

**STS + TD 5000 FAMILY**  
**for the test of CT, VT and PT**

DOCUMENT No. SIE10175, Rev. 14, «Date»



## TABLE OF CONTENTS

<b>SPECIFICATIONS</b> .....	<b>1</b>
<b>1 GENERAL</b> .....	<b>7</b>
<b>2 APPLICABLE STANDARDS</b> .....	<b>17</b>
<b>3 CHARACTERISTICS</b> .....	<b>19</b>
3.1 FOREWORD .....	19
3.2 MAIN GENERATOR .....	19
3.2.1 High AC current .....	20
3.2.2 High DC current .....	20
3.2.3 Low AC current .....	21
3.2.4 Low DC current .....	21
3.2.5 High AC voltage .....	22
3.2.6 Low AC voltage .....	23
3.2.7 High power output to the external modules .....	24
3.2.8 Output frequency .....	24
3.2.9 Other features of main outputs.....	24
3.3 OUTPUTS MEASUREMENT .....	25
3.4 EXTERNAL INPUTS MEASUREMENT .....	25
3.5 TIMER .....	26
3.6 PHASE ANGLE .....	26
3.7 OTHER MEASUREMENTS .....	27
3.8 DISPLAY.....	29
3.9 TEST CONTROL.....	29
3.10 MENU SELECTIONS.....	30
3.11 STANDARD CONNECTION CABLES (LONG CABLES CODE PII16175 AND EXTRA LONG CABLES CODE PII57175).....	47
3.12 OTHER CHARACTERISTICS.....	48
<b>4 OPTIONS</b> .....	<b>49</b>
4.1 TRANSIT CASES (CODE PII17175, PII 19175, PII51175) .....	49
4.2 PADS LICENCE (CODE PII10176P, PII10176F, PII10176T) .....	50
4.3 REMOTE SAFETY SWITCH (CODE PII42175) .....	51
4.4 WARNING STROBE LIGHT (CODE PII43175).....	51
4.5 STCS AUTOMATIC CONNECTION WINDINGS MODULE (CODE PII12175).....	52
4.6 STCS POWER GENERATOR BOOSTER 20 A DC (CODE PII32175) .....	53
4.7 STDE RESIDUAL MAGNETIZATION REMOVAL MODULE (CODE PII27175).....	54
4.8 STSA SURGE ARRESTER (CODE PII46175).....	55
4.9 BUX 3000, BUX 2000 CURRENT BOOSTER (CODES PII50175, PII56175).....	55
4.10 CURRENT CLAMP (CODE PII16102) .....	57
4.11 PLCK POLARITY CHECKER (CODE PII41175) .....	58
4.12 STLG CURRENT INJECTION POWER TRANSFORMER FOR GROUND TESTS (CODE PII70175).....	58
4.13 POWER FACTOR CORRECTION MODULE (CODE PII85175) .....	59
4.14 STLG LARGE STATION (CODE PII88175).....	60
4.15 STSG SAFETY GROUNDING MODULE (CODE PII71175) .....	62
4.15.1 Cylindrical studs .....	63
4.15.2 Surge arrester for STSG (code PII77175).....	63
4.16 GROUND GRID TEST ACCESSORIES KIT (CODE PII76175) .....	64
4.17 CURRENT CLAMP METER (CODE PII79175) .....	65
4.18 FOLDABLE TROLLEY (CODE PII18175) .....	66
4.19 TD 5000 MODULE FOR THE TAN( $\Delta$ ) LOSS ANGLE FACTOR MEASURE (CODE PII11175).....	66
4.20 CAP-CAL REFERENCE CAPACITOR (CODE PII40175) .....	72
4.21 STOIL CELL FOR THE INSULATING OIL CHECK (CODE PII13175).....	73

---

4.22	DIGITAL THERMO HYGROMETER (CODE PII44175).....	73
4.23	RCTD REACTOR FOR MOTORS AND GENERATORS MEASURES (CODE PII47175).....	74
<b>5</b>	<b>PROTECTIONS</b> .....	<b>76</b>

## ***Disclaimer***

Every effort has been made to make this material complete, accurate, and up-to-date. In addition, changes are periodically added to the information herein; these changes will be incorporated into new editions of the publication. ISA reserves the right to make improvements and/or changes in the product(s) and/or the program(s), described in this document without notice, and shall not be responsible for any damages, including but not limited to consequential damages, caused by reliance on the material presented, including but not limited to typographical errors.

Copies, reprints or other reproductions of the content or of parts of this publication shall only be permitted with ISA prior written consent.

All trademarks are the property of their respective holders.

Copyright 2015© ISA S.r.l. Italy - All rights reserve

## 1 GENERAL

The portable, high accuracy test sets of the STS family allow performing all tests foreseen by international Standards on CTs, measurement VTs, Power Transformers, and to measure the  $\tan(\delta)$ , dissipation factor and capacitance of any device. With the option STLG + STSG it is also possible to execute the Earth resistance and Step and Touch voltage measurements.

The following table lists the models of the STS Family:

Model	Description
STS 5000	It is the most performing test set of the STS family of devices. It allows executing all listed tests
STS 4000	It is the same as STS 5000, unless the high AC and DC current generators. High AC current tests can be performed using the BUX 3000 option; micro-Ohm metering is not available
STS 3000 light	It allows performing $\tan(\delta)$ tests with the option TD 5000

*Table 1 - STS Family models*

The following table summarizes the differences among the models:

Model	High current, AC & DC	High voltage	Low Ac-DC outputs	Optional $\tan(\delta)$ tests TD 5000	Optional High AC current BUX 3000
STS 5000	X	X	X	X	X
STS 4000		X	X	X	X
STS 3000 light				X	

*Table 2 - Differences among the STS Family models*

Keyboard, dedicated keys, control knob and display can control all test sets of the family locally. Test results and settings can be saved in a PC by the software suite TDMS, which comes with the device. The optional PADS program allows also controlling the device from the PC.

The following table lists the tests performable by the Current Transformers:

No.	Test	STS 5000	STS 4000	STS 3000 light
1	Ratio Polarity and Burden	X	+BUX +Manual Measure	+BUX +Manual Measure
2	Burden Secondary Side	X	X	
3	Excitation Curve	X	X	
4	Winding or Burden Resistance	X	X	
5	Voltage Withstand	X	X	
6	Polarity Check	X		
7	Ratio Polarity Voltage Mode	X	X	
8	Rogowski (Ratio)	X	+BUX +Manual Measure	+BUX +Manual Measure
9	Low Power (Ratio)	X	+BUX +Manual Measure	+BUX +Manual Measure
10	Tangent $\delta$	TD 5000	TD 5000	TD 5000
11	Ratio IEC61850-9-2LE	X		

*Table 3 - Current Transformer tests*

BUX is the BUX 3000, BUX 2000 option, for high current injection tests. The Ratio test for Not-Conventional transformer with the option IEC61850-9-2LE is available only in remote control mode, using the PADS software.

The following table lists the tests performable by the Voltage Transformers:

No.	Test	STS 5000	STS 4000	STS 3000 light
1	Ratio	X	X	
2	Ratio Electronics	X	X	
3	Burden	X	X	
4	Voltage Withstand	X	X	
5	Polarity Check	X		
6	Tangent $\delta$	TD 5000	TD 5000	TD 5000
7	Ratio IEC61850-9-2LE	X	X	

*Table 4 - Voltage Transformers tests*

The Ratio test for Not-Conventional transformer with the option IEC61850-9-2LE is available only in remote control mode, using the PADS software.

The following table lists the tests performable by the Power Transformers:

No.	Test	STS 5000	STS 4000	STS 3000 light
1	Ratio	X	X	
2	Winding Resistance	X	X	
3	Winding Resistance – Auto	X	X	
4	Voltage Withstand	X	X	
5	Short-Circuit Impedance	X	X	
6	No-Load Current	X	X	
7	Tangent $\delta$	TD 5000	TD 5000	TD 5000
8	Demagnetizer	X	X	

*Table 5 – Power Transformers tests*

The following table lists the tests performable by the Circuit Breakers:

No.	Test	STS 5000	STS 4000	STS 3000 light
1	Resistance - $\mu\Omega$	X		
2	Tangent $\delta$	TD 5000	TD 5000	TD 5000

*Table 6 - Circuit Breakers tests*

The following table lists the tests performable by the Resistances:

No.	Test	STS 5000	STS 4000	STS 3000 light
1	Resistance - $\mu\Omega$	X		
2	Earth Resistance	X	X	
3	Soil Resistivity	X	X	
4	Step and Touch	X	X	
5	Line Impedance	X	X	

*Table 7 – Resistances tests*

The test Ratio IEC61850-9-2LE can be executed only in remote mode, using the PADS software.

Tests are performed in accordance with the following standards:

- IEC EN 60044-1
- IEC EN 60044-2
- IEC EN 60044-5
- IEC EN 60044-7
- IEC EN 60044-8
- IEC EN 61869-x
- IEC EN 60076-1
- ANSI/IEEE C57.13.1

Earth resistance and step and touch tests are performed according to the following standards:

- IEC EN 20522:2011
- IEEE 80:2000
- IEEE 81:1983
- DIN VDE 0101
- CENELEC HD 63761

STS Family has the facility to test not conventional CT, VT, Merging Unit (MU), by the IEC 61850-9-2 (SV) protocol.

STS Family generates current or voltage and injects these quantities into primary side of the CT or VT under test. STS Family then reads the data from the network using its Ethernet port (Sample Values) in order to perform a variety of different tests, as CT ratio and polarity up to 800 A or up to 2000 A (with BUX 2000) or 3000 A (with BUX 3000). It is also possible to check the VT ratio and polarity, up to 2 kV. Test of MU.

The following table lists the optional modules enhance the STS features:

Item	Option	Code	Description
1	Transit Cases	PII17175 PII19175 PII51175	They allow transporting the device
2	PADS license	PII10176P PII10176T PII10176F	PC Remote control of the test set
3	Remote Safety Switch	PII42175	When the Remote Safety Switch is connected and enabled, it avoids any current or voltage generation from pressing START/STOP button on the STS only
4	Warning Strobe Light	PII43175	It alerts when the test is performed
5	STCS	PII12175	The Circuit Switch option performs the automatic measurement of the following parameters: PT transformer ratio, PT winding resistance, OLTC dynamic winding resistance
6	STCS Booster 20 A DC	PII32175	The Circuit Switch option performs the automatic measurement of the following parameters: PT winding resistance up to 20 A DC, OLTC dynamic winding resistance up to 20 A DC
7	STDE	PII27175	It allows neutralizing the residual magnetization of the power transformer core after the winding resistance test
8	STSA	PII46175	The option limits voltage surges generated on the 10 V input
9	BUX 3000 BUX 2000	PII50175 PII56175	This option performs high current tests, with currents up to 3,000 A or 2,000 A
10	Current Clamp	PII16102	The current clamp avoids opening the secondary current circuit when performing the primary test of CT burden
11	PLCK	PII41175	Sawtooth signal detector for CT/VT polarity test
12	STLG	PII70175	It is a high power transformer for the current injection for the Line Impedance and Step and Touch tests
13	Power factor correction module	PII85175	It is a module to increase the current in the grounding and step and touch tests
14	STLG large stations	PII88175	It is a high power transformer for current injection into transmission lines for large stations
15	STSG	PII71175	This option is used for the test of overhead lines parameters
16	Ground Grid test accessories kit	PII76175	The kit includes some accessories to perform the Soil Resistivity test, the Earth Resistance test and the Step and Touch test
17	Current Clamp Meter	PII79175	This option is used to check the induced current in the transmission line
18	Foldable Trolley	PII17175	The trolley eases the transport of STS + TD 5000
19	TD 5000	PII11175	It performs the measurement of the $\tan(\delta)$ , capacitance and Power factor of any device, at the frequency of the mains or in a wide frequency range
20	CAP-CAL (for TD 5000)	PII40175	Purpose of the reference capacitor is to check the actual calibration of TD for the measures of the capacitance and $\tan(\delta)$
21	STOIL (for TD 5000)	PII13175	The oil cell is for $\tan(\delta)$ measurement of PT oil
22	Digital thermo hygrometer (for TD 5000)	PII44175	The option allows measuring ambient temperature and humidity, and to input them into the test settings, if it is necessary
23	RCTD (for TD 5000)	PII47175	Compensation Inductor for high current $\tan(\delta)$ test on motors and generators

Table 8 - Optional modules

The basic STS function is to generate current and voltages, as requested by the type of test to be performed; only one test at a time. The test is selected on the LCD screen by means of the multi-function knob. Test results are kept in local memory or in a USB card, and can be transferred to a PC later, along with settings.

The capacitance and  $\text{Tan}(\delta)$  measurements with TD 5000 can be performed on CTs, VTs, CBs, PTs and bushings.

STS 5000 contains a generator, with the following six outputs:

- High AC current
- Low AC current
- High DC current
- Low DC current
- High AC voltage
- Low AC voltage

In addition, there is a high power AC voltage output, not isolated from the mains, which supplies the external options (TD 5000, BUX 2000, BUX 3000, STLG, STCS Booster 20 A DC).

In local control mode, the selected output is adjustable and metered on the large, graphic LCD display. With the control knob and the LCD display it is possible to enter the MENU mode, which allows setting many functions: this makes STS a very powerful testing device, with manual and automatic testing capabilities, and with the possibility to transfer test results to a PC via USB, ETHERNET or Pen Drive.

In the PC control mode, the PADS program allows performing the same tests as in the local mode, with the same control windows. It allows also downloading, displaying and analyzing test results obtained in local mode.

PADS operates with all WINDOWS versions.

The ease of operation has been the first goal of STS: this is why the LCD is graphic, and so large. With it, the dialogue in menu mode is made easy. Besides, all STS outputs relevant to the selected test are continuously measured, and output values are displayed, with no extra effort to the operator.

STS feature four measurement inputs:

- DC voltage, up to 10 V DC
- AC or DC voltage
  - High range, up to 300 V
  - Low range, up to 3 V
- AC or DC current, up to 10 A

All inputs, unless the 3 V and 300 V voltage measurements, are isolated among them, and allow measuring CT or VT outputs or any other source.

In all STS models, it is available a digital input, which accepts an input, which can be voltage free, or with a voltage up to 300 V. It allows measuring the time response of a protection relay. It is also possible to test the M.V. CB's timing: the time is stopped when the injected current is opened by the CB.

The instrument is housed in a transportable aluminum box, which is provided with removable cover and handles for ease of transportation. An optional trolley is also available.

The following image exhibits the STS 5000 as an example of the model of the family, with the protection cover lifted:



Figure 1 - STS 5000

The following image exhibits the front panel:

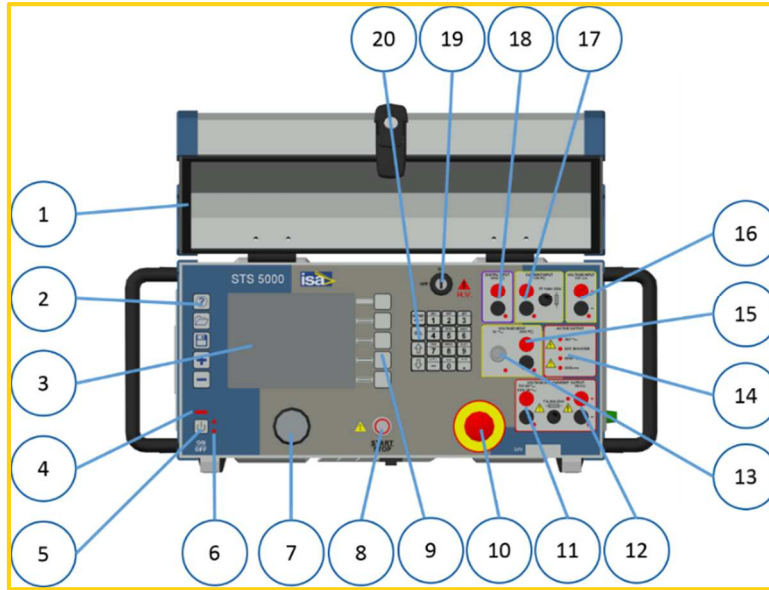


Figure 2 - Test set front panel

The following table lists all the elements of the front panel:

ITEM	Component		
1	Cover		
2	Pushbuttons		Help. Pressing it, the screen displays the information related to the test performed
			Open file. It allows to access the list of saved test results (the list can be located in the internal memory or on the USB key)
			Save file. It allows saving the test result. Pressing it, it is possible to access the list of saved test results (the list can be located in the internal memory or on the USB key)
			Increment and decrement buttons. To input a value, select the field, and then: <ul style="list-style-type: none"> <li>Edit the desired value, via the keypad</li> <li>Increment or decrement the value, pressing the above pushbuttons</li> <li>Rotate the knob clockwise (increment) or anti-clockwise (decrement)</li> <li>Press the keyboard up key to increment, and the keyboard down key to decrement</li> </ul> The amount of the increment or decrement is: ten units, for the plus and minus keys; one unit, for the knob, and one tenth, for the up-down arrows
3	Display		
4	Power-on light: it is ON when the test set is operating		
5	Power ON and OFF push-button		
6	Mains lights: they turn on very shortly as the test set is connected to the mains		
7	MENU control knob, with switch		
8	Test START and STOP push-button		

Table 9 - Frontal panel components (1/2)



ITEM	Component	
9	16-keys alpha-numeric keyboard	
10	Emergency push-button with lock-in	
11	AC voltage and current output, up to 6 A – 70 V or 3 A - 140 V, fuse protected. Fuse rating: FF 6.3 A 250 V. The LED turns ON when it is active	
12	DC current output, up to 6 A, fuse protected. Fuse rating: T 6.3 A 250 V. The LED turns ON when it is active	
13		ATTENTION: The connector to this input can be removed only acting on the connector body. Do not pull the cable
14	Active output lights. The LED turns ON when the corresponding output is active	
15	AC or DC voltage input sockets, up to 300 V. The LED turns ON when it is active	
16	DC voltage input sockets, up to 10 V. The LED turns ON when it is active	
17	AC or DC current input sockets, up to 10 A, fuse protected. Fuse rating: FF 10 A 250 V. The LED turns ON when it is active	
18	Digital input sockets, for voltage clean contact or with voltage up to 300 V. The LED turns ON when the input is closed or with voltage	
19	Enable key, for HV tests	
20	Function keys	 <ul style="list-style-type: none"> <li>• The twelve buttons to the right behave as a portable phone</li> <li>• ENTER confirms what is edited</li> <li>• DEL             <ul style="list-style-type: none"> <li>○ If the field is numeric, it deletes the first digit to the left. It is not possible to select the digit to delete: as the wheel is touched, the digit changes</li> <li>○ If the field is alphabetic, it is possible to use the knob to reach for the letter to be deleted: the deleted letter is the one to the left with respect to the cursor. If the cursor is completely to the left, DEL deletes the letter to the right</li> </ul> </li> <li>• As explained above the arrows, when the context is numeric, increment or decrement the value; in a selection page, they allow to move around</li> </ul>

Table 10 – Frontal panel components (2/2)

The following image exhibits the side panel on the left:

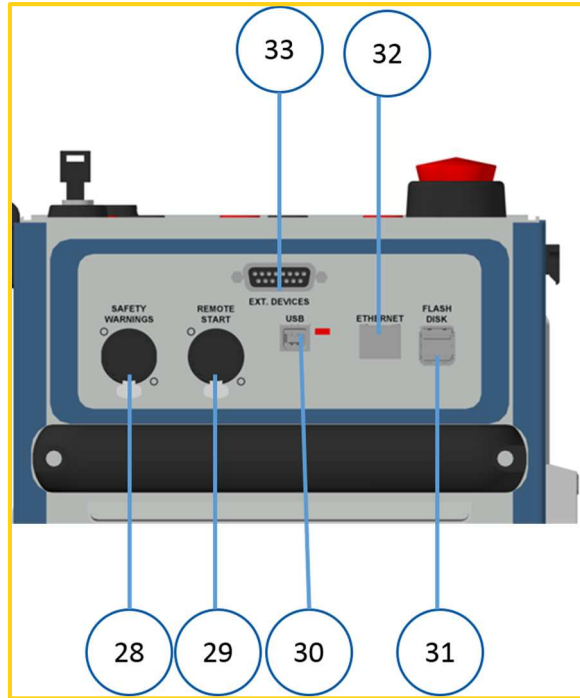


Figure 3 – Left panel components

The following table lists the elements of the left panel:

ITEM	Component
28	Alarm output connector, for the light strobe with buzzer option PII43175
29	Remote start input connector, for the remote push-button option PII42175
30	USB connection only for ISA diagnostic
31	Flash disk connector for the local test results saving or for moving the local test results from the local memory
32	ETHERNET connection to the PC. It incorporates two lights which turn on when the test set is connected
33	Communication Connector to the external devices (TD 5000, STCS, STDE)

Table 11 – Left panel components

The following image exhibits the side panel on the right:

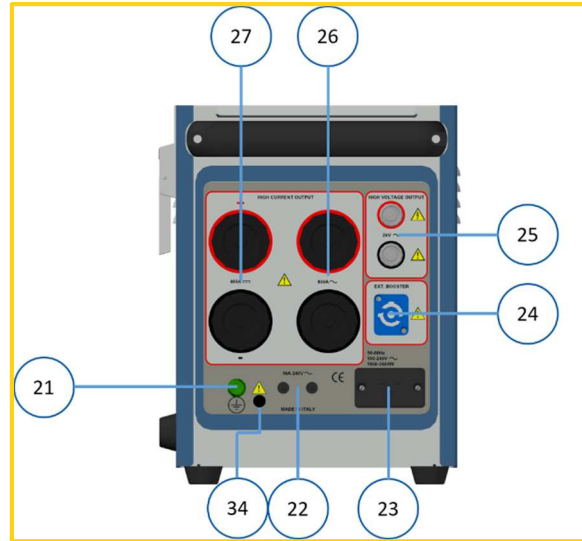


Figure 4 - Right panel components

The following table lists the elements of the right panel:

ITEM	Component
21	Ground connection socket
22	Resettable power supply automatic fuses, rated 16 A 240 V
23	Power supply plug
24	Power supply connection to external optional modules (TD5000, BUX3000, STCS Booster 20 A DC)
25	High voltage output connectors, rated 2 kV AC <div style="border: 1px solid black; padding: 5px; display: flex; align-items: center;"> <p>ATTENTION: The connectors to this input can be removed only acting on the connector body. Do not pull the cable</p> </div>
26	High AC current output connectors, rated 800 A
27	High DC current output connectors, rated 400 A
34	F6 fuse

Table 12 – Right panel components

## 2 APPLICABLE STANDARDS

The test set conforms to the EEC directives regarding Electromagnetic Compatibility and Low Voltage instruments.

The following table lists the standards related to the EMC Directive, 2004/108/EC:

Standard	Title	Requirement
EN 61326	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements	
IEC EN 61000-3-2:	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current $\leq 16$ A per phase)	Harmonic content of power supply Acceptable limits: basic
IEC 61000-3-2	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current $\leq 16$ A per phase and not subject to conditional connection	Limitation of voltage fluctuations and flicker Acceptable limits: basic
CISPR 16-1	Specification for radio disturbance and immunity measurement apparatus and methods	Acceptable limits for conducted emission: <ul style="list-style-type: none"> <li>0.15÷0.5 MHz: 79 dB pk; 66 dB avg</li> <li>0.5÷5 MHz: 73 dB pk; 60 dB avg</li> <li>5÷30 MHz: 73 dB pk; 60 dB avg</li> </ul> Acceptable limits for radiated emission: <ul style="list-style-type: none"> <li>30÷230 MHz: 40 dB (30 m)</li> <li>230÷1000 MHz: 47 dB (30 m)</li> </ul>
IEC EN 61000-4-2	Electromagnetic compatibility (EMC)- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	Immunity tests for ESD Test values: 8 kV in air; 4 kV in contact
IEC EN 61000-4-3	Electromagnetic compatibility (EMC)- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	Immunity tests for radio frequency interference Test values (f= 900 $\pm$ 5 MHz): field 10 V/m, modulated AM 80%; 1 kHz
IEC EN 61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Immunity tests for high speed transients (burst) Test values: 2 kV peak; 5/50 ns
IEC EN 61000-4-5:	Electromagnetic compatibility (EMC)- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	Immunity tests for surge Test values: 1 kV peak differential mode; 2 kV peak common mode; 1.2/50 us
IEC EN 61000-4-6:	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	Immunity to low-voltage sinusoidal waveform Test values: 0.15-80 MHz, 10 V <sub>rms</sub> , 80% AM 1 kHz
IEC EN 61000-4-8:	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	Immunity tests for low frequency magnetic fields. Test values: 30 Arms/m
IEC EN 61000-4-11	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	Immunity test for power supply drops. Test value: 1 cycle; 100% drop

Table 13 – Standards related to the EMC Directive (2/2)

The following table lists the standards related to the LV Directive, 2006/95/EC:

Standard	Title	Requirement
IEC EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements	<p>For a pollution degree 2: dielectric rigidity 1.4 kV AC, 1 minute The rigidity is 4600 V AC 1 minute between the high voltage output and the rest of inputs and outputs.</p> <ul style="list-style-type: none"> <li>Inputs/outputs protection: IP 2X, per IEC 60529, for all but high voltage outputs; IP4X for high voltage outputs</li> <li>Insulation resistance, at 500 V DC: &gt; 10 MΩ</li> <li>Ground resistance, at 200 mA DC: &lt; 0.1 Ω</li> <li>Operating temperature: (-10÷55) °C; storage: (-20÷70) °C</li> <li>Operating relative humidity: 5÷95%, without condensing. Storage relative humidity: 0÷96%, without condensing</li> <li>Altitude: less than 2,000 m</li> </ul>
IEC 60068-2-6	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	Vibration: 20 m/s <sup>2</sup> at 10÷150 Hz
IEC 60068-2-27	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	Shock: 15 g; 11 ms; half-sine

*Table 14 - Standards related to the LV Directive*

## 3 CHARACTERISTICS

### 3.1 Foreword

STS incorporates a generator with six outputs. When an output is generated, there is voltage also on all other outputs, unless for the high AC voltage.

The generator is made of an electronic type D switching amplifier, followed by a power transformer, which adapts the suitable current or voltage output.

### 3.2 Main generator

The main generator has six outputs:

- High AC current
- High DC current
- Low AC current
- Low DC current
- High AC voltage
- Low AC voltage

Output adjustment is performed automatically, as a function of the selected test. The following specification applies to the separate use of these outputs.

For all outputs, the following applies:

- **Type of generator.** Electronic type D switching amplifier, followed by a high power transformer, with a number of secondary windings, for the following outputs: high AC current, high DC current, high AC voltage. Loop control of the selected output. The transformer includes also the outputs: Low AC current, Low DC current, Low AC voltage, but they are not loop controlled
- **Output adjustable** from zero to the maximum value
- The specified **output power** is available at 25 °C maximum of external temperature, and with a power supply error of 2% maximum. For higher temperatures, the maximum power decreases of 20 VA/°C
- The specified **output accuracy** and THD applies at (25±2) °C, resistive load, and burden less than 20% of the maximum, currents up to 50% of the maximum. With full temperature range, maximum current and maximum burden, errors are twice as bigger
- The specified **output characteristics** may vary for frequencies below 50 Hz and above 60 Hz
- The **generated frequency** can be synchronized with the mains (with the Power Line Synchronizer option)
- The **selected output** is shown by a LED

### 3.2.1 High AC current

The output is available only on the STS 5000.

The following table lists the output characteristics, at 50 to 60 Hz and supply of 230 V:

Current output [A]	Output power [VA]	Load time [s]
800	4,800	25
600	3,780	200
400	2,560	500
300	1,940	900 (15 min)
200	1,300	> 2 h

Table 15 - High AC current: output characteristics (1/2)



ATTENTION: The output range decreases below 50 Hz and above 60 Hz

The following table lists some more characteristics:

<b>Connection</b>	Two high power sockets, with safety protections
<b>Generation resolution</b>	100 mA
<b>Measurement accuracy</b>	Typical < 0.1% of the reading < 0.1% of the 800 A range
	Guaranteed $\pm 0.2\%$ of the reading $\pm 0.2\%$ of the 800 A range

Table 16 - High AC current: output characteristics (2/2)

### 3.2.2 High DC current

The output is available only on the STS 5000.

The following table lists the output characteristics:

Current output [A]	Output power [W]	Load time [s]
400	2,600	140
300	1,950	180
200	1,300	> 2 h
100	630	>> 2 h

Table 17 - High DC current: output characteristics (1/2)

The following table lists some more characteristics:

<b>Connection</b>	Two high power sockets, with safety protections
<b>Generation resolution</b>	100 mA
<b>Measurement accuracy</b>	Typical < 0.2% of the reading < 0.05% of the 400 A range
	Guaranteed $\pm 0.4\%$ of the reading $\pm 0.1\%$ of the 400 A range

Table 18 - High DC current: output characteristics (2/2)

### 3.2.3 Low AC current

The output is available on the STS 5000 and STS 4000.

Type of generator: not controlled low AC current.

The output current can be manually adjusted using the front panel controls, and measured via the test set current meter.

The following table lists the output characteristics:

<b>Maximum output current</b>	6 A or 3 A
<b>Maximum output voltage</b>	70 V AC or 140 V AC
<b>Maximum output power</b>	360 VA, for both ranges
<b>Duration of the generation</b>	> 2 h (at 50 V for 70 V range)
<b>Output protection</b>	Fuse type T6A; electronic protection on the 3 A range
<b>Connection</b>	Two safety 4 mm banana sockets

*Table 19 – Low AC current: output characteristics*

### 3.2.4 Low DC current

The output is available on the STS 5000 and STS 4000.

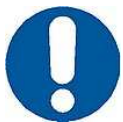
Type of generator: not controlled low DC current.

The output current can be manually adjusted using the front panel controls, and measured via the test set current meter.

The following table lists the output characteristics:

<b>Maximum output current</b>	6 A DC
<b>Maximum output voltage</b>	65 V DC
<b>Maximum output power</b>	360 W
<b>Duration of the generation</b>	> 2 h (at 50 V)
<b>Output protection</b>	Fuse type T 6 A
<b>Connection</b>	Two safety 4 mm banana sockets

*Table 20 – Low DC current: output characteristics*



**ATTENTION:** During the high impedance burdens tests, the output sinks the energy stored into the inductance

### 3.2.5 High AC voltage

The output is available on the STS 5000 and STS 4000.

The high AC voltage output is coming from the same transformer as high AC or DC current, but an HV switch inside the test set isolates it.



ATTENTION: This switch is closed only when the operator selects a High voltage test, after the enable key is turned on

Three voltage ranges are available:

- 2,000 V
- 1,000 V
- 500 V

The following table lists the output characteristics for each range:

Voltage range [V]	Output current [A]	Output power [VA]	Load time [s]
2,000	1.25	2,500	60
2,000	1	2,000	130
2,000	0.5	1,000	> 2 h

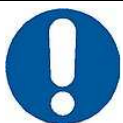
*Table 21 - High AC voltage: output characteristics (1/4)*

Voltage range [V]	Output current [A]	Output power [VA]	Load time [s]
1,000	2.5	2,500	60
1,000	2	2,000	130
1,000	1	1,000	> 2 h

*Table 22 - High AC voltage: output characteristics (2/4)*

Voltage range [V]	Output current [A]	Output power [VA]	Load time [s]
500	5	2,500	60
500	4	2,000	130
500	2	1,000	> 2 h

*Table 23 - High AC voltage: output characteristics (3/4)*



ATTENTION: The output range decreases below 50 Hz and above 60 Hz

The following table lists the output characteristics:

<b>Generation resolution</b>	100 mV, on all ranges
<b>Total Harmonic distortion</b>	Less than 2% on linear loads
<b>Measurement accuracy</b>	For all ranges, there are four measuring ranges, with automatic switch: 2,000 V; 1,000 V; 500 V; 250 V
<b>Accuracy</b>	Typical < 0.05% of the reading < 0.05% of the metering range
	Guaranteed $\pm 0.1\%$ of the reading $\pm 0.1\%$ of the metering range
<b>Connection</b>	Two HV safety sockets

*Table 24 – High AC voltage: output characteristics (4/4)*

On this output is also measured the output current, with automatic range selection, and the phase shift of the current with respect to the voltage.

The following table lists the current ranges and the associated errors:

Current range [A]	Resolution [mA]	Typical amplitude error		Guaranteed amplitude error		Typical phase error [°]
		[<%rdg]	[<%rg]	[ $\pm$ %rdg]	[ $\pm$ %rg]	
5	1	< 0.2	< 0.05	$\pm 0.4\%$	$\pm 0.1\%$	< 0.1
0.5	0.1	< 0.05	< 0.05	$\pm 0.1\%$	$\pm 0.1\%$	< 0.1
0.05	0.01	< 0.1	< 0.1	$\pm 0.2\%$	$\pm 0.2\%$	< 0.2

*Table 25 - High AC voltage: current ranges and associated errors*

The following table lists the phase shift metering characteristics:

<b>Metering range</b>	$0^\circ \div 360.0^\circ$
<b>Resolution</b>	0.1°
<b>Accuracy</b>	< 0.1° typical
	0.2° maximum, for amplitudes more than 10% of the metering range

*Table 26 – High AC voltage: phase shift metering characteristics*

### 3.2.6 Low AC voltage

The output is available on the STS 5000 and STS 4000.

Type of generator: not controlled low AC voltage.

The output voltage can be manually adjusted using the front panel controls, and measured via the test set voltage meter.

The following table lists the output characteristics:

<b>Two voltage ranges</b>	140 V AC or 70 V AC
<b>Output power</b>	420 VA, for both ranges
<b>Output protection</b>	Fuse type T6A
<b>Connection</b>	Two safety 4 mm banana sockets

*Table 27 – Low AC current: output characteristics*

### 3.2.7 High power output to the external modules

The output is available on all models of the STS family.

The output feeds the external modules type TD 5000, BUX 2000, BUX 3000, STLG, STCS Booster 20 A DC.

The following table lists the output characteristics:

<b>Insulation</b>	Output not insulated from the mains supply
<b>Output voltage</b>	Adjustable in the range (0÷220) V AC
<b>Output power</b>	Supply 230 V: 1,500 VA steady, 4,000 VA during 5 minutes; 5,000 VA during 25 s
	Supply 110 V: 1,360 VA steady, 2,500 VA during 1 minute; 3,150 VA during 25 s

*Table 28 – High power output: output characteristics*

This output goes to a safety connector.

### 3.2.8 Output frequency

The following table lists the frequency range on all the AC outputs:

<b>Frequency</b>	15÷500 Hz
<b>Frequency resolution</b>	10 mHz
<b>Frequency accuracy</b>	< 100 ppM; output voltage > 200 V

*Table 29 – Frequency range on all the AC outputs*

### 3.2.9 Other features of main outputs

The following table lists other features of main outputs:

<b>Zero crossing control</b>	The generation starts and stops on the zero crossing
<b>Over-current</b>	Alarm message
<b>Thermal protection</b>	For: Power supply, Power amplifier, Power transformer. The operator is alerted by a message
<b>Output measurement</b>	The used output is selected from the front panel

*Table 30 – Other features of main outputs*

### 3.3 Outputs measurement

The display shows the following:

- The High AC current
- The High DC current
- The High AC voltage
- The corresponding output current

All of them are shown in their evolution during the test.

The display shows also the selected measurement inputs.

<b>Type of measurement</b>	True rms for AC outputs DC component for DC outputs
<b>Metering temperature coefficient</b>	$\pm 0.05\%/^{\circ}\text{C}$ of the value $\pm 0.02\%/^{\circ}\text{C}$ of the range

Table 31 – Outputs measurement

### 3.4 External inputs measurement

The following measurements are performed by all the test sets of the family. It is possible to meter the current and the voltage of an external (or internal) generator. Four metering inputs are available, isolated between them and with respect to the rest of the test set:

- AC or DC current, up to 10 A, with two 4 mm safety banana sockets. This input is also protected by a FF10A fuse
- AC voltage, with two independent connections, in alternative:
  - High range, up to 300 V AC (four ranges with automatic selection), with two 4 mm safety banana sockets
  - Low range, up to 3 V AC (three ranges with automatic selection), with a shielded connector
- DC voltage, up to 10 V DC (four ranges with automatic selection), with two 4 mm safety banana sockets. On the same sockets is also available an Ohmmeter, for the 2-wire resistance measurements from 0.1÷20 k $\Omega$

Above inputs allow measuring CT or VT outputs or any other source. The selected input is shown in the front panel with a LED. All inputs have two or more metering ranges, with automatic range selection.

The following table list the resolution and accuracy:

Input	Range	Impedance	Resolution	Typical error		Guaranteed error	
				[<%rdg]	[<%rg]	[ $\pm$ %rdg]	[ $\pm$ %rg]
AC current	10 A 1 A	0.1 $\Omega$	1 mA 0.1 mA	< 0.05%	< 0.05%	$\pm 0.10\%$	$\pm 0.10\%$
DC current	10 A 1 A	0.1 $\Omega$	1 mA 0.1 mA	< 0.03%	< 0.08%	$\pm 0.05\%$	$\pm 0.15\%$
High AC voltage range (sockets)	300 V 30 V 3 V 300 mV	500 k $\Omega$	15 mV 1.5 mV 0.15 mV 0.015 mV	< 0.05% < 0.05% < 0.10% < 0.15%	< 0.05%	$\pm 0.10\%$ $\pm 0.10\%$ $\pm 0.20\%$ $\pm 0.30\%$	$\pm 0.1\%$
Low AC voltage range (connector)	3 V 300 mV 30 mV	10 M $\Omega$	150 $\mu\text{V}$ 30 $\mu\text{V}$ 3 $\mu\text{V}$	< 0.03% < 0.08% < 0.1%	< 0.05% < 0.08% < 0.25%	$\pm 0.05\%$ $\pm 0.15\%$ $\pm 0.2\%$	$\pm 0.10\%$ $\pm 0.15\%$ $\pm 0.50\%$
DC voltage	10 V 1 V 100 mV 10 mV	500 k $\Omega$	400 $\mu\text{V}$ 75 $\mu\text{V}$ 4 $\mu\text{V}$ 0.4 $\mu\text{V}$	< 0.03% < 0.03% < 0.05% < 0.05%	< 0.08% < 0.08% < 0.10% < 0.15%	$\pm 0.05\%$ $\pm 0.05\%$ $\pm 0.10\%$ $\pm 0.10\%$	$\pm 0.15\%$ $\pm 0.15\%$ $\pm 0.20\%$ $\pm 0.30\%$

Table 32 - Resolution and accuracy

### 3.5 Timer

The STS 5000 and STS 4000 allow to measure a device timing, using a special input.

At the test start with voltage or current generation, a timer is started; the timer stops when the relay has tripped. It is also possible to stop the timer when the injected current is stopped by the intervention of the device under test.

Characteristics of the Digital In input:

- The input is isolated with respect to all other inputs and outputs
- The input may be selected as Normal Open or Normal Closed
- The timer can start from an analog input (current or voltage)
- The timer can start and stop at the changing of the digital input, both dry or wet contact
- Type of input: either dry or wet. Maximum input: 300 V AC or DC
- With the dry input selection, the wetting voltage is 24 V nominal (unregulated); the test current is 3 mA nominal. With a resistance less than 200 k $\Omega$  the contact can be seen closed
- With the voltage input selection, four thresholds can be selected: 5 V, 24 V, 48 V or > 80 V
- When the input is closed or with voltage, an LED on the front panel turns on
- Wrong selection protection. If a voltage is applied when clean input is selected, input circuits are not damaged, provided that the voltage is less than 300 V
- Input connection: two safety 4 mm banana sockets
- Time measurement: elapsed time between the test start and the Digital In input
- Timer resolution: 1 ms
- Timer accuracy, digital input:  $\pm 0.01\%$  of the measurement  $\pm 0.1$  ms, for inputs lasting more than 1 ms
- Maximum measured time: 9,999 s

### 3.6 Phase angle

The test set measures the phase angle between the two AC selected parameters, which are used during the test.

The following table lists the resolution and the accuracy:

Measurement	Range	Resolution	Accuracy
Phase	(0÷360) °	0.01 °	Typical $\pm 0.1$ ° Guaranteed $\pm 0.2$ °

*Table 33 - Phase angle resolution and accuracy*

The angles accuracy is valid for values greater than 10% of the measurement range used.

Phase shift variation (temperature function) angle temperature drift:  $\pm 0.002$  °/°C.

### 3.7 Other measurements

Starting from the internal and external measurements, the test set computes derived measurements, according to the test selection.

The following table lists the available measurements (the accuracy is the sum of voltage, current and possibly angle accuracy):

No.	Parameter AC outputs	Derived from	Formula	Units
1	Ratio (Rat) CT or VT or PT	$I_{out}, I_{in}$ OR $V_{out}, V_{in}$	$Rat = I_{out}/I_{in}$ $Rat = V_{out}/V_{in}$	-
2	Polarity CT or VT or PT	$\varphi I_{out}, I_{in}$ OR $\varphi V_{out}, V_{in}$	$K \Rightarrow \varphi < 10^\circ$	-
3	Burden CT and VT	$V_{out}, I_{out}$	$VA = I_{in}^2 \cdot V_{out}/I_{out}$	VA
4	Saturation knee CT	$V_{out}, I_{out}$	VKn, Ikn: according to the standards	V, A
5	Resistance CB and others	$I_{out}, V_{out}$	$R = V_{out}/I_{out}$	$\Omega$
6	Impedance CT and VT insulation test	$I_{out}, V_{out}$	$Z = V_{out}/I_{out}$	$\Omega$
7	Short circuit impedance PT test	$I_{out}, V_{out}$	$Z = V_{out}/I_{out}$	H

Table 34 - Available measurements

The following table lists the parameters for the CT, VT and PT ratio measurement:

Range	Resolution	Ratio range	Typical accuracy	Maximum accuracy
0÷9,999	1	0.8÷166	0.20%	0.40%
		167÷1,666	0.25%	0.50%
		1,667÷9,999	0.30%	0.60%

Table 35 - Parameters for CT, VT and PT ratio measurement

For the polarity test, the phase shift between the two parameters is tested. Answer is OK if phase shift is less than 10°. The ratio and the polarity are checked also for non-conventional transformers through IEC61850-9-2LE protocol.

For the burden test, the result is the product of voltage and current; the accuracy depends upon the VA range. The following table lists the parameters for the burden test:

Test voltage [V]	Test current [A]	VA range [VA]	Resolution [VA]	Typical accuracy		Maximum accuracy	
				%	%	%	%
130	3	3,000	0.05	±0.1	±0.1	±0.2	±0.2
30	2	300	0.01	±0.1	±0.1	±0.2	±0.2
10	1	30	0.005	±0.1	±0.1	±0.2	±0.2
3	1	3	0.001	±0.2	±0.1	±0.3	±0.2

Table 36 - Parameters for the burden test

For the resistance test it is possible to perform it with four wires, with the two available DC sources, or with two wires, using the 10 V measurement input. The following table lists the corresponding range and accuracy (the maximum resistance is 20 k $\Omega$ ):

Source	Resistance range	Resolution	Typical accuracy	Guaranteed accuracy
High current 400 A 4-wire	10 $\mu\Omega$	0.01 $\mu\Omega$	< 0.7%	1.35%
	100 $\mu\Omega$	0.1 $\mu\Omega$	< 0.5%	1.10%
	1 m $\Omega$	1 $\mu\Omega$	< 0.5%	0.95%
	10 m $\Omega$	10 $\mu\Omega$	< 0.5%	0.95%
Low DC current 6 A 4-wire	100 m $\Omega$	0.1 m $\Omega$	< 0.3%	0.6%
	1 $\Omega$	1 m $\Omega$	< 0.3%	0.6%
	10 $\Omega$	10 m $\Omega$	< 0.2%	0.4%
DC voltage meter 2-wire	100 $\Omega$	0.1 $\Omega$	< 0.6%	1.2%
	1 k $\Omega$	1 $\Omega$	< 0.5%	1.0%
	20 k $\Omega$	10 $\Omega$	< 0.5%	1%.0

Table 37 - Resistance test: range and accuracy

The impedance test is performed applying high voltage and measuring the corresponding current. The following table lists the range and accuracy (the impedance is 100  $\Omega$ , the maximum impedance is 2 M $\Omega$ ):

HV source [V]	I output [A]	Impedance range [ $\Omega$ ]	Resolution [m $\Omega$ ]	Typical accuracy		Maximum accuracy	
				%	%	%	%
500	0.5 $\div$ 5	1,000	20	$\pm$ 0.25	$\pm$ 0.1	$\pm$ 0.5	$\pm$ 0.2
500	0.05 $\div$ 0.5	10,000	200	$\pm$ 0.10	$\pm$ 0.1	$\pm$ 0.2	$\pm$ 0.2
1,000	0.5 $\div$ 2.5	2,000	400	$\pm$ 0.25	$\pm$ 0.1	$\pm$ 0.5	$\pm$ 0.2
1,000	0.05 $\div$ 0.5	20,000	2,000	$\pm$ 0.10	$\pm$ 0.1	$\pm$ 0.2	$\pm$ 0.2
2,000	0.05 $\div$ 1.25	4,000	800	$\pm$ 0.25	$\pm$ 0.1	$\pm$ 0.5	$\pm$ 0.2
2,000	0.05 $\div$ 0.5	40,000	2,000	$\pm$ 0.10	$\pm$ 0.1	$\pm$ 0.2	$\pm$ 0.2
2,000	0.001 $\div$ 0.05	2 M	10 <sup>5</sup>	$\pm$ 0.15	$\pm$ 0.15	$\pm$ 0.3	$\pm$ 0.3

Table 38 - Impedance test: range and accuracy

The following table lists the range and tolerances for the short-circuit impedance test:

Measurement range	Digits No	Range	Maximum Resolution	Accuracy
10 mH $\div$ 2 H	5	Self-adjusting	0.001 mH	1% of the reading, $\pm$ 0.5 mH

Table 39 - Phase angle resolution and accuracy

### 3.8 Display

The following image exhibits the STS display:



Figure 5 - STS display

The following table lists the main features of the display:

Pixel	Light	LCD type	View area
640 x 480, colors	Backlight	TFT	132 x 99 mm

Table 40 - Main features of the display

### 3.9 Test control

Test control: by the START / STOP pushbutton. Pressing it, the output is generated, after test selection, according to the type of test. During ON, if a manual control test is selected, the operator adjusts the output at the desired value.

Test saving:

- Automatic save
- After operator confirmation

### 3.10 Menu selections

The following image exhibits the Home page of the test set of the Test Plan Editor:



Figure 6 – Home page

The menu is entered pressing the knob and selecting the item moving the knob.

The Test Plan Editor is an innovative and advanced software module, allowing the operator to define and plan a sequence of tests. The operator defines the desired sequence of tests and sets the parameters of each test: the Editor creates a sequence of tests to be performed automatically. The feature is available for the tests of Current, Voltage and Power transformers.

Test plans can be saved or recalled, like test results. Up to 64 settings can be stored and recalled; setting no. 0 is the default one, and pops up at power-on. Settings are permanently stored in the memory; new settings can be written to the same address after confirmation. For normal mode operation it is possible to recall the standard setting, which cannot be modified.

For instance, in the Home page select the icon “Current Transformers” and press the knob:



Figure 7 – “Current Transformers” icon

The following image exhibits the “Power Transformers – Header and Nominal Values” page (tab Description), visible at first time in which entering this section, or pressing the button “Header/Nominal Values”:

Figure 8 - "Current Transformers/Header and Nominal Values" page (tab Description)

The following image exhibits the tab “Nominals” (Conventional Type without the IEC61850-9-2LE output):

#	Name	I Prim (A)	Nom Ik (A)	Nom Vk (V)
1	1S1-1S2	600.0	50.000m	400.000
2	1S1-1S3	300.0	43.300m	200.000
3	1S1-1S4	150.0	32.000m	100.000
4	1S1-1S5	100.0	10.000m	50.000

Figure 9 - "Current Transformers/Header and Nominal Values" page (tab Nominals)

From these nominal data, the program computes the nominal saturation knee.

The following image exhibits the tab “Tolerances”:

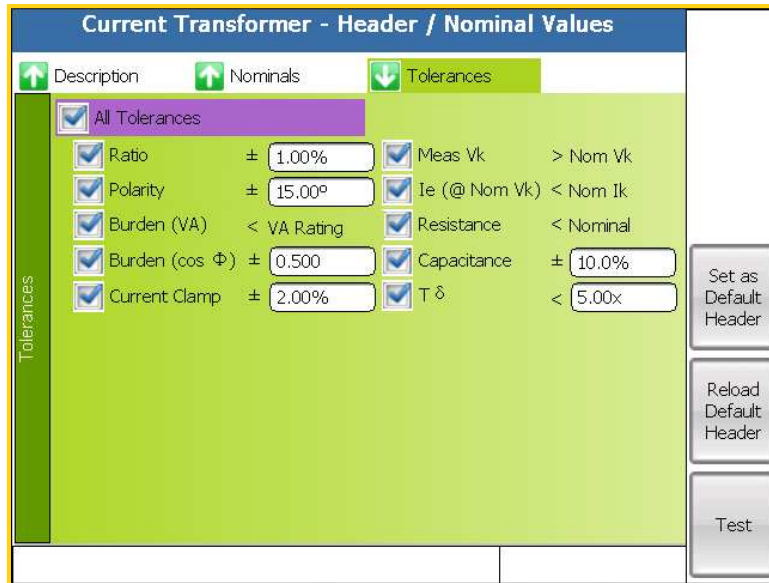


Figure 10 - "Current Transformers/Header and Nominal Values" page (tab Tolerances)

The page allows setting the tolerances for each of the available tests. If the tolerance is exceeded, the deviation is shown in the test result table.

After having set this basic information, pressing the shortcut “Edit Test Plan” at the side of the icon and enter the Editor mode; else, it is possible to continue with a single test.

The following image exhibits the “Current Transformers” test page (Conventional Type):



Figure 11 - "Current Transformers" test page (Conventional Type)

The page allows selecting the test to be performed: the corresponding window is opened, and test parameters can be programmed

For instance, the following image exhibits the “CTs – Ratio Polarity and Burden Current Method” page:

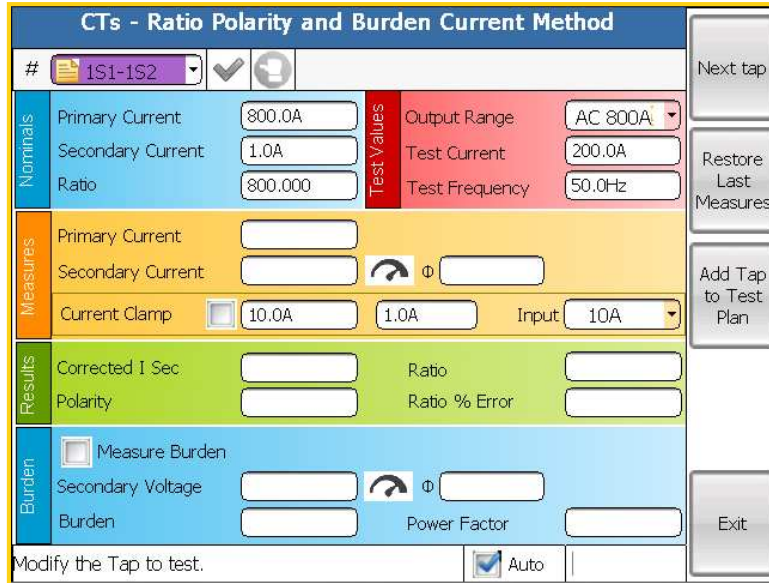


Figure 12 - "CTs – Ratio Polarity and Burden Current Method" page

As the test programming is finished, pressing the shortcut “Exit” by the side of the icon, it is possible to come back to the test selection table. Pressing here the shortcut “Exit Ct’s” by the side of the icon, it is possible to come back to the main menu, and the Editing is finished.

At the end of the programming, starting the first test, the test set executes the complete sequence. During the test, test results are stored in the memory.

At the end of the tests, settings and results can be downloaded to a PC, with PADS program included in the TDMS suite, which comes with the device. The software allows saving test results into a file, examining them, printing them.

Optionally, PADS allows controlling the device from the PC. It is also possible to edit settings with PADS, and to upload them to STS.

In general, the test is performed ramping the parameter until the desired value is reached; after the necessary test duration, the parameter is reduced to zero.

The following tables summarizes all tests and the corresponding performances.

The following table lists the Current Transformers tests:

No.	Test	Test description
1	Ratio Polarity and Burden	<p>The ratio measurement is performed applying high current to the CT primary, and measuring the CT secondary current. The burden can be by-passed, or left in series for the measurement: in this instance, the voltage drop is measured. The secondary current can be measured by a clamp.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary and secondary current, from which the program computes the nominal ratio</li> <li>• The nominal test current</li> </ul> <p>The display shows:</p> <ul style="list-style-type: none"> <li>• The actual current output</li> <li>• The corresponding current input, and the value of the secondary current with the nominal primary current*</li> <li>• Actual ratio and ratio error</li> <li>• Phase shift and polarity*</li> </ul> <p>When the burden is tested, the following parameters are displayed</p> <ul style="list-style-type: none"> <li>• The voltage drop across the burden</li> <li>• For the burden: VA rating at the nominal current, angle, power factor</li> </ul> <p>*For Non - CT transformers equipped with IEC61850-9-2LE interface, the STS reads the CT samples output from its Ethernet interface to measure ratio and polarity</p>
2	Burden Secondary Side	<p>The burden measurement is performed applying low AC current to the CT burden, and measuring the voltage drop.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal secondary current</li> <li>• The nominal test current</li> </ul> <p>The display shows:</p> <ul style="list-style-type: none"> <li>• The actual current output</li> <li>• The voltage drop across the burden</li> <li>• For the burden: VA rating at the nominal current, angle, power factor</li> </ul>
3	Excitation Curve	<p>The excitation curve is tested connecting the high AC voltage to the CT secondary, slewing the voltage and measuring at the same time the output voltage and current.</p> <p>Input parameters are taken from the CT Nominal Values window. Other inputs are the following:</p> <ul style="list-style-type: none"> <li>• Maximum test voltage and current</li> <li>• Test frequency</li> </ul> <p>The test set controls the output voltage and current during the test, and stops as the knee is recognized. The display shows the following:</p> <ul style="list-style-type: none"> <li>• The characteristic curve</li> <li>• The actual voltage knee and the error with respect to the nominal</li> <li>• The actual current error at knee</li> </ul> <p>In addition to this, it is possible to define a point-by-point test, where:</p> <ul style="list-style-type: none"> <li>• It is possible to input the desired number of test points, defined with current and voltage</li> <li>• The test result reports the deviation from the nominal values, and shows if results are in the set tolerance</li> </ul>

Table 41 - Current Transformers tests (1/4)

No.	Test	Test description
4	Winding or Burden Resistance	<p>The resistance (not impedance) is measured connecting the low DC current source to the winding or burden, and measuring the test current and the voltage drop. Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal resistance</li> <li>• The connected output</li> <li>• The test current</li> <li>• The resistance limits</li> </ul> <p>It is also possible to compensate the test temperature. The test set controls the output current and voltage during the test, and stops as the test current is reached. The display shows the following:</p> <ul style="list-style-type: none"> <li>• The test current</li> <li>• The voltage drop</li> <li>• The measured resistance and the compensated resistance</li> <li>• The test duration</li> <li>• The current deviation when the measurement was achieved</li> </ul>
5	Voltage Withstand	<p>The test is performed connecting the high AC voltage source between the CT secondary cabling and the ground or between the CT primary and secondary. Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Maximum test current (with automatic switch-off)</li> <li>• Test time</li> <li>• Output range</li> <li>• Test voltage</li> <li>• Test frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• During the HV ramping, the test voltage and current;</li> <li>• As the test is completed, the test voltage, the maximum current, the total elapsed time, the isolation impedance (not resistance)</li> </ul>
6	Polarity Check	<p>The test is performed connecting the high AC current source to the primary side, generating a special waveform, and measuring the induced secondary current with the optional PLCK polarity sensor. Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The test current</li> <li>• The generation duty cycle</li> <li>• The test result (OK or NO)</li> </ul> <p>The display shows the test current and records the test result of the different points</p>
7	Ratio Polarity Voltage Mode	<p>The ratio measurement is performed applying High V AC to the CT secondary, and measuring the CT primary voltage. Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary and secondary current, from which the program computes the nominal ratio</li> <li>• The voltage range</li> <li>• The nominal test voltage and the test frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• The current test voltage on the secondary side</li> <li>• The secondary measured voltage and the secondary current with the nominal primary current</li> <li>• Actual ratio and ratio error</li> <li>• Phase shift and polarity</li> </ul>


*Table 42 - Current Transformers tests (2/4)*

No.	Test	Test description
8	Rogowski (Ratio)	<p>The test is performed connecting the high AC current source to the primary side, and connecting the CT secondary side to the low voltage measurement.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary current and the nominal secondary voltage, from which the program computes the nominal ratio</li> <li>• The current range</li> <li>• The test current</li> <li>• The test frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary current and the test current</li> <li>• The actual test current, the secondary voltage, and the value of the primary current with the nominal secondary voltage</li> <li>• Actual ratio and ratio error</li> <li>• Phase shift and polarity</li> </ul>
9	Low Power (Ratio)	<p>The test is performed connecting the high AC current source to the primary side, and connecting the CT secondary side to the low voltage measurement.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary current and the nominal secondary voltage, from which the program computes the nominal ratio</li> <li>• The current range</li> <li>• The test current</li> <li>• The test frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary current and the test current</li> <li>• The actual test current, the secondary voltage, and the value of the primary current with the nominal secondary voltage</li> <li>• Actual ratio and ratio error</li> <li>• Phase shift and polarity</li> </ul>
10	Tan( $\delta$ ) measures	<p>The test is performed using the TD 5000 optional module, and then connecting the high AC voltage source to test target.</p> <p>Displayed parameters are the following:</p> <ul style="list-style-type: none"> <li>• <i>Test type (1)</i>: Where the HV output is applied: in case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Capacitance (2)</i>: In case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Generation mode</i>: to execute a single shot, a voltage or a frequency gradient</li> <li>• <i>Test mode</i>: It is selected in reference to the TD 5000 and the device under test connection. In case of a specific device under test (VT, in this case), the more correct test mode is automatically selected, considering also the selections (1) and (2)</li> <li>• <i>Voltage/Frequency test table</i>: It allows to input the test voltage and frequency</li> <li>• <i>Nominal Values</i>: Capacitance and TD reference values. In case of a specific device under test (CT, VT, PT or bushing), these values are kept from the related headers</li> <li>• <i>Temperature compensation</i>: The Capacitance and TD values vary with the temperature: optionally, the “k” factor is used to compensate the measures</li> <li>• Test table</li> <li>• Results table <ul style="list-style-type: none"> <li>• Test voltage, current and frequency</li> <li>• Capacitance, Tan(<math>\delta</math>), power factor (PF)</li> <li>• Power: active, reactive, apparent</li> <li>• Impedance: module, argument, components</li> </ul> </li> </ul>

Table 43 - Current Transformers tests (3/4)

No.	Test	Test description
11	Ratio IEC61850-9-2LE	<p>Ratio measure and currents polarity for Not Conventional Transformers. The test is executed applying current to the primary side and reading the corresponding “Sample Values”.</p> <p>The test is executed using the test set remote connection with the PC, using the PDS program.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Nominal primary current</li> <li>• Test current and frequency</li> <li>• The sender MAC address</li> <li>• The recipient MAC address</li> <li>• The svID (sample value ID)</li> <li>• The Stream Number</li> </ul> <p>The results are the following:</p> <ul style="list-style-type: none"> <li>• The primary current</li> <li>• The measured Sample Values</li> <li>• The angle between the primary current and the Sample Values</li> <li>• Corrected primary current, polarity, error ratio and error %</li> </ul>

*Table 44 - Current Transformers tests (4/4)*

	<p>ATTENTION: for the excitation curve test, the following standards apply:</p> <ul style="list-style-type: none"> <li>• IEC 60044-1; paragraph 14.4.1. The knee point is the voltage at which the increase of 10% of voltage causes the increase of the 50% of the exciting current</li> <li>• ANSI C57.13.1; chapter 9. Plotting a log-log diagram with the excitation current on the X axis and the exciting voltage on the y axis, the knee point is the one where the tangent of the curve is at 45°</li> <li>• ANSI C57.13.1; chapter 9. Plotting a log-log diagram with the excitation current on the X axis and the exciting voltage on the y axis, the knee point is the one where the tangent of the curve is at 30°</li> </ul>
------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

The following table lists the Voltage Transformers tests:

No.	Test	Test description
1	Ratio	<p>The ratio measurement is performed applying high voltage to the VT primary, and measuring the VT secondary voltage.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary and secondary voltage, from which the program computes the nominal ratio</li> <li>• Type of connection (Y or Delta)</li> <li>• The HV range</li> <li>• The nominal test voltage and frequency</li> <li>• The selected voltage meter</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• The actual test voltage</li> <li>• The secondary voltage*</li> <li>• The value of the secondary voltage with the nominal primary voltage</li> <li>• Actual ratio and ratio error</li> <li>• Phase shift and polarity*</li> </ul> <p>*For Non-conventional VT transformers equipped with IEC61850-9-2LE interface, the STS reads the VT samples output from its Ethernet interface to measure ratio and polarity</p>
2	Ratio Electronics	<p>The ratio measurement is performed applying high voltage to the VT primary, and measuring the low-level VT secondary voltage.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary and secondary voltage, from which the program computes the nominal ratio</li> <li>• Type of connection (Y or Delta)</li> <li>• The HV range</li> <li>• The nominal test voltage and frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• The actual test voltage</li> <li>• The secondary voltage</li> <li>• The value of the secondary voltage with the nominal primary voltage</li> <li>• Actual ratio and ratio error</li> <li>• Phase shift and polarity</li> </ul>
3	Burden	<p>The burden measurement is performed applying low AC voltage to the VT burden, and measuring the corresponding current.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal secondary voltage</li> <li>• The voltage range</li> <li>• The test voltage and frequency</li> </ul> <p>The test current can also be metered by a clamp.</p> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• The actual voltage and current test</li> </ul> <p>The results are the following:</p> <ul style="list-style-type: none"> <li>• Performance in VA at rated voltage</li> <li>• Cos(<math>\varphi</math>)</li> </ul>
4	Voltage Withstand	<p>The test is performed connecting the high AC voltage source between the VT secondary cabling and the ground or between the VT primary and secondary.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Maximum test current (with automatic switch-off)</li> <li>• Test time</li> <li>• Output range</li> <li>• Test voltage</li> <li>• Test frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• During the generation, the test voltage and current</li> <li>• As the test is completed, the maximum current, the total elapsed time, the isolation impedance</li> </ul>

*Table 45 - Voltage Transformers tests (1/2)*

No.	Test	Test description
5	Polarity Check	<p>The test is performed connecting the high AC voltage source to the primary side, and measuring the induced secondary voltage with the optional PLCK polarity sensor.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The test voltage</li> <li>• The generation duty cycle</li> <li>• The test result (OK or NO)</li> </ul> <p>The display shows the test voltage, and records the test result of the different points</p>
6	Tan( $\delta$ ) measures	<p>The test is performed using the TD 5000 optional module, and then connecting the high AC voltage source to test target.</p> <p>Displayed parameters are the following:</p> <ul style="list-style-type: none"> <li>• <i>Test type (1)</i>: Where the HV output is applied: in case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Capacitance (2)</i>: In case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Generation mode</i>: to execute a single shot, a voltage or a frequency gradient</li> <li>• <i>Test mode</i>: It is selected in reference to the TD 5000 and the device under test connection. In case of a specific device under test (VT, in this case), the more correct test mode is automatically selected, considering also the selections (1) and (2)</li> <li>• <i>Voltage/Frequency test table</i>: It allows to input the test voltage and frequency</li> <li>• <i>Nominal Values</i>: Capacitance and TD reference values. In case of a specific device under test (CT, VT, PT or bushing), these values are kept from the related headers</li> <li>• Temperature compensation: The Capacitance and TD values vary with the temperature: optionally, the “k” factor is used to compensate the measures</li> <li>• Test table</li> <li>• Results table <ul style="list-style-type: none"> <li>• Test voltage, current and frequency</li> <li>• Capacitance, Tan(<math>\delta</math>), power factor (PF)</li> <li>• Power: active, reactive, apparent</li> <li>• Impedance: module, argument, components</li> </ul> </li> </ul>
7	Ratio IEC61850-9-2LE	<p>Ratio measure and currents polarity for Not Conventional Transformers. The test is executed applying current to the primary side and reading the corresponding “Sample Values”.</p> <p>The test is executed using the test set remote connection with the PC, using the PDS program.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Nominal primary current</li> <li>• Test current and frequency</li> <li>• The sender MAC address</li> <li>• The recipient MAC address</li> <li>• The svID (sample value ID)</li> <li>• The Stream Number</li> </ul> <p>The results are the following:</p> <ul style="list-style-type: none"> <li>• The primary current</li> <li>• The measured Sample Values</li> <li>• The angle between the primary current and the Sample Values</li> <li>• Corrected primary current, polarity, error ratio and error %</li> </ul>

Table 46 - Voltage Transformers tests (2/2)

The following table lists the Power Transformers tests:

No.	Test	Test description
1	Ratio	<p>The ratio measurement is performed applying high voltage to the VT primary, and measuring the VT secondary voltage for each tap. If the STCS option is available, connection is performed via the option, and the test is completely automatic.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal primary and secondary voltage, from which the program computes the nominal ratio</li> <li>• Type of connection (Y or Delta)</li> <li>• The type of Tap changer</li> <li>• The nominal test voltage and frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• The test voltage, primary and secondary</li> <li>• Actual ratio and ratio error</li> <li>• Phase shift and polarity</li> </ul>
2	Winding Resistance	<p>The test is performed applying low DC current to the PT primary plus Tap Changer and measuring the voltage drop. The tester measures the resistance peak during the switch and the resistance after the selection.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal resistance</li> <li>• The output current (6 A or 400 A)</li> <li>• The test current</li> <li>• The nominal resistance and the resistance limits</li> </ul> <p>It is also possible to compensate the test temperature.</p> <p>The test set controls the output current during the test and issues the Tap Change command. The display shows the following:</p> <ul style="list-style-type: none"> <li>• The test current</li> <li>• The tap number</li> <li>• For the static resistance: the test voltage and resistance, also compensated</li> <li>• For the dynamic resistance: the measured values are the Ripple and the Slope and the diagrams of the current or of the resistance</li> </ul> <p>During the current discharge, voltage and current are displayed.</p> <p>The dynamic resistance measurement is performed also without the STCS option. The tap changer command is manual</p>
3	Winding Resistance – Auto	<p>The test is performed applying low DC current to the PT primary plus Tap Changer and measuring the voltage drop. The tester measures the resistance peak during the switch and the resistance after the selection. Using the STCS option, the connection to the PT is performed using the option and the test is completely automatic.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The nominal resistance</li> <li>• The output current (6 A or 400 A)</li> <li>• The test current</li> <li>• The nominal resistance and the resistance limits</li> </ul> <p>It is also possible to compensate the test temperature.</p> <p>The test set controls the output current during the test and issues the Tap Change command. The display shows the following:</p> <ul style="list-style-type: none"> <li>• The test current</li> <li>• The tap number</li> <li>• For the static resistance: the test voltage and resistance, also compensated</li> <li>• For the dynamic resistance: the measured values are the Ripple and the Slope and the diagrams of the current or of the resistance</li> </ul> <p>During the current discharge, voltage and current are displayed.</p> <p>The dynamic resistance measurement is performed also without the STCS option. The tap changer command can be automatic</p>

Table 47 - Power Transformers tests (1/3)

No.	Test	Test description
4	Voltage Withstand	<p>The test is performed connecting the high AC voltage source between the CT secondary cabling and the ground or between the CT primary and secondary.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Maximum test current (with automatic switch-off)</li> <li>• Test time</li> <li>• Output range</li> <li>• Test voltage</li> <li>• Test frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• During the HV ramping, the test voltage and current;</li> </ul> <p>As the test is completed, the test voltage, the maximum current, the total elapsed time, the isolation impedance (not resistance)</p>
5	Short-Circuit Impedance	<p>The test is performed applying low AC current to the winding under test, while other windings are short-circuited, and measuring the associated voltage and phase shift. If the STCS option is available, connection is performed via the option, and the test is completely automatic.</p> <ul style="list-style-type: none"> <li>• Input parameters are the following:</li> <li>• The test current and frequency</li> <li>• The type of winding</li> <li>• The phase under test</li> </ul> <p>It is also possible to compensate the test temperature. The test set measures the output voltage, and computes the related parameters. The display shows the following:</p> <ul style="list-style-type: none"> <li>• Phase shift; the power loss; the R, X, Z and inductance of the transformer</li> <li>• The same parameters, but expressed in Per Unit</li> </ul>
6	No-Load Current	<p>The test is performed connecting the TD 5000 optional module (or the HV output), to the device under test.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• The test voltage</li> <li>• The frequency</li> </ul> <p>The test set applies the high voltage and measures the output current during the test. The display shows the following:</p> <ul style="list-style-type: none"> <li>• The test voltage</li> <li>• The current and the phase shift</li> <li>• The power losses</li> <li>• The reactance</li> </ul>

*Table 48 – Power Transformers tests (2/3)*

No.	Test	Test description
7	Tan( $\delta$ ) measures	<p>The test is performed using the TD 5000 optional module, and then connecting the high AC voltage source to test target.</p> <p>Displayed parameters are the following:</p> <ul style="list-style-type: none"> <li>• <i>Test type (1)</i>: Where the HV output is applied: in case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Capacitance (2)</i>: In case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Generation mode</i>: to execute a single shot, a voltage or a frequency gradient</li> <li>• <i>Test mode</i>: It is selected in reference to the TD 5000 and the device under test connection. In case of a specific device under test (VT, in this case), the more correct test mode is automatically selected, considering also the selections (1) and (2)</li> <li>• <i>Voltage/Frequency test table</i>: It allows to input the test voltage and frequency</li> <li>• <i>Nominal Values</i>: Capacitance and TD reference values. In case of a specific device under test (CT, VT, PT or bushing), these values are kept from the related headers</li> <li>• <i>Temperature compensation</i>: The Capacitance and TD values vary with the temperature: optionally, the “k” factor is used to compensate the measures</li> <li>• Test table</li> <li>• Results table <ul style="list-style-type: none"> <li>• Test voltage, current and frequency</li> <li>• Capacitance, Tan(<math>\delta</math>), power factor (PF)</li> <li>• Power: active, reactive, apparent</li> <li>• Impedance: module, argument, components</li> </ul> </li> </ul>
8	Demagnetizer	<p>Purpose of this test is to apply a DC current with alternate polarity to the winding, in order to remove from the core the residual magnetism due to a previous winding resistance measurement.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Nominal current (primary and secondary)</li> <li>• Connections A, B, C according to the vector group</li> <li>• Transformer side selection</li> <li>• Output Range</li> <li>• Test current</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• DC current and voltage</li> <li>• Current behavior during the demagnetization procedure</li> </ul>

*Table 49 – Power Transformers tests (3/3)*

The following table lists the Circuit Breakers tests:

No.	Test	Test description
1	Resistance - $\mu\Omega$	<p>The contact resistance test is performed using the high DC current output. The test set measures the contact resistance down to the <math>\mu\Omega</math> range.</p> <p>With the same selection, and different generators, it is also possible to measure higher resistances.</p> <p>Input parameters are: current output range, test current, and resistance limits. The display shows the following:</p> <ul style="list-style-type: none"> <li>• DC current</li> <li>• DC voltage</li> <li>• Resistance</li> </ul>
2	Tan( $\delta$ ) measures	<p>The test is performed using the TD 5000 optional module, and then connecting the high AC voltage source to test target.</p> <p>Displayed parameters are the following:</p> <ul style="list-style-type: none"> <li>• <i>Test type (1)</i>: Where the HV output is applied: in case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Capacitance (2)</i>: In case of a specific device under test (CT, VT, PT or bushing), the options are displayed</li> <li>• <i>Generation mode</i>: to execute a single shot, a voltage or a frequency gradient</li> <li>• <i>Test mode</i>: It is selected in reference to the TD 5000 and the device under test connection. In case of a specific device under test (VT, in this case), the more correct test mode is automatically selected, considering also the selections (1) and (2)</li> <li>• <i>Voltage/Frequency test table</i>: It allows to input the test voltage and frequency</li> <li>• <i>Nominal Values</i>: Capacitance and TD reference values. In case of a specific device under test (CT, VT, PT or bushing), these values are kept from the related headers</li> <li>• Temperature compensation: The Capacitance and TD values vary with the temperature: optionally, the "k" factor is used to compensate the measures</li> <li>• Test table</li> <li>• Results table <ul style="list-style-type: none"> <li>• Test voltage, current and frequency</li> <li>• Capacitance, Tan(<math>\delta</math>), power factor (PF)</li> <li>• Power: active, reactive, apparent</li> <li>• Impedance: module, argument, components</li> </ul> </li> </ul>

Table 50 - Circuit Breakers tests

The following table lists the Resistances tests:

No.	Test	Test description
1	Resistance - $\mu\Omega$	<p>The contact resistance test is performed using the high DC current output. The test set measures the contact resistance down to the <math>\mu\Omega</math> range.</p> <p>With the same selection, and different generators, it is also possible to measure higher resistances.</p> <p>Input parameters are: current output range, test current, and resistance limits. The display shows the following:</p> <ul style="list-style-type: none"> <li>• DC current</li> <li>• DC voltage</li> <li>• Resistance</li> </ul>
2	Earth Resistance	<p>For the resistivity test, input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Voltage range</li> <li>• Test voltage</li> <li>• Test frequency</li> </ul> <p>The measurements are narrow filtered in order to reduce the noise, coming from the environment.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Output voltage range</li> <li>• Test voltage</li> <li>• Test frequency</li> </ul> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• Test probe distance</li> <li>• Output voltage</li> <li>• Test probe voltage</li> <li>• Output current</li> <li>• Phase shift</li> <li>• Earth resistance</li> <li>• Evaluation</li> </ul> <p>Ground Resistance Values : from 0.05 <math>\Omega</math> to 300 <math>\Omega</math></p> <p>The test of ground grid resistance is performed applying current between the ground grid and the auxiliary ground spikes. With the STLG option the test is performed using an overhead line to connect to the remote ground</p>
3	Soil Resistivity	<p>The test of soil resistivity is performed applying AC voltage to two spikes, and measuring the injected current, and the voltage across the voltage spikes.</p> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• Location</li> <li>• Probes distance</li> <li>• Output voltage</li> <li>• Voltage between probes</li> <li>• Output current</li> <li>• Corresponding resistivity</li> <li>• Evaluation</li> </ul>

Table 51 - Resistances tests (1/2)

No.	Test	Test description
4	Step and Touch	<p>The step and touch voltages test is performed applying current between the ground grid and the auxiliary ground spikes, and measuring the step or touch voltage with the test probes. With the STLG option, the current generation is performed using an overhead line to connect to the remote ground. Thanks to the STLG option, higher test currents can be achieved.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Substation fault current</li> <li>• Fault clearance time</li> <li>• Parallel resistance on the test probes</li> </ul> <p>Other selections are the following:</p> <ul style="list-style-type: none"> <li>• Output voltage range</li> <li>• Test voltage</li> <li>• Test frequency</li> </ul> <p>With the STLC option, we select the current range. Last, the operator selects the measurement mode: manual or on STS and the reference standard.</p> <p>The display shows the following:</p> <ul style="list-style-type: none"> <li>• Test current</li> <li>• Location description</li> <li>• Location coordinates</li> <li>• Measured voltage</li> <li>• Voltage in case of actual fault</li> </ul>
5	Line Impedance	<p>Test parameters are the following:</p> <ul style="list-style-type: none"> <li>• Line impedance</li> <li>• Earth impedance</li> <li>• Mutual factor</li> </ul> <p>The test is performed applying voltage to the line to be tested, and measuring the corresponding current and voltage. The test is performed with the STLG option.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Type of test</li> <li>• Phase under test</li> <li>• Frequency</li> </ul> <p>For the line impedance test, the display shows the following data:</p> <ol style="list-style-type: none"> <li>1) Test voltage;</li> <li>2) Test current;</li> <li>3) Line impedance, argument, R and X components.</li> </ol> <p>For the earth impedance test, the display shows the following:</p> <ul style="list-style-type: none"> <li>• Test voltage and current</li> <li>• Impedance and argument of: Z, ZL, ZE, earth coefficient KE</li> </ul> <p>For the mutual factor test, the display shows:</p> <ul style="list-style-type: none"> <li>• Module and phase of the mutual factor</li> <li>• ZL module and resistive component</li> <li>• External voltage, current, phase angle</li> </ul>

Table 52 – Resistances tests (2/2)

The following table lists other possible tests:

No.	Test	Test description
1	Primary and secondary M.V. CB and relay tests	<p>The selection allows injecting the test parameter, and measuring the relay threshold and trip delay. The tests are feasible using the trigger input logic, or by stopping the test when the current disappears (M.V. CB). With the option BUX 2000 and BUX 3000 it is possible to perform high current tests.</p> <p>Input parameters are the following:</p> <ul style="list-style-type: none"> <li>• Current range, output current</li> <li>• Output voltage</li> <li>• Frequency</li> </ul> <p>It is possible set the type of digital input (NO-NC, wet-dry, voltage threshold). The display shows the following data:</p> <ul style="list-style-type: none"> <li>• Test current or test voltage</li> <li>• Trip delay</li> <li>• External voltage and current measurements</li> </ul>

*Table 53 – Other possible tests*

### 3.11 Standard connection cables (Long cables code PII16175 and extra long cables code PII57175)

Connection cables differ somewhat as a function of the type of test set. The following table lists cables provided:

Item	Description	STS 5000	STS 4000	STS 3000 light
1	No 1 Mains supply cable, 2 m long	X	X	X
2	No 1 Grounding cable, 6 m long, 6 mm <sup>2</sup> , terminated on one side with a terminator, and on the other side with an earth connection clamp (No 2 cables for the option PII57175)	X	X	X
3	No 1 Interface cable for the USB port	X	X	X
4	No 1 ETHERNET interface cable	X	X	X
5	No 1 Operating manuals + Cd-Rom with TDMS	X	X	X
6	No 1 USB pen drive	X	X	X
7	No 6 "Kelvin" clamps, with two sockets: one to connect the current or voltage; the other one to connect the measurement. Clamp opening: 60 mm on the rear, 80 mm on the front	X	X	
8	No 4 Clamps to connect low voltage or low current or measurements, two red and two black, with a short cable terminating on a banana socket. Clamp opening: 25 mm	X	X	
9	No 4 Crocodiles for measurements connections (2 red, 2 black)	X	X	
10	No 1 Short cable, 50 cm long red, terminated with banana sockets on both sides, for the current measurement of the output 6 A DC	X	X	
11	No 6 connection cables, three red and three black, 2.5 mm <sup>2</sup> , 6 m long (10 m long option PII16175, 15 m long option PII57175), for the connection of the following: DC current output, low AC voltage output, digital input. Terminated on both sides with a 4 mm banana plug	X	X	
12	No 2 High voltage connection cables, 6 m long (10 m long option PII16175, 15 m long option PII57175), 5 kV, with earth screen. Terminated on one side with the HV connector, and on the other side with a 4 mm banana plug	X	X	
13	No 2 High current connection cables, 70 mm <sup>2</sup> , 6 m long (9 m for option PII16175 and 10 m for option PII57175 [70 mm <sup>2</sup> , 1 m long + 95 mm <sup>2</sup> , 9 m long]), for option PII57175). Terminated on one side with a high current male connector, and on the other side with spring-loaded clamps, with maximum opening 60 mm	X		
14	No 1 Cable for the 10 V or 300 V measurement connection, shielded, 6 m long (10 m long option PII16175, 15 m long option PII57175). Terminated on one side with three 4 mm banana plugs (two conductors plus shield), and on the other side with two banana plugs. Plugs are colored red, black and yellow for the screen	X	X	
15	No 1 Cable for the 3 V measurement connection, shielded, 6 m long (10 m long option PII16175, 15 m long option PII57175). Terminated on one side with the measurement connector, and on the other side with two banana plugs, red and black	X	X	
16	N. 1 Transport case for connection Cables	X	X	

Table 54 - Cables provided with the unit



ATTENTION: The previous cables come as standard with the test set; however, they can also be ordered separately. Optionally, the marked cables can be ordered longer for the option PII16175, or the option PII57175

### 3.12 Other characteristics

The following table list other characteristics of the STS:

Item	Characteristic	Description
1	Memory	<ul style="list-style-type: none"> <li>Up to 64 test plans</li> <li>More than 1,000 test results</li> </ul>
2	Interfaces	<ul style="list-style-type: none"> <li>ETHERNET for the PC connection. The Ethernet port can be used also for remote service and maintenance</li> <li>USB port for the USB key: this serves to download test settings and results</li> </ul>
3	Interfaces to external modules	<ul style="list-style-type: none"> <li>Commands to TD 5000, STCS and STDE</li> <li>Alarms interface from the modules</li> </ul>
4	Other interfaces	<ul style="list-style-type: none"> <li>Remote Start input. The test is started pressing the button on the option PII42175</li> <li>Safety warning. It can be connected to the strobe with light PII43175. In case of alarm, the output drives the optional flashing siren and light</li> </ul>
5	Main supply	100÷230 V ± 15%; 48÷62 Hz
6	Power consumption	Less than 1 kW in normal use; 1.8 kW (3,600 VA; 16 A) when generating the maximum power on High AC voltage output or high DC current output. For a maximum period of 25 s, the supply power can be up to 3.6 kW, (7,000 VA; 32 A) when generating the maximum power on the 800 A output or on the options BUX 2000 and BUX 3000
7	Dimensions	400 (H)x450 (W)x230 (D) mm STS 5000 weight: 29 kg STS 4000 weight: 22 kg STS 3000 light weight: 16 kg
8	Accessories	<ul style="list-style-type: none"> <li>User manual, in English, Italian, French and Spanish</li> <li>No 5 spare fuses, type T16A</li> <li>Connection cables, provided in a case with handle and wheels</li> </ul>

*Table 55 - Other characteristics of the STS*



**ATTENTION:** If the supply is less than 184 V AC, the test set does not guarantee the full output power on the 800 A AC output

## 4 OPTIONS

### 4.1 Transit cases (code PII17175, PII 19175, PII51175)

The following image exhibits a transit case:



Figure 13 - Transit case

This option applies to all STS models.

There are more types of transit cases:

- one for the STS
- one for TD 5000
- one for RCTD
- one for STLG
- one for BUX 3000
- one for BUX 2000

All of them allow transporting the device. The case has handles and wheels.

The following table lists the Transit case main characteristics:

Characteristic	Note
Handling	Handles on the top and on the side
Wheel	2
Dimensions	450 x 550 x 850 mm
Weight	15 kg

Table 56 – Transit case main characteristics

The following table lists the Transport cases coding:

Instrument	Code
STS	PII17175
TD 5000 RCTD STLG	PII19175
BUX 3000 BUX 2000	PII51175

Table 57 - Transport cases coding

## 4.2 PADS licence (code PII10176P, PII10176F, PII10176T)

The software PADS allows connecting to the PC all models of the STS.

Software features are the following:

- To download from the test set test results and settings, and to save them into a file
- To open and save test results in the formats: MDB (ACCESS), XLSX (EXCEL), CSV and JPEG
- To display in real time the measurements performed by the test set, with possibility to pause the test (when applicable)
- To display, save and print test results diagrams
- To zoom and compare different curves of more than one result
- To edit, display and print the test report, with the following information:
  - Place, substation name, line, phase, model, serial number, operator, date and time
  - Nominal values: type of device, power, primary and secondary voltage or current
  - Parameters tolerances
  - For PT's: nominal tap voltages
  - Test result table, with comments about the test results OK or NO
  - Notes and comments

The program allows also to do the following:

- Upload or download test settings
- Upload or download test set calibration parameters

PADS software is subject to license, and it is available in three different licenses:

- PADS software Primary - Primary test, CTs and VTs Modules
- PADS Software Transformer - Power Transformer and Tan( $\delta$ ) Modules
- PADS Full Suite - Primary test, CTs and VTs, Power Transformer and Tan( $\delta$ ) Modules



ATTENTION: The software runs with any WINDOWS© environment.  
Windows, EXCEL and Access are trademarks of Microsoft Corporation

### 4.3 Remote Safety Switch (code PII42175)

The following image exhibits the Remote Safety Switch:



Figure 14 - Remote Safety Switch

This option applies to all STS models.

When the Remote Safety Switch is connected and enabled, it avoids any current or voltage generation from pressing START/STOP button on the STS only.

The cable length is 20 m.

### 4.4 Warning Strobe Light (code PII43175)

The following image exhibits the Warning Strobe Light:



Figure 15 - Warning Strobe Light

This option applies to all STS models.

The Warning Strobe Light alerts when the test is performed. A siren is also included.

It has to be connected to the Safety Warnings (28) connector. The following image exhibits the (28) connector:

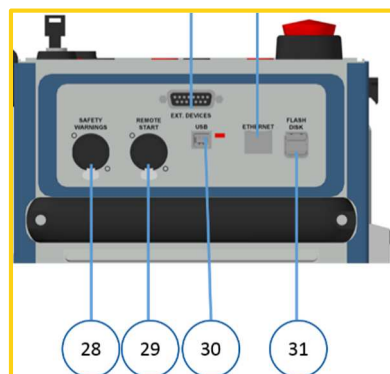


Figure 16 - Safety Warnings (28) connector

#### 4.5 STCS automatic connection windings module (code PII12175)

This option applies to STS 5000 and STS 4000.

It is applicable when it is necessary to perform one of the following tests on PT:

- Ratio
- Winding resistance
- Short-circuit impedance
- OLTC dynamic test

The following image exhibits the STCS option:



Figure 17 - STCS option

STCS allows performing automatically the tests.

Advantages:

- Fast measurement set-up
- Low probability of connection errors

The STCS option includes the following:

- The input sockets to the STS outputs
- The connections of the active output to the HV or LV sides of the PT under test
- The connection to the STS measurement inputs
- Two relays for the Tap Changer Up and Down commands up to 240 V, 1 A AC, or up to 110 V, 0.1 A DC
- The connector to the STS EXT. DEVICE connector

The STCS option comes complete with the following connection cables:

Cable	Characteristics
No. 10 cable reels	Marked with different colors, 15 m long
No. 2 High Voltage cables	2 m long, one red and one black, terminated on one side with the HV connector, and on the other side with 4 mm banana plugs
No. 6 Cables	2 m long, three red and three black, for the connection to: DC current generator, 300 V AC meter, 10 V DC meter. Cables are terminated on both sides with 4 mm banana plugs
No. 1 data cable	To the EXT. DEVICES connector of STS, 2 m long
No. 6 adaptors	From banana to terminal
No. 8 "Kelvin" type clamps	For the connection to the PT bushings
No. 1 Ground cable	6 m long, terminated with terminator and clamp
No. 1 Transport cases	

Table 58 – STCS cables



ATTENTION: The cables in the following list come as standard with STCS; they can also be ordered separately

#### 4.6 STCS power generator Booster 20 A DC (code PII32175)

This option applies to STS 5000 and STS 4000 and must be connected to the STCS, which controls the option itself.

The STCS Booster 20 A DC allows to perform winding resistance tests up to 20 A DC on a PT.

The following image exhibits the STCS Booster 20 A DC option:



Figure 18 - STCS Booster 20 A DC option

The module characteristics are the following:

- Maximum output current: 20 A DC
- Maximum power on output sockets: 400 W
- Current output switch: controlled by STCS
- Current output amplitude: controlled by STS 5000 or STS 4000

The option comes complete with the following connection cables:

- No. 2 interface connection cables to STCS
- No. 1 Booster power cable, to connect the option to the STS
- No. 1 Power supply cable
- No. 2 cables, 2 m long, one red and one black

#### 4.7 STDE residual magnetization removal module (code PII27175)

This option allows neutralizing the residual magnetization of the power transformer core after the winding resistance test. The connection to STS is mandatory.

The following image exhibits the STDE option:



Figure 19 - STDE option

The principle of the option is to apply a DC voltage with alternate polarity to the transformer winding, following the IEEE 62-1995 standard.

The following table lists the STDE main characteristics:

Characteristic	Note
Generator	Constant current, voltage limited
Maximum test current	7 A DC
Maximum test voltage	70 V DC
Current resolution	7 mA
Output current stability	Better than 0.5% of the rated value
Case	Plastic case with handle
Connections	<ul style="list-style-type: none"> <li>• Connection to the STS control connector</li> <li>• Two sockets to the STS DC output</li> <li>• Two sockets to the transformer to be de-magnetized</li> </ul>
Cables	<ul style="list-style-type: none"> <li>• No 1 interface connection cable to STCS, 2 m long</li> <li>• No 6 Cables, 2 m long, one red and one black, for the connection to the STS</li> <li>• No. 2 Cables, 10 m long, for the STDE current output to the device under test</li> </ul>

Table 59 – STDE main characteristics

#### 4.8 STSA Surge Arrester (code PII46175)

The following image exhibits the STSA Surge Arrester:



Figure 20 - STSA Surge Arrester

This option applies to STS 5000 and STS 4000.

The option limits voltage surges generated at the DC Voltage input measurement if, during the winding resistance test, the circuit is erroneously opened. In this event, the sudden opening of a circuit involving a large inductance generates a high voltage surge, which could disturb the instrument operation, or even damage it.

The option includes a surge arrester plus two fuses. If the impulse has a normal energy, this energy is dissipated by the surge arrester, and there is no permanent damage; if, instead, the energy is too high, the arrester is short-circuited, and fuses blow.

The option has the dimensions 35 x 70 x 20 mm; it is connected to STS 10 V measure output with two 4-mm banana plugs.

#### 4.9 BUX 3000, BUX 2000 current booster (codes PII50175, PII56175)

The optional current boosters BUX 3000 and BUX 2000 allow performing tests up to respectively 3,000 A and 2,000 A.

This option applies to STS 5000 and STS 4000.

The following image exhibits the BUX 3000 option:



Figure 21 - BUX 3000 option

The high current booster option allows performing the following tests:

- Manual measures, whenever AC current is necessary
- CT ratio, polarity and burden

The option includes the connection cable to the CT under test, and the connection clamps.

The option avoids wasting power on the connection cables, by putting the power transformers as close as possible to the test object. This approach is particularly useful when the test is performed on CTs in the field, which are some meters tall.

Cables:

- No. 1 high current cable, 1.2 m long, made of four cables having cross section of 95 mm<sup>2</sup>, type high flexibility. Terminated on each side with two high current clamps for the connection to the bar, having the following characteristics:
  - Material: aluminum
  - Opening range: from 5 to 60 mm
  - Short-circuit current rating: 41 kA ÷ 1 s
  - Applicable standard: EN 61230
  - Hole to lift the clamp to the gate, and ring to tight from the bottom
- No. 1 Voltage supply cable, 20 m long, 2 wires. Terminated on one side with the STS EXT. BOOSTERS connector and on the other side with the connector for the BUX 3000 module
- No. 1 Metering cable, 20 m long, 2 wires. Terminated on one side with the STS 3 V AC input connector and on the other side with the connector for the BUX 3000 module The cable includes a shunt, which converts the output current into voltage
- No. 2 Metering cables, 2 m long, terminated on both sides with 4 mm banana plugs, for the connection of the STS Current input to the CT secondary

The following table lists the maximum test currents and durations for the power supply of 230 V for BUX 3000:

Test current [A]	Output power [VA]	On duration [s]
500	300	Infinite
1,000	900	Infinite
1,500	1,500	1,200
2,000	2,400	300
2,500	3,400	120
3,000	4,800	60

*Table 60 - Max test currents and durations (230 V) for BUX 3000*

The following table lists the maximum test currents and durations for power supply of 110 V for BUX 3000:

Test current [A]	Output power [VA]	On duration [s]
500	300	Infinite
1,000	900	Infinite
1,500	1,500	1,200
2,000	2,400	300

*Table 61 - Max test currents and durations (110 V) for BUX 3000*

The following table lists the maximum test currents and durations for power supply of 230 V for BUX 2000:

Test current [A]	Output power [VA]	On duration [s]
500	700	Infinite
1,000	1,500	60
2,000	5,000	25

*Table 62 - Max test currents and durations (230 V) for BUX 2000*

The following table lists the maximum test currents and durations for power supply of 110 V for BUX 2000:

Test current [A]	Output power [VA]	On duration [s]
500	700	Infinite
1,000	1,500	600
1,300	2,400	200

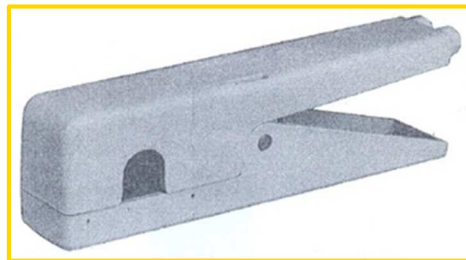
*Table 63 - Max test currents and durations (110 V) for BUX 2000*

BUX 3000 and BUX 2000 characteristics are the following:

- Output current metering ratio: 1000/1 A
- Accuracy class: typical  $\pm 0.1\%$  of reading  $\pm 0.1\%$  of range; guaranteed  $\pm 0.2\%$  of reading  $\pm 0.2\%$  of range
- Module power cable, 20 m long, terminated with connectors on both sides
- Module CT cable, 20 m long, terminated with connectors on both sides
- BUX 3000 weight: 16 kg
- BUX 2000 weight: 18 kg
- Cable and clamps weight: 8.2 kg
- Dimensions: external diameter 190 mm; height 120 mm

#### 4.10 Current Clamp (code PII16102)

The following image exhibits the Current Clamp option:



*Figure 22 - Current Clamp*

This option applies to STS 5000.

The current clamp avoids opening the secondary current circuit when performing the primary test of CT burden.

The following table lists the Current Clamp main characteristics:

Characteristic	Value
Ratio	1 A//1 mA
Maximum primary current	100 A
Maximum cable diameter	12 mm

*Table 64 - Current Clamp main characteristics*

#### 4.11 PLCK Polarity Checker (code PII41175)

This option applies to STS 5000 and 4000 models.

The following image exhibits the PLCK option:



Figure 23 - PLCK option

The PLCK Polarity Checker has three colored LED:

- Pass (GREEN).Indicates the right polarity
- Fail (RED).Indicates the wrong polarity
- Low Battery (BLUE). If it blinks, the battery has reached the first low voltage threshold; the fixed light indicates the second low voltage threshold, in this case the battery should be changed

The detection range of the PLCK Polarity Checker is from 40 mV to 300 V. If a low or distorted signal is detected, both Pass and Fail LEDs blink. To check the polarity on a very low impedance (e.g. the current terminals of a numeric relay), is possible that the voltage drop is much less than 40 mV even when the maximum possible current is generated; in this case check the polarity including the connection cables to the relay, in order to increase the voltage drop.

#### 4.12 STLG current injection power transformer for ground tests (code PII70175)

This option applies to STS 5000 and 4000 models.

The following image exhibits the STLG option:



Figure 24 - STLG option

It is a high power, five taps transformer, which acts as an impedance adaptor, increasing the impedance at high test currents. A high current switch allows selecting the desired current range. A voltage meter displays the generated voltage or the voltage on the line due to the inductive couplings.

Output current and voltage are measured and sent back to STS measuring inputs; a third output allows STS to understand which one is the selected range.

The STLG option characteristics are the following:

- Input: form STS 5000, via the booster connector
- Output current ranges: 11, 22, 35, 55, 105 A AC. Corresponding no-load voltages: 540, 270, 160, 108, 55 V
- Output current connection: via high current sockets
- Output power: 1,800 VA steady; 5,500 VA peak for 5 s, 5,200 VA on the 105 A range
- High current selector switch, to connect the selected tap to the output current sockets
- Analogue voltage meter, to display the voltage at the output sockets. Range: 600 V AC
- Outputs to STS:
  - Selected current output range, to the 10 V voltage input
  - Output current, to the 10 A current input
  - Output voltage, to the 300 V voltage input
- Transport case: black plastic case, with handles
- Weight: 25 kg
- Dimensions: 23 x 33 x 44 cm

All the followings connection cables are included in the option:

- No. 1 Cable, 6 m long, for the connection of the STS BOOSTER connector
- No. 2 Cables, 6 m long, for the current output connection, terminated with “Kelvin” type clamps
- No. 6 cables, red and black, 6 m long
- No. 1 cable for the connection of the STLG voltage meter output to the STS 300 V meter
- No. 1 bridge, to short circuit the current meter output if it is not connected to STS
- Cable transport case



ATTENTION: For safety reasons, STLG must always acts together with the STSG option

#### 4.13 Power factor correction module (code PII85175)

This option is applicable only the STLG option. It is a module to increase the current in the grounding and step and touch tests; the module has many capacitors and it allows to reduce the reactive component of the line, to obtain the increasing of the STLG test generated current.

- Dimensions: 325L, 295A, 285P. Aluminum case with handles
- Weight: 12 kg
- Selectable capacitance nominal values: 600  $\mu$ F, 400  $\mu$ F, 200  $\mu$ F, 150  $\mu$ F and 100  $\mu$ F
- Maximum voltage: 600 V (range 100  $\mu$ F and 150  $\mu$ F) , 450 V on the others
- Maximum current: 60 A

#### 4.14 STLG large station (code PII88175)

The following image lists the kit elements:







Element	Description	Photo
STLG PII80175	<ul style="list-style-type: none"> <li>• Transport case with wheels PII19175</li> <li>• Standard cable kit PII75175 with case</li> </ul>	
STSG PII71175	<ul style="list-style-type: none"> <li>• N°3 cable connection studs (diameter 20 mm) PII72175</li> <li>• N°3 surge arresters (N°3x PII77175)</li> <li>• Transport case with wheels</li> </ul>	
RCLG PII85175	<ul style="list-style-type: none"> <li>• Cable for series connection to STLG</li> <li>• Transport case with wheels</li> </ul>	
Transport trolley	N°1 Stainless steel transport trolley <b>PII18175</b> for the handling of the test set and of the STLG option	
Portable Handheld Multimeter	<p>N°1 Mod. KEYSIGHT U1271A</p> <ul style="list-style-type: none"> <li>• Count up to 30,000 (4 digits 3/4)</li> <li>• Analogue scale display</li> <li>• Impedance 10MR</li> <li>• Measures TRUE RMS and CC of Ampere, Volt; it measures Hertz, Ohm, mOhm, mA, capacitance and temperature</li> <li>• Operating temperature (-20÷+55) °C; humidity 0÷80%</li> <li>• CAT III 1000 V; CAT IV 600 V</li> <li>• Accuracy V CA 0.7% + 20 counts</li> <li>• Accessories: probes, hermocouple, 4 AAA batteries, calibration certificate, quick start guide</li> </ul>	
Step and touch resistive selector with active filter	N°1 Box with resistances 1kR for multimeter which includes an active filter to make the measurements of step and touch voltage at 80 Hz. Code PII87175	
Clamp meter with multimeter	<p>N°1 Mod. Chauvin Arnoux F203</p> <ul style="list-style-type: none"> <li>• Measures CA TRUE RMS, MISURA CC</li> <li>• Voltage measure CAT III 1000V</li> <li>• Scale 60 A e 600 A AC; 60 A, 600 A e 900 A in CC</li> <li>• Accuracy 1% up to 599.9 A AC e 900 A CC</li> <li>• Opening 34mm</li> </ul>	
Power cable	N°1 Power cable for control units, 2,5 mm <sup>2</sup> section, 50 m long, mounted on cable reel with wheels	

Table 65 – Kit elements (1/2)


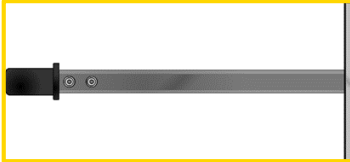




Element	Description	Photo
Additional power cables	N°2 exible cables, cross section 10 mm <sup>2</sup> 50 m long, for the connection of the power output, mounted on the cable-winding with wheels	
Measure cables	N°10 cables, 2,5 mm <sup>2</sup> , 100 m long, each mounted on its reel; terminated with banana and with securing sleeve 4 mm	
250 N electrodes	N°2 probes platform, with weights up to 250 N	
Tip electrodes	N°2 tip electrodes, 0,5 m, with 4 mm sockets	
Grounding cable	N°1 cable, 16 mm <sup>2</sup> 25 m long, yellow green, mounted on its reel with wheels	
Clamps	<ul style="list-style-type: none"> <li>N°3 phase clamps in light alloy with clamping up to 65 mm, with stem ring for laying and removal of cylindrical conductors from 5 mm to 65 mm (diameter)</li> <li>N°1 Grounding clamp, with tightening capacity up to 35 mm on cylindrical conductors</li> </ul>	
Switching Stick Kit	N°1 Kit compliant to CEI EN 61230, CEI EN 61235, CEI EN 60855, CEI EN 50508; in three parts, for voltages ≤380 kV	
Connection cables for phase clamps	N°3 Cable 10 m, section 10 mm <sup>2</sup> ; terminated on one side with lugs for connection to phase clamps and the other side with clamps suitable for the connection with STSG	
Stabilized power supply	N°1 stabilized power supply, input voltage 230 V 50 Hz, output voltage 0÷30 V CC 0÷20 A PII86175	
Power cable reels	N°2 flexible cables 50 m long, section 2,5 mm <sup>2</sup> . Lug 2P+T 16A 230V IP44; 2 sockets 2P+T 16A 230V IP44; 1 German/bi-pass socket 2P+T 16A IP44 + circuit breaker	
Line synchronization	N°1 Line synchronization PII24156	

Table 66 – Kit elements (2/2)

#### 4.15 STSG safety grounding module (code PII71175)

This option applies to STS 5000 and STS 4000; it is used with the STLG option, to increase the operator safety.

The following image exhibits the STSG option:



Figure 25 - STSG option

During tests, STLG is connected to the out of service overhead line to be tested. The purpose of the STSG device is to protect the operator against possible high voltage spikes during the operations.

STSG incorporates three voltage suppressors (one for each line) and one high current switch, to connect the three lines in parallel when necessary.

The STSG option characteristics are the following:

- Nominal AC spark-over voltage :  $<1,000 V_{rms}$
- Impulse spark-over voltage :  $<2,000 V_{peak}$
- Short-circuit proof with  $25 kA_{eff}/100 ms$ ;  $36 kA_{eff}/75 ms$
- Connection via three cylindrical studs 16, 20 or 25 mm diameter, for the clamps connection. Each stud is connected to the voltage suppressor. The stud dimensions must be specified at order
- Tightening torque:  $\geq 15 Nm$
- Metallic aluminum box with handle
- Weight: 9.1 kg (with grounding cable)
- Dimensions: 41 x 21 x 13,5 cm
- Grounding cable, included:  $95 mm^2$ , 2m; terminated with a universal clamp

The device must be connected to the ground and to the HV line.



ATTENTION: Connection cables to the HV line are not included in the option

#### 4.15.1 Cylindrical studs

The following table lists the studs for the STSG option:

Stud code	Drawing	Characteristics
PII72175		max short circuit current: 0.5 s: 33.5 kA max short circuit current: 1.0 s: 23.7 kA
PII73175		max short circuit current: 0.5 s: 42.0 kA max short circuit current: 1.0 s: 29.6 kA
PII74175		max short circuit current: 0.5 s: 42.0 kA max short circuit current: 1.0 s: 29.6 kA

Table 67 - Studs characteristics

#### 4.15.2 Surge arrester for STSG (code PII77175)

If a high voltage spike occurs on the line during the execution of the tests, the STSG surge arresters must be replaced.

Technical characteristics:

- Nominal AC spark-over voltage : < 940 Vrms
- Impulse spark-over voltage : < 1,600 Vpeak
- Short-circuit proof with 25 kAeff/100 ms; 36 kAeff/75 ms

### 4.16 Ground Grid Test Accessories Kit (code PII76175)

The following image exhibits the Ground Grid Test Accessories Kit:



Figure 26 - Ground Grid Test Accessories Kit

This option applies to STS 5000 and STS 4000 models.

The following table lists the elements of the Ground Grid Test Accessories Kit:

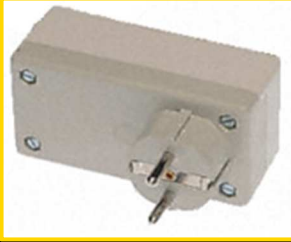


Quantity	Element	Characteristic
2	Earth Screw	0.95 m long, with 4 mm sockets
1	Spanner	To screw the spike into the ground
4	Earth electrode	0.5 m long, with 4 mm sockets
1	Transport bag	To carry earth spikes, electrodes and spanner
3	Cable	1.5 mm <sup>2</sup> , 200 m long, mounted on reel, terminated on one side with safety 4 mm socket and on the other side with safety 4 mm banana plug
2	Rectangular probe	With shaft 0.8 m long, with safety 4 mm sockets. Material: zinc-plated iron, dimensions 250 x 120 mm, thickness 10 mm, with rubber protection on the foot, on the rod and on the handle, and two safety sockets. The surface in touch with the ground is limited to 300 cm <sup>2</sup>
1	Line synchronizer	
1	Digital multimeter CAT III 600V, TRUE RMS, Accuracy AC ±1 % +3 digits	
1	Resistance selector for Step and Touch test	

Table 68 - Elements of the Ground Grid Test Accessories Kit

#### 4.17 Current Clamp Meter (code PII79175)

The following image exhibits the current clamp meter:



Figure 27 – Current Clamp Meter

When it is necessary to use the STSG and STLG options to execute the test, the options are connected to a transmission line. The line is put out of service, and connected to earth on both sides. Before connection to the HV line, it is necessary to measure the current flowing into the ground connections, using a clamp meter, to evaluate the residual voltage coupling.

The following table lists the Current Clamp Meter main characteristics:

Characteristic	Value
Maximum current	400 A AC
Digits	4
Accuracy	$\pm 2\% + 5$ digits
Clamp opening	37 mm

Table 69 - Current Clamp Meter main characteristics

#### 4.18 Foldable Trolley (code PII18175)

The following image exhibits the Foldable Trolley:



Figure 28 - Foldable Trolley

This option applies to all STS models.

The trolley eases the handling of STS + TD 5000. The trolley hosts both instruments and the HV cable for TD 5000.

When not used, it can be folded, to minimize the volume.

The following table lists the main characteristics:

Characteristic	Value
Material	Stainless Steel
Weight	19 kg
Dimensions (closed)	68 x 34 x 106 cm
Wheel dimensions	Ø 25 x 9 cm

Table 70 - Trolley characteristics

#### 4.19 TD 5000 module for the Tan( $\delta$ ) loss angle factor measure (code PII11175)

This option applies to all STS XXX models. The following image exhibits the TD 5000:



Figure 29 - TD 5000

The High Voltage generator TD 5000 performs the measurement of the  $\text{Tan}(\delta)$ , of the dissipation factor and of the capacitance of a transformer or of a bushing, at the frequency of the mains or in a wide frequency range. The measurement is performed by the module, which is equipped with a patented measurement circuitry; the result is sent to STS Family.

The measurement circuitry incorporates a reference high voltage capacitor, rated 200 pF, with the following: a variation better than 0.05%/year, a temperature factor better than 0.01%/°C, and a  $\text{Tan}(\delta)$  better than 0.005%, and a reference resistor bridge, with accuracy better than 0.01% and thermal drift less than 1 ppm/°C. The patented circuitry and the variable frequency output make test results immune from external noise, even in the very highly noisy environment. The noise is suppressed using a narrow bandwidth numerical filter. In case of a test frequency equal to the line frequency, the measurements are automatically performed at different frequencies ( $F_{\text{line}} \pm 4 \text{ Hz}$ ).

The module has two panels on the sides, and one below: one for the connection to the power supply, the other for the IN-A (UST-A) and IN-B (UST-B) measurements, and the other for the output connection.

The following image exhibits the power supply on the side:



Figure 30 - Power supply on the side

The following image exhibits the IN-A (UST-A) and IN-B (UST-B) measurements on the side:



Figure 31 - IN-A (UST-A) and IN-B (UST-B) measurements on the side

The following image exhibits the HV output on the front panel:



Figure 32 - HV output on the front panel

It is possible to see that there is one HV connector, and there are two metering inputs. This allows the Tan( $\delta$ ) measurements of all points with one connection. Besides, the IN-A (UST-A) and IN-B (UST-B) can be used as control points to avoid the measure of parasitic capacitances.

TD 5000 is powered and controlled by STS. During tests, the high power, not isolated STS voltage output is connected to TD 5000.

The HV generator has electronic control and the following table lists its main characteristics:

Maximum output voltage [V]	Output current [mA]	Maximum output duration	Frequency [Hz]
12,000	300	>120 s	15÷500
	125	> 1 h	
	100	steady	

Table 71 - HV generator main characteristics

	ATTENTION: At 10 kV, the output (current value and duration) has the same characteristic
--	------------------------------------------------------------------------------------------

The following table lists the voltage and current output measurement accuracy and resolution:

Internal measure	Resolution	Typical accuracy		Guaranteed accuracy	
		± % (rdg)	± % (rg)	± % (rdg)	± % (rg)
12,000 V AC	1 V	± 0.2%	± 0.5 V	< 0.3%	+ 1 V
5 A AC (@ inputs A or B > 10 mA)	1 mA	± 0.2%	± 1 mA	< 0.5%	< 0.5%
<10 mA AC (@ inputs A or B)	0.1 $\mu$ A	± 0.2%	± 0.1 $\mu$ A	< 0.3%	+ 0.1 $\mu$ A

Table 72 - voltage and current output measurement accuracy and resolution

The following table lists the frequency characteristics of TD 5000:

Range	Accuracy
15÷500 Hz	50 ppM typical; 100ppM maximum

*Table 73 - Frequency characteristics of TD 5000*

The connections of the TD 5000 are the following:

- HV panel for the connection of the double shielded safety cable
- TD 5000 Ground socket
- Two measurement sockets (IN A and IN B)

The available test selections are the following:

- Ungrounded: UST-A; UST-B; UST A+B
- Grounded: GST; GSTg-A; GSTg-B; GSTg-A+B

The following table lists the derived measurements from the measurements of V and I:

Measurement	Characteristics
Capacitance	Measurement range 1, from 1 pF to 3uF. Resolution: 6 digits. Accuracy, typical: $\pm 0.03\%$ of the value $\pm 0.1$ pF; guaranteed: $< 0.1\%$ of the value $+1$ pF ((from 45 to 70 Hz) Measurement range 2, from 10 nF to 3 uF Resolution: 6 digits. Accuracy, typical: $\pm 0.1\%$ of the value $\pm 10$ pF; guaranteed: $< 0,2\%$ of the value $+10$ pF
Tan( $\delta$ ) (dissipation factor DF)	<ul style="list-style-type: none"> <li>• Measurement range 1: from 0 to 10% (capacitive). Resolution: 5 digits; accuracy, typical: 0.05% of the value <math>\pm 0.005</math> %; guaranteed: 0.1% of the value <math>\pm 0.005</math> % (from 45 to 70 Hz, current <math>&lt; 10</math> mA)</li> <li>• Measurement range 2: from 0 to 100%. Resolution: 5 digits; accuracy, typical: 0.3% of the value <math>\pm 0.01</math> %; guaranteed: 0.5% of the value <math>\pm 0.02</math> %</li> <li>• Measurement range 3: over 100%. Resolution: 5 digits; accuracy, typical: 0.5% of the value <math>\pm 0.03</math> %; guaranteed: 0.8% of the value <math>\pm 0.05</math> %</li> </ul>
Power factor PF ( $\cos(\phi)$ )	<ul style="list-style-type: none"> <li>• Measurement range 1: from 0 to 10% (capacitive). Resolution: 5 digits; accuracy, typical: 0.05% of the value <math>\pm 0.005</math> %; guaranteed: 0.1% of the value <math>\pm 0.005</math> % (from 45 to 70 Hz, current <math>&lt; 10</math> mA)</li> <li>• Measurement range 2: from 0 to 100%. Resolution: 5 digits; accuracy, typical: 0.3% of the value <math>\pm 0.02</math> %; guaranteed: 0.5% of the value <math>\pm 0.02</math> %</li> </ul>
Impedance	From 1 kOhm to 1,400 M $\Omega$ . Accuracy, typical 0.3% of the value $\pm 0.1\%$ , guaranteed $< 0.5\%$ of the value. Resolution: 6 digits
Power	Measurement ranges: 10 kW, 100 kW, 1 MW. Resolution (5 digits): 0.1 mW; accuracy: $< 0.5\%$ of the value $\pm 1$ mW
Inductance	<ul style="list-style-type: none"> <li>• Measurement range 1: from 1 H to 10 kH. Resolution (5 digits): 0.1 mH; accuracy, typical: 0.3% of the value <math>\pm 0.5</math> mH; guaranteed: 0.5% of the value</li> <li>• Measurement range 2: from 100 H to 1 MH. Resolution (5 digits): 1 H; accuracy, typical: 0.3% of the value; guaranteed: <math>&lt; 0.5\%</math> of the value</li> </ul>

*Table 74 - Derived measurements from the measurements of V and I*

The same ranges and accuracies are applied to reactive and apparent power measurements.

Other characteristics:

- Dimensions: 440 (W) X 345 (H) X 210 (D) mm
- Weight: 25 kg

The following table lists the connection cables supplied with TD 5000 (they come as standard with the test set; however, they can also be ordered separately):

<b>Cable</b>	<b>Characteristics</b>
No 1 yellow-green connection cable	6 m long, for the ground connections. Terminated with terminator on one side, and with a clamp on the other side
No 2 yellow-green connection cables	1 m long, for the ground connections. Terminated with terminators
No 1 yellow-green connection cable	2 m long, for the ground connections. Terminated with terminators
No 1 power cable	To the BOOSTERS connector of STS, 1 m long
No 1 power cable	To the BOOSTERS connector of STS, 2 m long
No 1 High voltage connection cable	20 m long, 25 kV, with earth screen, for the connection to the device under test. Terminated on the device side with an isolated banana plug, and on the TD 5000 side with two plugs: one for the HV and the other one for the ground
No 1 clamp	25 mm opening, with a connector which mates with the HV cable with 6 mm plug
No 1 bigger clamp	60 mm min. opening, with a connector which mates with the HV cable with 6 mm plug
No 2 Shielded connection cables	20 m long, for the connection to the metering points. Terminated on the TD 5000 side with the metering connector, and on the device side with a 4 mm banana plug. Cables are mounted on wheels
No 2 clamps	25 mm opening, terminated with 4 mm sockets, which allow connecting to the metering point
No 2 Kelvin type clamps	60 mm opening, terminated with 4 mm sockets, which allow connecting to the metering point
No 1 signals connection cable	To the EXT. DEVICES connector of STS, 1 m long
No 1 signals connection cable	To the EXT. DEVICES connector of STS, 2 m long
No 1 Transport Case	

*Table 75 - Cables supplied with TD 5000*

The following table lists the parasitic capacitances which exist in a three winding (two secondary) power transformer, in a two winding (one secondary) power transformer and in a bushing transformer:

Transformer	Scheme	Terms
Three winding (two secondary) power transformer		<ul style="list-style-type: none"> <li>• H = high voltage terminal</li> <li>• L = low voltage terminal</li> <li>• T = third winding</li> <li>• G = Ground</li> </ul>
Two winding (one secondary) power transformer		<ul style="list-style-type: none"> <li>• C(H-T): parasitic capacitance between High voltage and T</li> <li>• C(H-L): parasitic capacitance between High voltage and Low voltage</li> <li>• C(H-G): parasitic capacitance between High voltage and Ground</li> </ul>
Bushing transformer		<ul style="list-style-type: none"> <li>• C(L-G): parasitic capacitance between Low voltage and Ground</li> <li>• C(L-T): parasitic capacitance between Low voltage and T</li> <li>• C(T-G): parasitic capacitance between T and Ground</li> <li>• C(H-Tap): parasitic capacitance between High voltage and Tap</li> <li>• C(Tap-G): parasitic capacitance between Tap and Ground</li> <li>• Test tap = test terminal</li> </ul>

Table 76 - Parasitic capacitances

#### 4.20 CAP-CAL reference capacitor (code PII40175)

The following image exhibits the CAP-CAL reference capacitor:



Figure 33 - CAP-CAL reference capacitor

Purpose of the reference capacitor is to check the actual calibration of TD 5000 for the measures of the capacitance and  $\text{Tan}(\delta)$ .

The CAP-CAL includes an extremely high accuracy high voltage and low  $\text{Tan}(\delta)$  capacitor. The device includes also 4 resistances to be connected to the capacitor in series mode, to generate some known  $\text{Tan}(\delta)$  values.

The following image exhibits the connection of the CAP-CAL to the TD 5000:

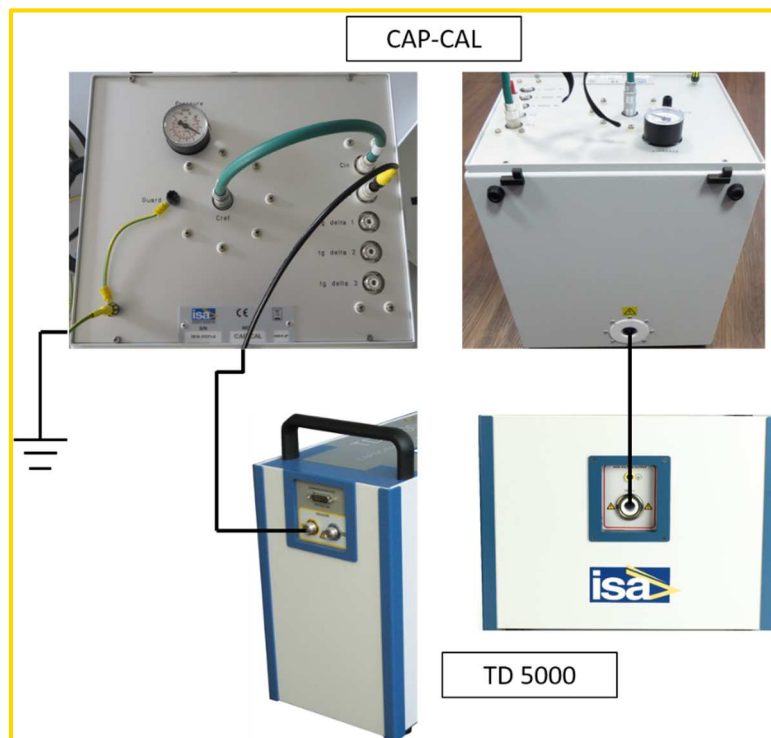


Figure 34 - Connection of the CAP-CAL to the TD 5000

A calibration certificate is issued by ISA laboratory and it is supplied together the CAP-CAL.

#### 4.21 STOIL cell for the insulating oil check (code PII13175)

This option applies to TD 5000, to perform Tan( $\delta$ ) test of the PT oil.

The following image exhibits the STOIL option:



Figure 35 - STOIL option

Cell characteristics are the followings.

- Maximum test voltage: 12 kV
- Cell volume: 1 l
- Empty cell capacity: (60±10) pF

The option comes complete with the following connection cables: No. 2 HV connection cables, 2 m long, terminated on the TD 5000 side with the HV connector, and on the other side with the proper termination for the cell.

#### 4.22 Digital Thermo Hygrometer (code PII44175)

The following image exhibits the Digital Thermo Hygrometer:



Figure 36 - Digital Thermo Hygrometer

Some tests performed by STS, such as Tan( $\delta$ ), are influenced by temperature and humidity. The option allows measuring these parameters, and to input them into the test settings.

The following table lists the main characteristics:

Characteristic	Value
Temperature range	(-10÷+60) °C (-50÷+250) °C with an external sensor
External temperature sensor	RTD Ni1000/6180 ppM, not included
Temperature measurement accuracy	±0.4 °C
Humidity measurement range	(5÷95)% RH
Resolution of humidity measurement	0.1%
Accuracy of humidity measurement	±2.5% RH over the whole range
Battery	9 V
Battery life	Typically 9 months
Dimensions	(141x71x27) mm
Weight	150 g

Table 77 - Digital Thermo Hygrometer main characteristics

#### 4.23 RCTD reactor for motors and generators measures (Code PII47175)

This option applies to TD 5000 and allows increasing the test current and getting the maximum test voltage on high capacitive burdens.

The following image exhibits the RCTD option:



Figure 37 - RCTD option

Each RCTD is composed by two inductors with a nominal value of 40 H and a steady current of 0.6 A.

The maximum current on each inductor can be up to 1 A for more a limited time.

The inductors can be connected in parallel on the load in order to increase the test frequency.

It is possible to connect two RCTD in parallel in order to have three or four inductors connected in parallel.

The following table lists the RCTD characteristics:

Characteristic	Value
Weight	39 kg
Dimensions	23 x 44 x 28 mm

Table 78 – RCTD characteristics

The reactor has a standard cable kit (code PII48175) and the following table lists them:


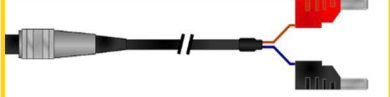

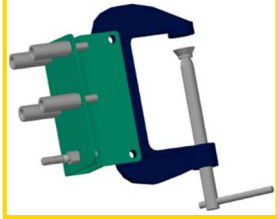

Cable	Characteristics	Scheme
N. 1 ground cable	6 m long, 6 mm <sup>2</sup> terminated with terminator and clamp	
N. 1 safety cable	To STS; 10 m long, 2x0,5 mm <sup>2</sup>	
N. 1 "Safety IN" connector	For the safety loop closure	
N. 1 Safety cable	To connect another RCTD; 2 m long, 2x0,5 mm <sup>2</sup>	
N. 1 clamp	Screw terminal, with plate for the HV connection	
N. 2 HV cables	5 m long, not shielded, terminated with 6 mm <sup>2</sup> male connectors	

Table 79 – RCTD cables

## 5 PROTECTIONS

The protections of the STS are the following:

- If the test set is not connected to the ground, the test set does not allow for power generation, and warns the operator with a diagnostic message and a fixed led light
- Fuse on the mains supply
- Fuse on the low power current and voltage outputs
- Fuse on the current meter input
- At power-on, a diagnostic sequence controls
  - Key microprocessor board components
  - Auxiliary supply voltages.

If something is wrong, the operator is alerted by a message.

- Emergency pushbutton: if pressed, all main outputs are removed
- The high voltage output has the following protections
  - Confirmation key: if not turned, the HV output is not generated
  - The HV is generated only if selected; the HV selection is confirmed by warning lights
- Thermal sensor on the main transformer. In case of over-temperature, an alarm message is displayed
- Thermal sensor on the active electronic devices. In case of over-temperature, an alarm message is displayed
- If maximum current limits and time duration of power transformer generators are trespassed, the generation is interrupted, and the operator is warned by an alarm message
- The current measurement input is protected against wrong connections



## LIST OF FIGURES

FIGURE 1 - STS 5000 .....	12
FIGURE 2 - TEST SET FRONT PANEL .....	13
FIGURE 3 – LEFT PANEL COMPONENTS .....	15
FIGURE 4 - RIGHT PANEL COMPONENTS.....	16
FIGURE 5 - STS DISPLAY .....	29
FIGURE 6 – HOME PAGE .....	30
FIGURE 7 – “CURRENT TRANSFORMERS” ICON .....	30
FIGURE 8 - "CURRENT TRANSFORMERS/HEADER AND NOMINAL VALUES" PAGE (TAB DESCRIPTION) .....	31
FIGURE 9 - "CURRENT TRANSFORMERS/HEADER AND NOMINAL VALUES" PAGE (TAB NOMINALS) .....	31
FIGURE 10 - "CURRENT TRANSFORMERS/HEADER AND NOMINAL VALUES" PAGE (TAB TOLERANCES).....	32
FIGURE 11 - "CURRENT TRANSFORMERS" TEST PAGE (CONVENTIONAL TYPE).....	32
FIGURE 12 - "CTS – RATIO POLARITY AND BURDEN CURRENT METHOD" PAGE .....	33
FIGURE 13 - TRANSIT CASE .....	49
FIGURE 14 - REMOTE SAFETY SWITCH .....	51
FIGURE 15 - WARNING STROBE LIGHT .....	51
FIGURE 16 - SAFETY WARNINGS (28) CONNECTOR .....	51
FIGURE 17 - STCS OPTION .....	52
FIGURE 18 - STCS BOOSTER 20 A DC OPTION.....	53
FIGURE 19 - STDE OPTION.....	54
FIGURE 20 - STSA SURGE ARRESTER.....	55
FIGURE 21 - BUX 3000 OPTION .....	55
FIGURE 22 - CURRENT CLAMP.....	57
FIGURE 23 - PLCK OPTION.....	58
FIGURE 24 - STLG OPTION.....	58
FIGURE 25 - STSG OPTION.....	62
FIGURE 26 - GROUND GRID TEST ACCESSORIES KIT.....	64
FIGURE 27 – CURRENT CLAMP METER .....	65
FIGURE 28 - FOLDABLE TROLLEY.....	66
FIGURE 29 - TD 5000.....	66
FIGURE 30 - POWER SUPPLY ON THE SIDE .....	67
FIGURE 31 - IN-A (UST-A) AND IN-B (UST-B) MEASUREMENTS ON THE SIDE.....	67
FIGURE 32 - HV OUTPUT ON THE FRONT PANEL .....	68
FIGURE 33 - CAP-CAL REFERENCE CAPACITOR.....	72
FIGURE 34 - CONNECTION OF THE CAP-CAL TO THE TD 5000 .....	72
FIGURE 35 - STOIL OPTION.....	73
FIGURE 36 - DIGITAL THERMO HYGROMETER.....	73
FIGURE 37 - RCTD OPTION .....	74

## LIST OF TABLES

TABLE 1 - STS FAMILY MODELS .....	7
TABLE 2 - DIFFERENCES AMONG THE STS FAMILY MODELS .....	7
TABLE 3 - CURRENT TRANSFORMER TESTS .....	7
TABLE 4 - VOLTAGE TRANSFORMERS TESTS .....	8
TABLE 5 - POWER TRANSFORMERS TESTS .....	8
TABLE 6 - CIRCUIT BREAKERS TESTS .....	8
TABLE 7 - RESISTANCES TESTS .....	8
TABLE 8 - OPTIONAL MODULES .....	10
TABLE 9 - FRONTAL PANEL COMPONENTS (1/2) .....	13
TABLE 10 - FRONTAL PANEL COMPONENTS (2/2) .....	14
TABLE 11 - LEFT PANEL COMPONENTS .....	15
TABLE 12 - RIGHT PANEL COMPONENTS .....	16
TABLE 13 - STANDARDS RELATED TO THE EMC DIRECTIVE (2/2) .....	17
TABLE 14 - STANDARDS RELATED TO THE LV DIRECTIVE .....	18
TABLE 15 - HIGH AC CURRENT: OUTPUT CHARACTERISTICS (1/2) .....	20
TABLE 16 - HIGH AC CURRENT: OUTPUT CHARACTERISTICS (2/2) .....	20
TABLE 17 - HIGH DC CURRENT: OUTPUT CHARACTERISTICS (1/2) .....	20
TABLE 18 - HIGH DC CURRENT: OUTPUT CHARACTERISTICS (2/2) .....	20
TABLE 19 - LOW AC CURRENT: OUTPUT CHARACTERISTICS .....	21
TABLE 20 - LOW DC CURRENT: OUTPUT CHARACTERISTICS .....	21
TABLE 21 - HIGH AC VOLTAGE: OUTPUT CHARACTERISTICS (1/4) .....	22
TABLE 22 - HIGH AC VOLTAGE: OUTPUT CHARACTERISTICS (2/4) .....	22
TABLE 23 - HIGH AC VOLTAGE: OUTPUT CHARACTERISTICS (3/4) .....	22
TABLE 24 - HIGH AC VOLTAGE: OUTPUT CHARACTERISTICS (4/4) .....	23
TABLE 25 - HIGH AC VOLTAGE: CURRENT RANGES AND ASSOCIATED ERRORS .....	23
TABLE 26 - HIGH AC VOLTAGE: PHASE SHIFT METERING CHARACTERISTICS .....	23
TABLE 27 - LOW AC CURRENT: OUTPUT CHARACTERISTICS .....	23
TABLE 28 - HIGH POWER OUTPUT: OUTPUT CHARACTERISTICS .....	24
TABLE 29 - FREQUENCY RANGE ON ALL THE AC OUTPUTS .....	24
TABLE 30 - OTHER FEATURES OF MAIN OUTPUTS .....	24
TABLE 31 - OUTPUTS MEASUREMENT .....	25
TABLE 32 - RESOLUTION AND ACCURACY .....	25
TABLE 33 - PHASE ANGLE RESOLUTION AND ACCURACY .....	26
TABLE 34 - AVAILABLE MEASUREMENTS .....	27
TABLE 35 - PARAMETERS FOR CT, VT AND PT RATIO MEASUREMENT .....	27
TABLE 36 - PARAMETERS FOR THE BURDEN TEST .....	27
TABLE 37 - RESISTANCE TEST: RANGE AND ACCURACY .....	28
TABLE 38 - IMPEDANCE TEST: RANGE AND ACCURACY .....	28
TABLE 39 - PHASE ANGLE RESOLUTION AND ACCURACY .....	28
TABLE 40 - MAIN FEATURES OF THE DISPLAY .....	29
TABLE 41 - CURRENT TRANSFORMERS TESTS (1/4) .....	34
TABLE 42 - CURRENT TRANSFORMERS TESTS (2/4) .....	35
TABLE 43 - CURRENT TRANSFORMERS TESTS (3/4) .....	36
TABLE 44 - CURRENT TRANSFORMERS TESTS (4/4) .....	37
TABLE 45 - VOLTAGE TRANSFORMERS TESTS (1/2) .....	38
TABLE 46 - VOLTAGE TRANSFORMERS TESTS (2/2) .....	39
TABLE 47 - POWER TRANSFORMERS TESTS (1/3) .....	40
TABLE 48 - POWER TRANSFORMERS TESTS (2/3) .....	41
TABLE 49 - POWER TRANSFORMERS TESTS (3/3) .....	42
TABLE 50 - CIRCUIT BREAKERS TESTS .....	43
TABLE 51 - RESISTANCES TESTS (1/2) .....	44
TABLE 52 - RESISTANCES TESTS (2/2) .....	45

TABLE 53 – OTHER POSSIBLE TESTS .....	46
TABLE 54 - CABLES PROVIDED WITH THE UNIT .....	47
TABLE 55 - OTHER CHARACTERISTICS OF THE STS .....	48
TABLE 56 – TRANSIT CASE MAIN CHARACTERISTICS.....	49
TABLE 57 - TRANSPORT CASES CODING .....	49
TABLE 58 – STCS CABLES .....	52
TABLE 59 – STDE MAIN CHARACTERISTICS .....	54
TABLE 60 - MAX TEST CURRENTS AND DURATIONS (230 V) FOR BUX 3000.....	56
TABLE 61 - MAX TEST CURRENTS AND DURATIONS (110 V) FOR BUX 3000.....	56
TABLE 62 - MAX TEST CURRENTS AND DURATIONS (230 V) FOR BUX 2000.....	56
TABLE 63 - MAX TEST CURRENTS AND DURATIONS (110 V) FOR BUX 2000.....	57
TABLE 64 - CURRENT CLAMP MAIN CHARACTERISTICS .....	57
TABLE 65 – KIT ELEMENTS (1/2) .....	60
TABLE 66 – KIT ELEMENTS (2/2) .....	61
TABLE 67 - STUDS CHARACTERISTICS .....	63
TABLE 68 - ELEMENTS OF THE GROUND GRID TEST ACCESSORIES KIT.....	64
TABLE 69 - CURRENT CLAMP METER MAIN CHARACTERISTICS.....	65
TABLE 70 - TROLLEY CHARACTERISTICS.....	66
TABLE 71 - HV GENERATOR MAIN CHARACTERISTICS.....	68
TABLE 72 - VOLTAGE AND CURRENT OUTPUT MEASUREMENT ACCURACY AND RESOLUTION.....	68
TABLE 73 - FREQUENCY CHARACTERISTICS OF TD 5000 .....	69
TABLE 74 - DERIVED MEASUREMENTS FROM THE MEASUREMENTS OF V AND I.....	69
TABLE 75 - CABLES SUPPLIED WITH TD 5000 .....	70
TABLE 76 - PARASITIC CAPACITANCES .....	71
TABLE 77 - DIGITAL THERMO HYGROMETER MAIN CHARACTERISTICS .....	74
TABLE 78 – RCTD CHARACTERISTICS.....	74
TABLE 79 – RCTD CABLES.....	75
TABLE 80 - REVISIONS .....	77