



T/3000

Substation Maintenance and Commissioning Test Equipment

- MULTI FUNCTION SYSTEM FOR TESTING SUBSTATION EQUIPMENT SUCH AS:
CURRENT, VOLTAGE AND POWER TRANSFORMERS, ALL TYPE OF PROTECTION RELAYS, ENERGY METERS AND TRANSDUCERS
- PRIMARY INJECTION TESTING CAPABILITIES
- 3000 V AC HIGH-POT TEST
- GENERATES UP TO 800 A (OPTION UP TO 2000A)
- MICROHMMETER FUNCTION (OPTION): UP TO 400A DC
- LARGE GRAPHICAL DISPLAY
- TEST RESULTS AND SETTINGS ARE SAVED INTO LOCAL MEMORY
- RS232 INTERFACE FOR PC CONNECTION
- COMPACT AND LIGHTWEIGHT (29 KG)

Application

T/3000 is a unique solution for all testing operations during commissioning and maintenance of substations, as it allows performing the test on both, relays of all types and of current and voltage transformers. Also capable of testing energy meters and transducers. In addition **T/3000** incorporates a powerful multi-meter and phase angle meter, with oscilloscope functions.

The following table lists the tests that can be performed on Current Transformers (CT), Voltage Transformers (VT) and Power Transformers (PT).

N. TEST	TEST DESCRIPTION
1 CT	Ratio, polarity and burden, Current mode
2 CT	Burden; secondary side
3 CT	Excitation curve
4 CT	Winding or burden resistance
5 CT	Voltage withstand
6 CT	Polarity by impulses
7 CT	Ratio, Voltage mode
8 VT	Ratio; polarity
9 VT	Burden, secondary side
10 VT	Ratio, electronic transformers
11 VT	Voltage withstand
12 VT	Secondary over-current protection
13 PT	Ratio per TAP
14 PT	Resistance of TAP Changer contacts
15 GR	Earth resistance
16 GR	Soil resistivity



The table below lists the relays that can be set and tested by T/3000.

RELAY TYPE	IEEE No
Distance (3 sets)	21
Synchronizing	25
Over/under-voltage	27 - 59
Power, varmetric or wattmetric	32 - 92
Under current	37
Reverse phase current	46
Instantaneous overcurrent	50
Ground fault	50N
Timed overcurrent	51
Power factor	55
Directional overcurrent	67
Directional ground fault	67N
Automatic reclose	79

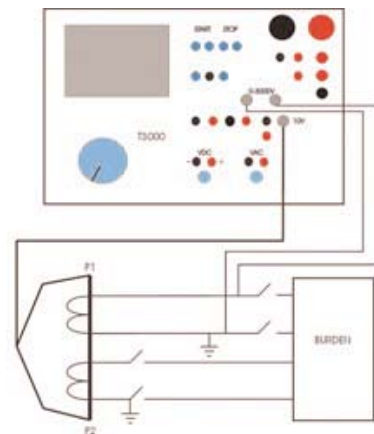
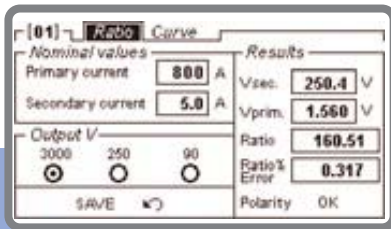
RELAY TYPE	IEEE No
Frequency	81
Frequency rate of change	81
Motor protection	86
Differential (starter only)	87
Directional voltage	91
Tripping relay	94
OTHER DEVICES	
Voltage regulation	
Timers	
Transducers	
Energy meters	

Typical application

Test of Current Transformer

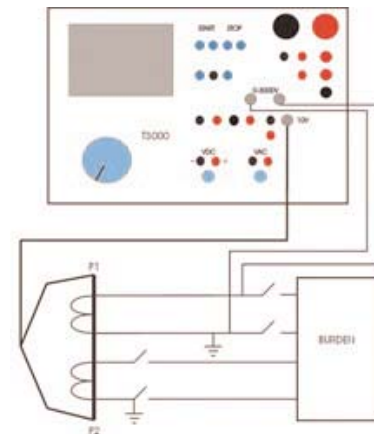
• CT RATIO V AND POLARITY - VOLTAGE METHOD

USED OUTPUT: 90V, 250V or 3000 V AC.
 USED INPUT: LOW AC VOLTAGE - 10 V AC.

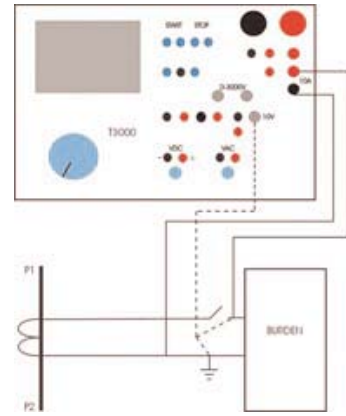
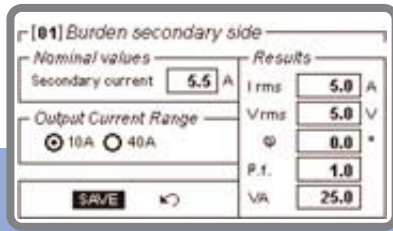


CT EXCITATION

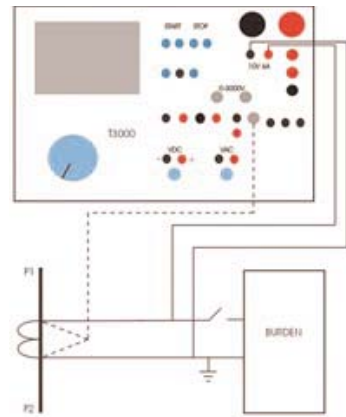
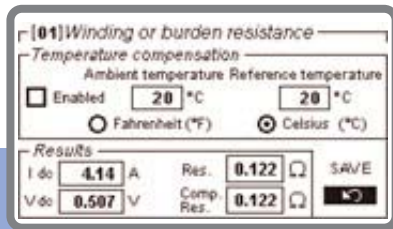
USED OUTPUT: 90V, 250V or 3000 V AC.
 USED INPUT: Internal measurement.



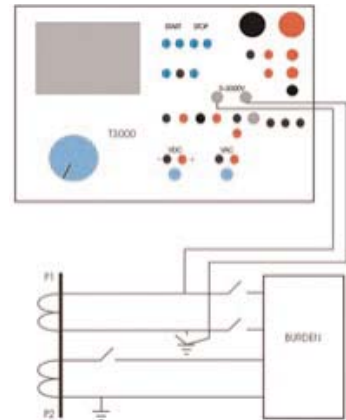
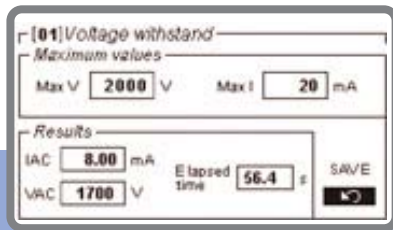
- CT BURDEN SECONDARY SIDE:
 USED OUTPUT: 10 A or 40 A AC.
 USED INPUT: LOW AC VOLTAGE - 10 V AC



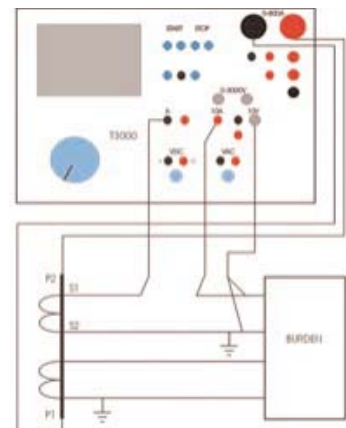
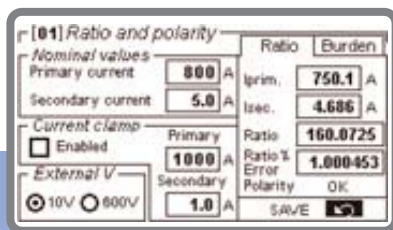
- WINDING RESISTANCE:
 USED OUTPUT: 6 A DC
 USED INPUT: 10 V DC



- VOLTAGE WITHSTAND:
 USED OUTPUT: 3000 V AC
 USED INPUT: Internal measurement.



- CT RATIO AND POLARITY – CURRENT METHOD
 USED OUTPUT: 800 A AC
 USED INPUT: LOW AC CURRENT - 10 A AC.



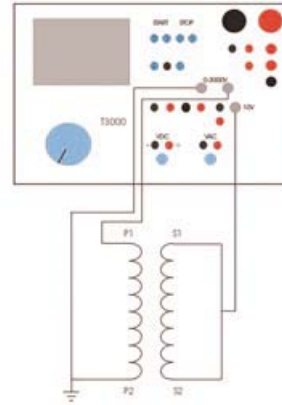
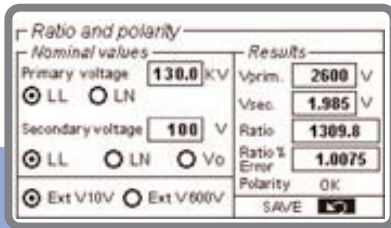
Typical application

Test of Voltage Transformer

• VT RATIO AND POLARITY

USED OUTPUT: 3000 V AC.

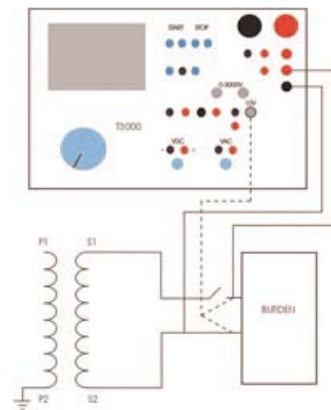
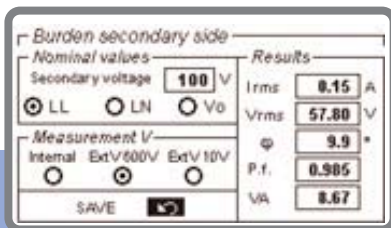
USED INPUT: LOW or HIGH AC VOLTAGE - 10 V AC OR 600 V AC.



• VT BURDEN

USED OUTPUT: 10 A AC.

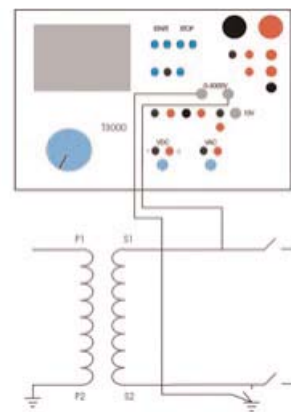
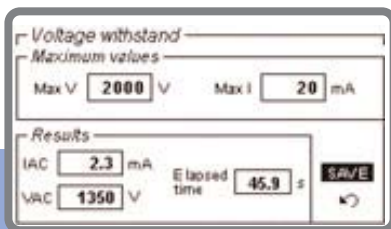
USED INPUT: LOW or HIGH AC VOLTAGE - 10 V AC OR 600 V AC.



• VOLTAGE WITHSTAND

USED OUTPUT: 3000 V AC

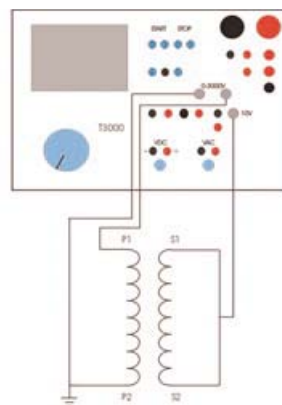
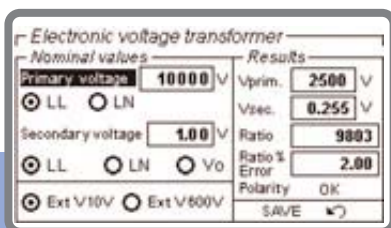
USED INPUT: Internal measurement.



• RATIO OF ELECTRONIC VOLTAGE TRANSFORMER

USED OUTPUT: 3000 V AC.

USED INPUT: LOW or HIGH AC VOLTAGE - 10 V AC OR 600 V AC.



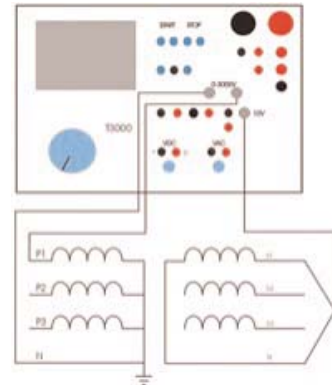
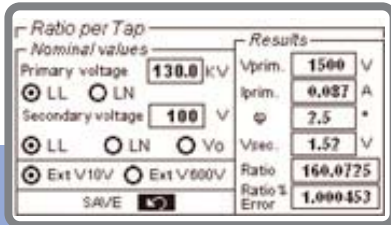
Typical application

Power Transformer

• RATIO PER TAP

USED OUTPUT: 3000 V AC.

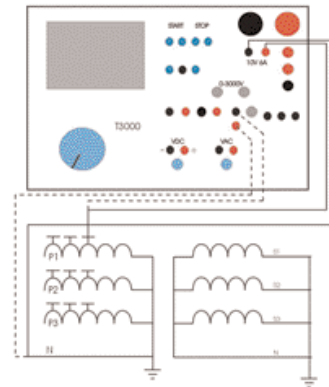
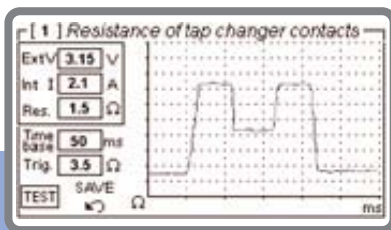
USED INPUT: LOW or HIGH AC VOLTAGE - 10 V AC OR 600 V AC.



• TAP CHANGER RESISTANCE AND CONTINUITY

USED OUTPUT: 6 A DC

USED INPUT: 10 V DC



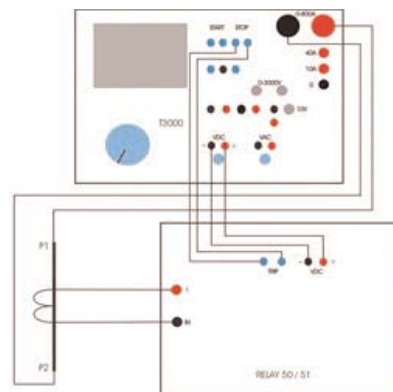
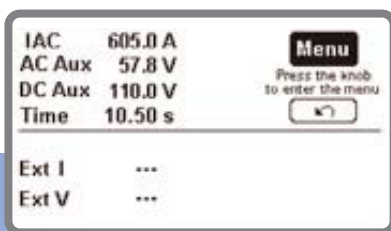
Typical application

Relay Testing

• PRIMARY INJECTION

USED OUTPUT: 800 A

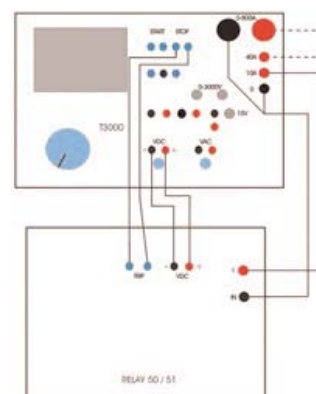
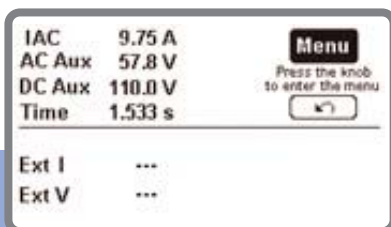
USED INPUT: TIMER



• SECONDARY INJECTION

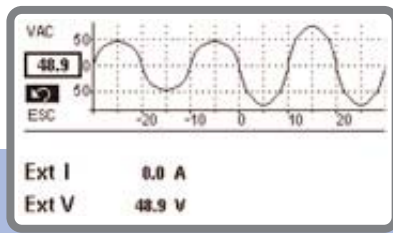
USED OUTPUT: 800A, 40A or 10 A

USED INPUT: TIMER



• SCOPE FUNCTION

USED OUTPUT: ANY
USED INPUT: V and I



System description

T/3000 contains three independent generators:

- Main generator. It has six outputs: High AC current; Low AC current; Low DC current; Current impulses; High AC voltage; Low AC voltage 1.
- Auxiliary AC voltage generator 2: it generates an independent, phase adjustable AC voltage.
- Auxiliary DC voltage generator, to feed relays under test.

All outputs are adjustable and metered on the large, graphic LCD display. With the multi-purpose control knob and the graphic LCD display it is possible to enter the MENU mode, that allows to control all functions, and makes T/3000 the most powerful testing device, with manual and automatic testing capabilities, and with the possibility to transfer test results to a PC via the RS232 interface. These results can be recorded, displayed and analysed by the powerful X.PRO-3000 software, which operates with all WINDOWS versions, starting from WINDOWS 98 included.

Additional features are:

- . Oscilloscope function: it is possible to display the current and voltage waveform measured;
- . Two independent measurement inputs, for current and voltage, and with High and Low inputs each, allow measuring CT or VT outputs or any other source;
- . The optional thermal printer gives the immediate printout of the CT saturation curve and other test results;
- . An auxiliary output contact, that follows START and STOP inputs, allows simulating the circuit breaker.

The instrument is housed in a transportable aluminium box, which is provided with removable cover and handles for ease of transportation.

NOTE: WINDOWS is a trademark of MICROSOFT inc.

T/3000 Specification

Main Generator

The main generator has six outputs: High AC current; Low AC current; Low DC current; Current impulses; High AC voltage; Low AC voltage. Output adjustment is performed via a knob. The following specification applies to the separate usage of these outputs.

High AC current output

APPLICATION:

- . CT TESTING: RATIO, POLARITY, BURDEN
- . RELAY TESTING
- . PRIMARY INJECTION

HIGH POWER RANGE

CURRENT OUTPUT A	OUTPUT POWER VA	LOAD TIME s	RECOVERY TIME min
100	600	STEADY	-
150	800	15 min	30
200	1000	4 min	15
400	1600	15	5
600	2000	5	3
800	2000	1	2

LOW POWER RANGE

CURRENT OUTPUT A	OUTPUT POWER VA	LOAD TIME s	RECOVERY TIME min
30	60	STEADY	-
50	80	10 min	10

Low AC current output

APPLICATION:

- . CT TESTING: BURDEN, SECONDARY SIDE
- . VT TESTING: OVERCURRENT PROTECTION

HIGH POWER RANGE

RANGE A AC	CURRENT OUTPUT A	OUTPUT POWER VA	LOAD TIME s	RECOVERY TIME min	
40	12	300	STEADY	-	
	18		15 min	30	
	24		4 min	15	
	36	800	15	5	
	48		5	3	
	60		1	2	
10	5	400	STEADY	-	
	7.5		15 min	30	
	10	800	60	15	
	15		30	10	
	20		1000	15	5

LOW POWER RANGE

RANGE A AC	CURRENT OUTPUT A	OUTPUT POWER VA	LOAD TIME s	RECOVERY TIME min
40	12	60	STEADY	-
	18		10 min	30
	24		60	10
	36		1	2
10	5	60	STEADY	-
	6		10 min	45
	7		60	2
	10		1	2

Low DC current output

APPLICATION:

- . CT TESTING: WINDING RESISTANCE, BURDEN RESISTANCE
- . PT TESTING: TAP-CHANGER CONTACT RESISTANCE

CURRENT OUTPUT A	LOAD RESISTANCE Ohm	OUTPUT POWER W	LOAD TIME min	RECOVERY TIME min
6	0	0	STEADY	-
3	2	18	STEADY	-
1	8	8	STEADY	-

Current impulses output

APPLICATION:

- . CT TESTING: POLARITY TEST WITH IMPULSE METHOD
- Current range: from 0 to 10 A peak.

High AC voltage output

Two version are available: 3000V or 1200V output

APPLICATION:

- . CT TESTING: EXCITATION CURVE, VOLTAGE WITHSTAND
- . VT TESTING: RATIO, POLARITY, ELECTRONIC VOLTAGE TRANSFORMER
- . PT TESTING: RATIO PER TAP

HIGH POWER RANGE

3000 V version

VOLTAGE OUTPUT V	CURRENT OUTPUT A	OUTPUT POWER VA	LOAD TIME min	RECOVERY TIME min
3000	0.2	600	STEADY	-
	0.6	1800	1	8

In alternative

1200V version

VOLTAGE OUTPUT V	CURRENT OUTPUT A	OUTPUT POWER VA	LOAD TIME min	RECOVERY TIME min
1200	0.5	600	STEADY	-
1200	1.5	1800	1	8

LOW POWER RANGE

VOLTAGE OUTPUT V	CURRENT OUTPUT A	OUTPUT POWER VA	LOAD TIME min	RECOVERY TIME min
600	0.1	60	STEADY	-
500	0.2	120	1	8

Low AC voltage output

APPLICATION:

- . CT TESTING: RATIO WITH VOLTAGE METHOD
- . VT TESTING: BURDEN SECONDARY SIDE

VOLTAGE V a.c.	VOLTAGE OUTPUT V	OUTPUT POWER VA	LOAD TIME min	RECOVERY TIME min
250	250	125	STEADY	-
	200	200	3	9

Auxiliary AC voltage

APPLICATION:

- . RELAY TESTING

RANGE V	MAX CURRENT mA
65	500
130	250
260	125

Auxiliary AC voltage

APPLICATION: . RELAY TESTING

Phase angle sfliter

- Phase angle adjustment: via the multi-function knob.
- Phase angle range: from 0° to 360°.
- Adjustment resolution: 1° (one degree).

Frequency & frequency rate
of change generator

- Frequency range: 40 Hz to 500 Hz.
- Frequency adjustment: 1 mHz, via control knob.
- Frequency ROC range: from 0.01 Hz/s to 99.99 Hz/s.

Auxiliary DC voltage

- D.C. voltage ranges: 130 V or 240 V.
- D.C. voltage power: 90 W at full range, continuous duty, with a current limit of 0.9 A @ 130 V and 0.45 A @ 240 V.

Timer

Available measurements:

- Timer start: at test start, or by an external contact;
 - Metering of elapsed time between START and STOP;
 - Current generation elapsed time.
 - Time can be metered as seconds or cycles.
 - . Inputs: free of voltage or with voltage.
 - . Programmable voltage threshold: 12 V or 80 V.
 - . Metering range, in seconds: from 0 to 99999.9 s.
 - . Resolution: 1 ms (up to 9.999 s).
 - . Metering range, in cycles: from 0 to 5999999 (60Hz).
 - . Resolution: 0.1 cycles (up to 999 cycles).
- Counting mode: this mode is foreseen for the test of energy meters. Maximum input frequency: 10 kHz.

Auxiliary binary Output

Contact range: 5 A; 250 V AC; 120 V DC



Measuring Section

Output measurements

Current and voltage AC and DC outputs measurement accuracy: $\pm 0.5\%$.

Phase angle measurement accuracy: 1° .

Frequency accuracy: 1 mHz.

Other measurements available on T/3000:

The following measurement are calculated from the T/3000 generated outputs:

OUTPUT MEASUREMENTS:	
ACTIVE POWER	P
REACTIVE POWER	Q
APPARENT POWER	S
POWER FACTOR	p.f.
IMPEDANCE	Z and φ
ACTIVE IMPED. COMPONENT	R
REACTIVE IMPEDANCE COMP.	X
RATIO	CT or VT or PT
POLARITY	CT or VT or PT
BURDEN	CT
VOLTAGE AND CURRENT KNEE	

External Inputs Measurement

Current measurements

- . Two inputs: 20 mA AC or DC or 10 A AC.
- . Accuracy: 0.5%
- Possibility to display the current waveform.

Voltage measurement

- . Two inputs: 10 V or 600 V, AC or DC
- . Accuracy: 0.5%
- Possibility to display the voltage waveform.
- Other measurements available on the T/3000 calculated from external inputs.

EXTERNAL INPUTS MEASUREMENTS:	
ACTIVE POWER	P
REACTIVE POWER	Q
APPARENT POWER	S
POWER FACTOR	p.f.
IMPEDANCE	Z and φ
ACTIVE IMPEDANCE COMP.	R
REACTIVE IMPEDANCE COMP.	X
FREQUENCY	f
PHASE ANGLE	IEXT to V AUX
PHASE ANGLE	VEXT to V AUX
RESISTANCE	R

Scope Function

T/3000 has an additional oscilloscope function that allows to display current and voltage waveforms.

Graphical display

The large graphical display has the following characteristics:

- Pixels: 240x128;
- backlight colour: white;
- LCD type: FSTN;
- View area: 135x80 mm.

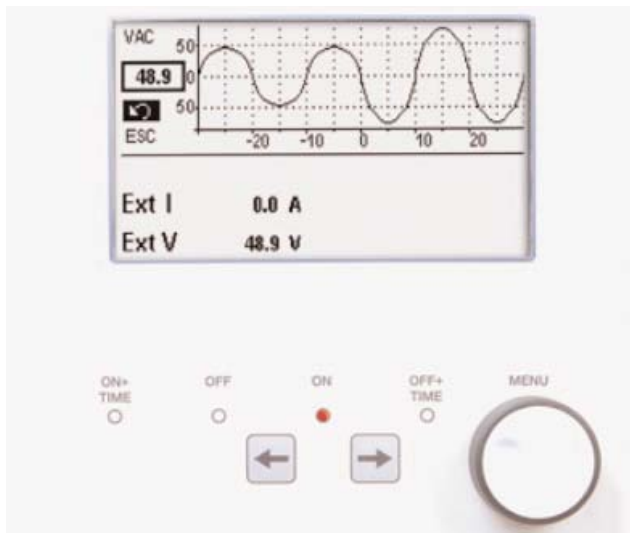
Local Memory

Test results can be stored in the T/3000 local memory (up to 500 results may be stored).

At the end of test, settings and test results can be transmitted to a PC provided with X.PRO-3000.

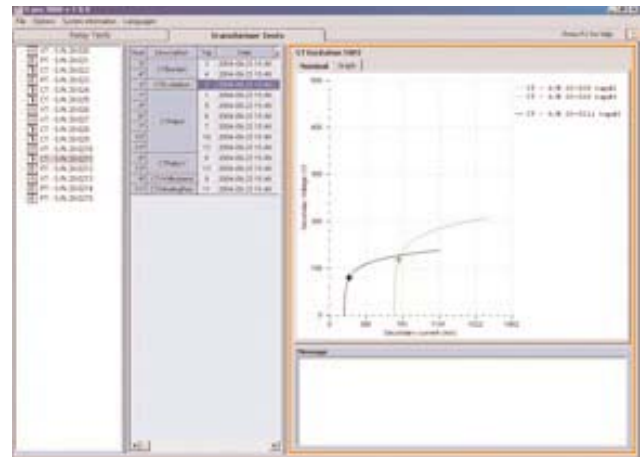
The software allows saving test results and examining them. X.PRO-3000 is also a powerful report editor that allows to prepare professional test reports.

Test settings can be stored and recalled from the memory. Up to 10 settings can be stored and recalled.



X.PRO-3000 Software

When the PC is connected, settings can be created and transferred into T/3000 using X.PRO-3000. X.PRO-3000 is a user friendly software that allows via a graphical interface, to control the set-up of T/3000 and to download test results. X.PRO-3000 is also a powerful report editor that allows to create professional Test Reports that can be exported in Access format.



Software X.PRO-3000

Other characteristics

- Interface: serial RS232; baud rate 57600 baud
- Mains supply: 230 V \pm 10%; 50-60 Hz, OR 115 V \pm 10%; 50-60 Hz; to be specified at order. (There are power reduction for mains voltage below 220V).
- Dimensions: 450 (W) x 320 (D) x 240 (H) mm.
- Weight: 29 kg.

ACCESSORIES

THE FOLLOWING ACCESSORIES ARE SUPPLIED WITH T/3000

Connection cable and test connectors

- N. 1 Mains supply cable, 2 m long.
- N. 1 Grounding cable, 4 m long, terminated on one side with a 4 mm banana plug, and on the other side with an earth connection clamp.
- N. 1 Interface cable for RS232 port.
- N. 2 High voltage connection cables, 4 m long, 5 kV, with earth screen. Terminated on both sides with HV connectors.
- N. 2 Clamps for the HV connection.
- N. 2 High current connection cables, 100 sq. mm, 4 m long. Terminated on one side with the high current connector, and on the other side with the high current clamp.
- N. 2 Low current connection cables, 10 sq. mm, 4 m long. Terminated on both sides with a 4 mm banana plug.
- N. 4 Clamps to connect low voltage or low current or measurements.
- N. 1 Cable for low voltage or low current connection, shielded, 4 m long. Terminated on one side with the measurement connector, and on the other side with two 4 mm banana plugs.
- Voltage outputs (4 cables: 2 red and 2 black);

- Measurement inputs (4 cables: 2 red and 2 black);
- Auxiliary output (2 cables: 1 red and 1 blue);
- Trip inputs (4 cables; blue).
- The instrument comes complete with the following items:
 - . User's manual;
 - . Spare fuses (no. 5), T16A;
 - . Software X.PRO-3000 with user manual.

Optional accessories

Thermal printer

The optional thermal printer, for the printout of the V-I curve in the CT saturation test and other test results. Thermal Paper 48 mm wide.

Transit case

Heavy duty aluminium transit case with wheels allows delivering T/3000 with no concern about transport shocks.

Current clamp

The current clamp allows to avoid the opening the secondary current circuit when performing the primary test of CT burden.

Earth resistance and soil resistività kit.

Complete kit including cables, drums and spikes.

Optional Modules

High IDC Module - 400A

The high DC current module allows the measurement of the low contact resistance of high voltage breakers or of joints. The option is connected to the high AC current output of T/3000; the current measurement is connected to the low DC current measurement input; the drop voltage is connected to the low voltage measurement input. DC current output is: 100 A steady; 200 A for 4 minutes; 400 A for 15 s. The selection of this function is performed via menu; the screen displays: test current; joint voltage; contact resistance. Resistance measurement ranges: μ Ohm 100.0, 1.000, 10.00, 100.0 mOhm; 1.000 Ohm, auto-ranging. The connection cables are included with the option.

Current booster - 2000A AC

The current booster module allows performing high current primary tests. The option is connected to the high AC current output of T/3000, and boosts the output current on two ranges: 1000 A or 2000 A. Output characteristics are the following.

RANGE A	OUTPUT A	POWER VA	TEST DURATION
1000	500	800	4 min
	1000	1400	15 s
2000	1000	800	4 min
	2000	1200	15 s

Current output is measured by connecting the option to the external high current measurement. The selection of this function is performed via menu; the screen displays the output current as kA. The connection cables are included with the option.

Safety Features and Protections

- Fuse on the mains supply.
- 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.
- Thermal NTC sensor on the main and auxiliary transformers. In case of over-temperature, an alarm message is displayed.
- Thermal sensors or the SCR that controls current injection, and of the internal temperature. In case of over-temperature, an alarm message is displayed.
- If maximum current limits and time duration of power transformer generators are reached, the generation is interrupted, and the operator is warned by an alarm message.
- The DC current source is protected against over-voltages. In addition, the output is automatically kept to zero as test stops, so that any residual energy on the external load is discharged.
- The auxiliary AC voltage is protected by an electronic circuit that stops the voltage generation and opens the connection to outputs socket in case of overload (short circuit included). In case of intervention, an

alarm message is displayed. Via the control knob the operator can reset the alarm and close the relay to restore operation. The auxiliary AC voltage is also protected by a thermo switch that intervenes in case of over-heating. In case of intervention, an alarm message is displayed.

- The DC voltage generator is protected by a current limiter. The user notices the low voltage and removes the overload. The fuse protects the case of counter-feed.
- Re-triggering fuse on the auxiliary contact.
- Timer inputs are protected against wrong selections. If the voltage free input is selected and a voltage is applied less than 250 V ac or 275 V DC, circuits will not be damaged.
- Trip inputs and the auxiliary relay contacts are protected by devices rated 380 V AC, which limit the maximum voltage between sockets and among sockets and ground.
- The 20 mA measurement input is protected by a fuse.

Applicable Standards

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

A) Electromagnetic Compatibility:

Directive no. 89/336/CEE dated may 3, 1989, modified by the directive 92/31/CEE dated may 5, 1992.

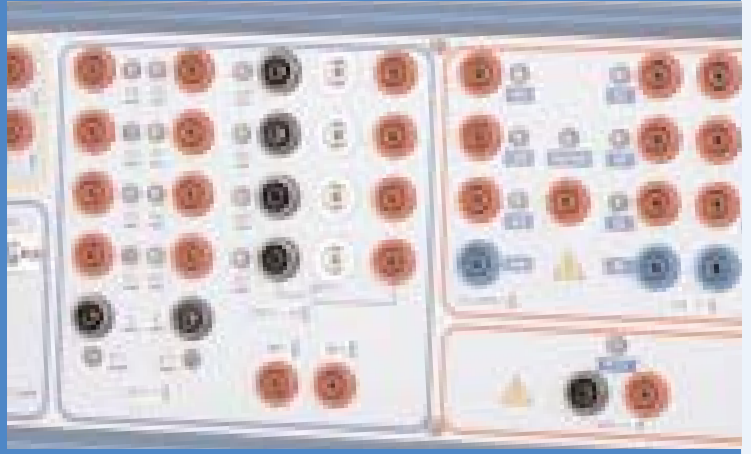
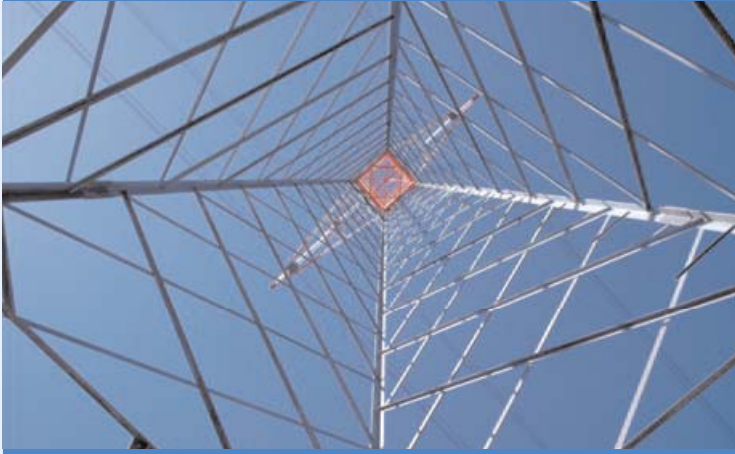
B) Low Voltage Directive:

Directive n. 73/23/CEE, modified by the directive 93/68/CEE.

Applicable standards, for a class I instrument, pollution degree 2, Installation category II:

- . CEI EN 61010-1. In particular:
 - . Inputs/outputs protection: IP 2X - CEI 70-1.
 - . Operating temperature: 0 to 50 °C; storage: -40 °C to 70 °C.
 - . Relative humidity: 10 - 80% without condensing.





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