SPECIFICATION

iCT 1

CT / VT Test Set

DOCUMENT No. SIE10183, Rev. 08, July 2019

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1 GENERAL

The portable, high accuracy test set iCT 1 allows performing all tests foreseen by international Standards on CTs and measurement VTs.

The following table summarizes the differences among the models:

Model	Code	High voltage output 2kVac	DC Voltage generator for knee points up to 30kV
iCT 1 Advanced tests with cables kit	PII10183	X	X
iCT 1 Standard tests with cables kit	PII12183	X	

Table 1 Differences among the ICT 1 models

The large display can control all test sets of the family locally. Test results and settings can be saved in a PC by the software iCT1, included in TDMS suite, which comes with the device.

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

No.	Test	iCT 1 Advanced PII10183	iCT 1 Standard PII12183
1	Turn Ratio and Polarity Voltage Mode	X	X
2	Burden Secondary Side	X	X
3	Excitation Curve standard method 2kVac	X	X
4	Excitation Curve DC method	X	
5	Winding Resistance	X	X
6	ALF/ISF	X	X
7	No Load current AC	X	X
8	Accuracy	X	X
9	CT Explorer	X	X
10	Demagnetizer	X	X

Table 2- Current Transformer tests

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

No.	Test	iCT 1 Advanced PII10183	iCT 1 Standard PII12183
1	Ratio	X	X
2	Ratio Electronics	X	X
3	Burden	X	X
4	No Load current AC	X	X

Table 3- Voltage Transformers tests

Tests are performed in accordance with the following standards:

- IEC EN 60044-1
- IEC EN 60044-2
- IEC EN 60044-5
- IEC EN 60044-6
- IEC EN 60044-7
- IEC EN 61869-x
- ANSI/IEEE C57.13.1

The following table lists the optional modules enhance the iCT 1 features:

Item	Option	Code	Description
1	Transit Cases	PII15183	Allows to transport the device
2	iCT1 SW license	PII10183C	Tests and data results on PC management
3	HVB4000	PII17183	High voltage booster

Table 4- Optional modules

The basic iCT 1 test set 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 a color LCD touch screen.

Test results are kept in local memory or in a USB pen drive, and can be transferred to a PC later, along with settings.

iCT 1 contains a generator, with the following five outputs:

- High AC voltage
- Low AC current
- Low DC current
- Low AC voltage
- Low voltage for excitation curve DC method

In addition, the low AC voltage output supplies the external option HVB4000 (high voltage booster) for testing high voltage VTs over 240 kV.

In local control mode, the selected output is adjustable and metered on the large, graphic LCD display. Through the LCD touch screen display it is possible to enter the MENU mode, which allows the functions setting.

This makes ICT 1 a very powerful testing device, with manual and automatic testing capabilities, and with the possibility to transfer test results to a PC via ETHERNET (plug or wireless) or Pen Drive.

The iCT1 SW allows downloading, displaying and analyzing test results executed in local mode.

iCT1 SW operates with all WINDOWS versions (starting from Win7 64 bit).

The ease of operation has been the first goal of iCT 1: this is why the LCD is graphic, and so large. With it, the dialogue in menu mode is made easy. Besides, all outputs relevant to the selected test are continuously measured, and output values are displayed, with no extra effort to the operator.

For CT tests, the instrument can be connected **directly up to 6 taps**; in this way the connection to the device under test it's executed only one time without the need of any further manual operation.

All iCT 1 current and voltage outputs are measured at the same time; an insulated voltage measurement input allows to perform ratio tests on CTs or VTs.

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

The following image exhibits the iCT 1 with the protection cover lifted:

Figure 1–iCT 1 – CT / VT Test set

The following image exhibits the front panel:

Figure 2 – iCT 1 front panel

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

ITEM	Component
1	Power supply plug. Includes two fuses.
2	Ground connection socket
3	Emergency push-button with lock-in
4	Power ON and OFF push-button
5	USB Flash disk connector for the local test results saving or for moving the local test results from the local memory
6	ETHERNET connection to the PC. It incorporates two lights which turn on when the test set is connected
7	Test START and STOP push-button
8	Display
9	Voltage inputs for measuring CTs primary side or VTs secondary side
10	Tap inputs coming from CTs secondary side
11	Voltage or current outputs for excitation tests, ratio etc. . These outputs are used by all the generators unless the Insulation Tester. The LED HV turns ON when it is active

Table 5– Frontal 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, 2014/30/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 ≤ 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 ≤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: • 0,15÷0.5 MHz: 79 dB pk; 66 dB avg • 0,5÷5 MHz: 73 dB pk; 60 dB avg • 5÷30 MHz: 73 dB pk; 60 dB avg Acceptable limits for radiated emission: • 30÷230 MHz: 40 dB (30 m) • 230÷1.000 MHz: 47 dB (30 m)
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 ± 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 Vrms, 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 6– Standards related to the EMC Directive

The following table lists the standards related to the LV Directive, 2014/35/EC:

Standard	Title	Requirement
IEC EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements	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. • Inputs/outputs protection: IP 2X, per IEC 60529, for all but high voltage outputs; IP4X for high voltage outputs • Insulation resistance, at 500 V DC: > 10 MΩ • Ground resistance, at 200 mA DC: < 0.1 Ω • Operating temperature: (-10÷50) °C; storage: (-20÷70) °C • Operating relative humidity: 5÷95%, without condensing. Storage relative humidity: 0÷96%, without condensing • Altitude: less than 2,000 m
IEC 60068-2-6	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	Vibration: 20 m/s² 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 7- Standards related to the LV Directive

3 CHARACTERISTICS

3.1 Foreword

The iCT 1 instrument incorporates a generator with five outputs.

The generator is made of an electronic type D switching amplifier, followed by a power transformer or by electronic devices for DC curve method and other tests, which adapts the suitable current or voltage output.

3.2 Main generator

The main generator has five outputs:

- High AC voltage
- Low AC current
- Low DC current
- Low AC voltage
- Low voltage for excitation curve DC method

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

3.2.1 High AC voltage

The output is available on all iCT 1 models.

The high AC voltage output up to 2kV is coming from a transformer that provides to insulate the outputs from the power supply.

The following table lists the output characteristics (three ranges, maximum voltages and currents):

Voltage output [V]	Output current [A]	Load time [s]
2.000	0,7	5
2.000	0.25	>2 min
500	1,5	60
9	15	>2 min

Table 8- High AC voltage: output characteristics (1/2)

	ATTENTION: The output range decreases below 50 Hz and above 60 Hz. Power values with cosφ< 0.15 (Supply 230V, output current < 0.5 A) Power values with cosφ< 0.10 (Supply 110V, output current < 0.5 A) Cosφ value decreases for currents > 0.5 A

The following table lists other output characteristics:

Total Harmonic distortion	Less than 2% on linear loads
Over range voltage output (max. value)	2100 V (output current 0,2 A)
Measurement accuracy	There are four measuring ranges, with automatic switch: 2000 V; 200 V; 20V; 2V
Connection	Two safety 4 mm banana sockets

Table 9– High AC voltage: output characteristics (2/2)

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.

3.2.2 Low DC current

The output current can be manually adjusted using the front panel controls (i.e. defining the DC test current in the winding resistance test), and measured internally at the same time as the corresponding voltage output.

The following table lists the output characteristics:

Maximum output current	6 A DC
Maximum output voltage	30 V DC
Maximum output power	180 W
Duration of the generation	>10 min (at 50 W)
Output protection	electronic protection
Connection	Two safety 4 mm banana sockets

Table 10- Low DC current: output characteristics

3.2.3 Low AC current

The output current can be manually adjusted using the front panel controls (i.e. defining the AC test current in the burden test), and measured internally at the same time as the corresponding voltage output.

The following table lists the output characteristics:

Maximum output current	6 A AC
Maximum output voltage	100 V AC
Maximum output power	200 VA
Duration of the generation	>10 min (at 50 VA)
Output protection	electronic protection
Connection	Two safety 4 mm banana sockets

Table 11– Low AC current: output characteristics

3.2.4 Low AC voltage

The output voltage it's automatically adjusted depending upon the selected test (typically an excitation curve where the voltage knee value it's relatively low) .

The following table lists the output characteristics:

Maximum output voltage	180V AC
Maximum output current	3.5A AC
Maximum output power	Supply 230V : 400 VA Supply 110V : 330VA
Duration of the generation	>10 min (at 50 VA)
Output protection	electronic protection
Connection	Two safety 4 mm banana sockets

Table 12– Low AC voltage: output characteristics

3.2.5 Low voltage for excitation curve DC method

The low DC voltage output is automatically controlled in amplitude, polarity and duration. This generator it's used to find CT knee points up to 30kV.

The following table lists the output characteristics:

Maximum output voltage	200V DC
Maximum output current	2Arms, 15A peak
Maximum output power	Supply 230V : 400 VA Supply 110V : 330VA
Output protection	electronic protection
Connection	Two safety 4 mm banana sockets

Table 13– Low voltage for excitation curve DC method: output characteristics

3.2.6 Output frequency

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

Frequency	15÷400 Hz
Frequency resolution	10 mHz
Frequency accuracy	< 100 ppM; output voltage > 200 V

Table 14– Frequency range on all the AC outputs

3.2.7 Other features of main outputs

The following table lists other features of main outputs:

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

Table 15– Other features of main outputs

3.3 Input / Outputs measurements

As written in chapter 1, iCT 1 measures the voltage and/or current generated and at the same time performs an additional voltage measurement if required for the test (i.e. the turn ratio) . The measurements are isolated between them and with respect to the rest of the test set.

The display shows the measurements basing upon the selected tests.

The following table list the resolution and accuracy of the internal measurements:

Input	Range	Resolution	Typical error		Guaranteed error	
			[<%rdg]	[<%rg]	[±%rdg]	[±%rg]
AC current	10 A 1 A 0,1 A	1 mA 0,1 mA 0,01 mA	< 0,025% < 0,025% < 0,025%	< 0,025% < 0,025% < 0,025%	±0,05% ±0,10% ±0,15%	±0,1% ±0,05% ±0,05%
DC current	15 A 1,5 A 0,15 A	1 mA 0,1 mA 0,01 mA	< 0,025%	< 0,025%	±0,05%	±0,05%
AC voltage primary side	300 V 30 V 3 V 300 mV	15 mV 1,5 mV 0,15 mV 0,015 mV	< 0,02%	< 0,02%	±0,05%	±0,05%
AC voltage secondary side	2100 V 200V 20V 2V	100 mV 10 mV 1mV 100µV	< 0,02%	< 0,02%	±0,05%	±0,05%
DC voltage	200 V 20 V 2 V 200 mV 20 mV	10 mV 1 mV 100µV 10µV 1µV	< 0,025% < 0,025% < 0,025% < 0,025% < 0,05%	< 0,025% < 0,025% < 0,025% < 0,025% < 0,05%	±0,05% ±0,05% ±0,05% ±0,05% ±0,1%	±0,05% ±0,05% ±0,05% ±0,05% ±0,1%

Table 14–Internal measurements. Resolution and accuracy

Type of measurement	True RMS for AC outputs DC component for DC outputs
Metering temperature coefficient	±0,05%/°C of the value ±0,02%/°C of the range

Table 15– Internal measurements. Other characteristics

3.4 Other measurements (Ratio, Polarity, Burden, Winding Resistance)

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

The following table lists the parameters for the CT turn ratio measurement:

Ratio range	Typical accuracy	Maximum accuracy
0,8÷2000	±0,02%	±0,05%
2000÷5000	±0,03%	±0,10%
5000÷20000	±0,05%	±0,20%

Table 16- Accuracy for CT ratio measurement

The following table lists the parameters for the VT ratio measurement:

Ratio range	Typical accuracy	Maximum accuracy
1÷400	±0,03%	±0,2%
400÷1000	±0,05%	±0,3%
1000÷2500	±0,05%	±0,5%

Table 17- Accuracy for VT 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 °. For ratios greater than the maximum specified (i.e.20000 for CTs) the accuracy error will be greater (i.e. ±0,50% or more).

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 18- Parameters for the burden test

For the winding resistance test the test it's performed using a pure DC current source. The following table lists the corresponding resolution and accuracy:

Source	Resolution	Typical accuracy	Guaranteed accuracy
Low DC current 6 A max	0,1 mΩ	< 0,05%	0,1% + 1mΩ

Table 19- Resistance test: range and accuracy

3.5 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 phase shift metering characteristics:

Metering range	0°÷360.0°
Resolution	0.01° (<1 minute)
Accuracy (cosφ 0.8 - 1)	<2 minutes(typical)
	< 4 minutes(maximum), for amplitudes more than 10% of the metering range

Table 20- Phase angle resolution and accuracy

Phase shift variation (temperature function) angle temperature drift: ±0,002 °/°C.

3.6 Display

The following image exhibits the iCT 1 display:

Figure 3 iCT 1 display

The following table lists the main features of the display touch:

Pixel	Light	LCD type	View area
800 x 480 , colors (7”)	Backlight	TFT	152 x 90 mm

Table 21- Main features of the display

3.7 Test control

Test control: by the START / STOP pushbutton. Pressing it, the output is generated, after test selection, according to the type of test.

Test saving:

- Automatic save
- After operator confirmation

3.8 Menu selections

The following image exhibits the Home page of the test set:

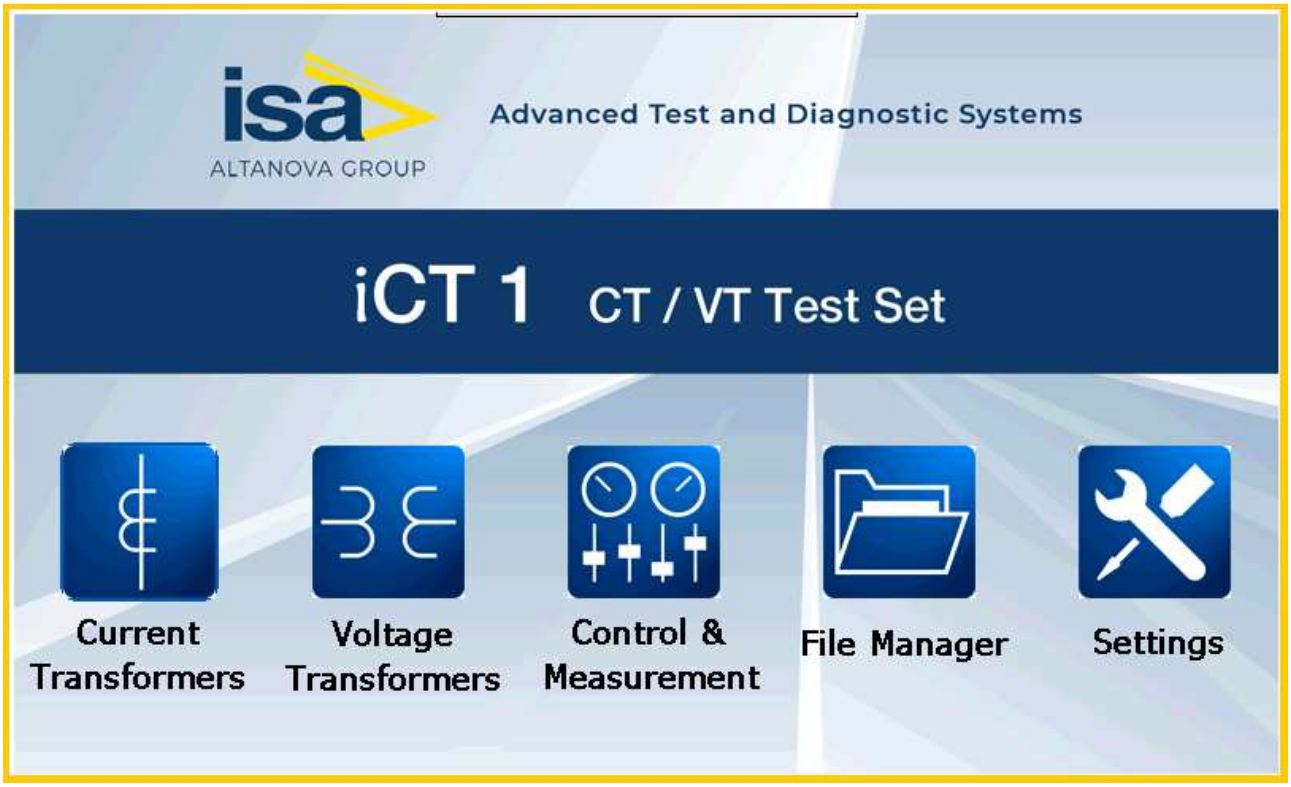

Figure 4 Home page

The menu is entered pressing the icons and buttons on the touch screen.

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 and Voltage 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 5 – “Current Transformers" icon

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

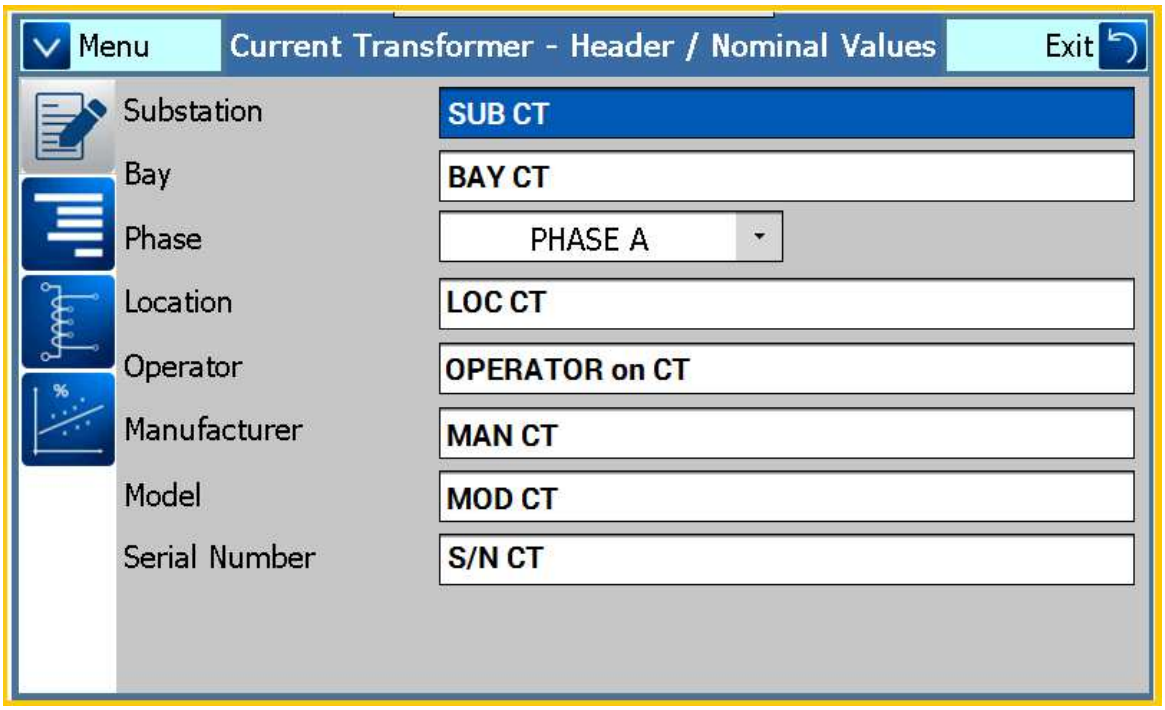

Figure 6- "Current Transformers/Header and Nominal Values" page (tab Description)

The following image exhibits the tab “Nominals”:

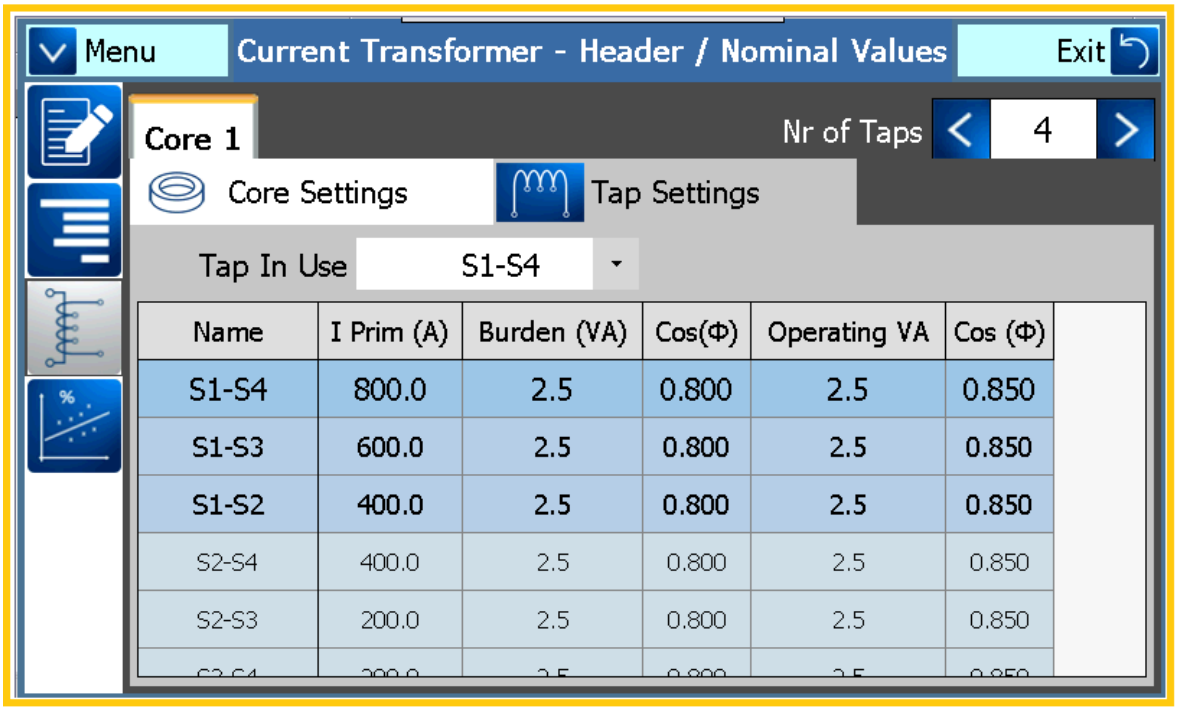

Figure 7- "Current Transformers/Header and Nominal Values" page (tab Nominals)

The following image exhibits the tab “Tolerances”:

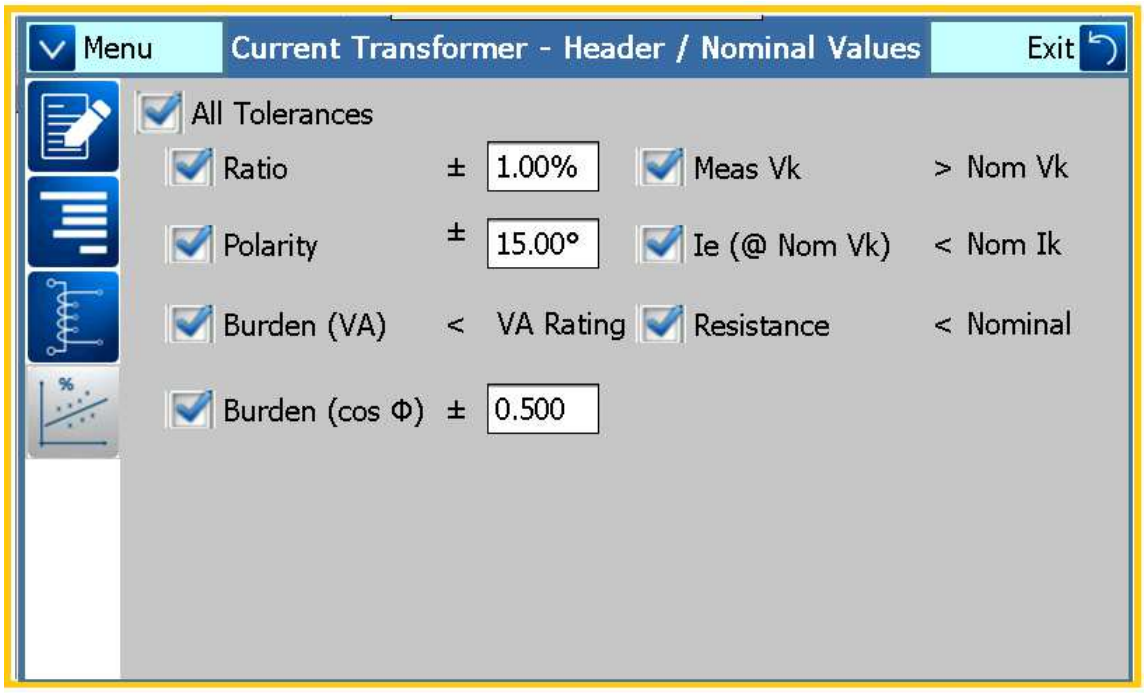

Figure 8- "Current Transformers/Header and Nominal Values" page (tab Tolerances)

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 with one test executed :

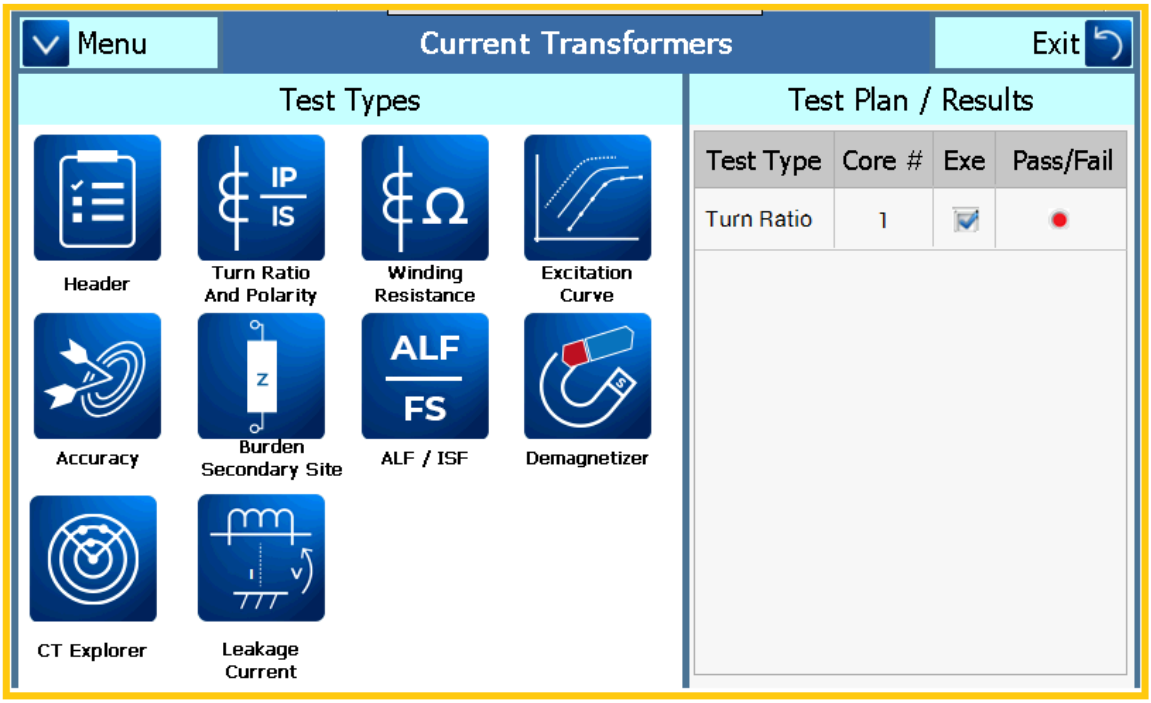

Figure 9- "Current Transformers" test page

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 – Turn Ratio and Polarity Voltage Method” page:

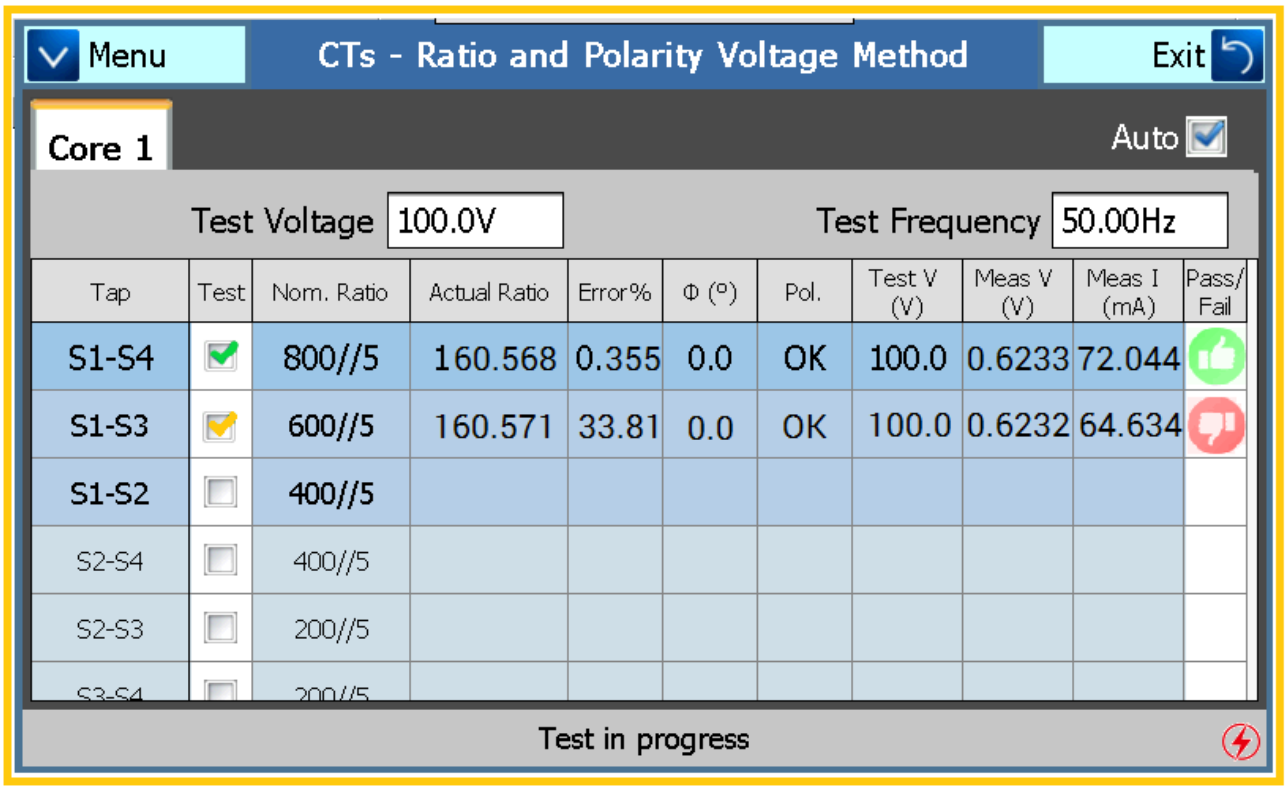

Figure 10- "CTs – Ratio Polarity Voltage Method" page

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” 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 iCT1 SW program included in the TDMS suite, which comes with the device. The software allows saving test results into a file, examining them, printing them.

It is also possible to edit settings and to upload them to iCT 1 instrument.

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.

Current Transformers tests:

No.	Test	Test description
1	Turn Ratio and Polarity Voltage Mode	The ratio measurement is performed applying High Voltage AC to the CT secondary, and measuring the CT primary voltage. Input parameters are the following: • The nominal primary and secondary current, from which the program computes the nominal ratio • The voltage range • The nominal test voltage and the test frequency The display shows the following: • The test voltage on the secondary side • The secondary measured voltage and the secondary current with the nominal primary current • Actual ratio and ratio error • Phase shift and polarity The measurements are narrow filtered in order to reduce the noise, coming from the environment.
2	Burden Secondary Side	The burden measurement is performed applying low AC current to the CT burden, and measuring the voltage drop. Input parameters are the following: • The nominal secondary current • The nominal test current The display shows: • The actual current output • The voltage drop across the burden • For the burden: VA rating at the nominal current, angle, power factor The measurements are narrow filtered in order to reduce the noise, coming from the environment.
3	Excitation Curve	The excitation curve is tested in two different modes: • Standard Method. It is connected the high AC voltage output to the CT secondary, slewing the voltage and measuring at the same time the output voltage and current. • DC curve Method. It is connected the low DC voltage generator to the CT secondary, varying the voltage and measuring at the same time the output voltage and current. Input parameters are taken from the CT Nominal Values window. The excitation curve test it's performed on all the connected taps to the instrument without any manual operation. Other inputs are the following: • Maximum test voltage and current (Standard Method only) • Test frequency (Standard Method only) The test set controls the output voltage and current during the test, and stops as the knee is recognized. The display shows the following: • The characteristic curve • The actual voltage knee and the error with respect to the nominal • The actual current error at knee In addition to this, it is possible to define a point-by-point test, where: • It is possible to input the desired number of test points, defined with current and voltage • The test result reports the deviation from the nominal values, and shows if results are in the set tolerance

Table 22- Current Transformers tests (1/3)

No.	Test	Test description
4	Winding Resistance	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: • The nominal resistance • The connected output • The test current • The resistance limits 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: • The test current • The voltage drop • The measured resistance and the compensated resistance • The test duration • The current deviation when the measurement was achieved
5	ALF/ISF	Purpose of the test is to calculate the ALF/ISF value using the Winding Resistance test results and the Burden Secondary Side test results. ALF = Accuracy Limit Factor and ISF = Instrument Security Factor. Input parameters: Burden and Winding test results. Results: ALF value.
6	Leakage current AC	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: • Maximum test current (with automatic switch-off) • Test time • Output range • Test voltage • Test frequency The display shows the following: • During the HV ramping, the test voltage and current; • As the test is completed, the test voltage, the maximum current, the total elapsed time, the isolation impedance (not resistance)

Table 23- Current Transformers tests (2/3)

No.	Test	Test description
7	Accuracy	The Accuracy test verifies automatically the CT characteristics (ratio error and phase error) accordingly to the standards, typically at 120%, 100%, 20%, 5% and 1% of rated current. The ratio and phase error measurement is performed measuring the turn ratio and the winding resistance of the CT secondary. Input parameters are the following: • The nominal primary and secondary current, from which the program computes the nominal ratio • The nominal burden and the accuracy class • The test frequency The display shows a table with the ratio error and the phase shift at the rated currents (120%, 100%, 20%, 5%, 1%). The measurements are narrow filtered in order to reduce the noise, coming from the environment.
8	CT Explorer	This particular test finds the most important parameters, as Ratio, Type, Nominal current etc. for an unknown CT. It is required only to connect the primary and secondary side of the CT to the instrument.
9	Demagnetizer	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. Input parameters are the following: • Nominal current (primary and secondary) • Test current The display shows the following: • DC current and voltage • Current behavior during the demagnetization procedure

Table 24-Current Transformers tests (3/3)

	ATTENTION: for the excitation curve test (Standard Method generating AC voltage at nominal frequency 50 or 60 Hz), the following standards apply: • 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 • ANSI/IEEE 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° • ANSI/IEEE 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°

The following table lists the Voltage Transformers tests:

No.	Test	Test description
1	Ratio	The ratio measurement is performed applying high voltage to the VT primary, and measuring the VT secondary voltage. Input parameters are the following: • The nominal primary and secondary voltage, from which the program computes the nominal ratio • Type of connection (Y or Delta) • The HV range • The nominal test voltage and frequency • The selected voltage meter The display shows the following: • The actual test voltage • The secondary voltage • The value of the secondary voltage with the nominal primary voltage • Actual ratio and ratio error • Phase shift and polarity The measurements are narrow filtered in order to reduce the noise, coming from the environment.
2	Ratio Electronics	The ratio measurement is performed applying high voltage to the VT primary, and measuring the low-level VT secondary voltage. Input parameters are the following: • The nominal primary and secondary voltage, from which the program computes the nominal ratio • Type of connection (Y or Delta) • The HV range • The nominal test voltage and frequency The display shows the following: • The actual test voltage • The secondary voltage • The value of the secondary voltage with the nominal primary voltage • Actual ratio and ratio error • Phase shift and polarity The measurements are narrow filtered in order to reduce the noise, coming from the environment.
3	Burden	The burden measurement is performed applying low AC voltage to the VT burden, and measuring the corresponding current. Input parameters are the following: • The nominal secondary voltage • The voltage range • The test voltage and frequency The test current can also be metered by a clamp. The display shows the following: • The actual voltage and current test The results are the following: • Performance in VA at rated voltage • Cos(φ)
4	No Load Current AC	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. Input parameters are the following: • Maximum test current (with automatic switch-off) • Test time • Output range • Test voltage • Test frequency The display shows the following: • During the generation, the test voltage and current • As the test is completed, the maximum current, the total elapsed time, the isolation impedance

Table 25-Voltage Transformers tests

3.9 Standard connection cables (Long cables code PII18183)

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

Item	Description
1	No. 1 Mains supply cable, 2 m long
2	No. 1 Grounding cable, 6 m long, 6 mm^2, terminated on one side with a terminator, and on the other side with an earth connection clamp (No 2 cables for the option PII57175)
3	No. 1 ETHERNET interface cable
4	No. 1 Operating manuals + Cd-Rom with TDMS
5	No. 1 USB pen drive
6	2 clamps for CT primary side connection. Clamp opening: 60 mm on the rear, 80 mm on the front
7	2 clamps for CT secondary side connection, 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
8	No. 8 alligator clips for measurements connections on secondary side (3 red, 3 black, 2 blue)
9	No. 1 set of adaptors from banana sockets to terminators, 10 in all, with different colors
10	No. 2 connection cables for primary side measurements, 13m long(18 m long option PII18183) Each cable is labeled (i.e. P1/H1) in order to avoid connections mistakes
11	No. 6 connection cables for secondary side measurements, 6m long (10 m long option PII18183). Each cable is labeled (i.e. S1/X1) in order to avoid connections mistakes
12	No. 2 voltage connection cables, 6 m long (10 m long option PII18183) for generation on secondary side. Each cable is labeled in order to avoid connections mistakes
13	N° 1 plastic bag that hosts all the cables, with handle. Dimensions: 45 x 55 x 22 cm

Table 26-Cables provided with the unit

	ATTENTION: The previous cables come as standard with the test set. Optionally, the connection cables (items 10,11,12) can be ordered longer with the option PII18183

3.10 Other characteristics

The following table list other characteristics of the instrument iCT 1 :

Item	Characteristic	Description
1	Memory	• Up to 64 test plans • More than 1,000 test results
2	Interfaces	• ETHERNET for the PC connection. The Ethernet port can be used also for remote service and maintenance • USB port for the USB key: this serves to download test settings and results • Wireless for connection to a PC. It can be used in place of Ethernet standard port
3	Mains supply	100÷230 V ± 15%; 48÷62 Hz
4	Power consumption	Less than 1 kW in normal use
5	Dimensions and Weight	410 (H)x340 (W)x205 (D) mm iCT 1 all models. Weight: 16 kg
6	Accessories	• User manual, in English • No 5 spare fuses, type T8A • Connection cables, provided in a case with handle

Table 27-Other characteristics of the instrument iCT 1

	ATTENTION: If the supply is less than 184 V AC, the test set does not guarantee the full output power on the 2kV AC output

4 OPTIONS

4.1 Transit cases (code PII15183)

The following image exhibits a transit case:

Figure 11- Transit case

This option applies to all the models of iCT 1 and allows to transport 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 28-Transport cases coding

4.2 iCT1_SW licence (code PII10183C)

The software iCT1 SW allows connecting to the PC all models of the instrument iCT1.

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, exporting them in EXCEL format
- 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 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
    - 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

	ATTENTION: The software runs with any WINDOWS© environment starting from Win 7 64 bit Windows and EXCEL are trademarks of Microsoft Corporation

4.3 HVB4000High voltage booster for VTs (Code PII17183)

This option allows increasing the test voltage up to 4 kV in order to perform more accurate tests on high voltage CVT.

Output current and voltage are measured and sent back to iCT 1 while the power is taken by the iCT 1 on the output voltage plugs.

The HBV4000 option characteristics are the following:

- Input: from iCT 1, via the booster connector
- Output voltage : up to 4 kV
- Input power : 500 VA
- Weight: <15 kg

All the followings connection cables in a cable transport case are included in the option:

Cable	Characteristics
No. 1 ground cable	6 m long, 6 mm^2 terminated with terminator and clamp

No. 2 safety cable	No. 2 High voltage connection cables, 12 m long with earth screen. Terminated on one side with the HV connector, and on the other side with a 4 mm banana plug
No. 1 power cable	6 m long, for the power connection of the iCT 1
No 1 communication cable	6 m long, for the data connection of the iCT 1

Table 29-HBV4000 cables

5 PROTECTIONS

The protections of the iCT 1 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
- Fuse on the mains supply
- iCT 1 is protected against short circuit, overload and overvoltage
- 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 is generated only if selected
- 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

REVISIONS

The following table lists the revisions of the document:

No.	Date	Description
1	June 2017	First issue
2	July 2017	Second issue
3	September 2018	Third issue
4	December 2018	Fourth issue
5	January 2019	Fifth issue
6	March 2019	Sixth issue .
7	May 2019	Seventh issue
8	July 2019	Eighth issue

Table 30- Revisions

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