r \neq I_c$ ). In AC and DC voltage, the R//C mode modifies its servo-control algorithm in order to take into account the effects linked to the capacitance and the resistance of the sample under test.

The activation of R//C mode is indicated by the **R//C** symbol in the top left of the main measurement window.

R//C icon



**IMPORTANT**

It is essential to switch to discharge with the **Stop** button before disconnecting the component under test.



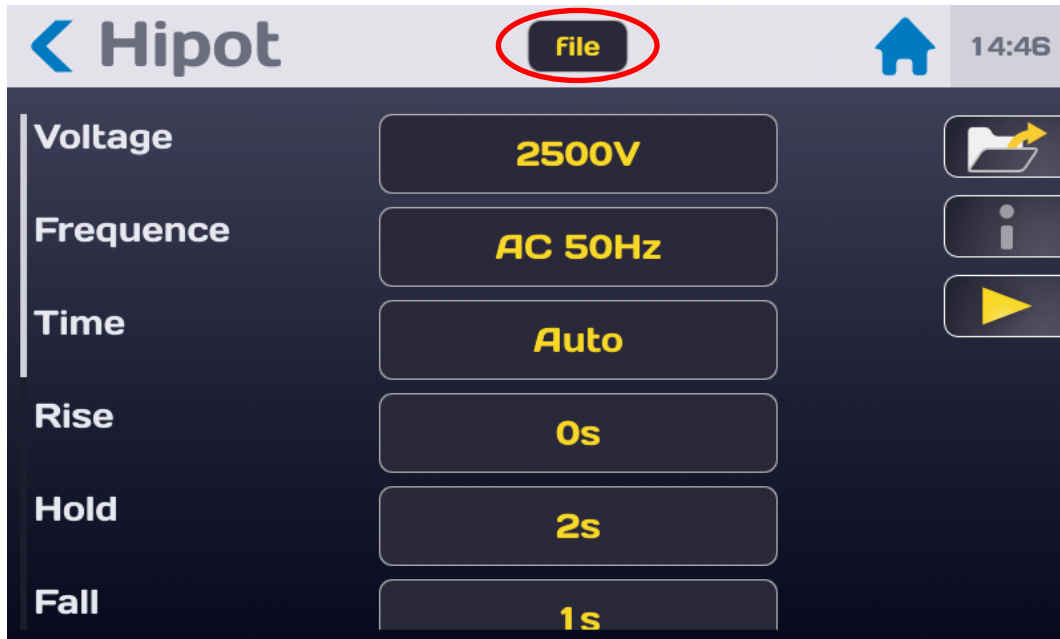
**IMPORTANT**

In DC voltage, the **CAPACITOR** mode does not control the output voltage in relation to the setpoint voltage.

## 9.6. BACKUP OF THE DIELECTRIC STRENGTH TEST SETTINGS

All the dielectric strength test settings can be saved under a file name allowing the setting to be found easily.

After you have set all the settings, they are located under the file name specified in the field below:



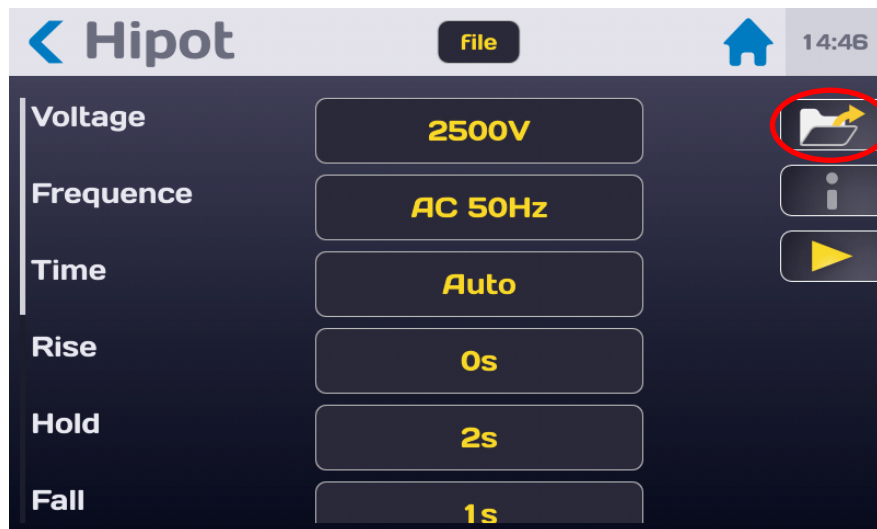
To change the name of the file press the field with the name of the file to show a virtual keyboard and enter the new name.

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

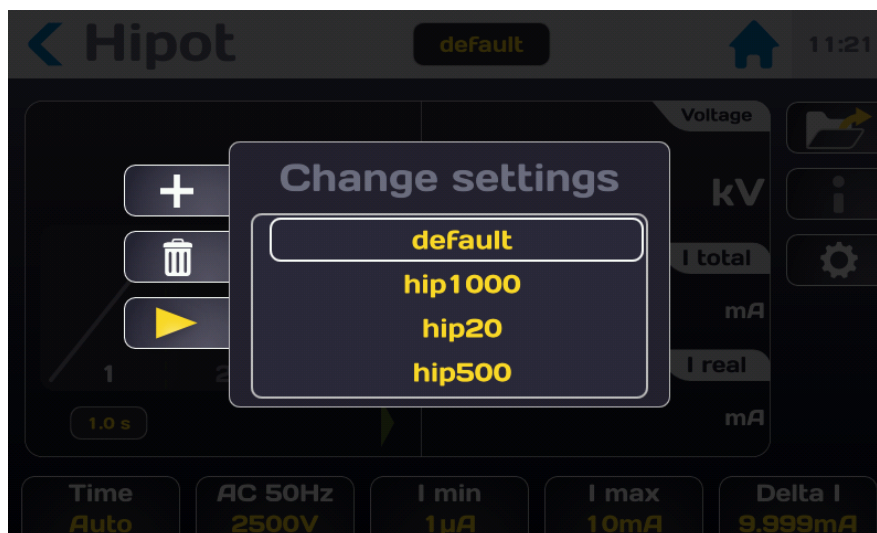
Special characters such as @, €, £, \$, &, μ, (), {}, etc. are not allowed in the file names. The file name can contain at least 50 characters.

When validating the machine proposes to keep the old file and to duplicate or rename it without keeping the original version.

To recall a file name, press the function key with a folder icon:



To obtain the following screen:



Find the name of the file by scrolling the list of files to the bottom or to the top. Press the desired file name then press outside the area of the display of the list of files or on the button with the yellow arrow.

This window also allows you to delete a file name. Select the name of the file to delete and then press the button in the form of bin. A Delete Confirmation window appears; confirm or cancel the deletion.

From this window it is also possible to create a new file with the (+) key which generates a file that auto-increments from a file named: file1



**NOTE**

**WARNING: Any change of a file setting is automatically saved in the file**



## 10. PERFORMING A DIELECTRIC STRENGTH TEST

### 10.1. CONNECTION OF THE COMPONENT TO BE MEASURED

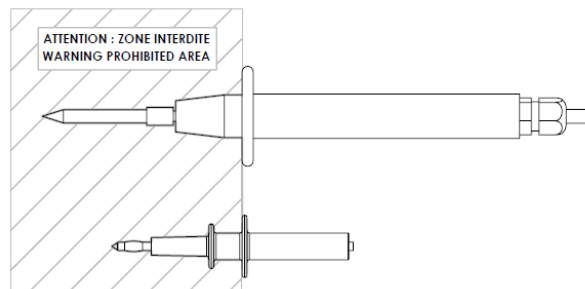


**WARNING**

**Danger of electric shock!**

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

- Only use accessories with the device or devices for which they are intended. The safety of the operator and the proper functioning of the device used depend on the respect of this rule.
- Do not try to modify an accessory; measurement accessories may contain imitation and protection elements. It is forbidden to modify the accessories without written agreement from SEFELEC-EATON.
- If the device is used in conditions other than those specified in the manual of the device, potential risks may occur for the safety of the user.
- **ALWAYS** observe the safety rules relating to the use of High Voltage equipment.
- Never touch the metal tip of an accessory connected to a device.
- Do not use accessories that are in poor condition, incomplete or defective. Check the integrity of the accessory before every use.
- Respect the conditions of use specified in the instructions of the associated measurement devices.
- Do not use an accessory in the place of another, just because it looks the same. Each accessory is designed for a specific use and in strict association with a measurement device.
- More than one person should never use the same measurement accessories at the same time.

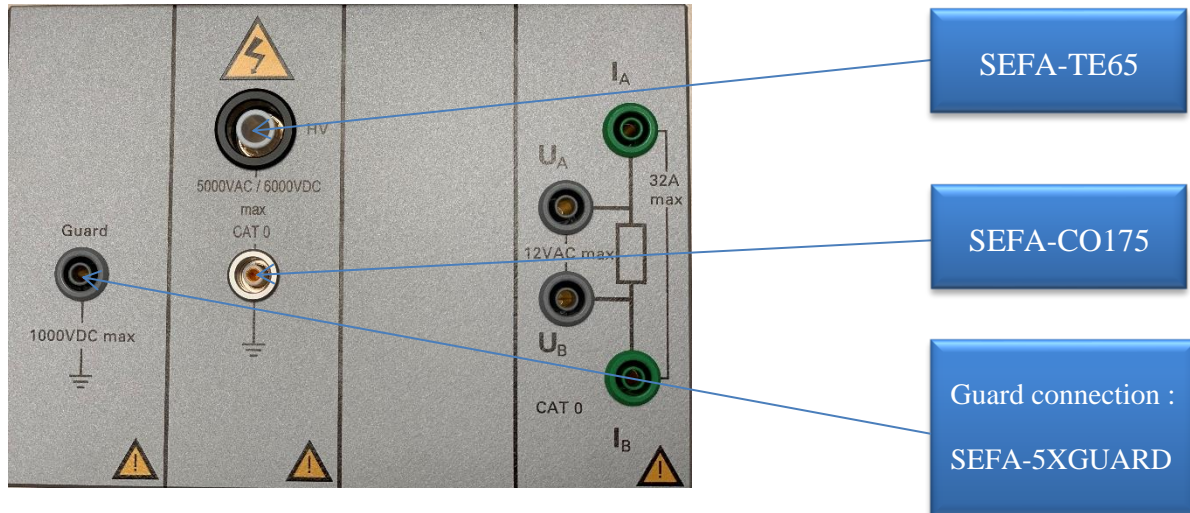


Connect the **SEFA-TE65** measurement power cord to in the **HV** socket provided; to lock the cord push the plug until you hear a click. Proceed in the same way with the **SEFA-CO175** return cord on the socket connected to the earth.



**IMPORTANT**

The connectors are fitted with a thumb wheel at the back preventing their extraction. Tighten the thumb wheel if necessary and loosen it to disconnect the plug from the socket.



**IMPORTANT**

To disconnect the cords, make sure that there is no voltage and then unscrew the rear thumb wheel, grasp the plug of the accessory by its ribbed ring and pull to remove the plug from the socket.

## 10.2. PRECAUTIONS TO BE OBSERVED DURING MEASUREMENT:



**WARNING**

Never disconnect a capacitive sample without switching to the discharge mode and waiting for the time required for the capacity of the sample to be discharged into the resistance of 1.5 MΩ of the discharge circuit.



It is recommended to check the proper functioning of the device regularly by connecting an element of known value to the measurement output and performing a measurement. In the absence of an element of known value, it is possible to make a measurement on an open circuit and on a short-circuit to confirm the consistency of the indications of the device.

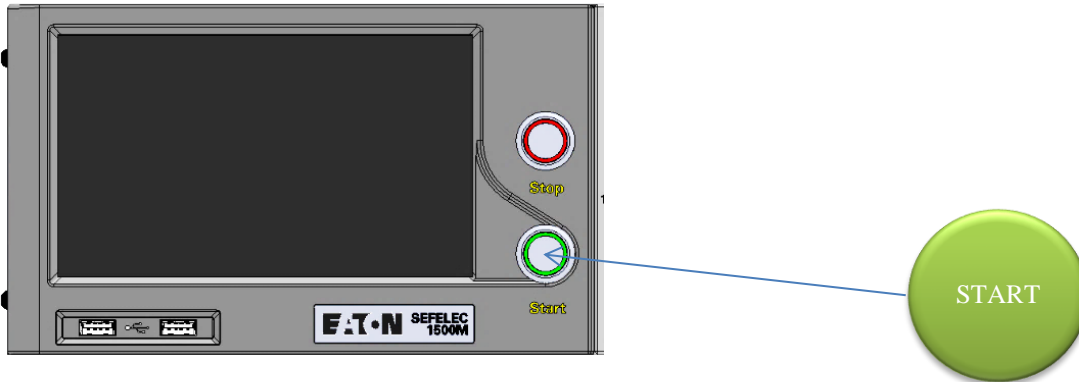
After having connected the component for measurement applying the precautions described above and selected the measurement settings required, return to the measurement screen:





**NOTE**

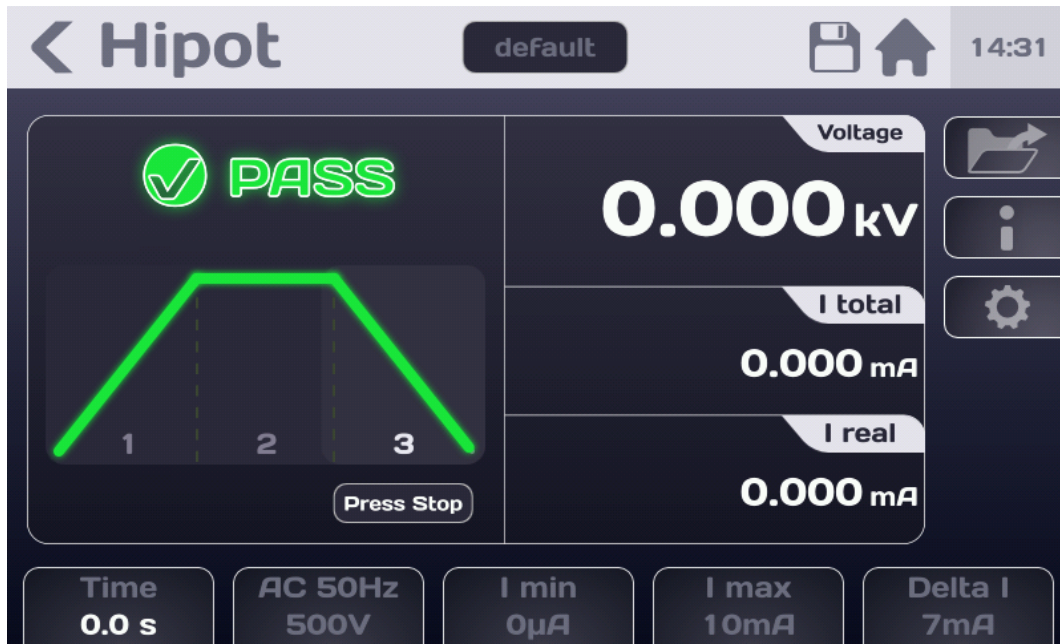
Press the Start button. For safety reasons, it is necessary to press the button for > 1 second for the device to switch into measurement mode. If the button is pressed for too short a time a message will be displayed momentarily on the LCD screen.



The measurement cycle takes place according to the Rise, Hold and Fall times with the display of the voltage and current according to the following screen:



At the end of the test the display shows if the measurement is between Rmin and Rmax i.e. considered PASS.



If the current flowing in the element tested exceeds the cut-out criteria set (in the  $\Delta I$  or IMAX mode), the device indicates that there a cut-out with cut-out of the high voltage (at the zero-crossing of the sine wave), the display then indicates:



The coloured function key indicates the setting that caused the FAIL sanction of the measurement.



**WARNING**

Before disconnecting the measured component, press the **STOP** button to confirm the stoppage of the high voltage generation and the component discharge. The device then performs a check of the residual voltage down to a value of 30 VAC or DC.



This action returns you to the initial measurement screen either to change the settings or to perform a new measurement by pressing the Start button.

### 10.3. THE FOLLOWING 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.

- **"VOLTAGE ERROR"**: The measurement voltage has not reached its final value. The voltage generator charges the capacity of the sample under test. This message should appear momentarily when switching to measuring mode. If this message persists the measurement voltage requested cannot be supplied to the impedance measured.

Check in relation to the characteristics of the voltage generator (difference of 20% in relation to the set point)

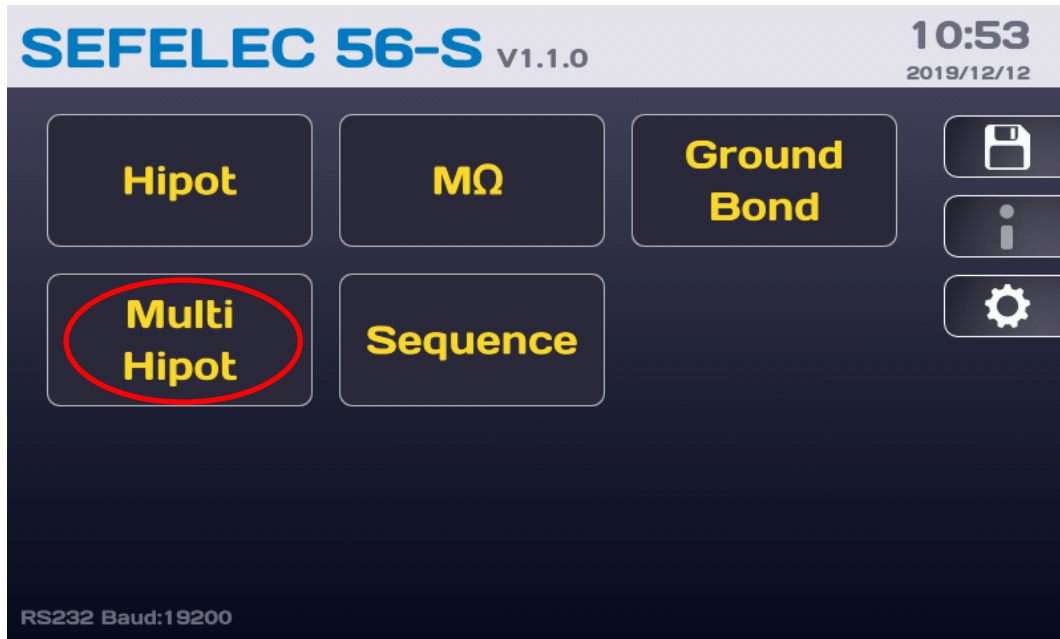
- **"OVER HEATING "**: The device is equipped with a thermal protection system. In case of extended use of the High-voltage generator on a short-circuit, the protection system will be activated.

In this case the message will be displayed permanently on the LCD screen. Switch off the device and let it cool down for 10 minutes prior to resuming use.

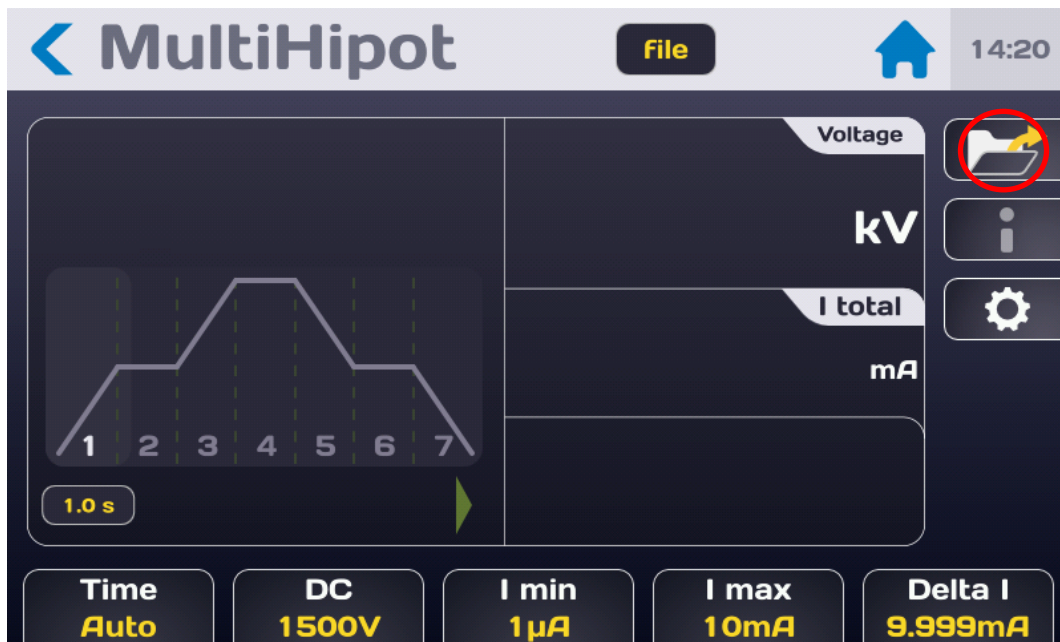


## 11. MULTI-SLOPE DIELECTRIC STRENGTH TESTS:

The multi-slope dielectric strength function enables us to produce a sequence of 7 voltage Rise, Hold or Fall phases. If the device has a multi-slope dielectric strength function, press the key from the following menu:

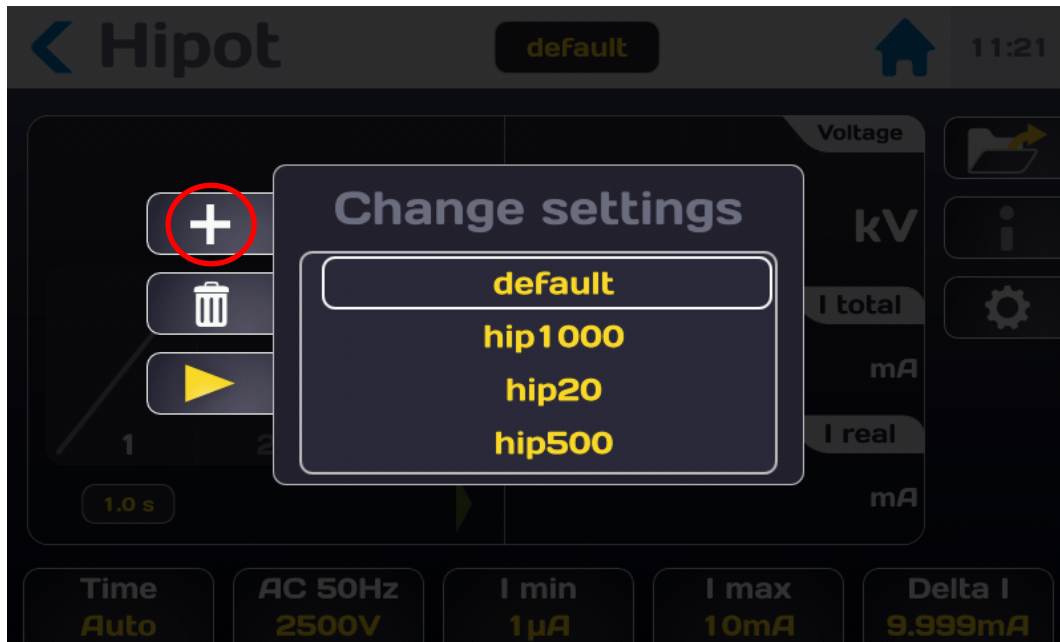


To obtain the following screen:

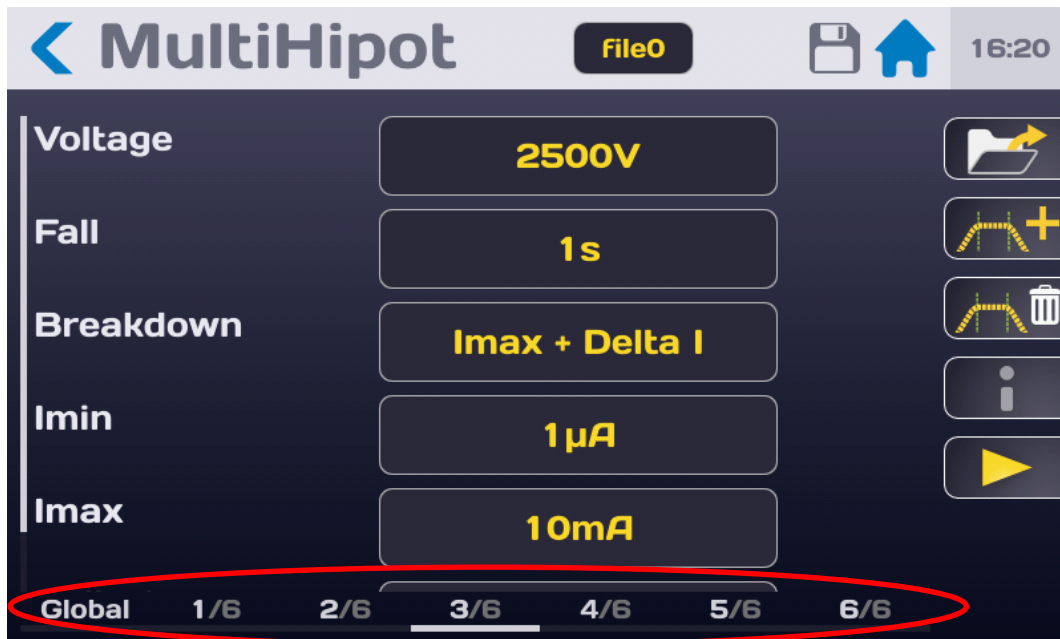


For each phase (1 to 7) it is possible to define an AC or DC voltage, a Rise, Hold or Fall time as well as the cut-out modes and associated thresholds.

Create a new test file by pressing the folder icon to obtain the following screen:



Press the (+) icon to create a new file (file name example: file1) and then press the key with the yellow arrow. The file offers 7 test phases that it is possible to change by pressing the gear wheel icon to obtain the following screen:



The lower part of the screen displays the different phases activated (1/n, 2/n, ...) as well as a zone of "Global" settings. Browsing in the different phases and in the Global mode is done either by pressing at the bottom of the screen on the desired phase or by pressing the screen and dragging the finger from right to left or left to right.

The "Global" mode allows to define the settings that will be applied to all the test phases enabled, for example the AC or DC nature of voltage, modes and thresholds of cut-out as well as the duration. The input of a setting is then applied to all phases, but it is possible to enter each phase to change the settings.

To delete or add a phase (maximum = 7), select the phase concerned and press the Delete or to Add icon:



Refer to paragraphs 9-1 to 9-6 of this manual for the adjust of the different settings.

## 11.1. CONNECTION OF THE COMPONENT TO BE MEASURED

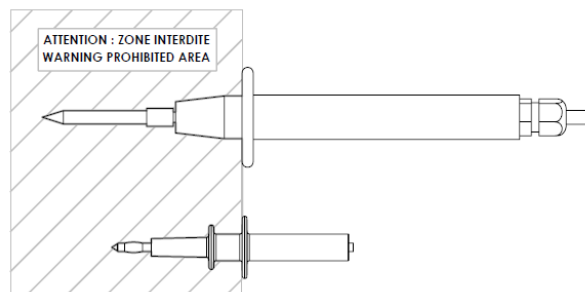


**Danger of electric shock!**

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

### **WARNING**

- Only use accessories with the device or devices for which they are intended. The safety of the operator and the proper functioning of the device used depend on the respect of this rule.
- Do not try to modify an accessory; measurement accessories may contain imitation and protection elements. It is forbidden to modify the accessories without written agreement from SEFELEC-EATON.
- If the device is used in conditions other than those specified in the manual of the device, potential risks may occur for the safety of the user.
- **ALWAYS** observe the safety rules relating to the use of High Voltage equipment.
- Never touch the metal tip of an accessory connected to a device.
- Do not use accessories that are in poor condition, incomplete or defective. Check the integrity of the accessory before every use.
- Respect the conditions of use specified in the instructions of the associated measurement devices.
- Do not use an accessory in the place of another, just because it looks the same. Each accessory is designed for a specific use and in strict association with a measurement device.
- More than one person should never use the same measurement accessories at the same time.

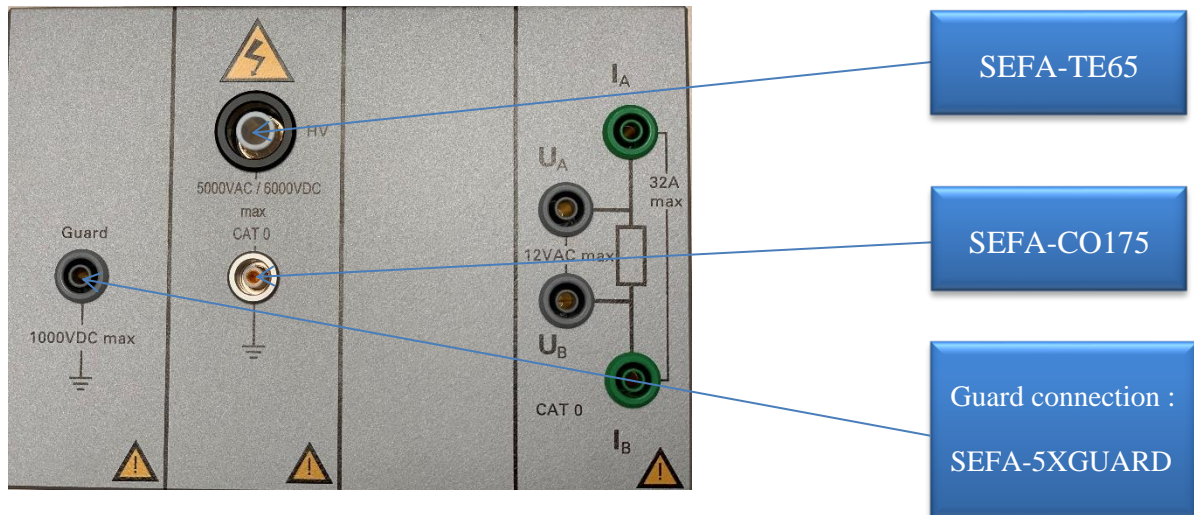


Connect the **SEFA-TE65** measurement power cord to in the **HV** socket provided; to lock the cord push the plug until you hear a click. Proceed in the same way with the **SEFA-CO175** return cord on the socket connected to the earth.



**IMPORTANT**

The connectors are fitted with a thumb wheel at the back preventing their extraction. Tighten the thumb wheel if necessary and loosen it to disconnect the plug from the socket.



**IMPORTANT**

To disconnect the cords, make sure that there is no voltage and then unscrew the rear thumb wheel, grasp the plug of the accessory by its ribbed ring and pull to remove the plug from the socket.

## 11.2. PRECAUTIONS TO BE OBSERVED DURING MEASUREMENT:



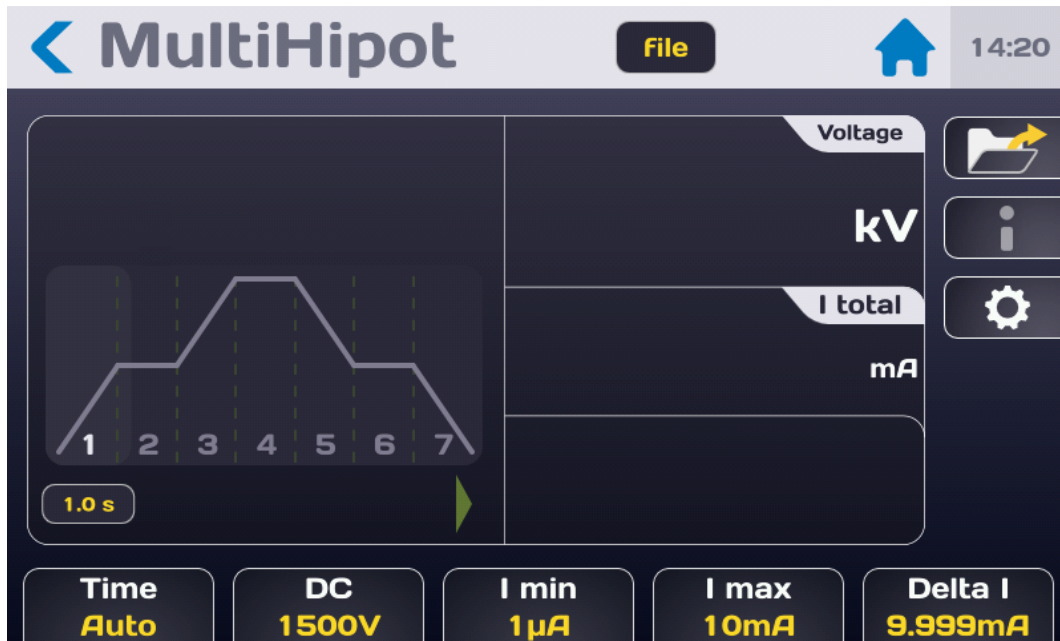
**WARNING**

Never disconnect a capacitive sample without switching to the discharge mode and waiting for the time required for the capacity of the sample to be discharged into the resistance of 1.5 MΩ of the discharge circuit.



It is recommended to check the proper functioning of the device regularly by connecting an element of known value to the measurement output and performing a measurement. In the absence of an element of known value, it is possible to make a measurement on an open circuit and on a short-circuit to confirm the consistency of the indications of the device.

After having connected the component for measurement applying the precautions described above and selected the measurement settings required, return to the measurement screen:

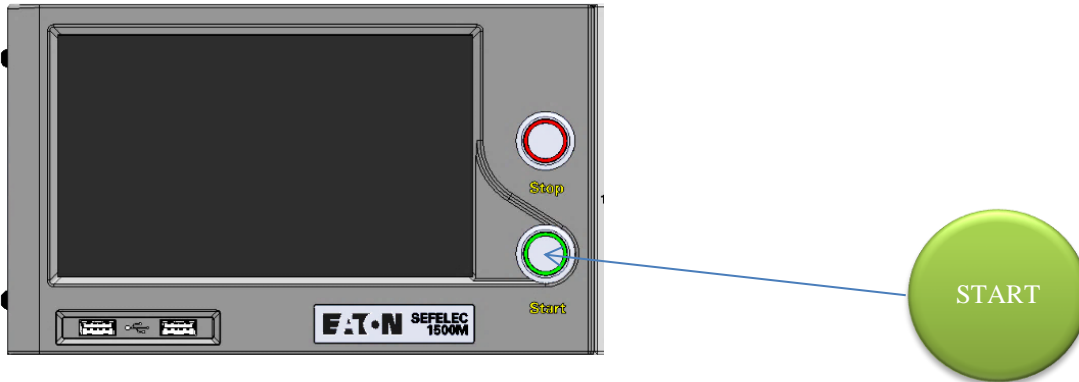






**NOTE**

Press the Start push button. For safety reasons, it is necessary to press the button for > 1 second for the device to switch into measurement mode. If the button is pressed for too short a time a message will be displayed momentarily on the LCD screen.



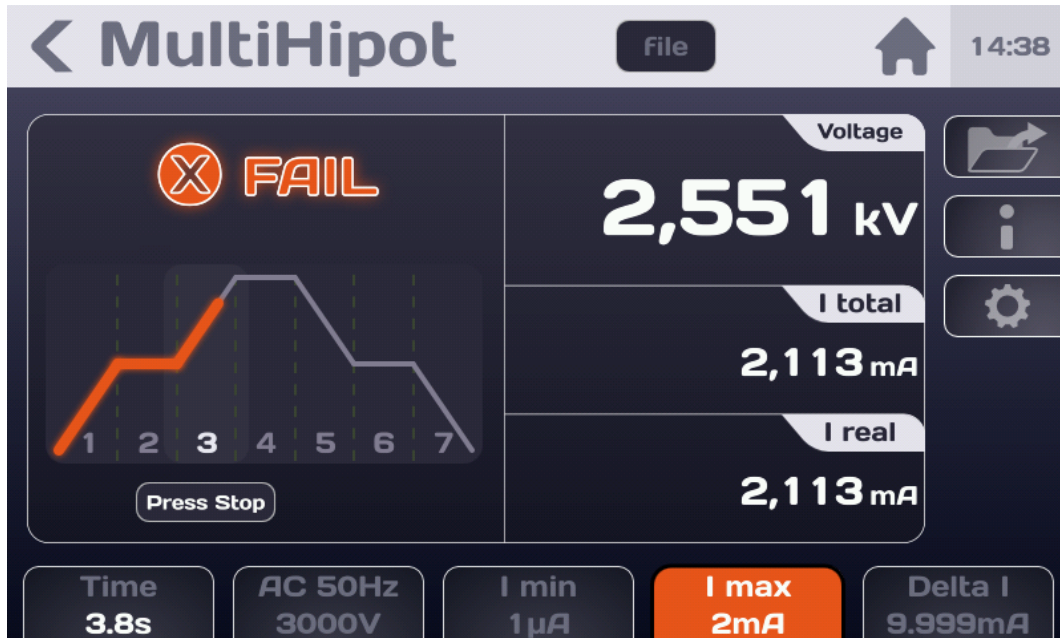
The measurement cycle comprising as a maximum 7 phases, takes place according to Rise, Hold and Fall times with the display of the voltage and current according to the following screen:



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



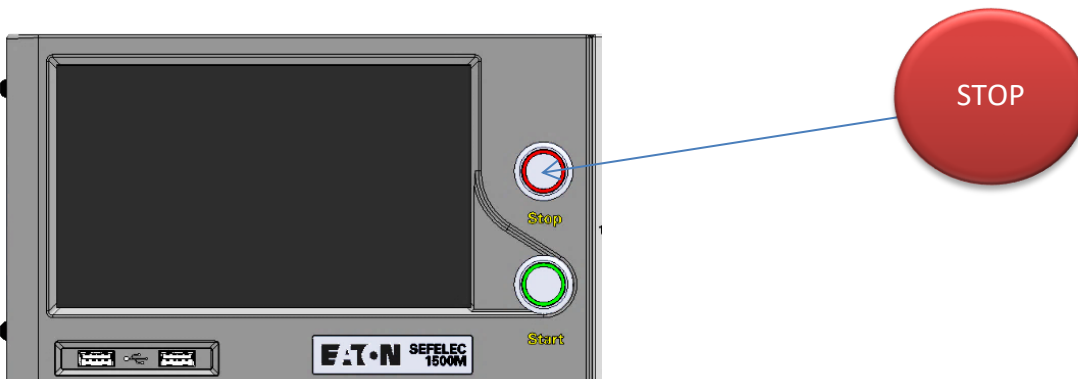
If the current flowing in the element tested exceeds the cut-out criteria set (in the  $\Delta I$  or IMAX mode), the device indicates that there a cut-out with cut-out of the high voltage (at the zero-crossing of the sine wave), the display then indicates:



The coloured function key indicates the setting that caused the FAIL sanction of the measurement.



Before disconnecting the measured component, press the **STOP** button to confirm the stoppage of the high voltage generation and the component discharge. The device then performs a check of the residual voltage down to a value of 30 VAC or DC.



This action returns the user to the initial measurement screen either to change the settings or to perform a new measurement by pressing the Start button.

### 11.3. THE FOLLOWING 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.

- **"VOLTAGE ERROR"**: The measurement voltage has not reached its final value. The voltage generator charges the capacity of the sample under test. This message should appear momentarily when switching to measuring mode. If this message persists the measurement voltage requested cannot be supplied to the impedance measured.

Check in relation to the characteristics of the voltage generator (difference of 20% in relation to the set point)

- **"OVER HEATING "**: The device is equipped with a thermal protection system. In case of extended use of the High-voltage generator on a short-circuit, the protection system will be activated.

In this case the message will be displayed permanently on the LCD screen. Switch off the device and let it cool down for 10 minutes prior to resuming use.

## 12.4-WIRE OPTION IN HIPOT FUNCTION

### 12.1. 4 WIRES HIPOT OPERATION

The purpose of this option is to detect the presence of the device under test (DUT) and not to improve measurement accuracy (like the 4-wire in ground continuity).

The detection principle is based on the use of an additional HV cable (SEFA-CO180) and a second GND return cable (SEFA-CO175) for the voltage reading. Detection of the absence of a test piece corresponds to a zero voltage reading.

Accessory set to order with the option:

- SEFA-CO180-xx : HV shielded cable with LEMO connector (xx = 2, 5 or 10 meters; **2 set to order per option**)
- SEFA-CO175-xx : return cable (xx = 2, 5 or 10 meters; **2 set to order per option**)



WARNING

**The option is only active during the test hold phase but not during rising and falling times.**

The user wishing to save time in case of the non-presence of a test piece can stop the test at the beginning of the hold phase, as soon as the instrument status switches to connection fault.



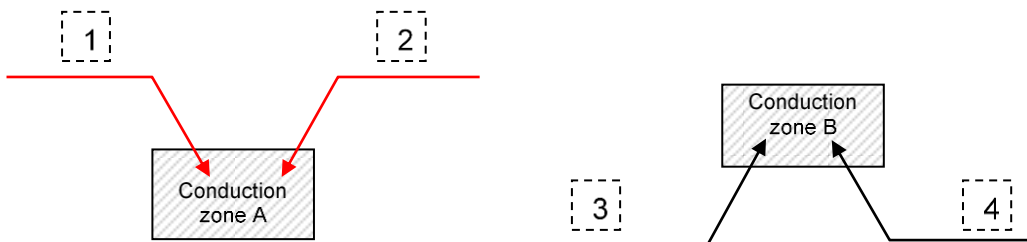
## 12.3. HV SENSOR CONNECTION RECOMMENDATIONS :



WARNING

To keep the option in good operating condition, it is essential to respect some connection rules

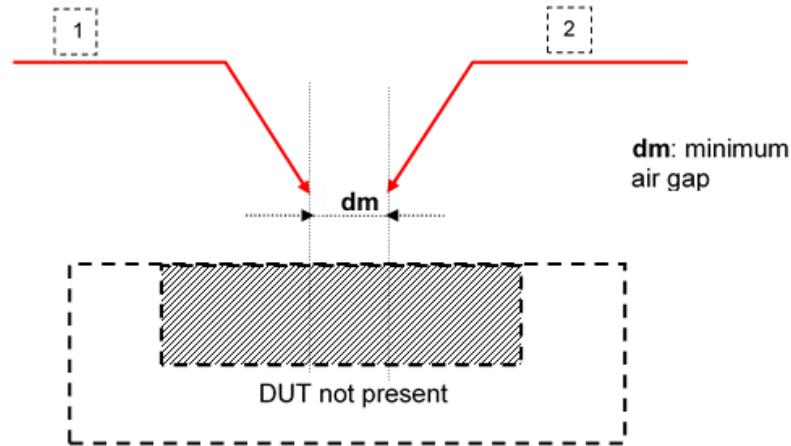
### 12.3.1. CONNECTION ZONES:



If  $R_A$  and  $R_B$  are the contact resistances in zones A and B for breakdown voltage  $> 1\text{kV}$  :

- $R_A < 5\text{ k}\Omega$
- $R_B < 100\text{ }\Omega$

### 12.3.2. MINIMUM AIR GAP BETWEEN ELECTRODES



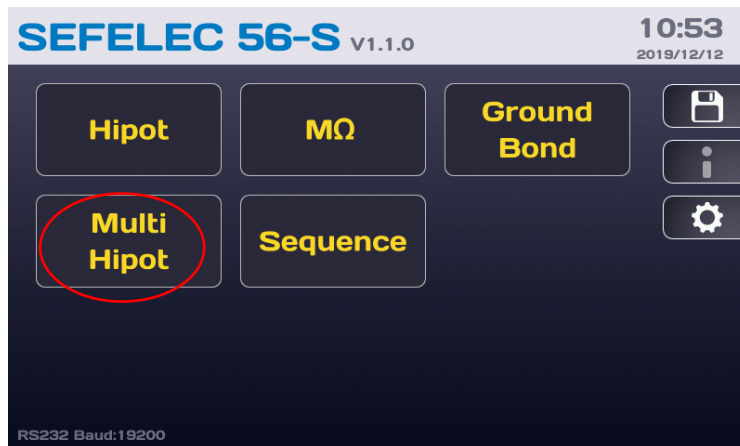
$dm \geq 2 \text{ mm/kV in dry air}$



WARNING

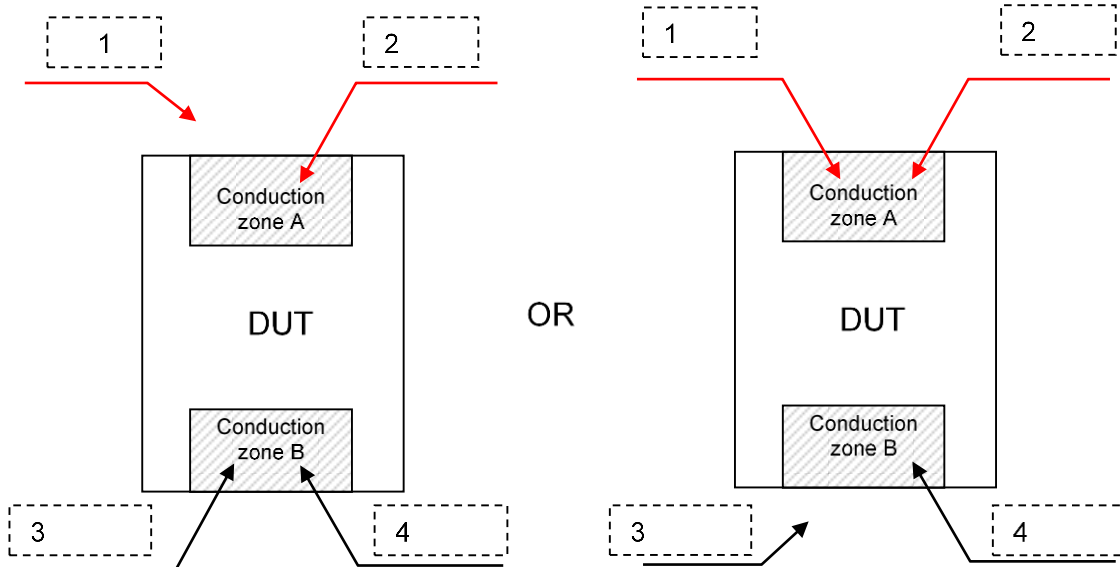
It is essential to respect the 2mm per 1000V rule, i.e. 10mm for 5000V for the air gap (dm) between the HV generation and reading probes (1 and 2). This is essential for the proper operation of the system. If this rule is not followed, arcing between the HV generation and reading probes may interfere with the detection or even trigger the instrument's circuit breakdown system.

If the DUT dimensions don't allow to respect the distances according to the dielectric strength test voltage, it is possible to use the MULTI-HIPOT mode, refer to section 11 of the complete operating manual



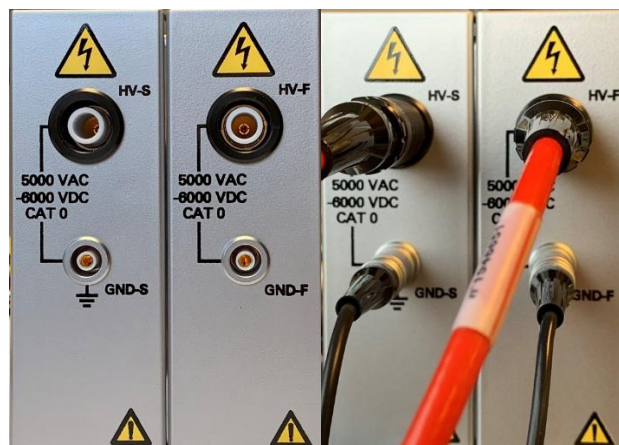
Set a first phase with a lower voltage, i.e. a few 100 volts with a short hold time ( a few 100msec.) which will allow the DUT presence detection without any arcing issue. Then set a second phase with the final Hipot test voltage and the requested hold time.

### 12.3.3. CASE OF MALFUNCTION OF THE OPTION



In the 2 situations described above, the high voltage is applied to the test piece by probes 2 and 4. As the system is not equipped with a self-test function it is not possible to distinguish clearly between a connection problem and a test piece fault.

### 12.4. REAR VIEW OF THE UNIT, 4 WIRE HV MODULE :



**Accessory connections** (2 x SEFA-CO180 HV red cable and 2 x SEFA-CO175 ground return black cable)



### 13. SETTING THE MEASUREMENT OF GROUND CONTINUITY

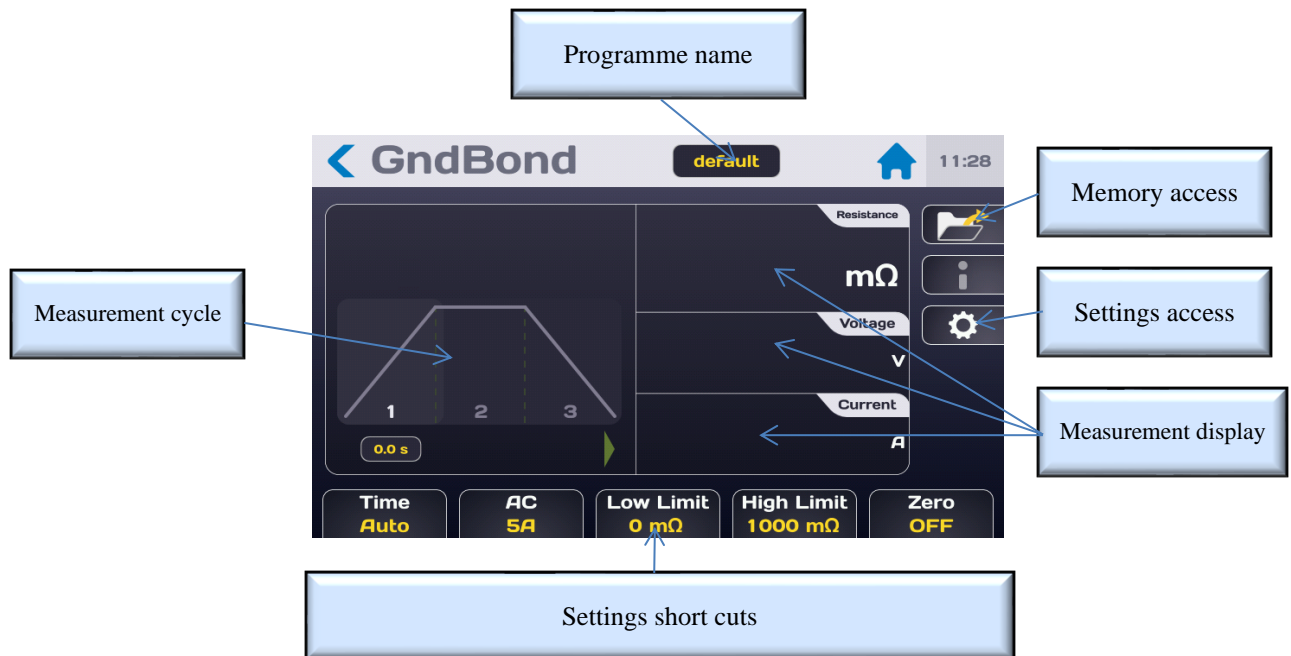
After switching on the device or returning to the Start menu, the Home screen shows:




Press the **Ground Bond** key to access the following measurement screen:

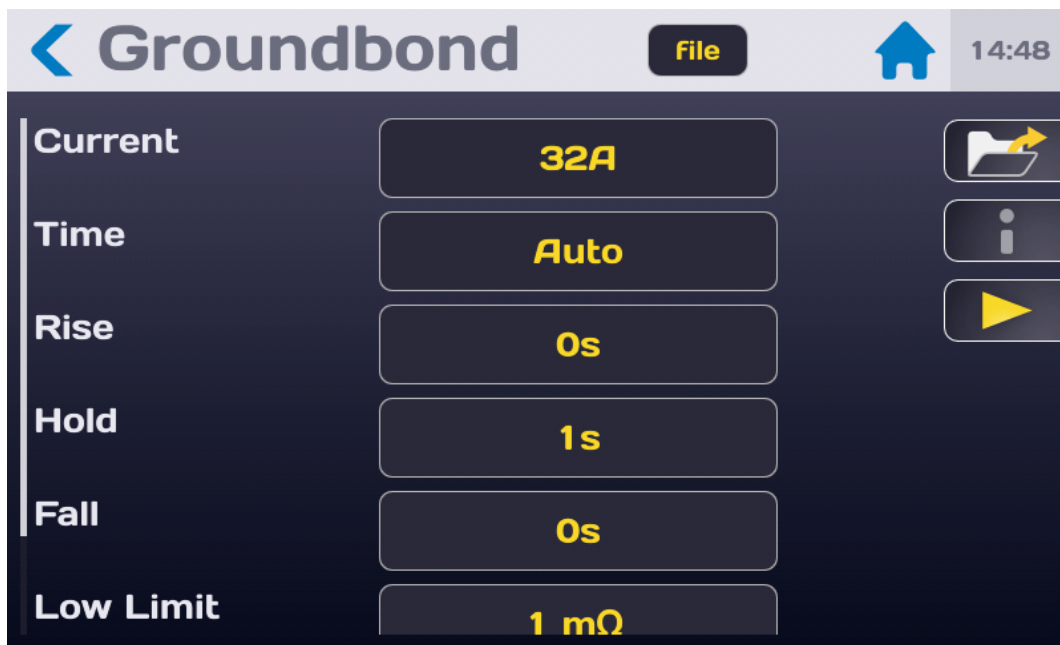


Description of the measurement screen:



The measurement display is done on 3 screens (current, voltage and resistance) the order of which can be changed by pressing one of the 3 areas and dragging up or down.

Access to the measurement settings can be from the shortcut keys located on the bottom of the measurement screen or from the key with the gear wheel icon  which displays the following menu:



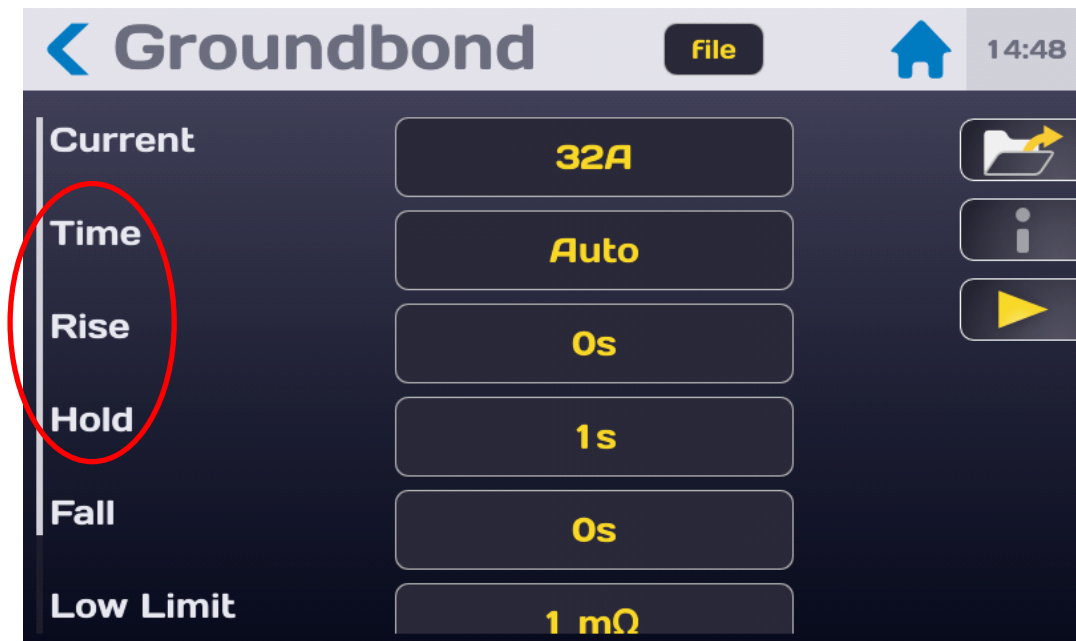
Select the setting to be changed by pressing the active area (yellow) of the line of the setting.

### 13.1. ADJUSTING THE MEASUREMENT TIME

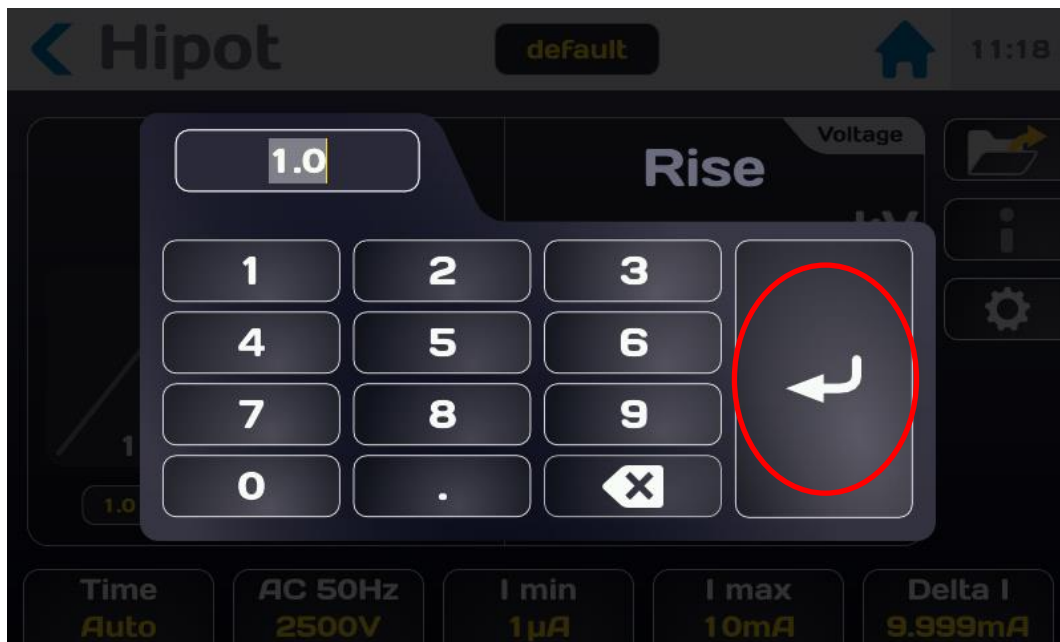
To change the measurement time press the active area of the "Time" line to obtain:



To use the internal timer Select the **AUTO** mode and adjust the Rise, Hold and Fall times from the settings menu (values between 0.1 and 9999 sec.):



To adjust the measurement time press the active area of the line of the corresponding setting:

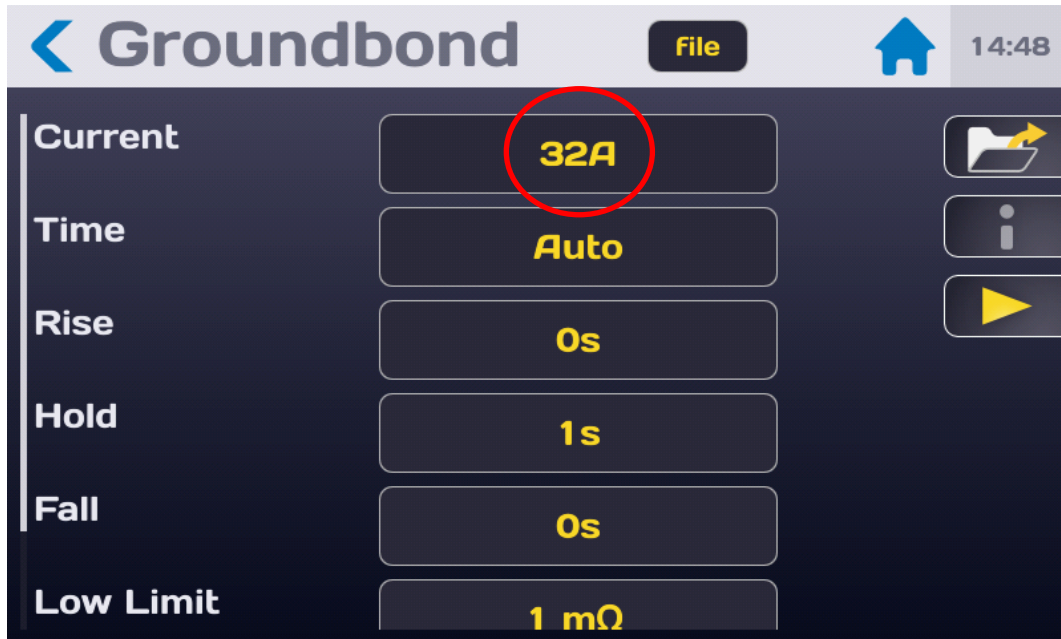


Enter the time in seconds, if the value entered is outside the minimum and maximum limits it will be displayed in red. Press the arrow key to validate the entry and return to the Settings menu.

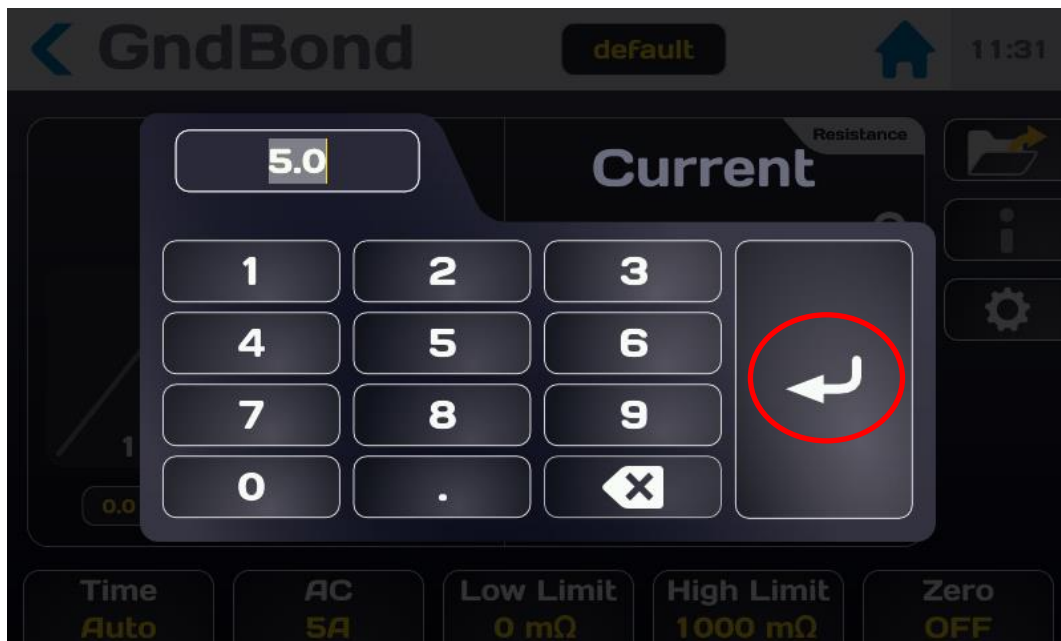
The **Permanent** mode: a rise time applies to the test and then the output current is equal to the set point. The test is stopped if the user requests to stop the test by pressing the red button STOP on the front panel.

## 13.2. ADJUSTING THE MEASUREMENT CURRENT

From the settings menu or by the current short cut key at the bottom of the measuring screen press the active area of the Current line:



To obtain the following screen:



Enter a current between 5.0 to 32.0A AC (or 5.0 to 50.0A AC on option) if the value entered is outside the permitted limits it is shown in red. Press the enter key to validate the entry and return to the previous menu.

### 13.3. ADJUSTMENT OF THE COMPARISON THRESHOLDS IN RESISTANCE OR VOLTAGE DROP

The device includes two comparison thresholds to verify if the measured item is PASS or FAIL. These thresholds can be a resistance or a voltage (according to the recommendations of the EN60204-1 standard)

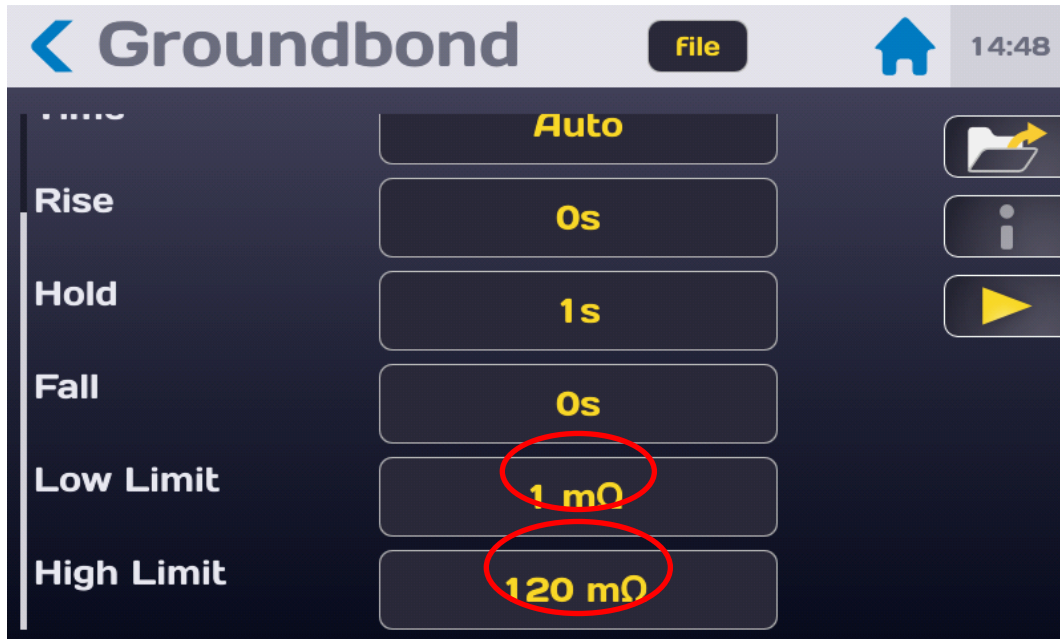
The High Threshold defines the maximum limit of validity of the measurement.

The Low threshold defines the minimum value that the element measured must reach.

An element tested is PASS if its value is lower than the High Threshold and higher than the Low Threshold, if not the element is declared FAIL.

The High Threshold must always be greater than the Low Threshold.

To access the High and Low threshold settings scroll the ground continuity settings screen to display:



Then press the active area of the threshold to be changed to obtain the following input menu:



Enter the threshold value using mΩ or V units.  
If the value entered is beyond the limits, it is displayed in red.  
Validate the threshold by pressing the enter key.  
Proceed in the same way to adjust the other threshold.



**NOTE**

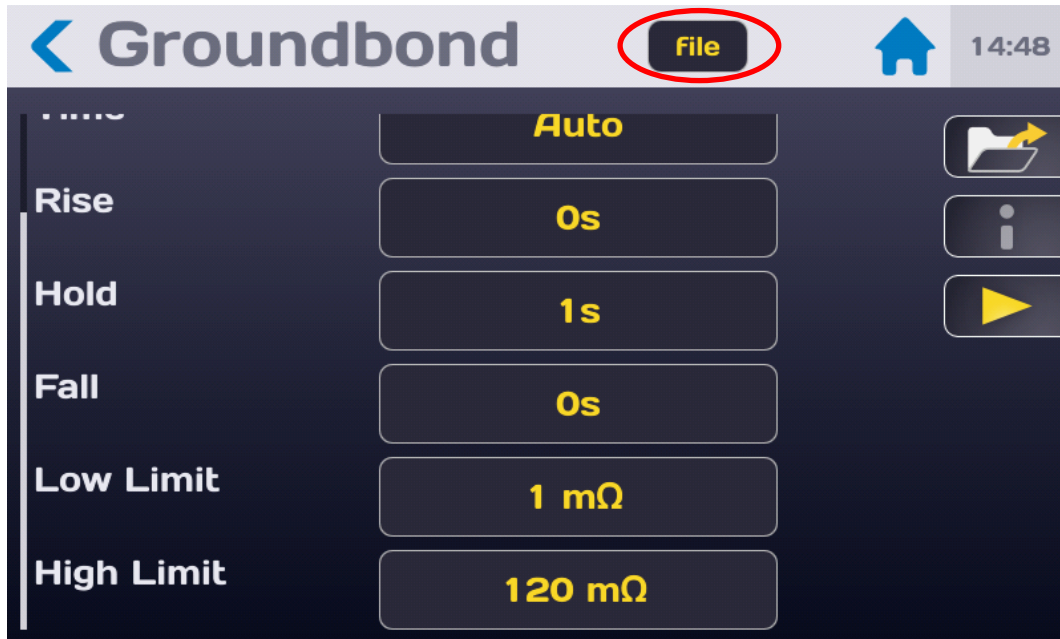
**In case of invalid thresholds an INVALID TEST error message will be displayed in a POPUP window**



## 13.4. SAVE UNDER A FILE NAME CITING THE MEASUREMENT SETTINGS

All the ground continuity measurement settings can be saved under a file name allowing the setting to be found easily.

After you have set all the settings, they are located under the file name specified in the field below:



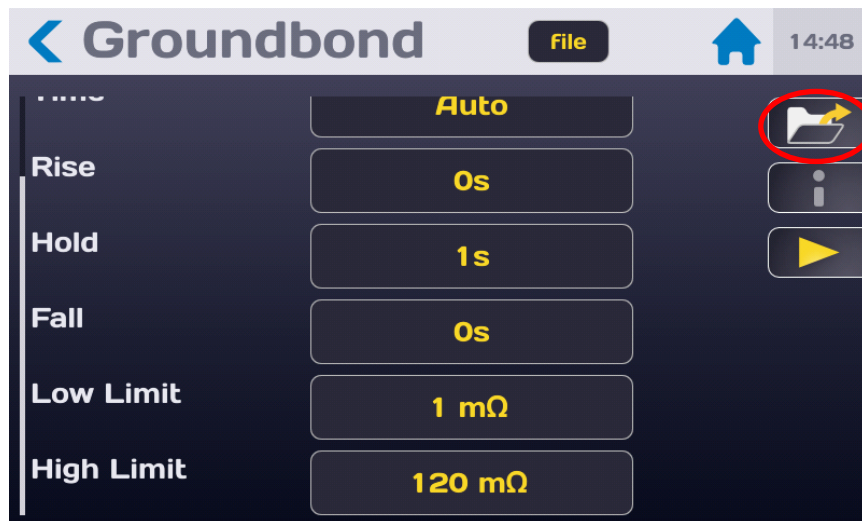
To change the name of the file press the field with the name of the file to show a virtual keyboard and enter the new name.

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

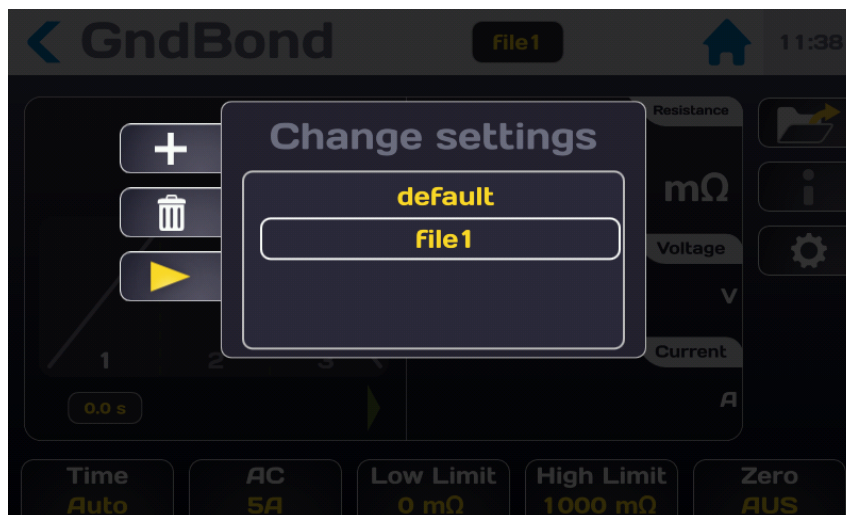
Special characters such as @, €, £, \$, &, μ, (), {}, etc. are not allowed in the file names. The file name can contain at least 50 characters.

When validating the machine proposes to keep the old file and to duplicate or rename it without keeping the original version.

To recall a file name press the function key with a folder icon:



To obtain the following screen:



Find the name of the file by scrolling the list of files to the bottom or to the top. Press the desired file name and then press outside the area of the display of the list of files or on the button with the yellow arrow.

This window also allows you to delete a file name. Select the name of the file to delete and then press the button in the form of bin. A Delete Confirmation window appears; confirm or cancel the deletion.

From this window it is also possible to create a new file with the (+) key which generates a file that auto-increments from a file named: file1



**NOTE**

**WARNING: Any change of a file setting is automatically saved in the file**

## 14. GROUND CONTINUITY RESISTANCE MEASUREMENT

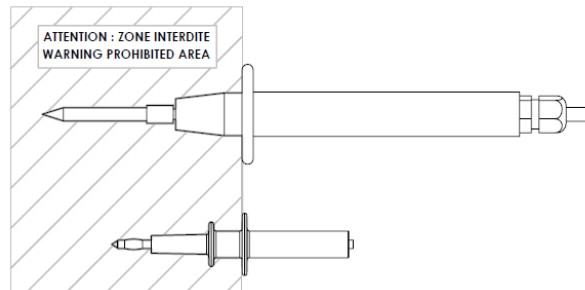
### 14.1. CONNECTION OF THE COMPONENT TO BE MEASURED



#### WARNING

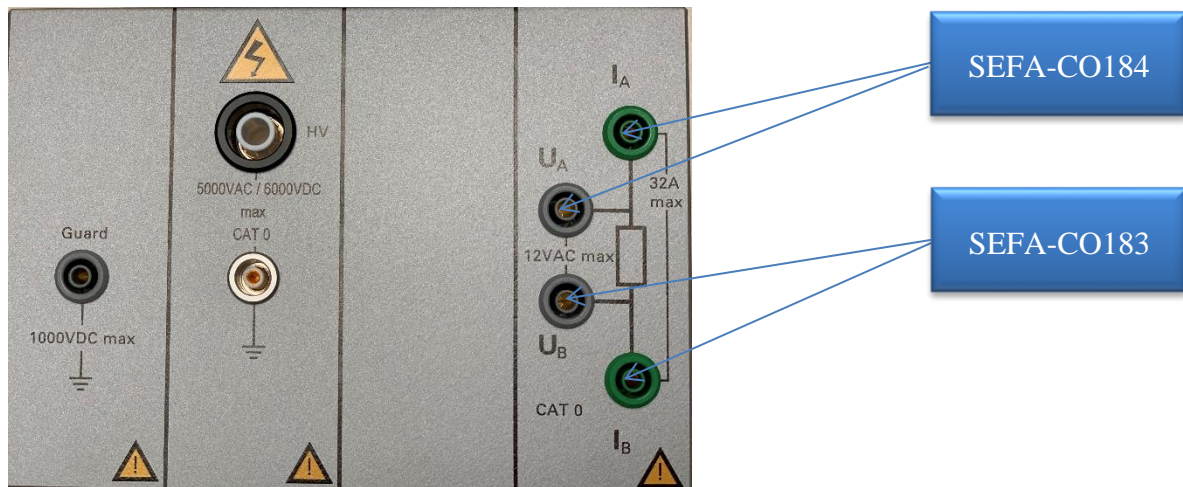
**WARNING: The accessories must only be handled by qualified personnel.**

- Only use accessories with the device or devices for which they are intended. The safety of the operator and the proper functioning of the device used depend on the respect of this rule.
- Do not try to modify an accessory; measurement accessories may contain imitation and protection elements. It is forbidden to modify the accessories without written agreement from SEFELEC-EATON.
- If the device is used in conditions other than those specified in the manual of the device, potential risks may occur for the safety of the user.
- **ALWAYS** observe the safety rules relating to the use of High Current equipment.
- Never touch the metal tip of an accessory connected to a device.
- Do not use accessories that are in poor condition, incomplete or defective. Check the integrity of the accessory before every use.
- Respect the conditions of use specified in the instructions of the associated measurement devices.
- Do not use an accessory in the place of another, just because it looks the same. Each accessory is designed for a specific use and in strict association with a measurement device.
- More than one person should never use the same measurement accessories at the same time.



Connect the **SEFA-CO184** measurement power cord to piggy back terminals of diameter 4mm I<sub>A</sub> and U<sub>A</sub> respecting the colour code.

Proceed in the same way with the **SEFA-CO183** measurement cord and terminals I<sub>B</sub> and U<sub>B</sub>



#### WARNING

**WARNING:** The cable sections are calculated according to the currents flowing in these cables. It is very important to observe the colour codes of the accessories (connect plugs of a colour on sockets of the same colour). In the event of replacement of accessories, it is important to use the same cable sections.



#### REMARQUE

Using the SEFA-TE81-32 or 50 accessory adds a residual resistance of around 5 mΩ. This value can be canceled with the zero function.

## 14.2. PRECAUTIONS TO BE OBSERVED DURING MEASUREMENT:

As the resistances measured are low ( $< 1 \Omega$ ), it is essential to perform the measurement using the '4-wire' method to be liberated from the spurious resistance of the measuring leads (interfacing, adapters, etc.) it is essential to guarantee this measurement principle in all circumstances in the connections between the measurement device and the points tested.

If special links need to be implemented, it is important to use large section conductors (minimum  $5 \text{ A/mm}^2$ ) for the transmission of the current, and conductors in contact as close as possible to the points to be measured for the measurement of the voltage drop.

During measurement, it is recommended not to move or break the electrical contact with the parts tested so as, on one hand, not to distort the test conditions (e.g.: duration of application) and, on the other hand, not to affect the contact area by arcing due to the strong current.



**WARNING**

**The passage of a strong current in an element with low resistance can lead to a significant temperature rise. Do not touch the item tested or the metal parts of accessories during or after the tests.**



**It is recommended to check the proper functioning of the device regularly by connecting an element of known value to the measurement output and performing a measurement. In the absence of an element of known value, it is possible to make a measurement on an open circuit and on a short-circuit to confirm the consistency of the indications of the device.**

## 14.3. SAFETY LOOP OPERATION IN GROUND CONTINUITY FUNCTION

The 5x series devices offer a safety loop which, depending on its Closed or Open state, authorizes the generation of voltages and currents that can be dangerous.

In the case of the Ground continuity function, it is possible to activate or not the safety loop. In fact, for ground continuity measurements, it may be necessary for an operator to enter the test area to contact the ground points and therefore to operate with the safety loop open.

To deactivate the safety loop only in Ground continuity function, press the padlock icon:



To display the message :



Enable or disable the safety loop according to the displayed messages.

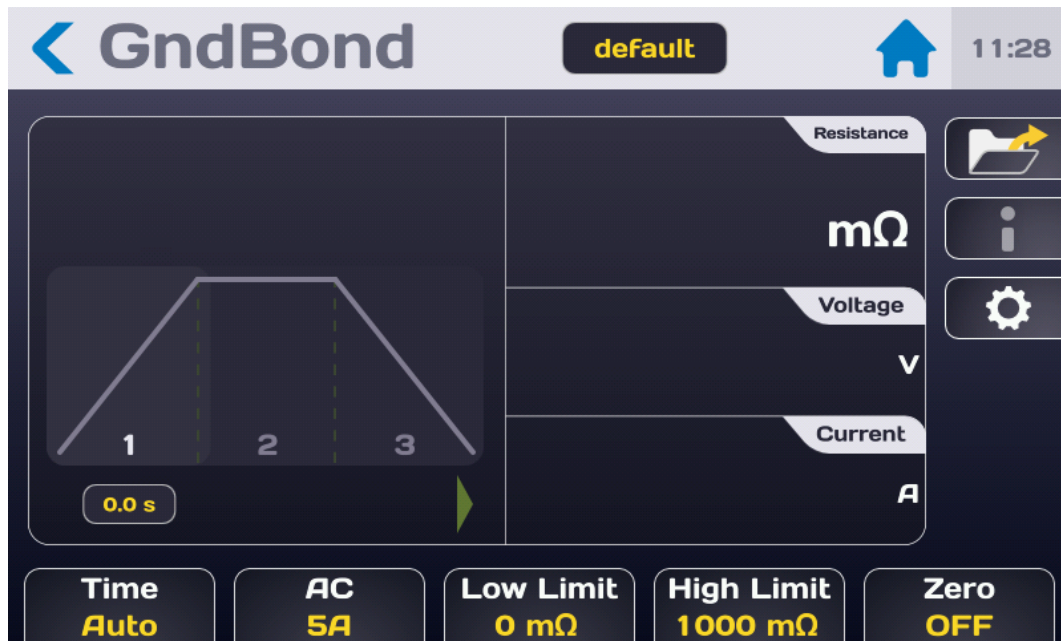


**If the safety loop is deactivated in the Ground continuity function, the safety loop remains active in the other measurement functions.**

**ATTENTION**

## 14.4. GROUND CONTINUITY MEASUREMENT

After having connected the component for measurement applying the precautions described above and selected the measurement settings required, return to the measurement screen:

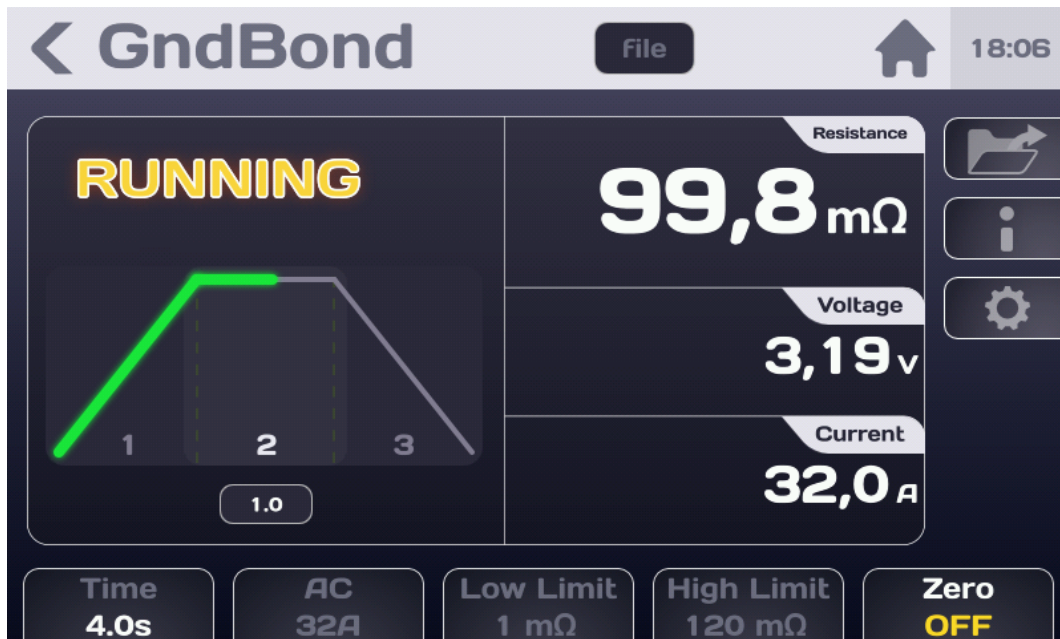


### NOTE

Press the Start push button. For safety reasons, it is necessary to press the button for > 1 second for the device to switch into measurement mode. If the button is pressed for too short a time a message will be displayed momentarily on the LCD screen.

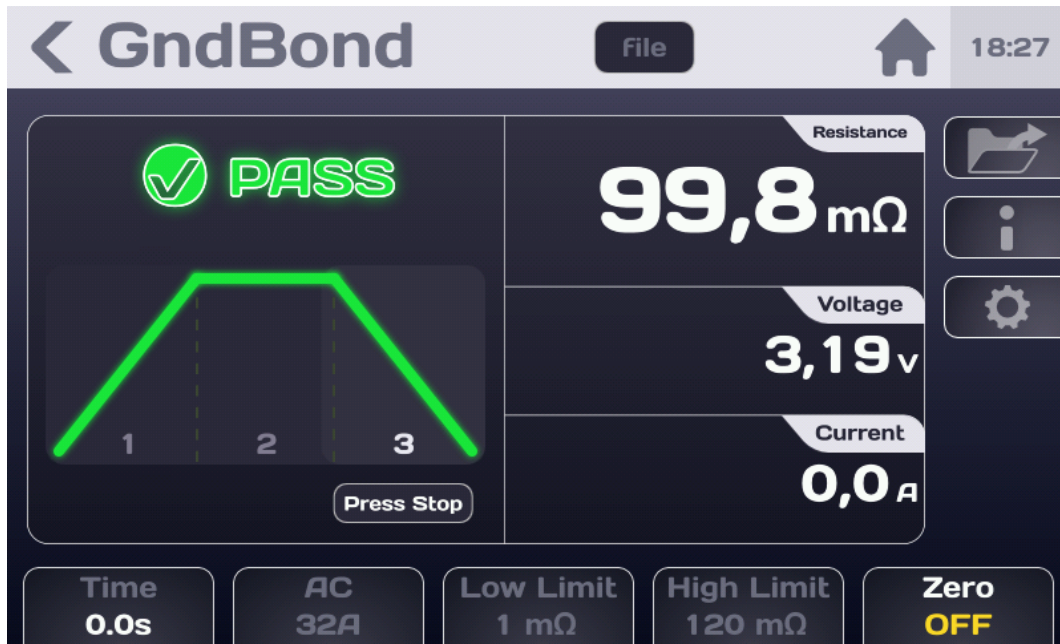


The measurement cycle takes place according to the Rise, Hold and Fall times with the following screen:

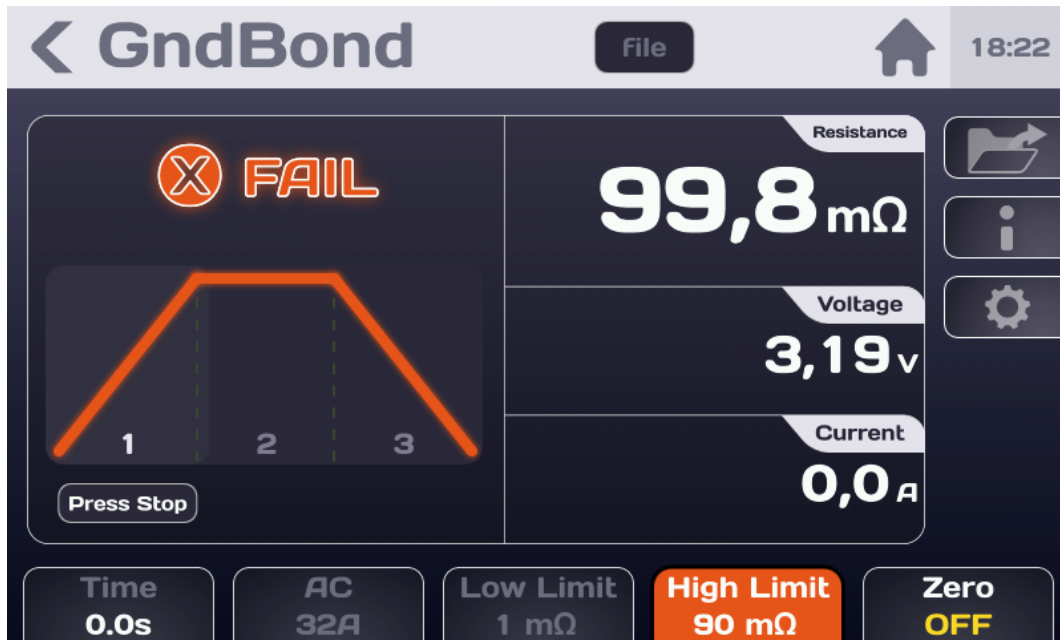


Display	Rise	Hold	Fall	End of test
Voltage	No	Yes	Yes	Yes
Current	Yes	Yes	Yes	No
Resistance	No	Yes	Yes	Yes
PASS/FAIL	No	No	No	Yes

At the end of the test the display shows the last value measured before the reduction of the voltage and if the measurement is between Rmin and Rmax i.e. considered PASS.



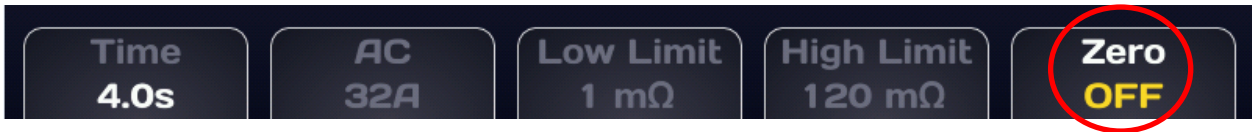
If the measurement is  $< R_{min}$  or  $> R_{max}$ , it will be regarded as FAIL:



The coloured function key indicates the setting that caused the FAIL sanction of the measurement.

#### 14.5. ELIMINATION OF RESIDUAL RESISTANCE:

It is possible to subtract a value of residual resistance from the measured resistance.  
Make a first measurement of the residual resistance, when the value is stabilized press the Zero key:



The zero function key then switches to a clear background and ON  
The resistance value displayed should then be near to 0.0 mOhm.  
Perform the measurement of the overall resistance of the sample.



**The residual resistance value is not saved when the device is switched off.**

#### REMARQUE



**Using the SEFA-TE81-32 or 50 accessory adds a residual resistance of around 5 mΩ. This value can be canceled with the zero function.**

#### REMARQUE



**Before disconnecting the component measured, press the Stop button to confirm the stoppage of the high current generation**

#### IMPORTANT

#### 14.6. MULTI-POINT GROUND CONTINUITY:

In the case of many ground continuity points to be checked, it is possible to define a loop from 1 to N repeating the ground continuity measurements

See the paragraph 15.1.2 of the Sequence mode

## 14.7. THE ERROR MESSAGES:

- **"SAFETY LOOP WAS OPENED"**: in the case of an active security loop (closed padlock) if it is not closed, there is no connection between points 1-9 or 2-10 of socket C5 located on the panel back of the device which cannot generate current.  
Press OK to acknowledge the message.  
Close the loop to be able to make a measurement, if the safety loop cannot be closed for ground continuity measurements, see paragraph 14.3 for how to de-activate the safety loop according to the ground continuity function.
- **"OVER RANGE"**: the continuity resistance of the sample under test is higher than the measurement possibilities of the device ( $> 1,000 \text{ m}\Omega$ )
- **"CONTINUITY ERROR"**: The wires are not connected correctly, or the element tested between these wires has a resistance that is too high (approximately a few ohms) for the device to measure it.



### IMPORTANT

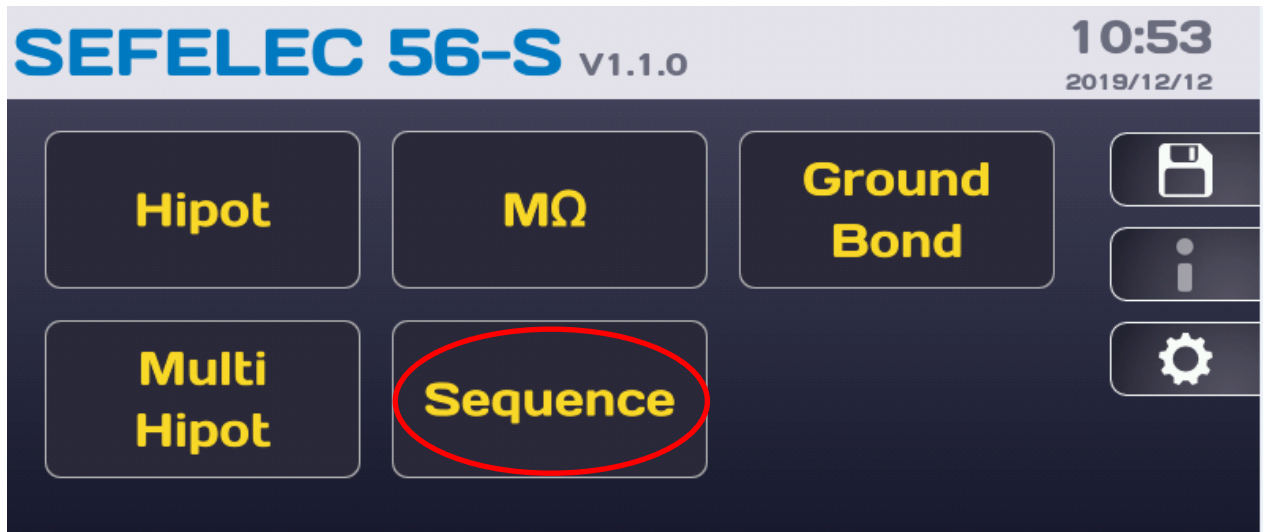
The device is equipped with a thermal protection system. In case of extended use of the High-current generator, the protection system will be activated. In this case the **"OVER HEATED"** message will be displayed permanently on the LCD screen.

Switch off the device and let it cool down for 10 minutes prior to resuming use.

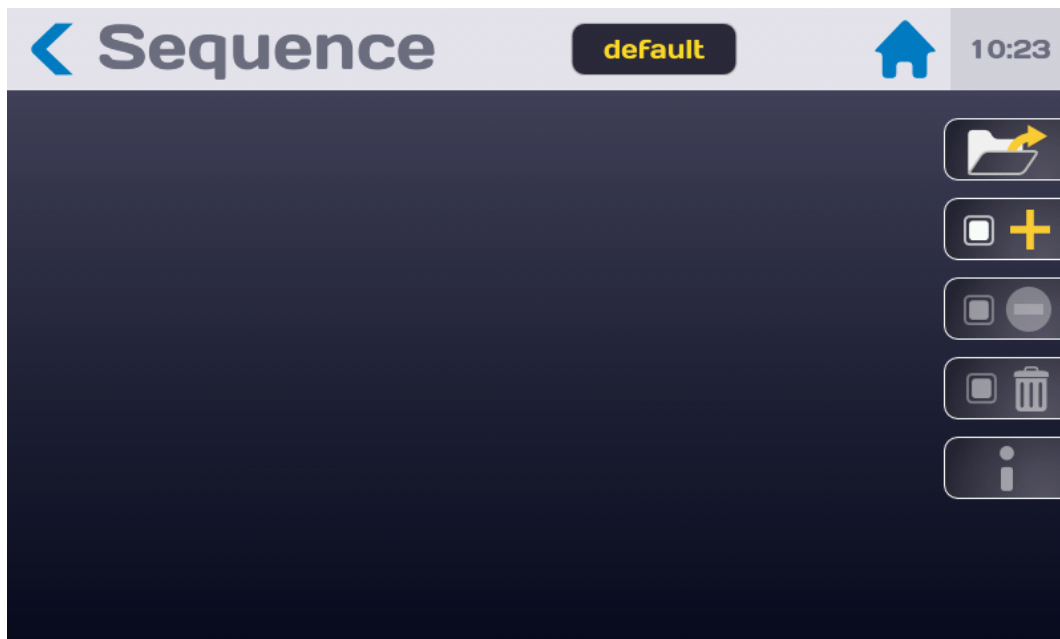
## 15. SEQUENCE MODE

The sequence mode is a very complete mode of operation which allows us to create measurement programmes involving files with different settings, different measurement functions, messages giving information or instructions for the operators as well as opportunities for viewing photos or drawings. A set of instructions allows a flow of each sequence according to the results of measurement, conditional loops as well as jumps at certain stages of the sequence.

After switching on the device or the return to the Start menu, press the **Sequence** key:



to access the following screen:



## 15.1. LIST OF FUNCTIONS AVAILABLE IN THE SEQUENCE MODE

From the sequence mode screen press the function key:



to show the drop-down list of available functions.

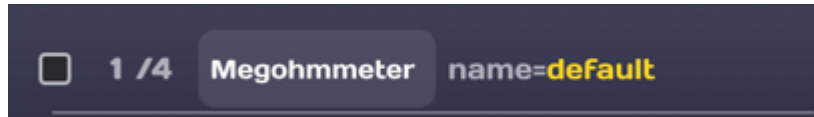
A Sequence is composed of a sequence of steps, each step can be any of the following functions:

- **Megohmmeter**
- **Hipot**
- **Multi Hipot**
- **Gnd Bond**
- **Gnd Bond Multi points**
- **Text message**
- **Image message**
- **PDF message**
- **Condition**
- **Repeat**
- **Pause**
- **Keyboard entry**

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

## General rules of the sequence mode:

Each step consists of a line comprising:

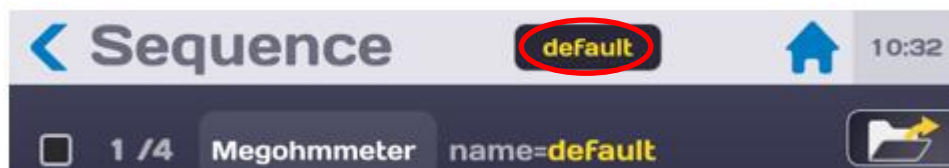


- a check box that allows the step to be selected so that it can be deleted (bin icon), put in standby or reactivated (no entry icon). It is possible to make a multiple selection of several lines to delete them or put them in standby. The lines disabled are greyed out completely.
- An order number in the x/n format which gives the ranking x of the step over a total of n steps
- the name of the function
- the associated settings file. Pressing the file name (in yellow) allows to access a list of available files or to enter titles and texts.

Prolonged pressure on a step puts the line in brightness and allows to move it by dragging it on the screen towards the top or bottom.

The measurement function settings files called by the sequence mode must not use the Permanent mode of the timer.

Each addition, deletion or change to a step line is automatically saved under the name of the Sequence file; **"default"** in the example below:



It is possible to change the sequence file name by pressing on the name and typing in the new name.

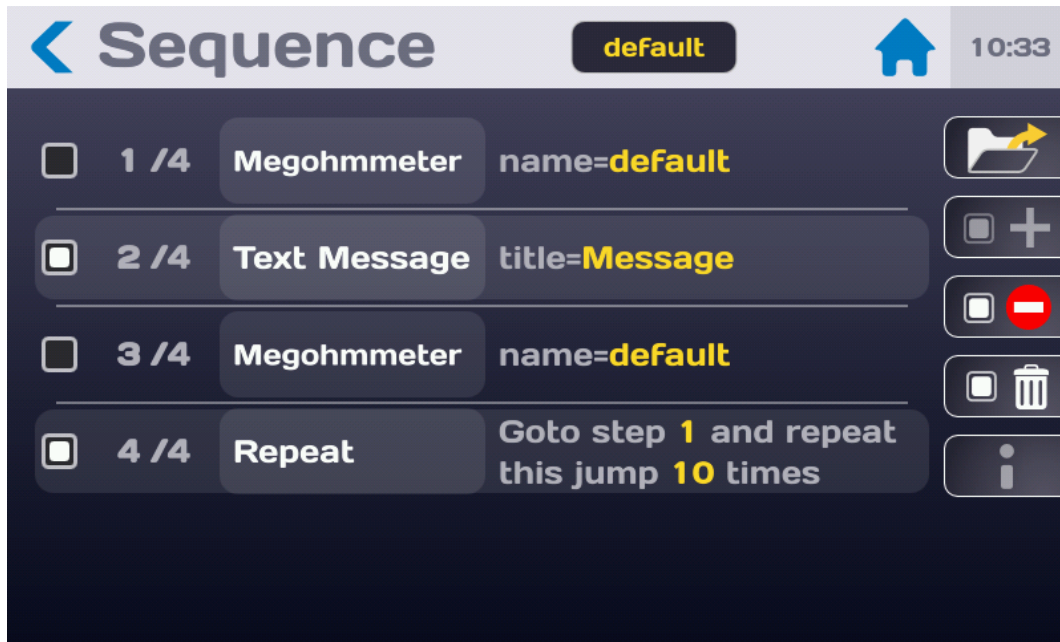
Spaces are not allowed in the file name, use the dash (-) or the underscore (\_) as a separator.

Special characters such as @, €, £, \$, &, μ, (), {}, etc. are not allowed in the file names. The file name can contain at least 50 characters.

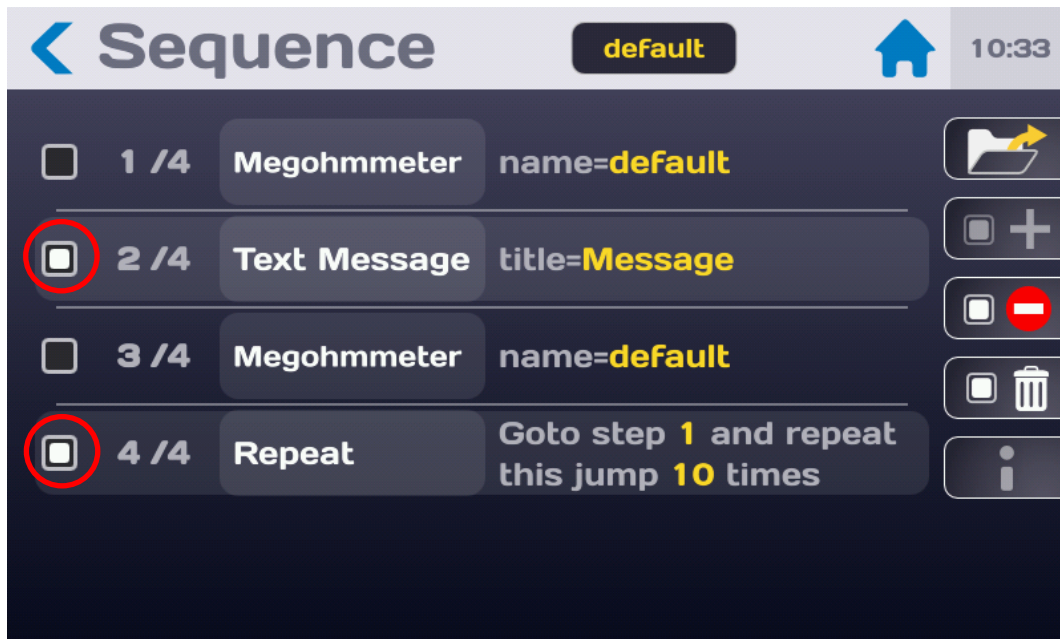
When validating the machine proposes to keep the old file and to duplicate or rename it without keeping the original version.

The exploration of all the step lines is done by placing one's finger on the LCD screen and dragging to the top (to go toward the end) or the bottom (to go towards the beginning)





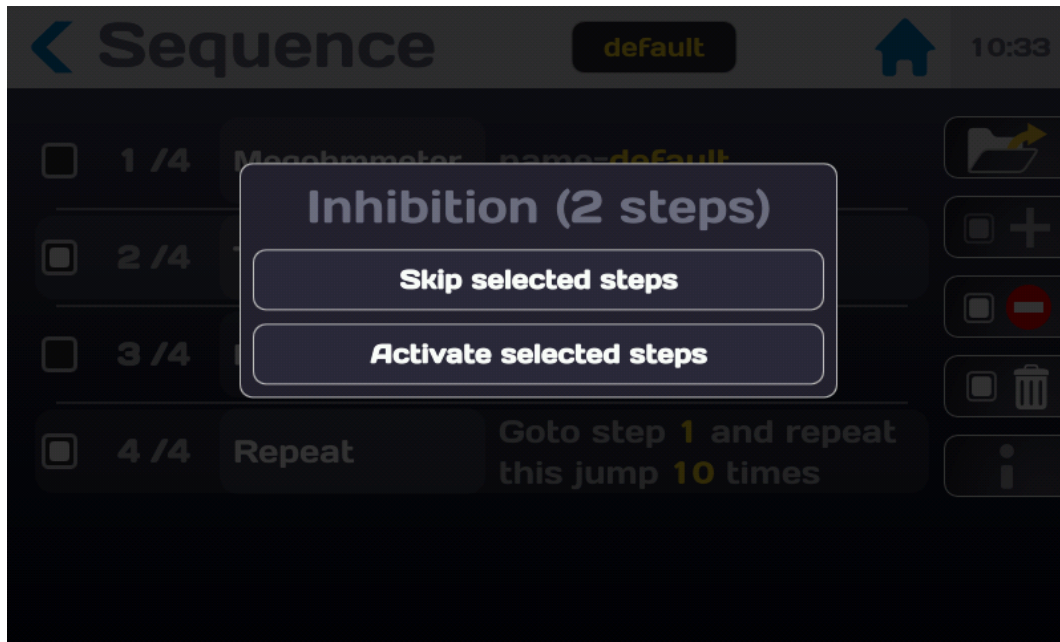
It is possible to inhibit a step of a sequence without deleting it completely. This allows easier fine tuning of the sequences. Select the step line or lines to be inhibited by checking the selection check box:



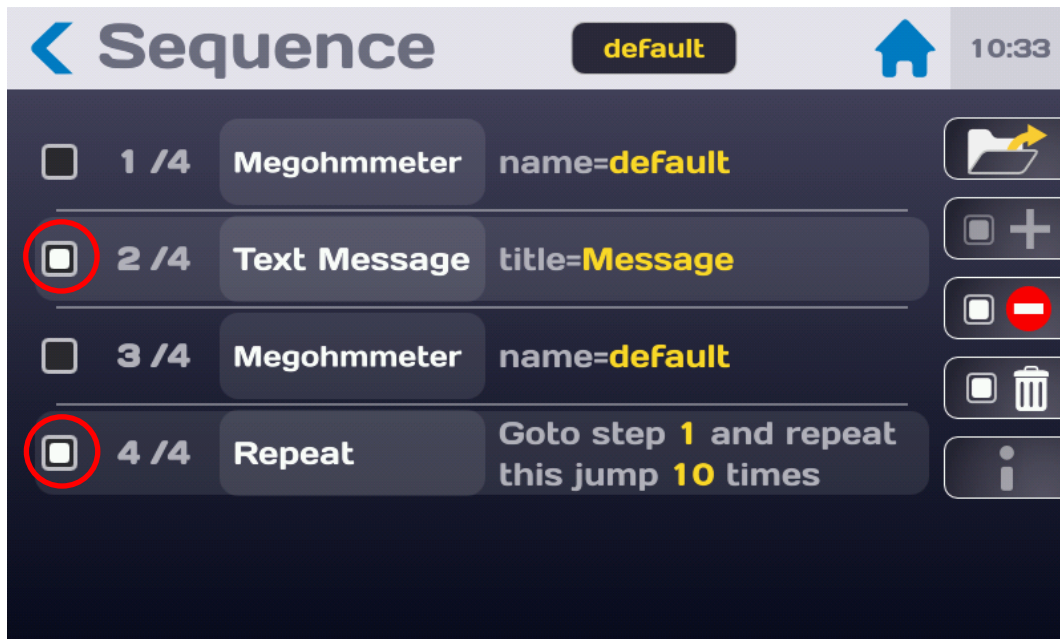
Then press the no entry icon:



Choose to pass these steps or to enable them:



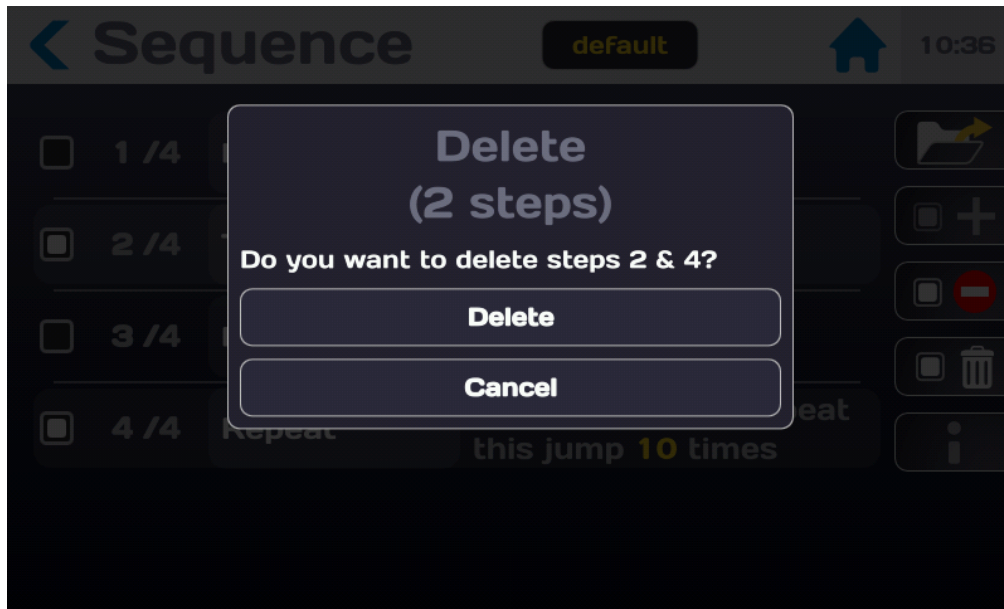
To delete a step of a sequence, select the line or lines to be deleted by checking the selection check box:



Then press the bin icon:



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



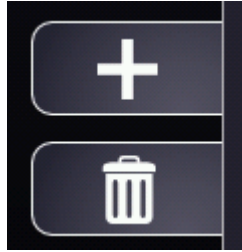
To recall an existing sequence file, press the icon:



to view the list of available files:



The keys:



allow us to add or delete files.

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

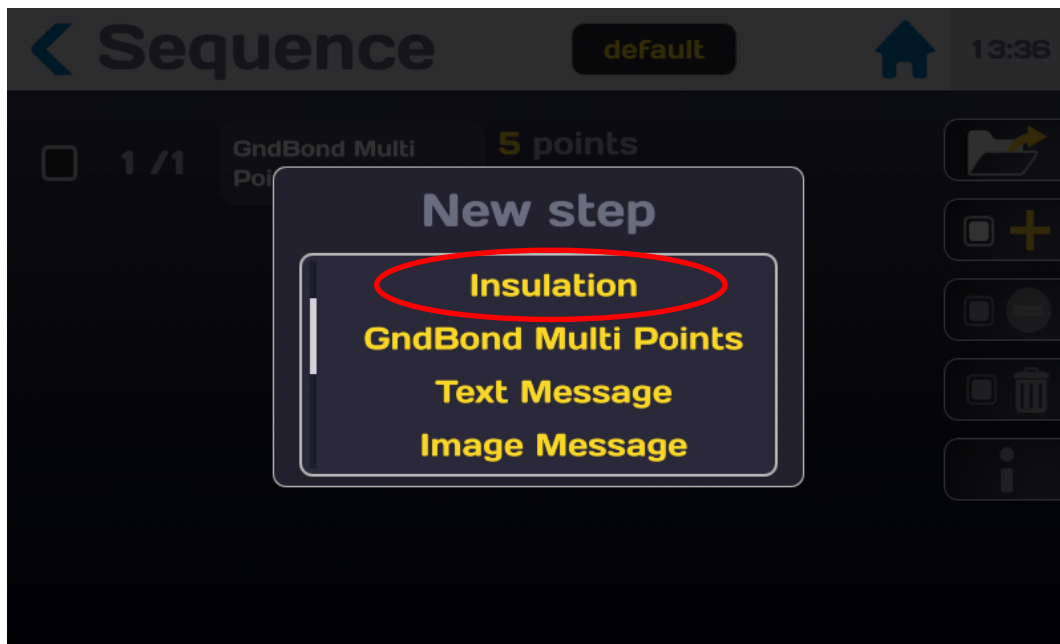


### 15.1.1. MEGOHMMETER STEP AND OTHER MEASUREMENT FUNCTIONS:

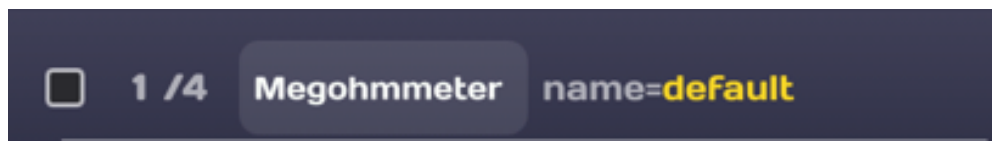
The Megohmmeter step allows us to perform a measurement of the insulation resistance with a chosen setting file. To view the drop-down list of the steps press the icon:



Choose the Megohmmeter function from the list of steps:



It is displayed as follows:



See the general rules of the sequence mode in paragraph 11-1.

Select the settings file required for this test step by pressing the area in yellow. If the file does not exist, create it by going into the Megohmmeter function from the Home menu.

Proceed in the same way for the other measurement functions

### 15.1.2. MULTIPOINT GROUND CONTINUITY STEP:

The multipoint ground continuity function allows us to simply define a step in the sequence mode in which several points need to be tested successively for continuity.

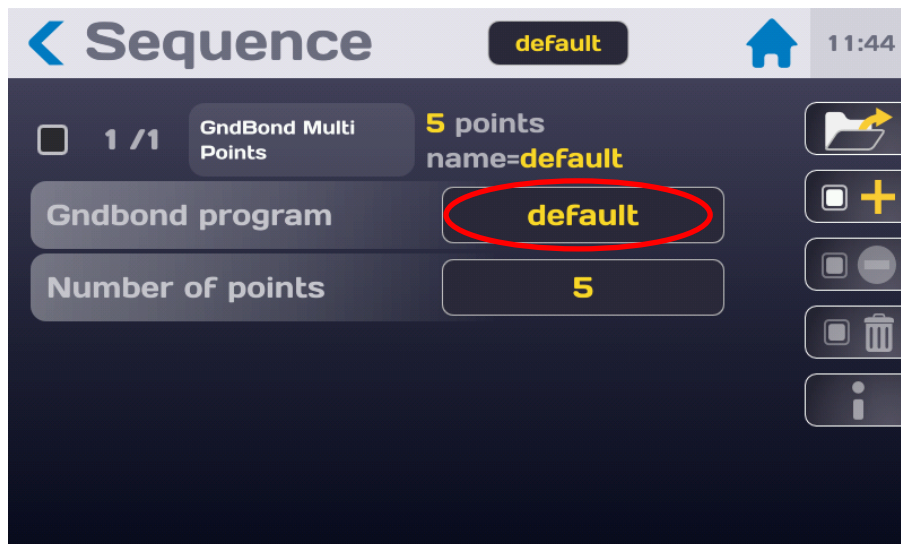
To view the drop-down list of the steps, press the icon:



Choose the multipoint continuity function from the list of steps:



It is displayed as follows:



Choose the name of the continuity programme with the test parameters required by pressing the yellow text. Define the number of continuity points to be tested from 1 to 10,000.

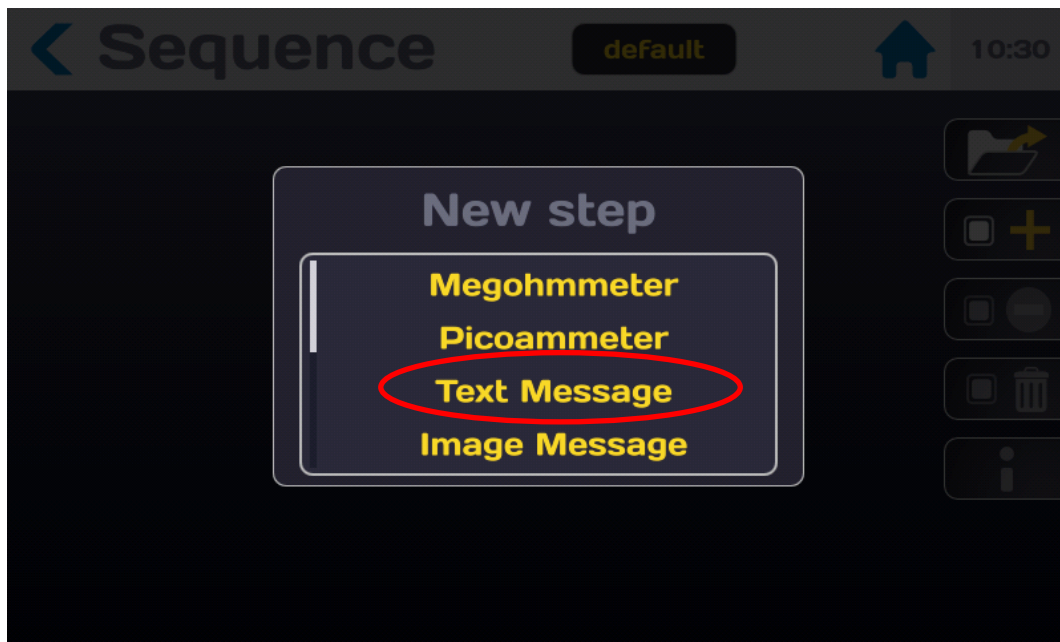
During the execution of this step a message will ask the operator to validate passage to the next point.

### 15.1.3. TEXT MESSAGE STEP:

The **Text Message** step allows you to insert a text message to inform or guide the operator. To view the drop-down list of steps press the icon:



Choose the Text Message function from the list of steps:



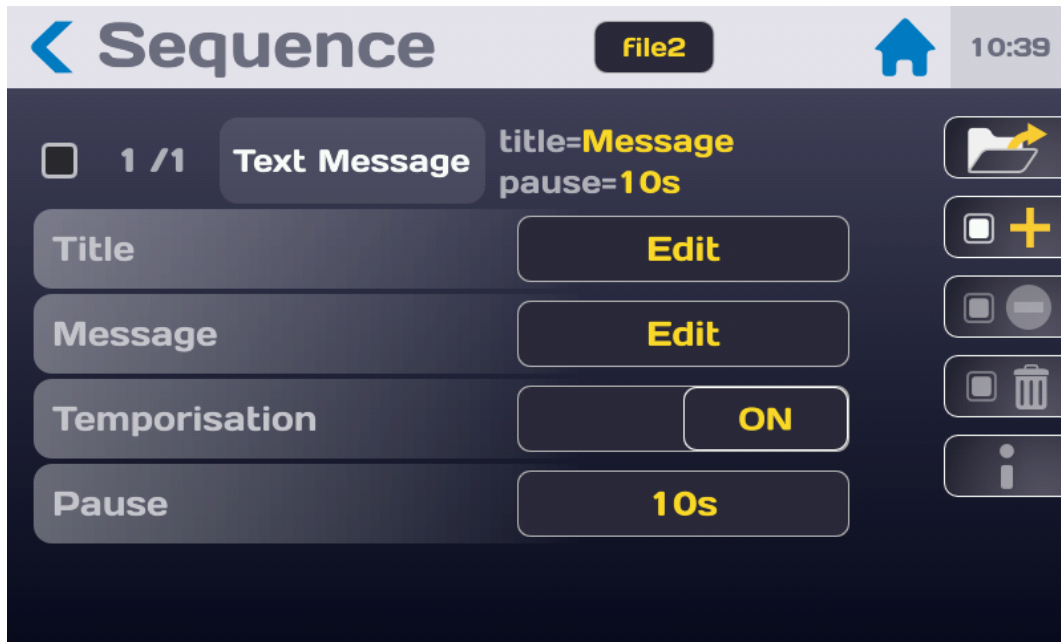
The step is displayed as follows:



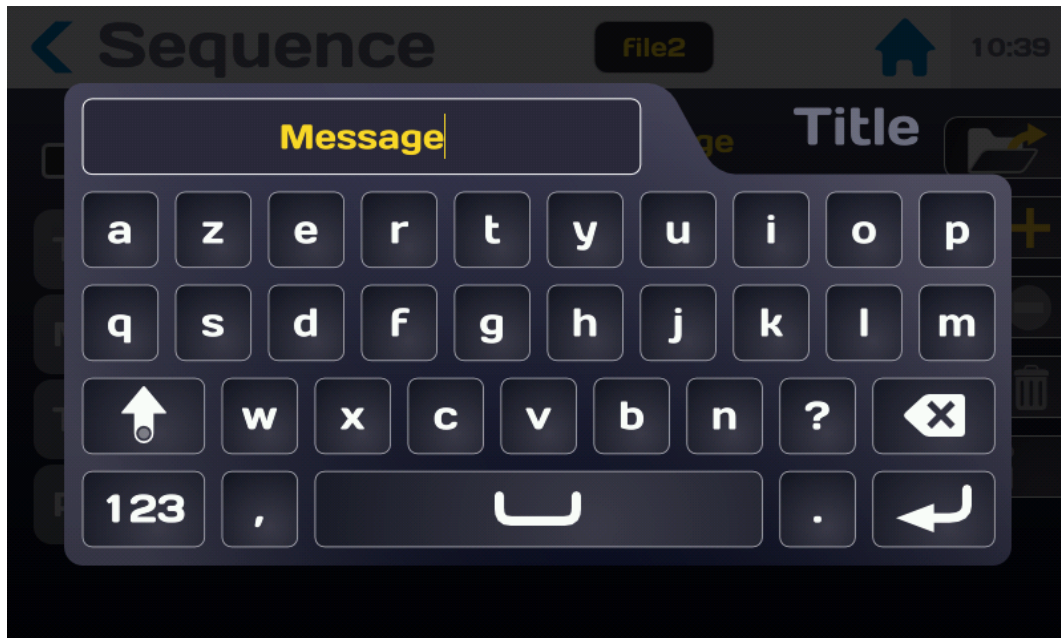
See the general rules of the sequence mode in paragraph 11-1.

Press the Message text zone in yellow; it is possible to enter a text for the title of the message, for the message itself as well as to activate a timer for the display. In the mode without timer (OFF) the message must be acknowledged by the operator pressing OK, in the case of the mode with timer (ON), the message disappears after the specified period of time.





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



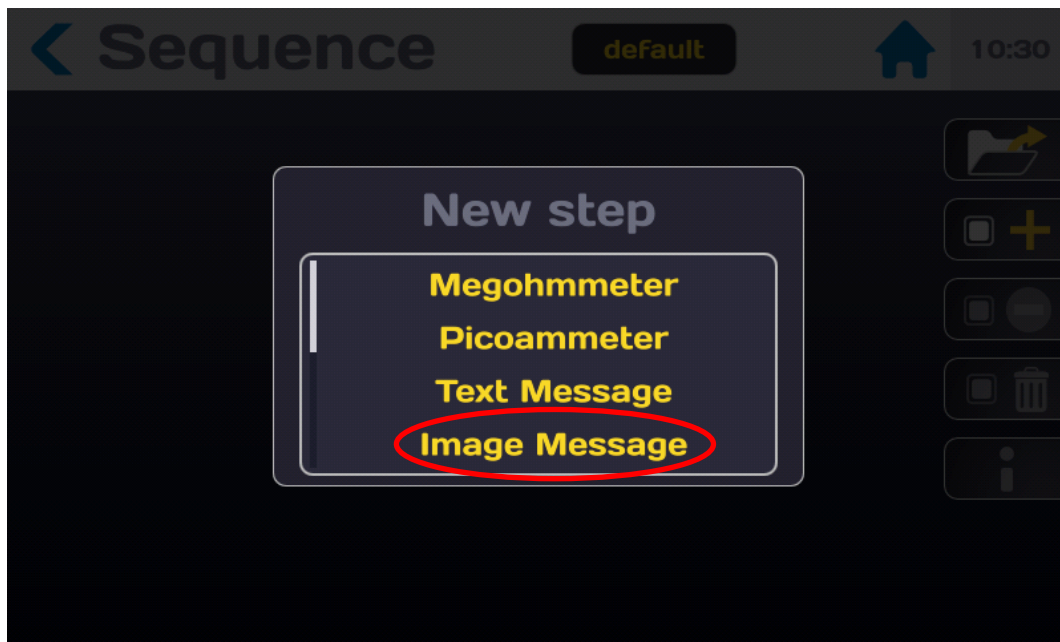
Proceed in the same way for the other message text. It is necessary to enter a text, if not, a sequence error message is displayed.

#### 15.1.4. IMAGE MESSAGE STEP:

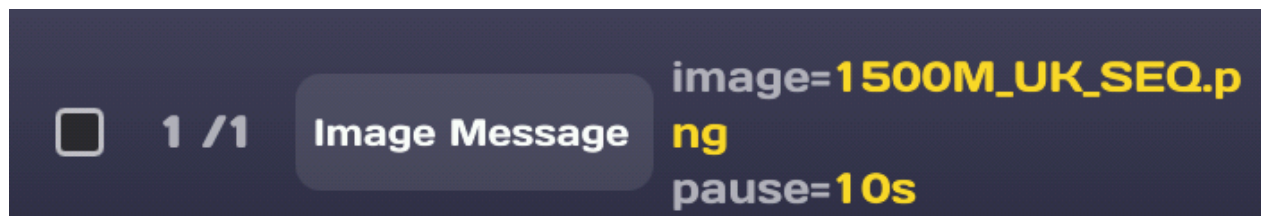
The **Image Message** step allows us to insert an image to inform or guide the operator. To view the drop-down list of the steps press the icon:



Choose the Image Message function from the list of steps:



The step is displayed as follows:



See the general rules of the sequence mode in paragraph 11-1.

Press the Message area in yellow, it is possible to enter a text for the title of the photo. Press Edit the Title to access an input keyboard to give a title to the photo. In the mode without timer (OFF) the photo must be acknowledged by the operator pressing OK, in the case of the mode with timer (ON), the photo disappears after the specified period of time.

On the Image Line Press **Modify** to display the list of images. Scroll through the list of available images and select by pressing on the name of the image.



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

- Copy the image files in the format JPEG or PNG from a PC on a USB key (32Gb max. capacity). We recommend limiting the size of the images to < 1 Mo
- 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 (Home icon)
- Press the key with the floppy disc icon.
- On the USB memory line press "Install"
- Press the Home icon
- Return to the Sequence mode
- Click on the Message zone of the Image Message line
- Image Line press **Modify**
- Press **Add to the Library**
- The list of images on the USB key is displayed in the Image window
- Scroll through the names and select the file by pressing its name
- If the image file already exists, the device proposes to replace it or to cancel the operation



**NOTE**

**Before removing the USB key from the device return to the Home menu (Home icon) and the Floppy menu and eject the USB memory**

#### 15.1.5. PDF MESSAGE STEP:

The **PDF message** step allows you to insert a PDF format file to inform or guide the operator. To view the drop-down list of the steps press the icon:



Choose the PDF Message function from the list of steps:



The step is displayed as follows:



See the general rules of the sequence mode in paragraph 11-1.

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

On the PDF Line Press **Modify** to display the list of files. Scroll through the list of available files and select by pressing on the name of the file.

If there are no PDF file or to import new ones:

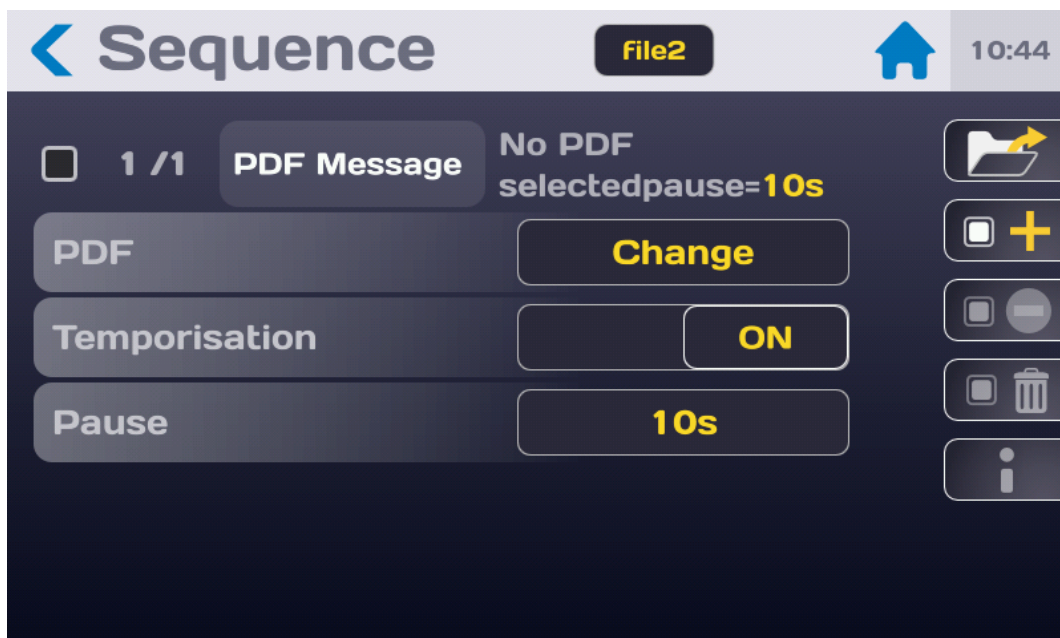
- Copy the files in the PDF format from a PC onto a USB key (32Gb max. capacity).
- Eject the USB key from the PC
- Put the USB key containing the files in one of the USB connectors on the front panel
- Go to the Home Menu (Home icon)
- Press the key with the Floppy icon
- On the USB memory line press **"Install"**
- Press the Home icon
- Return to the Sequence mode
- Click on the message area of the PDF message line
- PDF Line press **Modify**
- press **Add to the Library**
- The list of files available on the USB key is displayed in the PDF window
- Scroll through the names and select the file by pressing its name
- If the PDF file already exists, the device proposes to replace it or to cancel the operation



**Before removing the USB key from the device return to the Home menu (Home icon) and then the Floppy menu and de-install the USB memory**

**NOTE**

In the mode without timer (OFF) the PDF file must be acknowledged by the operator pressing OK. In the case of the mode with timer (ON), the PDF file disappears after the specified period of time.

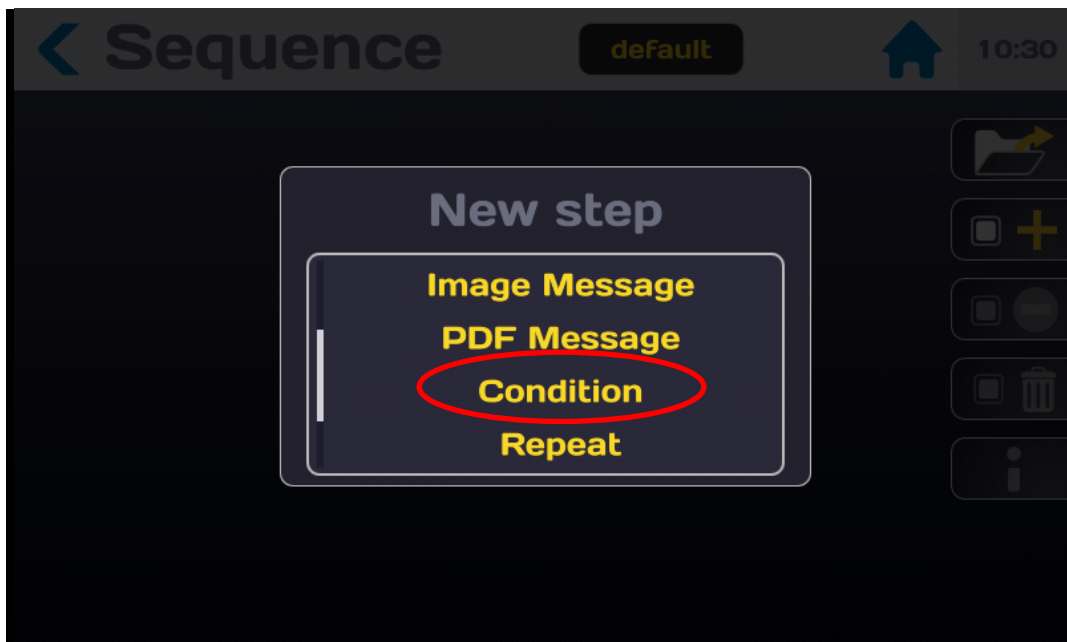


#### 15.1.6. CONDITION STEP:

The **Condition** step allows us to insert a condition in the sequence of steps of a sequence. To view the drop-down list of the steps press the icon:



Choose the Condition function from the list of steps:



The step is displayed as follows:



See the general rules of the sequence mode in paragraph 11-1.



Press the area in yellow to set the condition:

The screenshot shows a 'Sequence' configuration interface. At the top, there is a title bar with a back arrow, the word 'Sequence', a 'File2' button, a home icon, and the time '10:47'. Below the title bar, there is a summary line: 'If test 1 is PASS then goto next else stop sequence'. The main area contains four rows of configuration options:

Field	Value
Step to test	1
Test condition	PASS
Action if true	goto next
Action if false	stop sequence

On the right side of the screen, there is a vertical toolbar with icons for adding, deleting, and viewing sequence elements.

The Condition function requires the following information:

- The number of the step to which the condition applies
  - Enter a step number corresponding to a measurement function. If a step number does not correspond to a measuring function, the result of the step will always be PASS and will enable a non-conditional connection to be made.
- The condition of the selected step
  - Choose the result of the step: PASS, FAIL, Error, FAIL or Error, or not yet tested
- Action to be taken if the condition is realised
  - Choose: Stop sequence (sequence stoppage), goto next (go to the next step), go-to XX (go to step xx)
- Action to be taken if the condition is not realised
  - Choose: Stop sequence (sequence stoppage), goto next (go to the next step), go-to XX (go to step xx)

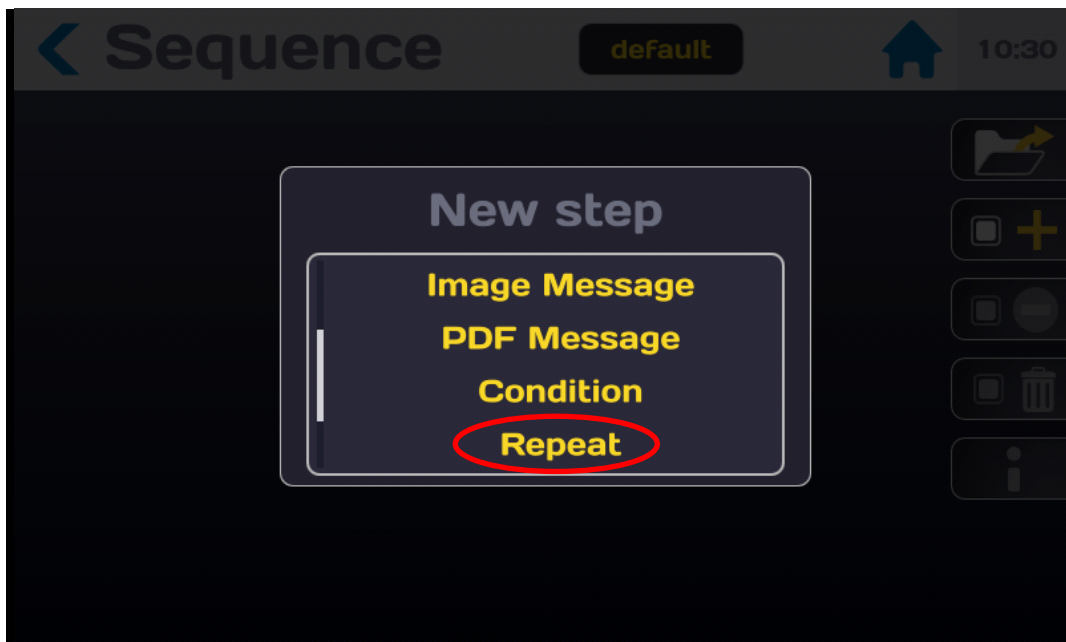


### 15.1.7. REPETITION STEP:

The **Repetition** step allows us to insert an iterative loop in the sequence of steps of a sequence. To view the drop-down list of the steps press the icon:



Choose the Repetition function from the list of steps:



The step is displayed as follows:



See the general rules of the sequence mode in paragraph 11-1.

Repetition requires the following information:

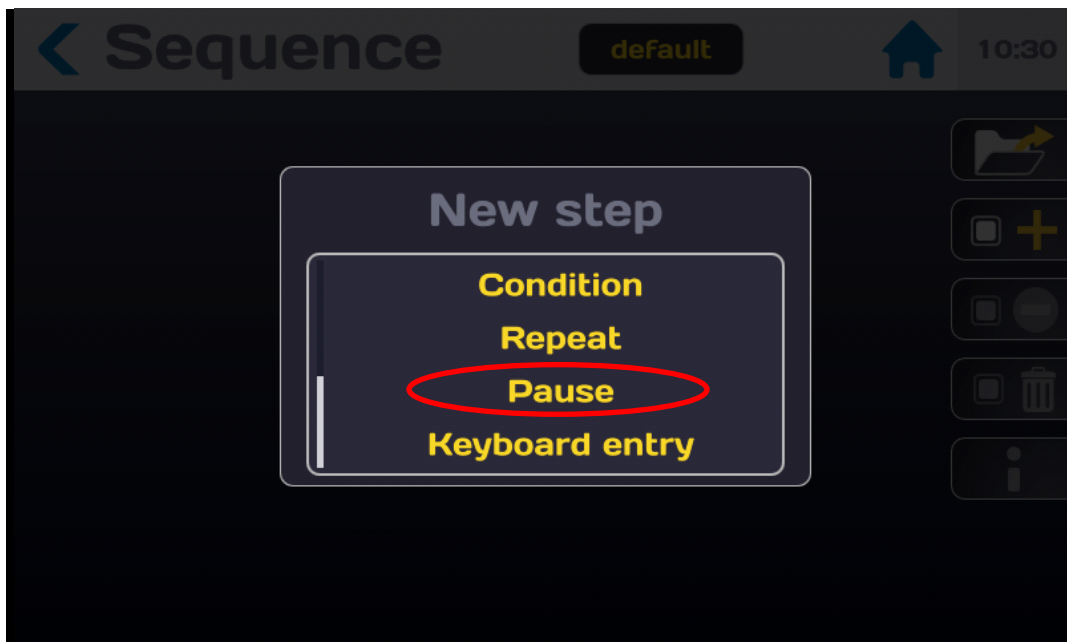
- The number of the step to which the Repetition applies
  - Enter a valid step number
- The number of repetitions
  - Choose the number of occurrences of the repetition

#### 15.1.8. PAUSE STEP:

The **Pause** step allows us to insert a timed pause in the sequence of steps of a sequence. To view the drop-down list of the steps press the icon:



Choose the Pause function in the list of steps:



The step is displayed as follows:



See the general rules of the sequence mode in paragraph 11-1.

Pause requires the following information:

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

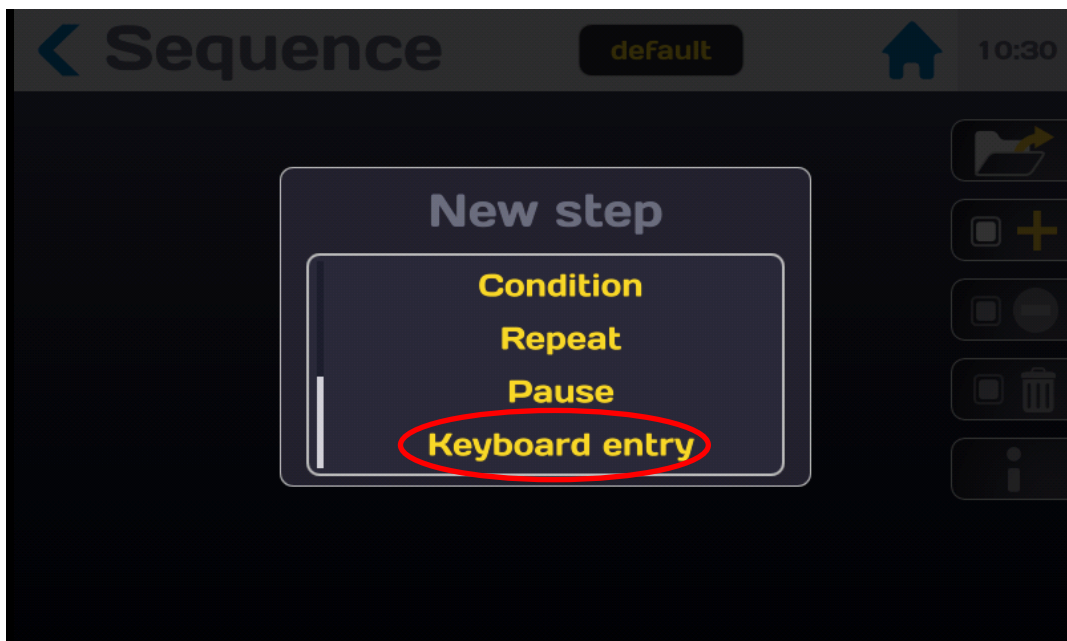
#### 15.1.9. KEYBOARD ENTRY STEP:

The **Keyboard entry** step allows us to insert a data input in the conduct of the different steps of a sequence, for example, the name of an operator or a batch number of parts or any other information. The text entered will be saved in the Result file.

To view the drop-down list of the steps press the icon:



Choose the **Keyboard entry** function in the list of steps:



The step is displayed as follows:



See the general rules of the sequence mode in paragraph 11-1.

It is possible to give a title to the keyboard entry

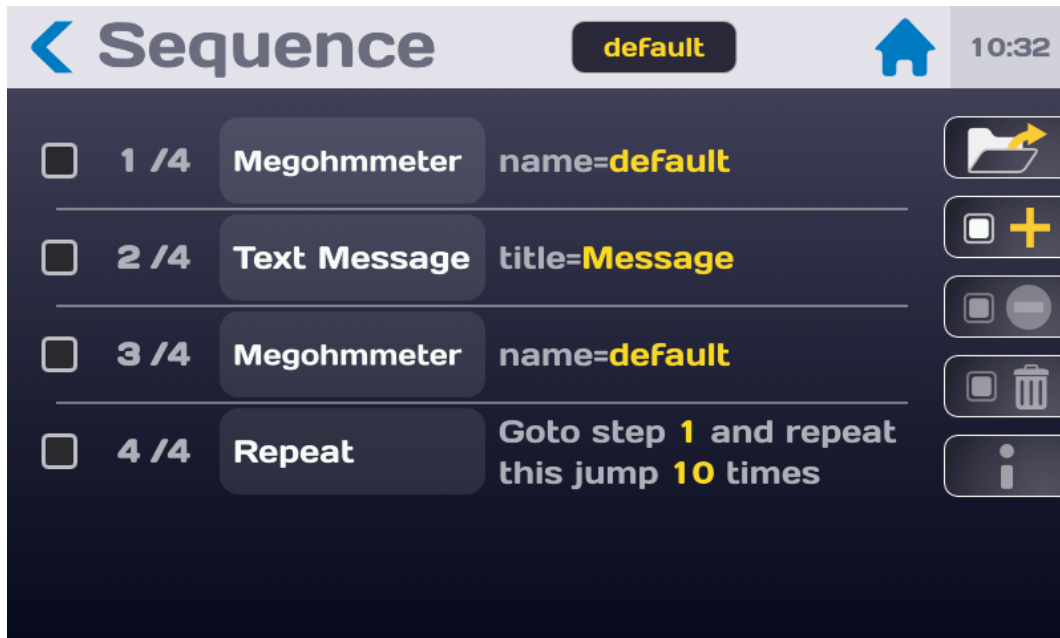
- Press the area in yellow of the keyboard input line
- Press the **Edit title** area
- A keyboard is displayed
- Enter the title of the keyboard entry, for example the **Name of the operator**:

During the course of the sequence at the **keyboard entry** step, the entry keyboard will be displayed with the entry title allowing the operator to enter the data requested.

## 15.2. EXECUTION OF A SEQUENCE

Either a "default" sequence name calling a Megohmmeter function with a set of settings called "default" settings followed by a text message and a call to a Megohmmeter function with a set of settings called "default" settings and a looping of 10 times.

This corresponds to the following sequence:



When the Start button on the front of the device is illuminated in green, it is possible to start the sequence

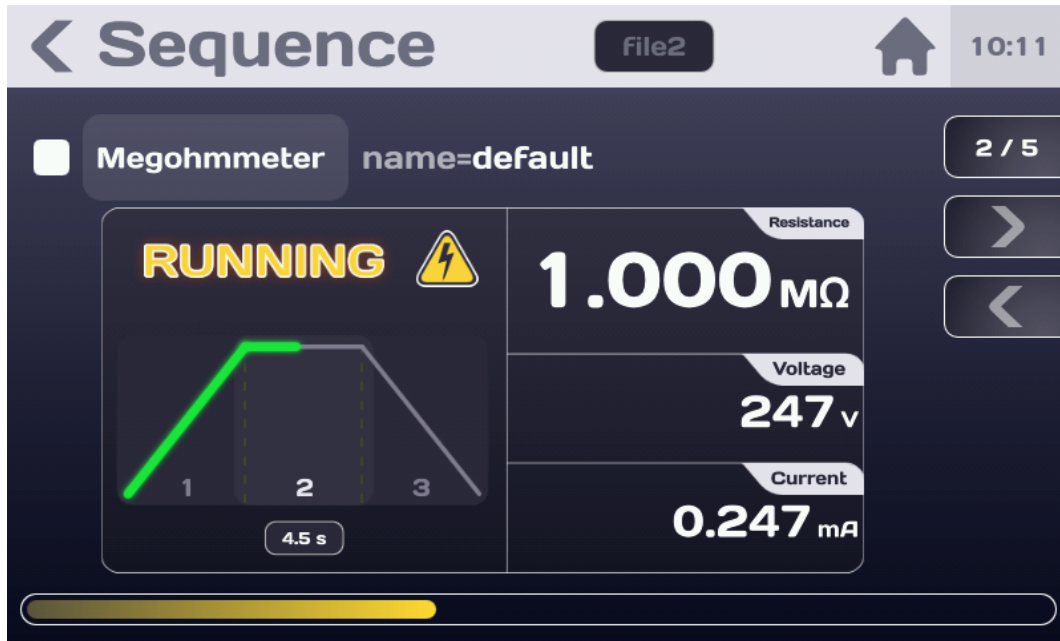


**NOTE**

Press the Start push button. For safety reasons, it is necessary to press the button for > 1 second for the device to switch into measurement mode. If the button is pressed for too short a time a message will be displayed momentarily on the LCD screen.



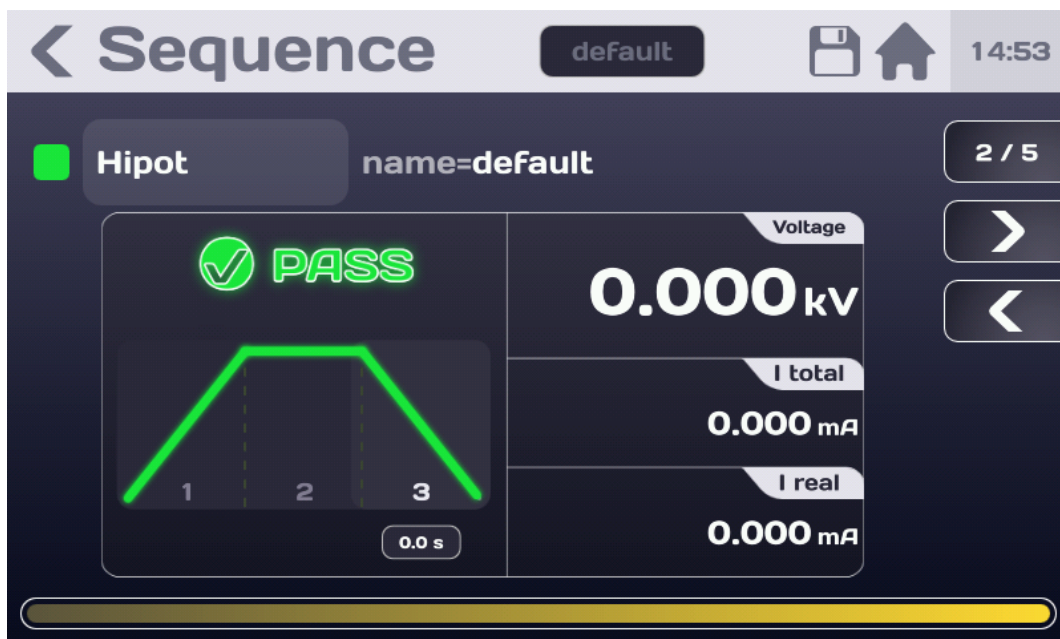
The first step of the sequence will run while displaying a measurement screen in the Megohmmeter mode:



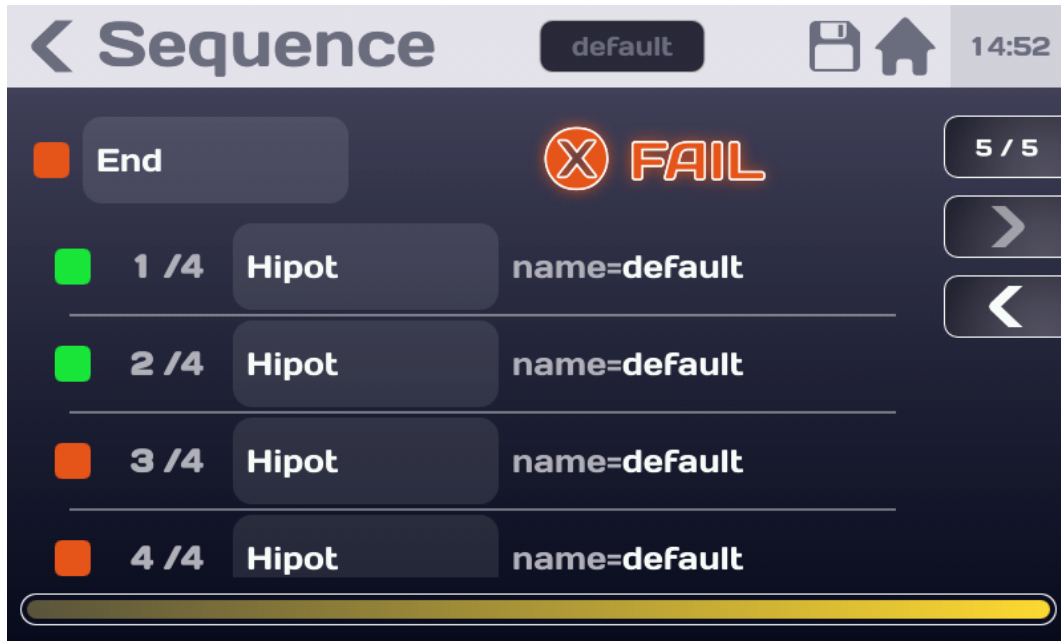
The yellow progress bar at the bottom of the screen indicates the relative position of the step in the sequence.

At the end of the measurement, the next step displays a text message

Then the sequence passes to the second measurement in the Megohmmeter mode:



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

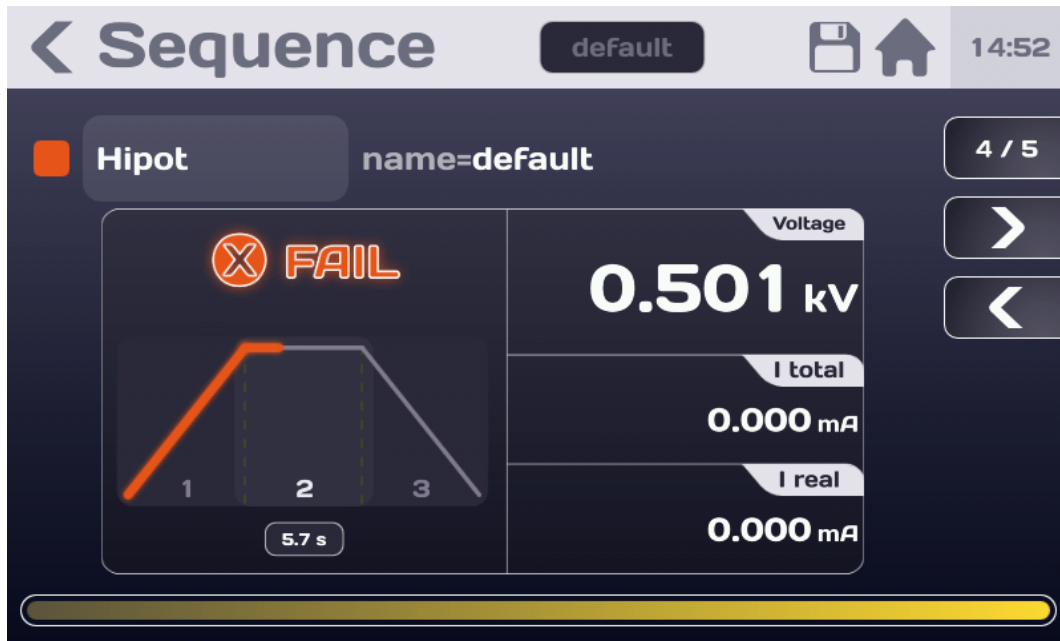


In this example, the result of the sequence is FAIL because of the measurement step 3/4 and 4/4 in the Hipot mode with the "default" settings file.

It is possible to review the screens of the different stages with the browse keys:

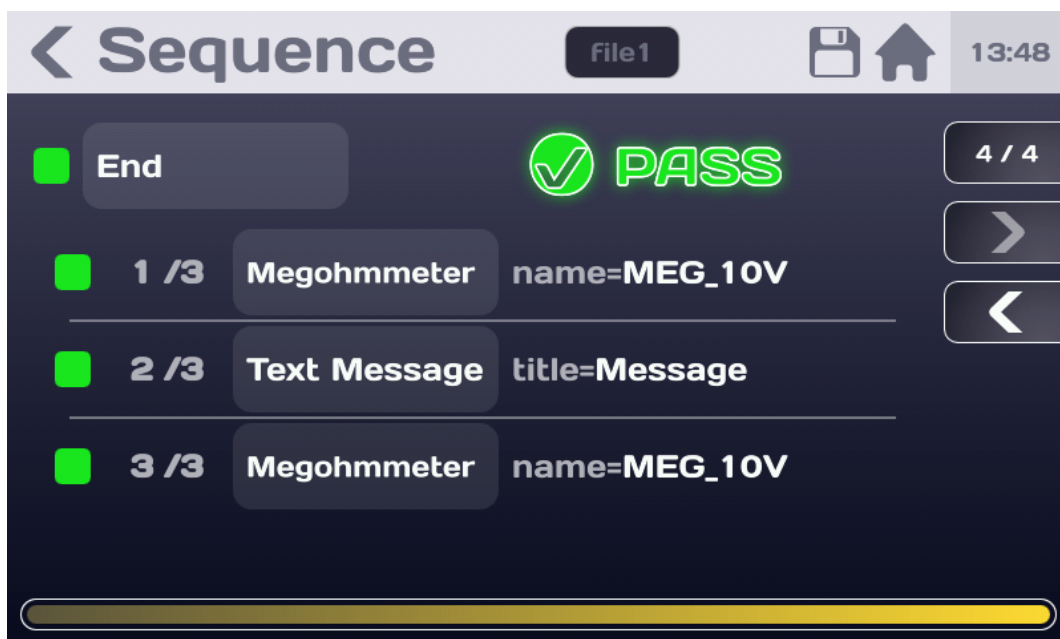


Press the arrow key to the left to view the screen of the last step:



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

Case of a PASS sequence result:



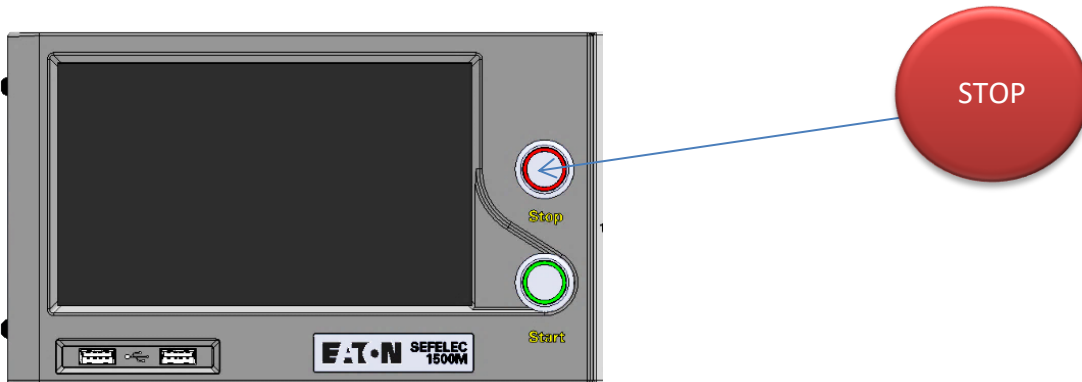


To finish the sequence completely, press the Stop button illuminated in red



**IMPORTANT**

**Before disconnecting the measured component, press the Stop button to confirm the stoppage of the high voltage generation and discharge the component:**



This action returns us to the initial Sequence screen either to change the settings or to perform a new sequence of measurement by pressing the START button.

## 16. ACCESSORIES WITH REMOTE CONTROL OPERATION

There are three types of accessories with remote control and dedicated connector:

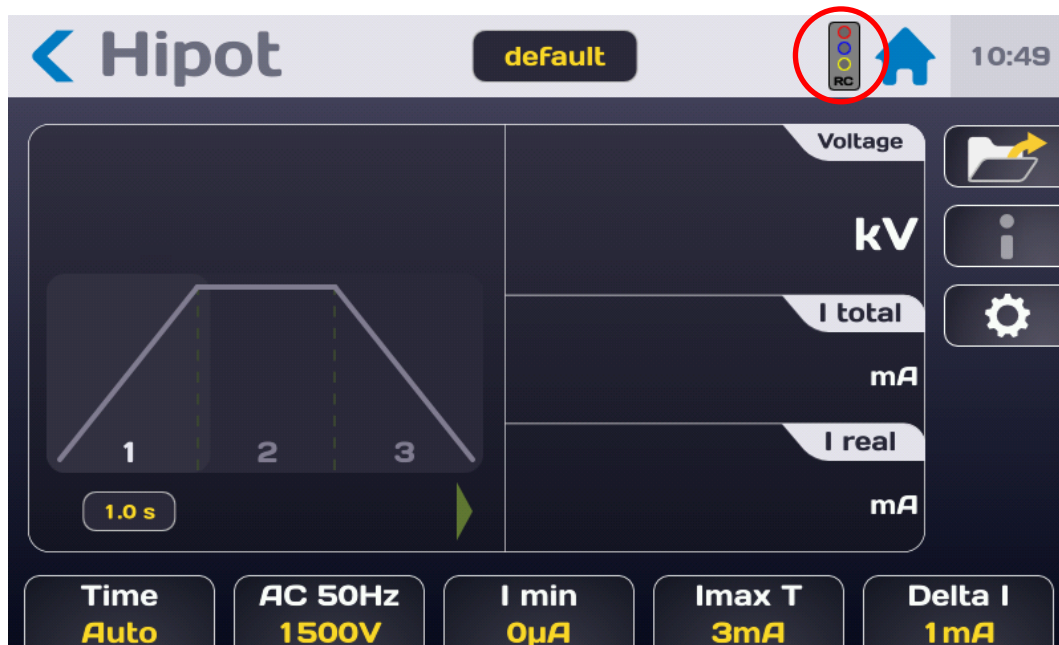
- The HV remote control (SEFA-TE58-xx or SEFA-PI001-xxxx), which allows you to launch high voltage tests such as insulation and dielectric strength, it is red
- The HC remote control (SEFA-TE81-xxxx), which is used to launch high current tests in ground continuity, it is blue
- The Auxiliary remote control (SEFA-AO10 or SEFA-AO11), which allows any test to be launched and which is yellow

Accessories with remote control must be associated with the optional remote control module SEFO-5XRC below:



Each connector is associated with a single remote control and is not interchangeable. The color code as well as polarizers make it possible to distinguish them.

Detection of remote controls by the HMI is automatic and is manifested by the appearance of the icon below:



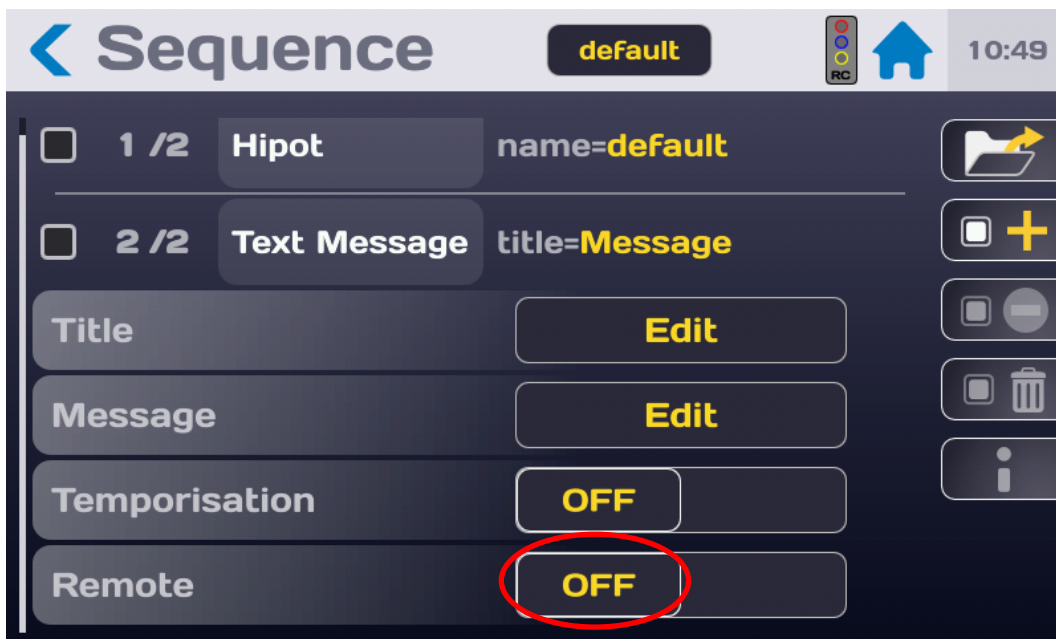
## 16.1. REMOTE CONTROL IN FUNCTION MODE

The remote controls allow you to launch the tests like the START button.  
To launch a test, press the button on the remote control associated with the test for one second and keep the button pressed throughout the test.  
Releasing the button causes the test to stop.

When taking remote control of the device via interface (RS232, Ethernet,...), the remote controls do not allow a test to be launched without first sending a "MEAS" command.

## 16.2. REMOTE CONTROL IN SEQUENCE MODE

It is possible to perform sequences using the remote controls.  
If a remote control is connected, it is possible to start the sequence by pressing the remote control button for one second.  
In remote control mode, the tests of the sequence are not linked automatically, but a pop-up indicates on the screen that to launch the following test, the use of the remote control is required.  
As for launching a normal test, pressing for one second and holding it down until the end of the test allows you to perform the test and go to the next step in the sequence.  
Sequence steps such as messages, pdf or images can be configured to be validated by a short press on the remote control button during sequences.  
Remote mode ON



### 16.3. REMOTE CONTROL IN MULTI-POINT CONTINUITY

Multipoint Continuity offers a series of continuity tests.

With a remote control these tests are not linked automatically.

To start the next point during a multipoint continuity a short press on the HC or Aux remote control button is necessary.

The LEDs present on the remote control make it possible to follow the progress: the green LED lights up at the start of the continuity point and flashes in green or red once the point is finished depending on whether the point is GOOD or BAD.

### 16.4. EXAMPLE OF ACCESSORY WITH REMOTE CONTROL

SEFA-TE58-xx accessory for dielectric strength tests and insulation measurements.

The plug with the red color code must be connected to the red socket (HV / MΩ) of the remote control module

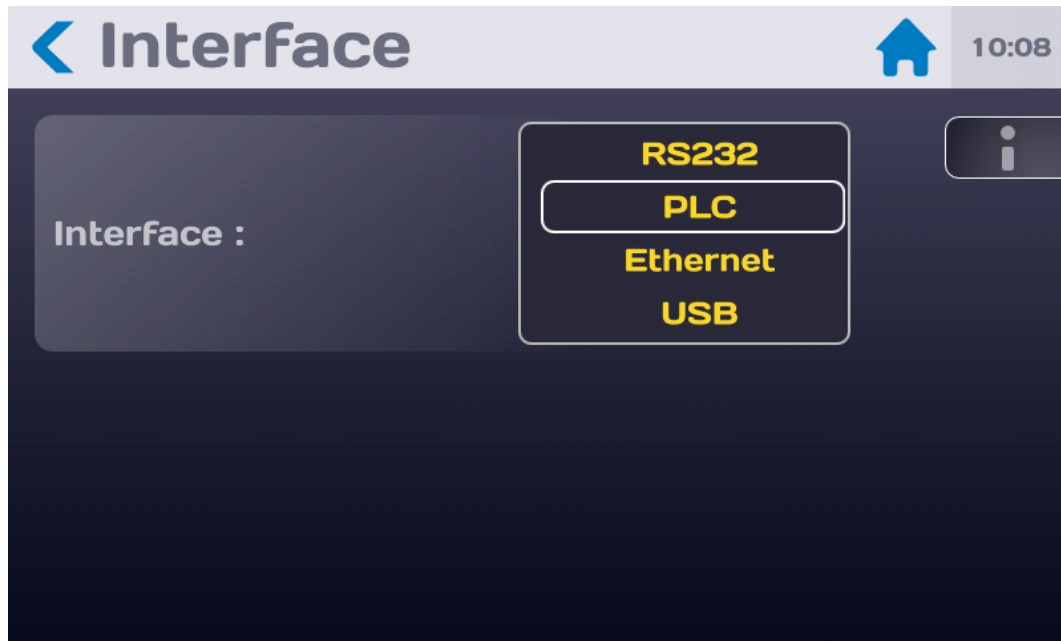


## 17. PLC INTERFACE (PROGRAMMABLE LOGIC CONTROLLER)



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

**Note:**



The role of the **PLC** interface is to allow control of the measurement instrument by a system such as an industrial PLC.



**IMPORTANT**

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

## 17.1. ELECTRICAL CHARACTERISTICS OF THE SIGNALS

### INPUTS:

- Number: 11
- Type: Optoelectronic
- Input resistance 2.2 k $\Omega$
- U minimum: 11 VDC
- U maximum: 43 VDC

### OUTPUTS

- Number: 9
- Type: Photo-electric relay
- Maximum voltage: 48 VDC
- Maximum current / output: 100 mADC
- Resistance in the closed state < 1.2 $\Omega$



**WARNING**

The 5x series input/output operate only with **DC voltage**.

## 17.2. CONVENTIONS ON THE DIFFERENT LOGICAL STATES

### ON INPUT

The high logic state is defined by the presence of a DC voltage between Umin and Umax.  
The low logic state is defined by an absence of voltage.

### ON OUTPUT

The high logic state is defined by a closed contact.  
The low logic state is defined by an open contact.

### 17.3. CONNECTIONS

The input-output signals are accessible on the rear face of the device on terminals C6, C7 and C8



**Every terminal has a mechanical coding**

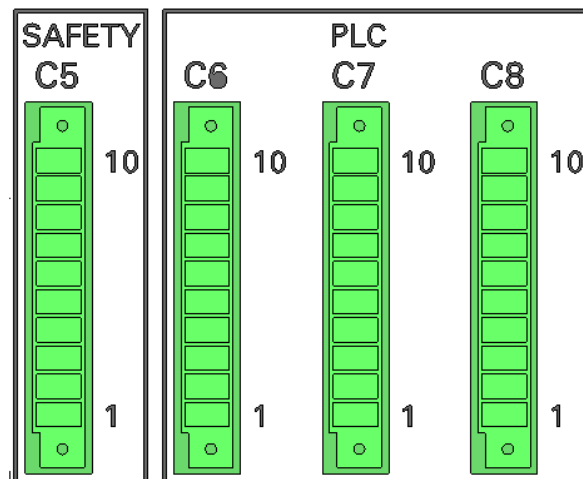
**Note:**

Connector C6			Connector C7			Connector C8		
1	IN_OUT_0-10V_0 <sup>(3)</sup>		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 <sup>(1)</sup>		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 <sup>(2)</sup>	

(1) Unregulated internal 24VDC power supply protected by a resettable PTC fuse, maximum current 1 A

(2) NC = Not Connected

(3) The analog I/O (in red in the above board) are not currently operating





## 17.4. DEFINITION OF INPUT-OUTPUT SIGNALS

### COMIN (C6-5)

Electrical common line for the input signals.

### COMOUT (C7-4)

Electrical common line for the output signals.

### CTRLIN (input C6-6)

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

### MES\_DCH (input C7-2)

Switching to measurement or discharge.

- In the high logic state: Measurement.
- In the low logic state: Discharge.

### TYPE (input C7-1)

This input corresponds to the previous choice of the measurement function of the XS range, with the SEFELEC 5x range:

- At the low logic state: offsets the memory numbers of 256 positions (256-512)
- At the high logic state: does not offset the memory numbers. (0-255)

### N0, N1, N2, N3 (inputs C6: 7,8,9,10)

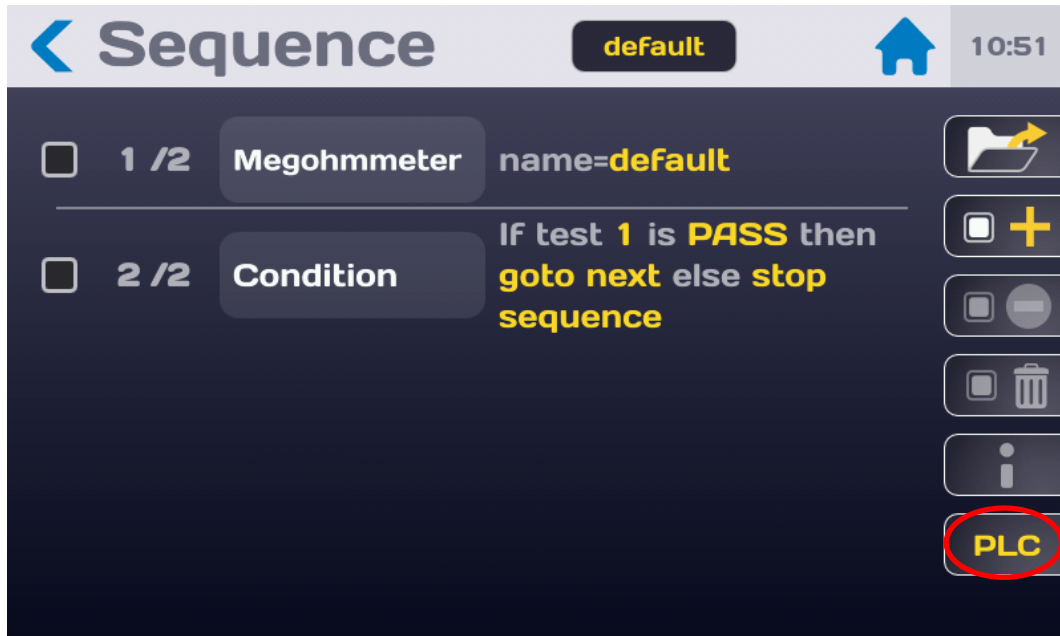
### N4, N5, N6, N7 (inputs C8: 1,2,3,4)

Binary encoding enabling the user to select a memory number (0 to 255) and an associated settings sequence file. See also **TYPE** input

N7	N6	N5	N4	N3	N2	N1	N0	Memory	File name
0	0	0	0	0	0	0	0	0	Name1
0	0	0	0	0	0	0	1	1	Name2
0	0	0	0	0	0	1	0	2	Name3
0	0	0	0	0	0	1	1	3	Name4
0	0	0	0	0	1	0	0	4	Name5
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	Name256

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

To make the correspondence between the memory numbers and the Sequence file names, go to the sequence menu (see 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:

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

Display the memory number by swiping the screen toward the top or pressing the vertical scroll bar on the left of the screen. On the line of the selected memory number, press the area in yellow (File Name) to view the list of names of available Sequence files. Choose the file by pressing its name. It is now associated with the memory number.

### **CTRLOUT (Output C7-5)**

Validation contact for the taking of 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 whether an error occurred during the test; outputs SR0 to SR3 give the type of error

### **SR0 to SR3 (Inputs C8-5,6,7,8)**

Coding of the type of error according to the following table:

SR3	SR2	SR1	SR0	Type of error
0	0	0	0	Open Safety loop
0	0	0	1	Saturation
0	0	1	0	Over range
0	0	1	1	Charge
0	1	0	0	Voltage error
-	-	-	-	...
1	1	1	1	....

### **IN\_OUT\_0-10V\_0 (Output C6-1)**

Analogue output 0-10VDC, configurable. **Not operating**

### **IN\_OUT\_0-10V\_1 (Output C6-2)**

Analogue output 0-10VDC, configurable. **Not operating**

### **IN\_0-10V\_2 (Input C8-9)**

Analogue input 0-10VDC, configurable. **Not operating**

### **IN\_0-10V\_3 (Input C7-3)**

Analogue input 0-10VDC, configurable. **Not operating**



**ATTENTION**

**Analog I/O are not operating**

## 17.5. MEASUREMENT-DISCHARGE CYCLE



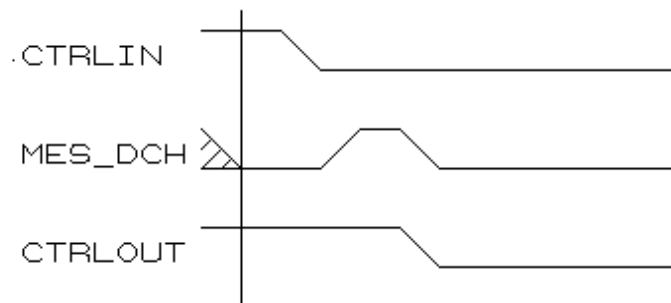
**The PLC (Programmable Logic Controller) function must be selected in the configuration menu (Interface: PLC).**

**Note:**

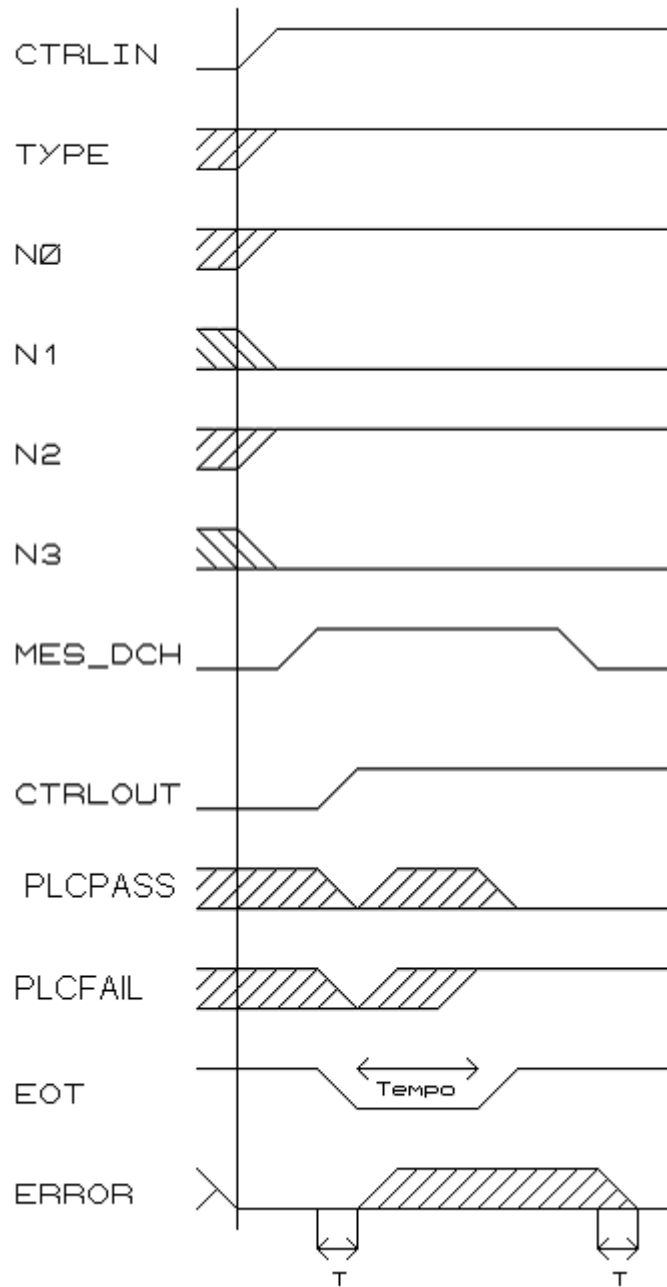
To make a measurement (*see diagram no. 2*)

- Activate the **CTRLIN** signal (High Logic state).
- The PLC must specify the memory range (0-255 or 256-512) on the **TYPE** input.
- The PLC must choose a setting number that will be encoded in binary on inputs **N0** to **N7**, **N0** being the least significant bit and **N7** being the most significant bit.
- Put the signal **MES\_DCH** at the high logic state to start the measurement. Note: The status of the inputs **CTRLIN**, **TYPE**, **N0** to **N7** are only taken into account on a rising edge of the **MES\_DCH** signal. This signal must be in the high state during the measurement.
- As soon as the first measurement is done, the device sends a **CTRLOUT** signal which remains stable until the validation (by a rising edge of the signal **MES\_DCH**) of the setting to the low state of the **CTRLIN** signal. Other signals may appear depending on the progress of the test: an error signal (**ERROR**), an end of test (**EOT**) signal, and a signal indicating if the test is PASS or FAIL (**PLCPASS** or **PLCFAIL**). All these signals are active at the high logic state.

To switch to discharge, put the signal **MES\_DCH** at a low level. To restore the local control to the device, eliminate the high state on the **CTRLIN** signal, enable a high state on **MES\_DCH**, and disable it (see diagram no. 1).

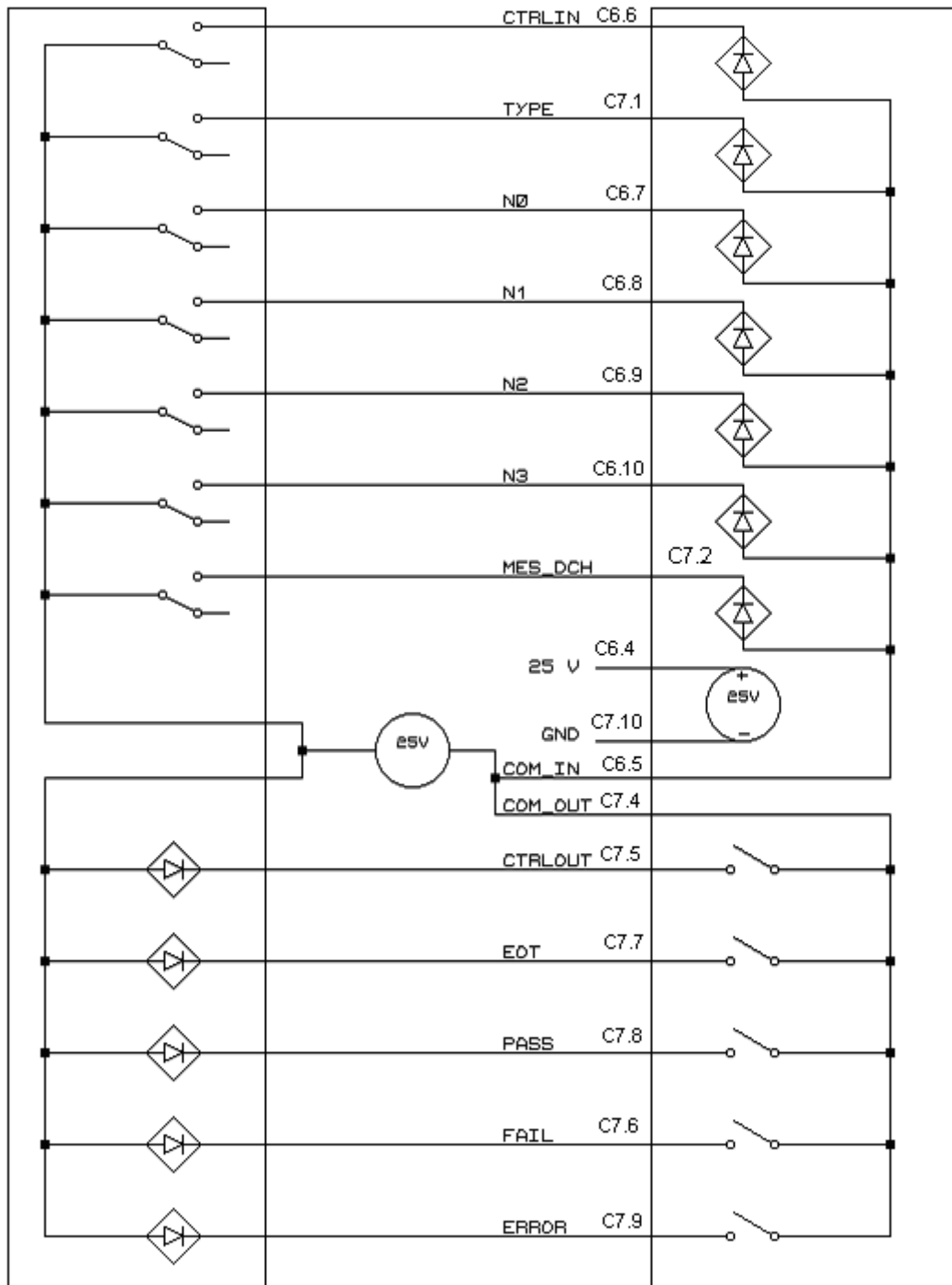


**Diagram No 1: Disabling of the CTRLOUT signal**



**Diagram No. 2: Launch of an insulation test**

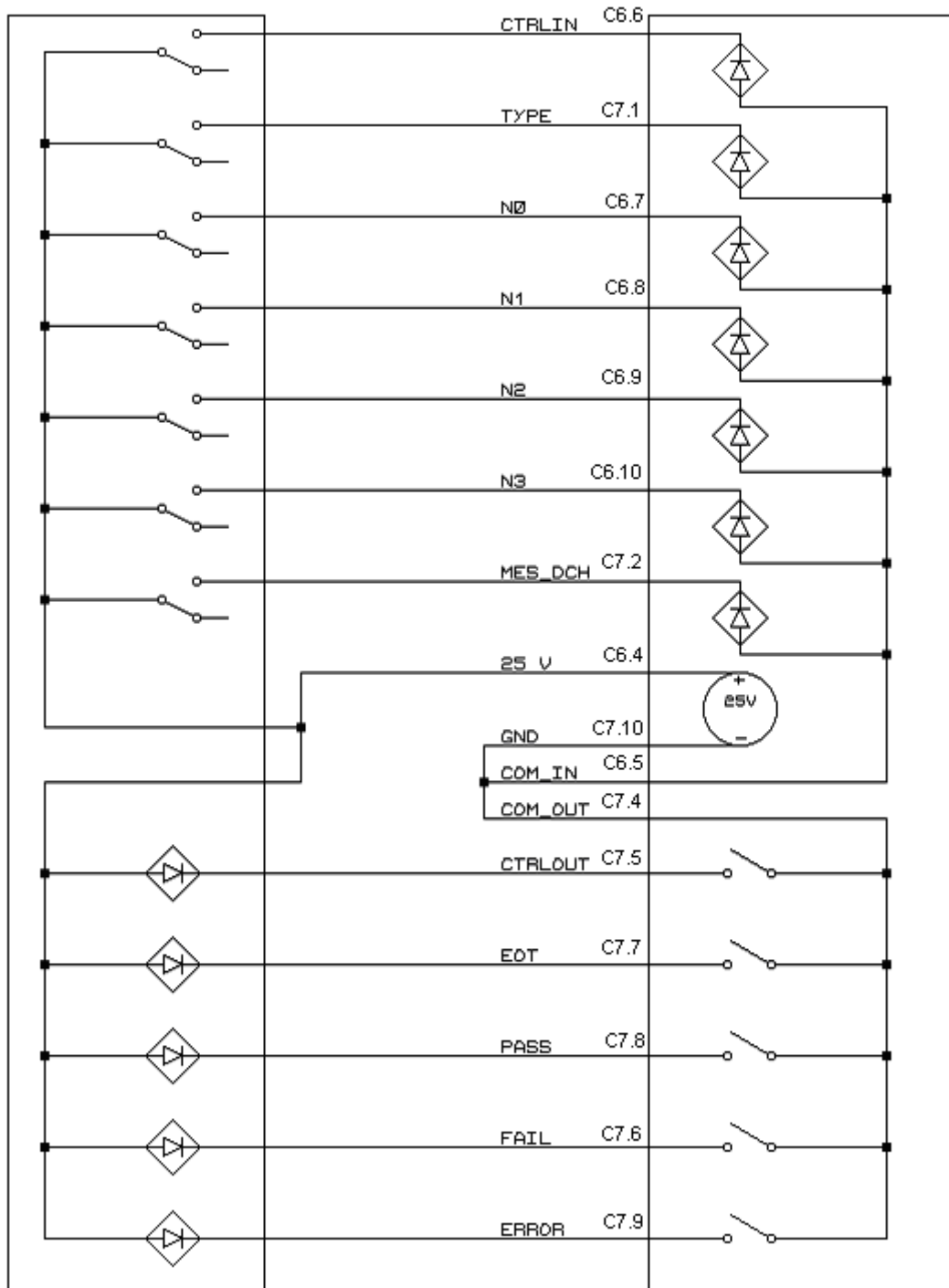
**Memory 5 - Test result NG.**



**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 to the measuring device.**

### 17.6. PLC AND RS232 TALKER MODE

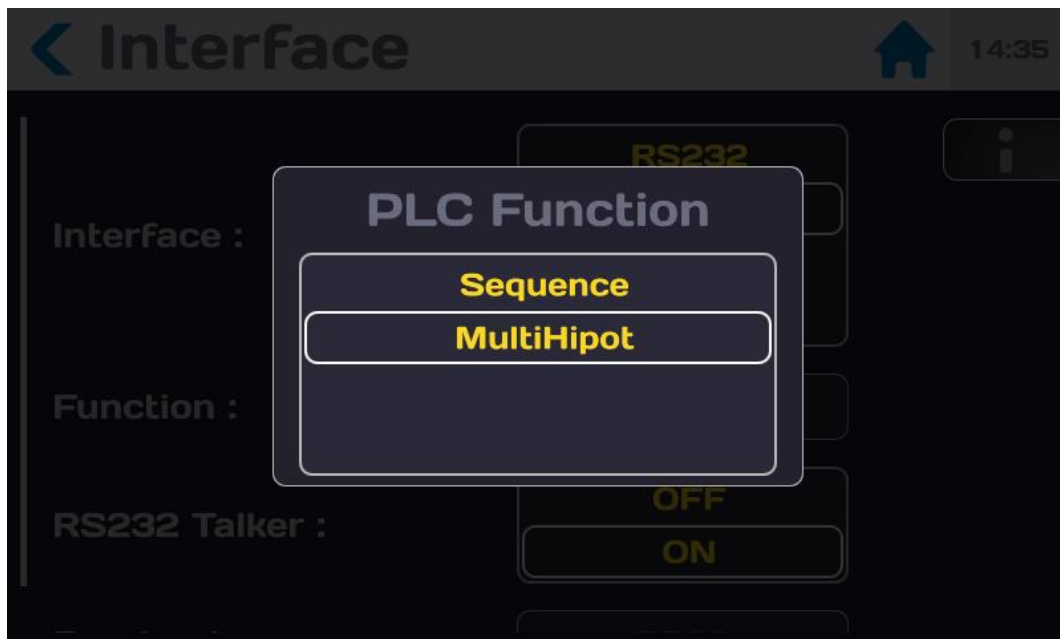


The PLC interface proposes to activate the RS232 Talker only mode which allows at the end of a sequence to return the measurement results to the RS232 interface. To activate the RS232 Talker only mode, select the PLC mode and select ON in the active zone of the RS232 Talker line.

Choose the appropriate baud/rate for your RS232 interface.



Select the operating mode: SEQUENCE or MULTIHIPOT



At the end of each step (in Sequence) or at the end of each test (Multi-Hipot) the RS232 connected computer receives the measurements taken during the test.

At the end of the Sequence or at the end of a Multi-Hipot test in PLC, the STB register is received.

PLC, setup in Sequence, 5X:

```
08/06/2021 10:05:51 L1/3 HIP:VOLT 0.00E+00 AMP 3.1E-05 AMPR 3.0E-05<CR>
08/06/2021 10:05:56 L2/3 GND:AMP 0.0E+00 OHM 1.0000E+00 VOLT 6.459E+00<CR>
08/06/2021 10:06:02 L3/3 MEG:VOLT 5.0E+02 OHM 9.987858E+10 AMP 5.000000E-09
#H41<CR>
```

PLC, setup in Multi-Hipot 5X:

```
22/06/2021 11:43:16 HIPM:VOLT 0.00E+00 AMP 1.7E-04 AMPR
#H43<CR>
```

## 18. IEEE488-2 (OPTION SEFO-IEEE488) INTERFACE



### NOTE

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



SEFELEC test and measurement instruments can be equipped as an option SEFO-IEEE488 with an IEEE-488 interface. 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.

The interface is accessible through a connector on the rear panel of the device. We recommend using National Instrument IEEE488-2 boards.



### IMPORTANT

**The implementation of the safety loop is essential. The control of the device and therefore the generation of a dangerous voltage by IEEE488-2 can be done from a point where visual inspection of the device is not possible.**

## 18.1. SYNTAX RULES

A command destined for the device should preferably end by the character:

LF (hexadecimal 0A, decimal 10).

The codes can be sent in upper case or lower case.

The maximum number of characters in the same block must not exceed 100.

Take care not to associate normalized orders or queries with other types of commands.

Events occurring during the measurement can be reported to the computer by the issuance of an SRQ (error format, end of test, safety loop open, etc.). To activate this function it is necessary to send the SRQ code after initialization of the device. During the occurrence of such an event, it is necessary to examine the internal registers of the IEEE488 controller (STB, SRE, etc.) to find out more precisely the reasons for the event.

In the case of incorrect syntax, the DIALOGUE ERROR 1 message is displayed.

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

## 18.2. IEEE-488-1 FUNCTIONS SUPPORTED

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

## 18.3. LIST OF IEEE488 COMMANDS

The syntax of the commands sent on the [IEEE-488](#) connection has been made consistent with the [IEEE488-2](#) standard (1992 revision).

Reminders of the digital formats according to the [IEEE488-2](#) standard.

NR1 format: +/-<digit>...<digit>

NR2 format: +/-<digit>...<digit>.<digit>...<digit>

NR3 format: +/-<digit>...<digit>.<digit>...<digit>E+/-<digit>...<digit>

Note: The codes in brackets are the expanded codes that can be interpreted by the device.

The command set the of the [IEEE488](#) option is the same as that of the RS232 interface. It is described in detail in the [RS-232C interface](#) paragraph.

## 19. ETHERNET INTERFACE



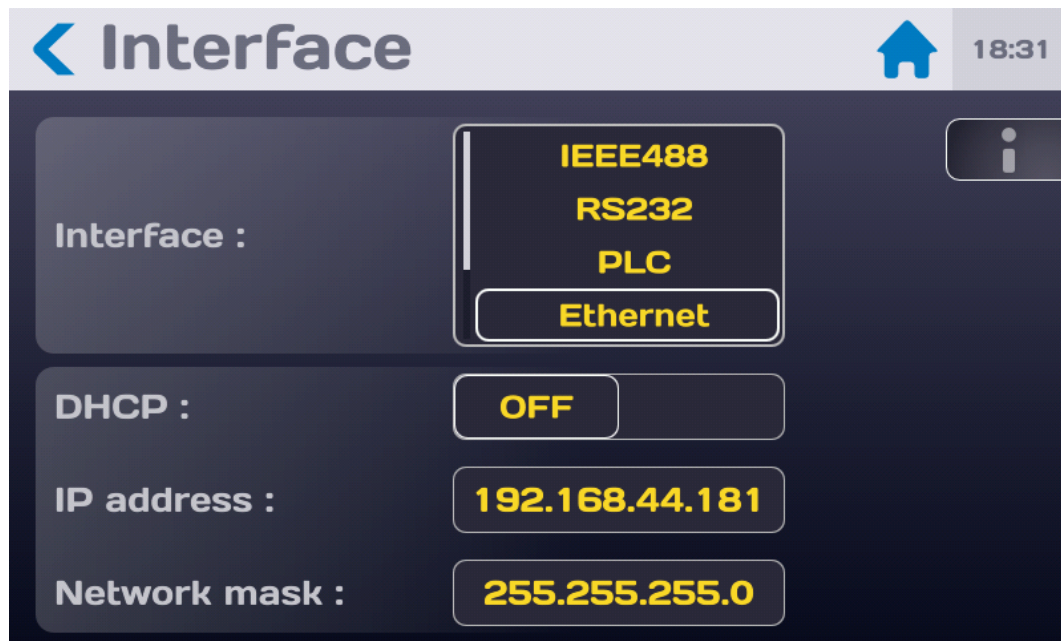
**IMPORTANT**

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



**Note:**

**IMPORTANT:** The ETHERNET function must be selected in the configuration menu, on the Interface line: ETHERNET.



SEFELEC 5x range test and measurement instruments can be fitted with an Ethernet interface. 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.

The interface is accessible via an RJ45 connector on the rear of the device.



**IMPORTANT**

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

## 19.1. CYBER SECURITY RECOMMENDATIONS

SEFELEC 5x range 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.

### 19.1.1. 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.

### 19.1.2. 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.

### 19.1.3. 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.

---

#### 19.1.4. 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.

---

#### 19.1.5. 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.

---

#### 19.1.6. 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

---

#### 19.1.7. 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

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#### 19.1.8. MALWARE DEFENCES:

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

---

#### 19.1.9. 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

#### 19.1.10. BUSINESS CONTINUITY/ CYBERSECURITY DISASTER RECOVERY:

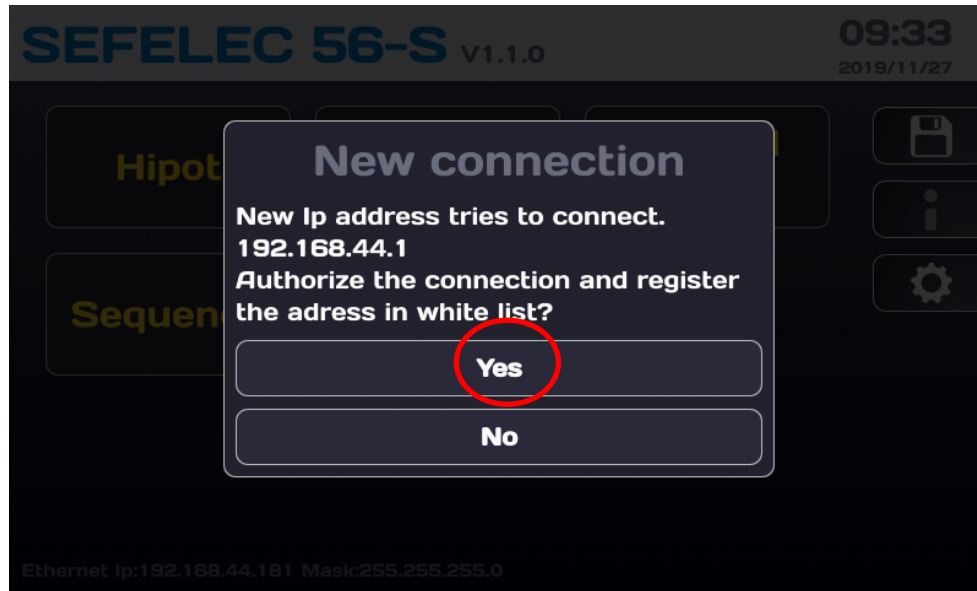
##### Plan for Business Continuity / Cybersecurity Disaster Recovery

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.

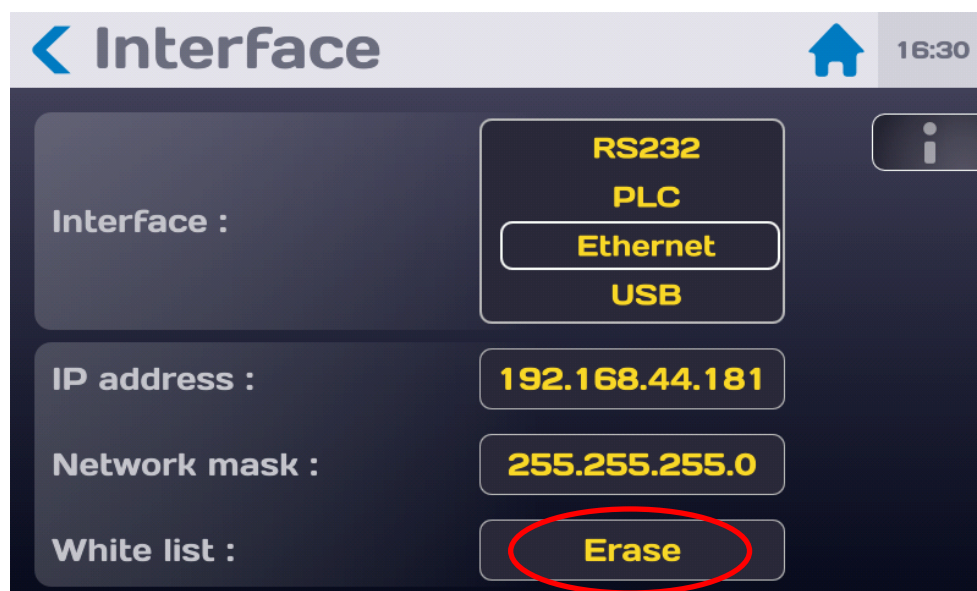
## 19.2. FIRST TIME CONNECTION - WHITELIST

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 (Whitelist), if not press NO. Then repeat a connection attempt which will be accepted by the device without repeating the question.

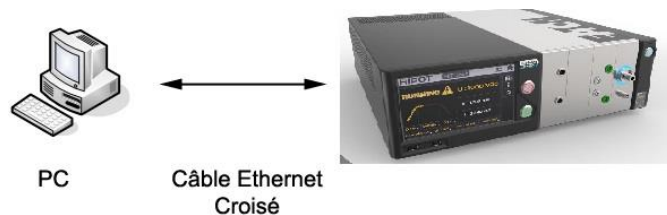
It is possible to clear the list of permitted addresses (Whitelist). From the Ethernet Interface menu, on the White list line, press Delete and confirm or not to the deletion of the all the authorised IP addresses.



## 19.3. CONNECTION EXAMPLES

### 19.3.1. SINGLE CONNECTION BETWEEN A PC AND A DEVICE WITH A FIXED IP ADDRESS

In this configuration we must use a [crossover Ethernet cable](#). In order to clearly identify the device of the SEFELEC 5x range we need to determine a fixed IP address for our device and our PC.

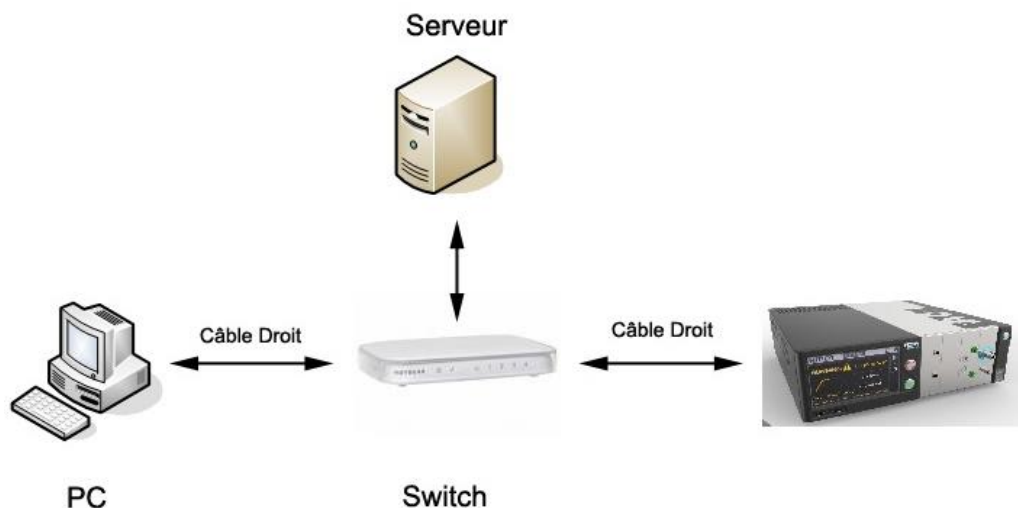


Example of the IP addresses for this application:

	PC	5x range device
IP Address	<a href="#">192.168.0.1</a>	<a href="#">192.168.0.2</a>
Network mask	<a href="#">255.255.255.0</a>	<a href="#">255.255.255.0</a>

### 19.3.2. CONNECTION BETWEEN A PC AND A DEVICE THROUGH A NETWORK

In this configuration we must use a [straight \(non-crossover\) Ethernet cable](#). See your network administrator for the choice of parameters of 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 with either a "straight" or "crossover" cable.*

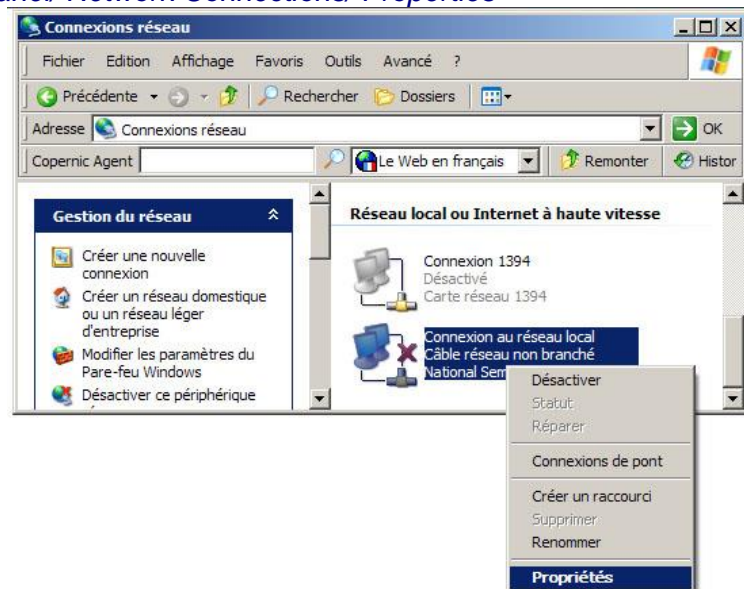
## 19.4. SETTING OF THE ETHERNET CARD OF THE PC UNDER WINDOWS XP

This paragraph only concerns the case of connection no. 1 and has no meaning for the case no. 2 since the device is inserted in a network.

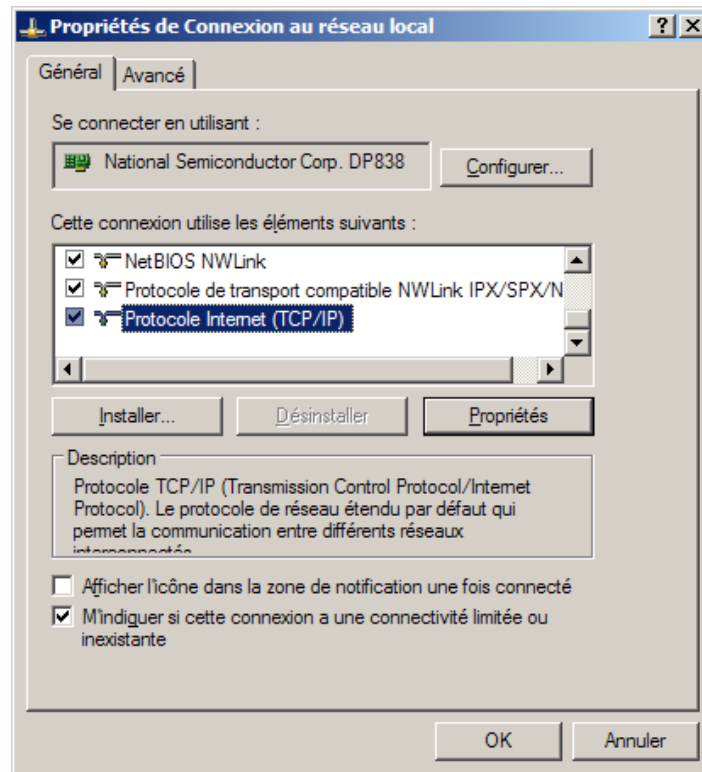
In the case no. 1 only one device is connected to the network card and constitutes a small local area network with a single node (device).

### 19.4.1. PROCEDURE TO BE FOLLOWED

Go to the *Control Panel/ Network Connections/ Properties*



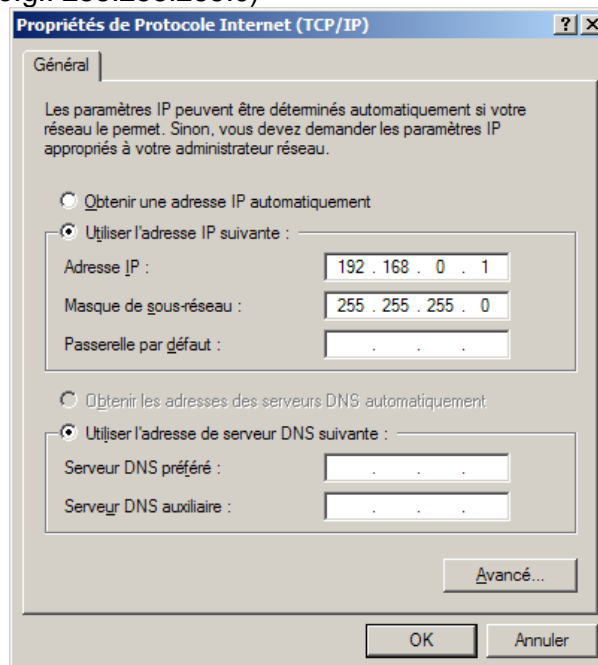
- Select *Internet Protocol (TCP/IP)* in the fields "This Internet connection uses the following items:" and then click on Properties
-



Select: Use the following IP address:

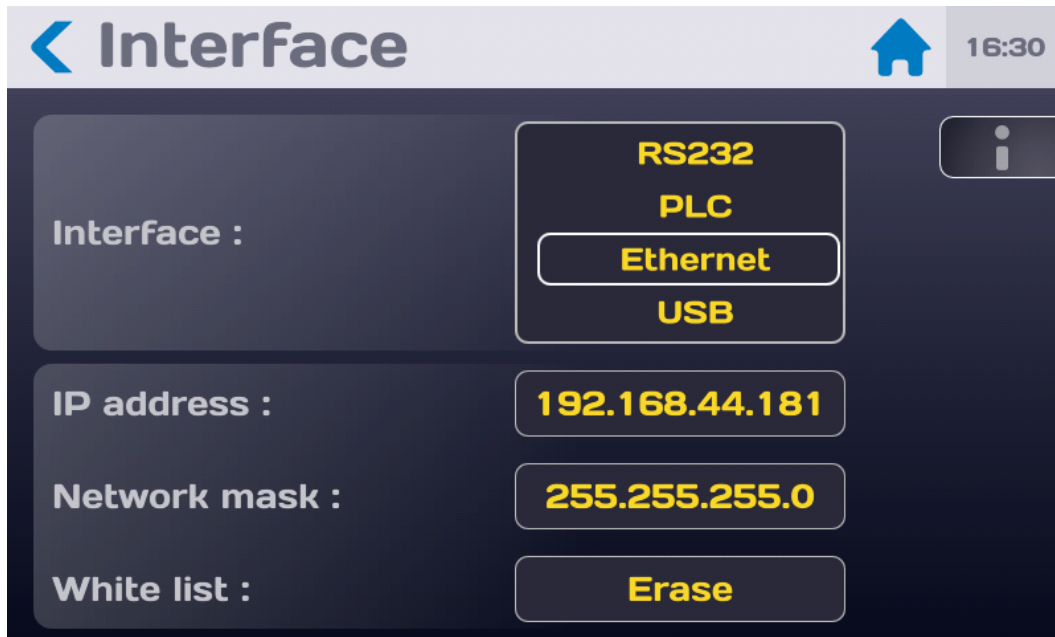
Enter the IP address of the network card (PC) (e.g.: 192.168.0.1)

Enter your subnet mask (e.g.: 255.255.255.0)



On the last two open windows click OK.

## 19.5. SETTING OF THE ETHERNET CONNECTION ON THE DEVICE



### 19.5.1. IP ADDRESS

Select the [IP address](#) line and validate, wait a few moments.

### 19.5.2. NETWORK MASK

Select the line [network mask](#) and validate.  
Enter your network mask, confirm and wait a few moments.

### 19.5.3. PROTOCOL AND COMMUNICATION PORT

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



---

#### 19.5.4. SYNTAX RULES

A command destined for the device should preferably end by 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.**

Events occurring during the measurement can be reported to the computer by the issuance of an SRQ (error format, end of test, safety loop open, etc.). To activate this function it is necessary to send the **SRQ** code after initialization of the device. During the occurrence of such an event, it is necessary to examine the internal registers of the IEEE controller (STB, SRE, etc.) to find out more precisely the reasons for the event.

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

---

#### 19.5.5. LIST OF ETHERNET COMMANDS

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

Reminders of the digital formats according to the **IEEE488-2** standard.

NR1 format: +/-<digit>...<digit>

NR2 format: +/-<digit>...<digit>.<digit>...<digit>

NR3 format: +/-<digit>...<digit>.<digit>...<digit>E+/-<digit>...<digit>

Note: The codes in brackets are the expanded codes that can be interpreted by the device.

---

#### 19.5.6. ORDERS

The command set of the **ETHERNET** option **SEFELEC 5x** is the same as that of the RS232 interface. It is described in detail in the **RS-232C interface** paragraph.

---

#### 19.5.7. ERROR MESSAGE

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

- The device has not been identified, press on Ethernet again
- You have left a communication with the device open, close the connection and press on Ethernet again

---

#### 19.5.8. MALFUNCTION

If the Ethernet connection does not work as described in this manual, check the following points:

*Absence of a reaction by the device when commands are sent:*

- Devices of the SEFELEC 5x range have several types of possible interfaces, check in the configuration menu that the Ethernet mode has been selected on the interface line.
- Check if the IP address of your device and your control device (PC) are on the same network. (Modify the network mask if necessary)
- The End of Message character must be the character LF (hexadecimal: 0A, decimal: 10). If this character is not sent, the device does not process the command received.
- Check that this character **LF** is added to the characters of the command sent.
- The first command that must be sent is the REM command, the latter is reflected by the display of an icon symbolizing 2 rings of a chain at the top left of the screen and the greying out of the keys, the device is then ready to process the other commands.

**Warning: The first REM command must not wait for an XON character before being sent.**

*The device goes into Remote and then seems to block*

Before sending a new command, it is imperative to wait until the SEFELEC 5x range device reports its availability by sending the XON character.  
If a code arrives during the processing of the previous code, it can cause an inconsistent operation by the device or block it.

## 20. USB INTERFACE



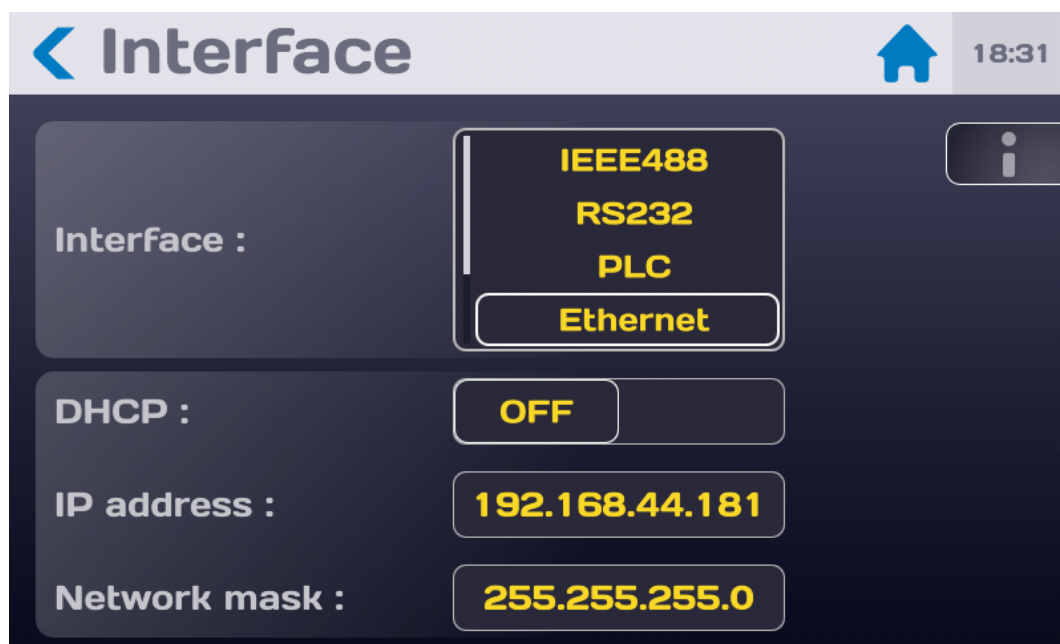
### IMPORTANT

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 5x 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.

## 20.1. 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.

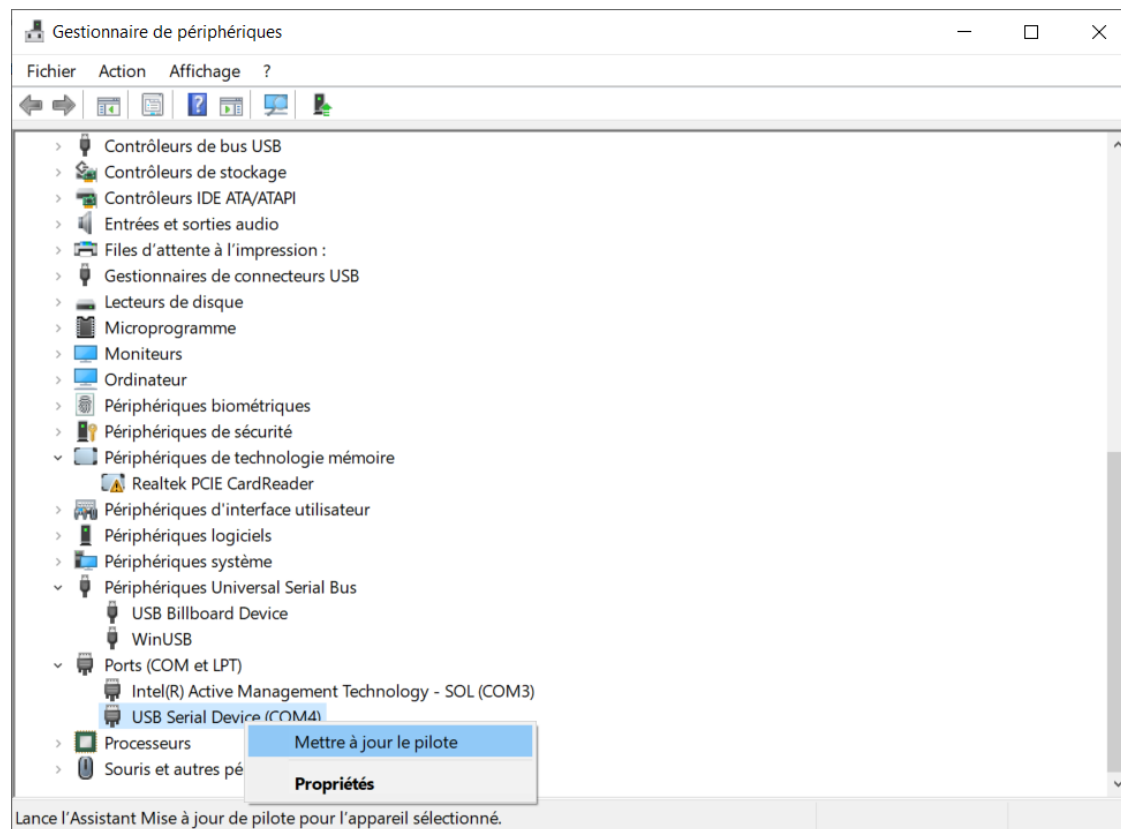
You will get a compressed file with the “.zip” extension that you will have to extract on your computer.

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

## 20.2. 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 :

C:\Users\E0398293\Downloads\mod-duo-rndis

Parcourir...

☒ 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



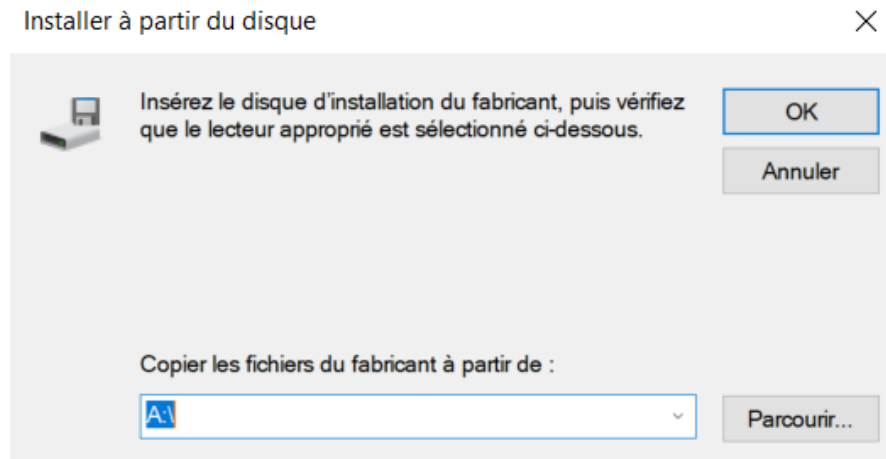
Ce pilote a été signé numériquement.

[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**

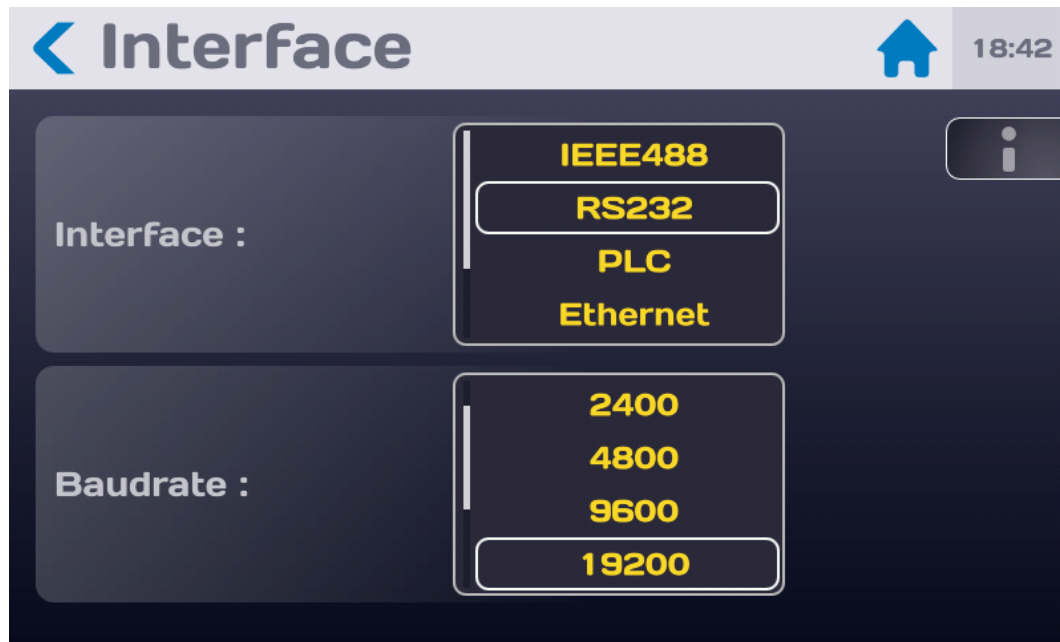
**For the use of the USB interface, please refer to the information given in paragraph ‘18 ETHERNET interface’**

## 21. 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.**

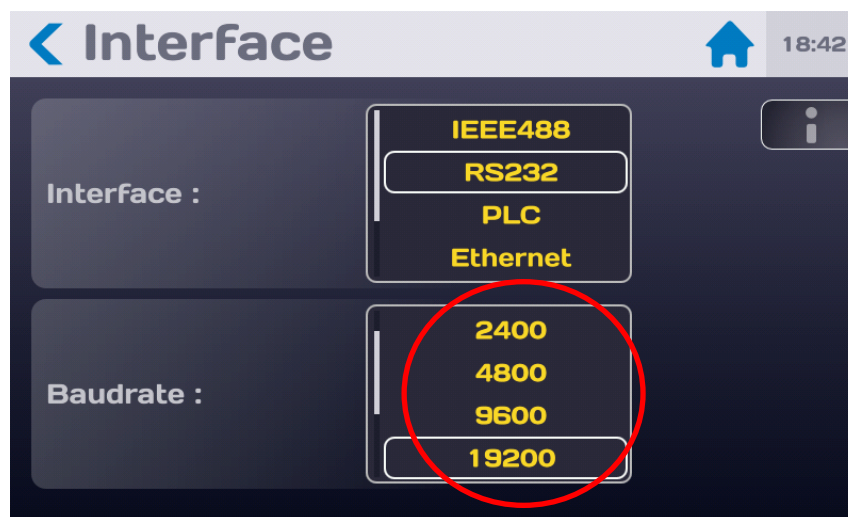
The interface is accessible via a 9-pin connector on the rear of the device. The RS232C standard describes the hardware aspects for series data transmission. It requires five lines which are:

- 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).



## 21.1. LIST OF RS232C COMMANDS

The syntax of the commands sent on the **RS232C** connection has been made consistent with the **IEEE488-2** standard (1992 revision).  
Reminders of the digital formats according to the **IEEE488-2** standard.

NR1 format: +/-<digit>...<digit>

NR2 format: +/-<digit>...<digit>.<digit>...<digit>

NR3 format: +/-<digit>...<digit>.<digit>...<digit>E+/-<digit>..<digit>

Note: The codes in brackets are the expanded codes that can be interpreted by the device.

### 21.1.1. 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.

## 21.1.2. STANDARDIZED COMMANDS

### **\*SRE <NR1>**

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

### **\*ESE <NR1>**

(*Standard Event Enable Status*). Selects the events bits likely to enable the Overall Event Indicator (BSE) in the "Event Register" registry. Using these event indicators the user can control the active events field.

### **\*CLS**

Positions all standardized registers in the state in which the user finds them at power 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

### 21.1.1.3. STANDARDIZED QUERIES

#### **\*STB?**

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

<b>b0</b>	0 = Safety loop open 1 = Safety loop closed
<b>b1</b>	0 = No error 1 = Error (Test error, Communication error, safety loop error on MEAS command, fan error)
<b>b2</b>	0 = End of test 1 = Test in progress
<b>b3</b>	0 = Test Bad 1 = Test Good
<b>b4</b>	Not used
<b>b5</b>	Logical OR of ESR register bits and filtered by ESE mask
<b>b6</b>	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
<b>b7</b>	Not used

#### **\*SRE?**

Returns to the NR1 format and in the hexadecimal base the value of the "SRE" register (STB register mask)

#### **\*ESR?**

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

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



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

**Note:**

### \*ESE?

Returns to the NR1 format and in the hexadecimal base the value of the "ESE" register (ESR register mask)

### STAT:OPER:EVENT?

Returns the value of the register **\*OSB**: Operation Summary Bit in NR1 format  
Indicates that an operation/step is in progress: Generation and/or measurement in progress

Bit	Description
b0	Rise (Yes = 1; No = 0)
b1	Hold (Yes = 1; No = 0)
b2	Fall (Yes = 1; No = 0)
b3	Phase 1 (Yes = 1; No = 0)
b4	Phase 2 (Yes = 1; No = 0)
b5	Phase 3 (Yes = 1; No = 0)
b6	Phase 4 (Yes = 1; No = 0)
b7	Phase 5 (Yes = 1; No = 0)
b8	Phase 6 (Yes = 1; No = 0)
b9	Phase 7 (Yes = 1; No = 0)
b10	Waiting for a "Stop" (Yes = 1; No = 0)
b11	Waiting for remote control Start test (Yes = 1; No = 0)
b12	Discharge (Yes = 1; No = 0)
b13	Charge (Yes = 1; No = 0)
b14	
b15	

## STAT:QUEST:EVENT?

Returns the value of the register **\*QSB**: Questionable Summary Bit in NR1 format  
 Indicates that a standard operating event has occurred: triggering of the Thermal switch, opening of the safety loop, etc.

Bit	Description
b0	Thermal switch triggering (Yes = 1; No = 0)
b1	Test stopped (Yes = 1; No = 0)
b2	Safety loop opening during test (Yes = 1; No = 0)
b3	Test Start failure (Com Error) (Yes = 1; No = 0)
b4	
b5	
b6	
b7	
b8	
b9	
b10	
b11	
b12	
b13	
b14	
b15	

## STAT:MEAS:EVENT?

Returns the value of the register **\*MSB**: Measurement Summary Bit in NR1 format  
 Reports a result that does not meet expectations: Out of limit, Out of range, zero, Infinite, ...

Bit	Description
b0	High limit exceeded (Yes = 1; No = 0)
b1	Low limit exceeded (Yes = 1; No = 0)
b2	Delta I breakdown detection (Yes = 1; No = 0)
b3	Over range (Yes = 1; No = 0)
b4	Under range (Yes = 1; No = 0)
b5	Current or voltage generator error (Yes = 1; No = 0)
b6	Over voltage (Yes = 1; No = 0)
b7	Over current (Yes = 1; No = 0)
b8	
b9	
b10	
b11	
b12	
b13	
b14	
b15	

### \*LRN?

This query allows the programmer to receive an "answer message" suite informing him on the state of the device (function and settings active). It is reusable so that it can be used later to put the instrument in the State in which it was at the time that the request was issued

### \*IDN?

Allows identification of the device. The message returned by the device is of the following form: <field1>, <field2>, <field3>, <field4> with

- Field 1: The name of the manufacturer (e.g.: EATON)
- Field 2: Type of the device (e.g.: SEFELEC56S.)
- Field 3: Serial number
- Field 4: Software version (e.g.: 1.60).

### \*TST?

Allows verification of the operation of the device. The message returned obeys the following syntax: #H<NR1>

	b3	b2	b1	b0	result
Hipot missing	X	X	X	1	#H01
Megohm missing	X	X	1	X	#H02
Continuity missing	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:**

#### 21.1.4. COMMANDS DEPENDENT ON THE DEVICE

**MEG (MEGohmmeter) :**

Selects the megohmmeter. Must be sent from the initialization display.

**HIP (HIPot) :**

Selects the Hipot function. Must be sent from the initialization display.

**HIPM (HIPotMulti) :**

Selects the Multi Hipot function. Must be sent from the initialization display.

**GND (GrouND) :**

Selects ground continuity function. Must be sent from the initialization display.

**CONF (CONFig) :**

Selects the configuration function of the unit. Must be sent from the initialization display.

**PAR (PARAmeter) <NR1> :**

Selects the parameter set for the running function.  
i.e.: MEG : PAR 1

**DCV (DCVoltage) <NR1> :**

Sets a new value in volt to the current DC voltage parameter to the parameter set of the running function.

Megohmmeter: Min: 20 Max : 1000 or Min : 10 Max : 500

Hipot : Min : 100 Max : 6000

i.e: DCV 500

**ACV (ACVoltage) <NR1> :**

Sets a new value in volt to the current AC voltage parameter to the parameter set of the running function without changing the pre-set frequency.

**ACV50 (ACVoltage) <NR1> :**

Sets a new value in volt to the current AC (50Hz frequency) voltage parameter to the parameter set of the running function

Hipot tester: Min.: 100 Max. : 5000

I.e : ACV50 5000

**ACV60 (ACVoltage) <NR1> :**

Sets a new value in volt to the current AC (60Hz frequency) voltage parameter to the parameter set of the running function

Hipot tester: Min.: 100 Max. : 5000

I.e : ACV60 5000

**ACC (ACCurent) <NR3> :**

Sets a new value in ampere to the AC current parameter to the parameter set of the ground continuity function.

**OHM (OHMmeter) :**

Sets the main thresholds unit (Ohm) and the ground continuity display function.

**Caution : The action on this command will erase all previous recorded thresholds (Reset to zero).**

**VOLT (VOLTmeter) :**

Sets the main thresholds unit (Volt) and the ground continuity display function.

**Caution : The action on this command will erase all previous recorded thresholds (Reset to zero).**

**HTIM (HTIME) <NR2> :**

Sets a new value in second to the current hold time parameter to the parameter set of the running function.

For instance : HTIM 3.2

**RTIM (RTIME) <NR2> :**

Sets a new value in second to the current rise time parameter to the parameter set of the running function

For instance : RTIM 10.5

**FTIM (FTIME) <NR2> :**

Sets a new value to the current fall time parameter to the parameter set of the running function.

For instance : FTIM 0.5

**HLIM (HLIMit) <NR3> :**

Sets a new value to the high limit parameter to the parameter set of the running function.

For instance :

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

HIP:HLIM 1.45E-4 (new value in Amps)

GND:HLIM 1.00E-1 (new value in milliohm)

The unity is automatic, given in Volt, Ohm or Amp and function dependent.

**CBHLIM <NR3> :**

Same command as HLIM, but reset the low limit parameter before to change the high limit value.

**LLIM (LLIMit) <NR3> :**

Sets a new value to the low limit parameter to the parameter set of the running function.

For instance :

MEG:LLIM 1.0E+6 (new value in Ohms)

HIP:LLIM 3.50E-6 (new value in Amps)

GND:LLIM 5.02E-2 (new value in milliohm)

The unity is automatic, given in Volt, Ohm or Amp and function dependent.

**TIM (TIME) AUT / PERM / MAN :**

Select the temporization mode. AUT for automatic, PERM for Permanent test, MAN for manual mode in Hipot.



### **FILT (FILTer) NOR / CAP / RC**

Enables the normal, the capacitor or the R//C (Hipot only) measurement modes.  
For instance:

HIP:FILT NOR  
HIP:FILT RC  
MEG:FILT CAP

### **DET (DETection) OFF / I / I+DELTA / DELTA :**

Hipot function only sets the mode of the breakdown.

### **IDE (IDEltA) <NR3>**

Hipot function : Delta I breakdown detection value adjustment

### **TDET (TDETection) REEL / TOTAL :**

Hipot function only sets the breakdown threshold on real or total current.

### **MKM (MEGOHMKM) ON OFF**

Allows to activate or disactivate the Megohm.km mode

### **MKMLN (MEGOHMKMLENGTH) <NR1>**

with <NR1> cable length (1 to 16000 meters) in Megohm.km mode

### **MKMCOUNT (MEGOHMKMCOUNT) <NR1>**

With <NR1> number of wires (0 to 999) in Megohm.km mode

### **MEAS (MEASure)**

Runs the current function.

### **COUNT <NR1>**

With <NR1> the number of phases of the multiple Hipot test

### **COUNT ?**

Allows you to know the number of phases of the multiple Hipot test

### **STEP <NR1>**

Used to select a phase of multiple Hipot and then to configure it individually (without this command, all the phases are modified by the parameter commands).:

### **STIM <NR1>**

Allows to set the time of a multiple Hipot phase (if the STEP <NR1> command precedes it) or otherwise of all the phases. Only works for multiple Hipot.

Example of setup of all the phases:

STIM 3:ACV 1000:CBHLIM 5E-3<LF>

Example of setup of phase 3 only:

STEP 3:ACV 1500:STIM 8:CBHLIM 3E-3

### **AC50, AC60, DC**

Used to set the frequency (50Hz, 60Hz or DC) of the test voltage for all the phases of a multiple Hipot.

### **STOP**

Stops the current function.

### **QUIT**

Exits the current function.

### **SRQ**

Similar to the Service Request feature of the IEEE488-2 bus, this code allows the emission of the **Z** character to inform the computer about the events (end of test, format error, interlock open, ...). This command must be sent at the program start, after the REM command.

---

## 21.1.5. REQUEST DEPENDING ON THE DEVICE

### **MEAS?**

Return the current measurement value(s) regarding the running function. The format of the response in a function offers 2 to 7 significant digits depending on the values:

#### **Megohmmeter:**

VOLT 9.90E+01 OHM 4.952468E+06 AMP 1.990033E-06

#### **Dielectric strength test AC:**

VOLT 1.000E+03 AMP 7.000E-05 AMPR 0.100E-06

#### **Dielectric strength test DC:**

VOLT 1.500E+03 AMP 4.000E-05

#### **Continuity:**

VOLT 2.810E+00 OHM 2.810E-01 AMP 1.000E+01

## 21.1.6. MULTI HIPOT PHASES REMOTE SETUP

### As a reminder:

- It is not allowed to change the frequency (50Hz, 60Hz or DC) of the voltage between the phases. The codes AC50, AC60 and DC are used to define the frequency of the voltage.  
If this does not agree with the voltage values (ex: ACV50 200, ACV60 200 or DCV 200) a message **DIALOG ERROR: 2** will be displayed.
- The last phase must return to zero voltage

Example of programming a cycle of 5 Multi-Hipot phases with a threshold  $IMAX = 5mA$ ,  $IMIN = 0$  and  $DELTA-I = 1 mA$ , detection in  $IMAX+DELTA-I$ :

- Phase 1: voltage rise to 200VAC in 0.1 sec.
- Phase 2: maintaining the voltage at 200VAC for 0.2 sec.
- Phase 3: voltage rise from 200 to 5000VAC in 0.4 sec.
- Phase 4: maintaining the voltage at 5000VAC for 1 sec.
- Phase 5: voltage drop to 0VAC in 0.4 sec.

Blue colored characters are sent to the 5x series device, green colored characters are received by the PC, comments are orange.

```

REM<LF>      // unit goes into REMOTE mode
<XON>
QUIT:H1PM:PAR Test<LF>  //exit of a function, switch to Multi-Hipot function, recall of the Test parameter file
<XON>
AC50<LF>     // select the voltage frequency (50 Hz) for all the phases
<XON>
COUNT 5<LF> // define the number of phases : 5
<XON>
STEP 1:ACV50 200:STIM 0.1:CBHLIM 5E-3:LLIM 0:DET I+DELTA:IDE 1E-3<LF> // Phase 1 setup
<XON>
STEP 2:ACV50 200:STIM 0.2:CBHLIM 5E-3:LLIM 0:DET I+DELTA:IDE 1E-3<LF> // Phase 2 setup
<XON>
STEP 3:ACV50 5000:STIM 0.4:CBHLIM 5E-3:LLIM 0:DET I+DELTA:IDE 1E-3<LF> // Phase 3 setup
<XON>
STEP 4:ACV50 5000:STIM 1.0:CBHLIM 5E-3:LLIM 0:DET I+DELTA:IDE 1E-3<LF> // Phase 4 setup
<XON>
STEP 5:ACV50 0:STIM 0.4:CBHLIM 5E-3:LLIM 0:DET I+DELTA:IDE 1E-3<LF> // Phase 5 setup
<XON>>
MEAS<LF>     // unit goes into Measurement mode
<XON>
  
```

Waiting loop for the 'Z' character or SRQ signal to inform about the test end.

```

MEAS ?<LF>   // Measurement result request
VOLT 5.000E+03 AMP 7.000E-05 AMP 0.100E-06 // values from the phase with the highest voltage
STOP<LF>    // stop the test
<XON>
  
```

## 21.1.7. RS232 / IEEE488-2 COMMANDS SUMMARY

Code	Menu Init	Config	mΩ	HV	Multi HV	MΩ
REM	X	X	X	X	X	X
GTL	X	X	X	X	X	X
.LLO	X	X	X	X	X	X
*CLS	X	X	X	X	X	X
*ESE	X	X	X	X	X	X
*ESE?	X	X	X	X	X	X
*ESR?	X	X	X	X	X	X
*IDN?	X	X	X	X	X	X
*LRN?			X	X	X	X
*RST	X	X	X	X	X	X
*SRE	X	X	X	X	X	X
*SRE?	X	X	X	X	X	X
STAT:MEAS:EVENT?	X	X	X	X		
STAT:QUEST:EVENT?	X	X	X	X		
STAT:OPER:EVENT?	X	X	X	X		
*STB?	X	X	X	X	X	X
*TST?	X					

Code	Menu Init	Config	mΩ	kV	Multi HV	MΩ
ACC			X			
ACV				X	X	
ACV50				X	X	
ACV60				X	X	
AC50					X	
AC60					X	
CONF	X	X				
COUNT					X	
COUNT ?					X	
DC					X	
DCV				X	X	X
FILT				X	X	
DET				X	X	
DIE				X	X	
FTIM			X	X	X	X
GND	X		X			
HIP	X			X		
HIPM	X				X	
HLIM			X	X	X	X
CBHLIM			X	X	X	X
HTIM			X	X	X	X
LLIM			X	X	X	X
MEAS			X	X	X	X
MEAS?			X	X	X	X
MEG	X					X
MKM						X
MKMLEN						X
MKMCOUNT						X
OHM			X			
PAR			X	X	X	X
QUIT	X	X	X	X	X	X
RTIM			X	X	X	X
SRQ	X	X	X	X	X	X
STEP					X	
STIM					X	
STOP			X	X	X	X
TDET				X	X	
TIM				X	X	
VOLT			X			

#### 21.1.1.8. OPERATION FAULT OF THE RS232C SERIES CONNECTION

If the RS232C connection does not work as described in this manual, check the following points:

*Absence of a reaction by the device when commands are sent:*

- The connection cord between the device in the SEFELEC 5x range and the computer must be properly connected to both ends and be of the **non-crossover type**. The SEFELEC CO179 cord is not compatible with this device.
- Devices of the SEFELEC 5x range have several types of possible interfaces, check in the **configuration** menu that the **RS232** mode has been selected on the **INTER-FACE** line.
- The End of Message character must be the character LF (hexadecimal: 0A, decimal: 10). If this character is not sent, the SEFELEC 5x device does not process the command received.
- Check that this character is added to the characters of the command sent.
- The first command that must be sent is the REM command, the latter is reflected by the display of an icon symbolizing 2 rings of a chain at the top left of the screen and the greying out of the keys, the device is then ready to process the other commands.  
**Warning: The first REM command must not wait for an XON character before being sent.**

*The device goes into Remote and then seems to block*

Before sending a new command, it is essential to wait until the SEFELEC 5x range device reports its availability by sending the **XON** character.  
If a code arrives during the processing of the previous code, it can cause an inconsistent operation of the device or block it.

## 22. APPLICATION NOTES

### 22.1. WHY DIELECTRIC TESTS ?

The dielectric tests are performed in order:

- to detect manufacturing fault on electrical equipment
- to verify the quality of the insulating material of an electrical equipment
- to verify that an electrical installation has been correctly done
- to control the insulation resistance of an equipment or an installation to trace its changes during the years.

Dielectric tests consist of both insulation resistance measurements and dielectric strength tests

### 22.2. GLOSSARY OF TERMS

- **LEAKAGE DISTANCE:** The smallest required distance, measured on the surface of the insulating material, between 2 conductive parts, to avoid breakdown.
- **LEAKAGE CURRENT:** Steady current flowing in an insulating material subject to high voltage.
- **BREAKDOWN:** The immediate break of the dielectric property of an insulating material. Every breakdown creates more or less damages to the insulating material. The breakdown tests can be therefore destructive or not.
- **INSULATION RESISTANCE:** Characteristic of an insulating material that being subject to a voltage, shows a resistance such as the value of the leakage current which flows through it stays within acceptable limits.
- **DIELECTRIC STRENGTH:** Ratio between the voltage at which a dielectric break of the insulating material occurs and the distance between the two points subject to the voltage (generally given in kV/cm). Regarding the insulating material type (solid, liquid or gas) a dielectric break can be: a perforation, a flash over or an arc.

## 22.3. ENVIRONMENTAL INFLUENCES

Temperature, pressure and humidity conditions have an influence on the dielectric tests results.

### 22.3.1. TEMPERATURE

The temperature having an influence on the gas density, this one is altering the performances of the liquid or gaseous insulating material. The oils, often used as insulation are never pure, the dissolved quantity of gas increases with the temperature and is decreasing the insulation quality of the oil. The large variety of materials used as solid insulation does not allow to deduce a general rule on their behaviour with the temperature (the insulation specifications having a tendency to dissipate when the temperature increases).

### 22.3.2. PRESSURE

The withstand voltage in gas changes with the pressure following the Paschen's law. This law shows a minimum of the breakdown voltage for a particular value of the pressure by distance product, otherwise the more the pressure increases, the more the breakdown voltage is high. The liquids used as dielectric insulation are influenced by the pressure, the dielectric strength increasing with the pressure. In theory, the solid insulations are a little influenced by the pressure because this one does not modify a lot their thickness and their internal composition.

### 22.3.3. HUMIDITY

The withstand voltage of gas changes with humidity. In example for the air and for values of relative humidity  $< 80\%$ , the dielectric strength increases a little with the humidity increasing (the water molecules, more dense than the gas, slows down the avalanche phenomena). The water presence in an insulating liquid such as oil degrades the dielectric strength by water electrolysis, development of gas producing partial discharges bringing to breakdown. Under combined effect of the humidity ( $> 95\%$ ) and the temperature ( $> 100^{\circ}\text{C}$ ) most of the polymers dissipate. The water can produce inflating in the insulation and create cracks which will facilitate the electric arcs advance.



## 22.4. INSULATION RESISTANCE MEASUREMENT

The insulation resistance measurement is intended to verify that the various components and sub-assemblies of electrical equipment have an insulation resistance such as the leakage currents do not reached inadmissible values.

The principle is to apply a DC voltage, stable and specified (selected among the standard values) between defined points and after a prescribed time, to measure the current flowing in the tested material. By using the Ohm's law (resistance = voltage / current), the result is given by the value of the insulation resistance. Then this value is compared to the minimum threshold specified by the standard used for the test.

### 22.4.1. PRECAUTIONS TO BE OBSERVED

It is important to connect the specimen to be measured in taking care of the parasite leakages which could be created by the measurement operating procedure.

The supplied accessories have a shielding which is connected to a guard potential, this insures a good immunity of the measurement regarding the parasitic leakage currents and the AC residuals.

When using extending of the basic probes, take the necessary cares to avoid to introduce measurement errors (short leads, leads not touching any metallic or insulating parts,...).

During insulation resistance measurements having high values ( $> 100 \text{ Gohms}$ ), the proximity of the operator putting his hand close to the specimen under test, can alter or make unstable the measurement. It is important to beware of Nylon blouses or of insulating material things capable of generating by static electricity, high electrical fields which can alter the measurement of high value resistances ( $100 \text{ Gohms}$  under  $100 \text{ VDC} = 1 \text{ nA}$  of measurement current)

### 22.4.2. MEASUREMENT OF CAPACITORS

We remind that a lot of recent electrical units are fitted with main line filters including capacitors for the electromagnetic compatibility. When measuring on capacitors it is advised to select the filter mode **CAPACITOR** of the SETUP menu in order to stabilize the measured values.

A) Indeed, on capacitors, the variations of the measurement power supply, even small as well as the interferences are entirely transmitted to the input of the current measurement system which have a very high gain, and therefore will amplify these variations. The **CAPACITOR** filter switches on circuits which will limit the instability of the measurement.

B) Never perform insulation resistance measurements on capacitive specimens in reducing the measurement voltage between each test, but always in increasing the voltage. The hysteresis and polarization phenomena of the dielectric material will alter the results. In

that case the unit indicates its maximum value and takes a long time to come back to the real measured value.

C) The insulation resistance value of a capacitor being a function following a time exponential law, it is important to make sense to the measured value, to indicate the duration of the measurement. The units of the 5x series allow complying with this requirement with the built-in timer, able to measure times going from 1 second up to 16 minutes.

D) Never disconnect a capacitive specimen before switching into DISCHARGE mode and waiting the necessary time to discharge its capacitance through the 2.2 kohms built-in resistance of the discharge circuit (about 1 second per 100 uF).

---

### 22.4.3. MEASUREMENT ON CABLES

The measurement on cables is similar to the measurement on capacitors

The measurement configurations on cables are very varied. The measurements have to be performed either between each conductor for multi-wires cables, either between main conductor and shielding for shielded cables, either between the cable and its environment for mono-wire cables.

A) In that last case, the generally used way is to immerse the cable reel in a water tank (called SWIMMING POOL), to wait for the water penetration in to the cable reel centre, and then to perform the insulation resistance between the cable and the water. For safety and construction reasons the water tank is grounded. The insulation resistance measurement unit must be able to measure a specimen with one grounded end. The units of the 5x series allow performing easily this type of measurement, because the hot point of the high voltage generator is already grounded. You just have to connect the measurement input of the unit (with the HV probe) on the cable to be measured and to trigger the measurement.

B) Another specific point, when measuring on cables, is that the specifications of the cable manufacturers give resistance values for a standard length of cable equal to 1 km (1,000 meters). When testing the reels of cable, those are never equal to the standard length, that forces the operators to calculate the resistance as a function of the cable length and the number of wires in parallel for the multi-wire cables. Consequently, the built-in comparators of the measurement units cannot be used, because they compare regarding to the total insulation value and not regarding the standard value. The units of the 5x series allow with the option 23 to display insulation resistance measurements reduced to 1 km and 1 wire, and therefore allow the use of the built-in comparators. The operator can enter in a specific menu of the unit the length of the cable under test as well as the number of wires. The result is given in Mohm per km.

i.e.: the unit measures a value of 10 Mohm for a 10 km long mono-wire cable. Therefore, the value reduced to 1 km will be:

$$(R_{\text{total}} / 1 \text{ km}) \times \text{Length} = 100 \text{ Mohm.km}$$

For the same cable with 10 wires, the value for 1 wire will be:

$$100 \text{ Mohm.km} \times 10 = 1,000 \text{ Mohm.km}$$

- C) The insulation resistance value of a cable being a function following a time exponential law, it is important to make sense to the measured value, to indicate the duration of the measurement. The units of the SEFELEC 5x range allow complying with this requirement with the built-in timer, able to measure times going from 1 second up to 3 hours.

---

#### 22.4.4. MEASUREMENT VOLTAGE SELECTION

The insulation resistance measurements intending to verify that materials or equipments comply with standard requirements, it is important to refer to these standards to select the voltage. The standard voltages are generally: 50, 100, 250, 500 VDC.

In case of no standard, select a 100 VDC value.

When measuring on capacitive specimens and when studying the voltage influence on the insulation resistance values, it is important to start always with the lowest voltage and then to follow the measurements in increasing the voltage. A procedure in the reverse way could give incoherent results.

### 22.5. DIELECTRIC STRENGTH TESTS

The dielectric strength test is intended to stress components and sub-assemblies of electrical equipment and to check that the leakage lines either between points or between points and ground are correctly designed according to the used technology.

The principle of a dielectric strength test is to apply a voltage (DC or AC) between defined points and after voltage stabilization, to check that the leakage current, created by breakdown phenomena or breakdown discharges (in the air or in the insulating materials), is not greater than the nominal acceptable value.

The default sanction is determined by the analyse of the shape, the amplitude and the holding time of the current supplied by the generator to the specimen under test and by comparison with a preset limit.

## 22.5.1. Selection of the test voltage

The dielectric strength tests intending to verify that materials or equipment comply with standard requirements, it is important to refer to these standards to select the voltage.

In case of no indication regarding the test voltage, a common rule is to apply the following formula:

$$U_{\text{test}} = 2 \times U_{\text{nominal}} + 1,000 \text{ volts}$$

Most of the standards specify the type of the test voltage: AC (50-60 Hz) or DC. A common rule is to test the specimen with a test voltage of the same type that the voltage which will be apply during the final use. However, certain among of technical difficulties exist which force to depart from this common rule.

### 22.5.1.1. DIELECTRIC STRENGTH TESTS WITH AC VOLTAGE

#### BENEFITS:

- The specimen is stressed with both voltage polarities.
- The specimen being not charged, there is no need for a discharge system

#### DISADVANTAGES:

- Most of the tested specimens having a certain amount of capacitance, the HV source have to supply the leakage current as well as the reactive current, this involves an over-sized generator with an increase in prices, in weight and a decreasing of the operator safety who is exposed to higher currents.

The reactive current can be evaluated with the following formula:

$$\text{Impedance} = \text{Voltage} / \text{Current (Ohm's law: } Z = U/I)$$

for capacitances:  $Z = 1 / Cw$  with  $w = 2\pi F$

reactive current:  $I_r = U \cdot C \cdot 2\pi F$

i.e.  $U = 3,000 \text{ volts}$   $C = 1 \text{ nF}$  (~ 10 meters of shielded cable)

$$I_r = 3,000 \cdot 1E-9 \cdot 2 \cdot 3.14 \cdot 50 = 0.942 \text{ My}$$

- Require adjusting the permanent leakage current threshold (IMAX) regarding the capacitance of each specimen.
- When testing a specimen which will be used with a DC voltage, the AC voltage test can result in a decreasing of the lifetime because in particular of the heating and the CORONA effect. Under the effect of an electrical field, the orientation of molecules is done with friction which will occur with an AC voltage at each cycle (every 20 or 16 mS). Consequently, the AC test is more severe than the DC voltage test.

## 22.5.1.2. DIELECTRIC STRENGTH TESTS WITH DC VOLTAGE

### BENEFITS:

- \* The power of the HV source can be lower than the one necessary in AC voltage (less weight and more safety for the operator). The current flows through the specimen only during the charging phase.

### DISADVANTAGES:

- \* The charging current can trigger the breakdown detection
- \* The specimen being charged, it must be discharged through the built-in discharge resistance (1.5 Mohm).

**WARNING:** Wait enough for the discharge of the specimen capacitance before disconnection from the unit (about 8 seconds per uF).

- \* The specimen is tested in only 1 polarity
- \* The test voltage must be higher than the one provided with AC test voltage. A common rule is to use a 1.4 correction factor between the DC and the AC voltages (= square root of 2 = ratio between the rms value of a sinusoidal wave and its crest value):

$$U_{dc} = U_{AC} * 1.4$$

## 22.5.2. Breakdown detection mode selection

The most common and simple leakage current control mode is the threshold current control mode or IMAX mode. This mode allows setting a maximum limit of current flowing in the specimen under test above which the unit detects a breakdown and stops the test by cutting off the HV generation and memorizing the voltage value on the LCD screen. As described, the HV source has to supply the leakage current as well as the reactive current coming from its capacitance. Therefore this requires to adjust the breakdown threshold regarding the reactive current of each specimen, and to follow the procedure:

- \* Make a test on a good specimen
  - \* Collect the total current flowing
  - \* Adjust the current threshold to a value greater than the total current.

The 5x series units offer the above-described detection mode, combined with the  $\Delta$ -I detection mode (called sometimes ARC detection mode). The  $\Delta$ -I mode allows to release from the reactive current flowing in the capacitive specimens.

To detect a breakdown, the  $\Delta$ -I mode (ARC detection) monitors only the fast-current variations ( $t > 10 \mu s$  and amplitude  $> 1 mA$ ). This does not require any adjustment regarding the specimen capacitance. However, this mode cannot detect a dielectric strength default in case of a specimen in short-circuit since the high voltage application. That is why the 5x series units allow to combine the IMAX and the  $\Delta$ -I modes to make reliable and without adjustment of dielectric strength tests. The IMAX value is set to a value close to the unit short-circuit current under the test voltage.

The 5x series units allow to inhibit the detection systems (OFF mode) in order to locate visually where is the dielectric strength fault. **WARNING:** this mode does not cut off the high voltage and

therefore it is possible to destroy or burn the specimen under test. The power of the HV source being limited, continued use of the OFF detection mode can trigger the built-in thermal safety switch. Under those circumstances (display of the message: INTERLOCK DISABLE) wait between 3 and 5 minutes before proceeding to the tests.

## 22.6. Ground continuity measurement

On a unit or an electrical device using or generating hazardous voltages, ground continuity measurements ensure that all the accessible protective parts are correctly connected to the protective ground connection wire.

This measurement is almost a low resistance measurement except that it has to be performed with a high current, mostly in AC.

The principle is to flow a current between each metallic accessible parts and the protective ground connection, to measure the voltage drop between the 2 parts and to check with the Ohm's law that the equivalent resistance is lower than the standard required value.

### 22.6.1. Current selection

The measurement current is defined by the safety standards which have to be used for each product. According to the main standards, this high current is comprised between 10 and 25 A AC or equal to 2 times the nominal operating current of the device.

The choice is justified by the fact that the protective ground connections have to be able to flow the fault current for the maximum value of the unit operating current and this during the reaction time of the other protective devices (fuses, breakers, etc...)

### 22.6.2. Voltage selection

This is the open voltage of the current generator used for the measurement. This voltage, mostly given by each safety standards is mandatory a low value (lower than the threshold defining a hazardous voltage) but it must allow the measurement current flowing, taking care of the voltage drops between the generator and the measurement points.

The open voltages are comprised between 6 and 12 AC volts.

---

### 22.6.3. Test time

Unlike a simple resistance measurement, the time that the current is being flowing for the ground continuity measurement is important because of the 'Safety' function of the tested connection.

Beyond the ohm value evaluation, it is mandatory to test the quality of the connection to the ground potential (diameter of the wire, solders quality, screwing quality, ...). A manufacturing fault of one of these connections may in certain circumstances give an immediate correct ohm value but increasing quickly by heating causes by the high current value used for the test: this high current can produce a break of the wire (wounded wire, which diameter becomes too small).

This is why some standards are requiring a minimum test time from 1 to 5 minutes for this measurement. Other standards do not give any time indication, but it is advised to apply for type test a minimum time of 1 minute and for series tests at least 10 seconds.

---

### 22.6.4. Precaution to be observed

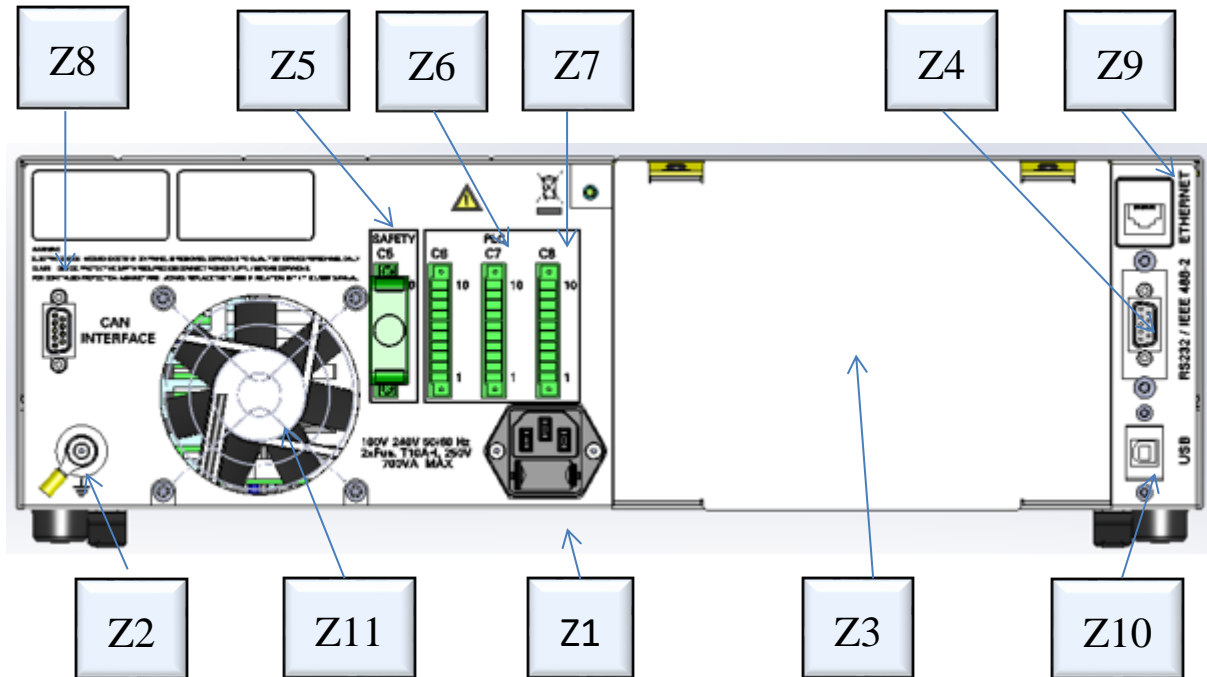
The measured resistance values being very low ( $< 1 \text{ ohm}$ ), it is necessary to perform the measurement in using the 4-wire method to avoid the measurement lead parasitic resistance (interfaces, adapters, ...) It is necessary to warrant this measurement principle when connecting the measurement unit to the test points.

If specific connections have to be done, it is necessary to use correctly rated cables (at least  $5 \text{ A/mm}^2$ ) for the current and to connect voltage measurement cables as close as possible to the measured points.

During the test time, it is advised not to move the probe to avoid breaking the current flowing which will produce sparks. This can modify the real total test time and can alter the contact surface of the specimen.

## 23. REAR PANEL CONNECTORS

### 23.1. REAR PANEL DESCRIPTION

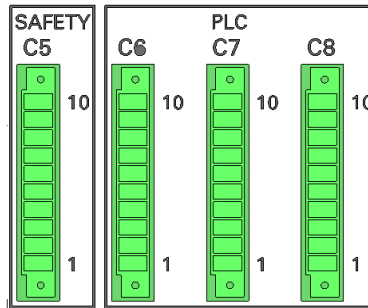


The rear panel carries the following elements:

- **Z1** Mains supply sockets with fuses incorporated
- **Z2** Ground connection
- **Z3** Exit area of the measurement cables in the case of the rear face outlet option.
- **Z4** 24-point ribbon connector for the IEEE-488-2 interface
- **Z5** 10-pole terminal block for the safety loop.
- **Z6** 10-pole terminal block for the PLC command.
- **Z7** 10-pole terminal block for the PLC command.
- **Z8** SUB-D 9-point connector for the control CAN bus of an external matrix
- **Z9** RJ45 base for the Ethernet connection.
- **Z10** Mini USB base for the USB connection.
- **Z11** Fan

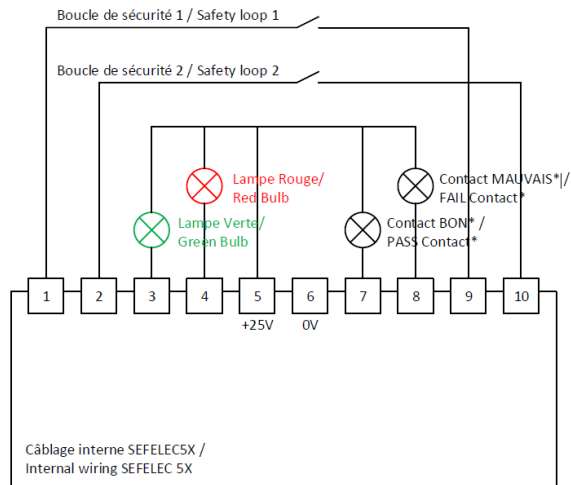


### 23.1.1. C5 SAFETY CONNECTOR



1	Safety loop contact: to be linked to 9
2	Safety loop contact: to be linked to 10
3	Green light
4	Red light
5	25V common line, red-green light
6	0VG
7	PASS contact (= +25 V)
8	FAIL contact (= +25 V)
9	Safety loop contact: to be linked to 1
10	Safety loop contact: to be linked to 2

**Connection example of the red/green lights, of the contacts of the safety loop and contacts PASS/FAIL:**



\* : Ne pas utiliser les couleurs ROUGE/VERT pour ces signaux  
(exclusivement pour la sécurité) /  
Do not use RED/GREEN colors for these signals (exclusive for safety)



#### NOTE

**The contacts of the safety loop must be free of any potential (24 VDC, 230 VAC, ground, etc.) they are protected by thermal fuses, in the event of an over-current wait 15 seconds to try again.**

## 24. CARE, MAINTENANCE AND CALIBRATION

### 24.1. PRELIMINARIES

Our warranty (see the beginning of this manual) certifies the quality of the equipment of our production. If a malfunction is suspected or for any technical information concerning the use of our devices, call our technical department for France on 33.1.64.11.83.40. For foreign countries Contact your local representative.



**WARNING**

**Dangerous voltages may be present in the devices.**

**Repairs should only be performed by the manufacturer or by personnel instructed.**

### 24.2. RETURN OF EQUIPMENT

Before returning equipment to our service department, contact the latter at the phone number indicated above to find out about the conditions for the return of the equipment.

Use the original packaging or if this is not possible packaging guaranteeing the protection of the equipment during its transport.

### 24.3. MAINTENANCE



**WARNING**

**Danger of electric shock!**

- The commissioning, use and maintenance of the equipment must be carried out by qualified personnel.

Our devices do not require special maintenance, except for calibration. In case of problems, please follow the simplified check-list. If the breakdown persists, contact our service department.

For your Production devices a new service is offered: appointment information. Contact our service department for the terms.

## **Cleaning the device**

Only clean the device with a soft cloth or one slightly moistened with water. For the LCD screen use a microfibre cloth.

## **Calibration**

We recommend annual calibration of our devices. This calibration may be advanced or delayed depending on the rate of use of the measurement device (ask the EATON service department for advice). The latter must be carried out by qualified personnel with the detailed procedure and duly verified calibration means. Our service department is at your disposal to carry out the annual calibrations at the best prices and as quickly as possible.

## **Maintenance**

Our technicians are specially qualified for verification and scheduled maintenance of measuring devices.

However, the customer's maintenance staff will need to handle the cleaning, the dust filter changes (depending on the models) and the clearance of the vents of the device.

In workshops with cold floors or using water for washing, we recommend installing the measurement device on a pedestal to limit condensation.



**IMPORTANT**

**The safety loop and the proper functioning of the danger warning lamps (SEFA-CO160) must be checked each time the device is switched on by trying to launch a test with the safety loop open and by checking the green lighting: no danger and red: presence of danger. A check of each associated safety device: Emergency Stop Button, door safety, etc. in detail once a year.**

## **Periodicity:**

Daily	Red/green lamp
Daily	Safety loop
Monthly	Filter cleaning
Annually	Metrological calibration
Annually	Safety devices
Annually	Dust cleaning

## 25. EULA: END USER LICENSE AGREEMENT

### **IMPORTANT, READ CAREFULLY.**

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### 4.0 Infringement and Warranties

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## 5.0 General Provisions.

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5.2 Limitation on Liability. NOTWITHSTANDING ANY PROVISION OF THIS AGREEMENT TO THE CONTRARY, LICENSEE EXPRESSLY UNDERSTANDS AND AGREES THAT EATON, ITS AFFILIATES, AND ITS LICENSORS, WILL NOT BE LIABLE FOR: (A) ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES WHICH MAY BE INCURRED BY LICENSEE OR ANY THIRD PARTY, HOWEVER CAUSED AND UNDER ANY THEORY OF LIABILITY. THIS WILL INCLUDE, BUT NOT BE LIMITED TO, ANY LOSS OF PROFIT (WHETHER INCURRED DIRECTLY OR INDIRECTLY), ANY LOSS OF GOODWILL OR BUSINESS REPUTATION, ANY LOSS OF DATA SUFFERED, COST OF PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, OR OTHER INTANGIBLE LOSS; (B) ANY LOSS OR DAMAGE WHICH MAY BE INCURRED BY LICENSEE OR ANY THIRD PARTY. THESE LIMITATIONS ON EATON'S LIABILITY WILL APPLY WHETHER OR NOT EATON HAS BEEN ADVISED OF OR SHOULD HAVE BEEN AWARE OF THE POSSIBILITY OF ANY SUCH LOSSES ARISING.

TO THE EXTENT PERMITTED BY LAW, THE TOTAL LIABILITY OF EATON, ITS AFFILIATES, AND ITS LICENSORS, FOR ANY CLAIMS UNDER THESE TERMS, INCLUDING FOR ANY IMPLIED WARRANTIES, IS LIMITED TO THE AMOUNT PAID FOR THE SOFTWARE.

THIS SECTION 5.2 STATES EATON'S ENTIRE LIABILITY AND LICENSEE'S SOLE AND EXCLUSIVE REMEDY UNDER THIS AGREEMENT, AND IS SUBJECT TO ALL LIMITATIONS STATED IN SECTION 4.2.

5.3 Notices. All notices required to be sent hereunder will be in writing and will be deemed to have been given when mailed by first class mail to the address shown below:

LICENSE NOTICES:  
EATON Intelligent Power Limited  
EATON Home,  
30 Pembroke Road,  
Dublin 4,  
D04 Y0C2,  
Ireland

5.4 Severability. If any provision of this Agreement is held to be invalid or unenforceable, the remaining provisions of this Agreement will remain in full force.

5.5 Waiver. The waiver by either party of any default or breach of this Agreement will not constitute a waiver of any other or subsequent default or breach. Failure to enforce or delay in enforcing any provision of this Agreement will not constitute a waiver of any rights under any provisions of this Agreement.

5.6 Entire Agreement. This Agreement constitutes the complete agreement between the parties and supersedes all prior or contemporaneous agreements or representations, written or oral, concerning the subject matter of this Agreement. This Agreement may not be modified or amended except in a writing specifically referencing this Agreement and signed by a duly authorized representative of each party. No other act, document, usage or custom will be deemed to amend or modify this Agreement. Certain components of the Software may also be subject to additional paper or electronic license agreements. In such cases, the terms of this Agreement will be supplemental to those in the additional agreements, to the extent not inconsistent with the additional agreements. If a copy of this Agreement in a language other than English is included with the Software or Documentation, it is included for convenience and the English language version of this Agreement will control.

5.7 Heirs, Successors, and Assigns. Each and all of the covenants, terms, provisions and agreements herein contained will be binding upon and inure to the benefit of the parties hereto and, to the extent expressly permitted by this Agreement, their respective heirs, legal representatives, successors and assigns.

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5.15 Governing Law. This Agreement will be interpreted and enforced in accordance with the laws of Ireland, without regard to choice of law principles. Any claim or suit with respect to this Agreement shall be brought in the Courts of Ireland, unless mandatory law imposes otherwise.

EATON EULA



## 26. EU DECLARATION OF CONFORMITY

**EU Declaration of Conformity**

We,  
Sefelec sas Eaton groupe  
19 rue des campanules  
77185 LOGNES  
France

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

**Sefelec 5x 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 (3<sup>rd</sup> 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: 24th July 2020



Didier Delacourt  
Engineering Director

## Types within the range

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

Reference	Description
SEFELEC 56-H	Dielectric strength tester - 5 kVAC - 6 kVDC 50 VA
SEFELEC 56-D	Dielectric strength tester - 5 kVAC - 6 kVDC 50 VA
	Megohmmeter - 200 Gohm @1,000 VDC
SEFELEC 56-S	Dielectric strength tester - 5 kVAC - 6 kVDC 50 VA
	Megohmmeter - 200 Gohm @1,000 VDC
	Ground continuity - 1,000 mOhm @32 AAC
SEFELEC 506-H	Dielectric strength tester - 5 kVAC - 6 kVDC 500 VA
SEFELEC 506-D	Dielectric strength tester - 5 kVAC - 6 kVDC 500 VA
	Megohmmeter - 200 Gohm @1,000 VDC
SEFELEC 506-S	Dielectric strength tester - 5 kVAC - 6 kVDC 500 VA
	Megohmmeter - 200 Gohm @1,000 VDC
	Ground continuity - 1,000 mOhm @32 AAC
SEFELEC 1000-M	Megohmmeter - 200 Gohm @1,000 VDC
SEFELEC 32-C	Ground continuity 1,000 mOhm @32 AAC
SEFA-KR	19" rack mounting
SEFA-TE65-02	HV/Insul. measurement probe. Length 2 m
SEFA-TE65-05	HV/Insul. measurement probe. Length 5 m
SEFA-TE65-10	HV/Insul. measurement probe. Length 10 m
SEFA-CO175-02	4mm return cord HV/Insul. Length 2 m
SEFA-CO175-05	4mm return cord HV/Insul. Length 5 m
SEFA-CO175-10	4mm return cord HV/Insul. Length 10 m
SEFA-CO180-02	HV cable/Insul. Without probe Length 2 m
SEFA-CO180-05	HT Cable/Insul. Without probe Length 5 m
SEFA-CO180-10	HT Cable/Insul. Without probe Length 10 m

SEFA-TE58-02	HV/Insul. probe with remote control Length 2 m
SEFA-TE58-05	HV/Insul. probe with remote control Length 5 m
SEFA-TE58-10	HV/Insul. probe with remote control Length 10 m
SEFA-SE15-02	Insulation measurement probe. Length 2 m
SEFA-SE15-05	Insulation measurement probe. Length 5 m
SEFA-SE15-10	Insulation measurement probe. Length 10 m
SEFA-CO183-5002	2-wire power cord 50 A, Lemo/Croco. Length 2 m
SEFA-CO183-5005	2-wire power cord 50 A, Lemo/Croco. Length 5 m
SEFA-CO183-5010	2-wire power cord 50 A, Lemo/Croco. Length 10 m
SEFA-CO183-3202	2-wire power cord 32 A, 4mm Croco. Length 2 m
SEFA-CO183-3205	2-wire power cord 32 A, 4mm Croco. Length 5 m
SEFA-CO183-3210	2-wire power cord 32 A, 4mm Croco. Length. 10 m
SEFA-CO184-3202	Retractable 2-wire probe, 4 mm 32 A Length 2 m
SEFA-CO184-3205	Retractable 2-wire probe, 4 mm 32 A Length 5 m
SEFA-CO184-3210	Retractable 2-wire probe, 4 mm 32 A Length 10 m
SEFA-TE81-5002	2-wire probe 50A remote control Length 2 m
SEFA-TE81-5005	2-wire probe 50A remote control Length 5 m
SEFA-TE81-5010	2-wire probe 50A remote control Length 10 m
SEFA-TE81-3202	2-wire probe 32A remote control Length 2 m
SEFA-TE81-3205	2-wire probe 32A remote control Length 5 m
SEFA-TE81-3210	2-wire probe 32A remote control Length 10 m
SEFA-EMBUNIV	External universal base test unit
SEFA-AO10	2-hand control - cable 2 m
SEFA-AO11	Remote control pedal - 2.5 m

SEFO-IEEE488	IEEE 488-2 interface option
SEFO-CO160	red/green lamp for presence of high voltage option
SEFO-5X50A	50 A AC for ground continuity option
SEFO-5XREAR	rear outputs option
SEFO-5X3MY	short-circuit current limit of < 3 mA at HV 50VA option
SEFO-5x2TB	2 TOhm in insulation option
SEFO-5XRC	remote control for accessories option



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