Manual

Surge Tester
ST 6600B

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Table of Contents

1 General Information

1.1 Information on this Operation Manual

This operating manual is part of the technical documentation for the Surge Tester ST6600B of SPS electronic GmbH.

This operating manual contains all the information on how to operate this device properly, safely and economically, how to prevent dangerous situations, how to reduce repair costs and downtimes and how to prolong the service life of these devices.

Should you, while perusing this operating manual, find any misprints, any information you do not understand or which are incorrect please do not hesitate to inform *SPS electronic GmbH* about same.

Pictographs and Symbols

- **Warnings** are characterized by warning triangles with danger symbol and warn of dangers which can lead to personal injury and/or material damage:

General Warning

Danger caused by electric current or voltage

- **Information** on same are characterized by the Information Pictograph and give advice or additional information:

You can order accessories directly from *SPS electronic GmbH*.

- **Continuations** of contextual paragraphs on the next page are characterized by the symbol on the right-hand margin.

1.2 Requirements for the operation of this device

1.2.1 Regulations for application

The tester must be in an operational and reliable condition.

Only personnel having completely read and understood this operating manual and who are authorized skilled electricians or who have been instructed in electrical engineering are allowed to perform any operations with and at the testers.

The tester is not to be operated if or for:

- operations are performed which are not specified in this operating manual or which have not been recommended by *SPS electronic GmbH* concerning installation, operation, maintenance and service.
- unauthorized alterations and/or repairs
- dismantling and/or avoiding of safety devices
- use of components, tools, additional installations, supplements and working material which have not been approved or recommended by *SPS electronic GmbH*
- building in of spare parts which are not original *SPS electronic GmbH* spare parts or of spare parts from suppliers not recommended by *SPS electronic GmbH*

1.2.2 Product liability

The testers have been produced, adjusted and tested according to the state of the art and the approved safety requirements.
The devices comply with the conditions agreed upon by contract of the confirmation of order concerning execution, single parts and accessories selection.

SPS electronic GmbH will be liable for errors or omissions to the extent of the guarantee liabilities of the confirmation of order.
Applicable are the general conditions of delivery of the Central Association of Electrical Engineering and the Electronics Industry, registered association (ZVEI).

The contents of this operating manual is in compliance with the condition of the tester on the date when same was drawn up.
Subject to change are technical alterations because of further developments and improvements of these products by *SPS electronic GmbH*.
Liability claims can therefore not be derived from the contents of this operating manual (data, descriptions, graphs, misprints, etc.).

Errors and omissions excepted!

⚠ ***SPS electronic GmbH* will only be liable in case of application of the testers according to regulations (pl. see 1.2.1).**
If those regulations have not been applied the operator is solely responsible for risks of hazard to body and life of the user or a third party and impairments of the tester and other material assets!

1.3 General Safety Regulations

The surge tester ST6600 has been manufactured according to the state of the art at the time of its delivery. Nevertheless the tester is not without hazards if it is applied by untrained personnel, applied improperly or not applied according to regulations

In addition to this operating manual the generally applicable legal regulations and other binding instructions concerning safety regulations, regulations for preventing accidents and regulations for the protection of the environment must be adhered to.

Beware of high electronic voltage and electromagnetic fields
In case of defective test objects, like e.g. arc-overs, there can occur electromagnetic fields. This is of particular concern to persons with active or passive medical devices, like e.g. cardiac pacemaker.

1.3.1 Obligations of the operator

- The tester is only to be operated according to regulations and in operational condition (see chap. 1.2.1)
- Protective and safety devices, locking devices and couplings, etc. have to be inspected by an expert at least once a year.
- A protocol on the test results has to be drawn up in form of a **test report** same has to be retained.
- Instructions on operations with or at a machine or installation as to hazards to health and/or life of persons are obligatory.
- Persons who operate with or at an ST 6600B have to confirm by their signature to have read and comprehended this operating manual especially in regard to the operating instructions.
- Dangerous zones resulting from the integration of the tester into a system or a device have to be located by the operator and safeguarded against.
  When assembling or installing devices, systems or items of equipment of different manufacturers or suppliers and after modifications by company or service personnel where changes within the electric equipement were made the operator has, before putting into operation, to perform a precise inspection according to the accident prevention regulations VBG 4 in compliance with the individually applicable rules of electrical engineering.

1.3.2 Operating instructions for personnel

- Operating instructions, general instructions and regulations are part of the tester and have to be accessible, readable and complete for all those who operate with or at the ST 6600B.
- Before operating with or at the ST 6600B questions have to be answered or uncertainties have to be explained by the personnel in charge.
- Any operations with or at the ST 6600B may only be performed by workers skilled in electrical engineering or trained in electronic engineering and who have been given instructions for such operations and thus been authorized by the operator.
- Testing personnel may only operate the ST 6600B when a skilled electrician is in charge.
- Adjustments, service and inspections have to be performed according to the instructions specified and according to schedule.

1.3.3 Note on possible disorder of USB devices

When testing with high-voltage, it is possible that failing testpieces may cause disorder of USB devices in close surrounding of the test field.
Please see annex 0 for a problem description, and measures to avoid.

1.3.4 Information on further publications

For the protection of persons the trade associations and unions have published below literature:

• DIN EN 50191	Installation and Operation of Electrical Installations
• DIN EN 50274	Protection against Electric Shock – Protection against unintended direct contact of dangerous active parts
• DIN 40 008 part 3	Safety Signs for Electrical Engineering; Warning Signs and Additional Signs
• DIN 40 050	IP-Protective System, Protection against Contact, Foreign Matter and Water for Production Equipment
• DIN 57100	Specifications for the Installation of Power Plants with Nominal Voltages of up to 1000 V
• BGI 891	Establishing and operation of electrical test plants

2 Description

2.1 Technical Data

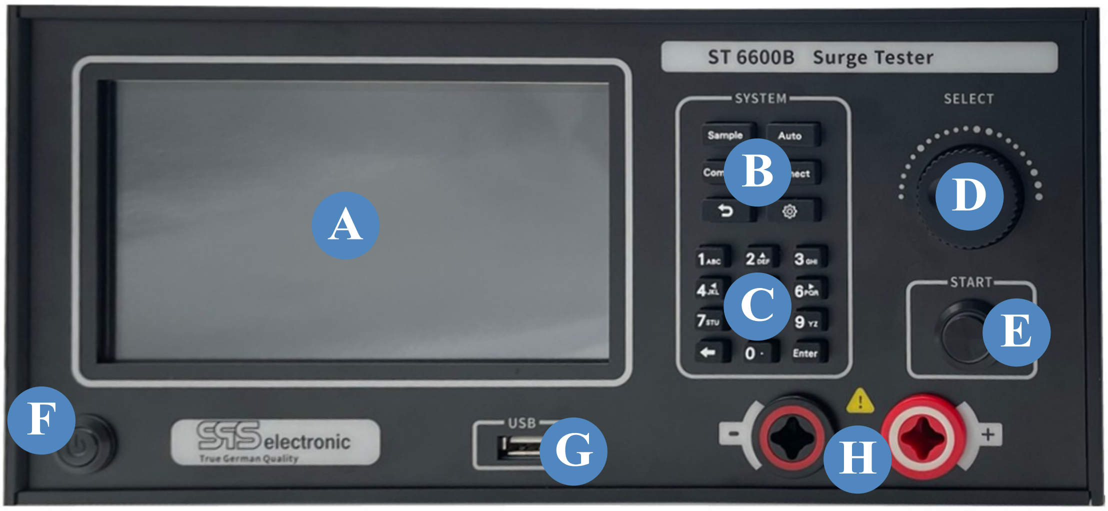
Measurements and weights	
Width / depth / height	ca. 328 / 340 / 167 mm
weight	ca. 68 N (6,8 kg)

Ambient	
temperature	operation: 15 °C – 40 °C storage: 5 °C – 60 °C
Air humidity	max. 70 % (non-condensing)

Connection data	
Power supply	230 V / 50 Hz or 115 V / 60 Hz
Mains fuse	AC250V, 3At
Power input	operationca. 46 W, standby ca. 24 W

Test technology	
High Voltage	200 V – 6000 V , ± 3% ±10V
Surge energy	max. 250 mJ
Min. DUT inductivity	> 10 µH
ADconverter: resolution / speed	12 bit / 5 ns (200 MHz)
Sampling memory width	600 x 12 bit
Input resistance	10 MΩ
Evaluation methods	Error area Differential error area Corona number Corona amount Lenz ppercentual error Corona pulse strength
Mastercurve memory	20 Curves internally, externally unlimited via USB media
PC-Link interface	LAN / TCP/IP
Digital I/O interface	TTL I/O , standard D-Sub 15Pin
Remote interface	RS-232 , standard D-Sub 9Pin
Display	Touchscreen Color TFT , 7" , 800x480 Pixel

2.2 Overview Device Front Panel



A. Touchscreen

Supports mixed display of text and graphics, with a resolution of 800 × 480 pixels, using a resistive touch panel.

B. Function Keys

(a) 

Enter the sampling menu to set sampling parameters.

(b) 

Calls up the automatic test function, for automatic determination of the sampling frequency and/or test voltage suitable for the DUT, for determination of the master curve.

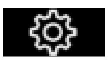
(c) 

Enter the comparator menu, to set the parameters of each comparator.

(d) 

Calls up the connection settings menu, the connection parameters can be set and the connection can be changed. To terminate an existing connection, press and hold this button for approx. 3 sec.

(e) 
Returns to the previous menu, or a current editing of parameters is cancelled. Pressing several times leads back to the start page.

(f) 
Enters the system menu, with the available function "Memory", "Connect", "USB", "CAL", "Factory".

C: Numeric keys

The numeric keys are divided into numeric mode and letter mode according to the different parameter input modes. The numeric input mode can be selected according to the key for entering digits. In letter mode, the numeric key corresponding to the letter must be clicked to enter and then touch the letter or decimal point displayed on the screen to enter.

If the input content is incorrect and needs to be changed, click ← to correct. When entering of parameters is finished, click **Enter** to save.

D: Shuttle key

The shuttle key is used in the parameter editing state to configure and confirm parameter settings by rotating and pressing. Configurable parameters include Voltage, DIV, AVG in the Sample option; Cursor-L, Cursor-R, Thr in the Compare option; and Baud Rate, Data Bit, Parity, Stop Bit in the RS232 option under Connect. It can control menu selection, including Memory submenu, Connect submenu, and USB submenu, as well as cursor position movement in the waveform display.

E: **START** is used to start high-voltage test and sampling, and it can be activated on the Sample, Test, Auto, TPM and auto calibration pages. When the light signal is the breathing light, the action can be triggered by pressing.

☞ **Caution:**

Please make sure that the test object is placed on the insulation platform before testing!

F: Power key

is used to turn on and off the power of the host. When pressing the power button and pressing down to turn on the power, the power light will be on to indicate that the host is on; when the power button is pressed to turn off the power, the power light will be off, indicating that the host is off..

G: USB slot

is used to connect a USB flash drive to read and export sample waveform data.

H: Test lead socket

Socket for the high-voltage terminal of the test lead. To avoid accidental contact at either end, please disconnect the test lead when not performing a test.

2.3 Overview Device Rear Panel

I: Test lead socket (HV+ Out)

This test lead socket is identical to the red high voltage connection test lead socket on the front of the instrument.

J: Test lead socket (HV− Out)

This test lead socket is identical to the black high voltage connection test lead socket on the front of the instrument..

K: Fan

It is used to regulate air circulation and dissipate heat from inside the device.

L: Expansion port

This is the expansion slot used to connect other equipment.

M: I/O

External pedal, light display, mode switch and other function controls.

N: RS-232

Connect to a computer via the RS-232 terminal for remote control, setting, testing, uploading and downloading data.

O: Network port (TCP/IP)

Connect to a computer through a network cable, you can perform remote control settings, tests, and upload and download data.

P: AC input power main switch

This is the AC power cable socket and the main power switch. The AC power cable is a three-wire socket, the power switch 0 is off; 1 is on. The AC fuse is included and the specification is AC250V/3A..

2.4 About the Surge Test

The ST 6600 surge tester can be used to test wound goods such as stators, rotors, transformers, etc. for insulation faults and pre-damage. The most significant difference between the surge test and all other EST tests (high voltage tests, insulation tests, etc.) is that there are no fixed thresholds to judge the test results as GOOD or FAIL. Instead, an electric oscillation gets excited within the DUT by a line surge. Then, the task is to judge the characteristics of the resulting oscillation!

Therefore, prior to performing any real testing, it must be evaluated how the oscillation of the DUT should look at all. For that purpose, several test runs with DUTs confirmed to be error free are performed. By averaging their oscillation curves, the so-called master curve is obtained. Later, when doing real world test runs, the measurement of the DUTs is compared to that master curve to decide if the result is GOOD or FAIL. The software evaluates the percental deviation of the measured curve to the master curve. The percentage of the maximally allowed deviation can be specified by the user.

From the appearance and shape of the vibration curve, or the deviations from the master curve, conclusions can be drawn about, for example:

– Inductivity of the DUT

– Quality factor Q,

– Differences in the number of turns,

– Material differences in the coil core,

– Winding shorts.

By using voltage surges with high voltage, the occurrence of corona discharges can also reveal insulation weaknesses in the windings that do not (yet) represent a winding short circuit.

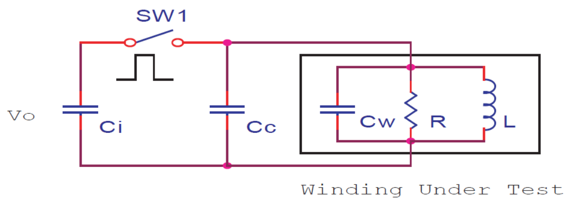


Fig. 1: Schematic diagram for the surge voltage test of a coil

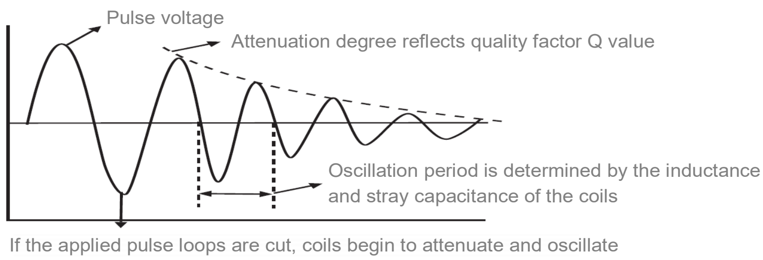


Fig. 2: Typical oscillation curve of the self-damping of a coil

2.5 Methods of evaluation

2.5.1 AREA

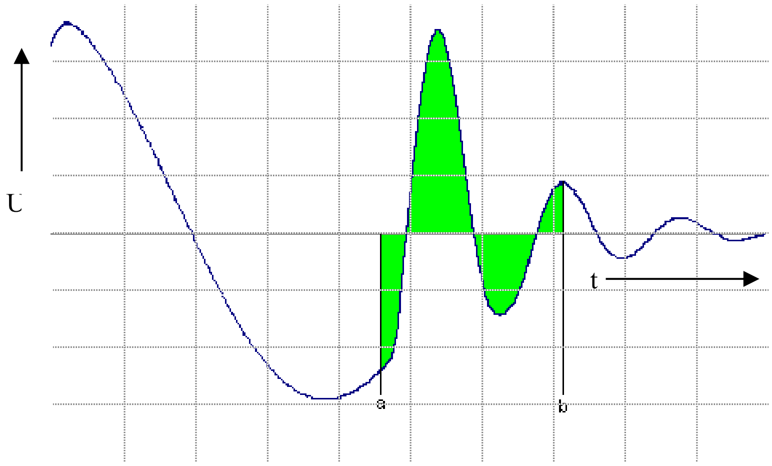


Fig. 3: Curve with evaluation of error area

Relevant for this method is the area included between a curve and the time axis. The area derived from the actually measured curve is compared to the area of the reference curve, and the percentual deviation is calculated.
Fig. 3 shows an example with fixed integral boundaries, between which the evaluation is done.
Mathematically, the used formula is this:

$$\frac{\int_a^b \left| U(t)\{\text{Prüfling}\} \right| dt}{\int_a^b \left| U(t)\{Master\} \right| dt} = A_{Fehler} \text{ in \%}$$

The areas of the reference curve and of the test specimen are computed. Subsequently, the deviation is calculated by division of the two areas, and indicated in per cent.

The cruical point for error detection is the size of the curve area. Phasing is not considered. Thus, the testing is sensitive to short-circuited coil, since the change of area size is proportional to the energy loss after the surge, and energy loss increases vastly due to short-circuit current.

The optimal result of this test is 100% (area of measured curve == area of reference curve).
The more the result becomes smaller or bigger than 100%, the more different the DUT is to the master.

2.5.2 DIFA

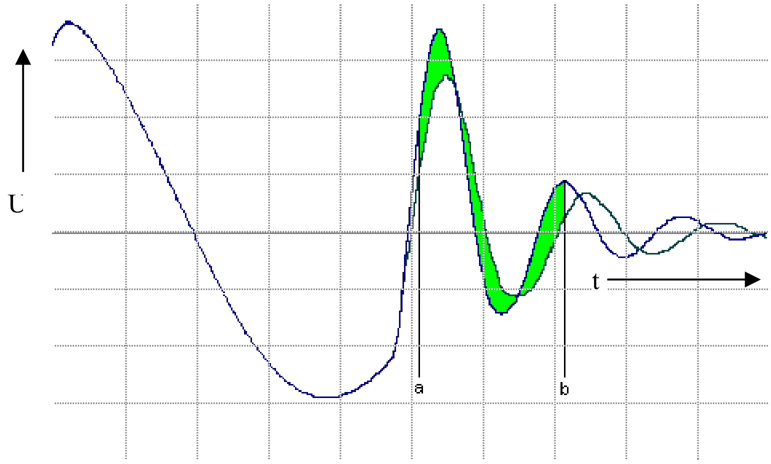


Fig. 4: Curves with differential error area

This method determines the difference area of master curve and specimen curve, then calculates the ratio of that difference and the area of the master curve. This method is more stringent than the error area method, in that it also evaluates phase shifts caused by winding tolerances. Therefore this method is used when uniformity of coil windings and inductive reactance is of major concern (e.g. exploring coils).
The evaluation of master curve's area is the same as used in the error area method, however instead of using the area of the measured curve, the difference between measured curve and master curve is calculated, and the area of this difference is used:.

$$\frac{\int_a^b \left(\left|U(t)\{Master\} - U(t)\{\mathrm{Pr}\,\ddot{u}fling\}\right|\right)dt}{\int_a^b \left|U(t)\{\mathrm{Master}\}\right|dt} = A_{Fehler} \text{ in } \%$$

The optimal result of this test method is 0% (measured curve shows no difference to the master curve).
The bigger the result's percentual value gets, the more different the DUT is to the master.

The relative size of the result is highly dependent on the amplitude of the master curve: if the amplitude of the master curve is rather small, then even relatively small deviations of the DUT may lead to "big numbers": results in range of 1000% are absolutely common..

Therefore, for this test method it is necessary ...

- to choose the voltage range as small as possible, so that the master curve has a sufficiently big extension in "y"-direction
- to place the evaluation period so that only the very first oscillations (after the swing-in transient) are measured, and not the swing-out transient.

2.5.3 Glow discharge – Corona N/S

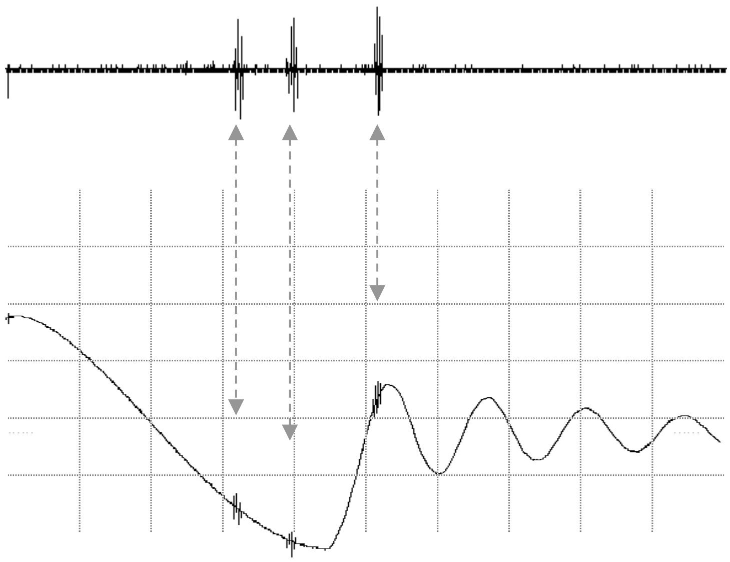
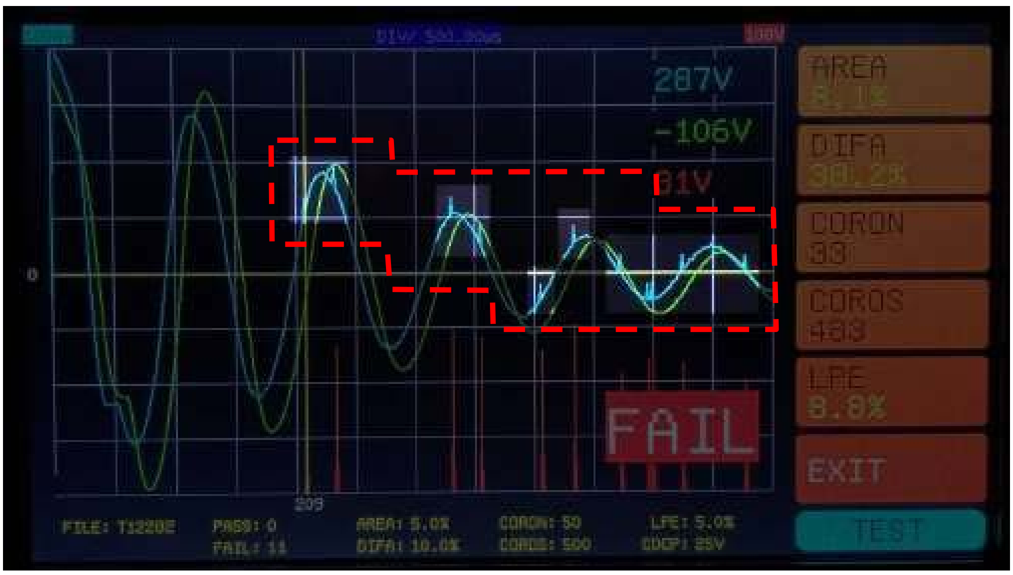


Fig. 5: Glow discharge

This method is mainly used to detect incipient wire insulation weaknesses inside the winding. which manifest by partial discharges, glow discharges (corona), and in extreme cases by arc-overs.
By means of a special mathematical procedure, the proportion of "high-frequency energy" (visible on the measured curve as "needles" or points) around the test curves is recorded and evaluated. This means - equivalent to an analogue circuit - to send the curve as a test function through a high-pass filter (differentiation). For evaluation, either the energy content (area) of the glow discharges can now be determined (method "CoronaS"), or the number of occurrences of glow discharges (method "CoronaN").



2.5.4 Inductance Percentage Error – LPE (Lenz Percentual Error)

In this procedure, the inductance value of the test object is determined and the difference between this value and the inductance of the master coil is set in relation to the master value. The ideal result of this test is as small as possible, i.e. almost zero.

Example:

Inductivity of the master coil: 90 µH
Measured inductivity of the DUT: 81 µH

Comparison: percentage error of the inductance values:

$$LPE = \frac{|90 - 81|}{90} \times 100\% = 10\%$$

2.5.5 Strength of Partial Discharge – CDCP

This procedure works similarly to the Corona-N/S evaluation, but here explicitly the strength of the peaks of the partial discharges is measured and evaluated. The threshold is specified in the unit Volt.
If all partial discharge deflections remain below the threshold during the measurement interval, the measurement is GOOD; as soon as a single measured value is above the threshold, the result is FAIL.

3 Putting int Operation

3.1 Requirements

The surge tester ST 6600B as well as all of the electric connections and lines must be in operational and reliable condition.
The General Safety Regulations (pl. see chapter Fehler! Verweisquelle konnte nicht gefunden werden.**) and the generally applicable legal rules as well as other binding directives for industrial safety, for accident prevention and for the protection of the environment have to be adhered to and persons staying in the area of operation must be informed respectively.**

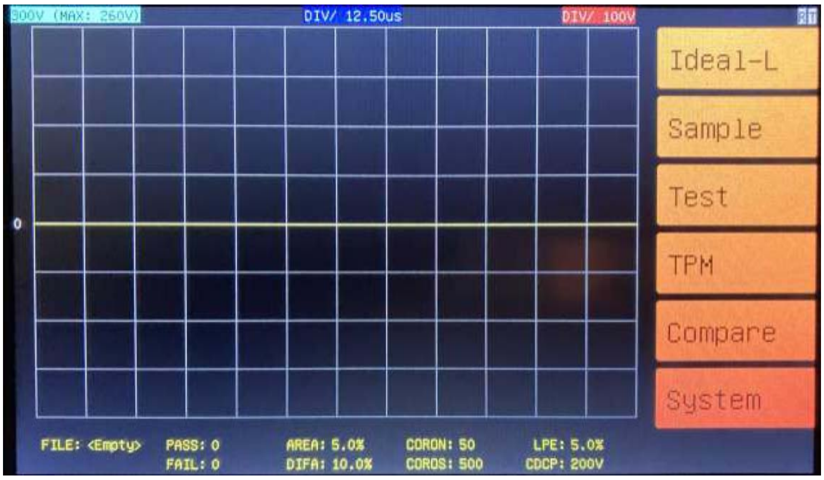
There is danger to life caused by electric current or voltage in case of handling electric installations inappropriately!

3.2 Connection of device

1. If necessary, switch off the power switch on the test device
2. Plug the power cable of the test device into the power socket on the back of the device
3. Connect the power cable to the power supply
4. Connect the high-voltage test cable to the HV+/ HV− sockets on the front of the device.
5. Connect the test cables to the DUT as required.

3.3 Switching the Device ON

The ST6600 is switched ready-for-operation with the power switch on the back of the unit. Then the tester can be started with the "Power" button on the front panel. First, the tester initialises itself and performs a self-test. After approx. 2 seconds, the initialisation is completed and the unit comes up with the main screen display.

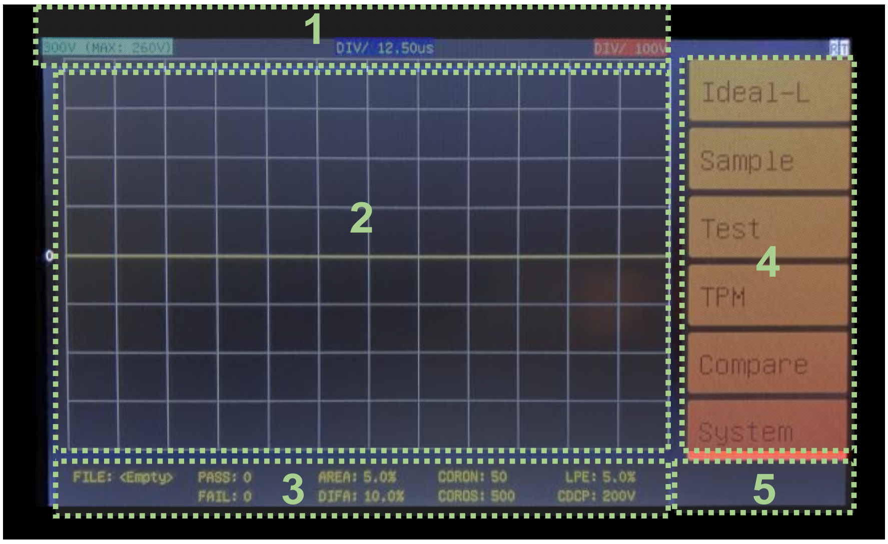


3.4 Switching the Device OFF

To switch off the ST6600, the blue "Power" button on the front panel must first be pressed. The device saves the current status of its system parameters, and then switches off (standby state). The device can then be switched off using the power switch on the rear panel.

4 Operation, Functions of the Device

4.1 Overview Main Screen



1 Parameters of the upper line

(a) Voltage range (left, cyan) – shows the range of values for displaying the test voltage. This value is automatically selected slightly larger than the currently set test voltage in order to be able to display the complete surge curve.

(b) DIV / µs (middle, blue) – shows the division of the horizontal axis for the currently set sample speed.

(c) DIV / V (right, red) – shows the division of the vertical axis for the representation of corona discharges.

2 Display range for Surge Curves

The "Oscilloscope" display area consists of 8 vertical and 12 horizontal grids. Several surge curve diagrams can be displayed simultaneously for visual comparison:

- white represents the ideal "ideal-L" waveform,
- green represents the master curve,
- cyan represents the last measured surge curve,
- red represents the measured corona discharges.

3 Parameters of the lower line

Among other things, the currently set limit values are displayed here.

(a) File: <file name>

Displays the name of the master curve read from memory or USB, or <empty> if the master curve is not saved.

(b) PASS/FAIL: Number of tests passed/failed

Here, the number of PASSS and FAIL tests are continuously counted during test operation.
These counters continue to run as long as tests are performed with the same master curve. If another master curve is called up, the counters are reset to zero and restarted.

(c) AREA / DIFA / CORON / COROS / LPE / CDCP:

The currently set limit values for the respective comparison methods are displayed here.
If one or more of the comparison methods is deactivated, this is indicated by "–" or "–%".

4 Function keys

In the right-hand screen area 6 function keys are displayed, which are used to call up the various functions of the device. Additional function keys may be displayed for extended entries.

Ideal-L – serves to generate an "ideal" surge curve of an "ideal" inductance

Sample – serves to record a surge curve which is then used as master curve

Test – switches to test mode, in which DUTs are compared against the master curve

Auto – automatic determination of the sampling frequency suitable for the DUT, for determining the master curve (only via the function key of the mechanical keypad)

TPM – "Three Phase Motor Testing" - special test mode in which the phases of 3-phase test specimens can be recorded and compared with each other.

Compare – Setting the test procedures and threshold values used in the test module

System – Access to the system menu, where various device settings can be made

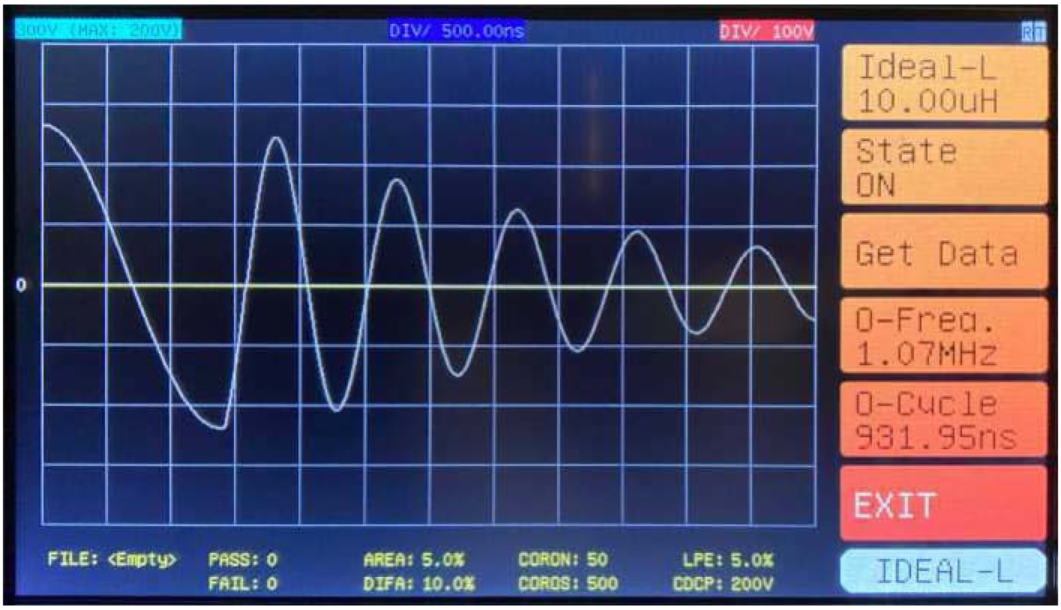
5 Status display

Here the current operating mode of the device is displayed.
There are the five states "Ideal-L", "Sample", "Test", "Auto" and "TPM"

4.2 Function Overview

From the main screen, the following functions can be accessed:
Ideal Inductance, Sample, Test, TPM, Compare and System. Various functions can be entered and follow-up actions can be performed using the touch and click controls on the screen.

4.2.1 "Ideal-L"



(a) Click the "Ideal-L" button to display the ideal oscillation curve at a given inductance value. After calling the function, "Ideal-L" must be clicked again to enter the inductance value. The input range should be chosen larger than 10 µH.
Ideally, the inductance value of the DUT type to be tested should be selected here in order to be able to make a meaningful comparison.

(b) The "Status" option can be used to activate or deactivate the display of the ideal L-waveform of the ideal inductance. If the status is "ON", this curve is then superimposed on the master curve on the screen during sampling.

(c) In addition, the values "O-Freq. (frequency of the oscillation curve) and "O-Cycle" (time period for one oscillation period) are displayed as well.

4.2.2 "Sample"

After pressing the "Sample" key, the screen shown below appears. This is used to record a new master curve. First, the test voltage, sample speed, and sample-averaging are set when sampling the master curve. The parameters are set using the six function keys on the right of the display:

Voltage: Setting the test voltage. This value is set with the rotary wheel. The available range is 200 V ~ 6000 V, adjustable in steps of 100 V.

DIV: Setting the sampling speed (sample rate) of the A/D converter. This value is set with the rotary wheel. The available range is 250 ns/div ~ 25 ms/div.

AVG: Setting the number of voltage surges (and averaging). During the execution, several voltage surges are triggered one after the other, and the curve data recorded in each case are mediated with each other. (Range: min=1 surge, max=15 surges).

When the test parameters are set as desired, the master curve can be recorded by pressing the **START** key.

Freq.: After recording the master curve, the determined frequency of the oscillation curve is displayed. This value is purely informative and cannot be changed.

Lenz: After recording the master curve, the determined inductance of the DUT is displayed. This value is purely informative and cannot be changed.

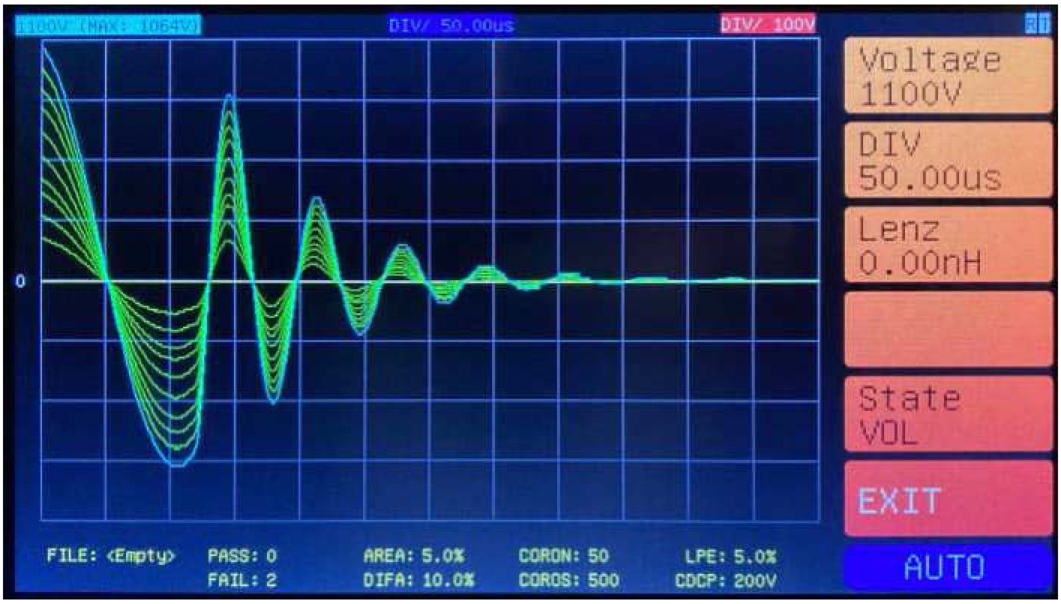
4.2.3 "Auto"

This function can only be called up via the function key of the mechanical keypad on the right.

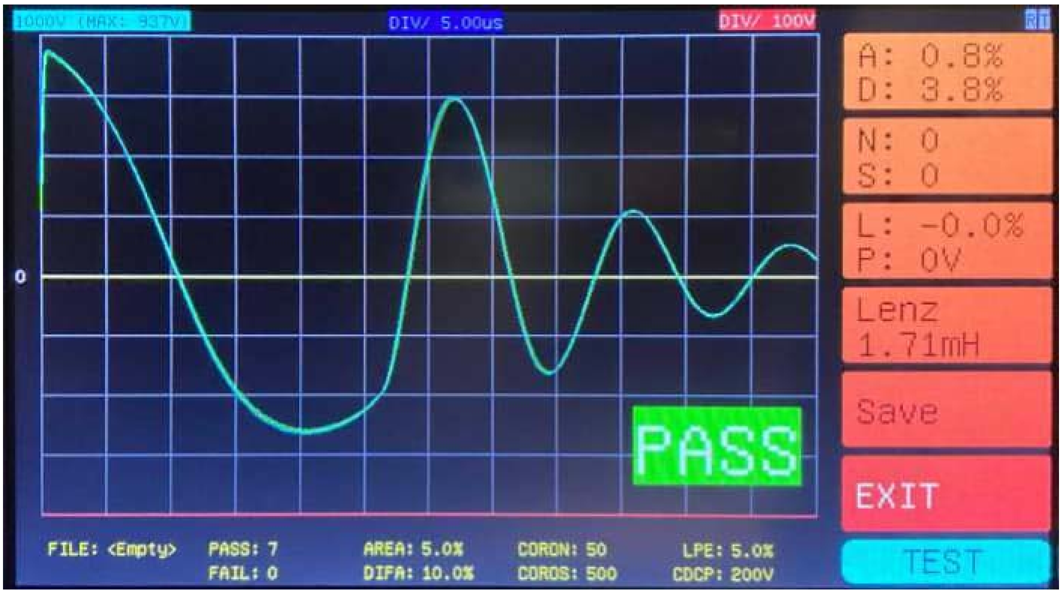
This function can be used to automatically set the sampling rate so that a suitable, "sensible" range for the sampling rate can be quickly obtained for the type of DUT currently connected.

In the "DIV" status, the device waits for a voltage pulse to be triggered with the **START** key. With several pulses, all available DIV ranges are now analyzed and a suitable range for DIV is automatically determined. The display is updated according to the result.

In VOL mode, starting from the current voltage range, 10 successive voltage ranges are sampled with an increment of 100 V each, while the sampling rate remains unchanged. The acquired data is displayed simultaneously on the screen:



4.2.4 "Test"



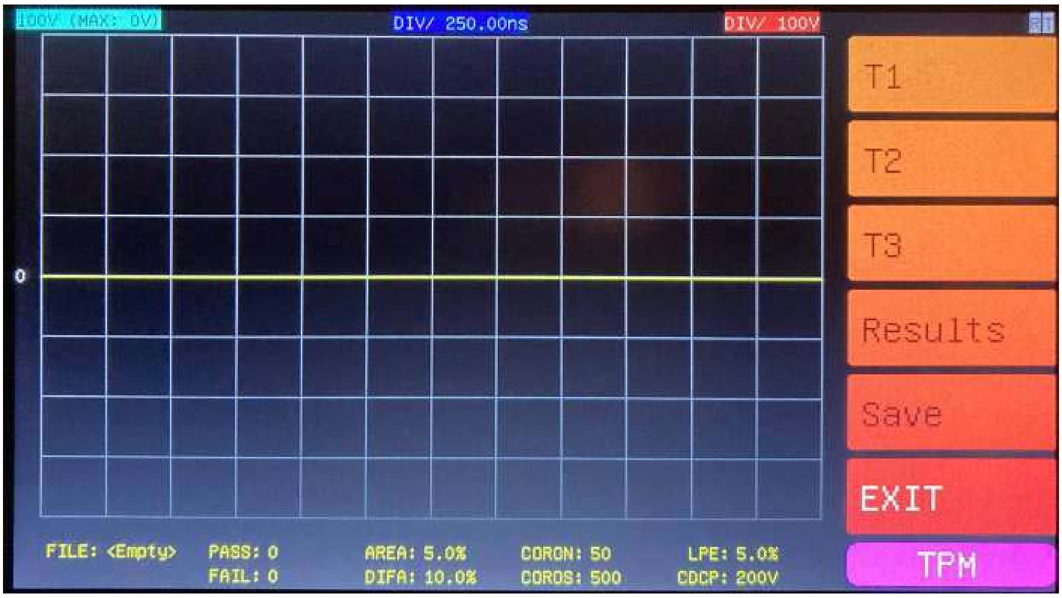
(a) Before calling the test function, a master curve must have been determined (SAMPLE) or a stored master curve must have been loaded. In the COMPARE menu, at least one comparator – or several – must be activated for evaluation.

(b) Connect the coil to be tested with the terminals to HV+ and HV-, then the test can be performed with the **START** button. Afterwards, the PASS/FAIL result is displayed, which is determined after analysis and evaluation of the various measured values and test criteria.

(c) If a USB memory is connected, the measured curve with all data may be saved automatically (depending on the setting in *System/USB/Test/Auto Save*), or the curve can also be saved manually with the "Save" button.

4.2.5 "TPM" – Three-Phase Motor Testing

In this menu you can select T1, T2 or T3 for testing different phases. The tests should be performed in order from top to bottom. The results, either in text or waveform comparison, are displayed in the "Results" section.

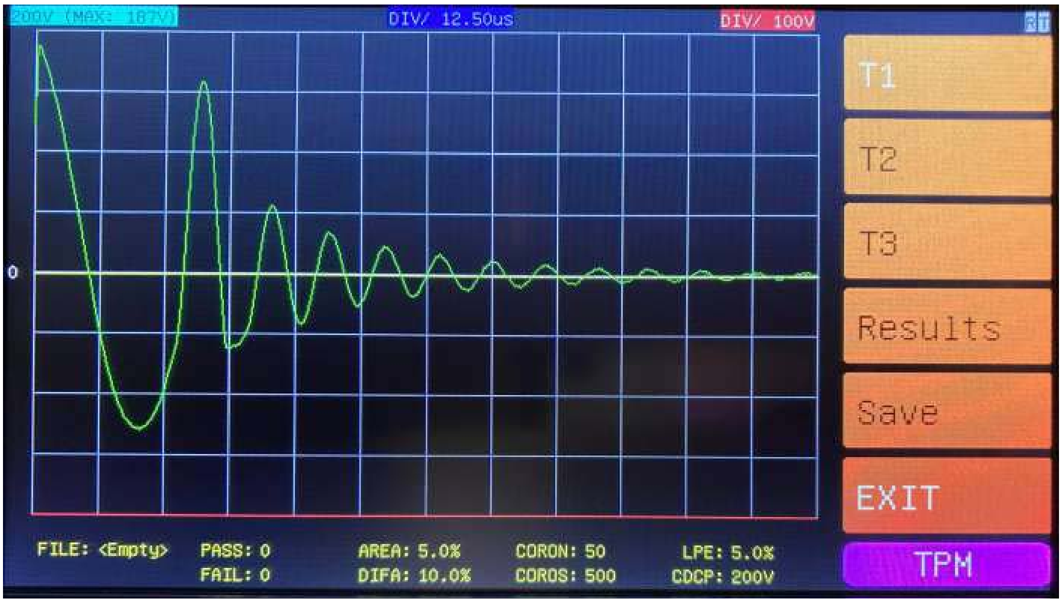


(a) T1 Sampling

First click on the T1 function area, the text in the button will turn white, this shows that T1 capture mode is now active. Press the **START** button to obtain the T1 surge curve.

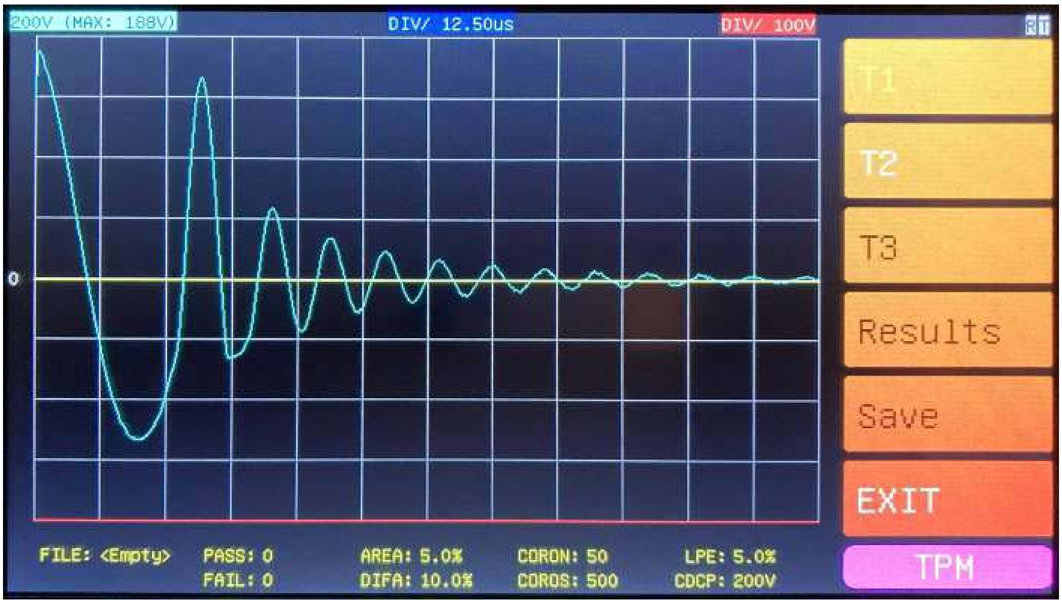
When the surge curve sampling is complete, the text in the button will turn yellow, indicating that the sampling is complete. The T1 surge curve is displayed in GREEN and the corona discharge is displayed in RED.

⇛ This step deletes the T1, T2 and T3 data and comparison results from a previous measurement, and now serves as the starting point for a new 3-phase comparison measurement.



(b) T2 Sampling

Click the T2 button to enter the T2 acquisition mode. Press the **START** button to obtain the T2 surge curve. The T2 surge curve is displayed in CYAN and the corona discharge in RED. If the result of the recording is not as expected, this step can also be repeated.



(c) T3 Sampling

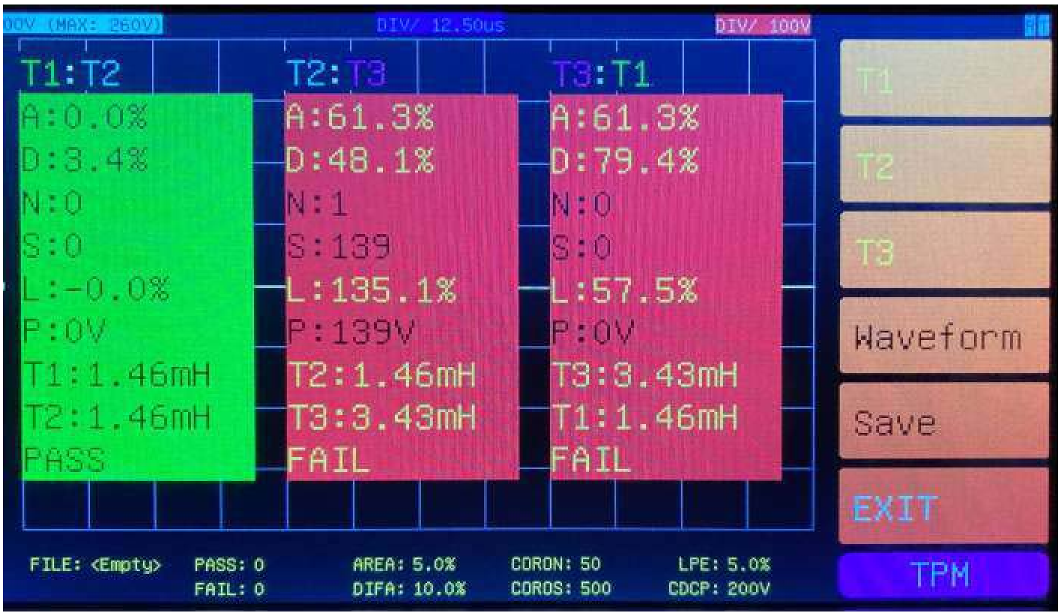
Click the T3 button to enter the T3 acquisition mode. Press the **START** button to obtain the T3 surge curve. The T3 surge curve is displayed in MAGENTA and the corona discharge in RED. If the result of the recording is not as expected, this step can also be repeated.

(d) Results: Comparison and Analysis

When the T1, T2 and T3 recordings are completed, click on this step to enter the analysis status. The first display of the analysis result is in text mode.

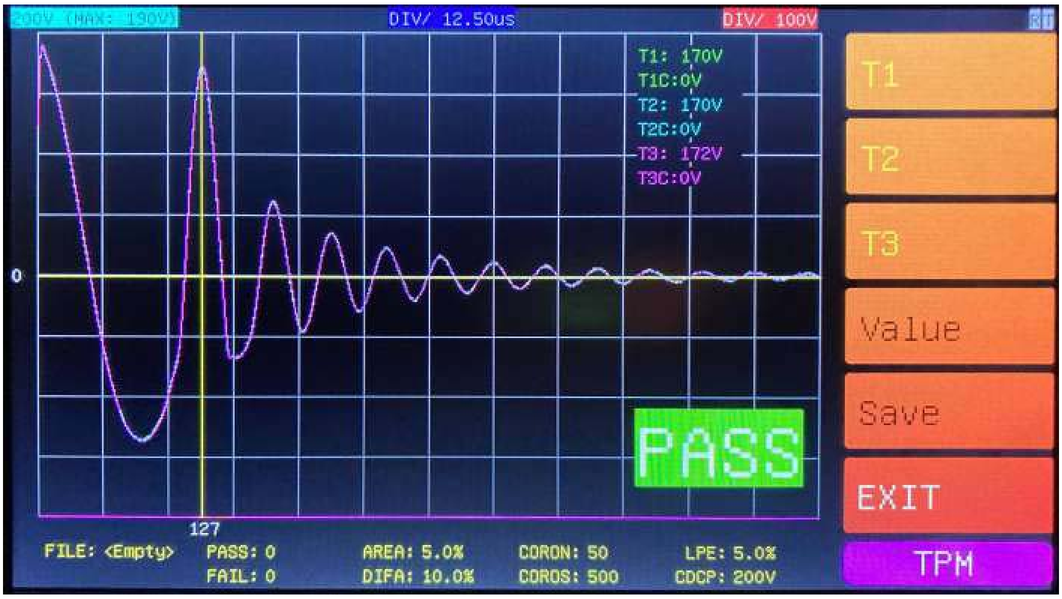
i. Value Text Display Result

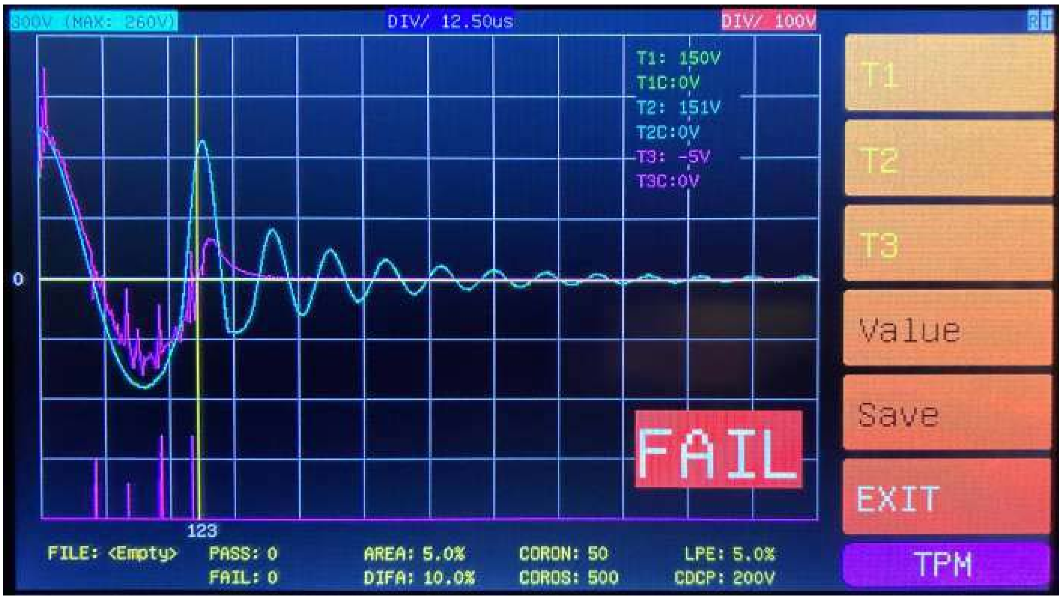
From left to right, the comparison results between T1↔T2, T2↔T3 and T3↔T1 are shown. Each section shows the following: A: area sum, D: area difference, N: corona discharge count, S: corona discharge level, L: inductance percentage error, P: corona discharge waveform detection, both inductance values and the comparison result from the section. When the results of each element are within the threshold range, the text is displayed in black and the background color of the section is green, indicating a good test. If the results exceed any one of the threshold values, the text is displayed in yellow and the background color of the section is red, signaling a FAIL test.



ii. Waveform Graph Display Result

The screen simultaneously displays the shock curves and corona discharges of T1, T2 and T3. T1 is represented by green, T2 by cyan and T3 by magenta. Using the touchscreen cursor or shuttle key, you can view the parameter values of specific points in the waveform. The overall result of the comparison is displayed in the lower right corner of the screen and shows a green "PASS" if the comparison was successful or a red "FAIL" if it was not.





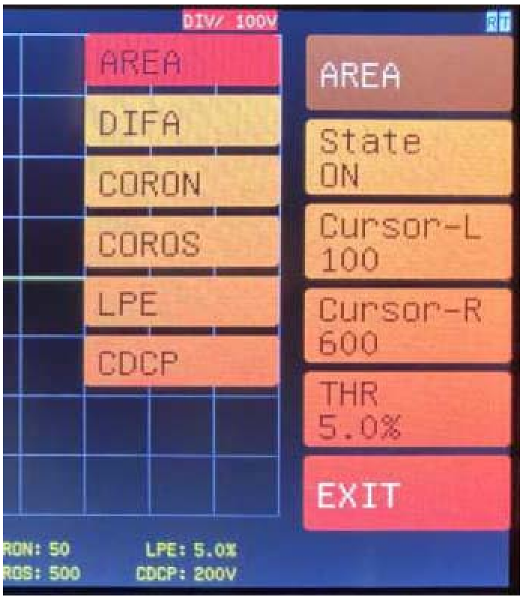
(e) Save: Manual Waveform Data Storage

After the comparison analysis, the system automatically detects a USB device and saves the waveform data. You can also save the waveform data manually by clicking the "Save" function button on the screen.

4.2.6 "Compare"

This is where the selection and parameterization of the evaluation procedures that are subsequently to be used in the test module takes place. After pressing the "Compare" key, the screen shown below appears. The parameters are set using the six function keys on the right of the display.

AREA, DIFA: Error Area / Differential Error Area



STATE: ON/OFF: The respective evaluation can be activated or deactivated by toggling it on or off.

CURSOR-L: sets the left limit of the time interval that is evaluated. The limit can be changed with the rotary wheel.

CURSOR-R: sets the right limit of the time interval that is evaluated. The limit can be changed with the rotary wheel.

Note: Cursor-L and Cursor-R apply identically to both evaluation methods, i.e. they cannot be set independently of each other.

THR: Setting the limit values for the respective evaluation procedure. The values are again set using the rotary wheel.

AREA – thresholds: min = 0.1%, max = 99.9%
DIFA – thresholds: min = 0.1%, max = 99.9%

CORON, COROS: Corona discharges number / energy

STATE: ON/OFF: The respective evaluation can be activated or deactivated by toggling it on or off.

CURSOR-L: sets the left limit of the time interval that is evaluated. The limit can be changed with the rotary wheel.

CURSOR-R: sets the right limit of the time interval that is evaluated. The limit can be changed with the rotary wheel.

Note: Cursor-L and Cursor-R apply identically to both evaluation methods, i.e. they cannot be set independently of each other.

THR: Setting the limit values for the respective evaluation procedure. The values are again set using the rotary wheel.

CoroN – thresholds: min = 1, max = 999.
CoroS – thresholds: min = 1, max = 9999.

LPE: Inductivity Comparison (Lenz Percentual Error)

STATE: ON/OFF: The LPE evaluation can be activated or deactivated by toggling the state on or off.

THR: Setting of the limit value for the max. permitted percentage deviation. The value is set with the rotary wheel.

CDCP: Partial Discharge Strength

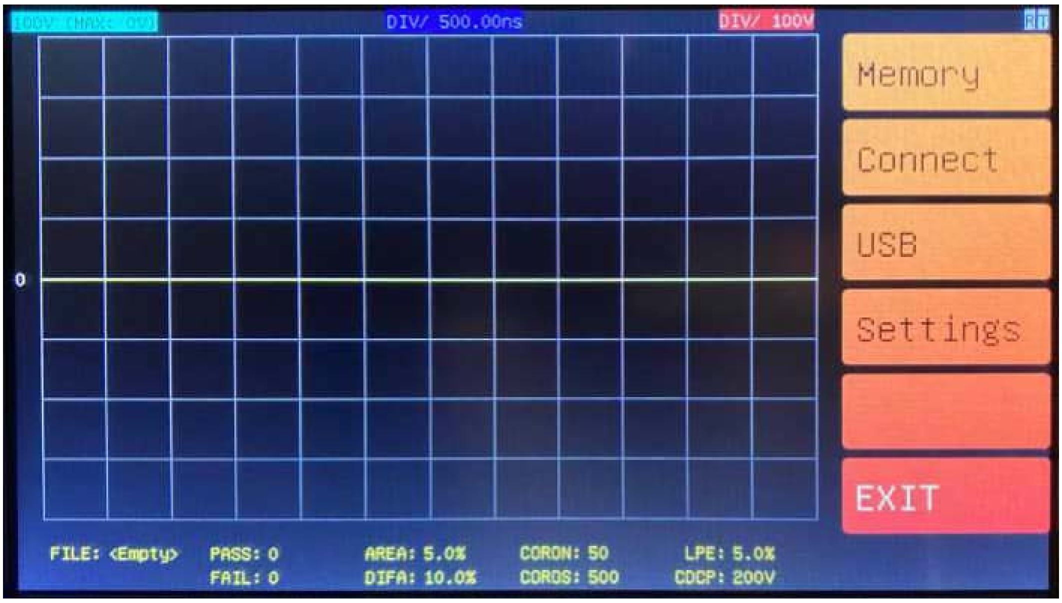
STATE: ON/OFF: The CDCP evaluation can be activated or deactivated by toggling the state on or off.

THR: Setting of the limit value for the max. allowed size of voltage peaks. The value is set with the rotary wheel.

DIV: Setting the vertical scaling (per grid line) for the display of the voltage peaks.

4.3 System

System options include "Memory" for internal storage of master curves, "Connect" for remote control via a network connection, "USB" for saving & loading master curves to external memory, and "Settings" for configuration.



4.3.1 Memory

The internal memory of the device has 20 memory slots for master curves. Both the waveform and the associated test parameters of the master curve are saved.
When saving, a file name must be assigned for the curve, this can be max. 7 characters long.

4.3.2 Connect

This menu allows setting the RS232 and TCP/IP connection parameters. All changes of the connection parameters are recorded in the internal memory, the settings are retained even after a restart or switching the device off and on again.

STATE: ON/OFF: This switches the remote control mode on, or off again.

Attention: When the remote control mode is activated, manual operation of the device is no longer possible! To exit the remote control mode again, the STATE button or the Connect function key must be pressed for a long time (approx. 5 seconds).

STYLE: TCP/IP / RS232: Selection of which interface is used for communication with the PC.

Setup: Setting the interface parameters.

RS232:

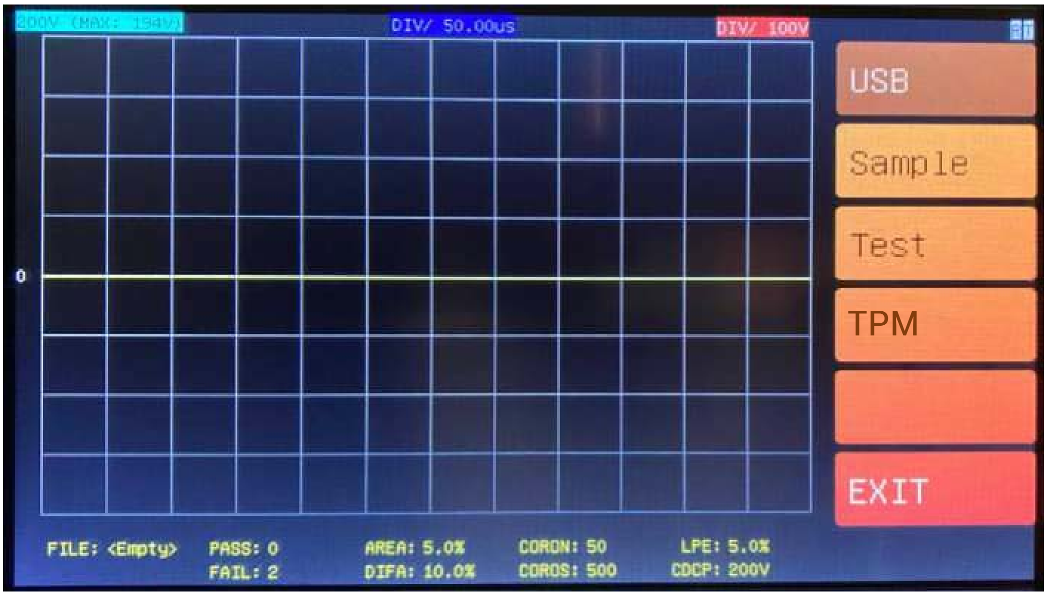
Baud Rate: Setting of the transmission speed, possible values are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 74880, **115200**, 230400, 250000.
Data Bit: Setting of the number of data bits per word, possible are 5, 6, 7, **8**.
Parity: Setting of the parity bit for error control. Possible are Even, Odd, **None**.
Stop Bit: Setting of the number of stop bits per word, possible are **1**, 2.
Time Out: Waiting time setting, the setting range is 1 - 60000 ms (default 100 ms)

TCP/IP:

IP: Assignment of the network address of the device, range 0.0.0.0–255.255.255.255 (default **192.168.0.60**)
Port: Determination of the communication port, range 0– 65535 (default **6060**)

4.3.3 USB

With the USB memory function, master curves can be saved, loaded and deleted. In addition, automatic storage of surge curves measured during testing can be activated. All types of curve data are saved in CSV format.



Data format of master curves

Curve	Format of Data in CSV	
Master curve	vvvv,vvv.vvu,vvv.vvu **\r\n** dddd,dddd,dddd...	v(value): Sampling voltage v(value)/u(unit): Sampling rate v(value)/u(unit): Inductance value \r\n: new line d(data): 600 data separated by commas

Data format of measured curves (1-phase)

Curve	Format of Data in CSV	Explanation
test curve	vvvv,vvv.vvu,vvv.vvu,	v(value): Sampling voltage v(value)/u(unit): Sampling rate v(value)/u(unit): Test inductance
	a,lll,rrr,aa.a,aa.a,	a(0/1): Area sum enable status l(AREA-L): Area sum start position r(AREA-R): Area sum end position a(AREA-THR): Area sum threshold a(AREA-RES): Area sum result value
	f,lll,rrr,ff.ff,ff.f,	f(0/1): Area difference enable status l(DIFA-L): Area difference start position r(DIFA-R): Area difference end position f(DIFA-THR): Area difference threshold f(DIFA): Area difference result value
	n,lll,rrr,nnn,nnn,	n(0/1): Corona count enable status l(CORON-L): Corona count start position r(CORON-R): Corona count end position n(CORON-THR): Corona count threshold n(CORON): Corona count result value
	s,lll,rrr,ssss,ssss,	s(0/1): Corona sum enable status l(COROS-L): Corona sum start position r(COROS-R): Corona sum end position s(COROS-THR): Corona sum threshold s(COROS): Corona sum result value
	l,ll.l,ll.l,	l(0/1): Inductance percentage error enable status l(LPE-THR): Inductance percentage error threshold l(LPE): Inductance percentage error result value
	c,cccc,cccc,ccc **\r\n**	c(0/1): Corona waveform detection enable status c(CDCP-THR): Corona waveform detection threshold c(CDCP): Corona waveform detection result value c(CDCP): Corona waveform detection display threshold upper limit **\r\n**: New line
	tttt,tttt,tttt... **\r\n**	t(TEST Data): 600 test data samples (DUT)
	ssss,ssss,ssss... **\r\n**	s(SAMPLE Data): 600 sample data samples (Master)
	cccc,cccc,cccc...	c(TEST-Coro Data): 600 test corona data samples (DUT)

Data format of measured TPM-curves (3-phase)

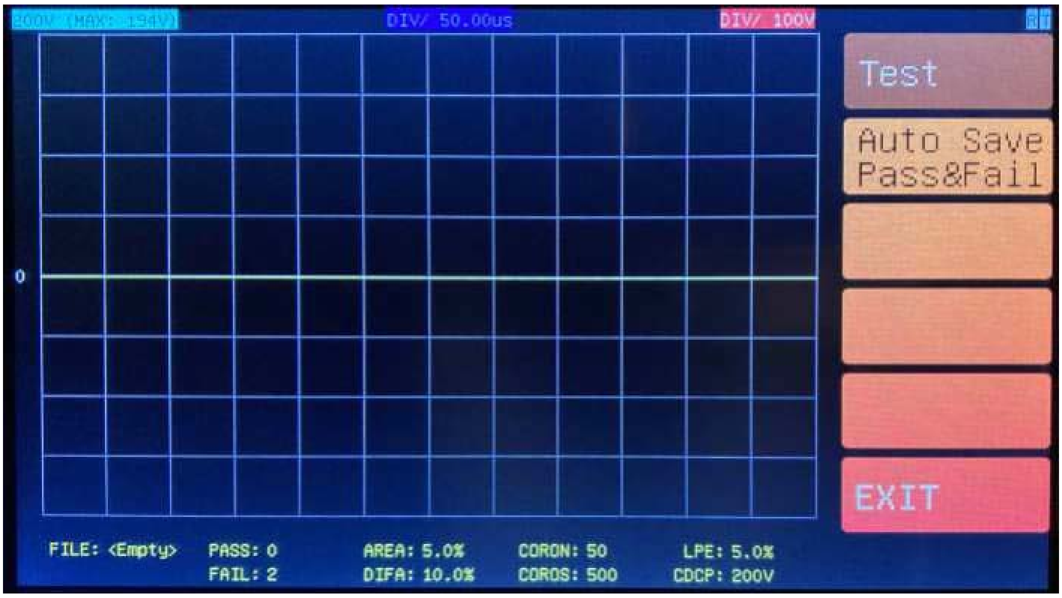
Curve	Format of Data in CSV	Explanation
TPM-curves	vvvv,vvv.vvu,vvv.vvu,	v(value): Sampling voltage
		v(value)/u(unit): Sampling rate
		v(value)/u(unit): Test inductance
	a,lll,rrr,aa.a,aa.a,	a(0/1): Area sum enable status
		l(AREA-L): Area sum start position
		r(AREA-R): Area sum end position
		a(AREA-THR): Area sum threshold
		a(AREA-RES): Area sum result value
	f,lll,rrr,ff.ff,ff.f,	f(0/1): Area difference enable status
		l(DIFA-L): Area difference start position
		r(DIFA-R): Area difference end position
		f(DIFA-THR): Area difference threshold
		f(DIFA): Area difference result value
	n,lll,rrr,nnn,nnn,	n(0/1): Corona count enable status
		l(CORON-L): Corona count start position
		r(CORON-R): Corona count end position
		n(CORON-THR): Corona count threshold
		n(CORON): Corona count result value
	s,lll,rrr,ssss,ssss,	s(0/1): Corona sum enable status
		l(COROS-L): Corona sum start position
		r(COROS-R): Corona sum end position
		s(COROS-THR): Corona sum threshold
		s(COROS): Corona sum result value
	l,ll.l,ll.l,	l(0/1): Inductance percentage error enable status
		l(LPE-THR): Inductance percentage error threshold
		l(LPE): Inductance percentage error result value
	c,cccc,cccc,ccc **\r\n**	c(0/1): Corona waveform detection enable status
		c(CDCP-THR): Corona waveform detection threshold
		c(CDCP): Corona waveform detection result value
		c(CDCP): Corona waveform detection display threshold upper limit
		\r\n: New line
	tttt,tttt,tttt... **\r\n**	t(T1 Data): 600 records of T1 data
	tttt,tttt,tttt... **\r\n**	t(T2 Data): 600 records of T2 data
	tttt,tttt,tttt... **\r\n**	t(T3 Data): 600 records of T3 data
	cccc,cccc,cccc... **\r\n**	c(T1-Coro Data): 600 records of T1 corona data
	cccc,cccc,cccc... **\r\n**	c(T2-Coro Data): 600 records of T2 corona data
	cccc,cccc,cccc...	c(T3-Coro Data): 600 records of T3 corona data

Saving of Master Curves

Call up the "Sample" item in the USB menu to manage master curves. You can manually save, load and delete the files in the _SAMPLE folder. The saved content includes the curve data and parameter information in CSV file format. The file name for saving can be a maximum of 8 characters.

Saving of Measured Curves

In the USB menu, access the "Test" item to manage measured curves. When "Auto Save" is set to ON, all measured curves (either PASS, or FAIL, or PASS and FAIL) are saved in the _TEST folder (simple curves) or in the _TPM folder (3-phase curves) as CSV files. The file name is "T+Serial number" for simple curves, and "M+Serial number" for 3-phase TPM curves.

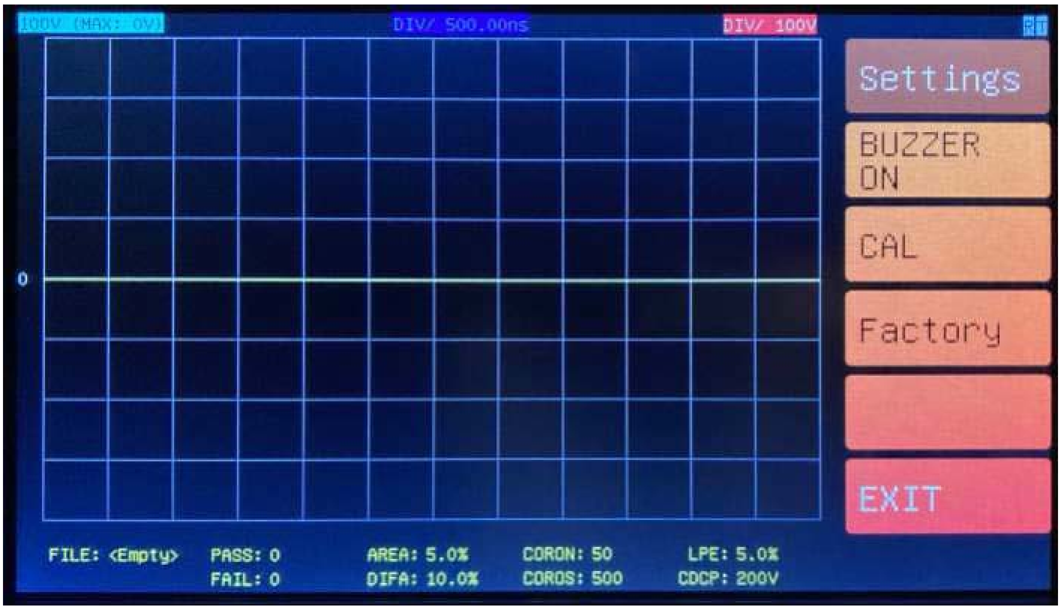


Note:

If you enable continuous auto-save, please make sure not to save more than 1000 files in the _TEST folder to avoid read delays.

4.4 Settings

In the "Settings" menu, you can switch the buzzer on or off, perform an automatic voltage calibration, or reset the device to the factory settings.



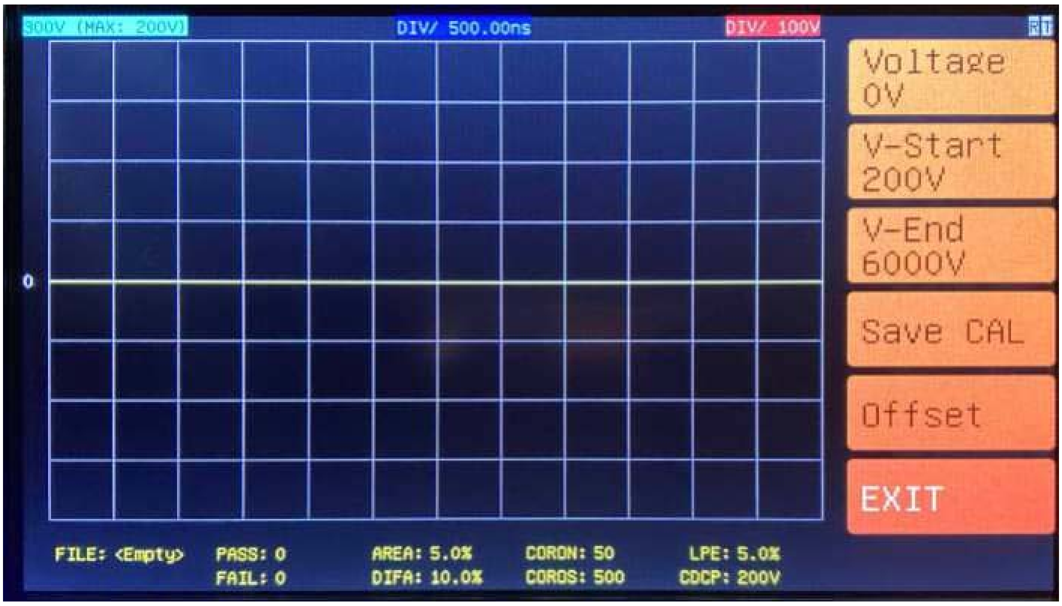
Buzzer

The buzzer can be switched ON or switched OFF. When the buzzer is ON, a 50 ms short beep sounds during PASS tests and a 500 ms long beep sounds during FAIL tests.

CAL

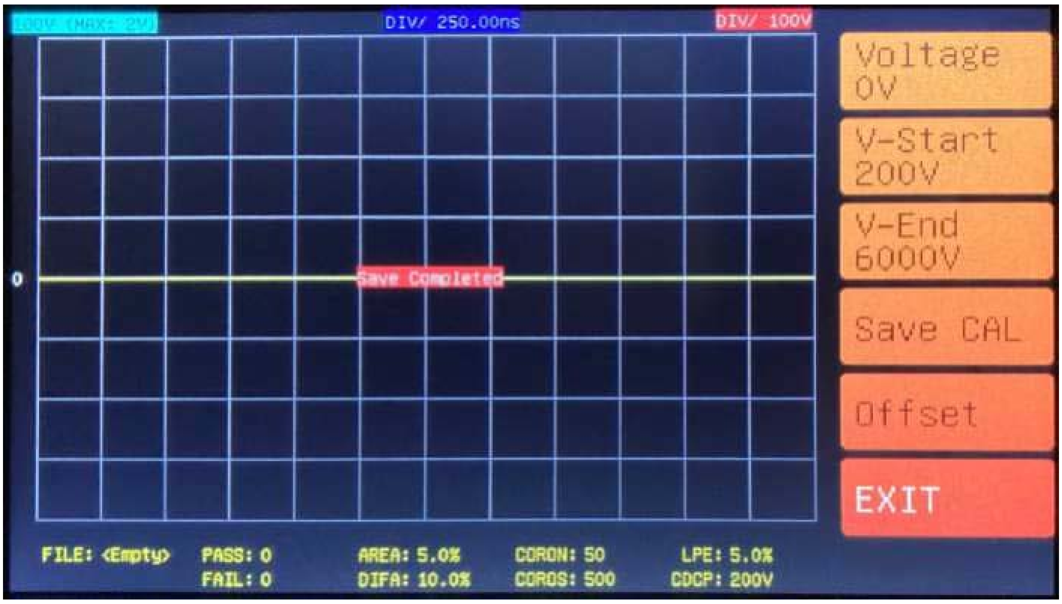
Pressing the **START** - key activates the automatic calibration function. The instrument calibrates all 59 available voltage values from 200 V to 6000 V and balances them. This process takes about 15 minutes. It is also possible to specify a different start voltage (V-Start) and end voltage (V-End) to calibrate only within a certain voltage range, thus reducing the calibration time. The calibration data is stored in the internal memory and will not be reset the next time the instrument is turned on. When a connected USB media is detected, a file named CAL.csv is also saved in the _CAL folder. If there are files with the same name and format in this folder, they will be overwritten and updated directly.

CAUTION:
Remove the high-voltage cables before performing the automatic calibration!



Save CAL

This function can be used to manually save the calibration data currently stored in the device to the USB medium, e.g. if no USB medium was connected during the last calibration. If the _CAL folder already contains the same file, the file will be overwritten for updating.

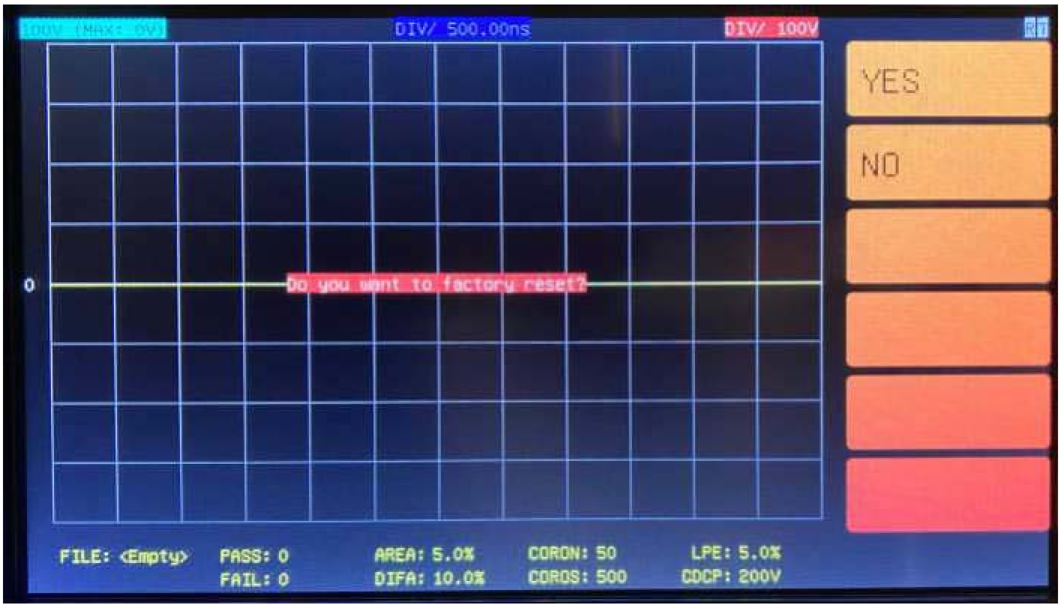


Offset

If the waveforms are vertically offset from the center (zero axis), use the OFFSET function. The instrument will compensate for the offset internally, and the calibration data will be updated and stored exactly as with CAL.

Factory

Restore the factory settings. All device parameters are reset to the default settings. The default parameter values are listed in the following table. After completing the factory settings, the system restarts and reloads the parameters.



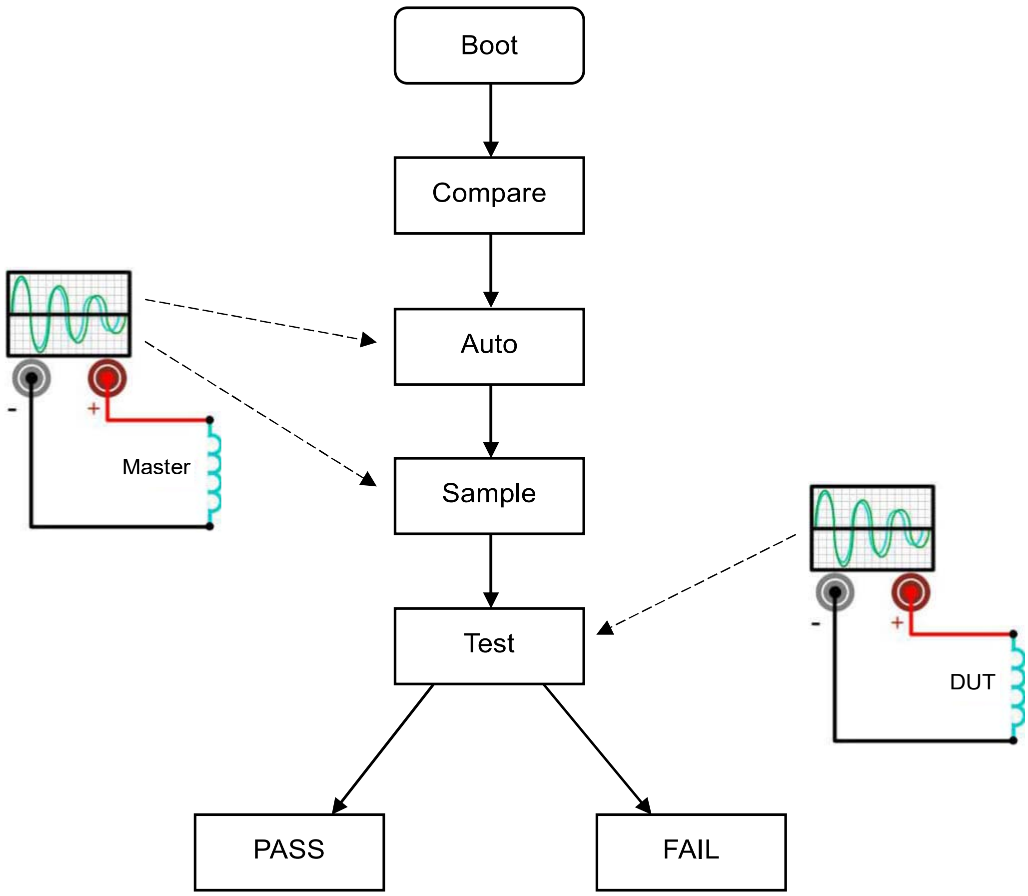
4.4.1 Standard Values of Factory Settings

Kategorie	**Unterkategorie**	**Parameter**	**Standardwert**
Ideal-L	—	Ideal-L	10 µH
Sample	—	Voltage	200 V
Sample	—	DIV	250 ns
Compare	AREA	State	ON
Compare	AREA	Cursor-L	100
Compare	AREA	Cursor-R	600
Compare	AREA	THR	5.00%
Compare	DIFA	State	ON
Compare	DIFA	Cursor-L	100
Compare	DIFA	Cursor-R	600
Compare	DIFA	THR	10.00%
Compare	CORON	State	ON
Compare	CORON	Cursor-L	100
Compare	CORON	Cursor-R	600
Compare	CORON	THR	50
Compare	COROS	State	ON
Compare	COROS	Cursor-L	100
Compare	COROS	Cursor-R	600
Compare	COROS	THR	500
Compare	LPE	State	ON
Compare	LPE	THR	5.00%
Compare	CDCP	State	ON
Compare	CDCP	THR	200 V
Connect	—	State	OFF
Connect	—	Style	RS-232
Connect	RS-232	Baud Rate	115200
Connect	RS-232	Data Bit	8
Connect	RS-232	Parity	None
Connect	RS-232	Stop Bit	1
Connect	RS-232	Time Out	100 ms
Connect	TCP/IP	IP	192.168.0.60
Connect	TCP/IP	Port	6060
Settings	USB/Test	Auto Save	ON

5 Workflow and Use

5.1 Flow diagram

1. Start the device, the main screen appears.
2. [COMPARE] Set the desired comparison parameters & comparators.
3. [AUTO] Connect the reference specimen (master), enter the Auto mode, automatically acquire the surge curve. You will get the surge curve display with the most optimal sampling rate possible.
4. [SAMPLE] Enter the sampling mode and capture the master curve (using the values generated by [AUTO] as a guide).
5. [TEST] Enter the test comparison mode. Connect the DUT to be tested, record the DUT waveform, this is compared with the master curve and the result is evaluated using the selected comparison parameters.



Annex

A USB Devices, and "Testing with High Voltage"

- During tests with high voltage, high-frequency interference frequencies can occur for short periods of time if the current DUT is faulty (because the test voltage "bleeds through" or "jumps over" at the weak point of the DUT); especially during surge voltage testing, high-frequency interference frequencies are generated quasi "by principle". The "spraying" that occurs for fractions of a second can then cause high-frequency interference frequencies that are radiated by the test leads according to the "antenna principle" and are received again by nearby USB leads.
- USB controllers are generally sensitive to stray radio frequencies, so in this case communication with USB devices can be disturbed. I.e. the USB controller can be disturbed by this in such a way that it remains in a non-functional state.
- If a USB device malfunctions after a high-voltage error occurs, it may be sufficient to disconnect the USB cable briefly and reconnect it after a few seconds. If the USB connection is still disturbed, it is necessary to switch the affected device(s) off and on again..

Affected situations and devices:

- basically any PC or comparable device that uses a USB connection and is in close proximity to a test with high voltage.
- especially such PCs, which control a tester via software DAT3805 or similar and are connected to the tester via USB.
- also testing devices themselves, if they use USB devices independently, e.g. USB keyboard, USB barcode scanner, USB stick for data exchange, ...

Measures to avoid disturbances:

- As far as possible, the greatest possible distance should be maintained between USB devices / USB cables on the one hand, and the DUT or test leads on the other.
  (Recommended minimum 30 cm, "the more the better" applies).
- The use of well-shielded USB cables with ferrite core choke is recommended.
  (This alone may not prevent the possibility of USB errors, but it may further reduce the likelihood of an error occurring).

B Description of Remote Commands

B-1 Command functions

*N	Function	Get the model.
	Return	ST-6K
	Example	⇒ *N ⇐ ST-6K
*I	Function	Get the system version.
	Return	v2.2.1.0
	Example	⇒ *I ⇐ v2.2.1.0
*R	Function	Restart the power supply and set the system, all parameters are set to default values.
	Return	*R
	Example	⇒ *R ⇐ *R
:STC	Function	Set screen touch function on and off
	Parameters	space 1/0
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒ :STC 0 ⇐ 0
:SIL	Function	Set the ideal inductance of the system.
	Parameters	space vvv.vu **v(value)** Positive integers to hundreds and two decimal places can be entered **u(unit)** Enterable units : n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Range	1n ~ 5
	Return	vvv.vu **v(value)** Displays positive integers to hundreds and two decimal places **u(unit)** display unit n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒ :SIL 1.00m ⇐ 1.00m
:SSV	Function	Set the system sampling voltage
	Parameters	space vvvv **v(value)** Enter a positive integer to thousands digit
	Range	200 ~ 6000
	Return	vvvv **v(value)** Displays positive integers to thousands
	Example	⇒ :SSV 3000 ⇐ 3000

:SST	Function	Set the system sample rate
	Parameters	space nn **n(number)** Positive values within the input range
	Range	0 ~ 15 0: 250n, 1: 500n, 2: 1.25u, 3: 2.5u, 4: 5u, 5: 12.5u, 6: 25u, 7: 50u, 8: 125u, 9: 250u, 10: 500u, 11: 1.25m, 12: 2.5m, 13: 5m, 14: 12.5m, 15: 25m
	Return	vvv.vu **v(value)** Displays positive integers to hundreds and two decimal places **u(unit)** Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒ :SST 1 ⇐ 500n
:SSN	Function	Set the average number of tests for the system
	Parameters	space nn **n(number)** Positive values within the input range
	Range	1 ~ 15
	Return	nn **n(number)** Displays positive values within the range
	Example	⇒ :SSN 5 ⇐ 5
:SCA	Function	Set the comparison method area sum (AREA) test on and off
	Parameters	space 1/0
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒ :SCA 1 ⇐ 1
:SCAL	Function	Setting the Cursor-L Range for the Comparative Area Sum (AREA) Test
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds in the range (cannot be greater than Cursor-R)
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒ :SCAL 0 ⇐ 0

:SCAR	Function	Setting the Cursor-R Range for the Comparative Area Sum (AREA) Test space
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds of digits in the range (cannot be less than Cursor-L)
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒ :SCAR 600 ⇐ 600
:SCAT	Function	Set the THR parameter for the comparison method area sum (AREA) test
	Parameters	space nn.n **n(number)** Positive numbers to ten digits and one decimal place can be entered in the range
	Range	0.1 ~ 99.9
	Return	nn.n **n(number)** Displays positive numbers to ten digits and one decimal place within the display range
	Example	⇒ :SCAT 10.5 ⇐ 10.5
:SCD	Function	Set the comparison method area difference (DIFA) test on and off
	Parameters	space 1/0
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒:SCD 0 ⇐ 0
:SCDL	Function	Setting the Cursor-L Range for Comparative Area Difference (DIFA) Tests
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds in the range (cannot be greater than Cursor-R)
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCDL 5 ⇐ 5

:SCDR	Function	Setting the Cursor-R Range for Comparative Area Difference (DIFA) Tests
	Parameters	space nnn **n(number)**: Enter a positive integer to hundreds of digits in the range (cannot be less than Cursor-L)
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCDR 590 ⇐ 590
:SCDT	Function	Set the MAX parameter for the comparison method area difference (DIFA) test.
	Parameters	space nn.n **n(number)** Positive numbers to ten digits and one decimal place can be entered in the range
	Range	0.1 ~ 99.9
	Return	nn.n **n(number)** Displays positive numbers to ten digits and one decimal place within the display range
	Example	⇒:SCDT 5.0 ⇐ 5.0
:SCN	Function	Setting the comparison method corona discharge number (CORON) test on and off
	Parameters	space 1/0
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒:SCN 1 ⇐ 1
:SCNL	Function	Setting the Cursor-L Range for Comparative Corona Number (CORON) Testing
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds in the range (cannot be greater than Cursor-R)
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCNL 5 ⇐ 5

:SCNR	Function	Setting the Cursor-R Range for Comparative Corona Number (CORON) Testing
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds of digits in the range (cannot be less than Cursor-L)
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCNR 550 ⇐ 550
:SCNT	Function	Set the THR parameter for the comparative corona discharge number (CORON) test
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds in the range
	Range	1 ~ 999
	Return	nnn
	Example	**n(number)** Displays positive integers to hundreds in the range ⇒:SCNT 20 ⇐ 20
:SCS	Function	Setting the comparison method corona discharge (COROS) test on and off
	Parameters	space 1/0
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒:SCS 0 ⇐ 0
:SCSL	Function	Setting the Cursor-L Range for Comparative Corona Discharge (COROS) Testing
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds in the range (cannot be greater than Cursor-R)
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCSL 5 ⇐ 5

:SCSR	Function	Setting the Cursor-R Range for Comparative Corona Discharge (COROS) Testing
	Parameters	space nnn **n(number)** Enter a positive integer to hundreds of digits in the range (cannot be less than Cursor-L)
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCSR 590 ⇐ 590
:SCST	Function	Setting the THR parameter for the comparative corona discharge (COROS) test
	Parameters	space nnnn **n(number)** Enter a positive integer to hundreds in the range
	Range	1 ~ 999
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCST 10 ⇐ 10
:SCL	Function	Sets the comparative inductance percentage error (LPE) test on and off
	Parameters	space 1/0
	Range	1/0
	Return	b **b(boolean)** display 1 is ON, 0 is OFF
	Example	⇒:SCL 1 ⇐ 1
:SCLT	Function	Sets the THR parameter for the comparative inductance percentage error (LPE) test
	Parameters	space nn.n **n(number)** Positive numbers to ten digits and one decimal place can be entered in the range
	Range	0.1 ~ 99.9
	Return	nn.n **n(number)** Displays positive numbers to ten digits and one decimal place within the display range
	Example	⇒:SCLT 0.5 ⇐ 0.5
:SCP	Function	Sets comparative corona discharge current pulse (CDCP) test on and off
	Parameters	space 1/0
	Range	1/0
	Return	b **b(boolean)** displays 1 for ON and 0 for OFF
	Example	⇒:SCP 0 ⇐ 0

:SCPT	Function	set the THR parameter for the comparative corona discharge current pulse (CDCP) test
	Parameters	space nnnn **n(number)** can input hundreds of integer values in the range
	Range	1 ~ 9999
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCPT 10 ⇐ 10
:SCPM	Function	set the MAX parameter for the comparative corona discharge current pulse (CDCP) test
	Parameters	space nnnn **n(number)** can input hundreds of integer values in the range
	Range	10 ~ 9999
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:SCPM 10 ⇐ 10
:GIL	Function	Obtain the ideal inductance of the current system
	Range	1n ~ 5
	Return	vvv.vu **v(value)** Displays positive integers to hundreds and two decimal places
	u(unit)	Enterable units: n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒:GIL ⇐ 1.00m
:GSV	Function	Get the current system sampling voltage
	Range	200 ~ 6000
	Return	vvvv v(value) Displays positive integers to thousands
	Example	⇒:GSV ⇐ 3000
:GST	Function	Get the current system sample rate
	Range	125n ~ 1m
	Return	vvv.vu **v(value)** Displays positive integers to hundreds and two decimal places
	u(unit)	Enterable units: n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒:GST ⇐ 10.00u

:GSN	Function	Get the current system average number of tests
	Range	1 ~ 15
	Return	nn **n(number)** Displays positive integer values in the range
	Example	⇒:GSN ⇐ 5
:GCA	Function	Acquires State ON/OFF of AREA comparison method
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒:GCA ⇐ 1
:GCAL	Function	Obtain the range Cursor-L of the AREA comparison method
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCAL ⇐ 0
:GCAR	Function	Get the range Cursor-R of the AREA comparison method
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCAR ⇐ 600
:GCAT	Function	get THR value setting for AREA comparison
	Range	0.1 ~ 99.9
	Return	nn.n **n(number)** Display positive numbers to ten digits and one decimal place in the display range
	Example	⇒:GCAT ⇐ 10.5
:GCD	Function	Get the State ON/OFF of the DIFA comparison
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒:GCD ⇐ 0

:GCDL	Function	Get the range Cursor-L of the DIFA comparison method
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCDL ⇐ 5
:GCDR	Function	Get the range Cursor-R of the DIFA comparison method
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCDR ⇐ 590
:GCDT	Function	get THR value setting for DIFA comparison
	Range	0.1 ~ 99.9
	Return	nn.n **n(number)** Display positive numbers to ten digits and one decimal place in the display range
	Example	⇒:GCDT ⇐ 5.0
:GCN	Function	Get the State ON/OFF of the CORON comparison
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒:GCN ⇐ 1
:GCNL	Function	Get the range Cursor-L of the CORON comparison method
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCNL ⇐ 5
:GCNR	Function	Get the range Cursor-R of the CORON comparison method
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCNR ⇐ 550
:GCNT	Function	get THR value setting for CORON comparison
	Range	1 ~ 999
	Return	nnn **n(number)** Display positive integers to hundreds of digits in the range
	Example	⇒:GCNT ⇐ 20

:GCS	Function	Get the State ON/OFF of the COROS comparison
	Range	1/0
	Return	b **b(boolean)** 1 is ON, 0 is OFF
	Example	⇒:GCS ⇐ 1
:GCSL	Function	Get the range Cursor-L of the COROS comparison method
	Range	0 ~ 599
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCSL ⇐ 5
:GCSR	Function	Get the range Cursor-R of the COROS comparison method
	Range	1 ~ 600
	Return	nnn **n(number)** Displays positive integers to hundreds in the range
	Example	⇒:GCSR ⇐ 590
:GCST	Function	get THR value setting of COROS comparison method
	Range	1 ~ 9999
	Return	nnnn **n(number)** Displays positive integers to thousands of digits in the range
	Example	⇒:GCST ⇐ 10
:GCLT	Function	get THR value setting for LPE comparison method
	Range	0.1 ~ 99.9
	Return	nn.n **n(number)** Display positive numbers to ten digits and one decimal place in the display range
	Example	⇒:GCLT ⇐ 0.1
:GCPT	Function	get THR value setting of CDCP comparison method
	Range	1 ~ 9999
	Return	nnnn **n(number)** Displays positive integers to thousands of digits in the range
	Example	⇒:GCPT ⇐ 10

:GCPM	Function	Get the MAX value setting of CDCP comparison method
	Range	10 ~ 9999
	Return	nnnn **n(number)** Displays positive integers to thousands of digits in the range
	Example	⇒:GCPM ⇐ 20
:CL	Function	according to the relevant parameters to execute the ideal inductance generation action , and obtain the frequency, period and other values after the calculation of ideal inductance
	Return	vvvv,vvv.vu,vvv.vu **v(value)** Sampling voltage, Displays positive integers to thousands **v(value)/u(unit)** frequency, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} , k: 10^{3} **v(value)/u(unit)** Period, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} , k: 10^{3}
	Example	⇒:CL ⇐ 3000,107.30k,9.32u
:CS	Function	Execute the sampling action of the sample test piece according to the relevant parameters, and obtain the sample, Sampling Voltage, Sampling rate and Sampling Inductance value.
	Return	vvvv,vvv.vu,vvv.vu **v(value)** Sampling voltage, Displays positive integers to thousands **v(value)/u(unit)** Sampling rate, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **v(value)/u(unit)** Sampling Inductance value,Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒:CS ⇐ 3000,10.00u,1.15m
:CT	Function	Perform sampling on the test item and determine the result as PASS/FAIL based on the sample waveform data (requires obtaining :CS to execute :CT and obtain the comparison result). If a USB device is detected, the waveform data will be saved as a CSV file according to the Auto Save settings in System/USB/Test.
	Return	b,vv.v,vv.v,vvv,vvvv,vv.v,vvvv **b(boolean)** PASS/FAIL,1 is Pass, 0 is Fail **v(value)** AREA, Displays positive numbers to ten digits and one decimal place within the display range **v(value)** DIFA, Displays positive numbers to ten digits and one decimal place within the display range **v(value)** CORON, Displays positive integers to hundreds in the range **v(value)** COROS, Displays positive integers to thousands in the range **v(value)** LPE, Displays positive numbers to ten digits and one decimal place within the display range **v(value)** CDCP, Displays positive integers to thousands in the range
	Example	⇒:CT ⇐ 1,0.3,2.6,0,0,0,0

:CM1	Function	Perform single-phase T1 motor sampling based on the relevant parameters, and obtain the sampled voltage, sampling rate, and T1 single-phase inductance value.
	Return	vvvv,vvv.vu,vvv.vu **v(value)** Sampled voltage, displayed as a positive integer up to the thousands place. **v(value)/u(unit)** Sampling rate, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}. **v(value)/u(unit)** Calculated T1 single-phase inductance value, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}.
	Example	⇒:CM1 ⇐ 200,12.50u,1.46m
:CM2	Function	Perform single-phase T2 motor sampling based on the relevant parameters, and obtain the sampled voltage, sampling rate, and T2 single-phase inductance value.
	Return	vvvv,vvv.vu,vvv.vu **v(value)** Sampled voltage, displayed as a positive integer up to the thousands place. **v(value)/u(unit)** Sampling rate, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}. **v(value)/u(unit)** Calculated T2 single-phase inductance value, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}.
	Example	⇒:CM2 ⇐ 200,12.50u,1.46m
:CM3	Function	Perform single-phase T3 motor sampling based on the relevant parameters, and obtain the sampled voltage, sampling rate, and T3 single-phase inductance value.
	Return	vvvv,vvv.vu,vvv.vu **v(value)** Sampled voltage, displayed as a positive integer up to the thousands place. **v(value)/u(unit)** Sampling rate, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}. **v(value)/u(unit)** Calculated T3 single-phase inductance value, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}.
	Example	⇒:CM3 ⇐ 200,12.50u,1.46m

:GLR	Function	Obtain the frequency, period, and other values calculated by the ideal inductance (Requires obtaining :CL first).
	Return	vvv.vu,vvv.vu
		v(value)/u(unit) Calculated oscillation frequency, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}, k: 10^{3}.
		v(value)/u(unit) Calculated oscillation period, displayed as a positive integer up to the hundreds place, followed by two decimal places. The unit is indicated as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}, k: 10^{3}.
	Example	⇒:GLR ⇐ 107.30k,9.32u
:GSR	Function	Get the sample, Sampling Voltage, Sampling rate and Period. (Need to get first :CS)
	Range	(Sampling voltage): 200 ~ 6000 (Sampling rate): 125n ~ 1m
	Return	vvvv,vvv.vu,nn
		v(value) Sampling voltage, Displays positive integers to thousands
		v(value)/u(unit) Sampling rate, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Period, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒:GSR ⇐ 3000,10.00u,1.15m
:GTR	Function	Obtain the parameters of the sampled object, including the resulting PASS/FAIL status after comparison, area sum, area difference, corona discharge count, corona discharge amount, percentage error of inductance, and corona discharge waveform analysis. (Requires obtaining :CT first)
	Range	(PASS/FAIL):1/0 (AREA):0 ~ 99.9 (DIFA):0 ~ 99.9 (CORON):0 ~ 999 (COROS):0 ~ 999 (LPE):0 ~ 99.9 (CDCP):1 ~ 9999
	Return	b,vv.v,vv.v,vvv,vvvv,vv.v,vvvv
		b(boolean) PASS/FAIL, 1 is Pass, 0 is Fail
		v(value) AREA, Displays positive numbers to ten digits and one decimal place within the display range
		v(value) DIFA, Displays positive numbers to ten digits and one decimal place within the display range
		v(value) CORON, Displays positive integers to hundreds in the range
		v(value) COROS, Displays positive integers to thousands in the range
		v(value) LPE, Displays positive numbers to ten digits and one decimal place within the display range
		v(value) CDCP, Displays positive integers to thousands in the range
	Example	⇒:GTR ⇐ 1,0.3,2.6,0,0,0,0

:GCR	Function	Obtain PASS/FAIL results for each of the six comparison functions, including area sum, area difference, corona discharge count, corona discharge amount, percentage error of inductance, and corona discharge waveform analysis. (Requires obtaining :CT first)
	Parameter	(PASS/FAIL):1/0 b,b,b,b,b,b
	Return	**b(value)** Result of AREA comparison, displaying 1 for PASS, 0 for FAIL
		b(value) Result of DIFA comparison, displaying 1 for PASS, 0 for FAIL
		b(value) Result of CORON comparison, displaying 1 for PASS, 0 for FAIL
		b(value) Result of COROS comparison, displaying 1 for PASS, 0 for FAIL
		b(value) Result of LPE comparison, displaying 1 for PASS, 0 for FAIL
		b(value) Result of CDCP comparison, displaying 1 for PASS, 0 for FAIL
	Example	⇒:GCR ⇐ 1,1,1,1,1,1

:GMR part.1	Function	Obtain sampling parameters for three-phase motor testing, including PASS/FAIL results after comparison, area sum, area difference, corona discharge count, corona discharge amount, percentage error of inductance, and corona discharge waveform analysis. (Requires obtaining :CM1, :CM2, :CM3). If a USB device is detected, waveform CSV files will be accessed.
	Parameter	(PASS/FAIL): 1/0 (AREA): 0 to 99.9 (DIFA): 0 to 99.9
		(CORON): 0 to 999 (COROS): 0 to 999 (LPE): 0 to 99.9
		(CDCP): 1 to 9999
	Return	b/b/b/b,vv.v,vv.v,vvv,vvvv,vv.v,vvvv
		b(boolean) PASS/FAIL: Displays 1 for PASS and 0 for FAIL. The first one represents the overall comparison result, the second one represents the comparison result between T1 and T2, the third one represents the comparison result between T2 and T3, and the fourth one represents the comparison result between T3 and T1.
		v(value) AREA: Displays positive numbers up to the tenth decimal place within the specified range. The first one represents the AREA threshold setting, the second one represents the result of the comparison between T1 and T2, the third one represents the result of the comparison between T2 and T3, and the fourth one represents the result of the comparison between T3 and T1.
		v(value) DIFA: Displays positive numbers up to the tenth decimal place within the specified range. The first one represents the DIFA threshold setting, the second one represents the result of the comparison between T1 and T2, the third one represents the result of the comparison between T2 and T3, and the fourth one represents the result of the comparison between T3 and T1.
		v(value) CORON: Displays positive integers up to the hundredth decimal place within the specified range. The first one represents the CORON threshold setting, the second one represents the result of the comparison between T1 and T2, the third one represents the result of the comparison between T2 and T3, and the fourth one represents the result of the comparison between T3 and T1.
		–To be continued on the next page–

:GMR part.2	Return	**v(value)** COROS: Displays positive integers up to the thousandth decimal place within the specified range. The first one represents the COROS threshold setting, the second one represents the result of the comparison between T1 and T2, the third one represents the result of the comparison between T2 and T3, and the fourth one represents the result of the comparison between T3 and T1.
		v(value) LPE: Displays positive numbers up to the tenth decimal place within the specified range. The first one represents the LPE threshold setting, the second one represents the result of the comparison between T1 and T2, the third one represents the result of the comparison between T2 and T3, and the fourth one represents the result of the comparison between T3 and T1.
		v(value) CDCP: Displays positive integers up to the thousandth decimal place within the specified range. The first one represents the CDCP threshold setting, the second one represents the result of the comparison between T1 and T2, the third one represents the result of the comparison between T2 and T3, and the fourth one represents the result of the comparison between T3 and T1.
	Example	⇒:GMR ⇐ 1/1/1/1,5.0/0.0/0.4/0.4,10.0/3.2/3.3/3.5,50/0/0/0, 500/0/0/0,5.0/0.0/0.0/0.0,200/0/0/0
:GWL	Function	Get the current ideal inductor parameters, including pulse voltage, sampling rate, set ideal inductance value, calculated oscillation frequency, calculated oscillation period, and other values, as well as waveform data (need to obtain :CL first).
	Return	vvvv,vvv.vvu,vvv.vvu,vvv.vvu,vvv.vvu; dddd,dddd, dddd...
		v(value) Sample voltage, display positive integer to thousands digits
		v(value)/u(unit) Sampling rate, display positive integer to hundreds and two decimal places, display unit n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Set ideal inductance value, display positive integer to hundreds and two decimal places, display unit n:10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Calculated oscillation frequency, display positive integer to hundreds and two decimal places, display unit n: 10^{-9}, u: 10^{-6}, m: 10^{-3}, k: 10^{3}, M: 10^{6}
		v(value)/u(unit) Calculated oscillation period, display positive integer to hundreds and two decimal places, display unit n: 10^{-9}, u: 10^{-6}, m: 10^{-3}, k: 10^{3}, M: 10^{6}
		d(data) 600 waveform data, display positive and negative integers to thousands digits
	Example	⇒:GWL ⇐ :GWL 3000,10.00u,1.00m,107.30k,9.32u;3000,2999,2998...

:GWS	Function	Get the sample parameters, including pulse voltage, sampling rate, and sample inductance values, as well as waveform data (need to obtain :CS first).
	Return	vvvv,vvv.vvu,vvv.vvu;dddd,dddd,dddd...
		v(value) Sample voltage, display positive integer to thousands digits
		v(value)/u(unit) Sampling rate, display positive integer to hundreds and two decimal places, display unit n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Calculated sample inductance value, display positive integer to hundreds and two decimal places, display unit n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		d(data) 600 waveform data, display positive and negative integers to thousands digits
	Example	⇒:GWS ⇐ :GWS 3000,10.00u,1.15m;3000,2999,2998...
:GWT	Function	Get the sampling parameters of the test object, including the compared PASS/FAIL result, area sum, area difference, corona discharge count, corona discharge quantity, inductance percentage error, and corona waveform detection, as well as waveform data (need to obtain :CT first).
	Return	b,vv.v,vv.v,vvv,vvvv,vv.v,vvvv;dddd,dddd,dddd...
		b(boolean) PASS/FAIL, 1 is Pass, 0 is Fail
		v(value) AREA, Displays positive numbers to ten digits and one decimal place within the display range
		v(value) DIFA, Displays positive numbers to ten digits and one decimal place within the display range
		v(value) CORON, Displays positive integers to hundreds in the range
		v(value) COROS, Displays positive integers to thousands in the range
		v(value) LPE, Displays positive numbers to ten digits and one decimal place within the display range
		v(value) CDCP, Displays positive integers to thousands in the range
		d(data) 600 waveform data, display positive and negative integers to thousands digits
	Example	⇒:GWT ⇐ :GWT 1,0.3,2.6,0,0,0,0;3000,2999,2998...
:GWC	Function	Obtain corona discharge waveform data after sampling and comparison of the object to be tested (need to obtain first: CT)
	Return	dddd,dddd,dddd...
		d(data) 600 corona discharge waveform data, displaying positive integers up to the thousands place.
	Example	⇒:GWC ⇐ :GWC 0,0,0...

:GWM1	Function	Get T1 single-phase sampling parameters, including pulse voltage, sample rate, and T1 single-phase inductance value, as well as waveform data (need to obtain :CM1)
	Returns	vvvv,vvv.vvu,vvv.vvu;dddd,dddd,dddd... **v(value)** Sample voltage, displaying positive integers up to the thousands place **v(value)/u(unit)** Sample rate, displaying positive integers up to the hundreds place and two decimal places, with units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **v(value)/u(unit)** Calculated sample inductance value, displaying positive integers up to the hundreds place and two decimal places, with units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **d(data)** 600 waveform data, displaying positive and negative integers up to the thousands place
	Example	⇒:GWM1 ⇐ :GWM1 200,12.50u,1.46m;200,199,198...
:GWM2	Function	Get T2 single-phase sampling parameters, including pulse voltage, sample rate, and T2 single-phase inductance value, as well as waveform data (need to obtain :CM2)
	Returns	vvvv,vvv.vvu,vvv.vvu;dddd,dddd,dddd... **v(value)** Sample voltage, displaying positive integers up to the thousands place **v(value)/u(unit)** Sample rate, displaying positive integers up to the hundreds place and two decimal places, with units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **v(value)/u(unit)** Calculated sample inductance value, displaying positive integers up to the hundreds place and two decimal places, with units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **d(data)** 600 waveform data, displaying positive and negative integers up to the thousands place
	Example	⇒:GWM2 ⇐ :GWM2 200,12.50u,1.46m;200,199,198...
:GWM3	Function	Get T3 single-phase sampling parameters, including pulse voltage, sample rate, and T3 single-phase inductance value, as well as waveform data (need to obtain :CM3)
	Returns	vvvv,vvv.vvu,vvv.vvu;dddd,dddd,dddd... **v(value)** Sample voltage, displaying positive integers up to the thousands place **v(value)/u(unit)** Sample rate, displaying positive integers up to the hundreds place and two decimal places, with units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **v(value)/u(unit)** Calculated sample inductance value, displaying positive integers up to the hundreds place and two decimal places, with units n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **d(data)** 600 waveform data, displaying positive and negative integers up to the thousands place
	Example	⇒:GWM3 ⇐ :GWM3 200,12.50u,1.46m;200,199,198...

:GWM1C	Function	Get corona discharge waveform data after T1 single-phase sampling (need to obtain :CM1) dddd,dddd,dddd...
	Returns	**d(data)** 600 waveform data of corona discharge, displaying positive integers up to the thousands place
	Example	⇒:GWM1C ⇐ :GWM1C 0,0,0...
:GWM2C	Function	Get corona discharge waveform data after T2 single-phase sampling (need to obtain :CM2) dddd,dddd,dddd...
	Returns	**d(data)** 600 waveform data of corona discharge, displaying positive integers up to the thousands place
	Example	⇒:GWM2C ⇐ :GWM2C 0,0,0...
:GWM3C	Function	Get corona discharge waveform data after T3 single-phase sampling (need to obtain :CM3) dddd,dddd,dddd...
	Returns	**d(data)** 600 waveform data of corona discharge, displaying positive integers up to the thousands place
	Example	⇒:GWM3C ⇐ :GWM3C 0,0,0...
:M	Function	Displays a list of Samples stored in Memory, If there is no archive in this location, only the serial number will be displayed
	Return	1.nnnnnnn, 2.nnnnnnn, 3.nnnnnnn, 4.nnnnnnn, 5.nnnnnnn, 6.nnnnnnn, 7.nnnnnnn, 8.nnnnnnn, 9.nnnnnnn, 10.nnnnnnn, 11.nnnnnnn, 12.nnnnnnn, 13.nnnnnnn, 14.nnnnnnn, 15.nnnnnnn, 16.nnnnnnn, 17.nnnnnnn, 18.nnnnnnn, 19.nnnnnnn, 20.nnnnnnn **n(name)** File name, Display name no more than 7 characters
	Example	⇒:M ⇐ 1.ABC123, 2.CBA321, 3., 4., 5., 6., 7., 8., 9., 10., 11., 12., 13., 14., 15., 16., 17., 18., 19., 20.
:MLV	Function	Retrieve the sample waveform from the specified position in EE
	Parameters	space nnn
	Returns	**n(number)** Input a positive integer within the specified range, determined by the maximum value in EE nnnnnnn,vvvv,vvv.vvu,vvv.vvu **n(number)** Display a positive integer up to the tens place v(value) Sample voltage, displayed as a positive integer up to the thousands place **v(value)/u(unit)** Sample rate, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3} **v(value)/u(unit)** Inductance value, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒:MLV 1 ⇐ ABC123,3000,10.00u,1.15m

:ML	Function	Retrieve the sample waveform from the specified position in EE
	Parameters	space nnn
		n(number) Input a positive integer within the specified range, determined by the maximum value in EE
	Returns	nnnnnnn,vvvv,vvv.vvu,vvv.vvu;dddd,dddd,dddd...
		n(number) Display a positive integer up to the tens place with one decimal place
		v(value) Sample voltage, displayed as a positive integer up to the thousands place
		v(value)/u(unit) Sample rate, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Inductance value, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		d(data) 600 waveform data, displayed as positive and negative integers up to the thousands place
	Example	⇒:ML 1 ⇐ ABC123,3000,10.00u,1.15m;3000,2999,2998...
:MS	Function	Store the Sample waveform to the specified EE location
	Parameters	space nnn space nnnnnnn
		n(number) Positive integers in the input range, depending on the maximum value of EE
		n(name) The file of storage data, Display name no more than 7 characters
	Return	nnnnnnn,vvvv,vvv.vvu,vvv.vvu
		n(name) File name, Display name no more than 7 characters
		v(value) Sampling voltage, Displays positive integers to thousands
		v(value)/u(unit) Sampling rate, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Inductance value, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒:MS 2 CBA321 ⇐ CBA321,3000,10.00u,1.15m
:MD	Function	Specify the EE position to delete the Sample waveform
	Parameters	space nnn
		n(number) Positive integers in the input range, depending on the maximum value of EE
	Example	⇒:MD 2 ⇐ 2

:U	Function	Displays a list of Samples saved in USB Flash drive
	Return	s.nnnnnnn, s.nnnnnnn, s.nnnnnnn, ...
		s(serial) sequence number, 1 ~ 100
		n(name) File name
	Example	⇒:U ⇐ 1.ABC, 2.CBA, 3.CCC
:UL	Function	Retrieve the sample waveform and parameters from the specified position in USB
	Parameters	space nnn
		n(number) Input a positive integer within the specified range, determined by the maximum number of CSV files in USB
	Returns	nnnnnnn,vvvv,vvv.vu,vvv.vu;dddd,dddd,dddd...
		n(name) File name, displayed with a maximum of 8 characters
		v(value) Sample voltage, displayed as a positive integer up to the thousands place
		v(value)/u(unit) Sample rate, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Inductance value, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		d(data) 600 waveform data, displayed as positive and negative integers up to the thousands place
	Example	⇒:UL 1 ⇐ CBA321,3000,10.00u,1.15m;3000,2999,2998...
:US	Function	save Sample waveforms and parameters to a CSV format file on USB flash drive
	Parameters	space nnnnnnn
		n(name) The file of the storage data, Display name no more than 8 characters
	Return	nnnnnnn,vvvv,vvv.vu,vvv.vu
		n(name) File name, Display name no more than 8 characters
		v(value) Sampling voltage, Displays positive integers to thousands
		v(value)/u(unit) Sampling rate, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Inductance value, Displays positive integers to hundreds and two decimal places, Enterable units n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
	Example	⇒:US CBA321 ⇐ CBA321,3000,10.00u,1.15m

:UD	Function	Specify the USB File name to delete the Sample waveform
	Parameters	space nnnnnnn
		n(name) The file of the storage data, Display name no more than 8 characters
	Example	⇒:UD CBA321 ⇐ CBA321
:TD	Function	Transmit sample waveform data to ST
	Parameters	space n space vvvv,vvv.vu,vvv.vu;dddd,dddd,dddd...
		n(number) Transmission sequence number, starting from 0, increment by 1 for each subsequent merged transmission, and F for the last transmission
		v(value) Sample voltage, displayed as a positive integer up to the thousands place
		v(value)/u(unit) Sample rate, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		v(value)/u(unit) Inductance value, displayed as a positive integer up to the hundreds place with two decimal places, unit displayed as n: 10^{-9}, u: 10^{-6}, m: 10^{-3}
		d(data) 600 waveform data, displayed as positive and negative integers up to the thousands place
		,(comma) Separates parameters and data, as well as data and data
		;(semicolon) Separates parameters and data
		Note 1: The length of a single command should not exceed 2000 characters
		Note 2: The accumulated data length should not exceed 4000 characters
		Note 3: Completion of a single transmission returns :TD
		Note 4: Completion of the last transmission returns 1
	Example	⇒:TD 0 3000,10.00u,1.15m;3045,3025,3005,2993,2972... ⇐ :TD
		⇒:TD 1 443,326,241,164,75,-4,-81,-153,-225,-291... ⇐ :TD
		⇒:TD F -65,-59,-49,-36,-25,-19,-9,6,17,28 ⇐ 1

Notes on Inputting Instructions:

1. The command and the setting parameter should be separated by a space. Ex.:":SIL 1.0m "
2. The input and return values will end with \r\n

Error Code:

Ex.: ERROR Level Type Content

Level:

1: Information

2: Warning(recoverable) 3: Critical error

Type:

0: SYSTEM

1: RS232

2: TCP/IP

Content:

000: Empty
No file name content entered in the memory or external USB storage function.

001: No Data
No data found at the specified location in the memory or external USB for reading or deleting function.

002: No Sample
Sampling information not obtained.

003: No Compare
No comparison function selected.

004: Command Error
Incorrect command script entered.

005: Wrong Format
The input file name exceeds the range during storage or the specified numbers, letters, or units are not entered in the correct format.

006: Wrong Location
Incorrect sequence number position specified in the memory or external USB.

007: Out Of Range
Input parameter exceeds the allowable range.

008: Exceed Cursor R
In the comparison function, the set value of Cursor L (left cursor) is higher than Cursor R (right cursor) setting value.

009: Less Than Cursor L
In the comparison function, the set value of Cursor R (right cursor) is lower than Cursor L (left cursor) setting value.

010: No USB Drive Found
No external USB device detected.

011: Duplicate File Name
File name duplication in the memory or external USB storage function.

012: Data Already Exists
Data already exists at the specified location in the memory storage function.

013: Transfer Value Exception
Parameter content exception during data transfer.

014: Transfer Data Exception
Waveform data content exception during data transfer.

B-2 Communication Example

The following is an example of commands used to communicate with the instrument, RS-232 and TCP/IP commands are the same.

B-3 Sample simple setup process

```
:SSV 200   //Adjust the voltage gear
:SST 0     //Adjust DIV position
:SSN 1     //Set AVG times
```

B-4 Sample simple process

```
:CS  //Perform Sample high voltage test
:GWS //Get Sample result and waveform data
```

B-5 Test / TPM simple setup process

```
:SCA 1 //Set AREA to enable or disable, the default is 1 (ON)
:SCD 1 //Set DIFA to enable or disable, the default is 1 (ON)
:SCN 1 //Set CORON to enable or disable, the default is 1 (ON)
:SCS 1 //Set COROS enable or disable, default is 1 (ON)
:SCL 1 //Set LPE enable or disable, the default is 1 (ON)
:SCP 1 //Set CDCP to enable or disable, the default is 1 (ON)
:SCAT 5   //Set the upper threshold of AREA
:SCDT 10  //Set the upper limit of DIFA threshold
:SCNT 50  //Set CORON threshold upper limit
:SCST 500 //Set the upper limit of the COROS threshold
:SCLT 5   //Set the upper limit of the LPE threshold
:SCPT 200 //Set the upper limit of CDCP threshold
```

B-6 Test Simple Process

```
:CT  //Perform Test high voltage test
:GTR //Get Test comparison result
```

B-7 TPM Simple Process

```
:CM1 //Perform T1 high voltage test
:CM2 //Perform T2 high voltage test
:CM3 //Perform T3 high voltage test
:GMR //Get T1, T2 and T3 comparison result
```

EU-Konformitätserklärung
EU Declaration of Conformity

Wir / *we* :

SPS electronic GmbH
The Electrical Safety Test Company
Eugen-Bolz-Straße 8
D-74523 Schwäbisch Hall

erklären hiermit, dass das nachfolgend genannte Gerät den einschlägigen grundlegenden Sicherheitsforderungen der EU-Richtlinien entspricht.

declare, that the following unit complies with all essential safety requirements of the EU Directives.

Geräteart: Stoßspannungsprüfgerät
Description of device: *Surge Tester*

Typ / *Type* : ST 6600 B

EU Richtlinien / *EU Directives:*

☐ EG Maschinenrichtlinie 2006/42/EG mit Änderungen
EC Directive for machinery 2006/42/EC with amendments

☒ EU Niederspannungsrichtlinie 2014/35/EU
EU Directive for low voltage 2014/35/EU

☒ EU Richtlinie Elektromagnetische Verträglichkeit 2014/30/EU mit Änderungen
EU Directive electromagnetic compatibility 2014/30/EU with amendments

Angewandte harmonisierte Normen:
Applicable harmonized standards:

- EN 61 000-3-2; EN 61 000-3-3; EN 55 014-1; EN 55 014-2; EN 50 191

Angewandte nationale Normen und technische Spezifikationen:
Applicable national standards and technical specifications:

02.06.2023
Datum / date:

Dipl. Ing. Johannes Geyer

Dieser Konformitätserklärung unterliegt grundsätzlich nur das von uns gelieferte oder in Betrieb genommene Gerät.
Für Änderungen und Erweiterungen ist der Betreiber verantwortlich und damit für die Sicherstellung der Übereinstimmung der veränderten Anlage mit der betreffenden EU-Richtlinie.

Subject to this declaration of conformity is the device as supplied or placed into operation by us.
The operator is responsible for subsequent alterations and extensions, and therefore has to ensure the altered unit complies with the corresponding EU directives.