



Testing the entire energy measurement system!

Accuracy of all kinds of meters ϵ [%]

Electromechanical (Ferraris)



Electronic (static)



4 - Quadrants
Smart Meters



Max. demand



CT/PT burden, ratio, phase shift error



Wiring errors



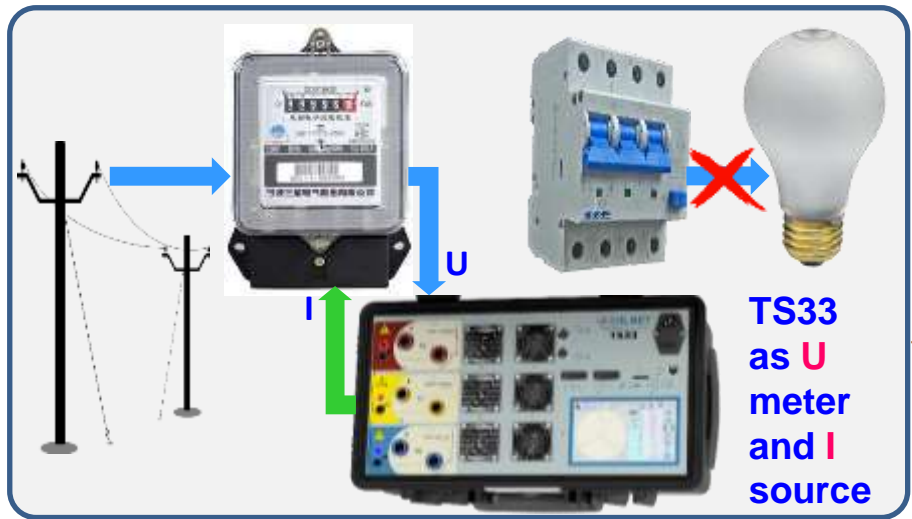
TS33

Reference Meter & 3-phase U&I Source in one case! Modes of testing



Testing **ON LINE** – meter and load are connected to the network; the value of metering point depends on current load; TS33 works as portable reference meter

Testing **OFF LINE** – meter & load are not connected to the network; metering point can be set in whole range of load; TS33 works as source of U&I and reference meter



Testing **U-ON/ I-OFF LINE** – meter is connected to the network but load is disconnected; metering point can be set in whole range of current; TS33 works as U meter and I source with built in reference meter

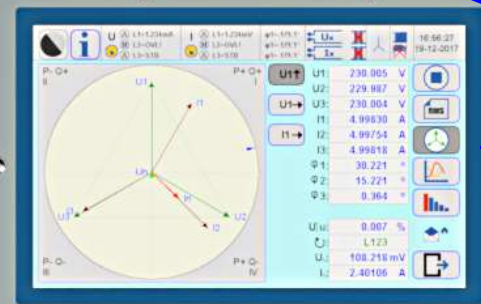
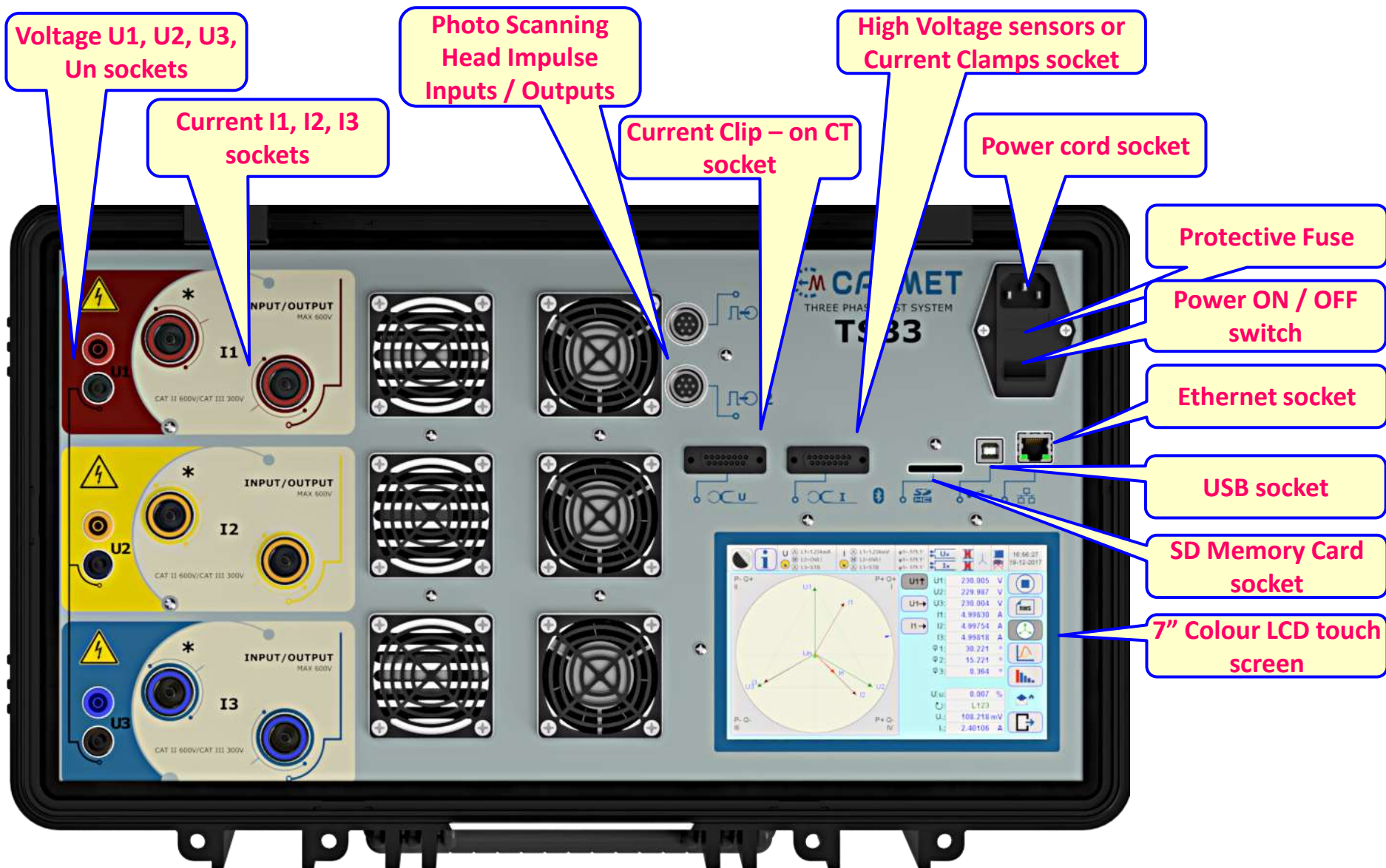
Testing without meter disconnecting!

- ▶ Easy verification of meters under precise load conditions, using integrated current and voltage source in class **0,04** or **0,1**
- ▶ Voltage range **0,05...600V**
- ▶ Current range **0,001...120A(10)(100)(1000)(30/300/3000)A**
- ▶ Testing of energy meters, potential and current transformers (**CT / PT**)
- ▶ **Automatic operation** with predefined load points without the need of an external PC
- ▶ **Vector, oscilloscope**, bar and trend charts of three phase network
- ▶ Automatic Meter Constant recognition
- ▶ Automatic setting of measurement conditions
- ▶ **Big 7-inch full colour touch screen** and computer software Calmet TE30 PC soft
- ▶ Reading data and remote controlled via **USB, Ethernet, Bluetooth**
- ▶ Recording data on flash memory SD card up to **32GB**
- ▶ Calibration Certificate



	L1	L2	L3		
U:	230.005 V	231.012 V	228.997 V	f:	50.000 Hz
U _{cr} :	377.610 V	408.054 V	407.067 V	U _N :	35.4767 V
I:	5.00031 A	5.10047 A	4.90017 A	I _N :	3.84876 A
φ:	19.998 °	25.007 °	-19.994 °	Σ:	0.92829
PF:	0.93970	0.90626	0.93973	Σ:	0.14715
sinφ:	0.34199	0.42272	-0.34192	Σ:	0.15851
tgφ:	0.36394	0.46645	-0.36386	Σ:	L123
Φ _{uu} :	0.000 °	109.989 °	-125.000 °	Σ:	3.20305 kW
P:	1.08075 kW	1.06781 kW	1.05449 kW	Σ:	507.726 var
Q:	393.327 var	498.081 var	-383.681 var	Σ:	3.45049 kVA
S:	1.15010 kVA	1.17827 kVA	1.12212 kVA		

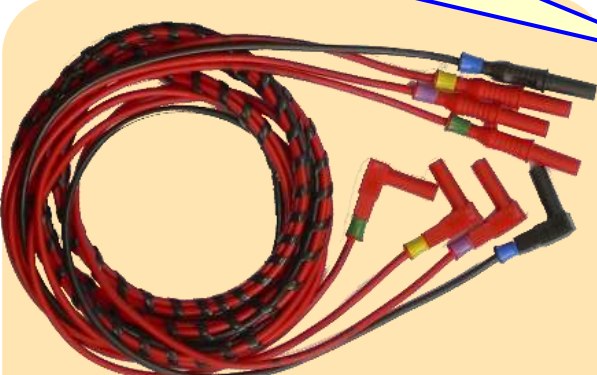
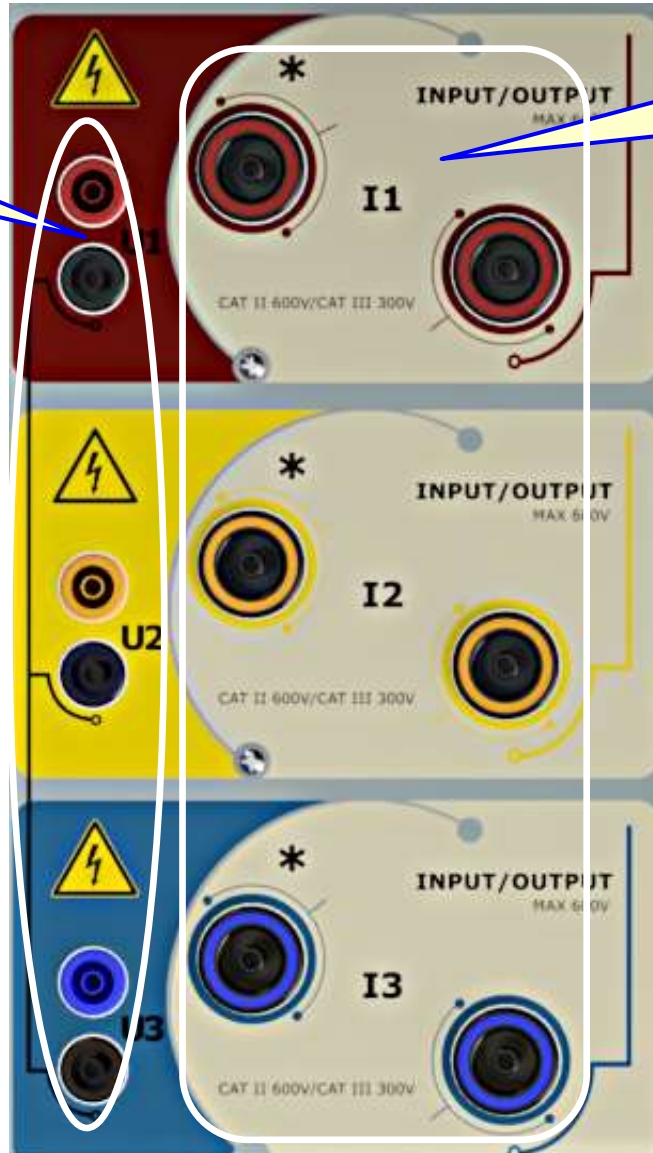
TS33 Inputs, Outputs and Connectors:



TS33 Voltage and Current Inputs:

Voltage U1, U2, U3, Un Input / Output sockets
0.05...600V

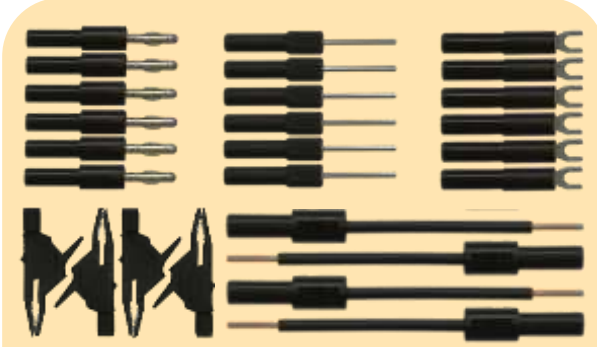
Current I1, I2, I3, Un Input / Output sockets
0.001...120A



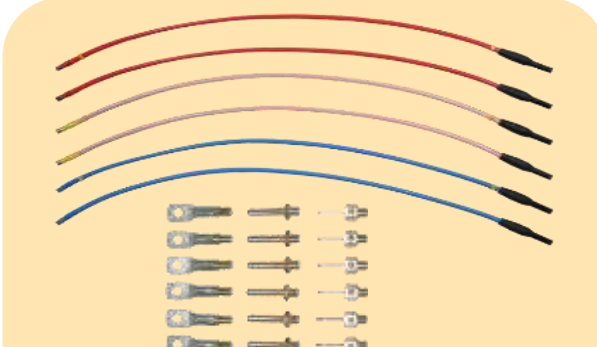
4mm Voltage Safety Cables
Length=2m



4mm Current Safety Cables
Length=2m, I ≤ 30A



Easy connection due to rich set of accessories for safety cables



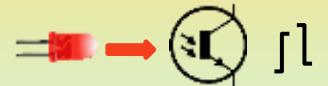
25mm² High Current Cables
Length=1m, I ≤ 120A

TS33 Pulse Input / Output;

can test all kinds of Electricity Meters

Electronic energy meter

- red, green or infrared LED blinking or LCD segment flashing
- photo head with photo sensor




0.0001Hz...200kHz

1. Pulse Input / Output socket

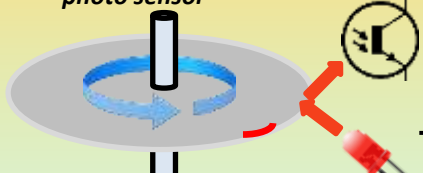
Electronic and Inductive energy meter

manual push – button and pulse generation



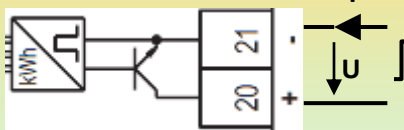
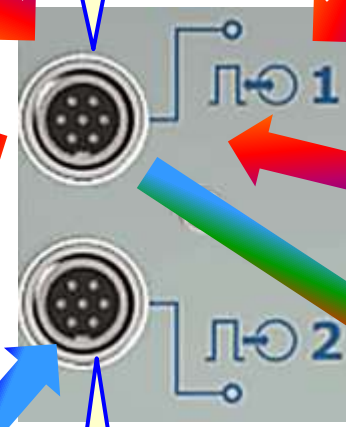
Inductive energy meter

- disk with red or black mark
- photo head with LED lamp and photo sensor



Electronic and Inductive energy meter

50 standard electric pulse

In case, that we need higher than offered by TS33 accuracy 0.04 or 0.1, we can use external reference easy way

Additional, external very, high accuracy Reference Meter

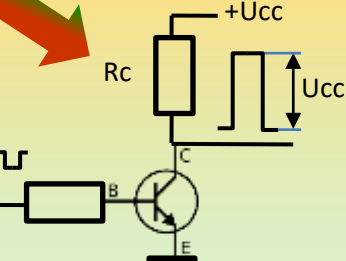


2. Pulse Input for external Reference Meter socket

Open collector pulse output + external Rc

$U_{cc} \max \leq 27V$
 $I_c \max \leq 100mA$

0.0001Hz...200kHz



TS33 has pulse output with frequency proportional to the power, with freely programmable constant imp/kWh

TS33 Current Clamps and Voltage Sensors; wide range of measured signals



10mA...120A, length=2m
max Ø cable 15mm



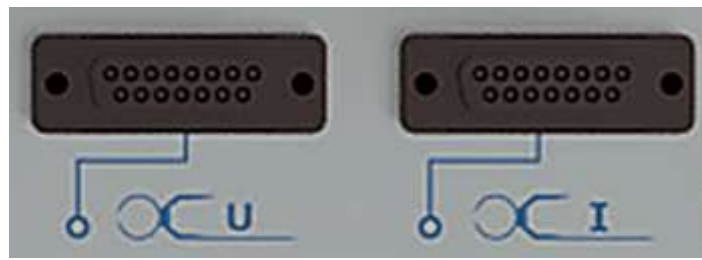
3mA...12A, max Ø cable 20mm
length=2m



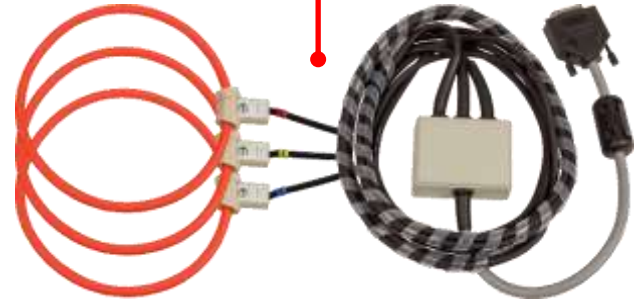
30A...2000A@150kV,
length=12m
max Ø cable 98mm



300mA...1200A, length=2m
max Ø cable 52mm



300mA...1200A, length=2m
max Ø cable 85mm,
loop length 300mm

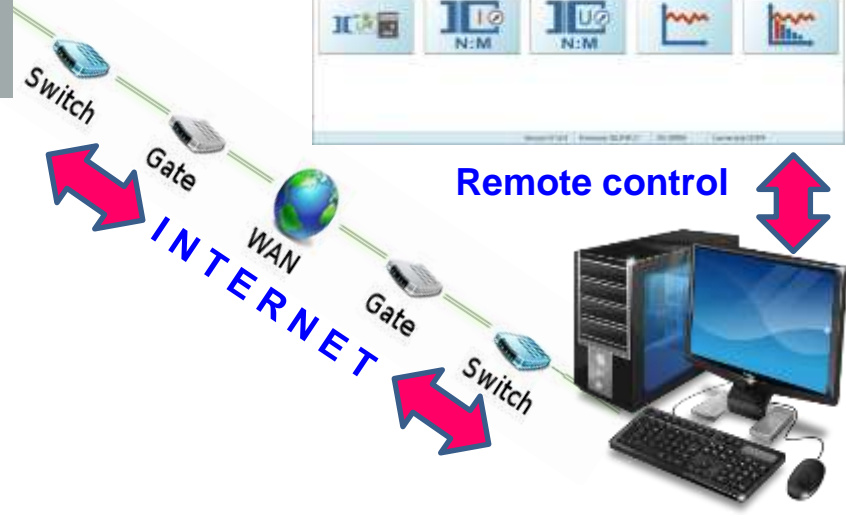
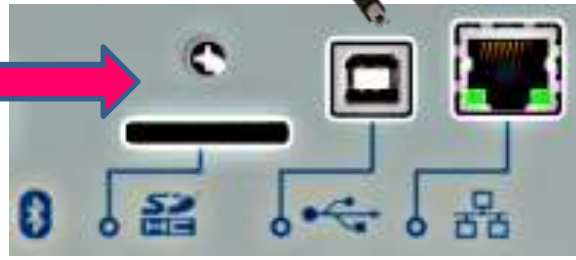
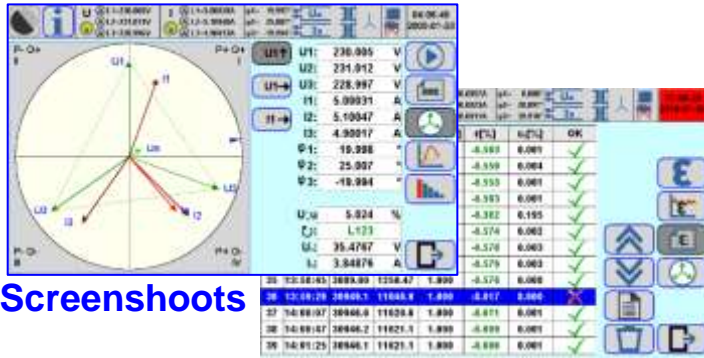


0.3..30A/3..300A/30..3000A, length=2m
max Ø cable 150mm,
loop length 500mm

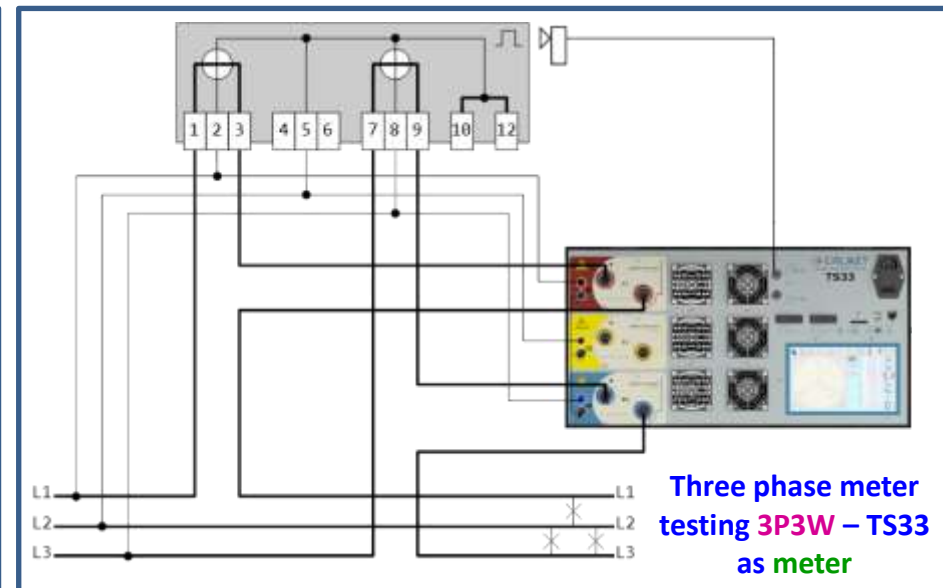
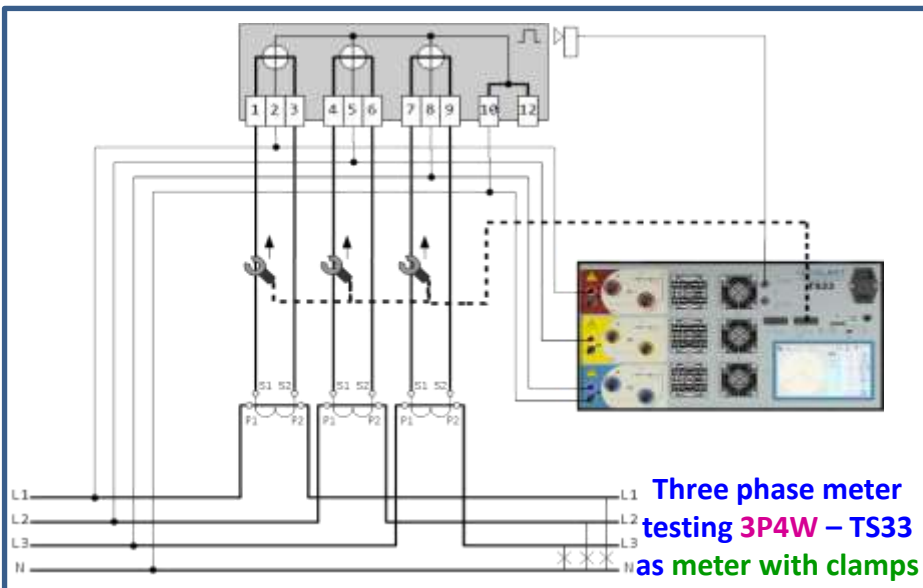
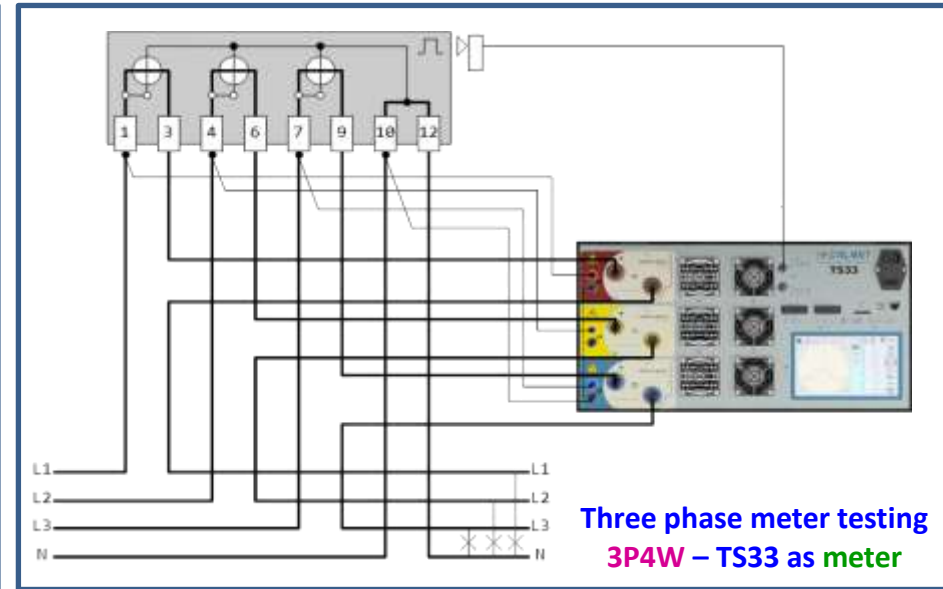
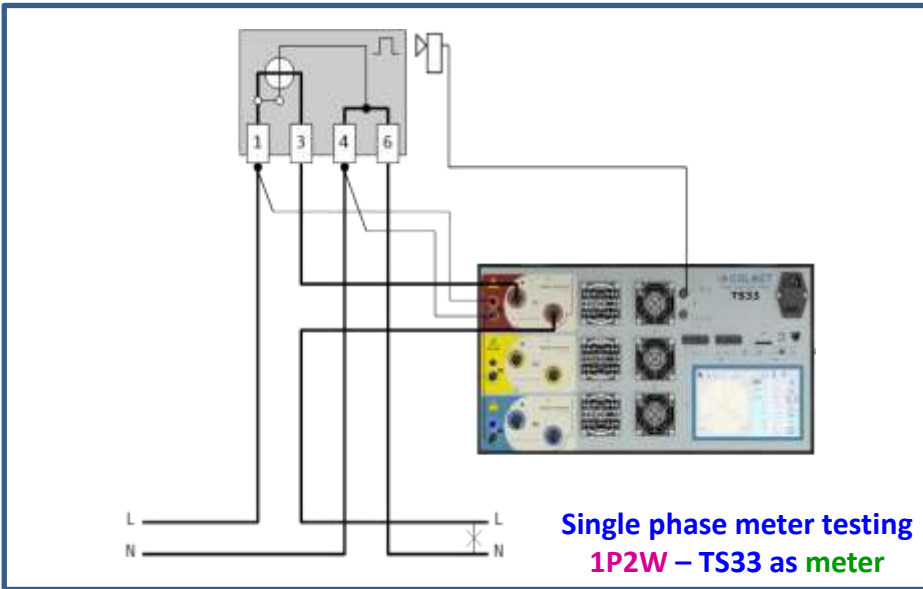


Voltage sensor
1kV...40kV,
length=12m

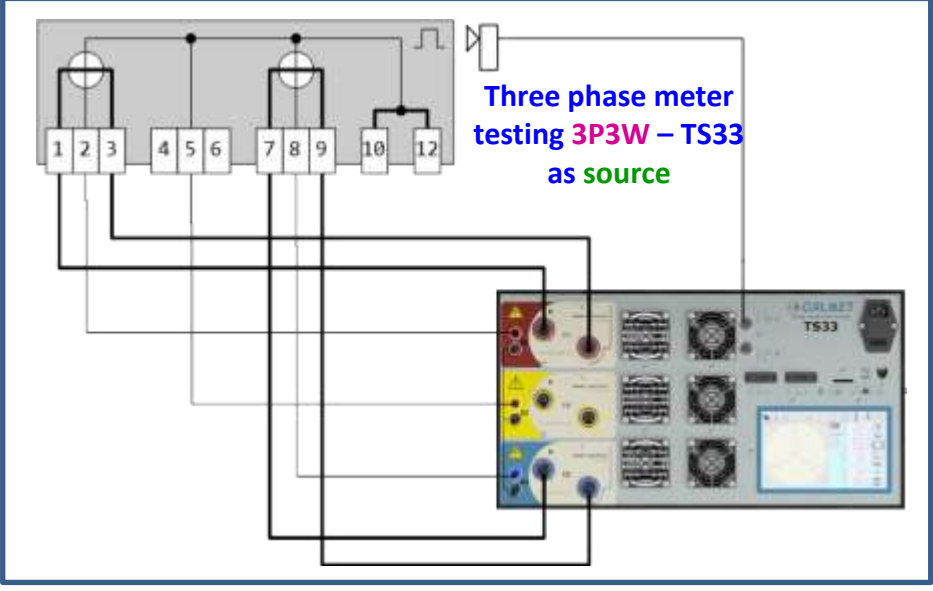
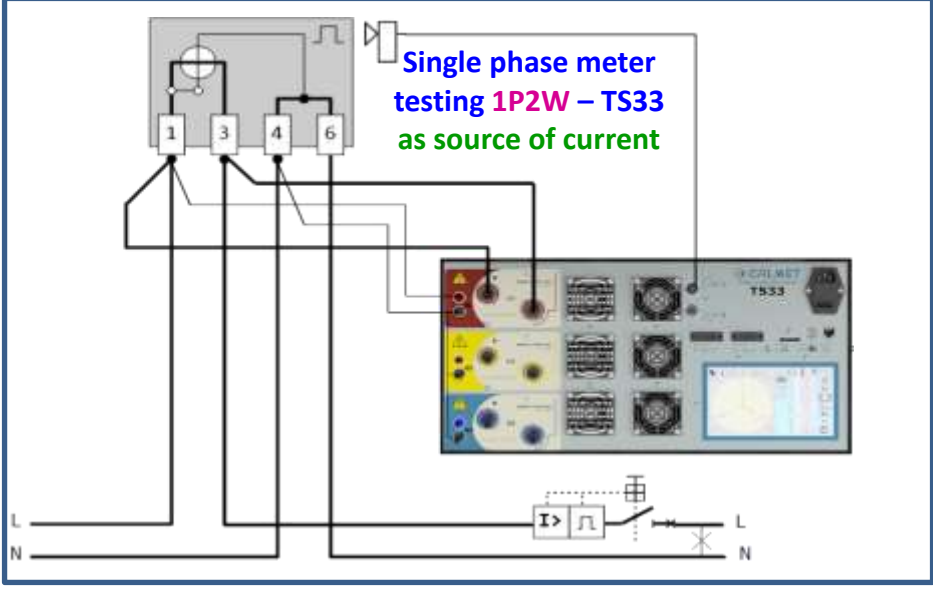
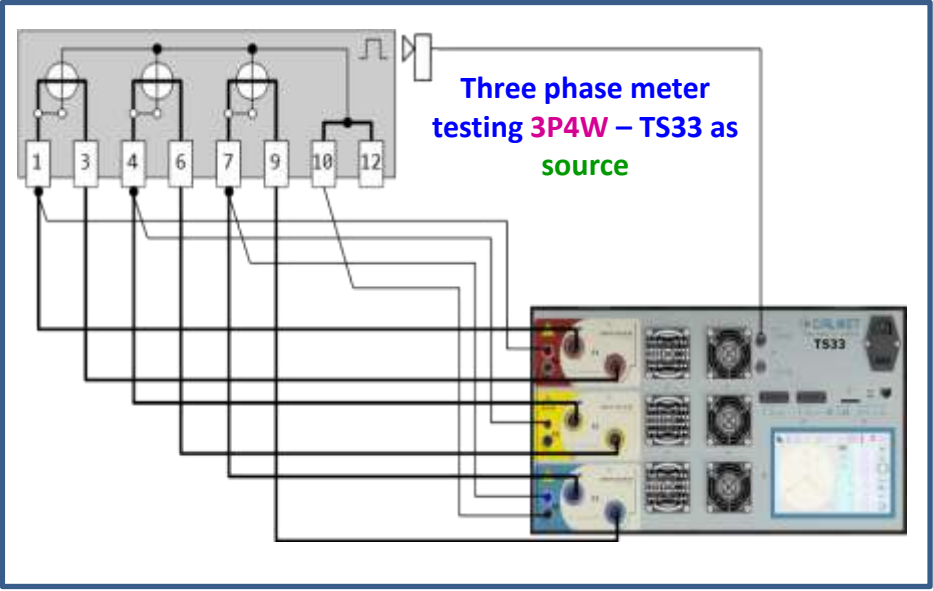
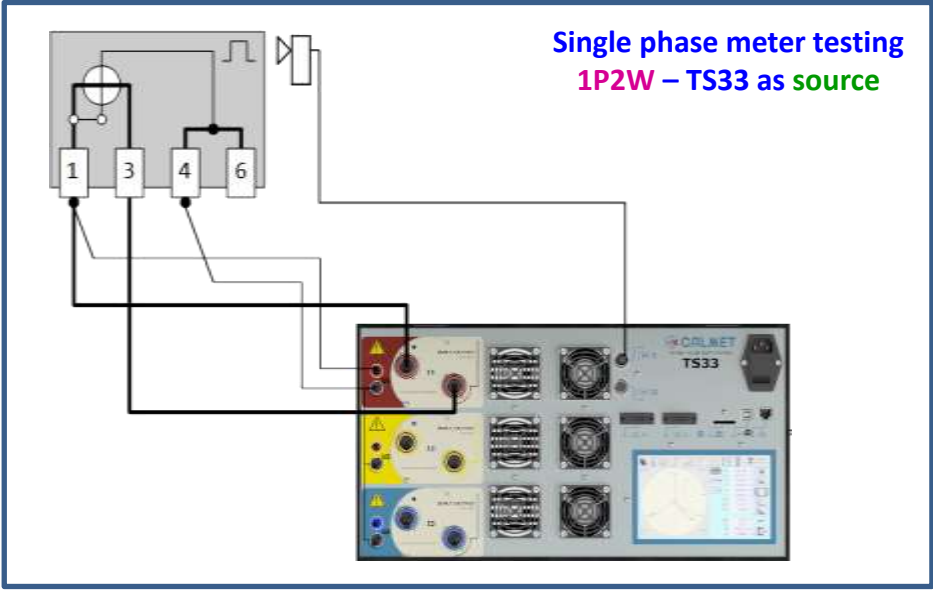
TS33 Communication; many ways of printer, PC connection and data storage



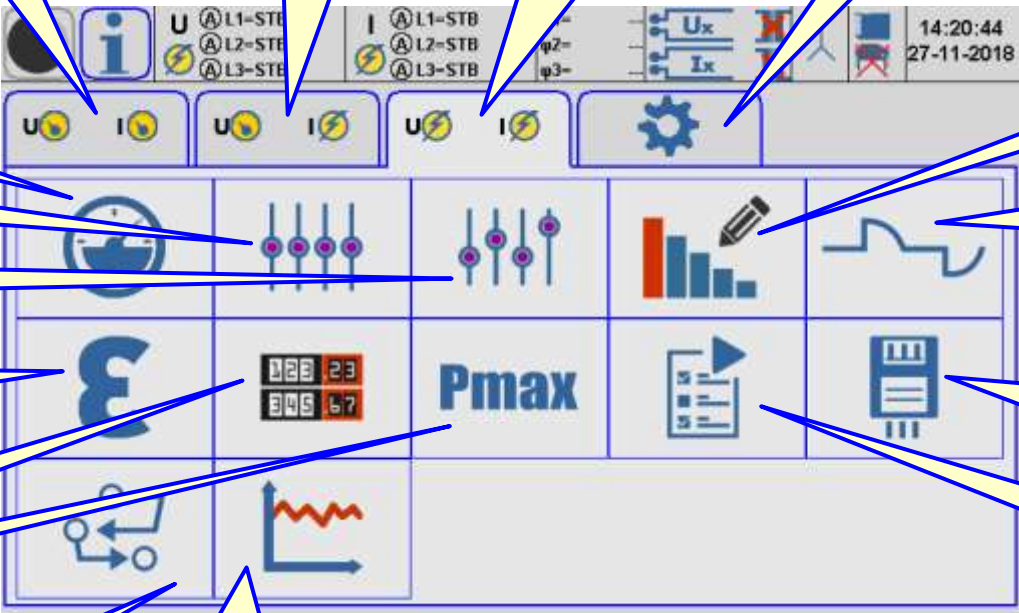
All possible types of connection: 1P2W, 3P4W, 3P3W, ... , direct or with clamps



All possible types of meters: 1P2W, 3P4W, 3P3W. TS33 as source and reference



Functionality of TS33: as reference meter, as source of U&I, as U meter & I source



The screenshot shows a software interface for the TS33 Automatic Test System. It features a top status bar with a clock (14:20:44, 27-11-2018) and various icons. Below this are three main control panels for voltage (U) and current (I) measurement and injection, each with a gear icon for settings. The interface is divided into several sections: a left sidebar with icons for status, RMS values, and settings; a central area with a large 'E' icon, a digital display showing '122 23' and '846 67', and a 'Pmax' label; and a right sidebar with icons for harmonics, special shapes, and automatic testing. Numerous callout boxes point to these features, describing their functionality.

- Reference meter mode
- Reference meter with current injection mode
- Voltage and current source with built in reference meter mode
- TS33 General Settings
- Status line
- RMS values at TS33 terminals
- Setting U, I, ϕ , F ... in symmetric output
- Setting U, I, ϕ , F ... in asymmetric output
- Meter error testing
- Register (counter) testing
- Maximum demand meter testing
- Load points setting for procedures in automatic testing
- All quantities trend (versus time) observation
- Setting harmonics in output signal
- Setting special shapes of the output signal
- Meter under test parameters settings for automatic testing
- Automatic test execution

Easy, icon driven, operation on big 7" touch screen

TS33 reference meter mode: whole installation measurement „as it is”

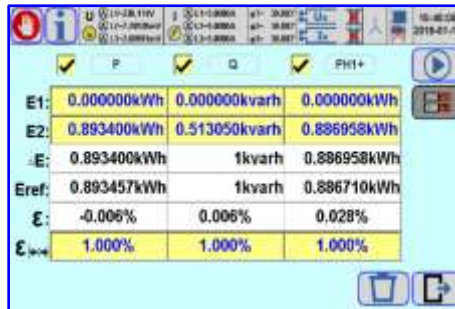
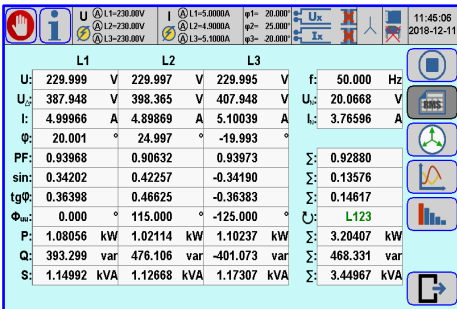


RMS values of U,I,φ,F,P,Q,S

Counter (register) test

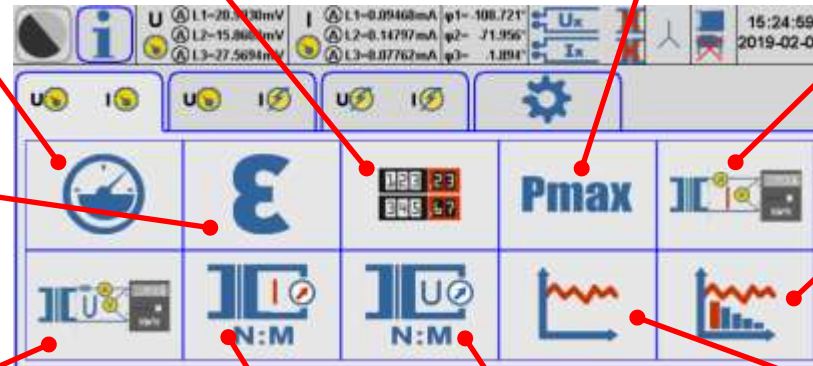
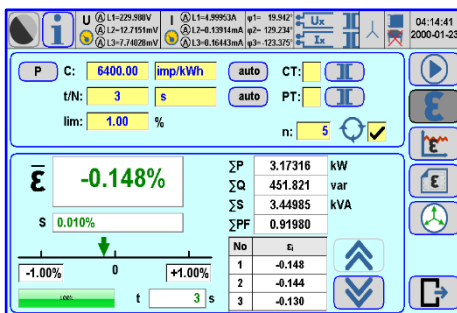
Maximum demand meter test

CT burden test



Meter error test in [%]

Harmonics trend test

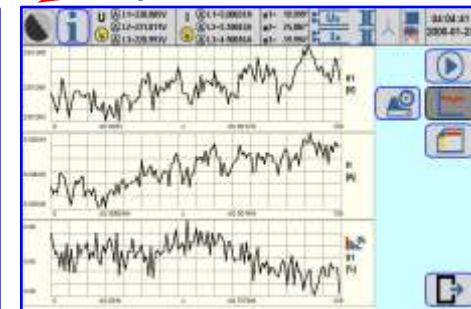


PT burden test

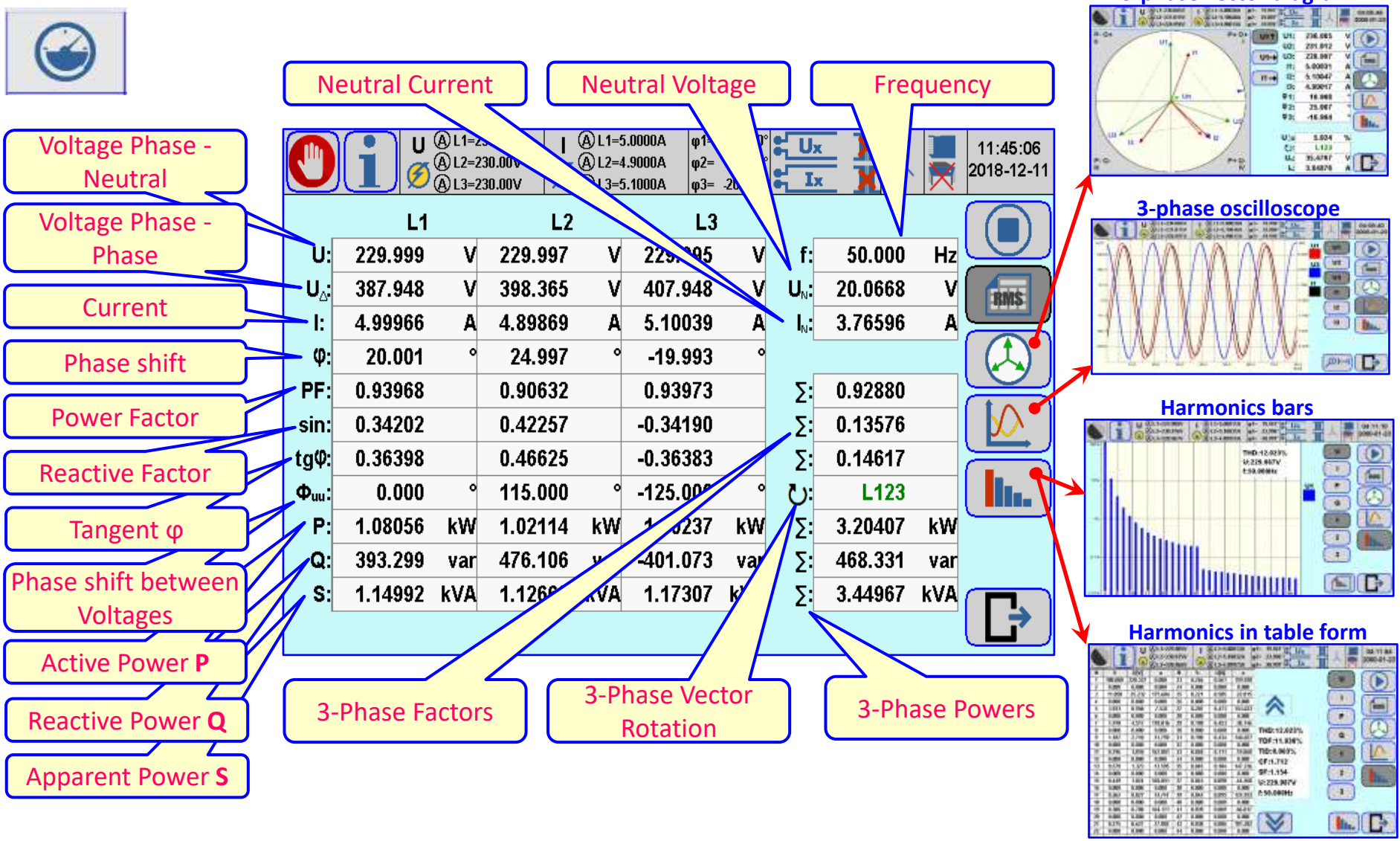
CT ratio test

PT ratio test

U,I,φ,F,P,Q,S trend test



TS33 functionality: RMS values of U,I,φ,F,P,Q,S measurement results



Neutral Current | **Neutral Voltage** | **Frequency**

	L1	L2	L3	
U:	229.999 V	229.997 V	229.995 V	f: 50.000 Hz
U _Δ :	387.948 V	398.365 V	407.948 V	U _N : 20.0668 V
I:	4.99966 A	4.89869 A	5.10039 A	I _N : 3.76596 A
φ:	20.001 °	24.997 °	-19.993 °	Σ: 0.92880
PF:	0.93968	0.90632	0.93973	Σ: 0.13576
sin:	0.34202	0.42257	-0.34190	Σ: 0.14617
tgφ:	0.36398	0.46625	-0.36383	Σ: 3.20407 kW
Φ _{uu} :	0.000 °	115.000 °	-125.000 °	Σ: 468.331 var
P:	1.08056 kW	1.02114 kW	1.02237 kW	Σ: 3.44967 kVA
Q:	393.299 var	476.106 var	-401.073 var	
S:	1.14992 kVA	1.12600 kVA	1.17307 kVA	

3-Phase Factors | **3-Phase Vector Rotation** | **3-Phase Powers**

3-phase vector diagram

3-phase oscilloscope

Harmonics bars

Harmonics in table form

Callout Boxes:

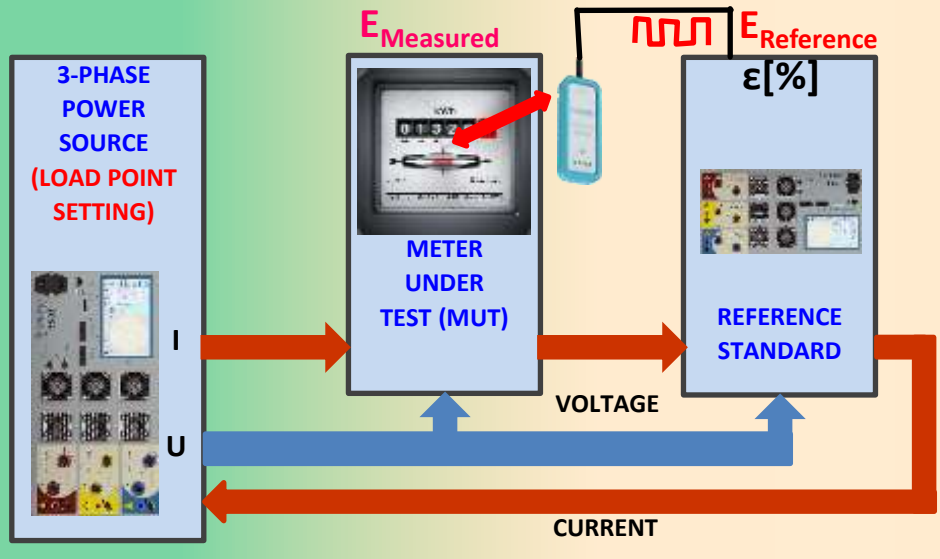
- Voltage Phase - Neutral
- Voltage Phase - Phase
- Current
- Phase shift
- Power Factor
- Reactive Factor
- Tangent φ
- Phase shift between Voltages
- Active Power P
- Reactive Power Q
- Apparent Power S



TS33 functionality: energy meter error testing idea

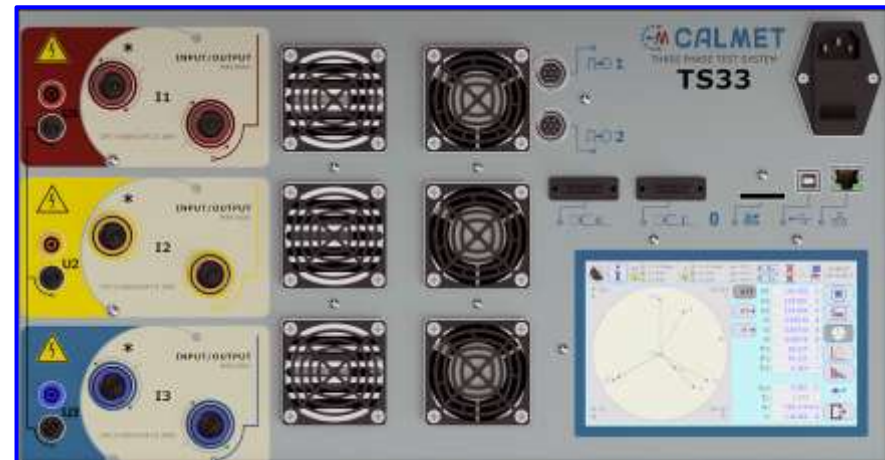
Principle of electricity meter testing

$$\varepsilon[\%] = \frac{E_{Measured} - E_{Reference}}{E_{Reference}} \cdot 100\%$$



TS33 works both:

- as programmable 3-phase source of voltage and current;
- as high accuracy reference meter.



Definition: energy meter testing (MUT) by energy comparison method consists in counting pulses from MUT and calculation of measured energy as:

$$E_{Measured}[kWh] = \frac{N[\text{pulses or turns number}]}{C[\text{imp/kWh}](\text{meter constant})}$$

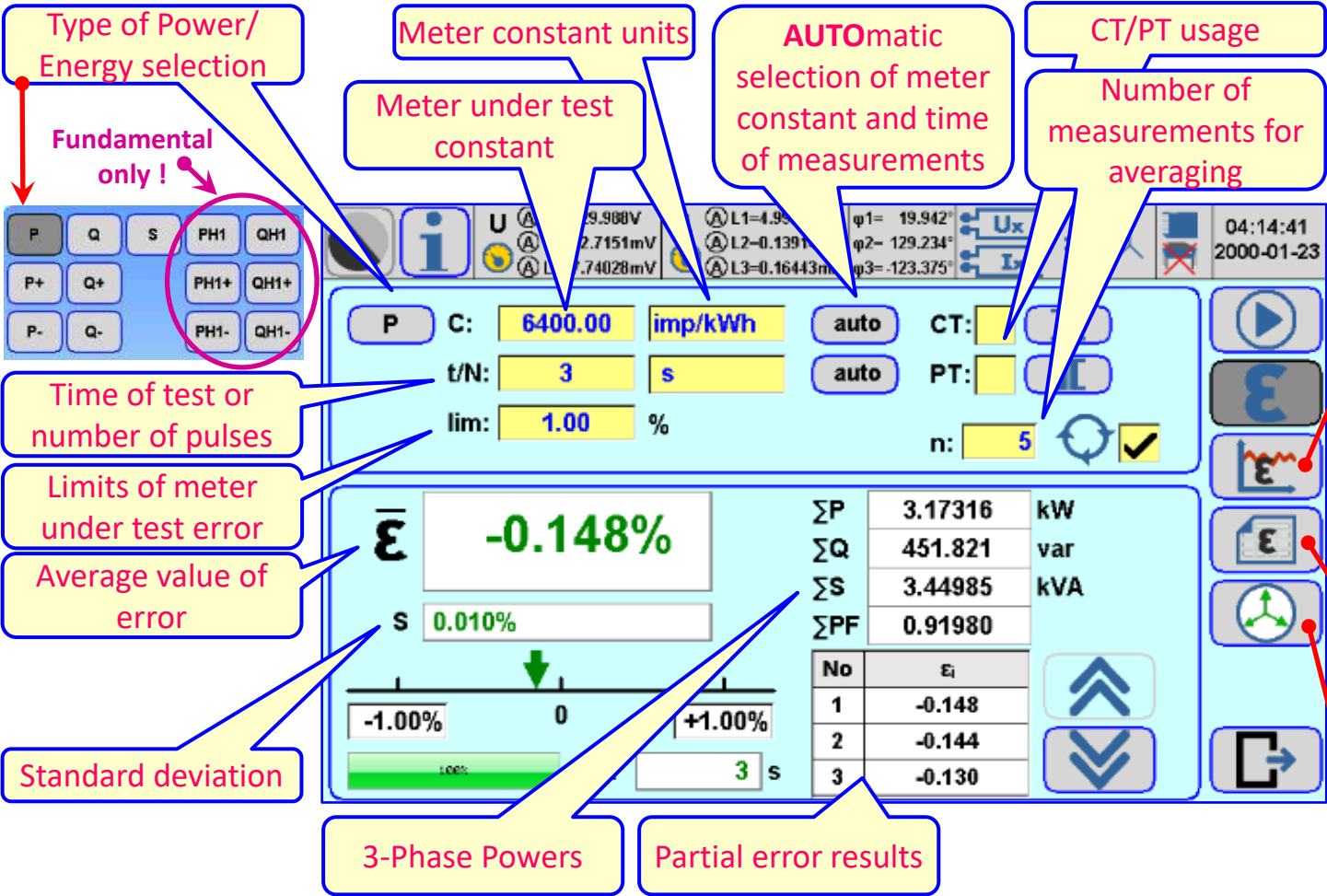
and then compare it with, reference value measured by special, at least 5 times more accurate standard meter ($E_{reference}$).

Example: counted were 500 pulses by meter with constant 375 turns/kWh. The measured energy is:

$$E_{Measured} = \frac{500}{375} kWh = 1.333 kWh$$



TS33 functionality: automatic energy meter error testing in [%]



Type of Power/Energy selection
Fundamental only!

Meter constant units
Meter under test constant

AUTOmatic selection of meter constant and time of measurements

CT/PT usage
Number of measurements for averaging

Time of test or number of pulses

Limits of meter under test error

Average value of error

Standard deviation

3-Phase Powers

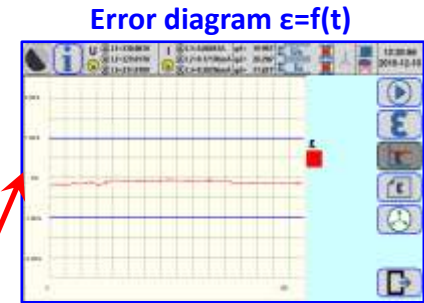
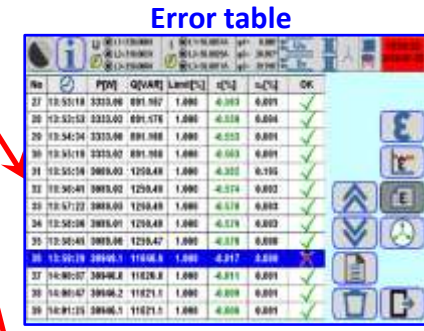
Partial error results

Settings shown: P: C: 6400.00 imp/kWh, t/N: 3 s, lim: 1.00 %, n: 5

Results shown: $\bar{\epsilon}$ -0.148%, S 0.010%

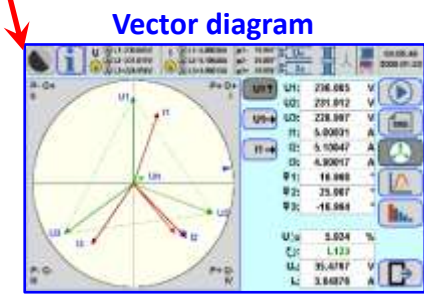
No	ϵ_i
1	-0.148
2	-0.144
3	-0.130

Summary statistics:
 ΣP 3.17316 kW
 ΣQ 451.821 var
 ΣS 3.44985 kVA
 ΣPF 0.91980

Error table

No	PPV	QVARI	Lim[%]	ϵ_i [%]	σ_i [%]	OK
27	10.5518	3333.00	0.91.987	1.000	-0.393	0.001
28	10.5253	3333.00	0.91.976	1.000	-0.338	0.004
29	10.5434	3333.00	0.91.988	1.000	-0.553	0.001
30	10.5618	3333.00	0.91.988	1.000	-0.603	0.001
31	10.5556	3089.00	1.259.48	1.000	-0.352	0.100
32	10.5641	3089.00	1.259.48	1.000	-0.574	0.003
33	10.5722	3089.00	1.259.48	1.000	-0.619	0.003
34	10.5826	3089.00	1.259.48	1.000	-0.619	0.003
35	10.5648	3089.00	1.259.47	1.000	-0.619	0.008
36	10.5618	30896.0	11606.8	1.000	-0.217	0.008
37	10.6057	30896.8	11626.8	1.000	-0.611	0.001
38	10.6047	30896.2	11621.0	1.000	-0.609	0.001
39	10.6125	30896.5	11621.5	1.000	-0.609	0.001

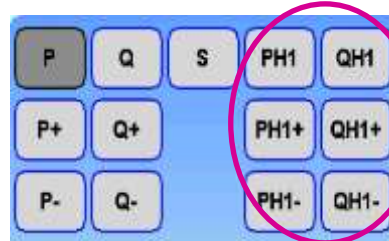


- ▶ function of computing meter error (partial errors, average error, standard deviation) directly in percentages [%] with method of setting time of measurement or number of impulses,
- ▶ function of automatic identification energy meter constant,
- ▶ function of automatic determining measurement time or number of pulses.

TS33 functionality: register (counter) test



The type of power setting for selected register



Fundamental only!

Up to 3 registers testing at time

U (A) L1=228.810V (A) L1=4.99986A φ1= 29.750° Ux Ix 13:36:17 2019-01-15

(A) L2=0.25538mV (A) L2=STB φ2= -0.018°

(A) L3=0.19500mV (A) L3=STB φ3= -0.002°

Test START / STOP

Register value before starting test

Register value after stopping test

Difference between E2-E1

Reference value of Energy flow

Value of error

Limits of error

<input checked="" type="checkbox"/>	P	<input checked="" type="checkbox"/>	Q	<input checked="" type="checkbox"/>	PH1+
E1:	0.000000kWh	0.000000kvarh	0.000000kWh		
E2:	1.019123kWh	0.588698kvarh	1.019680kWh		
ΔE:	1.019123kWh	0.588698kvarh	1.019680kWh		
Eref:	1.019277kWh	0.588480kvarh	1.018611kWh		
ε:	-0.015%	0.037%	0.105%		
ε ↔:	1.000%	1.000%	1.000%		

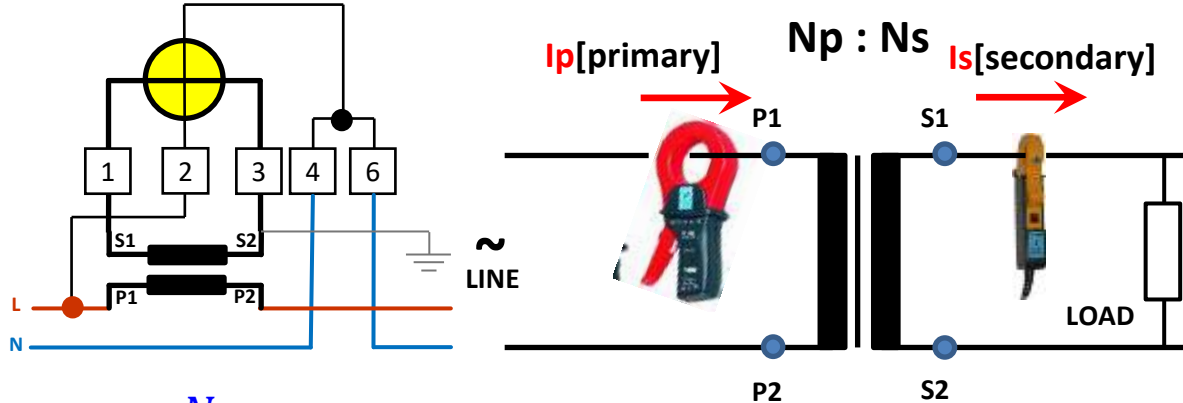
Value of active energy with all harmonics

Value of first harmonic only in active energy

- ▶ function of simultaneous testing up to three registers,
- ▶ function of every kind of power selection enables to test multi-quadrant meters,
- ▶ testing all harmonic energy or only fundamental (1-st harmonic) Energy, required for all new metres of reactive energy and active energy in near future



TS33 functionality: CT/PT ratio test idea;
small ratio and phase shift error are essential for reliable measurement



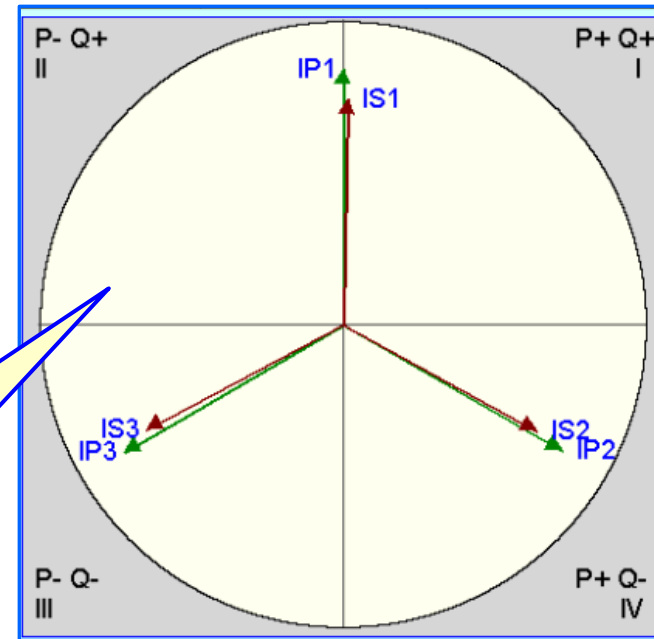
The test method is based on **primary current** measurement by means of current clamps from 0.1A to 3000A and **secondary current** measurement directly or also by means of clamps in 10mA to 10A range.

$$\delta I = \frac{\frac{N_P}{N_S} \cdot I_S - I_P}{I_P} \cdot 100\%$$

The ratio error is given by equation, where:

- δI – current transformer error [%]
- N_p - number of primary turns
- N_s - number of secondary turns
- N_p / N_s – nominal CT ratio
- I_p - primary current
- I_s - secondary current

Three phase vector diagram of primary I_p and secondary I_s currents



Expected value of ratio error is $\delta I = 0\%$ and phase shift error $\phi = 0^\circ$

TS33 functionality: CT/PT ratio test; vector diagram with primary and secondary side

Individual phase



	L1	L2	L3
lim:	0.200%	0.200%	0.200%
lpn:	100A	100A	100A
lsn:	5A	5A	5A

Ip:	100.006 A	99.0032 A	99.5007 A
Is:	5.00011 A	4.90018 A	4.95051 A
φ:	0.988 °	-1.001 °	1.980 °
Ip/Is:	20.0008	20.2040	20.0991
δ:	0.004 %	1.010 %	0.493 %
δs:	0.000 %	0.000 %	0.000 %

Number of measurements for averaging

n: 10

Test START / STOP

CT limit of error (accuracy class)

Nominal primary current

Nominal secondary current

Primary current flow

Secondary current flow

Phase shift primary / secondary current

Calculated ratio

Ratio error in [%]

Standard deviation of ratio error measurement

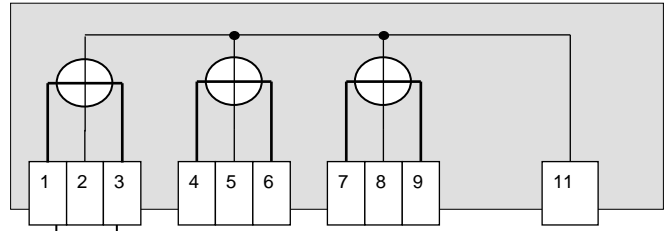
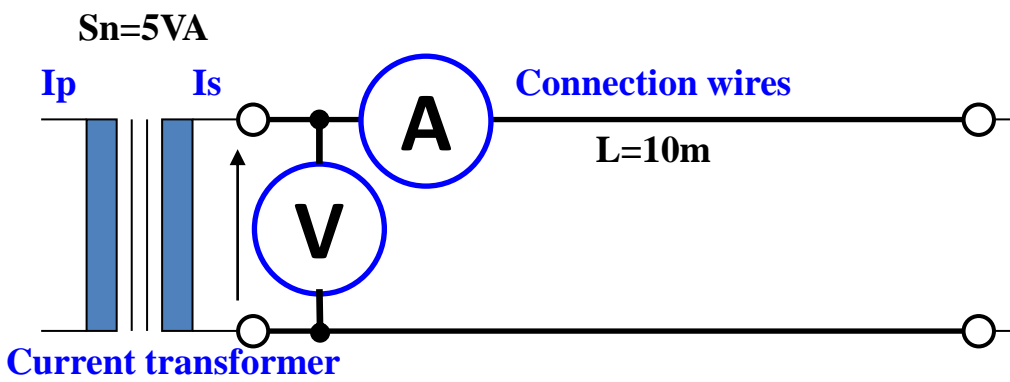
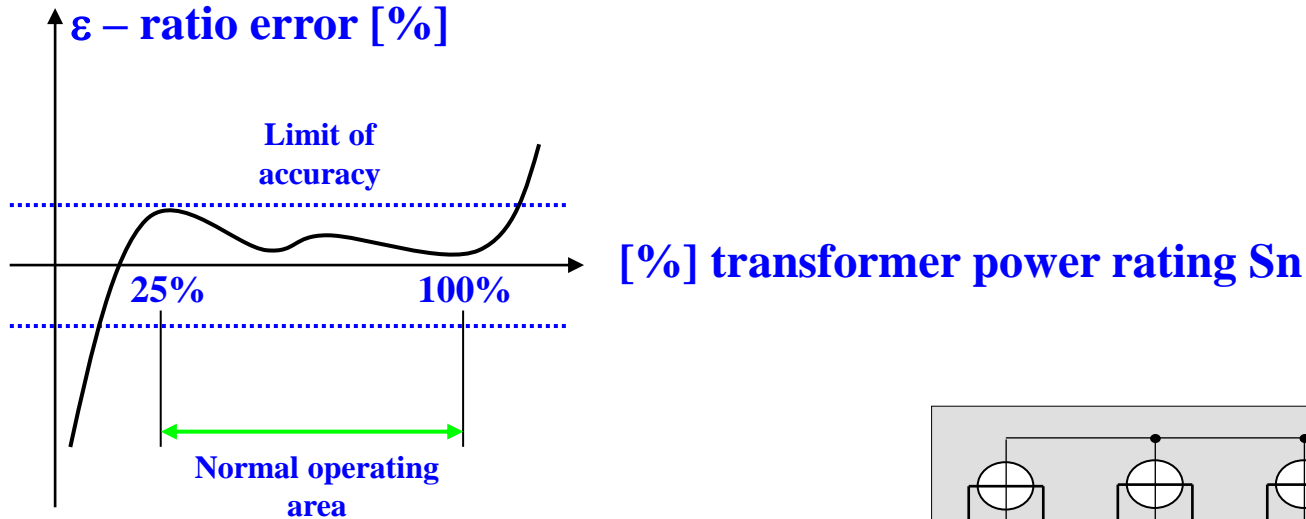
Vector diagram of primary and secondary side allows for easy connection testing

- ▶ testing CT / PT ratio and phase shift error simultaneously in three phases,
- ▶ ratio error measured directly in [%],
- ▶ vector diagram allows easy check of proper installation connections and error removing



TS33 functionality: CT/PT burden test idea

CT/PT – current / voltage transformer can operate with stated accuracy only between 25% - 100% of burden (load). In case of **too long** length, or **too thin** wire dimension or **too small load**, the result, secondary current / voltage can be **out of accuracy** limits



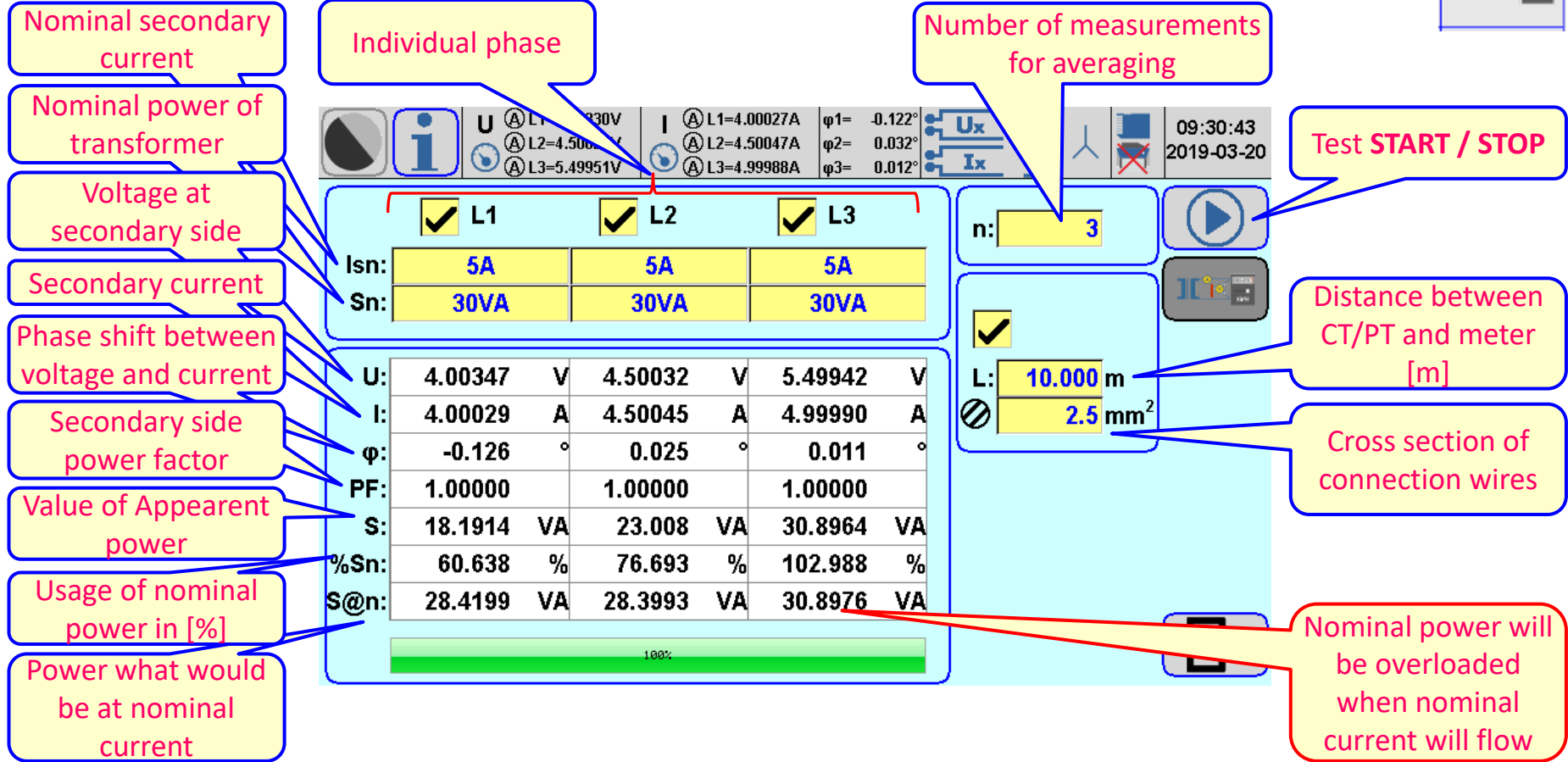
Example:

$$R_p = \frac{\rho_{Cu} \cdot l}{S} = \frac{0,0175\Omega \frac{mm^2}{m} \cdot 2 \cdot 10m}{1mm^2} = 0,35\Omega$$

$$P_p = I_2^2 \cdot R_p = 5^2 A \cdot 0,35\Omega = 8,75VA$$

Conclusion: transformer load (wires, connectors, fuses, meter) can influence on accuracy

TS33 functionality: CT/PT burden test

Individual phase

Nominal secondary current

Nominal power of transformer

Voltage at secondary side

Secondary current

Phase shift between voltage and current

Secondary side power factor

Value of Apparent power

Usage of nominal power in [%]

Power what would be at nominal current

Number of measurements for averaging

Test START / STOP

Distance between CT/PT and meter [m]

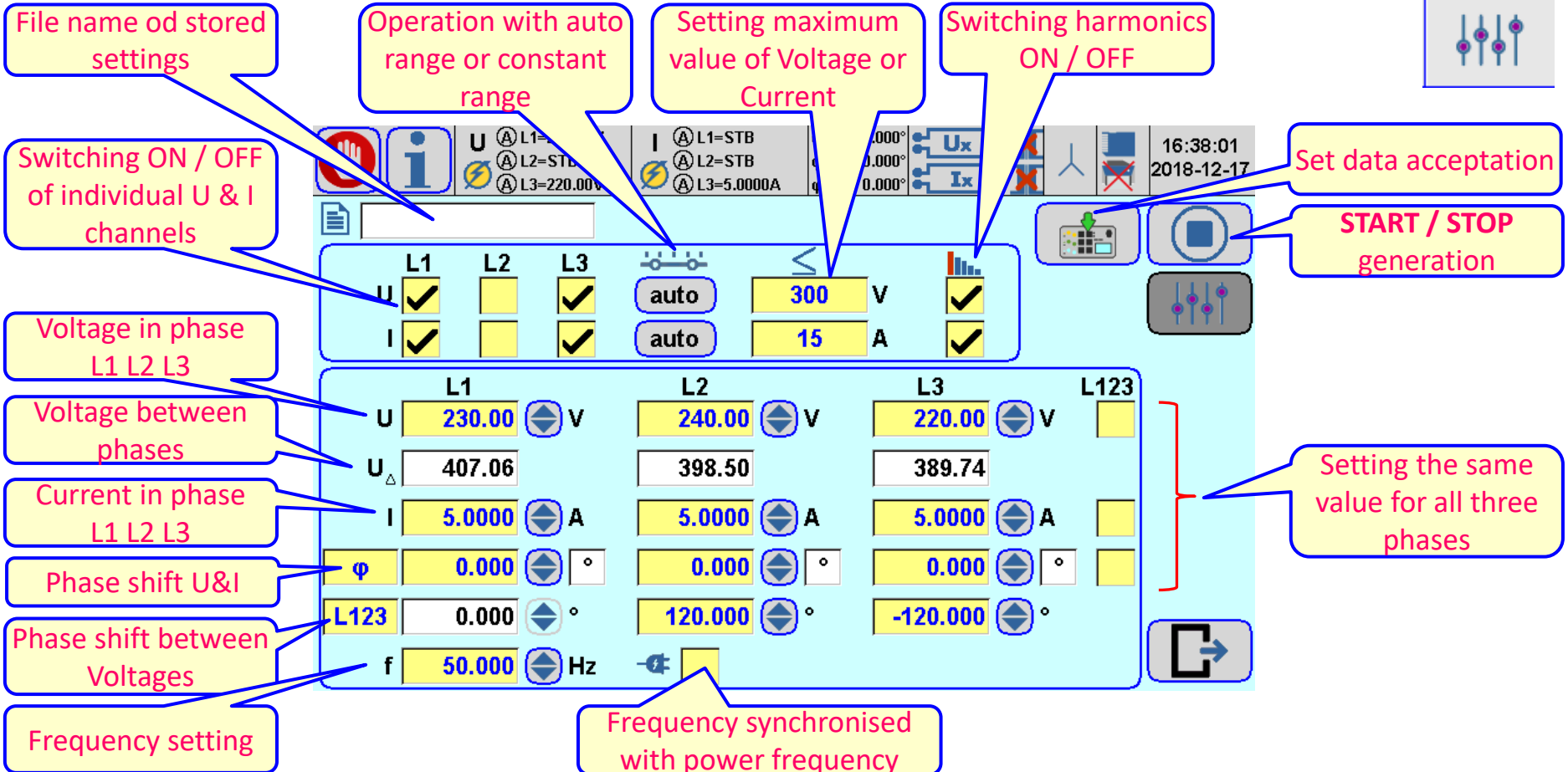
Cross section of connection wires

Nominal power will be overloaded when nominal current will flow

	L1	L2	L3
U:	4.00347 V	4.50032 V	5.49942 V
I:	4.00029 A	4.50045 A	4.99990 A
φ:	-0.126 °	0.025 °	0.011 °
PF:	1.00000	1.00000	1.00000
S:	18.1914 VA	23.008 VA	30.8964 VA
%Sn:	60.638 %	76.693 %	102.988 %
S@n:	28.4199 VA	28.3993 VA	30.8976 VA

- ▶ function of simultaneous testing up to three burdens,
- ▶ function of proper work prediction at nominal current and load,
- ▶ analysis of secondary side power factor

TS33 functionality: Voltage and current source with built in reference meter mode



The screenshot shows the main control interface of the TS33 system. At the top, there are status indicators for voltage (U) and current (I) across three phases (L1, L2, L3). The central part of the interface is a control panel with several sections:

- Channel Control:** A section with checkboxes for U and I in each phase (L1, L2, L3) and a central 'auto' range selector. Callouts point to 'Switching ON / OFF of individual U & I channels' and 'Operation with auto range or constant range'.
- Maximum Value Setting:** A section with numerical input fields for voltage (300 V) and current (15 A). A callout points to 'Setting maximum value of Voltage or Current'.
- Harmonics Control:** A section with a 'START / STOP generation' button and a 'Set data acceptance' button. A callout points to 'Switching harmonics ON / OFF'.
- Measurement Data:** A table showing real-time measurements for each phase:

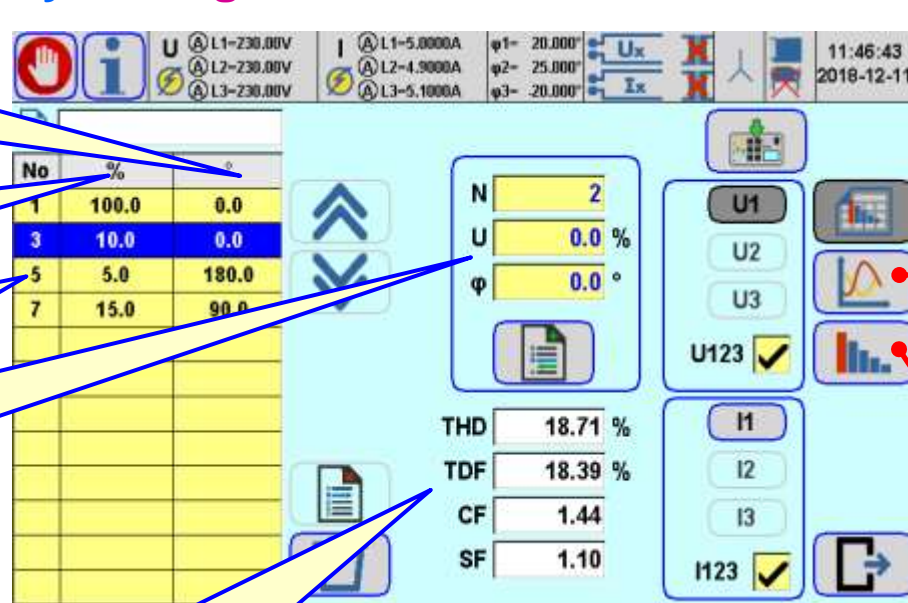
	L1	L2	L3	L123
U (V)	230.00	240.00	220.00	
U _Δ (V)	407.06	398.50	389.74	
I (A)	5.0000	5.0000	5.0000	
φ (°)	0.000	0.000	0.000	
L123 (°)	0.000	120.000	-120.000	
f (Hz)	50.000			

 Callouts point to 'Voltage in phase L1 L2 L3', 'Voltage between phases', 'Current in phase L1 L2 L3', 'Phase shift U&I', 'Phase shift between Voltages', and 'Frequency setting'. A callout also points to the frequency field with the text 'Frequency synchronised with power frequency'.

- ▶ Individual setting in each phase value of voltage, current, power factor and phase shift between voltages,
- ▶ Independent switching ON / OFF of each current and voltage in phase L1, L2, L3,
- ▶ Automatic or manual range selection,
- ▶ Protection against overvoltage or overcurrent
- ▶ Pure sinusoidal or harmonic distorted signal generation

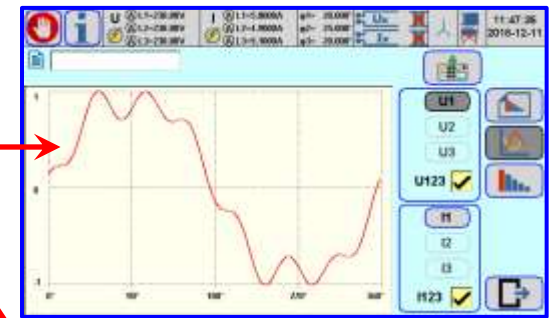
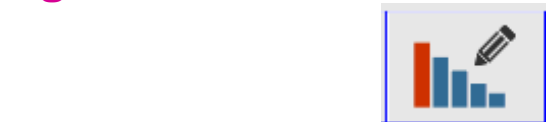
TS33 functionality: Voltage and current source – harmonic generation

- Phase shift with reference to fundamental
- Amplitude in % of fundamental
- Number of harmonic
- Setting number of harmonic, its amplitude and phase shift



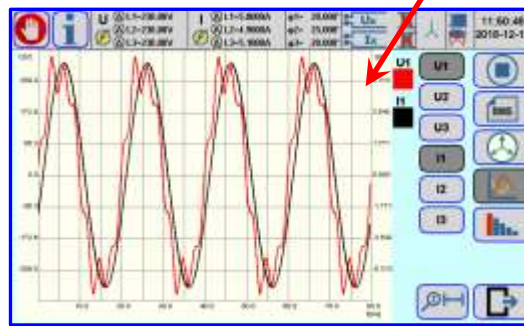
No	%	°
1	100.0	0.0
3	10.0	0.0
5	5.0	180.0
7	15.0	90.0

N: 2
 U: 0.0 %
 φ: 0.0 °
 THD: 18.71 %
 TDF: 18.39 %
 CF: 1.44
 SF: 1.10



Real signal measured at TS33 output

- Signal parameters:**
- THD** – total harmonic distortion (all harmonics to fundamental)
 - TDF** – total distortion factor (all harmonics to RMS value)
 - CF** – crest factor (peak value to RMS value)
 - SF** – shape factor (average rectified value to RMS value)



TS33 functionality: Automatic energy meter test in whole range of loads idea
METER TYPE


U:230V
 I:10(60)A
 f:50Hz
 C:375imp/kWh
 Cl: 2

U:230V
 I:0.25-5(60)A
 f:50Hz
 C:6400imp/kWh
 Cl: A


Data base

TEST PROCEDURE

Type of test:

- error
- repeatability
- start up current
- no load test
- dial (register) test

Load points:

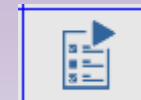
- value of current
- value of voltage
- power factor
- frequency
- harmonics


Data base

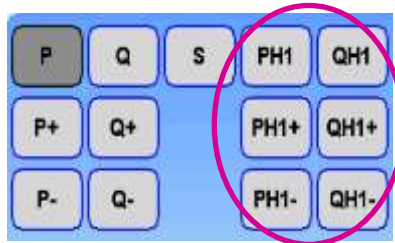
TEST EXECUTION

- load points for test selection
- serial number of meter under test
- test execution
- results table

No	🕒	P[W]	Q[VAR]	lim[%]	ε[%]	sc[%]	OK
1	11:43:27	172.502	-0.008651	1.000	0.660	0.022	✓
2	11:44:50	344.987	-0.013448	1.000	0.638	0.010	✓
3	11:45:35	689.912	-0.049329	1.000	0.505	0.107	✓
4	11:46:57	1725.03	-1.00910	1.000	0.628	0.003	✓
5	11:48:16	2760.15	-0.290766	1.000	0.616	0.006	✓
6	11:49:37	3450.06	-0.479581	1.000	0.600	0.004	✓
7	11:50:56	4139.97	-0.750822	1.000	0.589	0.001	✓


Data base


TS33 functionality: Automatic energy meter test – Meter Type



Fundamental only!

Power type measured by meter

Type of meter in Data Base or new meter

Comment to the meter

Meter connection type: STAR / DELTA / SINGLE PHASE

Meter constant entered in: [imp/kWh] [imp/Wh] [Wh/imp]

Programmable in [s] delay between applying signals to the meter and test start (prepayment meters with relay)

U A L1=STB A L2=STB A L3=STB $\varphi 1=$ $\varphi 2=$ $\varphi 3=$ U_x I_x 15:21:02 2019-01-02
PAFAL12E
PAFAL12EA5gw
 [Star] [P]
 Ub 230 V Umax 300 V
 Ib 5 A Imax 60 A
 C 6400 imp/kWh
 0:00 0 s
 PT [] CT []
 Upn 30000 V Ipn 800 A
 Usn 57.7 V Isn 5 A

Base voltage of meter under test

Maximum voltage to protect meter

Base (nominal) current

Maximum current


Current transformer if used and its primary and secondary nominal current

Potential transformer if used and its primary and secondary nominal voltage

Conclusion: parameters of different types of metres can be stored with individual names in data base and then recalled during automated tests

TS33 functionality: Automatic energy meter test – Procedure



-  - error test
- repeatability
- start up current
- no load, creep test
- register (dial) test

Type of test

Error limit

Time of test

Number of measurements for averaging

Name of load point

Load point parameters in [%] of base value defined in Meter Type

Phase shift or power factor

Symmetry of voltages and rotation direction

Harmonics in signal

Synchronization with network frequency

005 LOAD

lim 1.000 | t 10 s | n 3

	L1	L2	L3	L123
U	100.000 %	100.000 %	100.000 %	<input checked="" type="checkbox"/>
I	5.000 %	STB %	STB %	<input type="checkbox"/>
ϕ	10.00 °	10.00 °	10.00 °	<input checked="" type="checkbox"/>
L123	0.00 °	120.00 °	-120.00 °	<input type="checkbox"/>
f	50.000 Hz	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Table with load points

T	005 LOAD
Z	005 LOAD
I	005 LOAD
L	005 LOAD
F	005 LOAD
E	005 LOAD

Conclusion: it is possible to define each load point and kind of test and then save the sequence of points in one procedure in data base, which can be recalled during automated tests

TS33 functionality: Automatic energy meter test – Execution

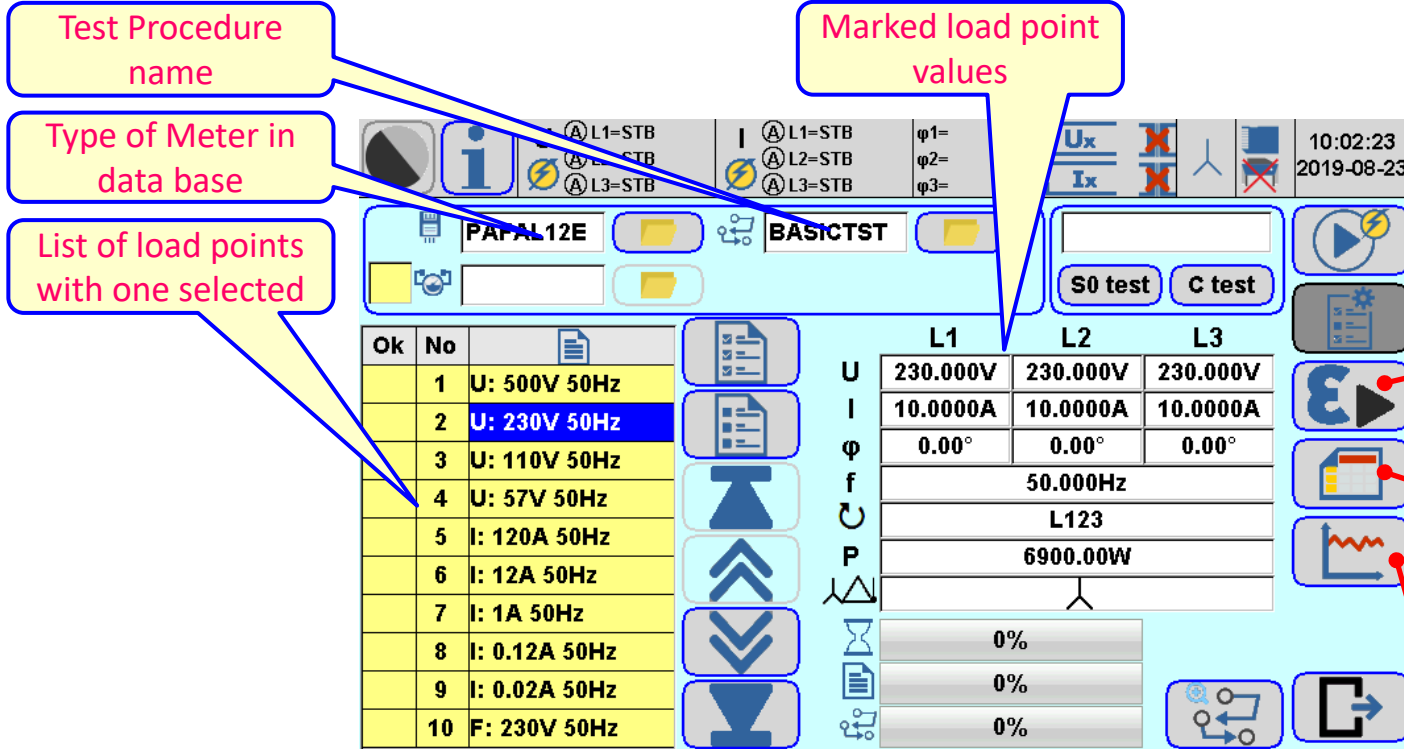


Test Procedure name

Type of Meter in data base

List of load points with one selected

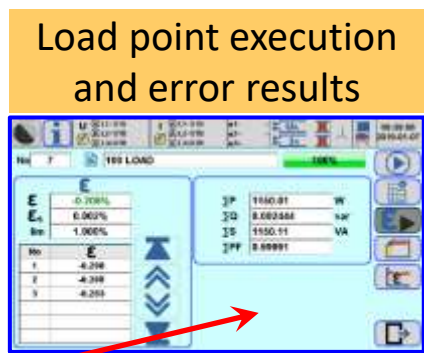
Marked load point values



Ok	No	
	1	U: 500V 50Hz
	2	U: 230V 50Hz
	3	U: 110V 50Hz
	4	U: 57V 50Hz
	5	I: 120A 50Hz
	6	I: 12A 50Hz
	7	I: 1A 50Hz
	8	I: 0.12A 50Hz
	9	I: 0.02A 50Hz
	10	F: 230V 50Hz

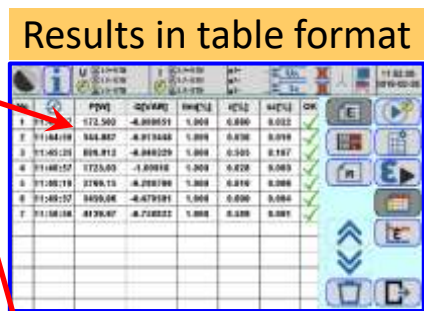
	L1	L2	L3
U	230.000V	230.000V	230.000V
I	10.0000A	10.0000A	10.0000A
φ	0.00°	0.00°	0.00°
f	50.000Hz		
P	6900.00W		
	0%		
	0%		
	0%		

Load point execution and error results



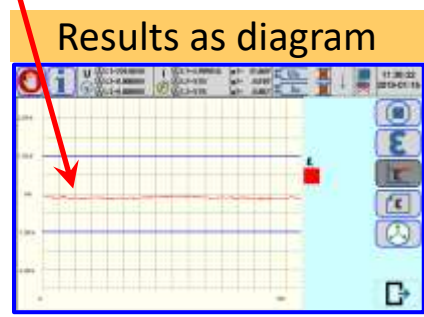
No	E	φ	IS	ISF
1	0.00%	1140.01	W	
2	0.00%	8.00244	VA	
3	1.00%	1550.11	VA	
		0.00001		

Results in table format



	PPW	SDVAR	PHASE	φS2	φS12	OK
1	1144.18	572.50	-0.00001	0.00	0.00	
2	348.807	-0.01000	0.00	0.00	0.00	
3	1140.25	808.812	-0.00020	0.00	0.00	
4	3140.57	1725.00	-0.00010	0.00	0.00	
5	3110.19	1706.13	-0.00000	0.00	0.00	
6	3110.57	1400.06	-0.07000	0.00	0.00	
7	3110.08	8190.07	-0.70000	0.00	0.00	

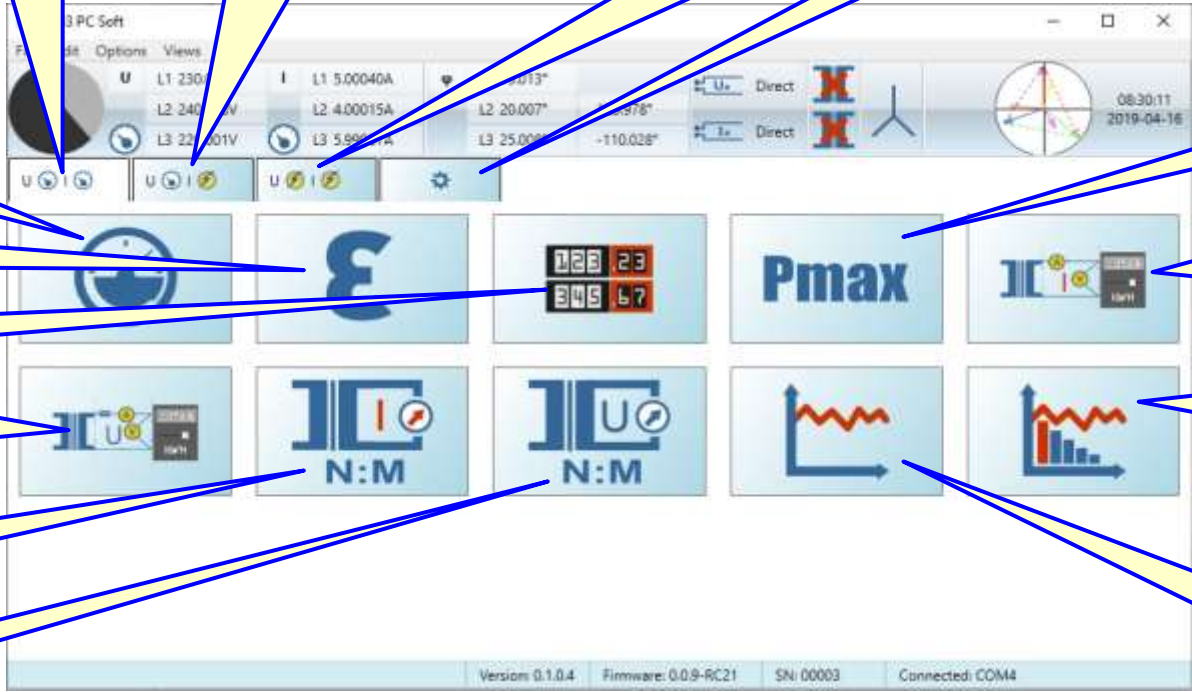
Results as diagram



Conclusion: Automatic testing allows to perform full test of Energy Meter on site due to Meter Type and Procedures stored in data base. As results are displayed:

- table, which can be stored in memory and transferred to PC
- diagram of error in [%] against load pint in the procedure

TS33 PC Soft functionality: all of TS33 functions can be accessed in remote way



The screenshot shows the TS33 PC Soft interface with various testing functions highlighted by callouts:

- Reference meter mode
- Reference meter with current injection mode
- Voltage and current source with built in reference meter mode
- TS33 General Settings
- RMS values at TS33 terminals
- Meter error testing
- Register (counter) testing
- PT Burden test
- CT ratio test
- PT ratio test
- Maximum demand meter testing
- CT Burden test
- Harmonics trend
- All quantities trend (versus time) observation

Conclusion: All functionality of the TS33 is available through **USB, Bluetooth and Ethernet** connection (including **Internet** remote control). TS33 PC Soft enables to download real time results of measurement made by TS33, download stored in memory results, readout the SD card memory and remote control of measurements. Results can be then saved in Data Base, printed or exported to eg. Excel sheet.

TS33 PC Soft functionality: example screenshots

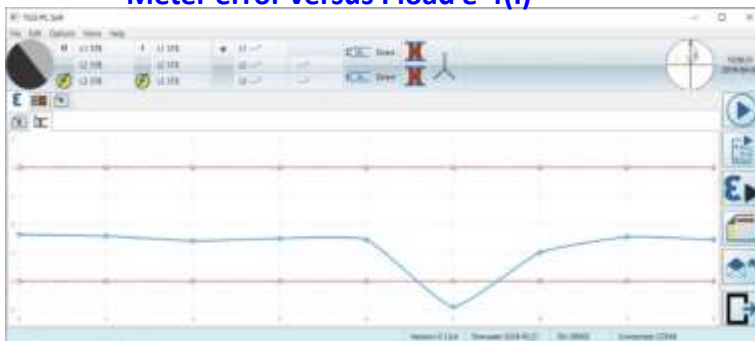
RMS values of U,I, ϕ ,F,P,Q,S



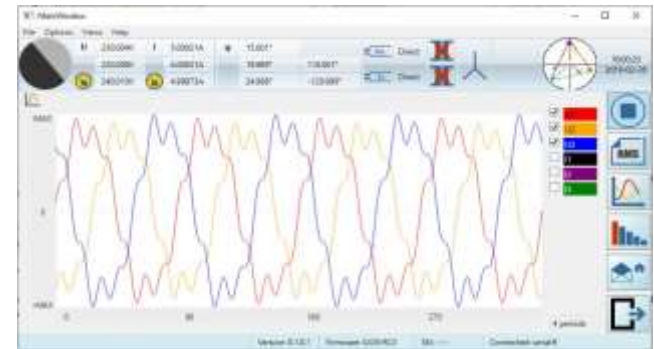
Voltage, current and THD trend



Meter error versus I load $\epsilon=f(I)$



Voltage U1, U2, U3 oscilloscope



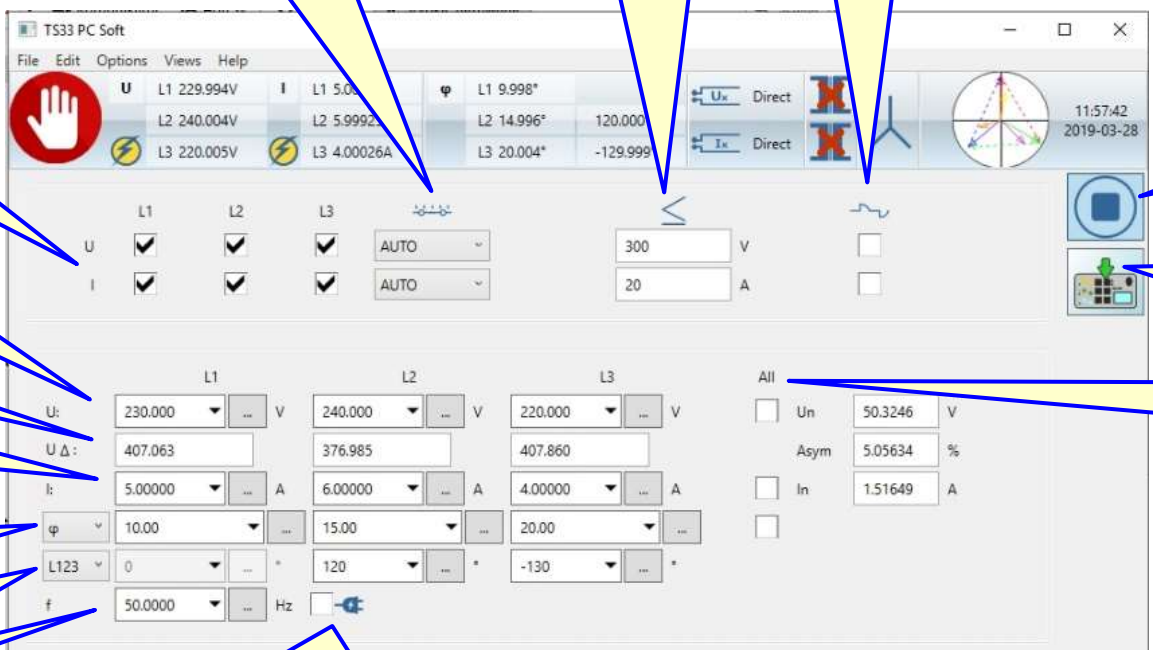
Harmonics in voltage U1



Harmonics in table form



TS33 PC Soft functionality: remote control of TS33 source



The screenshot shows the TS33 PC Soft interface with the following callouts:

- Operation with auto range or constant range**: Points to the 'AUTO' dropdown menus for voltage and current.
- Setting maximum value of Voltage or Current**: Points to the numerical input fields for voltage (300 V) and current (20 A).
- Switching harmonics ON / OFF**: Points to the harmonic control buttons.
- Switching ON / OFF of individual U & I channels**: Points to the 'U' and 'I' checkboxes for each phase.
- Voltage in phase L1 L2 L3**: Points to the 'U' row checkboxes.
- Voltage between phases**: Points to the phase angle settings.
- Current in phase L1 L2 L3**: Points to the 'I' row checkboxes.
- Phase shift U&I**: Points to the phase angle settings for U and I.
- Phase shift between Voltages**: Points to the 'L123' phase shift settings.
- Frequency setting**: Points to the frequency input field (50.0000 Hz).
- Frequency synchronised with power frequency**: Points to the synchronization checkbox.
- START / STOP generation**: Points to the blue square button.
- Set data acceptance**: Points to the data acceptance button.
- Setting the same value for all three phases**: Points to the 'All' checkbox and the summary table.

	L1	L2	L3
Un	50.3246 V		
Asym	5.05634 %		
In	1.51649 A		

- ▶ Individual setting in each phase value of voltage, current, power factor and phase shift between voltages,
- ▶ Independent switching ON / OFF of each current and voltage in phase L1, L2, L3,
- ▶ Automatic or manual range selection,
- ▶ Protection against overvoltage or overcurrent
- ▶ Pure sinusoidal or harmonic distorted signal generation

TS33: testing single phase electromechanical Energy Meter example (1)

TS33 as Reference Meter and meter under test directly connected



Meter parameters:

Base voltage: 230V

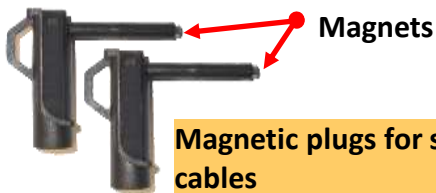
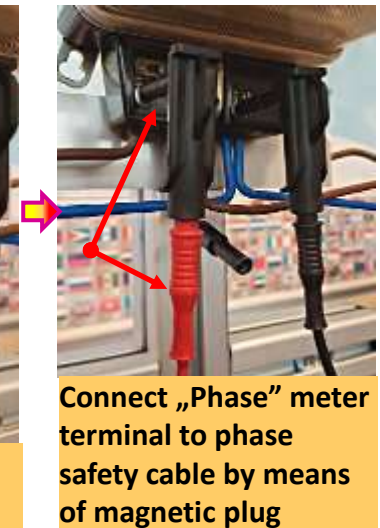
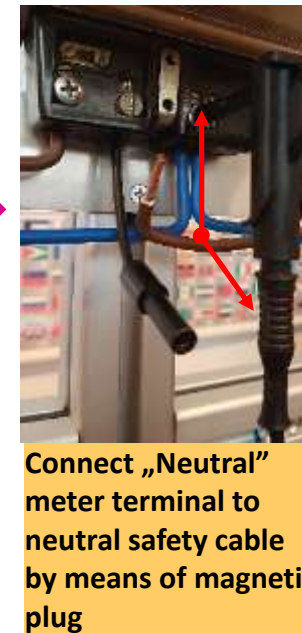
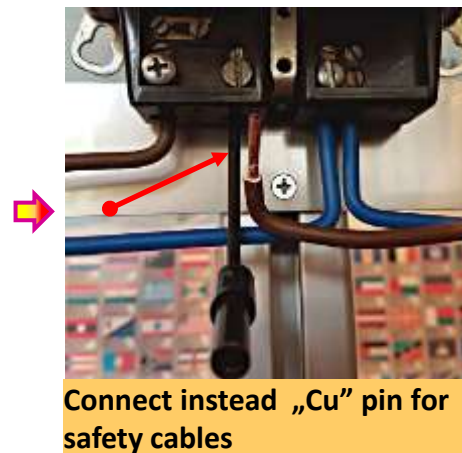
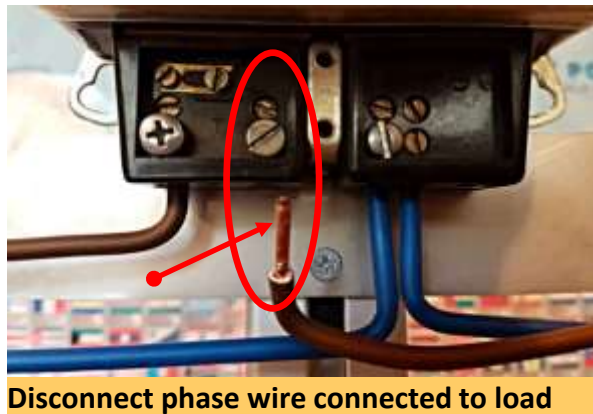
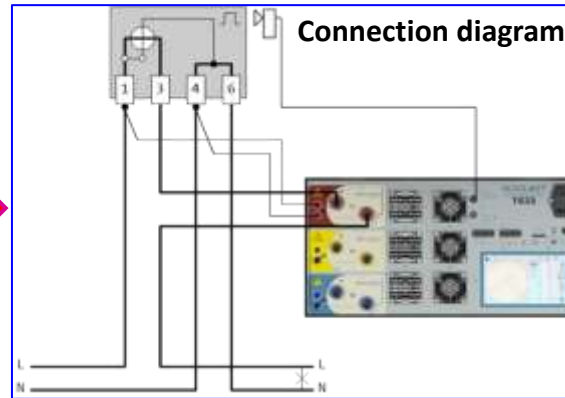
Base current: 5A

Max. current: 40A

Meter constant:

375 turns/kWh

Typical, „old fashioned”, electromechanical meter and its parameters



TS33 : testing single phase electromechanical Energy Meter example (2)

TS33 as Reference Meter and meter under test directly connected



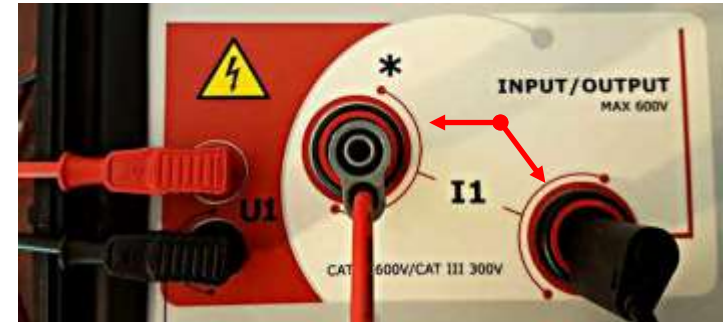
Connect cables from meter to voltage inputs of TS33



Connect phase current cable to „Cu” pin (red)



Connect return current cable by means of crocodile clip (black)



Connect current cables from meter to current inputs of TS33



Crocodile clip



Scanning head assembly:

- place mechanical fixing device in front of rotor
- „click” scanning head into hole
- connect cable to TS33 scanning head input no1

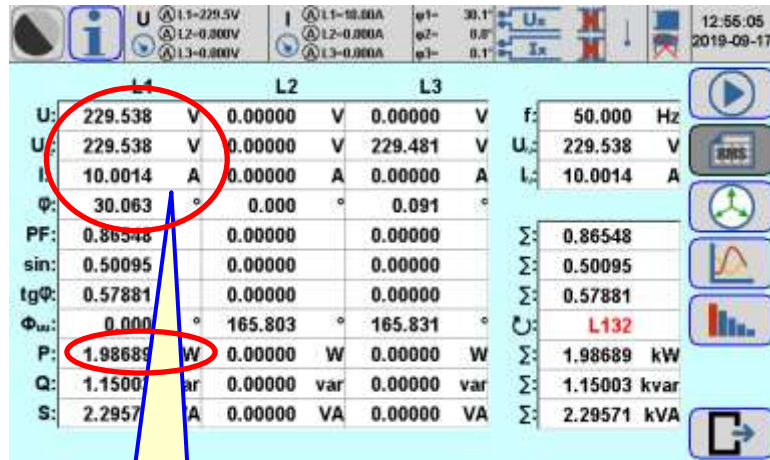
Now the measurement system is ready to test meter error and register test

In the TS33 LCD select U&I measurement mode and then RMS measurements, error test or register test



TS33 : testing single phase electromechanical Energy Meter example (3)

TS33 as Reference Meter and meter under test directly connected



Vector diagram



Testing schedule:

- connect meter
- check voltage current, PF and vector diagram
- enter meter parameters and start error measurement

Load point parameters

Meter constant

Class of Meter under test

TS33 enables fast end efficient way of testing

Type of power measured by meter

Time of test

Number of results for averaging

Table with recorded results versus time



Averaged error result

Standard deviation

Partial error results

No	P[W]	Q[VAR]	LI	ε[%]	σε[%]	OK	
1	13:05:14	1987.55	1149.65	2.000	0.716	0.009	✓
2	13:09:23	1987.42	1149.91	2.000	0.634	0.014	✓
3	13:10:50	1987.43	1149.89	2.000	0.706	0.004	✓
4	13:12:16	1987.42	1149.79	2.000	0.674	0.018	✓
5	13:13:43	1987.40	1149.88	2.000	0.705	0.003	✓
6	13:15:09	1987.43	1149.90	2.000	0.712	0.002	✓
7	13:16:35	1987.42	1149.77	2.000	0.714	0.003	✓
8	13:18:02	1987.41	1149.63	2.000	0.709	0.003	✓
9	13:19:26	1987.40	1149.74	2.000	0.694	0.006	✓
10	13:20:55	1987.39	1149.79	2.000	0.696	0.001	✓
11	13:22:20	1987.36	1149.85	2.000	0.652	0.004	✓
12	13:23:47	1987.29	1149.97	2.000	0.678	0.004	✓
13	13:25:13	1987.29	1150.05	2.000	0.628	0.016	✓

TS33 : testing single phase electronic (static) Energy Meter example (1)

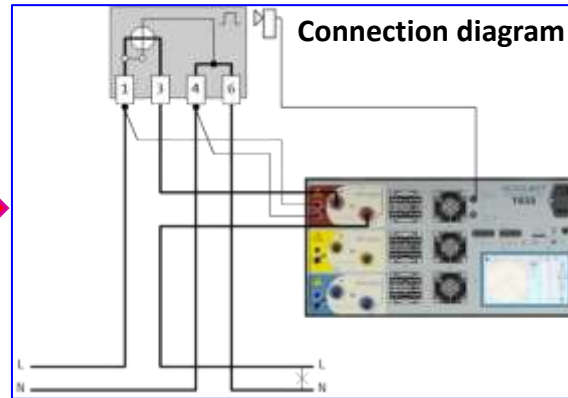
TS33 as Reference Meter and meter under test directly connected



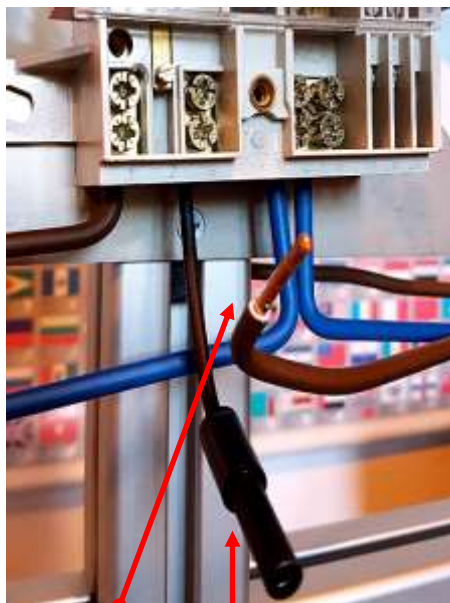
Meter parameters:

Base voltage: 230V
Base current: 5A
Max. current: 60A
Meter constant:
6400 imp/kWh

Typical single phase electronic meter with LED and its parameters



Wiring to meter terminals



Disconnect phase wire connected to load and connect „Cu” pin



Connect safety plug and crocodile clip to phase and load current accordingly



Connect voltage by safety magnetic plugs



Connect voltage and current to TS33 inputs

TS33 : testing single phase electronic (static) Energy Meter example (2)

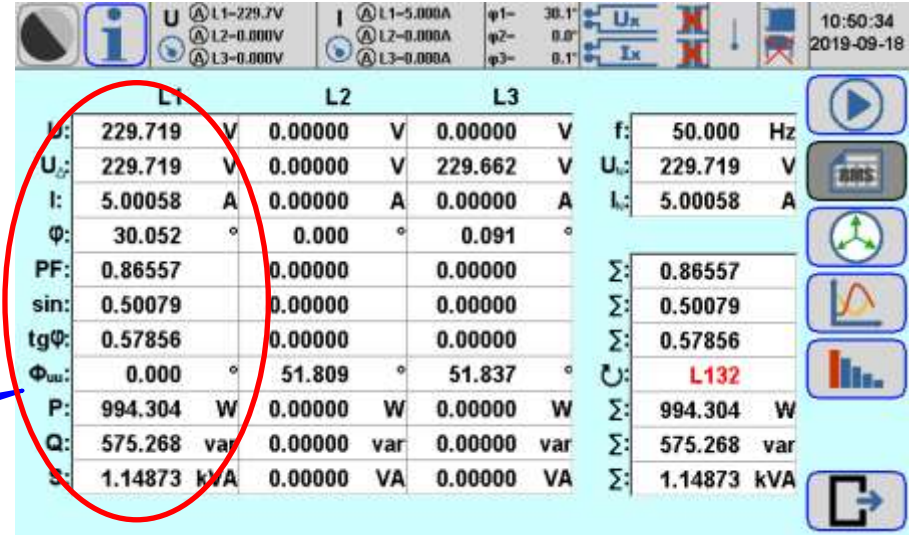
TS33 as Reference Meter and meter under test directly connected



Assembly scanning head fix to see LED in hole

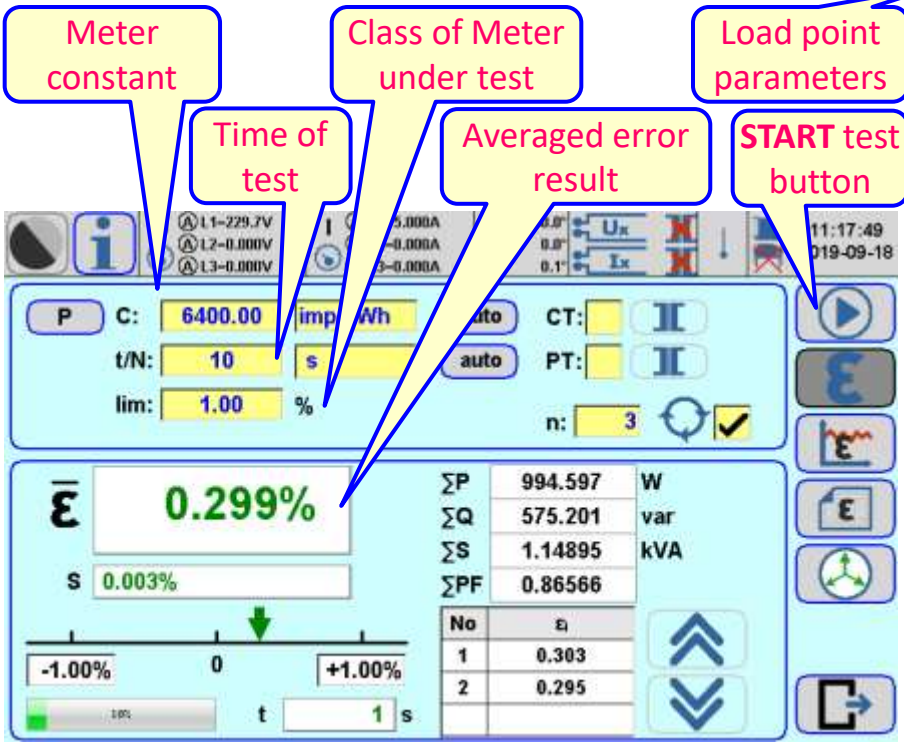


„Click” scanning head and set LED sensing option



U: L1-229.7V, L2-0.000V, L3-0.000V
 I: L1-5.000A, L2-0.000A, L3-0.000A
 φ1-30.1°, φ2-0.0°, φ3-0.1°

	L1	L2	L3	
U:	229.719 V	0.00000 V	0.00000 V	f: 50.000 Hz
U ₀ :	229.719 V	0.00000 V	229.662 V	U ₀ : 229.719 V
I:	5.00058 A	0.00000 A	0.00000 A	I ₀ : 5.00058 A
φ:	30.052 °	0.000 °	0.091 °	
PF:	0.86557	0.00000	0.00000	Σ: 0.86557
sin:	0.50079	0.00000	0.00000	Σ: 0.50079
tgφ:	0.57856	0.00000	0.00000	Σ: 0.57856
Φ _{uu} :	0.000 °	51.809 °	51.837 °	U: L132
P:	994.304 W	0.00000 W	0.00000 W	Σ: 994.304 W
Q:	575.268 var	0.00000 var	0.00000 var	Σ: 575.268 var
S:	1.14873 kVA	0.00000 VA	0.00000 VA	Σ: 1.14873 kVA



Meter constant: 6400.00 imp/Wh
Class of Meter under test: CT: I, PT: I, n: 3
Time of test: t/N: 10 s, lim: 1.00 %
Averaged error result: $\bar{\epsilon}$ 0.299%, S 0.003%
START test button: [Play icon]
Summary: ΣP 994.597 W, ΣQ 575.201 var, ΣS 1.14895 kVA, ΣPF 0.86566
Table:

No	ε _i
1	0.303
2	0.295

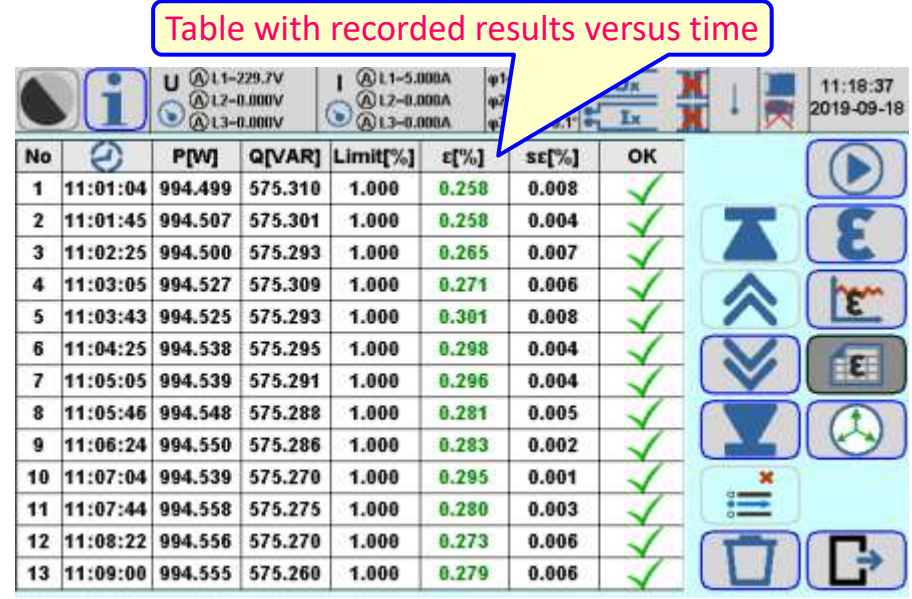


Table with recorded results versus time

No	Time	P[W]	Q[VAR]	Limit[%]	ε[%]	se[%]	OK
1	11:01:04	994.499	575.310	1.000	0.258	0.008	✓
2	11:01:45	994.507	575.301	1.000	0.258	0.004	✓
3	11:02:25	994.500	575.293	1.000	0.265	0.007	✓
4	11:03:05	994.527	575.309	1.000	0.271	0.006	✓
5	11:03:43	994.525	575.293	1.000	0.301	0.008	✓
6	11:04:25	994.538	575.295	1.000	0.298	0.004	✓
7	11:05:05	994.539	575.291	1.000	0.296	0.004	✓
8	11:05:46	994.548	575.288	1.000	0.281	0.005	✓
9	11:06:24	994.550	575.286	1.000	0.283	0.002	✓
10	11:07:04	994.539	575.270	1.000	0.295	0.001	✓
11	11:07:44	994.558	575.275	1.000	0.280	0.003	✓
12	11:08:22	994.556	575.270	1.000	0.273	0.006	✓
13	11:09:00	994.555	575.260	1.000	0.279	0.006	✓

TS33 : testing single phase electronic (static) Energy Meter example (1)

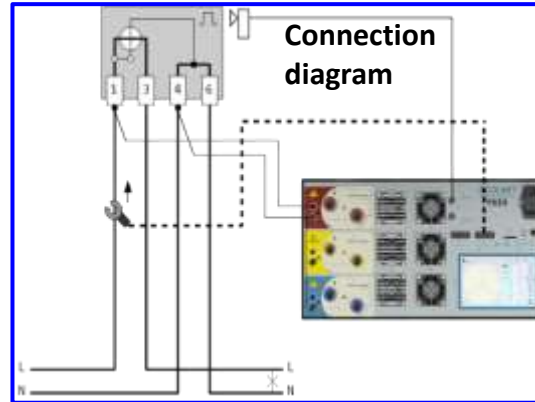
TS33 as Reference Meter and meter under test connected by **current clamps CT100AC**



Meter parameters:

Base voltage: 230V
Base current: 5A
Max. current: 60A
Meter constant:
6400 imp/kWh

Typical single phase electronic meter with LED and its parameters



Wiring to meter terminals



Current clamp closed on phase to load cable. Note **direction =>!**



Connect current clamps plug into the socket on TS33. Clamp symbol appears on display.



Connect voltage magnetic plugs and assembly the scanning head

TS33 : testing single phase electronic (static) Energy Meter example (2)

TS33 as Reference Meter and meter under test connected by **current clamps CT100AC**



Connect voltage cables to TS33

	L2	L3	
U ₁	229.736 V	0.00000 V	0.00000 V
U ₂	229.736 V	0.00000 V	229.679 V
I ₁	4.99855 A	0.00000 A	0.00000 A
φ	30.030 °	0.000 °	0.729 °
PF	0.86576	0.00000	0.00000
sin	0.50046	0.00000	0.00000
gφ	0.57806	0.00000	0.00000
φ _{un}	0.000 °	-2.673 °	-2.645 °
P	994.190 W	0.00000 W	0.00000 W
Q	574.702 var	0.00000 var	0.00000 var
S	1.14835 kVA	0.00000 VA	0.00000 VA

Current clamps connected

Load point parameters

START test button

Current clamps do not require any break or modification of metering installation

Meter constant: 6400.00 imp/kWh
Class of Meter under test: auto
Time of test: 10 s
Averaged error result: 0.350%
Table with recorded results versus time:

No	ε
1	0.345
2	0.355

No	Time	P[W]	Q[VAR]	Limit[%]	ε[%]	se[%]	OK
1	11:43:03	994.163	574.684	1.000	0.353	0.005	✓
2	11:43:43	994.177	574.689	1.000	0.350	0.001	✓
3	11:44:21	994.173	574.689	1.000	0.355	0.003	✓
4	11:45:01	994.164	574.686	1.000	0.356	0.003	✓
5	11:45:41	994.172	574.688	1.000	0.345	0.004	✓
6	11:46:22	994.173	574.686	1.000	0.356	0.004	✓
7	11:47:03	994.161	574.674	1.000	0.367	0.004	✓
8	11:47:44	994.165	574.675	1.000	0.374	0.006	✓
9	11:48:25	994.165	574.676	1.000	0.382	0.005	✓
10	11:49:04	994.167	574.677	1.000	0.378	0.006	✓
11	11:49:47	994.174	574.681	1.000	0.369	0.005	✓
12	11:50:27	994.161	574.669	1.000	0.381	0.006	✓
13	11:51:08	994.175	574.673	1.000	0.371	0.005	✓

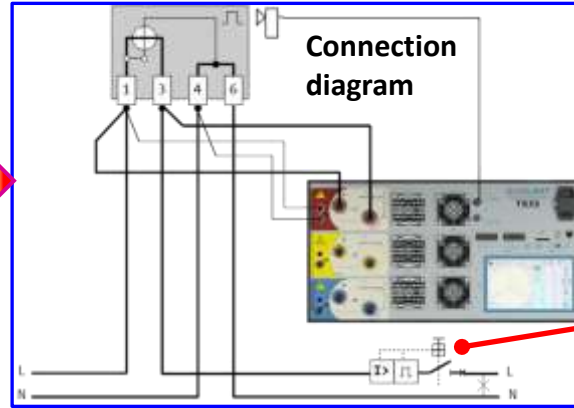
TS33 : testing single phase electronic (static) Energy Meter example (1)

TS33 as **Current Source** and Reference Meter and meter under test connected **directly**



Meter parameters:
Base voltage: 230V
Base current: 5A
Max. current: 60A
Meter constant: 6400 imp/kWh

Typical single phase electronic meter with LED and its parameters



CAUTION!!!
Switch OFF the circuit breaker before TS33 connection (voltage is taken from network, current is injected by TS33)



connect current input and output of the meter (eg. magnetic plugs) by means of safety cables to TS33 current inputs; connect neutral meter terminal to the neutral voltage input of TS33; Shunt TS33 voltage input and current output (*).



In the TS33 LCD select U measurement and I generation mode

Setting value of current and phase shift

RMS measured values

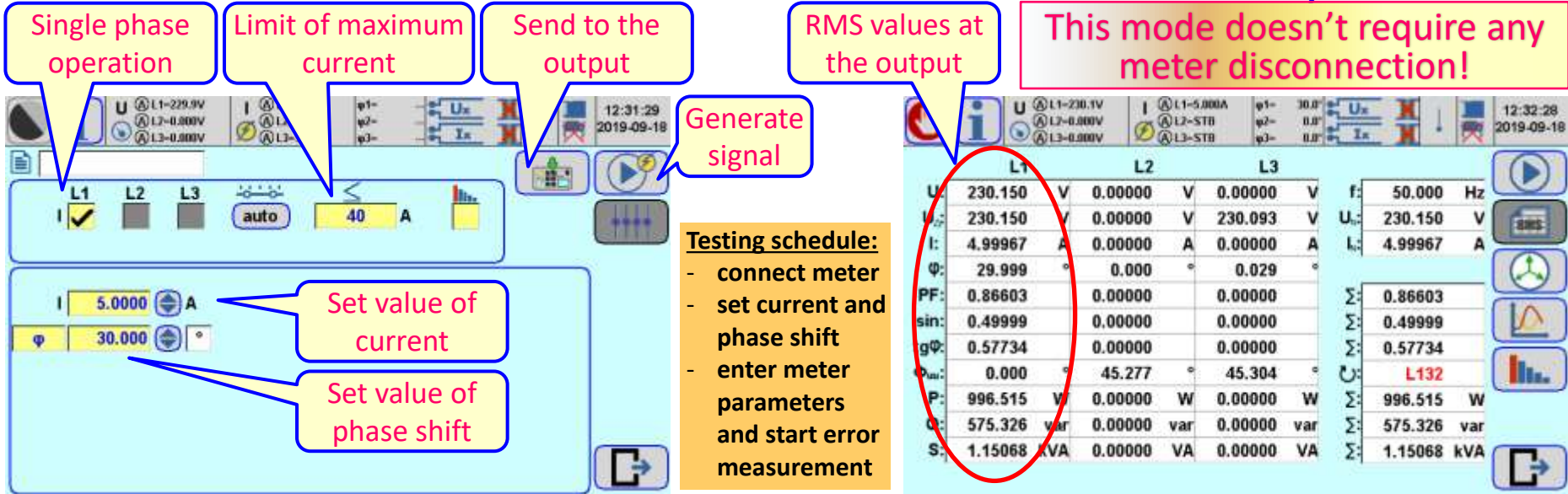
Meter error test

Meter register test



TS33 : testing single phase electronic (static) Energy Meter example (2)

TS33 as **Current Source** and Reference Meter and meter under test connected **directly**



Single phase operation

Limit of maximum current

Send to the output

RMS values at the output

This mode doesn't require any meter disconnection!

Generate signal

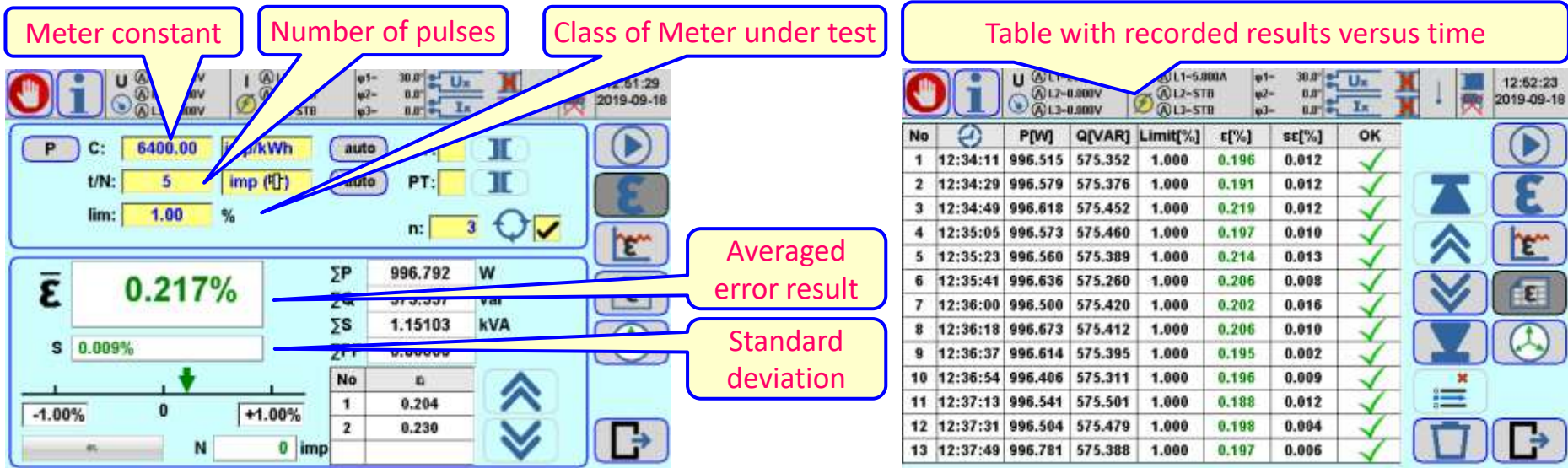
Testing schedule:

- connect meter
- set current and phase shift
- enter meter parameters and start error measurement

Set value of current

Set value of phase shift

	L1	L2	L3	
U	230.150 V	0.00000 V	0.00000 V	f: 50.000 Hz
V	230.150 V	0.00000 V	230.093 V	U ₁ : 230.150 V
I	4.99967 A	0.00000 A	0.00000 A	I ₁ : 4.99967 A
φ	29.999 °	0.000 °	0.029 °	
PF	0.86603	0.00000	0.00000	Σ: 0.86603
sin	0.49999	0.00000	0.00000	Σ: 0.49999
gφ	0.57734	0.00000	0.00000	Σ: 0.57734
φ _{sum}	0.000 °	45.277 °	45.304 °	Σ: L132
P	996.515 W	0.00000 W	0.00000 W	Σ: 996.515 W
Q	575.326 var	0.00000 var	0.00000 var	Σ: 575.326 var
S	1.15068 kVA	0.00000 VA	0.00000 VA	Σ: 1.15068 kVA



Meter constant

Number of pulses

Class of Meter under test

Table with recorded results versus time

Averaged error result

Standard deviation

No		P[W]	Q[VAR]	Limit[%]	e[%]	se[%]	OK
1	12:34:11	996.515	575.352	1.000	0.196	0.012	✓
2	12:34:29	996.579	575.376	1.000	0.191	0.012	✓
3	12:34:49	996.618	575.452	1.000	0.219	0.012	✓
4	12:35:05	996.573	575.460	1.000	0.197	0.010	✓
5	12:35:23	996.560	575.389	1.000	0.214	0.013	✓
6	12:35:41	996.636	575.260	1.000	0.206	0.008	✓
7	12:36:00	996.500	575.420	1.000	0.202	0.016	✓
8	12:36:18	996.673	575.412	1.000	0.206	0.010	✓
9	12:36:37	996.614	575.395	1.000	0.195	0.002	✓
10	12:36:54	996.406	575.311	1.000	0.196	0.009	✓
11	12:37:13	996.541	575.501	1.000	0.188	0.012	✓
12	12:37:31	996.504	575.479	1.000	0.198	0.004	✓
13	12:37:49	996.781	575.388	1.000	0.197	0.006	✓

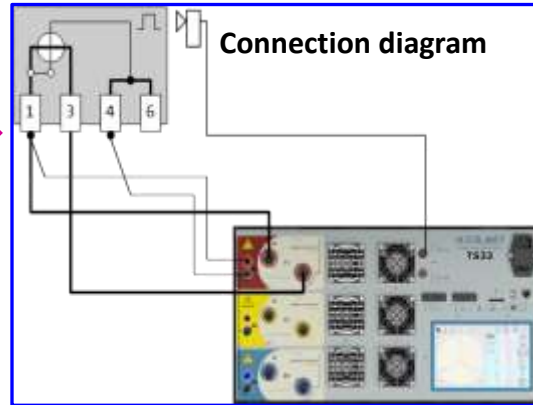
TS33 : testing single phase electronic (static) Energy Meter example (1)

TS33 as **Voltage and Current Source** and Reference Meter and meter under test connected **directly**



Meter parameters:
 Base voltage: 230V
 Base current: 5A
 Max. current: 60A
 Meter constant: 6400 imp/kWh

Typical single phase electronic meter with LED and its parameters



CAUTION!!! Unconnect meter from network before connection to TS33 (voltage and current is delivered by TS33)

In the TS33 LCD select U and I generation mode

Setting value of voltage, current and phase shift

Setting value of U, I, φ , f in asymmetrical circuit



connect current input and output of the meter (eg. By „Cu” pins) by means of safety cables to TS33 current inputs; connect neutral meter terminal to the neutral voltage input of TS33; Shunt TS33 voltage input and current output (*).



RMS measured values

Meter error test

Meter register test



TS33 : testing single phase electronic (static) Energy Meter example (2)

TS33 as **Voltage and Current Source** and Reference Meter and meter under test connected **directly**

Single phase operation

Limit of maximum current

Send to the output

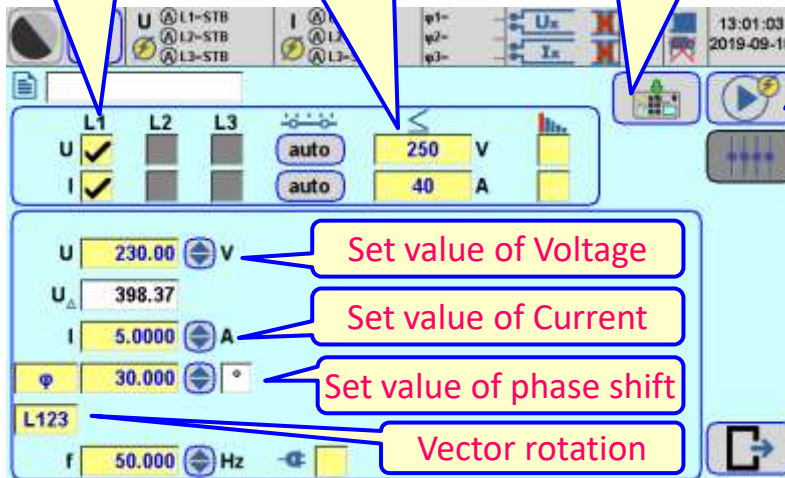
RMS values at the output

This mode doesn't require any meter disconnection!

Generate signal

Testing schedule:

- connect meter
- set current and phase shift
- enter meter parameters and start error measurement



Set value of Voltage

Set value of Current

Set value of phase shift

Vector rotation

Meter constant

Number of pulses

Class of Meter under test

Averaged error result

Standard deviation

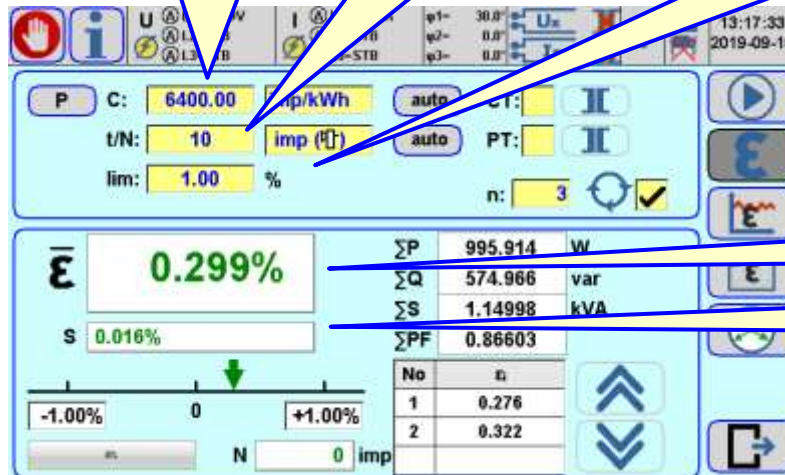


Table with recorded results versus time

No		P[W]	Q[VAR]	Limit[%]	t[%]	sc[%]	OK
1	13:04:29	995.990	574.989	1.000	0.229	0.011	✓
2	13:04:57	995.846	574.987	1.000	0.224	0.006	✓
3	13:05:25	995.810	574.975	1.000	0.220	0.007	✓
4	13:05:52	996.029	575.047	1.000	0.228	0.003	✓
5	13:06:19	995.970	574.951	1.000	0.226	0.007	✓
6	13:06:46	995.954	574.831	1.000	0.219	0.007	✓
7	13:07:13	996.037	575.059	1.000	0.224	0.003	✓
8	13:07:40	995.932	575.016	1.000	0.236	0.010	✓
9	13:08:06	995.960	575.051	1.000	0.245	0.009	✓
10	13:08:33	995.843	574.916	1.000	0.243	0.005	✓
11	13:09:00	995.930	574.981	1.000	0.245	0.005	✓
12	13:09:27	995.835	574.965	1.000	0.267	0.007	✓
13	13:09:54	995.842	575.066	1.000	0.265	0.005	✓

TS33 : testing three phase electronic (static) Energy Meter example (1)

TS33 as Reference Meter and meter under test connected by means of **current clamps**

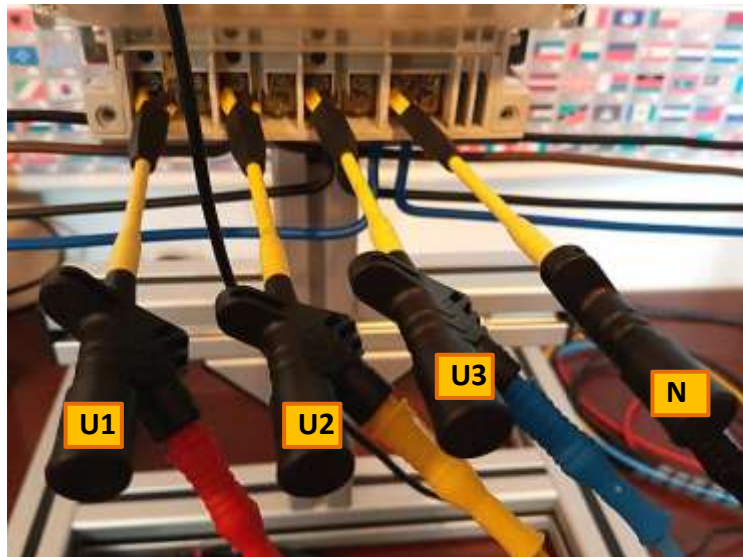
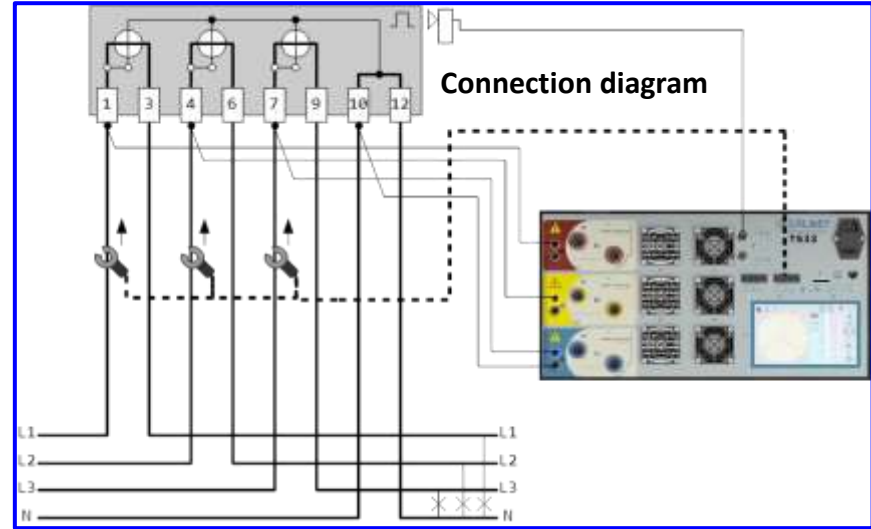


Meter parameters:

Base voltage: 230V
Base current: 5A
Max. current: 100A
Meter constant: 1000 imp/kWh

Typical three phase electronic meter with LED and its parameters

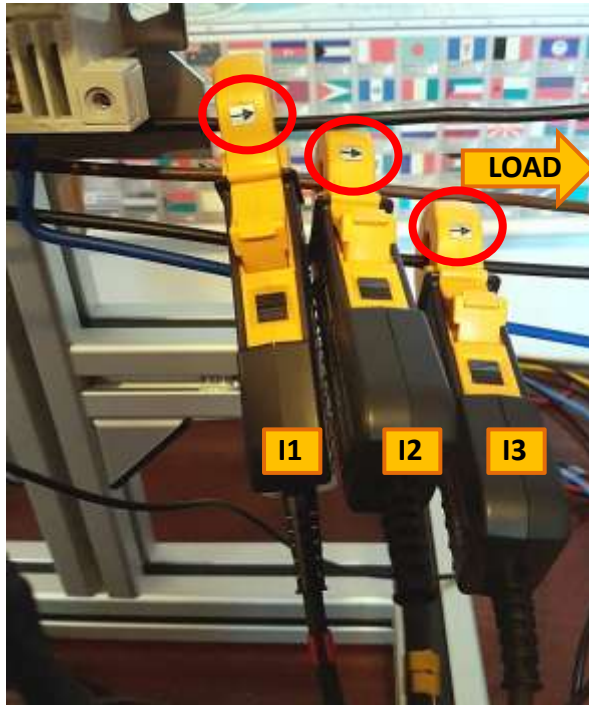
Connect voltage U1, U2, U3 and neutral N by means of crocodile clips



Connect voltage U1, U2, U3 and neutral N to voltage inputs of TS33. Neutral inputs in the TS33 are internally connected between them.

TS33 : testing three phase electronic (static) Energy Meter example (2)

TS33 as Reference Meter and meter under test connected by means of current clamps



Close current clamps on load cables, respectively I1, I2, I3. Take care about clamps direction (⇒)

Assembly to the meter and connect to the TS33 photo scanning head



Open clamp jaws and place them on wire. Direction (⇒)!

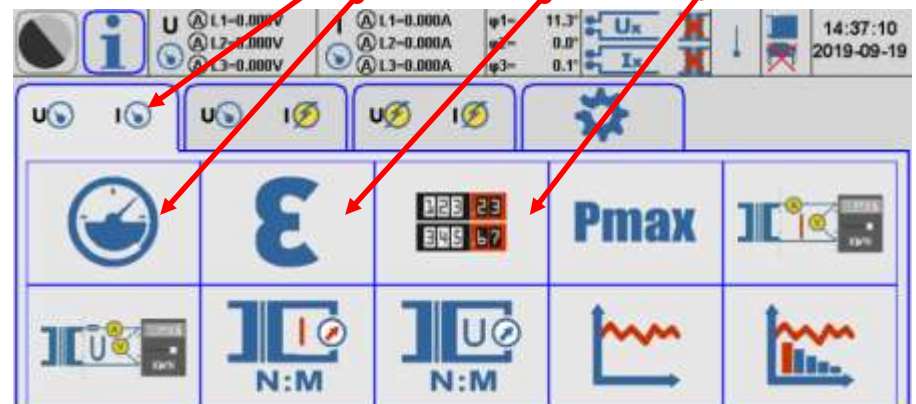


Close clamp jaws and lock them. Direction (⇒)!



Connect common current clamps output to the TS33 input

In the TS33 LCD select U&I measurement mode and then RMS measurements, error test or register test



TS33 : testing three phase electronic (static) Energy Meter example (3)

TS33 as Reference Meter and meter under test connected by means of current clamps

Load point parameters CT100AC current clamp This mode doesn't require any meter disconnection!

	L1	L2	L3
U:	229.658 V	239.747 V	219.654 V
U _φ :	406.523 V	397.916 V	389.304 V
I:	4.99845 A	4.00007 A	5.99794 A
φ:	14.993 °	19.999 °	24.983 °
PF:	0.96596	0.93970	0.90643
sin:	0.25870	0.34200	0.42235
tgφ:	0.26781	0.36395	0.46595
Q _{act} :	0.000	119.994	-120.038
P:	1.10885 kW	901.173 W	1.19420 kW
Q:	296.967 var	327.984 var	556.436 var
S:	1.14793 kVA	959.005 VA	1.31747 kVA

Vector diagram

Testing schedule:

- connect voltage and current by clamps
- enter meter parameters and start error measurement

U1:	229.659 V
U2:	239.748 V
U3:	219.656 V
I1:	4.99847 A
I2:	4.00009 A
I3:	5.99795 A
φ 1:	14.993 °
φ 2:	19.999 °
φ 3:	24.983 °
U _u :	2.498 %
U _c :	L123
U _φ :	17.4873 V
I _φ :	2.44526 A

Meter constant Time of test Class of Meter under test

C: 1000.00 p/kWh

t/N: 5 s

lim: 2.00 %

CT: II

PT: II

n: 3

ΣP: 0.00000 W

ΣQ: 0.00000 var

ΣS: 0.00000 VA

ΣPF: 0.00000

ε: 0.062%

Standard deviation

Table with recorded results versus time

No		P[W]	Q[VAR]	Limit[%]	ε[%]	se[%]	OK
1	13:35:13	3204.27	1181.38	2.000	0.032	0.013	✓
2	13:35:54	3204.27	1181.39	2.000	0.046	0.010	✓
3	13:36:36	3204.26	1181.38	2.000	0.026	0.004	✓
4	13:37:15	3204.29	1181.39	2.000	0.031	0.001	✓
5	13:38:00	3204.28	1181.39	2.000	0.042	0.007	✓
6	13:38:44	3204.26	1181.39	2.000	0.044	0.007	✓
7	13:39:26	3204.28	1181.39	2.000	0.045	0.009	✓
8	13:40:08	3204.28	1181.39	2.000	0.039	0.004	✓
9	13:40:50	3204.31	1181.41	2.000	0.032	0.006	✓
10	13:41:33	3204.28	1181.40	2.000	0.035	0.005	✓
11	13:42:15	3204.31	1181.40	2.000	0.044	0.006	✓
12	13:42:57	3204.30	1181.40	2.000	0.040	0.005	✓
13	13:43:39	3204.30	1181.39	2.000	0.035	0.010	✓

TS33 : testing three phase electronic (static) Energy Meter example (1)

TS33 as **Voltage and Current Source** and Reference Meter and meter under test connected **directly**

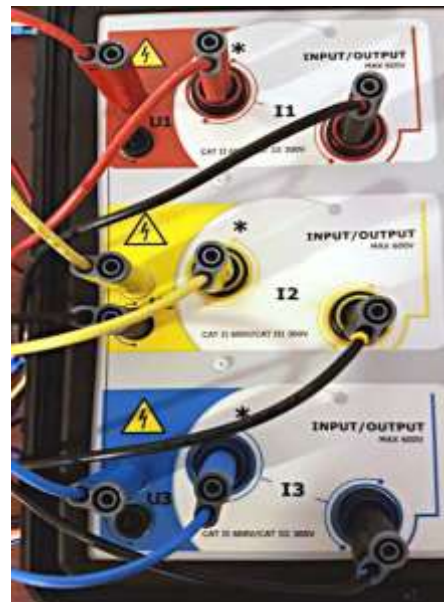
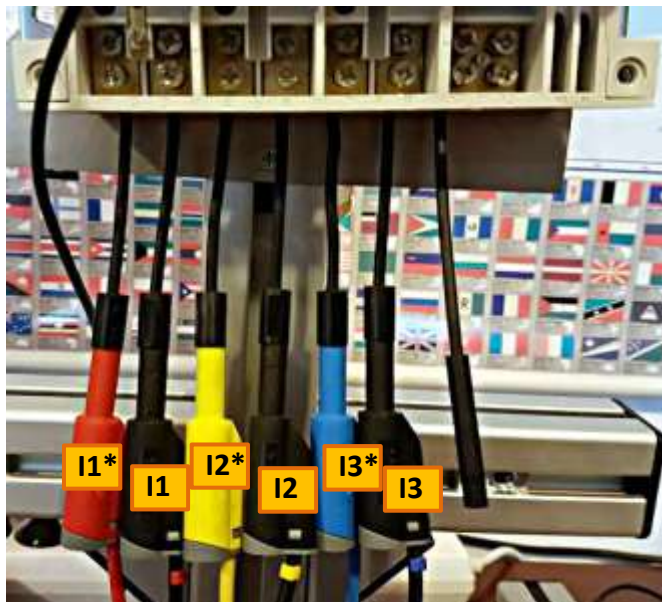
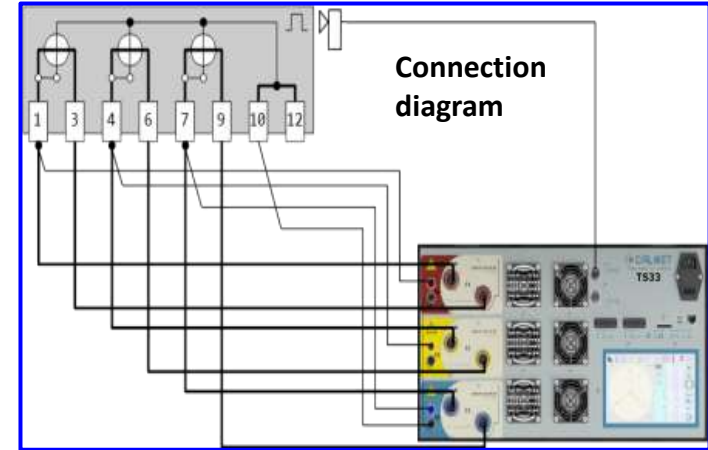


Meter parameters:
Base voltage: 230V
Base current: 5A
Max. current: 100A
Meter constant:
1000 imp/kWh

Typical three phase electronic meter with LED and its parameters

CAUTION!!!
Unconnect meter from network before connection to TS33 (voltage and current is delivered by TS33)

Connect current I1, I2, I3, N by means of „Cu” pins and then voltage U1, U2, U3 by stacked, safety plugs to I1*, I2*, I3* respectively and then to TE33 inputs U and I.



TS33 : testing three phase electronic (static) Energy Meter example (2)

TS33 as **Voltage and Current Source** and Reference Meter and meter under test connected **directly**



Connected meter ready for testing

Setting the output values (load point)

Three phase operation; individual outputs switch ON/OFF

Limit of maximum voltage & current

Send to the output

Generate signal

Set harmonics

Set value of Voltage

Set value of current

Set value of frequency

Set phase shift between U1&U2

Set phase shift between U2&U3

Set value of phase shift U&I

Set synchronization with network frequency

	L1	L2	L3	L123
U	230.00 V	240.00 V	220.00 V	
U _Δ	407.06	398.50	389.74	
I	5.0000 A	4.0000 A	6.0000 A	
φ	15.000 °	20.000 °	25.000 °	
φ ₁₂₃	0.000 °	120.000 °	-120.000 °	
f	50.000 Hz			

In the TS33 LCD select U&I generation mode and then RMS values at the output, setting symmetric U&I, setting asymmetric U&I, error test, register test or whole characteristics test procedure

U I U I U I

ε

23 23
6.7 6.7

Graph icons: sine wave, square wave, sawtooth, etc.

TS33 : testing three phase electronic (static) Energy Meter example (3)

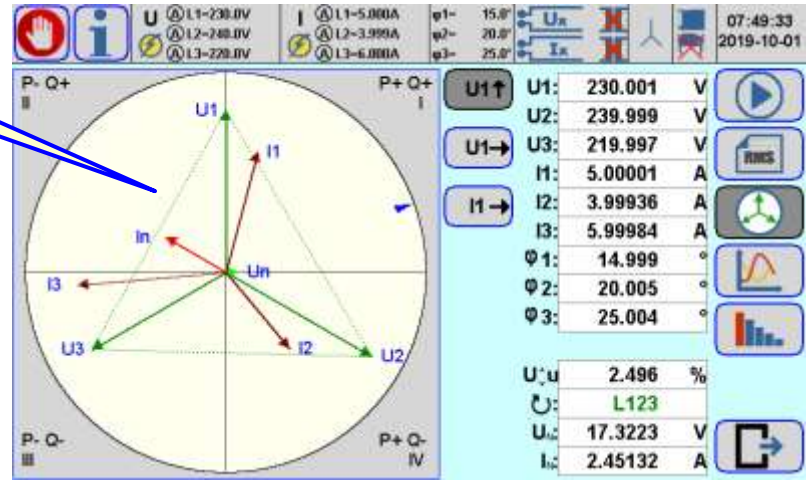
TS33 as Voltage and Current Source and Reference Meter and meter under test connected directly

Load point parameters

	L1	L2	L3	
U _L	229.999 V	240.002 V	220.001 V	f: 50.000 Hz
U _φ	407.050 V	398.497 V	389.825 V	U _φ : 17.3203 V
I	5.00005 A	4.00016 A	5.99939 A	I _L : 2.45044 A
φ	14.998 °	20.007 °	25.007 °	
PF	0.96592	0.93964	0.90624	
sinφ	0.25878	0.34213	0.42272	
gφ	0.26791	0.36411	0.46646	
φ _{un}	0.000 °	120.000 °	-120.000 °	
P	1.11082 kW	902.094 W	1.19613 kW	Σ: 3.20904 kW
Q	297.604 var	328.460 var	557.939 var	Σ: 1.18400 kvar
S	1.15001 kVA	960.046 VA	1.31967 kVA	Σ: 3.42993 kVA

This mode requires meter disconnection!

Vector diagram



Testing schedule:
 - connect voltage and current by clamps
 - enter meter parameters and start error measurement

Meter constant

Time of test

Class of Meter under test

Table with recorded results versus time

P C: 1000.00 imp/kWh
 t/N: 10 imp (kWh)
 lim: 2.00 %
 n: 3

Averaged error result: **0.005%**
 Standard deviation: **0.007%**

No	ε _i
1	0.007
2	-0.008
3	0.015

Averaged error result

Standard deviation

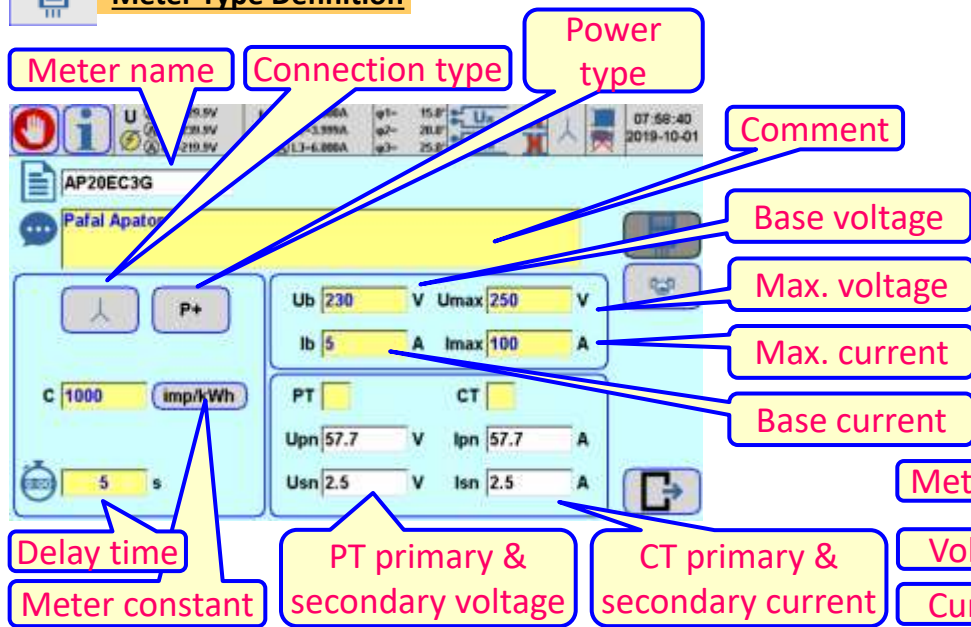
No	Time	P[W]	Q[VAR]	Limit[]	ε[%]	se[%]	OK
1	13:51:53	3209.16	1184.07	2.000	0.059	0.045	✓
2	13:52:10	3209.21	1184.18	2.000	0.038	0.048	✓
3	13:52:28	3208.99	1184.08	2.000	0.008	0.022	✓
4	13:52:48	3209.13	1183.98	2.000	0.117	0.010	✓
5	13:53:06	3209.15	1184.15	2.000	-0.011	0.023	✓
6	13:53:24	3209.19	1184.04	2.000	0.079	0.037	✓
7	13:53:39	3209.06	1184.14	2.000	0.047	0.037	✓
8	13:53:57	3209.23	1183.99	2.000	0.077	0.011	✓
9	13:54:17	3209.03	1184.04	2.000	0.050	0.040	✓
10	13:54:32	3209.03	1184.03	2.000	0.037	0.009	✓
11	13:54:50	3209.18	1184.06	2.000	0.052	0.010	✓
12	13:55:09	3209.20	1184.20	2.000	0.015	0.025	✓
13	13:55:26	3209.15	1184.13	2.000	0.006	0.008	✓

TS33 : testing three phase electronic (static) Energy Meter example (4)

TS33 as **Voltage and Current Source** and Reference Meter and meter under test connected **directly**

Automatic Procedure for whole load characteristics

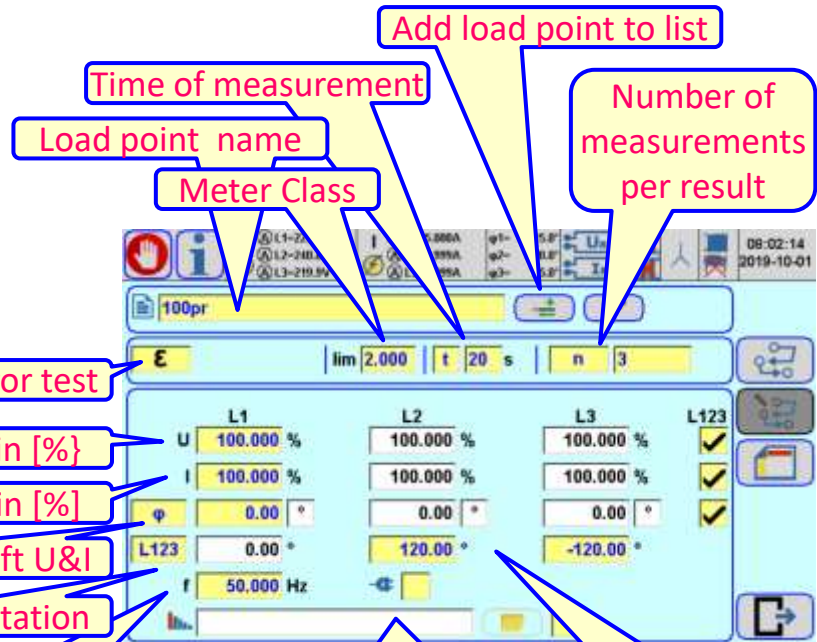
Meter Type Definition



Callouts for Meter Type Definition screen:

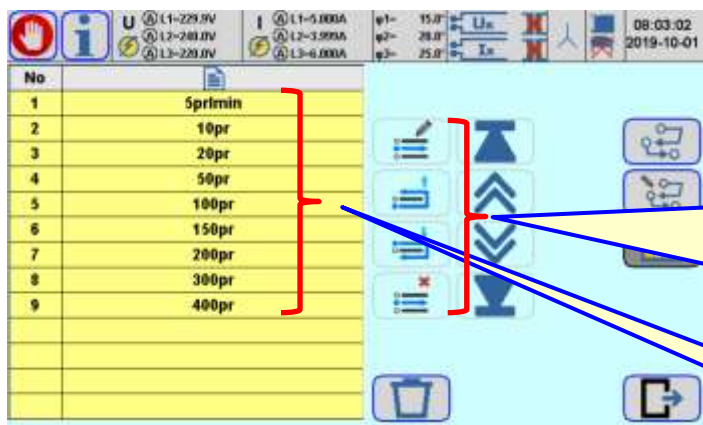
- Meter name
- Connection type
- Power type
- Comment
- Base voltage
- Max. voltage
- Max. current
- Base current
- Delay time
- Meter constant
- PT primary & secondary voltage
- CT primary & secondary current

Test Point and Procedure Definition



Callouts for Test Point and Procedure Definition screen:

- Add load point to list
- Time of measurement
- Load point name
- Meter Class
- Number of measurements per result
- Meter error test
- Voltage in [%]
- Current in [%]
- Phase shift U&I
- Vector rotation
- Frequency
- Harmonics
- Phase shift U&U



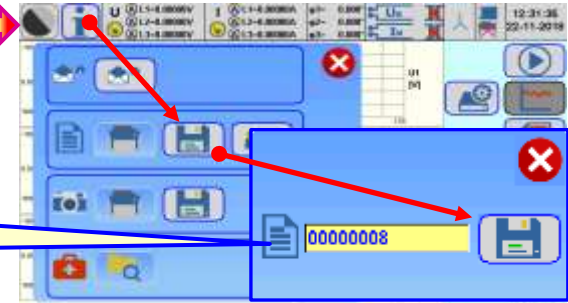
Callouts for Load Point List screen:

- List edition insert, move up/down remove
- List of load points

No	Load Point
1	Sprmin
2	10pr
3	20pr
4	50pr
5	100pr
6	150pr
7	200pr
8	300pr
9	400pr

To save Meter Type and Procedure use **i** button and then **button**

Meter or Procedure name field



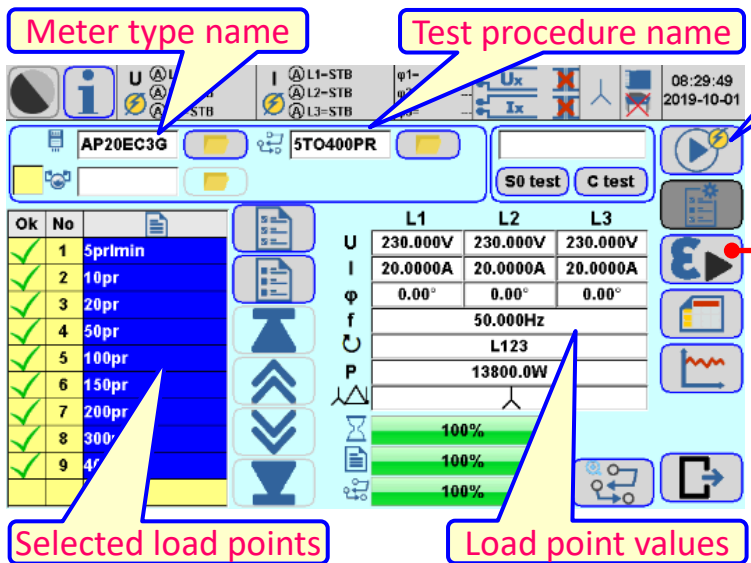
Save dialog box showing filename: 00000008

Automatic Procedure for whole load characteristics

TS33 : testing three phase electronic (static) Energy Meter example (5)

TS33 as Voltage and Current Source and Reference Meter and meter under test connected directly

Meter Test Execution



Meter type name: AP20EC3G

Test procedure name: 5TO400PR

Test starting: [Start button]

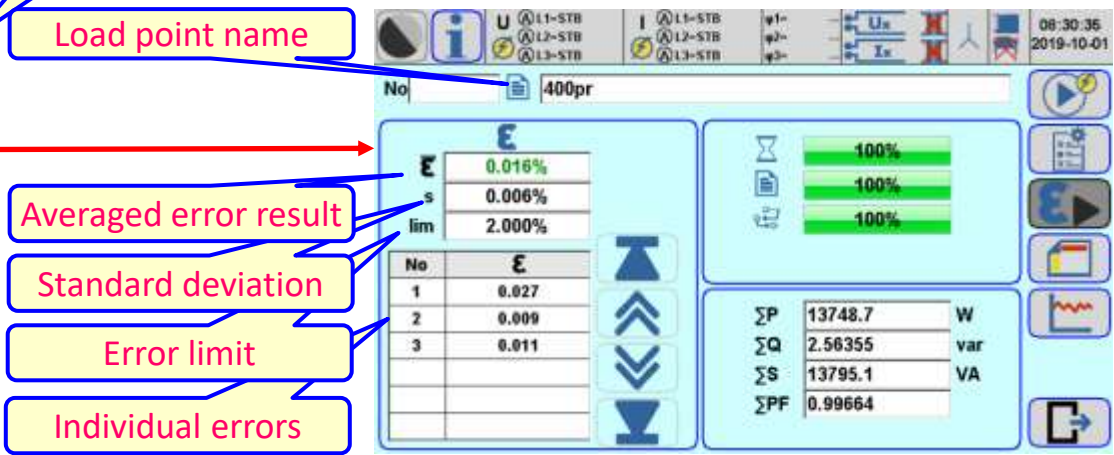
Load point name: 400pr

Ok	No	U	I	ϕ	f	P
		L1	L2	L3		
		230.000V	230.000V	230.000V		
		20.0000A	20.0000A	20.0000A		
		0.00°	0.00°	0.00°		
					50.000Hz	
						L123
						13800.0W

Selected load points: 1 Sprlmin, 2 10pr, 3 20pr, 4 50pr, 5 100pr, 6 150pr, 7 200pr, 8 300, 9 400

Load point values: 100%, 100%, 100%

Individual load point test



Averaged error result: 0.016%

Standard deviation: 0.006%

Error limit: 2.000%

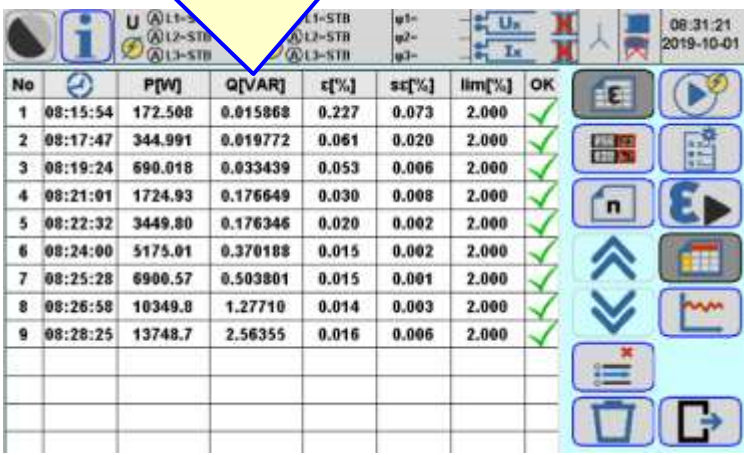
Individual errors:

No	ϵ
1	0.027
2	0.009
3	0.011

Summary Statistics:

ΣP	13748.7	W
ΣQ	2.56355	var
ΣS	13795.1	VA
ΣPF	0.99664	

Table with results for each load point



No	Time	P[W]	Q[VAR]	ϵ [%]	st ϵ [%]	lim[%]	OK
1	08:15:54	172.508	0.015868	0.227	0.073	2.000	✓
2	08:17:47	344.991	0.019772	0.061	0.020	2.000	✓
3	08:19:24	690.018	0.033439	0.053	0.006	2.000	✓
4	08:21:01	1724.93	0.176649	0.030	0.008	2.000	✓
5	08:22:32	3449.80	0.176346	0.020	0.002	2.000	✓
6	08:24:00	5175.01	0.370188	0.015	0.002	2.000	✓
7	08:25:28	6900.57	0.503801	0.015	0.001	2.000	✓
8	08:26:58	10349.8	1.27710	0.014	0.003	2.000	✓
9	08:28:25	13748.7	2.56355	0.016	0.006	2.000	✓

Results transferred to the PC Soft as diagram



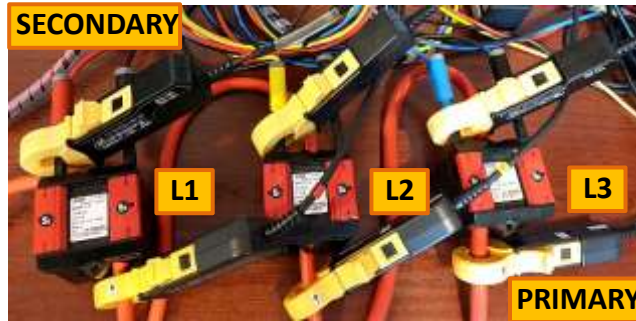
TS33 : testing current transformers CT ratio and phase shift error example (1)

TS33 as Reference Meter and CT primary and secondary current measured by current clamps



CT parameters:
Ratio: 100/5A
Power: 2.5VA
Class: 0.2

Typical current transformer CT in metering installation

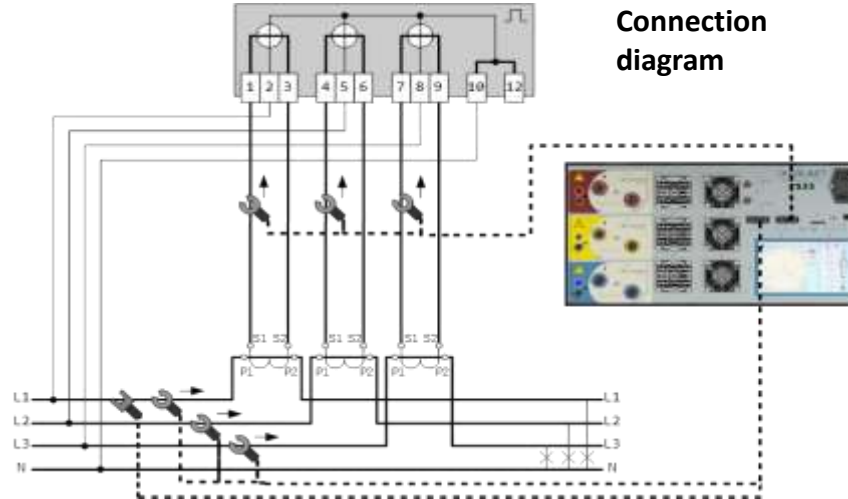


TS33 side clamps connection



Primary clamps

Secondary clamps



TS33 can test automatically up to 3 different CTs at time

Accuracy class of current transformer

Nominal primary current

Nominal secondary current

Primary current

Secondary current

Phase error

Actual ratio

Ratio error

Standard deviation



CT100AC current clamps on primary and secondary side

Number of measurements

	L1	L2	L3
lim:	0.200%	0.200%	0.200%
lpn:	100A	100A	100A
Isn:	5A	5A	5A
Ip:	99.9639 A	99.9773 A	99.9582 A
Is:	5.00889 A	4.99614 A	5.01250 A
φ:	-0.068 °	-0.002 °	0.018 °
Ip/Is:	19.9573	20.0109	19.9418
δ:	-0.214 %	0.055 %	-0.292 %
δs:	0.000 %	0.000 %	0.000 %

TS33 : testing current transformers CT burden example (1)

TS33 as Reference Meter and CT secondary current measured by current clamps and voltage directly



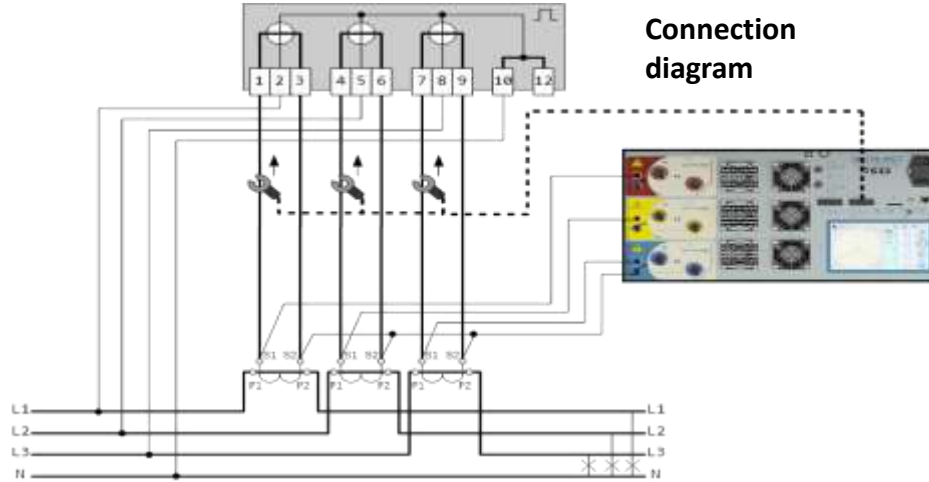
CT parameters:
Ratio: 100/5A
Power: 2.5VA
Class: 0.2

Typical current transformer CT in metering installation



TS33 side voltage connection

Voltage and clamps connection to the CT



Connection diagram

TS33 can test automatically up to 3 different CTs at time

- Nominal secondary current
- Nominal secondary power
- Voltage at secondary CT side
- Secondary current
- Phase shift
- Power factor
- Apparent power
- % of used power
- S which would be at nominal current

CT100AC current clamps on secondary side

Number of measurements: n: 3

	L1	L2	L3
U:	149.491 mV	156.350 mV	151.651 mV
I:	5.00105 A	4.99958 A	5.01941 A
φ:	5.455 °	5.336 °	5.451 °
PF:	0.99543	0.99562	0.99541
S:	2.10819 VA	2.14146 VA	2.13177 VA
%Sn:	84.327 %	85.658 %	85.271 %
S@n:	2.1073 VA	2.14182 VA	2.11532 VA

Length and cross section of CT connection cables: L: 4.000 m, 2.5 mm²

TS33 : how to order – versions, options, accessories

TS33 versions: accuracy class 0.04% or accuracy class 0.1%

Standard scope of delivery



TS33 Automatic Test System



Power cord



Fuses



C091 Amphenol connector



Voltage connection cables



Current connection cables



Manufacturer Calibration Certificate



Operation manual

TS33 : how to order – versions, options, accessories

TS33 optional accessories:

Optional scope of delivery 1



Laptop PC



TS33 PC Soft



CT10AC current clamps



CT100AC current clamps



CT1000AC current clamps



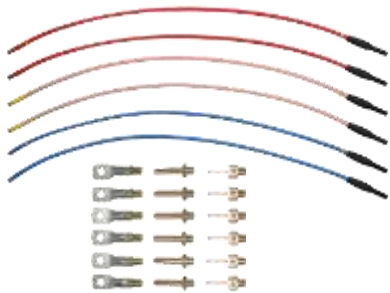
FCT3000AC flexible clamps



AmpLiteWire 2000AC
(@150kV)



VoltLiteWire 40kVC



AKD300 120A cable set



DR200 thermal printer



AKD100 accessories for
safety cables



CF106H photo head for LED
& mechanical meters

TS33 : how to order – versions, options, accessories

TS33 optional accessories:

Optional scope of delivery 2



ER10 single position rack for hanging meter



EH10.3 Quick Connector for meters



ER10H.3 single position rack with quick connector



ET32 case for additional accessories

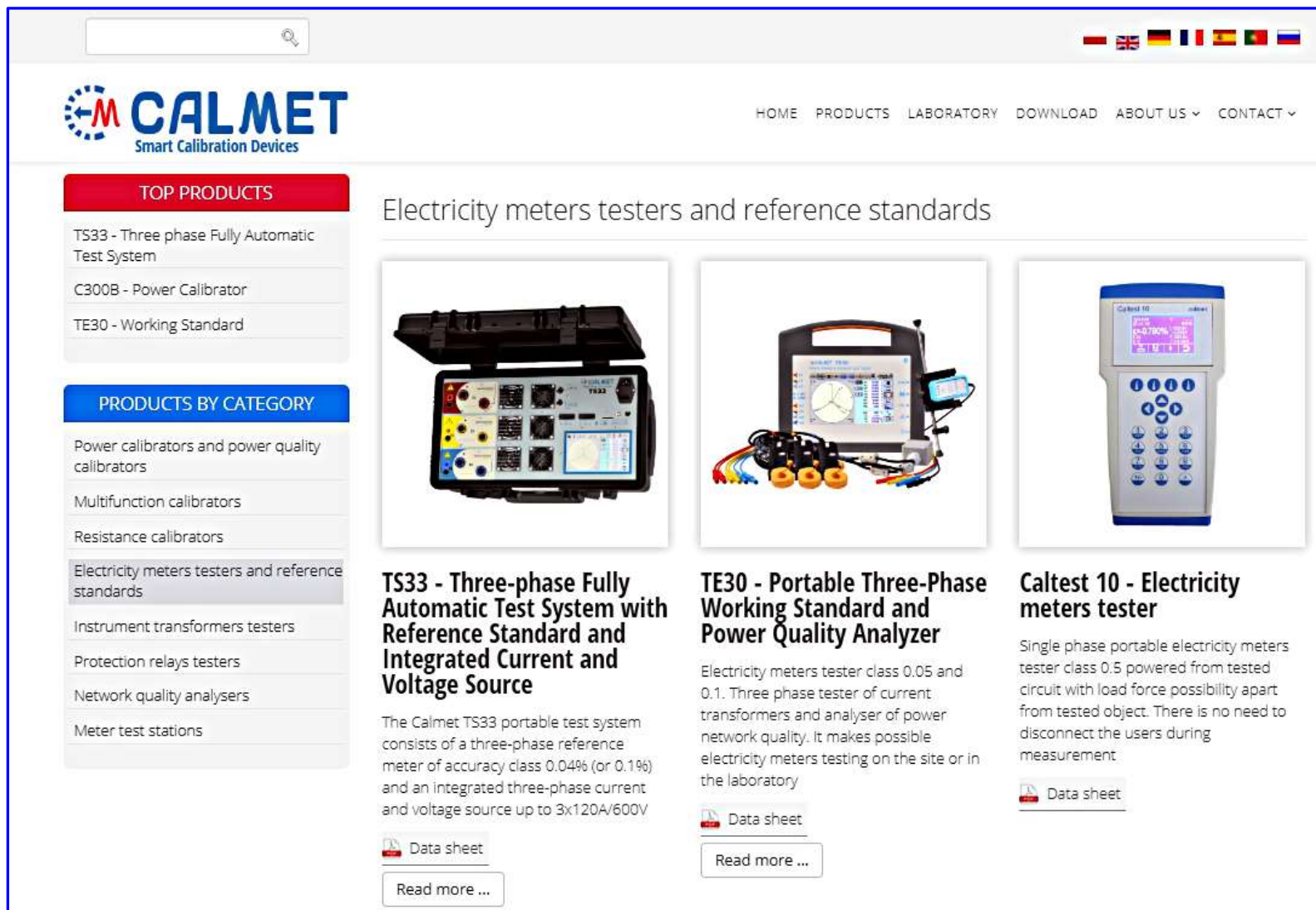


Calibration Certificate from ISO17025 accredited lab



Certificate of Origin from Customs and Chamber of Commerce

To see more devices and information visit our Web site: www.calmet.com.pl



The screenshot shows the CALMET website interface. At the top, there is a search bar and a navigation menu with links for HOME, PRODUCTS, LABORATORY, DOWNLOAD, ABOUT US, and CONTACT. The main content area is titled "Electricity meters testers and reference standards". On the left, there are two vertical menus: "TOP PRODUCTS" listing TS33, C300B, and TE30; and "PRODUCTS BY CATEGORY" listing various calibration and testing equipment. The main area features three product cards, each with an image, a title, a description, a "Data sheet" link, and a "Read more ..." button.

Electricity meters testers and reference standards

- TS33 - Three phase Fully Automatic Test System with Reference Standard and Integrated Current and Voltage Source**

The Calmet TS33 portable test system consists of a three-phase reference meter of accuracy class 0.04% (or 0.1%) and an integrated three-phase current and voltage source up to 3x120A/600V

[Data sheet](#)

[Read more ...](#)
- TE30 - Portable Three-Phase Working Standard and Power Quality Analyzer**

Electricity meters tester class 0.05 and 0.1. Three phase tester of current transformers and analyser of power network quality. it makes possible electricity meters testing on the site or in the laboratory

[Data sheet](#)

[Read more ...](#)
- Caltest 10 - Electricity meters tester**

Single phase portable electricity meters tester class 0.5 powered from tested circuit with load force possibility apart from tested object. There is no need to disconnect the users during measurement.

[Data sheet](#)

or contact by e-mail: mail@calmet.com.pl