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SINGLE PHASE RELAY AND MINIATURE CIRCUIT BREAKERS TEST SET

MOD. T1000 PLUS

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REVISIONS			SUMMARY	VISA
N	PAGE	DATE		
1	All	20/10/2008	Issued	Lodi.
2	32	11/06/2010	Added models TD1000 PLUS and TD1000 PLUS 15 Hz	Lodi
3	11-13; 34	09/11/2010	Extended the frequency range	Lodi
4	36	1/3/2011	Added the comparison table	Lodi
5	16	21/3/2011	Improved the Reclose test	Lodi
6	29, 30	19/5/2011	Corrected the cables list	Biotti
7	28; 35-36	29/11/2011	Removed the serial interface; added the Outputs transducer option	Lodi
8	5	20/07/2020	Minor comment at page 5	Puricelli

APPLICABLE STANDARDS

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

A) Electromagnetic Compatibility:
Directive no. 2004/108/EC. Applicable Standard : EN61326-1 + A1 + A2.

EMISSION

- EN 61000-3-2: Harmonic content of power supply. Acceptable limits: basic.
- EN 61000-3-3: Limitation of voltage fluctuations and flicker. Acceptable limits: basic.
- CISPR16 (EN 55011 class A): Limits and measurement methods of radio-electric disturbances for industrial, medical and scientific instruments at radio-electric frequencies.

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)
. 230-1000 MHz: 47 dB (30 m)

IMMUNITY

- EN 61000-4-2: Immunity tests for ESD. Test values: 8 kV in air; 4 kV in contact.
- EN 61000-4-3; Immunity tests for radio frequency interference. Test values (f= 900 ± 5 MHz): field 10 V/m, modulated AM 80%; 1 kHz
- EN 61000-4-4; Immunity tests for high speed transients (burst). Test values: 2 kV peak; 5/50 ns.
- EN 61000-4-5; Immunity tests for surge. Test values: 1 kV peak differential mode; 2 kV peak common mode; 1.2/50 us.
- EN 61000-4-6: immunity to low-voltage sinusoidal waveform. Test values: 0.15-80 MHz, 10 Vrms, 80% AM 1 kHz.
- EN 61000-4-8: Immunity tests for low frequency magnetic fields. Test values: 30 Arms/m.
- EN 61000-4-11: Immunity test for power supply drops. Test value: 1 cycle; 100% drop.

B) Low Voltage Directive:
- - Directive n. 2006/95/EC.
- Applicable standard: EN 61010-1. In particular, for a pollution degree 2: dielectric rigidity 1.4 kV AC, 1 minute.
- Inputs/outputs protection: IP 2X - EN60529.
- Operating temperature: 0 to 50 °C; storage: -20 °C to 70 °C.
- Relative humidity: 5 - 95%, without condensing.
- Vibration: IEC 68-2-6 (20 m/s^2 at 10 – 150 Hz);
- Shock: IEC 68-2-27 (15 g; 11 ms; half-sine).
- Altitude: less than 2000 m.

1 INTRODUCTION

The relay test set mod. T1000 PLUS can be used in all substations (from LV to EHV) and is suited for the testing and adjustments of Low Voltage Miniature Circuit Breakers and of the following types of relays:

- Distance protection (phase by phase) (21, *)
- Synchrocheck (25)
- Thermal (26)
- Undervoltage and overvoltage (27, 59)
- Directional power (32)
- Undercurrent (37)
- Negative sequence overcurrent (46)
- Phase sequence voltage relay (47)
- Incomplete sequence relay (48)
- Definite time overcurrent (50- 50N)
- Time dependent overcurrent (51 - 51N)
- Power factor (55)
- Directional overcurrent (67)
- Directional earth fault (67N)
- Automatic reclosing devices (79)
- Frequency (81<, 81>)
- Load shed (frequency ROC, 81R)
- Motor overload protection (86)
- Differential (87)
- Directional voltage (91)
- Tripping relays (94)

In addition to the above, T1000 PLUS can test:
. Converters: V; I; φ°; p.f.; W; VAr; f., both 0 to 5 and 4 to 20 mA.
. Energy meters, single phase or three phase.

T1000 PLUS is also suited to perform the following tests:

- Finding the CT saturation knee;
- Current and voltage transformer ratio test;
- Burden measurement of the protective relay test equipment;
- Impedance measurement;
- Polarity (direction) tests;
- Timed fault injection;
- Off delay - possibility to time delay the turning-off of generation after tripping.

In addition, T1000 Plus features:

- Reduced power operation, for the fine current regulation;
- Fine voltage regulation;
- Display the values of: current, AC voltage, DC voltage, time, and of derived measurements.
- Freeze function (HOLD) for voltage and current readings.
- The timer has separated inputs for start and stop impulses.
- The timer start and stop inputs respond to changes (EDGE).
- Start and stop input levels are displayed by LED's.

- The relay intervention is displayed by an LED.
- Test modes: ON, ON+TIME, OFF+TIME.
- The device is provided with USB and serial port for the communication to the computer (notebook).
- The TDMS Windows compatible software allows setting, testing and storing (also in a built-in Data Base) all data. Printing plus exporting report results in Words, Excel, PDF formats.
- TDMS is upgraded for free in the ISA WEB site.
- Main output adjustments: 0-250 A AC, 0-250 V AC (T1000E: 0-500 V AC), 0-300 V DC.
- Auxiliary AC voltage source, range 0-260 V AC (T1000E: 0-500 V AC), 0-359° phase shift, 15 to 550 Hz, separated from the other outputs with independent settings. Optional TD1000PLUS model: also an output of 0-20 A AC, phase and frequency adjustable.
- Auxiliary DC voltage source; range 20-240 V DC. Equipped with overload protection, and separated from the other outputs.
- Auxiliary AC and DC voltage sources can be turned ON and OFF via pushbuttons.
- Two auxiliary relay contacts, that can be independently timed with respect to test start and stop.

The instrument contains three separate generators:
. Main generator: it generates either AC current, AC voltage; DC voltage;
. Auxiliary AC voltage generator: it generates an independent, phase adjustable AC voltage;
. Auxiliary DC voltage generator: it generates the DC voltage that feeds the relay under test.

All outputs are adjustable and metered at the meantime on the large, graphic LCD display. With the multi-purpose knob and the LCD display it is possible to enter the MENU mode, which allows setting many functions, which make T1000 PLUS a very powerful testing device, with manual and semi-automatic testing capabilities, and with the possibility to transfer test results to a PC via the USB interface. These results can be recorded, displayed and analysed by the powerful TDMS software, which operates with all WINDOWS versions, starting from WINDOWS 98 included.

The basic T1000 PLUS function is to generate current and voltages and to stop generation as the relay trips. Test results are kept in memory, and can be transferred to a PC at a later time, along with settings.

The ease of operation has been the first goal of T1000 PLUS: this is why the LCD is graphic, and so large. With it, the dialogue in MENU mode is made easy. Besides, all T1000 PLUS outputs are continuously measured, and output values are displayed, with no extra effort to the operator. Also the show waveform feature can be of help: any doubt about strange measurements, distortion and so on can be solved.

This is also why we have added the reduced power feature. Modern relays have a very low burden. As current output is a low impedance voltage generator, adjusting low currents and/or current on low burdens is quite difficult because one has to operate at the very beginning of the adjustment knob. In this situation it is possible to connect resistors in series; however, one must be careful not to exceed the maximum current rating, and the wiring is more complicated. The solution to this problem is just to reduce the available power: this is easily performed via the multi-function knob. With less power, the maximum voltage is reduced by a factor of five; the adjustment span on the knob is increased accordingly.

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

The test set is shown here below.

NOTE: WINDOWS is a trademark of MICROSOFT Inc.

2 CHARACTERISTICS

2.1 MAIN GENERATOR

The main generator has three outputs: currents, voltage AC, voltage DC. The following specification applies to the separate usage of these outputs. It is possible to use them at the meantime, provided that the total maximum load is not exceeded.

The main generator is made of a variable transformer followed by a transformer. The variable transformer does not reach the zero position; so, when you are adjusting the output current on a low burden, the minimum current can be up to 5% of the range. If this is a problem, select the 60 VA power: the current is reduced to one fifth.

For all main output generators there is no specification related to the output distortion. This is because the output waveform follows the mains supply waveform, with its distortion. If it is desired to avoid distortions, the option FT100 solves the problem.

2.1.1 Main AC current

- Type of generator: voltage, high current output: the current depends upon the burden.
- On all outputs is provided the capability of generating the selected current at maximum power or at reduced power. Reduced power selection eases the current adjustment for modern relays, where the load is negligible. Current ranges; available power; duty cycle: see the table below.

1) MAXIMUM POWER 300 VA

RANGE A AC	CURRENT OUTPUT A	MAXIMUM POWER VA	LOAD TIME s	RECOVERY TIME min
100	30	300	STEADY	-
	50		30 min	100
	75		600	45
	100	800	60	15
	150		3	10
	250	1000	1	5
40	12	300	STEADY	-
	20		30 min	100
	30		600	45
	40	800	60	15
	60		3	10
	80	1000	1	5
10	5	400	STEADY	-
	7.5		15 min	45
	10	800	60	15
	15		5	10
	20	1000	2	5

2) MAXIMUM POWER 60 VA

RANGE A AC	CURRENT OUTPUT A	MAXIMUM POWER VA	LOAD TIME s	RECOVERY TIME min
100	30	60	STEADY	-
	38		10 min	45
	53		60	10
	70		0.75	2
40	12	60	STEADY	-
	17		10 min	45
	23		60	10
	36		1	2
10	5	60	STEADY	-
	6		10 min	45
	7		60	2
	10		1,5	2

- Power selection: via menu.
- Connection: four high power sockets, with safety protections, marked: 0; 10 A; 40 A; 100 A.

2.1.2 Main AC voltage

- The main AC voltage is isolated from the main AC current.

- AC voltage range: 250 V or 54 V (reduced power; power supply 230 V), or 108 V (reduced power; power supply 110 V).

- Available power and duty cycle: see table below.

RANGE V AC	VOLTAGE OUTPUT V	LOAD CONSUMPTION VA	LOAD TIME min	RECOVERY TIME min	REDUCED POWER
250	250	500	STEADY	-	NO
	250	750	10	45	NO
54 (108)	54 (108)	60	STEADY	-	YES

- Connection: two safety banana sockets.

2.1.3 Main DC voltage

- The main DC voltage is isolated from the main AC current, but not from the main AC voltage

- DC voltage range: 300 V or 60 V (reduced power; power supply 230 V), or 120 V (reduced power; power supply 110 V).

- Available power and duty cycle: see table below.

RANGE V DC	VOLTAGE OUTPUT V	LOAD CONSUMPTION W	LOAD TIME min	RECOVERY TIME min	REDUCED POWER
300	300	300	STEADY	-	NO
	300	500	10	45	NO
60 (120)	60 (120)	60	STEADY	-	YES

- Type of DC voltage: unregulated, via diode bridge rectifier and capacitor.

- Connection: two safety banana sockets.

2.1.4 Other features of main outputs

- Zero crossing control. Main AC outputs are generated and stopped as the output waveform crosses zero. This implies that in mode ON+TIME the output drops to zero from 0 to one cycle after STOP is detected.

- Overload alarm message. When the nominal current range is trespassed a message is displayed.

- Thermal protection: by NTC. Trespassing of the maximum temperature is signalled by a message.

- Output adjustment: from less than 5% to 100% of the output.

- Output measurement. The used output (current, V AC, V DC) is selected by a dedicated push-button; the selected socket is confirmed by a light.

2.2 AUXILIARY AC VOLTAGE

- The auxiliary AC voltage output, V AC aux, is isolated from the main AC current and voltage.
- Output ranges: 65 – 130 - 260 V. NOTE: at 15 Hz, the output ranges are: 25, 50, 100 V.

- Range selection: software driven, by the multi-function knob and LCD display.

- Auxiliary voltage power: 30 VA, continuous duty, at full range; 40 VA for 1 minute. At 15 Hz, the power is: 8.5 VA at 25 V; 13 VA at 50 V; 16 VA at 100 V. For lower voltages the limiting current is the following.

RANGE V	MAX CURRENT mA; > 40 Hz	MAX POWER VA; > 40 Hz	RANGE V; 15 Hz	MAX CURRENT mA; 15 Hz	MAX POWER VA; 15 Hz
65	500	30 (40)	25	350	8.5
130	250	30 (40)	50	260	13
260	125	30 (40)	100	160	16

- Output stability: the adjusted voltage drops of 5% maximum from zero load to full load.

- Output adjustment: continuous. For normal tests the voltage is continuously supplied, and the output voltage is adjusted by the dedicated knob.

- Output connection: safety banana sockets.

- ON-OFF switch to enable the output. A light confirms when the output is available.

- Possibility to phase shift the auxiliary AC voltage output with respect to: the main current and the main AC voltage. The phase angle reference is the auxiliary voltage. Phase shifter characteristics:
. Phase angle adjustment: via the multi-function knob.
. Phase angle range: from 0° to 360°.
. Adjustment resolution: 1° (degree).

- Possibility to define the pre-fault voltage: in this mode, the control knob allows to adjust the pre-fault value, while the dedicated knob adjusts the fault value. Voltage output selection is automatic: pre-fault voltage with test stopped; fault voltage with test started. The switch from a value to the other one is performed without falling to zero. The main current or voltage is generated at the zero crossing; the fault one is generated at the meantime of main voltage or current (figure 1). The selection of the reference is performed automatically, following the selection of main output measurement. If the main DC voltage is selected the reference is taken on the main AC voltage.
This feature allows testing voltage relays (27-59) or synchronizing relays (25).

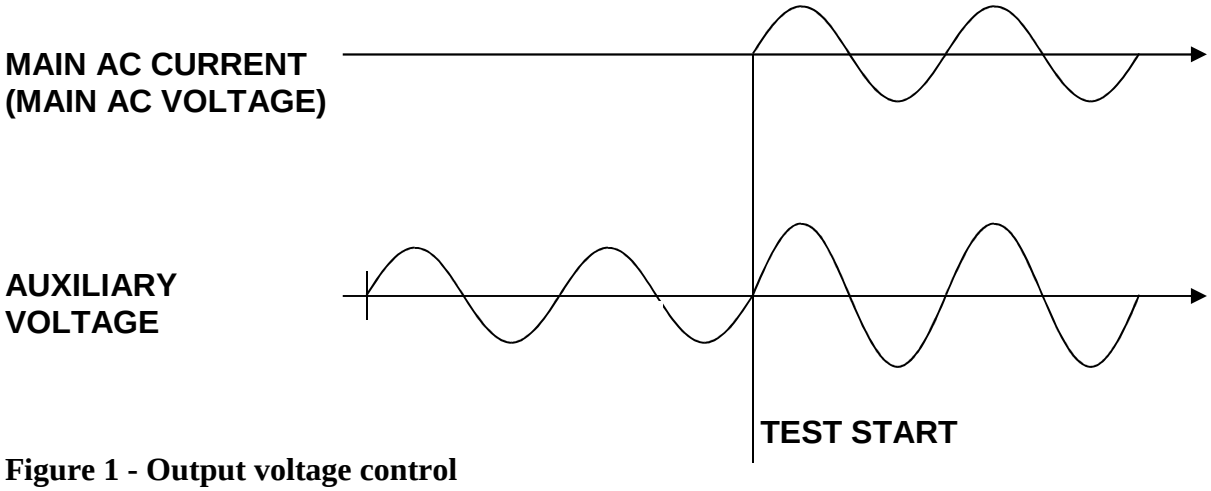


Figure 1 - Output voltage control

- Possibility to phase shift the pre-fault voltage, at an angle independent from the fault voltage. This parameter serves during the test of distance relays, when phase to phase faults are simulated: as test starts, the fault voltage changes amplitude and phase with respect to the pre-fault value (figure 2)

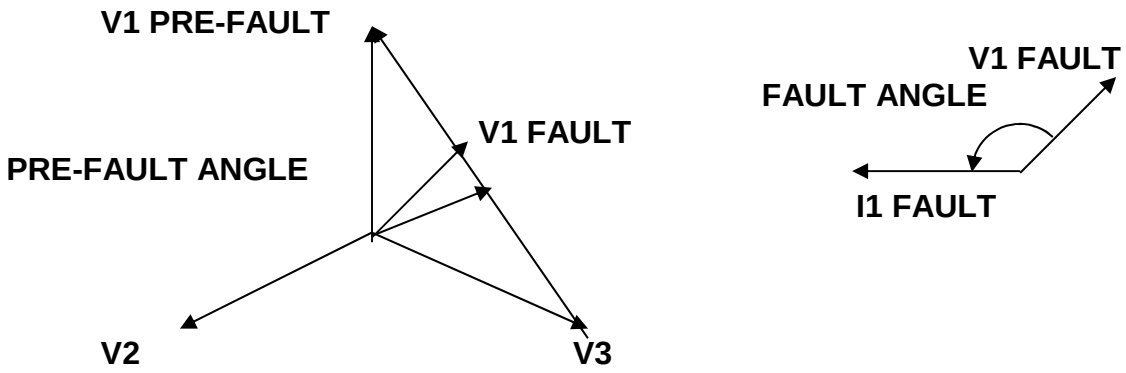
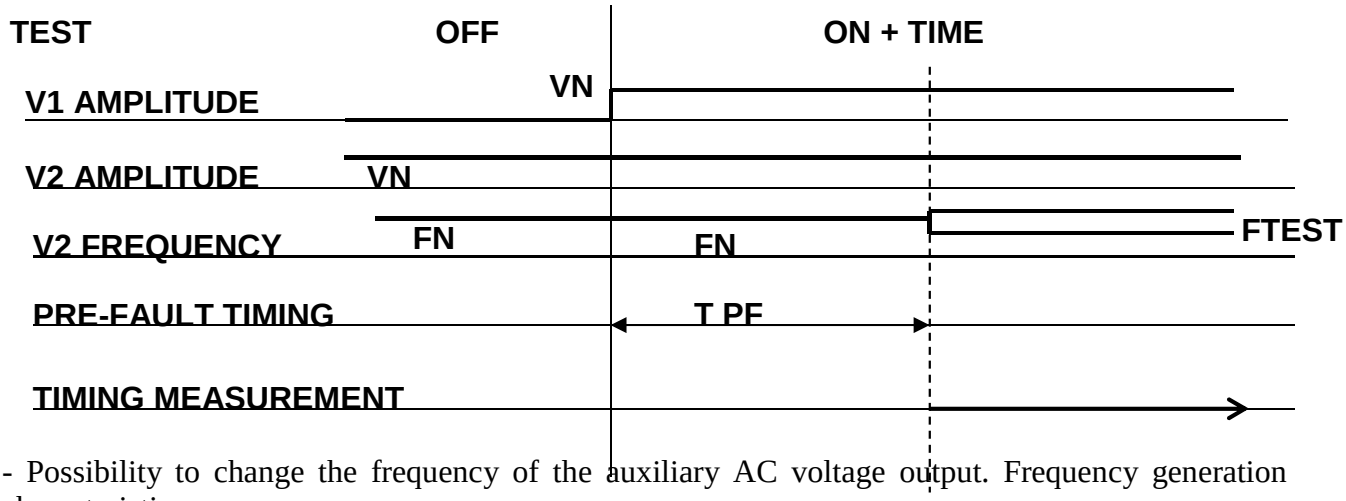


Figure 2 – Prefault voltage

- Possibility to define the duration TPF of pre-fault generation, after test start, prior to generating fault values. This feature is necessary to test synchronization relays: the main output voltage can be applied prior to frequency switching. TPF range: from 0 to 999.99 s.



- Possibility to change the frequency of the auxiliary AC voltage output. Frequency generation characteristics:
. Frequency range: 15.000 Hz to 550.000 Hz.
. Frequency adjustment: 1 mHz, via control knob.
. Frequency generation error: 100 ppM.
. It is possible to switch from the nominal frequency to the fault one. The nominal frequency is also selectable, independently from the fault.
. Switching from nominal frequency to fault frequency is performed without altering the output voltage (figure 3).

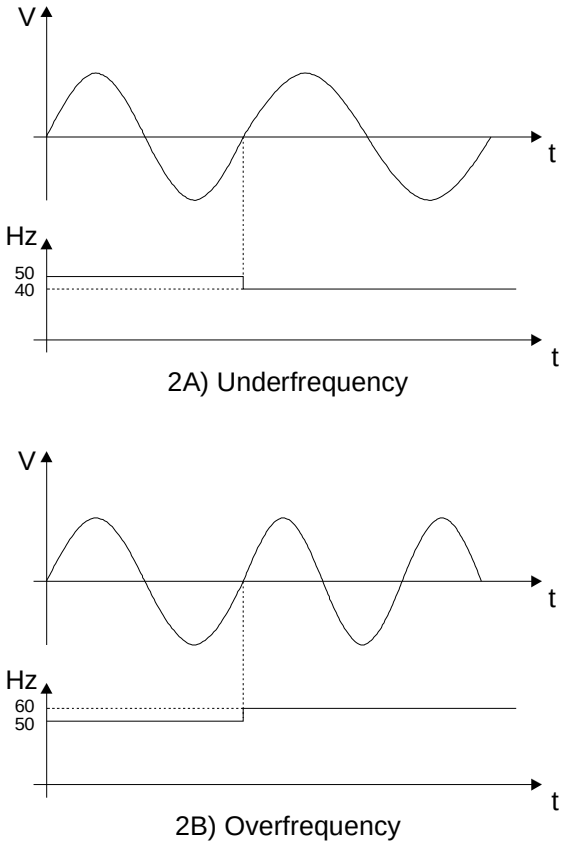


Figure 3 - Frequency relay test waveform

- Possibility to test frequency rate of change relays. Frequency ROC range: from 0.01 to 99.99 Hz/s. The frequency change stops at 40 or 70 Hz.

2.3 AUXILIARY DC VOLTAGE

- The auxiliary DC voltage output, V DC aux, is isolated from the main AC current and voltage and from the auxiliary AC voltage output.

- DC voltage ranges: 130 V or 240 V.

- Output adjustment: continuous, by knob, from 20 V to the selected range.

- ON-OFF switch to enable the output. A light confirms when the output is available.

- DC 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.

- DC output accuracy:
 . For mains supply variations: ± 1%;
 . For load changes: ± 1%;
 . Residual ripple: 1%.

- Output connection: on safety banana sockets.

2.4 TIMER

The electronic digital timer has a fully automatic start and stop, both for make and break of the input, which can be either a clean contact or a contact under voltage. All selections are menu-driven via the multi-function knob.

- Characteristics of Start and Stop inputs:
.. Inputs do not have any common point, and are opto-coupled from the instrument at 1.35 kV AC;
.. Inputs connection: two banana sockets per input;
.. Inputs may be independently selected as Normal Open or Normal Close;
.. It is also possible to select timer start or stop as the current is injected and timer start/stop on input transition;
.. Selections are displayed on the front panel by 10 dedicated lights;
.. Type of input: either clean or under voltage; selection via the multi-function knob. Maximum input: 250V AC or 275 V DC;
.. For both inputs, when the input is closed or with voltage an LED turns on;
.. When the relay intervenes, the TRIP light turns on;
.. Wrong selection protection. If a voltage is applied when the clean input is selected, input circuits are not damaged.

- Input thresholds: when the contact has voltage applied, two thresholds can be selected. The low setting applies to nominal voltages of 24 and 48 V; the high setting to 110 V up.

With voltage

Parameter	Nominal value	Unit
Low setting	12	V DC
High setting	80	V DC

Without voltage

Parameter	Nominal value	Unit
Nominal wetting voltage	24	V
Nominal wetting current	10	mA

- Available measurements:
. Timer start: at test start, or by an external contact;
. Metering of elapsed time between START and STOP.

- Time can be metered as seconds or cycles. Metering range, in seconds: see table.

Range	Resolution	Accuracy
From 0 to 9.999 s	1 ms	± (1 ms + 0.005%)
From 10.00 to 99.99 s	10 ms	± (10 ms + 0.005%)
From 100.0 to 999.9 s	100 ms	± (100 ms + 0.005%)
From 1000 to 9999 s	1 s	± (1 s + 0.005%)

. Metering range, in cycles, selectable at 50 Hz or at 60 Hz.

Range	Resolution	Accuracy
From 0 to 999.9	0.1 cycles	± (0.1 cycles + 0.005%)

(Equal to 19.998 s @ 50 Hz; 16.665 s @ 60 Hz)		
From 1000 to 499,998.5 cycles @ 50 Hz; From 1000 to 599,998 cycles @ 60 Hz (Equal to 9999 s)	1 cycle	± (1 cycle + 0.005%)

- Display reset: automatic, at test start.

- Counting mode: this mode is foreseen for the test of energy meters. Maximum input frequency: 10 kHz; voltage threshold can be set as for tripping. It is possible to select this mode via menu, and to set the number of impulses; the test set counts all impulses applied to START input after ON and during all generation, and measures the time elapsed during the count.

2.5 TEST CONTROL

- Manual start control:
. OFF: main outputs are not generated; V AC aux is generated, and it can be either the pre-fault value or the fault value, according to selections; V DC aux is generated.

. ON: main outputs are generated; Vac aux has the fault value. In this situation it is possible to verify and memorize the relay threshold, both trip and reset.

. From OFF to ON + time: main outputs are generated and the timer starts according to selections; as STOP is sensed, main outputs are removed and the elapsed time displayed and test result can be memorized.

. From ON to OFF + time: main outputs are removed the timer starts according to selections; as STOP is sensed, the elapsed time is displayed and test result can be memorized.

. Test control: by two push-buttons.

- Other test control selections:
. Momentary: in ON mode, main outputs are generated until the push-button is pressed;
. Timed: main outputs are generated for the programmed maximum time;
. External. This mode allows for the synchronization of more T1000 PLUS.

- Reclose test. It is possible to select via menu the test of a reclosing scheme. Two selections are available, according to the type of the recloser under test.
In the first operating mode, T1000 PLUS is connected as follows: Trip command to the STOP input; Close command to the START input. As Close is detected, the test set automatically applies current with the programmable reclaim time delay TD. The test set measures and stores the relay trip delay and the delay between trip leading or falling edge and CLOSE trailing edge (see figure 4).

The sequence is repeated the programmed N times; after this, a last fault is issued, and the test set verifies that there is no Close command.

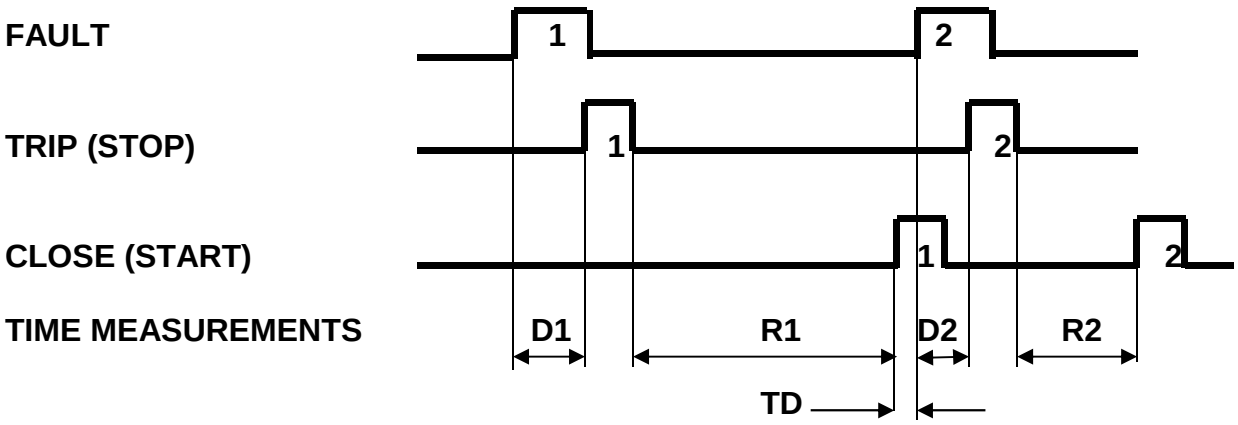
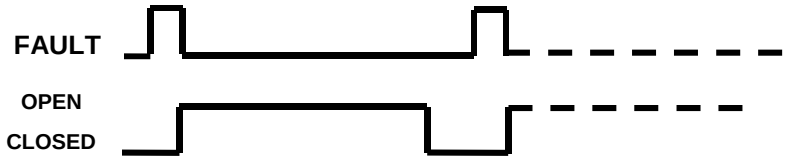


Figure 4: Measure of Delay and Close times

The second operating mode refers to pole mounted CB's. In this mode, there is only one signal coming from the device under test: the position of the CB. In this mode, the operation is the following.



In this test mode the test set is edge triggered; the CB position is connected to the STOP input, and, from the Closed – Open position, the test set derives the fault generation commands, to perform the test as above.

The following specification applies to both operating modes.
- Range of TD: from 0 to 999.9 s. Maximum number of Reclose commands: 49; maximum test duration for all Reclose commands: 9999 s.

- Circuit breaker delay simulation: possibility to set the delay from relay trip to generation off. Delay range: 0 to 999 ms or 0 to 999 cycles.

- Save selections:
. No automatic saving.
. Test data can be saved after confirmation. After relay trip, pressing the multi-function knob it is possible to save the test result.

2.6 AUXILIARY CONTACTS

- Two auxiliary make and break contacts.

- Each contact can be separately programmed to close (open) at test start, or after a programmable delay. Contacts switch off when the STOP input is sensed.

- Delay range with respect to test start: from 0 to 999.99 s.

- Maximum time error between current and make/break contact: 2 ms.
- Contacts range: 5 A; 250 V AC; 120 V DC

2.7 OUTPUTS MEASUREMENT

2.7.1 Current and voltage

- The following three outputs are displayed at the meantime on the LCD display:
. The selected main output: AC current, or AC voltage, or DC voltage;
. Auxiliary AC voltage output;
. Auxiliary DC voltage output.

- Type of measurement: true rms for AC outputs; average for DC outputs.

- Readings, resolution and accuracy: see table. Note that the available ranges can be greater than the maximum value of the socket to which the load is connected: this means that higher values can be measured without saturation. For example, on the 100 A output the measuring range is up to 999 A. Actually, the test set will not generate more than 250 A, as the test is stopped by the software, that indicates overload, and on the display currents more than 250 A will not be shown.

OUTPUT	**RANGE**	**RANGE CHANGE**	**RESOLUTION**	**ACCURACY**
10 A	1.999 A	1.5 A	1 mA	± (1% + 5 mA)
	19.99 A		10 mA	± (1% + 20 mA)
40 A	7.999 A	6 A	4 mA	± (1% + 20 mA)
	79.99 A		40 mA	± (1% + 80 mA)
100 A	19.99 A	15 A	10 mA	± (1% + 50 mA)
	199.9 A	150 A	100 mA	± (1% + 200 mA)
	249.9 A		100 mA	± (1% + 200 mA)
250 V AC	1.999 V	1.5 V	1 mV	± (1% + 50 mV)
	19.99 V	15 V	10 mV	± (1% + 50 mV)
	199.9 V	150 V	100 mV	± (1% + 200 mV)
	299.9 V		300 mV	± (1% + 300 mV)
300 V DC	1.999 V	1.5 V	1 mV	± (0.5% + 20 mV)
	19.99 V	15 V	10 mV	± (0.5% + 50 mV)
	199.9 V	150 V	100 mV	± (0.5% + 200 mV)
	299.9 V (599.9 V)		300 mV	± (0.5% + 300 mV)
65, 130 V AC	1.999 V	1.5 V	1 mV	± (1% + 10 mV)
	19.99 V	15 V	10 mV	± (1% + 20 mV)
	59.99 V	45 V	10 mV	± (1% + 50 mV)
	199.9 V		100 mV	± (1% + 200 mV)
260 V AC	1.999 V	1.5 V	1 mV	± (1% + 10 mV)
	19.99 V	15 V	10 mV	± (1% + 20 mV)
	199.9 V	150 V	100 mV	± (1% + 200 mV)
	299.9 V		300 mV	± (1% + 300 mV)

130 V DC	19.99 V	15 V	10 mV	± (0.5% + 100 mV)
	199.9 V		100 mV	± (0.5% + 200 mV)
240 V DC	19.99 V	15 V	10 mV	± (0.5% + 100 mV)
	199.9 V	150 V	100 mV	± (0.5% + 200 mV)
	299.9 V (599.9 V)		300 mV	± (0.5% + 300 mV)

NOTES:

- The range change is the value at which the range is changed. This value is less than full range in order to avoid saturation problems when we have to measure fast-changing values.

- Metering temperature coefficient: ± 0.05%/°C of the value ± 0.02%/°C of the range.

- Via menu selections, the metering can also be referred to the nominal current or voltage. In this situation the following applies.

OUTPUT	**NOMINAL VALUE RANGE**	**NOMINAL VALUE STEP**	**MEASUREMENT RANGE %**	**RESOLUTION %**	**ACCURACY %**
CURRENT	1 – 999 A	1 A	99.9	0.1	0.1
			999	1	1
VOLTAGE AC	1 – 999 V	1 V	99.9	0.1	0.1
			999.9	1	1

- Measurement options: see the MENU paragraph.

2.7.2 Phase angle

- The auxiliary voltage is the reference for the measurement of the phase shift of one of the following parameters:
. The main current;
. The main AC voltage;
. The mains supply.
- Readings, resolution and accuracy: see table.

MEASUREMENT	**RANGE**	**RESOLUTION**	**ACCURACY**
PHASE	0 - 360	1°	1° ± 1 DIGIT *

* Specified accuracy applies for outputs I,V or V,V greater than 20% of the selected range.

- Phase angle temperature coefficient: ± 1 ppM/°C of the value.

2.7.3 Other measurements

Starting from the above measurements, the test set can compute derived measurements; the selection is performed via the control knob.
The following is the list of available measurements. For all of them the following range and resolution applies; the accuracy is the sum of voltage, current and possibly angle accuracy.

PARAMETER RANGE; X IS THE MEASURED ENTITY	RESOLUTION
0 – 999 mX	0,001 X
1.00 – 9.99 X	0,01 X
10.0 – 99.9 X	0,1 X
100 – 999 X	1 X
1.00 – 9.99 kX	10 X
10.0 – 99.9 kX	100 X
100 – 999 kX	1000 X

N.	PARAMETER , AC outputs	DERIVED FROM	FORMULA	UNITS
1	ACTIVE POWER, P	Imain, Vac aux; φ	P= I*V*cos (φ)	W
	REACTIVE POWER, Q	Imain, Vac aux; φ	Q= I*V*sin(φ)	VAr
2	APPARENT POWER, S	Imain, Vac aux	S= I*V	VA
	POWER FACTOR, p.f.	φ	p.f. = cos(φ)	-
3	IMPEDANCE, Z and φ	Imain, Vac aux, φ	Z = V/I	Ohm, °
4	ACTIVE IMPED. COMPONENT, R	Imain, Vac aux; φ	R = Z* cos(φ)	Ohm
	REACTIVE IMPEDANCE COMP., X	Imain, Vac aux; φ	X = Z* sin(φ)	Ohm

2.8 EXTERNAL INPUTS MEASUREMENT

- It is possible to meter the current and the voltage of an external (or internal) generator.

- Input connection: by five safety sockets; three for current and two for voltage.

- Metering circuits are 1.35 kV isolated between them and from the rest of the instrument.

2.8.1 Current measurement

- Maximum input current. Two inputs: 20 mA or 10 A, AC or DC

- Range, resolution, accuracy: see table below.

RANGE 20 mA	RESOLUTION	ACCURACY
25 mA DC	0.1 mA	± (0.5% + 0.1 mA)

RANGE 10 A	CHANGE RANGE	RESOLUTION	ACCURACY
1.999 A AC	1.5 A	1 mA	± (1% + 2 mA)
10.49 A AC		10 mA	± (1% + 20 mA)
1.999 A DC	1.5 A	1 mA	± (0.5% + 2 mA)
10.49 A DC		10 mA	± (0.5% + 20 mA)

- Metering temperature coefficient: ± 0.05%/°C of the value ± 0.02%/°C of the range.

- Possibility to display the current waveform.

2.8.2 Voltage measurement

- Maximum input voltage: 600 V, AC or DC

- Range, resolution and accuracy: see table below.

RANGE	RANGE CHANGE	RESOLUTION	ACCURACY
19.99 V AC	15 V	10 mV	± (1% + 20 mV)
59.99 V AC	45 V	10 mV	± (1% + 60 mV)
199.9 V AC	150 V	100 mV	± (1% + 200 mV)
599.9 V AC		100 mV	± (1% + 600 mV)
19.99 V DC	15 V	10 mV	± (0.5% + 20 mV)
59.99 V DC	45 V	10 mV	± (0.5% + 60 mV)
199.9 V DC	150 V	100 mV	± (0.5% + 200 mV)
599.9 V DC		100 mV	± (0.5% + 600 mV)

- Metering temperature coefficient: ± 0.05%/°C of the value ± 0.02%/°C of the range.

- Possibility to say that the voltage input is a drop across a specified shunt. Shunt range: 1 to 1000 mOhm. In this situation the metering is converted into current, according to the formula:
I = V/Rshunt
The accuracy is the same as above.

- Possibility to display the voltage waveform.

2.8.3 Other measurements

As per main outputs, it is possible to compute measurements on external inputs. In this instance, measurements available depend upon the AC or DC selection for both inputs (no measurement for mixed selections).

N.	PARAMETER , AC INPUTS	DERIVED FROM	FORMULA	UNITS
1	ACTIVE POWER, P	Iext, Vext; φ	P= I*V*cos (φ)	W
	REACTIVE POWER, Q	Iext, Vext; φ	Q= I*V*sin(φ)	VAr
2	APPARENT POWER, S	Iext, Vext	S= I*V	VA
	POWER FACTOR, p.f.	φ	p.f. = cos(φ)	-
3	IMPEDANCE, Z and φ	Iext, Vext, φ	Z = V/I	Ohm, °
4	ACTIVE IMPEDANCE COMP., R	Iext, Vext; φ	R = Z* cos(φ)	Ohm
	REACTIVE IMPEDANCE COMP., X	Iext, Vext; φ	X = Z* sin(φ)	Ohm
5	FREQUENCY, F	Vext	-	Hz
6	PHASE ANGLE, IE TO V2	Φ, IE-V2; ref. V2	-	°
	PHASE ANGLE, VE TO V2	Φ, VE-V2; ref. V2	-	°

The angle measurement range is from 0° to 360.00°. The accuracy is ± 1° ± 1 digit. This accuracy applies to inputs greater than 10% of the input range, and for frequencies of 50 ± 0.5 Hz, and 60 ± 0.6 Hz. Temperature coefficient: ± 1 ppM/°C of the value.

The frequency measurement range is from 15.000 Hz to 550.00 Hz. The accuracy is ± 1 mHz ± 1 digit. This accuracy applies to inputs greater than 10% of the input range, and for frequencies of 50 ± 0.5 Hz, and 60 ± 0.6 Hz. Temperature coefficient: ± 1 ppM/°C of the value.

For other parameters, the accuracy is the sum of voltage, current and angle accuracies, as applicable.

PARAMETER , DC INPUTS	**DERIVED FROM**	**FORMULA**	**UNITS**
POWER, W	Iext, Vext	P= I*V	W
RESISTANCE, R	Iext, Vext	R = V/I	Ohm

2.9 DISPLAY

The graphical display has the following main features:

- pixels: 240x64
- backlight color: white
- LCD type: FSTN
- View area: 135x40

During the standard operation the display shows the measurements of: main AC current (or main AC voltage or main DC voltage, according to selection); auxiliary AC voltage; auxiliary DC voltage; elapsed time. To the left is the area for the access to the menu selection.

2.10 MENU SELECTIONS

The following is the list of features that are menu selected. The menu is operated by means of the control knob marked MENU that incorporates a switch. The menu is entered pressing the knob and selecting the item moving the knob. Once the item has been found and programmed, pressing the arrow the menu moves back of one step, so that other programming can be performed; else, selecting ESC the menu returns to the main window.

During this operation the display shows output measurements, in reduced format. After confirmation, menu messages disappear, and measurements are displayed in the standard format.

Any setting can be saved to and recalled from the memory. Up to 10 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 that cannot be modified.

During the test, test results can be stored in the 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 TDMS. The software allows saving test results, examining them and so on. The specification of TDMS is given in a separate document. When the PC is connected, settings can also be created and transferred into T1000 PLUS using TDMS. The flux diagram of menu selections can be found in Appendix 1.

LEVEL1	LEVEL 2	LEVEL 3	LEV. 4	FUNCTION
TEST CONTROL	**Test mode**	Normal (default)		Measures the time delay from START (internal, external) to STOP (internal, external).
		Trip + pulse time		Measures the time delay from START (internal, external) to STOP (internal, external), and the duration of STOP.
		Reclose mode	TD; No. reclose	Two delays are measured: fault to STOP; STOP to START (reclose command). At START, a new fault is generated after TD (0-999.99 s), until the number of reclose (max 49) is reached.
	Fault injection	Maintained (default)		Generation lasts indefinitely
		Momentary		Generation lasts until the ON button is pressed
		External		Generation starts upon reception of the START input: this allows synchronising T1000 PLUS.
		Timed	Max time	Generation lasts for the pre-set time duration. Max time 999 s.
		OFF delay	T delay	The main output OFF is delayed by the set amount of time or cycles.
	Output power	300 VA (default) – 60 VA		Selection of full (300 VA) or reduced (60 VA) power
	Save	Don’t save (default)		Test data are not saved
		Automatic, at trip		As relay trips data are saved to the next memory location
		Confirm, at trip		As relay trips data can be saved, after confirmation
		Manual		When selected, generated values are saved.
	Auxiliary contacts 1, 2	Timing		Sets the contact timings with respect to test start

LEVEL 1	**LEVEL 2**	**LEVEL 3**	**LEVEL 4**	**FUNCTION**
TIMER START/ STOP	**Start**	INT (default)		Timer starts when ON or ON+TIME are activated and outputs generated.
		EXT	NO-NC-EDGE	After ON or ON+TIME, timer starts on the external input. External START input Normally Open, or Normally Closed, or Both (EDGE).
			CLEAN-24 V – 80 V	After ON or ON+TIME, timer starts on the external input. External START input without or with voltage. If with voltage, two voltage thresholds are available: 24 or 80 V.
			COUNT	Timer enters the counting mode; it is possible to program the number of transitions prior to time measurement. After ON or ON+TIME, the test set waits for these transitions before measuring the time.
	Stop	INT		Timer stops when the current of the main generator is interrupted.
		EXT (def.t)	NO-NC-EDGE (def.t)	Timer stops when the STOP input is detected. External STOP input Normally Open or Normally Closed or Both (EDGE).
			CLEAN-24 V – 80 V	Timer stops when the STOP input is detected. External STOP input without or with voltage. If with voltage, two voltage thresholds are available: 24 or 80 V.
			COUNT	Timer enters the counting mode; it is possible to program the number N of transitions to be detected. After ON or ON+TIME, the time from the first valid input to input N+1 is measured; the corresponding energy can be read on the display.
	Timer	s (default)		Time duration metered in seconds
		cycles		Time duration metered in cycles

LEV. 1	LEV. 2	LEV. 3	LEVEL 4	LEVEL 5	FUNCTION
AUX VAC/ VDC	**Aux Vac con-trol**	Range			65 (default) ; 130 ; 260 V.
		Mode	Fault (default)		The auxiliary AC voltage is adjusted by the dedicated knob, and is always present, independently by test start. If the auxiliary voltage should be applied along with the main current or voltage, go to next selection.
			Prefault + Fault	Prefault Amplitude	Sets the pre-fault auxiliary AC voltage amplitude. Entering this selection in OFF mode the pre-fault voltage is immediately generated: pre-fault voltage is generated and displayed, and adjusted **by the multi-function knob**. The fault voltage is generated pressing ON or ON+TIME, and it is adjusted by the knob.
				Prefault Phase (0..359°)	Sets the pre-fault auxiliary voltage phases with respect **to the fault voltage**; the angle is adjusted by the multi-function knob. The pre-set value is not metered.
				Prefault duration	Sets the duration of the pre-fault auxiliary voltage. When ON or ON+TIME are pressed, the pre-fault will be generated at the mains frequency; then the fault voltage is generated, at the programmed frequency.
				Prefault frequency	The prefault frequency of the auxiliary voltage may be programmed. The frequency is applied with outputs OFF.
		Frequency	Locked to mains (default)		If “Locked”, the auxiliary voltage is at the mains frequency.
			Adjust freq	40-500.000	The frequency of the auxiliary voltage may be programmed. Frequency changes at test start; output voltage does not change in amplitude.
			Adjust r.o.c.:	± 0.01.. 9.99 Hz/s	The frequency ramps at the programmed rate of Change. The starting frequency can be the mains or the value set by adjust freq.
		Phase	Locked to mains (default)		With this selection Vaux is in phase with the mains.
			Adjust phase Vaux - mains		The fault auxiliary voltage can be phase shifted with respect to the mains. The measured angle is displayed. Test must be ON; for a correct angle measurement, the auxiliary voltage must be more than 20% of the range. Phase is adjusted by the multifunction knob.
			Adjust phase Vaux – I main		The fault auxiliary voltage can be phase shifted with respect to the main current. The measured angle is displayed. Test must be ON; for a correct angle measurement, current and voltage must be more than 20% of the range. Phase is adjusted by the multifunction knob.
			Adjust phase Vaux – V main		The fault auxiliary voltage can be phase shifted with respect to the main voltage. The measured angle is displayed. Test must be ON; for a correct angle measurement, both voltages must be more than 20% of the range. Phase is adjusted by the multifunction knob.
	Aux V DC control	Range			130 V (default) or 240 V. If this selection has to be changed, it’s necessary to adjust the voltage output to the minimum by the dedicated knob.

LEVEL 1	LEV. 2	LEVEL 3	LEVEL 4	FUNCTION

METERS	**Internal**	Units of I	Normal		If selected, current values are displayed in A.
			I/IN	IN	If selected, displayed values are defined as I/IN, that can be defined.
		Units of V	Normal		If selected, voltage values are displayed in V.
			V/VN	VN	If selected, displayed values are defined as V/VN (phase voltage), that can be defined.
	External I	Enabled	AC (default) - DC		With selection AC the meter performs the true rms measurement; with selection DC, the measurement is performed on the average.
			10A – 20 mA		Selects the current input socket
			Waveform		If selected, the current waveform is displayed
	External V	Enabled	AC (default) - DC		With selection AC the meter performs the true rms measurement; with selection DC, the measurement is performed on the average.
			Shunt : 1 – 1000 mOhm		If the voltage is coming from a current dropping on a shunt, specifying the shunt value the current is displayed; default 100 mOhm.
			Waveform		If selected, the voltage waveform is displayed

LEVEL1	LEVEL 2	LEVEL 3	FUNCTION
METERS (continued)	**Other internal**	None (default)	No extra measurement displayed
		Active power	P; W
		Reactive power	Q; VAr
		Impedance module	Z, Ohm
		Impedance argument	φ, °
		Active impedance component	R, Ohm
		Reactive impedance component	X, Ohm
		Apparent power	S; VA
		Power factor	p.f. = cos(φ V-I)
		Active energy (AC)	Ea; Wh
		Reactive energy (AC)	Er; VArh
	Other external	None (default)	No extra measurement displayed
		Active power	P; W
		Reactive power (AC)	Q; VAr
		Impedance module	Z, Ohm
		Impedance argument	φ, °
		Active impedance component	R, Ohm
		Reactive impedance component (AC)	X, Ohm
		Phase, I (AC)	φ, Iext - Vaux
		Phase, V (AC)	φ, Vext - Vaux
		Apparent power (AC)	S; VA
		Power factor	p.f. = cos(φ V-I)
		Frequency of V (AC)	f, Hz
		Active energy (AC)	Ea; Wh
		Reactive energy (AC)	Er; VArh

LEVEL1	LEVEL 2	LEVEL 3	LEVEL 4	FUNCTION
RESULTS	**Delete**			Selected result(s)
				All results
CONFIGU-RATION	**Settings**	Save to address	1..10	Saves current settings to X
		Restore address	1..10	Restores settings from X
		Restore default		Restores default settings
	Language	UK, FR, SP, PT, GE, IT		Select the desired language
	Display	Speed	Slow	The displayed value is refreshed every 1000 ms
			Fast	The displayed value is refreshed every 300 ms
		Hold mode	Hold trip	As relay trips, test data measured 4 periods before trip are held.
			Hold min	As relay trips, the minimum value within 0.5 s is held.
			Hold max	As relay trips, the maximum value within 0.5 s is held.
	LCD Contrast			It allows to adjust the LCD contrast

Note: measurements marked AC apply only if both inputs are selected as alternate current.

2.11 OTHER CHARACTERISTICS

- Set of resistors, for the test of low impedance relays. Available values:

RESISTOR Ohm	POWER W	MAX CURRENT A
0.5	50	10
1	50	7
22	50	2.15
470	50	0.33
1000	50	0.22
2200	50	0.15

- Type of interface: USB. Transmission rate: 3x minimum.

- Mains supply: 230 V ± 15%; 50-60 Hz.

- Maximum supply current: 5 A.

- The instrument comes complete with the following items:
. Mains cable;
. User's manual;
. USB cable;
. Spare fuses (no. 5), T5A ;
. Set of connection cables:
N°2 cables, 10 sq. mm cross section, 2m long, one red ad one black.
N°4 red cables, 2.5mmq, 2m long, terminated on both sides with safety 4 mm banana plug.
N°4 black cables, 2.5mmq, 2m long, terminated on both sides with safety 4 mm banana plug.

. Ground connection cable: 2 m, yellow/green, terminated with crocodile clamp.

- Dimensions: 380 (W) * 300 (D) * 240 (H) mm.

- Weight: 19 kg.

2.12 OPTIONS

2.12.1 Power supply, code PII81093

This option is to be specified at order.

- Mains supply: 115 V ± 15%; 50-60 Hz.

- Maximum supply current: 16 A.

With this power supply voltage, maximum output power is limited to 1600 VA. As a consequence, the current outputs table becomes the following. Other performances are unaffected.

RANGE A AC	CURRENT OUTPUT A	MAXIMUM POWER VA	LOAD TIME s	RECOVERY TIME min
100	30	300	STEADY	-
	50		30 min	100
	75		600	45
	100	800	60	15
	160	1000	3	10
	-	-	-	
40	12	300	STEADY	-
	20		30 min	100
	30		600	45
	40	800	60	15
	60	1200	3	10
	-	-	-	-
10	5	400	STEADY	-
	7.5		15 min	45
	10	800	60	15
	15		5	10
	20	1000	2	5

2.12.2 Connection cable kit, code ZII18093

This option includes the following cables:
. N. 14 cables, 2 m long, Cross section 2.5 sq. mm, terminated with safety banana plugs: 4 black; 5 red; 5 blue.
. N. 10 Adaptors with banana socket and terminators for screw terminals;
. N. 2 cables, 0.4 m long, cross section 1.5 sq. mm, terminated with safety banana plugs.
These cables, together with the standard ones, allow for the connection to the relay under test to all test set sockets.

2.12.3 Transit case, code PII17093

The transit case allows delivering T1000 PLUS with no concern about shocks up to a fall of 1 m.

2.12.4 "E" model: higher AC voltage outputs, code PII92093

In this model, AC voltage outputs are higher than in the standard version.

- Main AC voltage output. Available power and duty cycle: see table below.

RANGE V AC	VOLTAGE OUTPUT V	LOAD CONSUMPTION VA	LOAD TIME min	RECOVERY TIME min
500	500	100	STEADY	-
	500	150	10	45
108	108	20	STEADY	-

- Auxiliary AC voltage. Power: 30 VA, continuous duty, at full range; 40 VA for 1 minute. For lower voltages the limiting current is the following.

RANGE V	MAX CURRENT mA
65	500
130	250
500	62

All other performances are the same. To be specified at order.

2.12.5 D1000 differential relay test module, code PII40093

The differential relay test module D1000 allows for the test of the differential relay curve, and also of the harmonic restraint characteristic. The module performances are the followings.

- Input: from the test set auxiliary AC voltage output, at 250 V.

- Output: 0 to 5 A AC.

- Output power: 5 VA, that corresponds to a maximum load of 0.2 Ohm.

- Connection: the output current is connected in parallel to one relay branch, in order to make the differential current.

- Output current measurement: connected to the test set external measurement.

- Dimension: 325 x 290 x 290 mm

- Weight: 7 kg.

2.12.6 TD1000 PLUS model: auxiliary AC current output, code PII94093

In this model, the auxiliary voltage output has an additional selection that allows using it as a current source. With this feature, on a differential relay it is possible to test the characteristic curve, and not only the pick-up current. In addition, the frequency of this current can be changed as with voltages: this allows testing the second harmonic restricts characteristic of the differential relay. Last, the steady

voltage output power is increased from 30 VA to 50 VA. When the current range is selected, the output measurement is A, and not V. NOTE: as with the main current source, this is a low voltage, high current generator: the current is a function of the load, and is to be adjusted after the relay is connected. The following is the detail of the modified parameters.

- Auxiliary AC voltage. Power: 50 VA, continuous duty, at full range; 60 VA for 1 minute. For lower voltages the limiting current is the following.

RANGE V	**MAX CURRENT @ > 40 Hz, A**	**MAX POWER VA**		**RANGE @ 15 Hz, V**	**MAX CURRENT @ 15 Hz, A**	**MAX POWER @ 15 Hz, VA**
3	20	50 (60)		2	20 @ 1 V; 10 @ 1.4 V	20 @ 20 A; 14 @ 10 A
65	0,75	50 (60)		35	0,2	7
130	0,38	50 (60)		70	0,2	14
260	0,19	50 (60)		140	0,2	28

All other performances are the same. To be specified at order.
For the 110 V supply, the ordering code is PII96093.

2.12.7 TD1000 PLUS 15Hz model: higher power at low frequency, code PII93093

In this model, the auxiliary voltage output has an additional selection that allows using it as a current source. With this feature, on a differential relay it is possible to test the characteristic curve, and not only the pick-up current. In addition, the frequency of this current can be changed as with voltages: this allows testing the second harmonic restricts characteristic of the differential relay. Last, the steady voltage output power is increased from 30 VA to 40 VA.

The other feature is that both the new current source and the voltage source can be generated at the frequency of 15 Hz, at higher power than T1000PLUS and TD1000PLUS: this allows testing high burden railway and generator protection relays. This model is 3.8 kg heavier than the standard one, and DOES NOT have the DC voltage generator.

When the low voltage range is selected, the output measurement is A, and not V. NOTE: as with the main current source, this is a low voltage, high current generator: the current is a function of the load, and is to be adjusted after the relay is connected. The following is the detail of the modified parameters.

- Auxiliary AC voltage and current.

RANGE V	**MAX CURRENT @ > 40 Hz, A**	**MAX POWER, @ > 40 Hz, VA**	**RANGE V**	**MAX CURRENT @ 15 Hz, A**	**MAX POWER @ 15 Hz, VA**
3	20	40	3	20	25
65	0,6	40	65	0,38	25
130	0,3	40	130	0,19	25
260	0,15	40	260	0,1	25

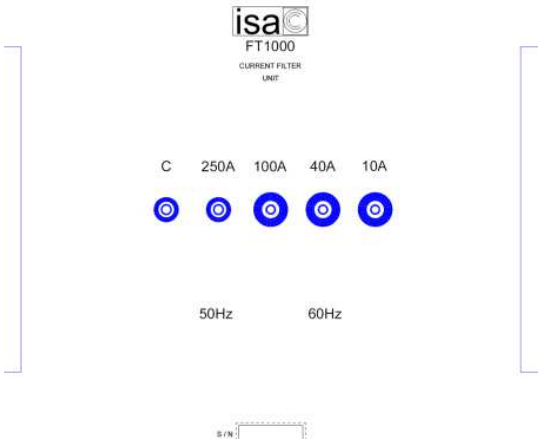
- Frequency range: from 15.5 Hz to 550 Hz.
- No Auxiliary DC voltage supply.
- Weight: 22.8 kg.

All other performances are the same. To be specified at order.
For the 110 V supply, the ordering code is PII95093.

2.12.8 FT/1000 current filter, code PII16093

The filter unit type FT/1000 is an option to be used with the T/1000 or T/X000 relay test sets. It is connected in series to the relay under test, and guarantees a sinusoidal waveform also when testing current relays with reverse time characteristics, or with heavily saturating burdens, that tend to distort the current waveform.
- Current input ranges: 10 - 40 - 100 - 250 A, on terminal bushings.
- Maximum power yield: 800 VA.
- Filter burden: less than 200 VA at 200 A. The burden is proportional to the range (50 VA at 50 A).
- Service: 50 A continuous service; 200 A for 30 s.
- Selection of the mains frequency: 50 or 60 Hz, by switch.
- Overall dimensions: 220 x 250 x 310 mm.
- Weight: 15 kg.

The following is the FT1000 front panel.



2.12.9 SH-2003 scanning head for T1000 PLUS and T3000, code PII43102

SHA-1000 is a scanning head that eases the test of energy meters. It is a universal scanning head because it can be used both with LED impulse electronic meters and Ferraris rotating disk meters; selection is performed via a switch located on the scanning head. In addition to this, a knob allows to adjust the sensitivity of the head.

With rotating disk the sensor uses a green light beam that optimizes the recognition of any type of mark.

With LED recognition the following specification applies:
. Impulse duration: more than 60 us;
. With an LED signal having a space ratio 1:2, the frequency must be less than 500 Hz.;
. Light wavelength: 500 to 960 nm (red: green and blue ARE NOT detected).

The option includes:
- The support that allows keeping the scanning head in front of the energy meter: maximum height 175 mm;
- The cable, 2 m long, from the scanning head to T1000 PLUS or T3000;

- The power supply transformer, for the power of 220 V AC, to supply the scanning head.
- Two safety banana plugs for the connection to T1000 PLUS or T3000.

Specifications:
- Supply voltage: 11 to 30 V DC;
- Maximum current consumption: 30 mA, with disk mark scanning; 5 mA with LED scanning;
- Output impedance: 470 Ohm;
- Output voltage: from 9.5 to 28.5 V;
- Connection: GND left connection; impulse central connection; DC supply left connection;
- Housing: hard plastic;
- Weight: 30 g;
- Dimensions: 54 (w) x 40 (h) x 35 (d).

2.12.10 Outputs transducer and connection cables for low level signal relays

The Outputs transducer is an option that allows converting the high current and voltage outputs into low voltage signals. The option is made of three components:

- The Outputs transducer, complete with the interface connector, code PII13093;
- The connection cable from the transducer to a two BNC connectors and one RJ-45 connector, for the ABB relays REF542PLUS, and REF601, code PII11093;
- The connection cable from the transducer to one RJ-45 connector, for the THYSENSOR series of THYTRONIC relays, code PII12093.

The items can be ordered separately: the Output transducer alone, or also one cable or both.

The characteristics of the Output transducer are the following.

- Input 1: Current. Maximum current input 8 A. Corresponding output: 250 mV/A.
- Input 2: Voltage. Maximum voltage input 120 V DC, or 85 V AC. Corresponding output: 20 mV/V.
- Transducer accuracy: 2% of the output.
- Inputs connection: by four safety banana sockets;
- Outputs connection: by a 12-poles connector. The mating connector and pins are included.
- Dimensions: 57 mm (H) x 103 mm (W) x 177 mm (D).
- Weight: 0.5 kg.

Pictures show the Outputs transducer front and rear views.

Connection cables characteristics:

- 2 m long;
- Connections, ABB: round connector to the Outputs transducer; two BNC connectors for V and I; one RJ-45 connector for the supply.

- Connections, THYSENSOR: round connector to the Outputs transducer; one RJ-45 connector for V and I outputs.

3 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.

- Thermal sensor on the main and auxiliary transformers. In case of over-temperature, an alarm message is displayed.

- Thermal sensors on the SCR that controls current injection, and of the internal temperature. In case of over-temperature, an alarm message is displayed.

- If the following current limits and time duration of main current outputs are trespassed, the generation is interrupted, and the operator is warned by an alarm message.

OUTPUT	**10 A**	**40 A**	**100 A**	**250 V AC**	**300 V DC**	**Tmax**
I (A)	5	12	30	2	1	infinite
I (A)	10	40	100	3	2	60 s
I (A)	25	100	250	4	3	1 s

- If the current of 3.5 A is exceeded on main AC or DC voltage outputs, the generation is interrupted, and the operator is warned by an alarm message.

- 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 auxiliary DC voltage is protected by a current limiter. The user notices the low voltage and removes the overload. The fuse protects the case of counter-feed.

- Self-restoring fuses on the auxiliary contacts.

- 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 that limit the maximum voltage between sockets and among sockets and ground. The same protection is applied to the auxiliary AC and DC voltage sources.

- The 20 mA measurement input is protected by a PTC against wrong connections: in case of error the PTC goes to high impedance. The PTC self-restores to the normal value in some minutes.

APPENDIX 1: AUXILIARY AC OUTPUT FEATURES COMPARISON

The following tables summarize the auxiliary AC output features of the different test models.

RANGE V	**MAX CURRENT @ > 40 Hz, A**	**MAX POWER @ > 40 Hz, VA**	**RANGE @ 15 Hz, V**	**MAX CURRENT @ 15 Hz, A**	**MAX POWER @ 15 Hz, VA**
65	0.5	30 (40)	25	0.35	8.5
130	0.25	30 (40)	50	0.25	13
260	0.125	30 (40)	100	0.125	16

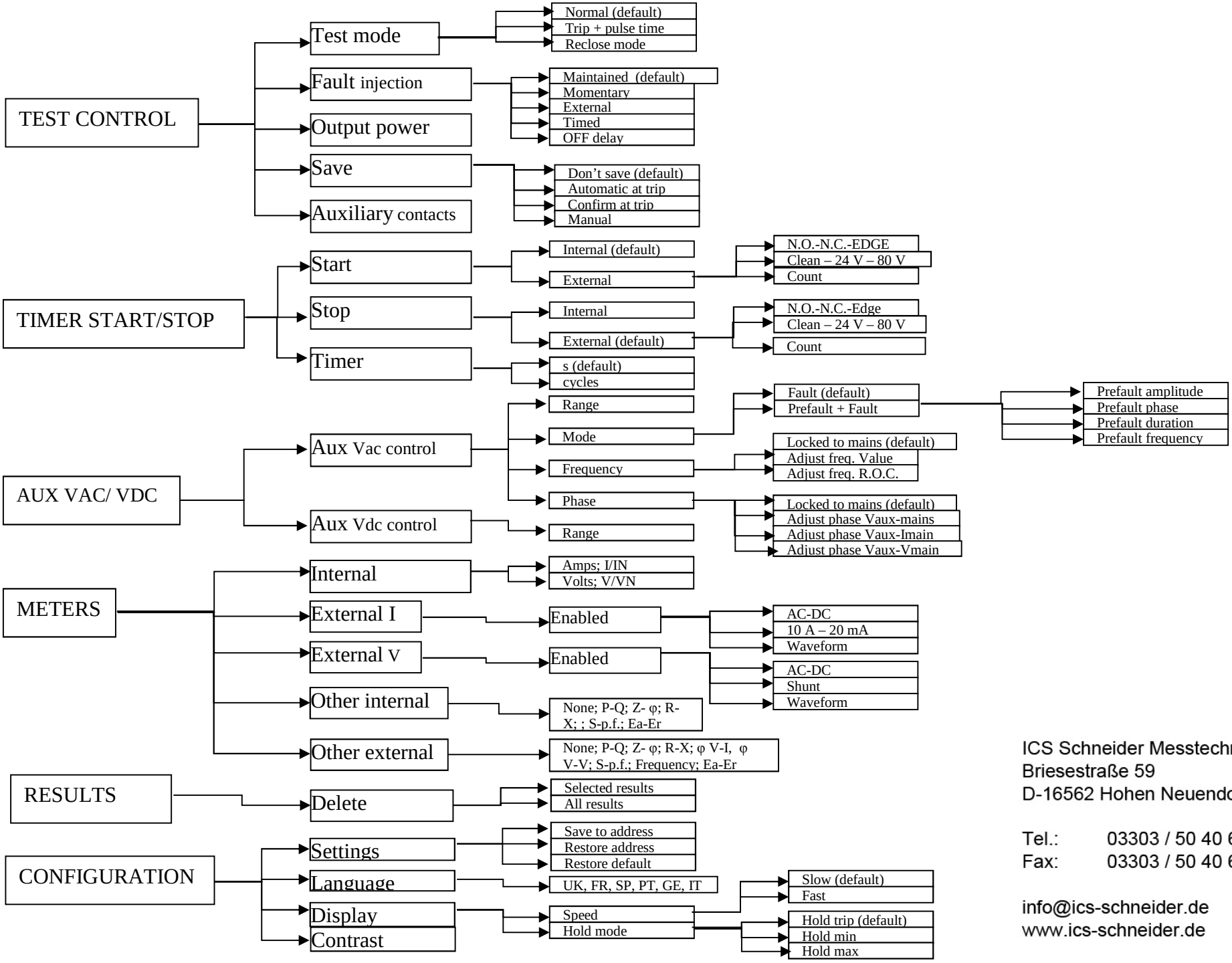
1) T1000PLUS

RANGE V	**MAX CURRENT @ > 40 Hz, A**	**MAX POWER @ > 40 Hz, VA**	**RANGE @ 15 Hz, V**	**MAX CURRENT @ 15 Hz, A**	**MAX POWER @ 15 Hz, VA**
3	20	50 (60)	2	20 @ 1 V; 10 @ 1.4 V	20 @ 20 A; 14 @ 10 A
65	0,75	50 (60)	35	0,2	7
130	0,38	50 (60)	70	0,2	14
260	0,19	50 (60)	140	0,2	28

2) TD1000PLUS

RANGE V	**MAX CURRENT @ > 40 Hz, A**	**MAX POWER, @ > 40 Hz, VA**	**RANGE @ 15 Hz, V**	**MAX CURRENT @ 15 Hz, A**	**MAX POWER @ 15 Hz, VA**
3	20	40	3	20	25
65	0,6	40	65	0,38	25
130	0,3	40	130	0,19	25
260	0,15	40	260	0,1	25

3) TD1000PLUS 15 Hz



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APPENDIX 2: MENU SELECTIONS FLUX DIAGRAM