

Testing the entire energy measurement system!

Accuracy of all kinds of meters ϵ [%]

Electromechanical (Ferraris)



Electronic (static)



4 - Quadrants Smart Meters



Max. demand



TS33

CT/PT burden, ratio, phase shift error



Wiring errors



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

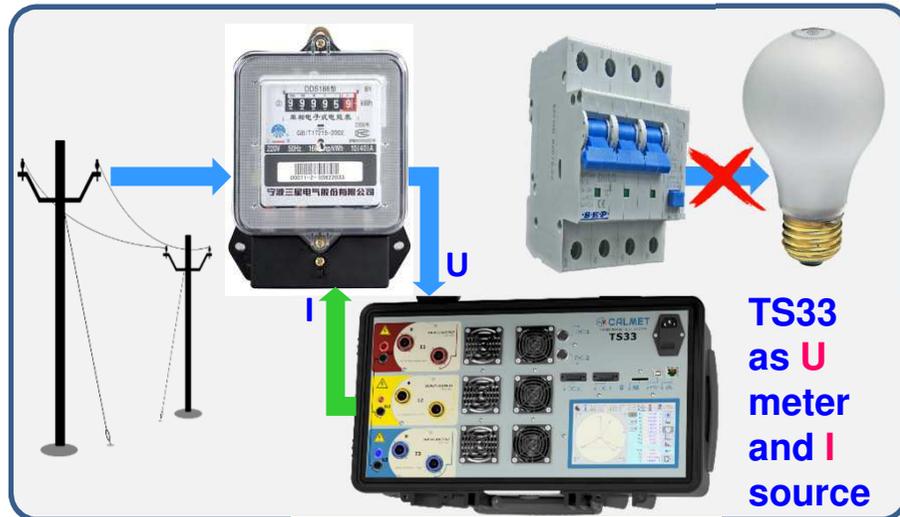


Testing **ON LINE** – meter and load are connected to the network; the value of metering point depends on current load; **TS33 works as portable reference meter**

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**

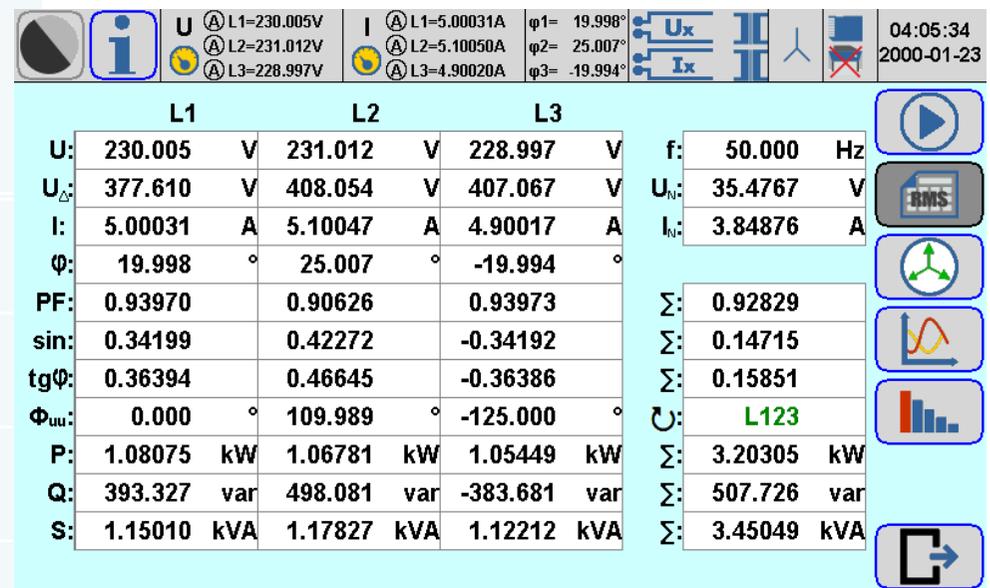


Testing **U-ON/ I-OFF LINE** – meter is connected to the network but load is disconnected; metering point can be set in whole range of current; **TS33 works as U meter and I source with built in reference meter**

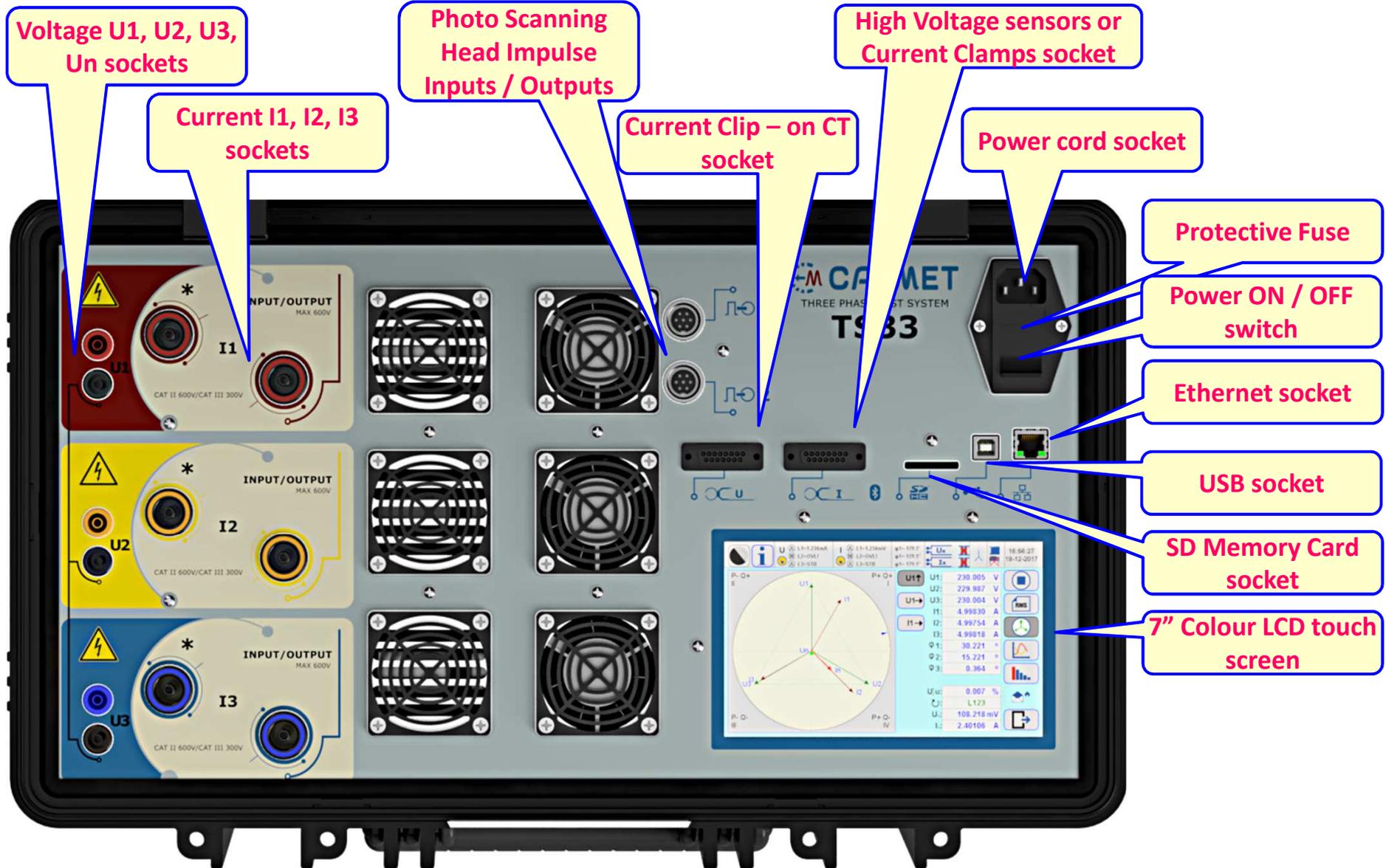


Testing without meter disconnecting!

- ▶ 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

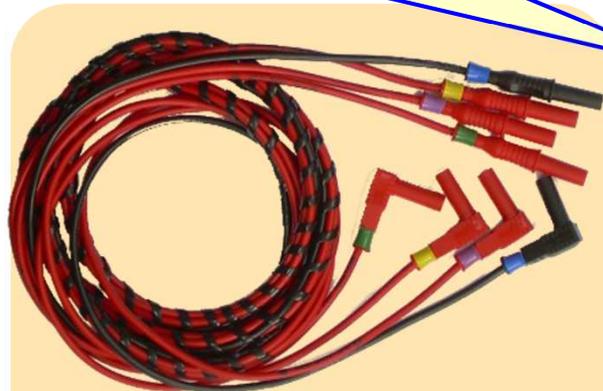


TS33 Inputs, Outputs and Connectors:

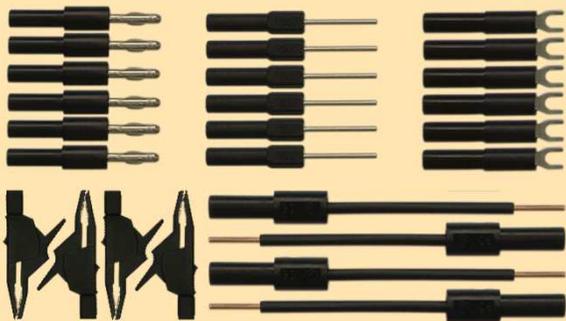


TS33 Voltage and Current Inputs:

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



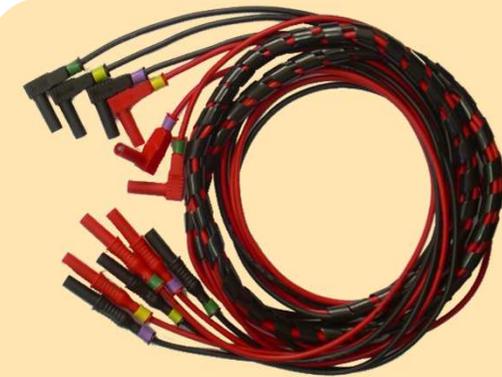
4mm Voltage Safety Cables
Length=2m



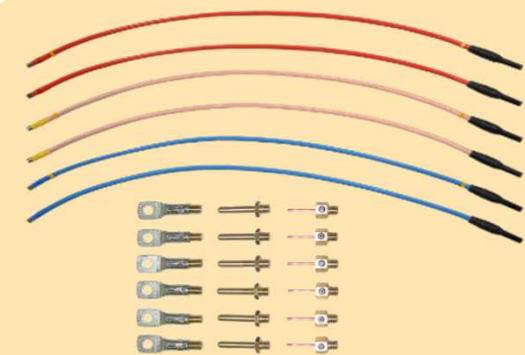
Easy connection due to rich set of accessories for safety cables



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



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



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

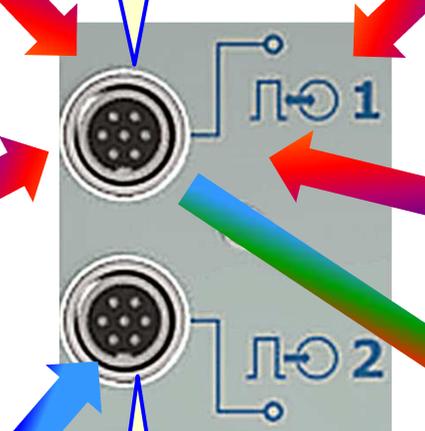
Electronic and Inductive energy meter
manual push – button and pulse generation



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

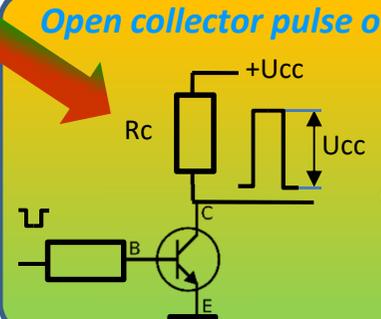
In case, that we need higher than offered by TS33 accuracy 0.04 or 0.1, we can use external reference easy way

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**

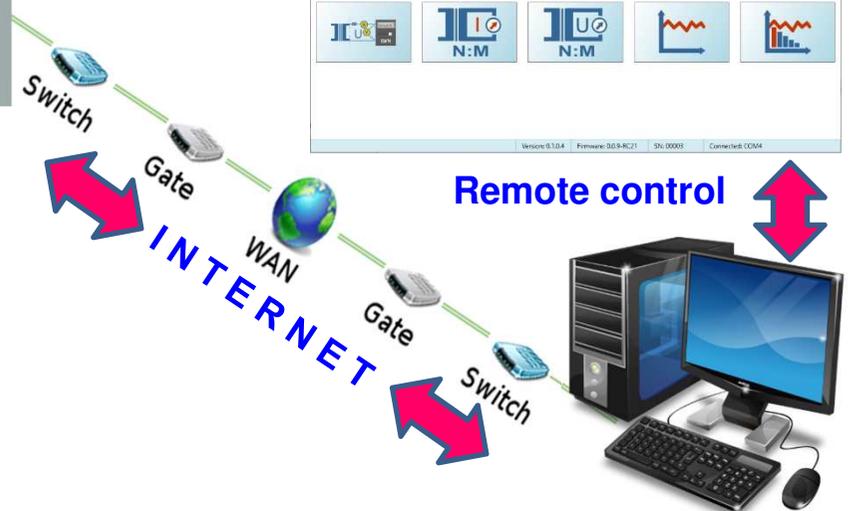
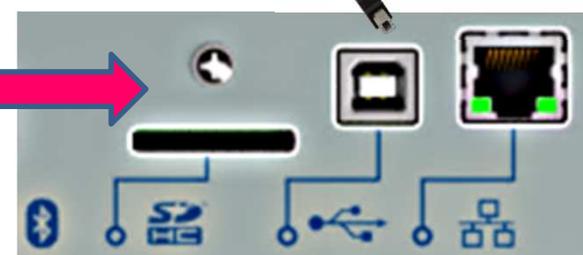
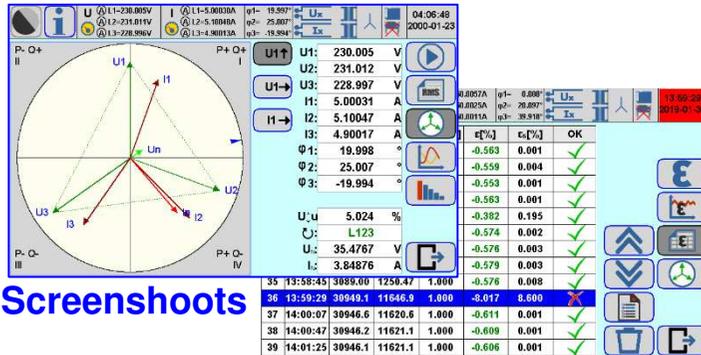
**300mA...1200A, length=2m
max Ø cable 52mm**

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

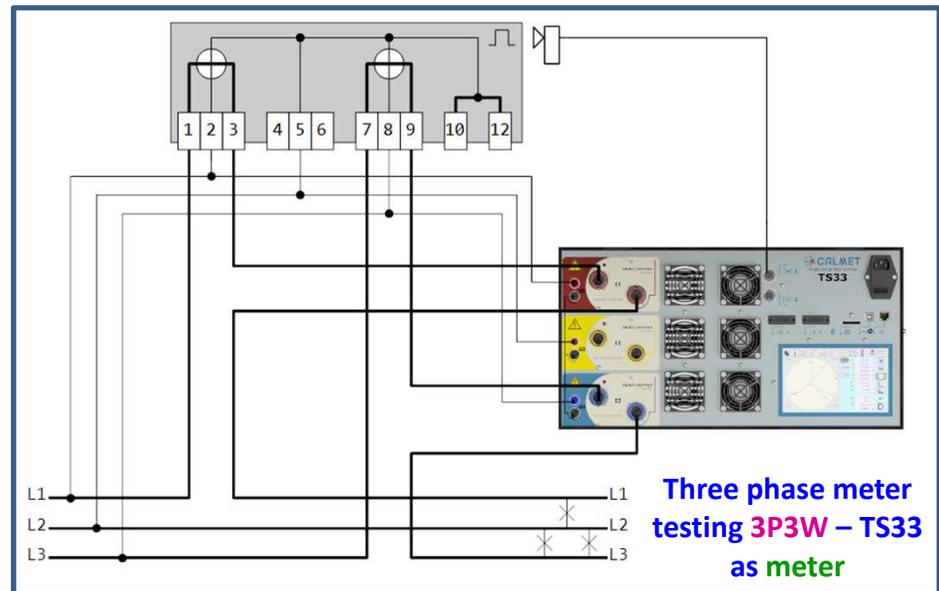
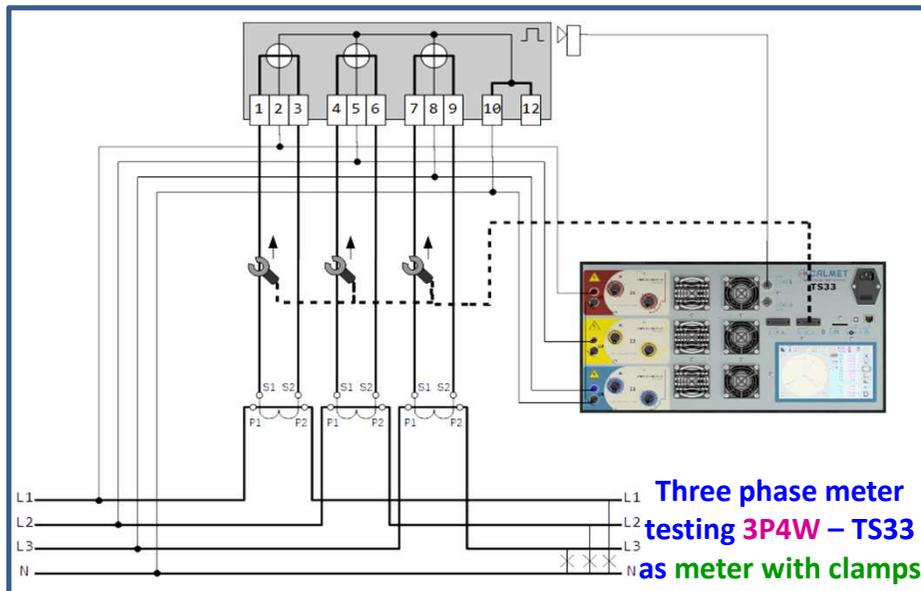
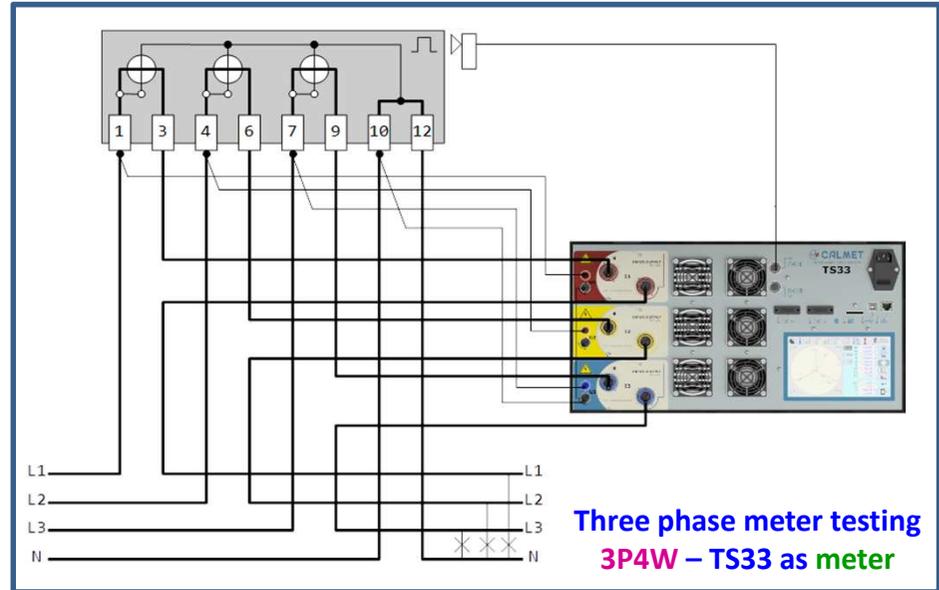
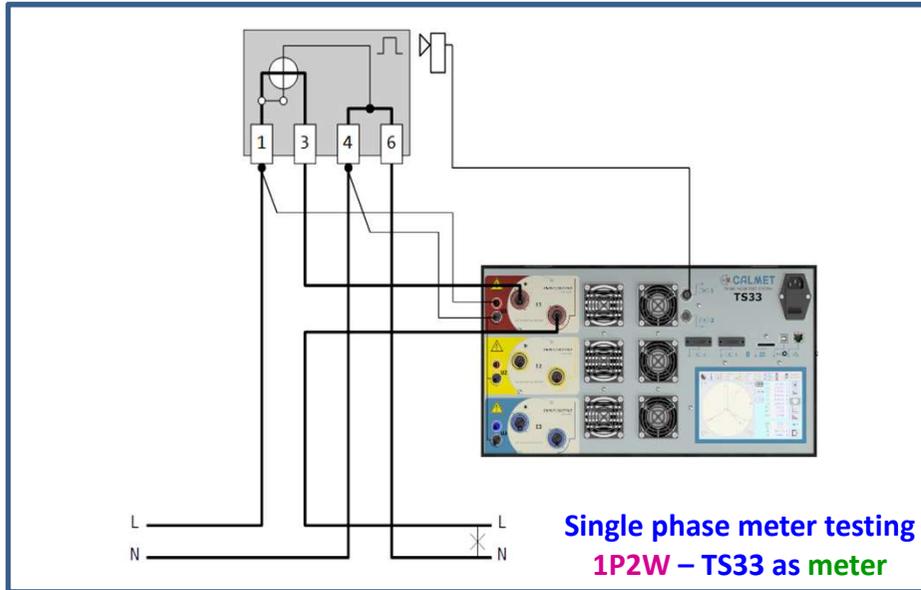
**0.3..30A/3..300A/30..3000A, length=2m
max Ø cable 150mm,
loop length 500mm**

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

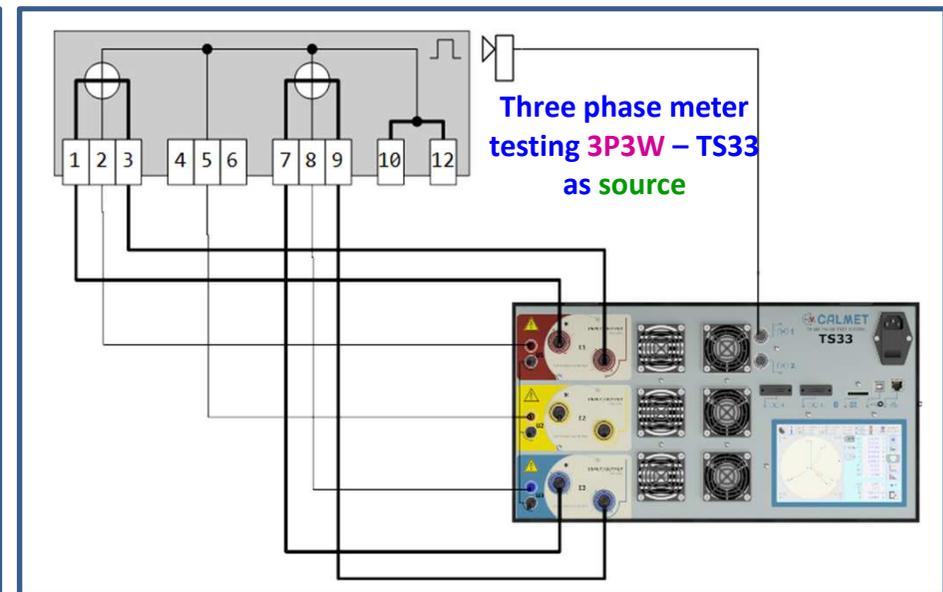
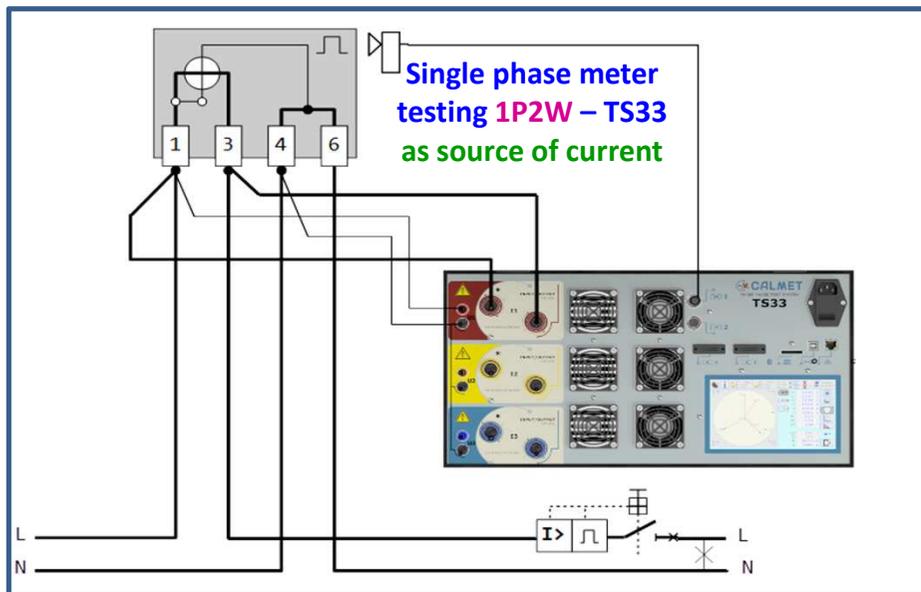
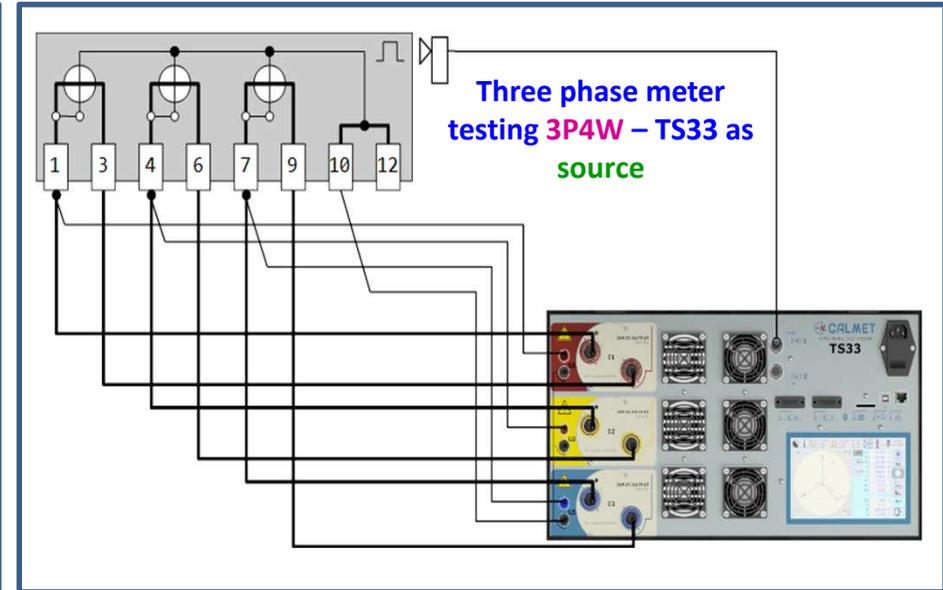
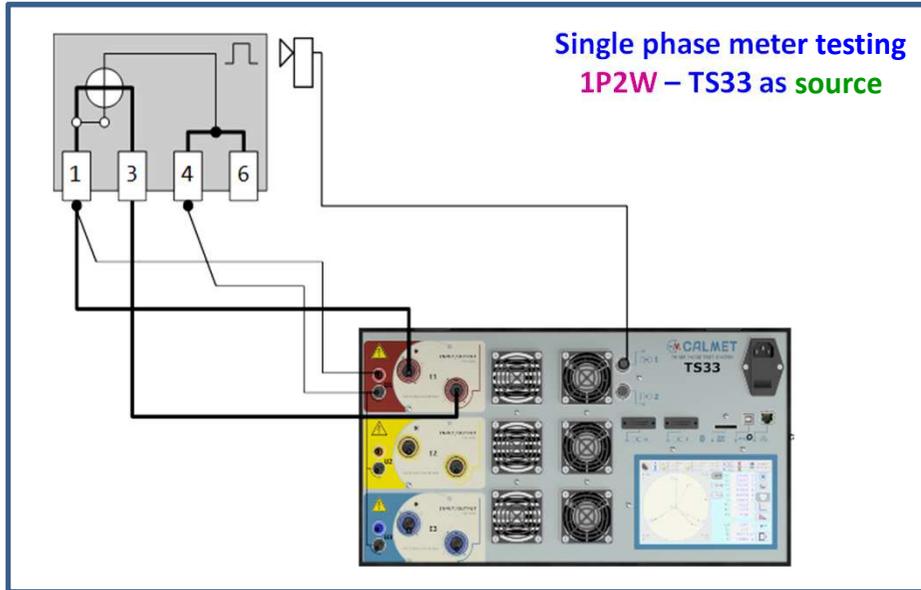
TS33 Communication; many ways of printer, PC connection and data storage



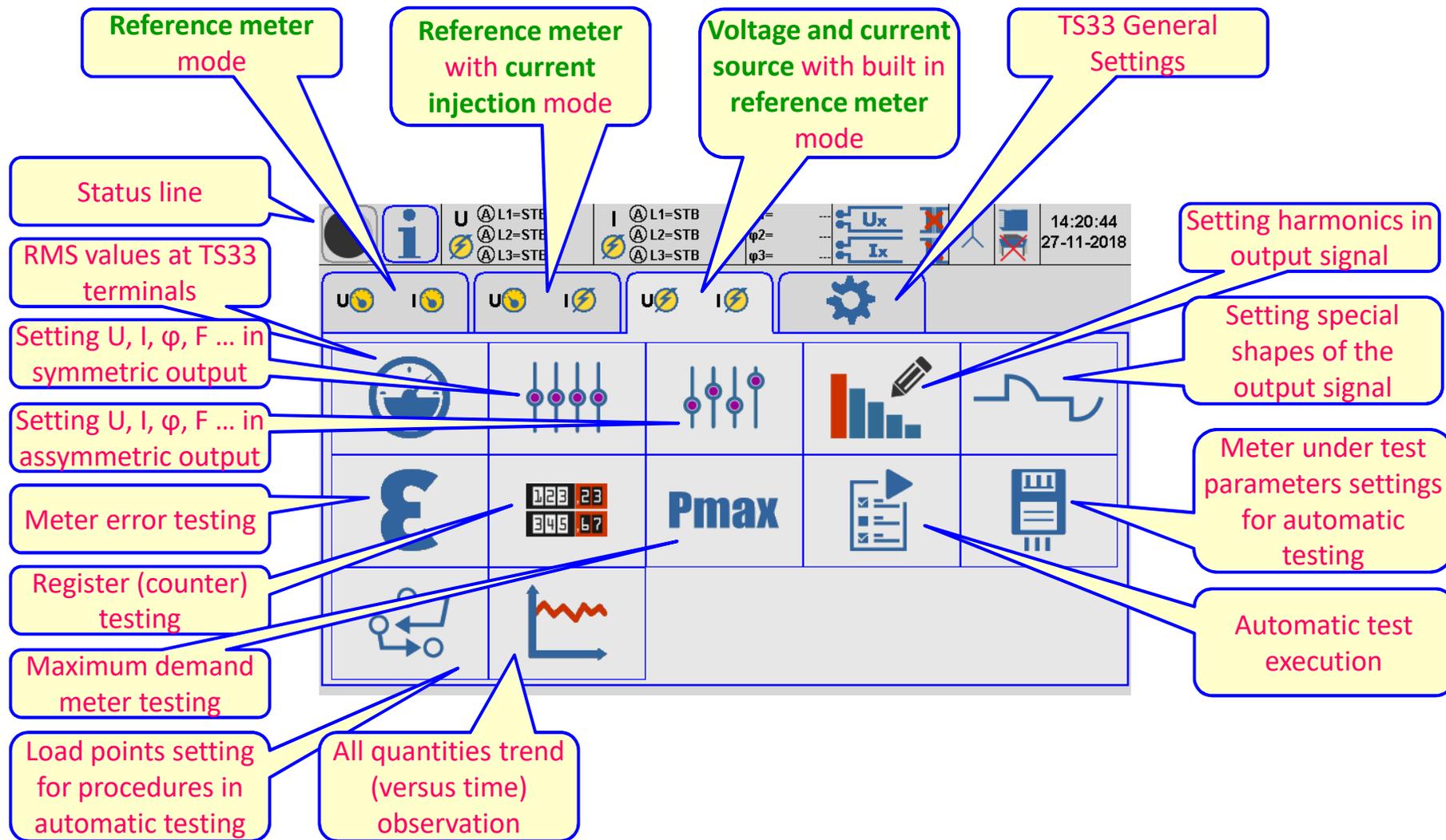
All possible types of connection: **1P2W, 3P4W, 3P3W, ...**, direct or with clamps



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



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

L1	L2	L3	f:	U _c :
U: 229.999 V	229.997 V	229.995 V	50.000 Hz	20.0668 V
U ₂ : 387.948 V	398.365 V	407.948 V		
I: 4.99966 A	4.89869 A	5.10039 A		
φ: 20.001 °	24.997 °	-19.993 °		
PF: 0.93968	0.90632	0.93973		
sim: 0.34202	0.42257	-0.34190		
tgφ: 0.36398	0.46625	-0.36383		
Φ _{max} : 0.000	115.000 °	-125.000 °		
P: 1.08056 kW	1.02114 kW	1.10237 kW		
Q: 393.299 var	476.106 var	-401.073 var		
S: 1.14992 kVA	1.12668 kVA	1.17307 kVA		

Counter (register) test

E1:	E2:	E:	Eref:	ε:	ε _{max} :
0.00000kWh	0.00000kvarh	0.00000kWh	0.893400kWh	-0.006%	1.000%
0.893400kWh	0.513050kvarh	0.886958kWh	1kvarh	0.006%	1.000%
0.893400kWh	1kvarh	0.886958kWh	0.886710kWh	0.028%	1.000%

Maximum demand meter test

Pmax[kW]	Pmax-Pref
3.394	-0.006
4.764	1.364
5.444	2.044
5.444	2.044
5.444	2.044
2.716	-0.684
0.680	-2.720
6.803	3.403
0.340	-3.060
0.340	-3.060
Σ 10.899	

CT burden test

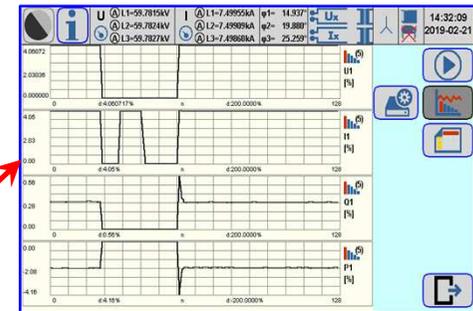
U:	I:	φ:	PF:	S:	%Sn:	S@n:
4.00347 V	4.50032 A	5.49942 V	1.00000	18.1914 VA	60.638 %	28.4199 VA
4.00029 V	4.50045 A	4.99990 A	1.00000	23.008 VA	76.693 %	28.3993 VA
4.00029 V	4.50045 A	4.99990 A	1.00000	30.8964 VA	102.988 %	30.8976 VA

Meter error test in [%]

ε	-0.148%
S	0.010%
ΣP	3.17316 kW
ΣQ	451.821 var
ΣS	3.44985 kVA
ΣPF	0.91980
No	ε _i
1	-0.148
2	-0.144
3	-0.130

Dashboard showing multiple meters (U, I, Pmax, ε, N:M) and graphs. Red arrows point from this dashboard to the individual test screens.

Harmonics trend test



PT burden test

U _{sn} :	I _{sn} :	φ:	PF:	%Sn:	S@n:
57.7V	57.7V	57.7V	30VA	30VA	30VA
58.0993 V	55.9992 V	57.6977 V	500.047 mA	460.052 mA	519.993 mA
0.067 °	0.148 °	0.128 °	1.00000	1.00000	1.00000
32.312 VA	28.5216 VA	33.5272 VA	107.707 %	95.072 %	114.757 %
28.6544 VA	27.3513 VA	30.0048 VA			

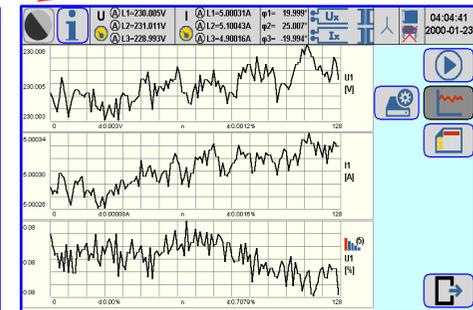
CT ratio test

lim:	I _p :	I _s :	φ:	Ip/Is:	δ:	δs:
1.000%	1.000%	1.000%	300A	300A	300A	5A
299.982 A	199.994 A	249.994 A	5.00041 A	3.35015 A	4.09987 A	0.098 °
59.9915	59.6972	60.9762	-0.014 %	-0.507 %	1.601 %	0.000 %

PT ratio test

lim:	U _{pn} :	U _s :	φ:	Up/Us:	δ:	δs:
1.000%	1.000%	1.000%	15000V	15000V	15000V	57.7V
14.9998 kV	14.9997 kV	14.9988 kV	57.8884 V	57.3483 V	58.1890 V	-0.018 °
259.116	261.554	257.760	-0.278 %	0.494 %	-0.475 %	0.057 %

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**

3-phase vector diagram

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

	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 _{ult} :	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 oscilloscope

Harmonics bars

Harmonics in table form

3-Phase Factors

3-Phase Vector Rotation

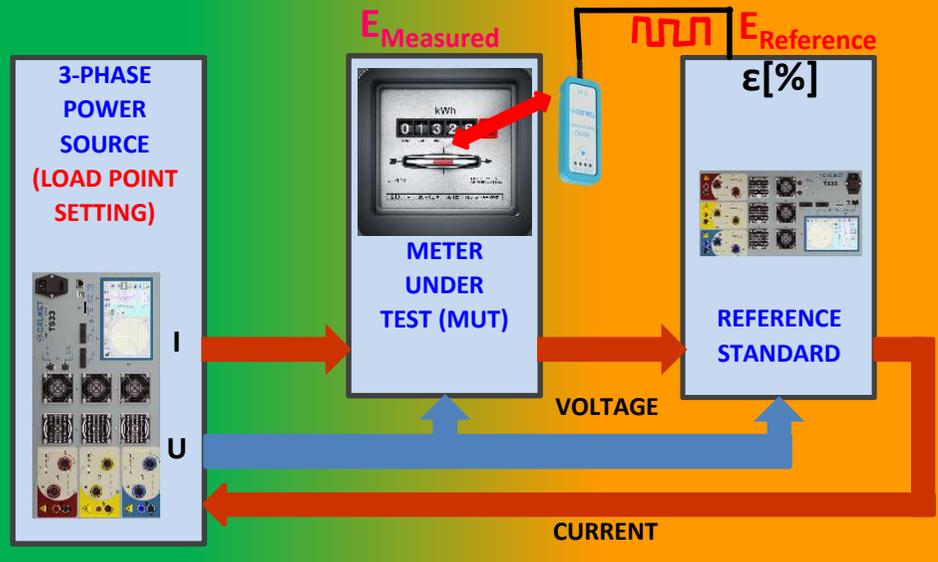
3-Phase Powers

TS33 functionality: energy meter error testing idea



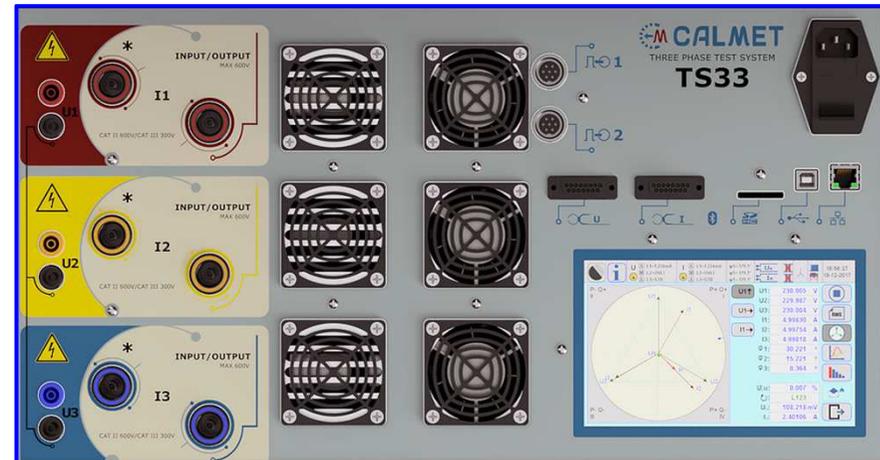
Principle of electricity meter testing

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



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:

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

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

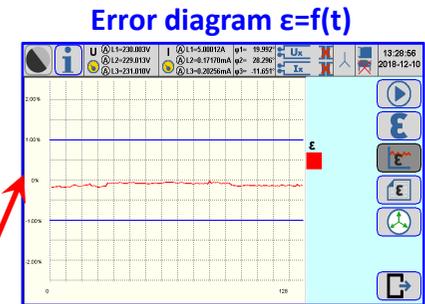
3-Phase Powers
Partial error results

Settings shown: P, C: 6400.00 imp/kWh, auto, CT: [], PT: [], t/N: 3 s, lim: 1.00 %, n: 5

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

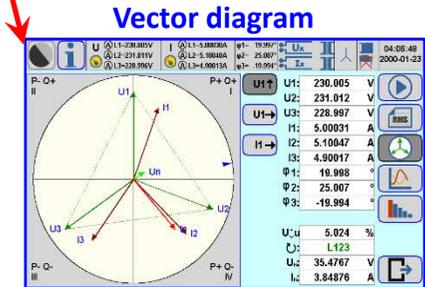
Summary statistics:
 $\Sigma P = 3.17316$ kW
 $\Sigma Q = 451.821$ var
 $\Sigma S = 3.44985$ kVA
 $\Sigma PF = 0.91980$

No	ϵ_i
1	-0.148
2	-0.144
3	-0.130



Error table

No	PPM	QVAR	Limit[%]	ϵ_i [%]	ϵ_a [%]	OK	
27	13:52:10	3333.00	891.176	1.000	-0.583	0.001	✓
28	13:52:53	3333.00	891.176	1.000	-0.559	0.004	✓
29	13:54:34	3333.00	891.166	1.000	-0.553	0.001	✓
30	13:55:18	3333.00	891.168	1.000	-0.563	0.001	✓
31	13:55:59	3089.03	1250.49	1.000	-0.382	0.195	✓
32	13:56:41	3089.02	1250.49	1.000	-0.574	0.002	✓
33	13:57:22	3089.03	1250.49	1.000	-0.576	0.003	✓
34	13:58:06	3089.01	1250.48	1.000	-0.579	0.003	✓
35	13:58:45	3089.00	1250.47	1.000	-0.576	0.008	✓
36	13:59:29	30949.1	11646.0	1.000	-0.017	8.600	✗
37	14:00:07	30946.5	11620.6	1.000	-0.611	0.001	✓
38	14:00:47	30946.2	11621.1	1.000	-0.609	0.001	✓
39	14:01:25	30946.1	11621.1	1.000	-0.606	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

Test START / STOP

Register value before starting test

Register value after stopping test

E1:	0.000000kWh	0.000000kvarh	0.000000kWh
E2:	1.019123kWh	0.588698kvarh	1.019680kWh

Value of active energy with all harmonics

Difference between E2-E1

$\Delta E:$	1.019123kWh	0.588698kvarh	1.019680kWh
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Value of first harmonic only in active energy

Reference value of Energy flow

Eref:	1.019277kWh	0.588480kvarh	1.018611kWh
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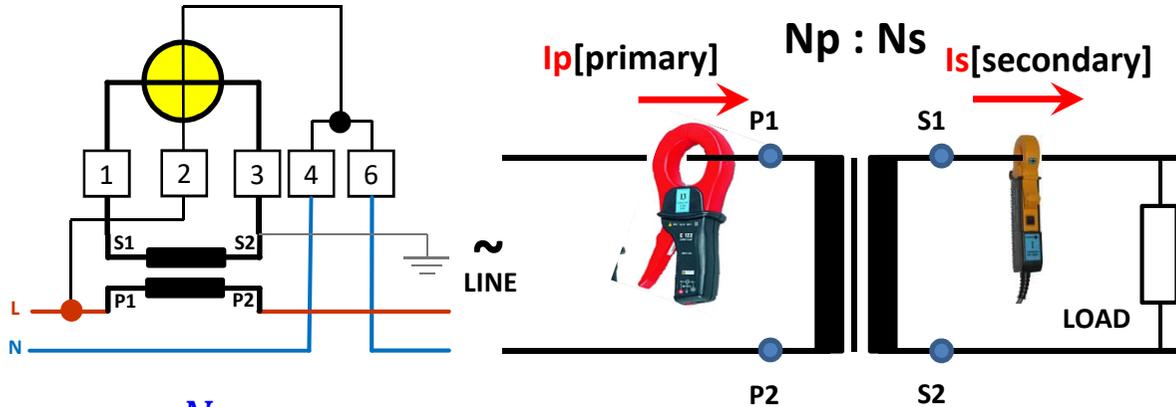
Value of error

$\epsilon:$	-0.015%	0.037%	0.105%
ϵ \leftrightarrow :	1.000%	1.000%	1.000%

Limits of error

- ▶ 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



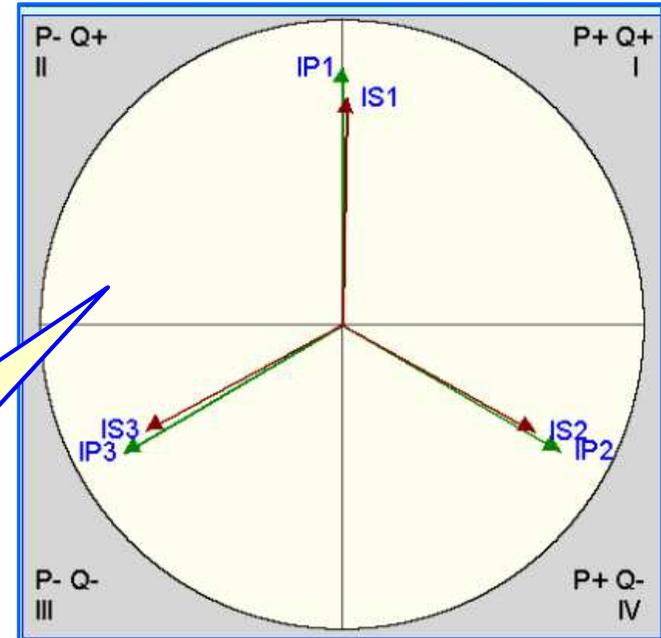
The test method is based on primary current measurement by means of current clamps from 0.1A to 3000A and secondary current measurement directly or also by means of clamps in 10mA to 10A range.

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

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 δI=0% and phase shift error φ=0°

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

Individual phase

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

	L1	L2	L3
lim:	0.200%	0.200%	0.200%
l _{pn} :	100A	100A	100A
l _{sn} :	5A	5A	5A

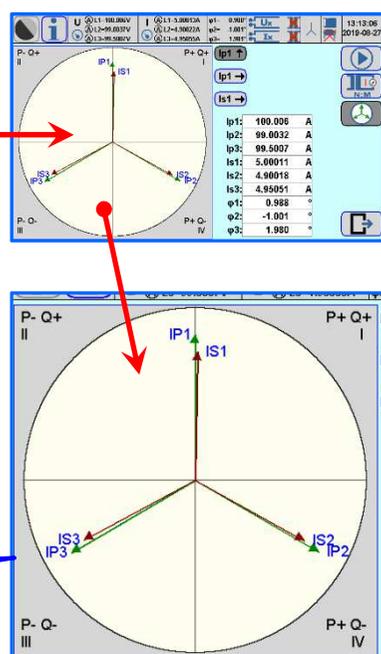
	L1	L2	L3
l _p :	100.006 A	99.0032 A	99.5007 A
l _s :	5.00011 A	4.90018 A	4.95051 A
φ:	0.988 °	-1.001 °	1.980 °
l _p /l _s :	20.0008	20.2040	20.0991
δ:	0.004 %	1.010 %	0.493 %
δ _s :	0.000 %	0.000 %	0.000 %

Number of measurements for averaging

n: 10

Test START / STOP

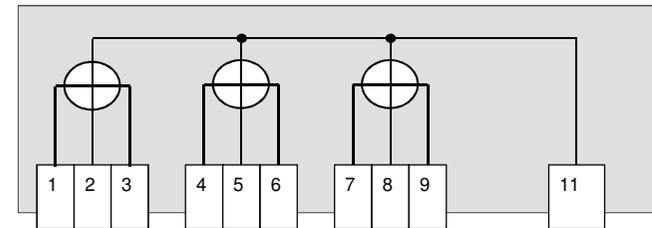
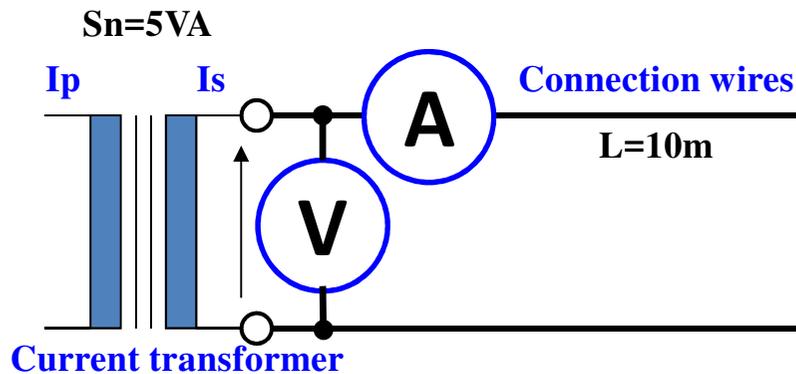
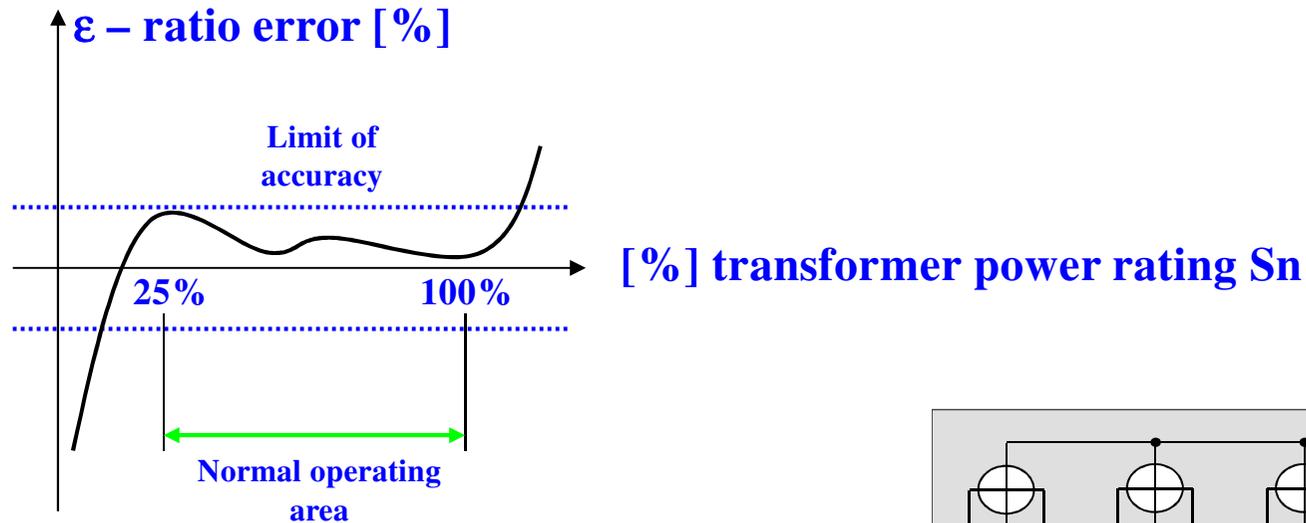
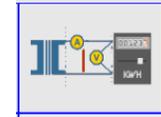
Vector diagram of primary and secondary side allows for easy connection testing



- ▶ 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



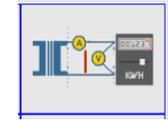
Example:

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

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

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]

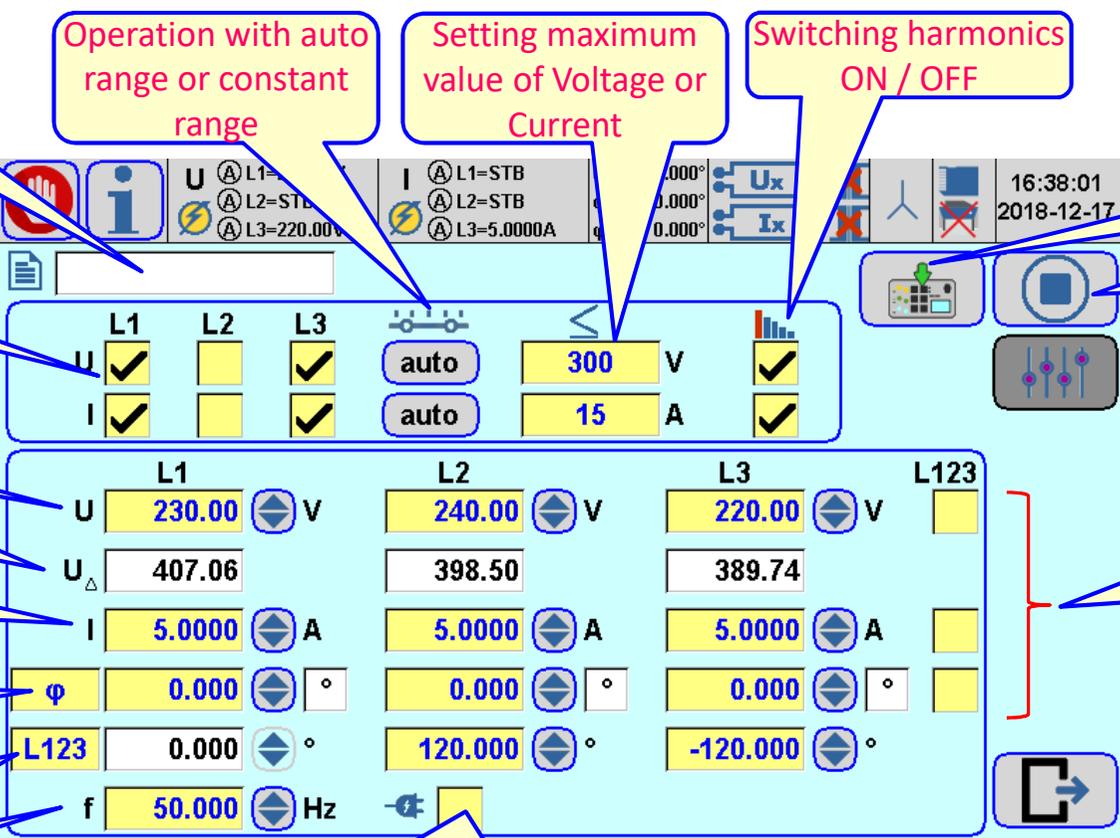
Cross section of connection wires

Nominal power will be overloaded when nominal current will flow

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 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: 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 features a grid of controls for each phase, including checkboxes for channel activation, range selection (auto/manual), and numerical input fields for voltage (V) and current (A). Below this, there are more detailed settings for phase voltages (U_{L1}, U_{L2}, U_{L3}), phase currents (I_{L1}, I_{L2}, I_{L3}), phase angles (φ), and phase shifts (L123). A frequency setting (f) is also present at the bottom.

Callouts and their corresponding features:

- File name of stored settings**: Points to the top-left icon.
- Operation with auto range or constant range**: Points to the 'auto' buttons for voltage and current.
- Setting maximum value of Voltage or Current**: Points to the numerical input fields (300 V, 15 A).
- Switching harmonics ON / OFF**: Points to the harmonic control icons.
- Switching ON / OFF of individual U & I channels**: Points to the checkboxes for U and I in each phase.
- Set data acceptance**: Points to the data acceptance icon.
- START / STOP generation**: Points to the start/stop button.
- Voltage in phase L1 L2 L3**: Points to the U_{L1}, U_{L2}, U_{L3} settings.
- Voltage between phases**: Points to the U_Δ settings.
- Current in phase L1 L2 L3**: Points to the I_{L1}, I_{L2}, I_{L3} settings.
- Phase shift U&I**: Points to the φ settings.
- Phase shift between Voltages**: Points to the L123 settings.
- Frequency setting**: Points to the f (50.000 Hz) setting.
- Frequency synchronised with power frequency**: Points to the sync icon.
- Setting the same value for all three phases**: Points to the L123 settings.

- ▶ 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

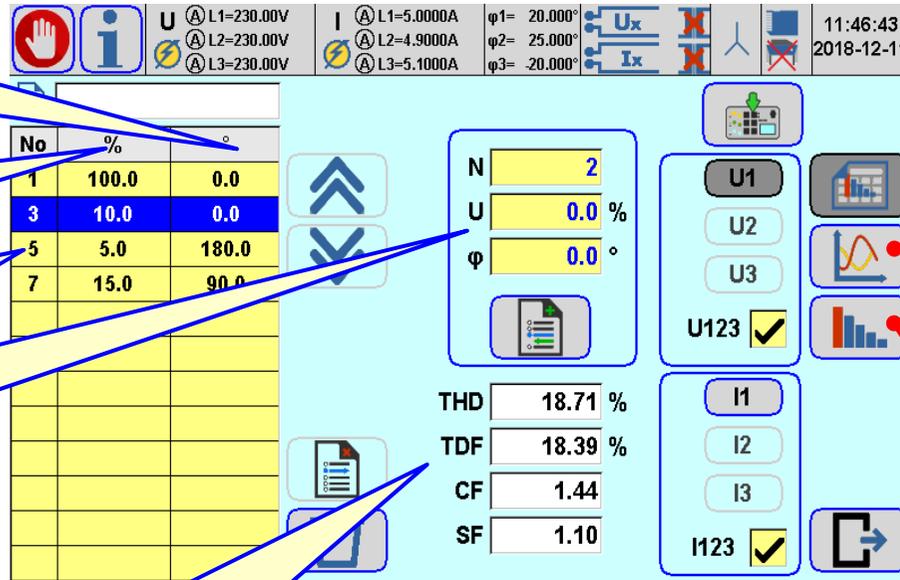
TS33 functionality: Voltage and current source – harmonic generation

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

Signal parameters:

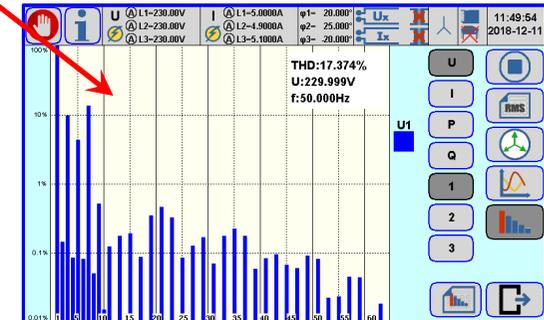
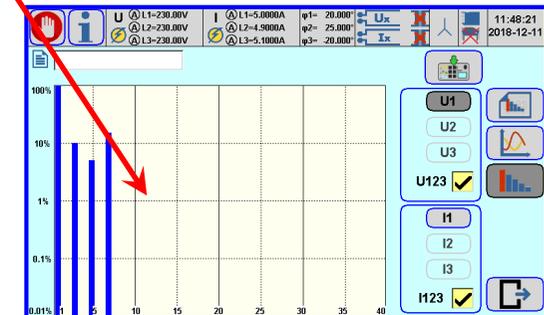
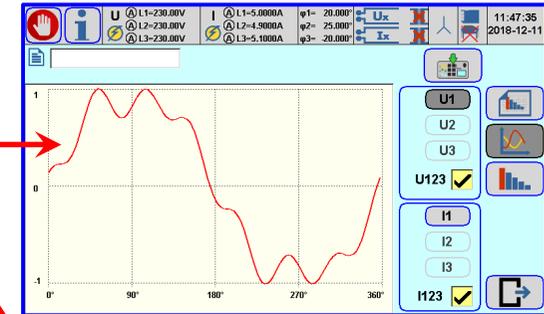
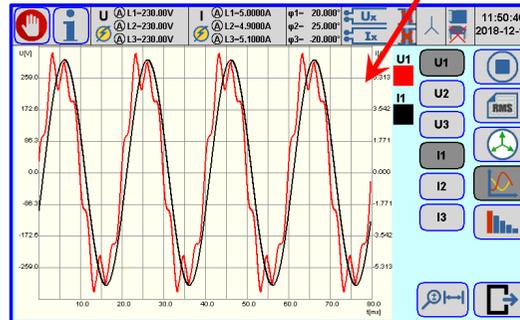
THD – total harmonic distortion (all harmonics to fundamental)

TDF – total distortion factor (all harmonics to RMS value)

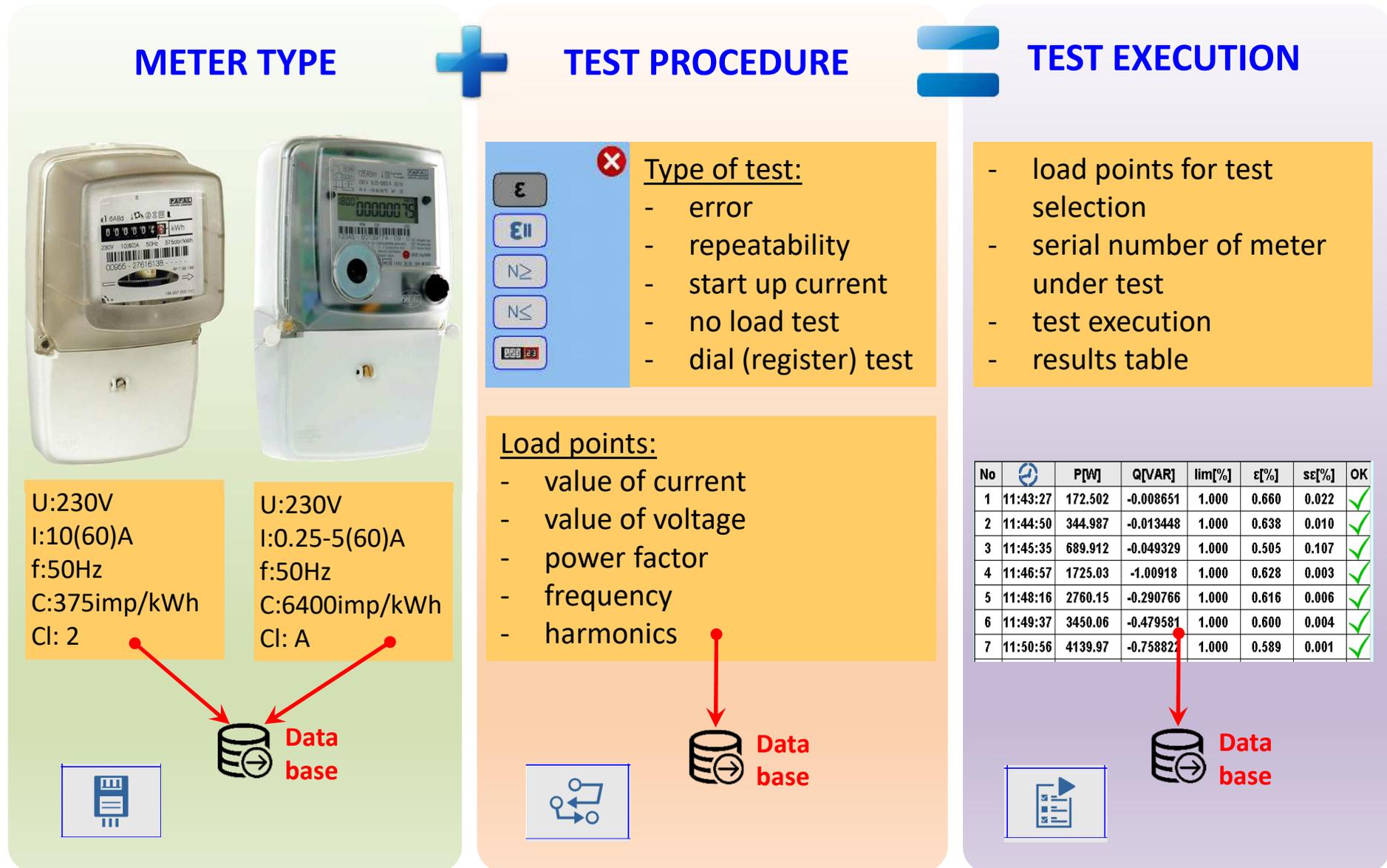
CF – crest factor (peak value to RMS value)

SF – shape factor (average rectified value to RMS value)

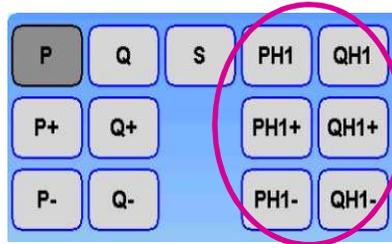
Real signal measured at TS33 output



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



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)

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

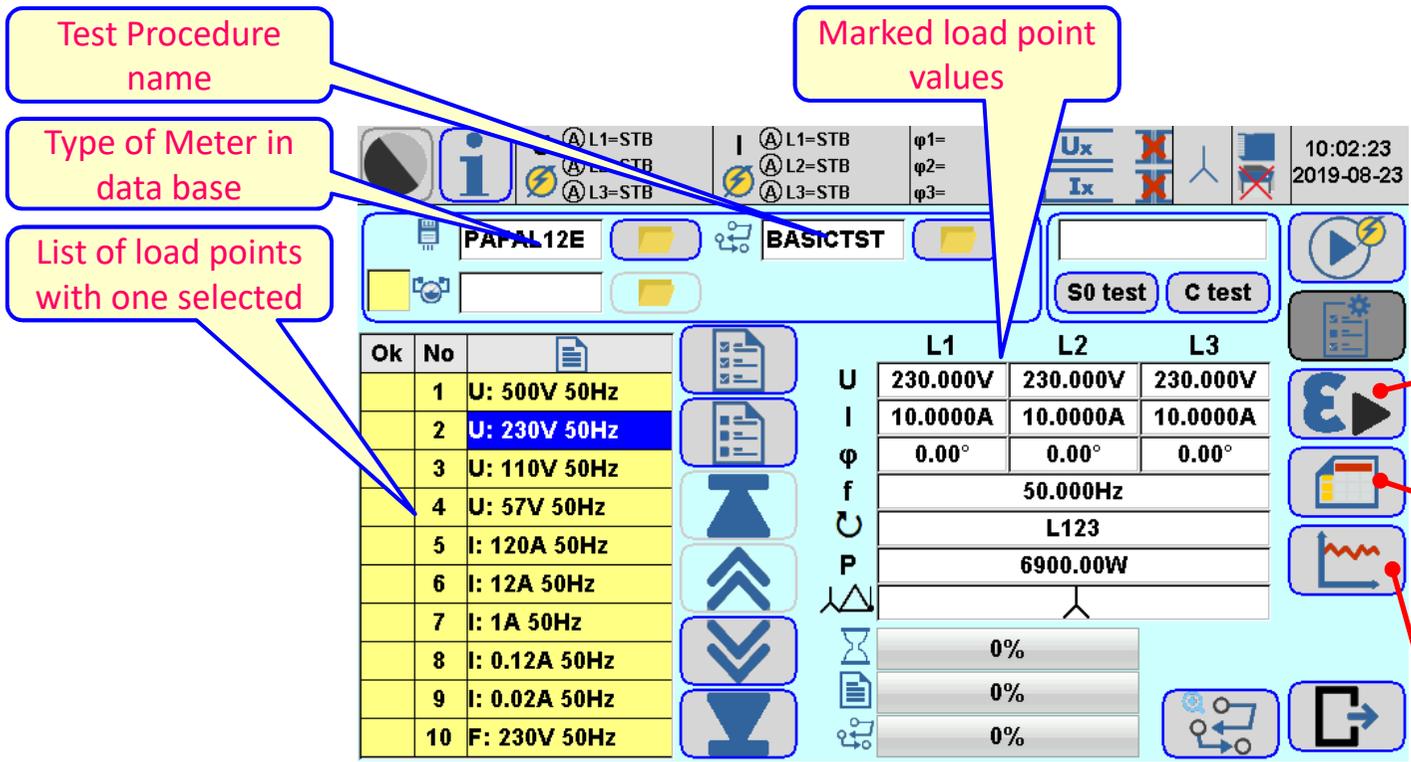
	L1	L2	L3	L123
U	100.000 %	100.000 %	100.000 %	<input checked="" type="checkbox"/>
I	5.000 %	STB %	STB %	<input type="checkbox"/>
ϕ	10.00 °	10.00 °	10.00 °	<input checked="" type="checkbox"/>
L123	0.00 °	120.00 °	-120.00 °	<input type="checkbox"/>
f	50.000 Hz	<input type="checkbox"/>	<input type="checkbox"/>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

Table with load points

No	LOAD
1	005 LOAD
2	010 LOAD
3	020 LOAD
4	040 LOAD
5	060 LOAD
6	080 LOAD
7	100 LOAD
8	120 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: PAFAL12E

Type of Meter in data base: BASICSTST

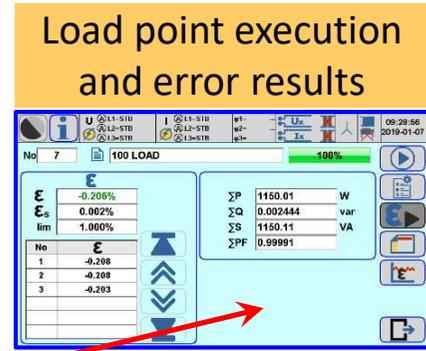
List of load points with one selected:

Ok	No	U
	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

Marked load point values:

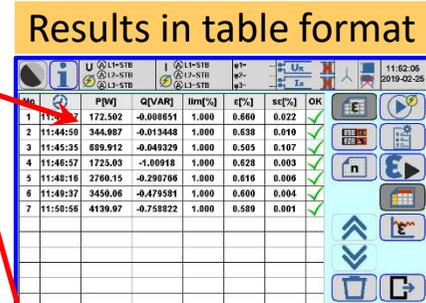
	L1	L2	L3
U	230.000V	230.000V	230.000V
I	10.0000A	10.0000A	10.0000A
φ	0.00°	0.00°	0.00°
f	50.000Hz		
P	6900.00W		
	0%		
	0%		
	0%		

Load point execution and error results

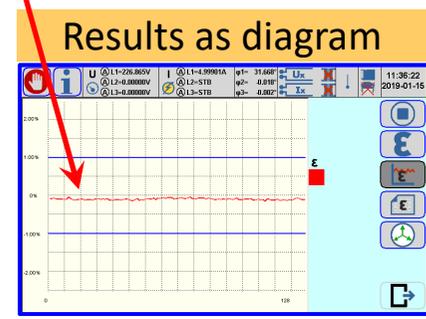


ΣP 1150.01 W
ΣQ 0.002444 var
ΣS 1150.11 VA
ΣPF 0.99991

Results in table format



No	U	I	P	Q	φ	f	OK
1	115:50	172.502	-0.00851	1.000	0.660	0.022	✓
2	11:44:50	344.687	-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	-1.00918	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	-0.478581	1.000	0.600	0.004	✓
7	11:50:56	4139.97	-0.758822	1.000	0.589	0.001	✓



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 the following callouts:

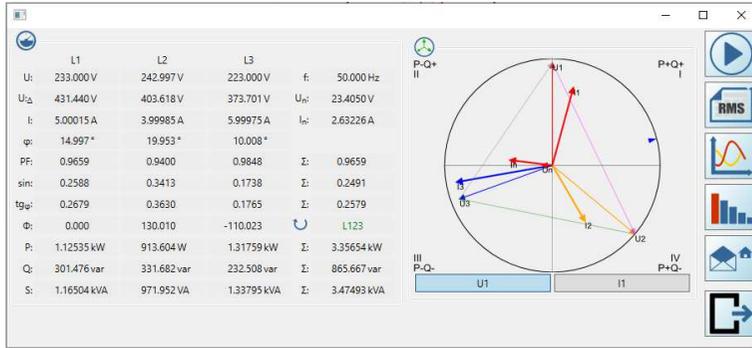
- Reference meter mode** (top left)
- Reference meter with current injection mode** (top center)
- Voltage and current source with built in reference meter mode** (top right)
- TS33 General Settings** (top right)
- RMS values at TS33 terminals** (left side)
- Meter error testing** (left side)
- Register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

The interface displays real-time data for three phases (L1, L2, L3) including voltage (U), current (I), and power factor (φ). It also features a 'Pmax' display and various trend graphs. The status bar at the bottom indicates: Version: 0.1.0.4, Firmware: 0.0.9-RC21, SN: 00003, Connected: COM4.

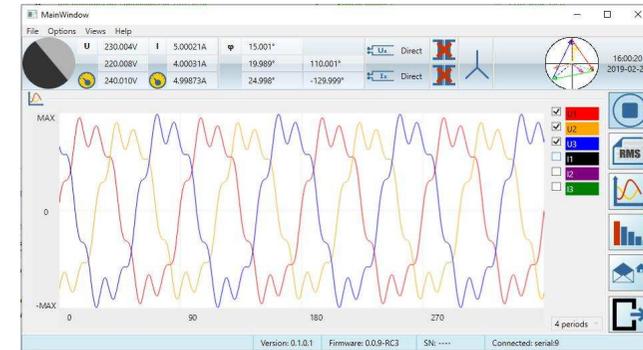
Conclusion: All functionality of the TS33 is available through **USB, Bluetooth and Ethernet** connection (including **Internet** remote control). TS33 PC Soft enables to download real time results of measurement made by TS33, download stored in memory results, readout the SD card memory and remote control 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



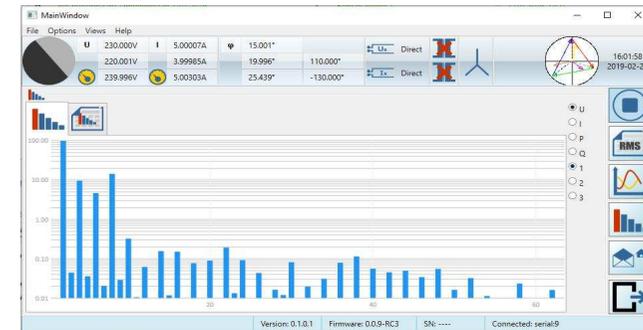
Voltage U1, U2, U3 oscilloscope



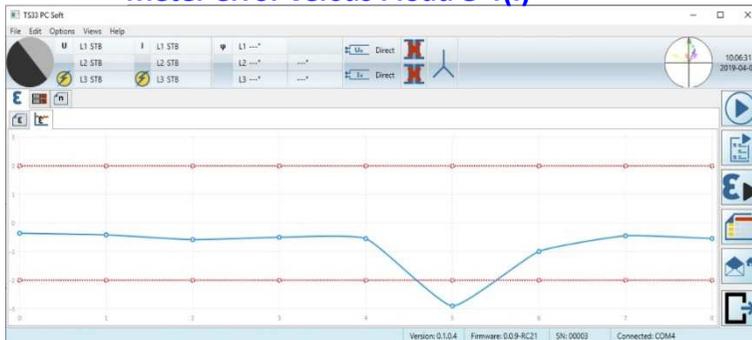
Voltage, current and THD trend



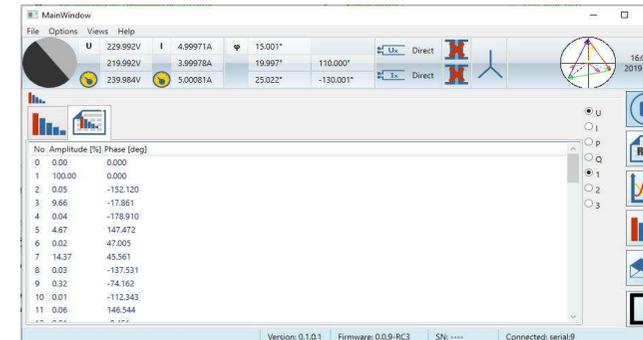
Harmonics in voltage U1



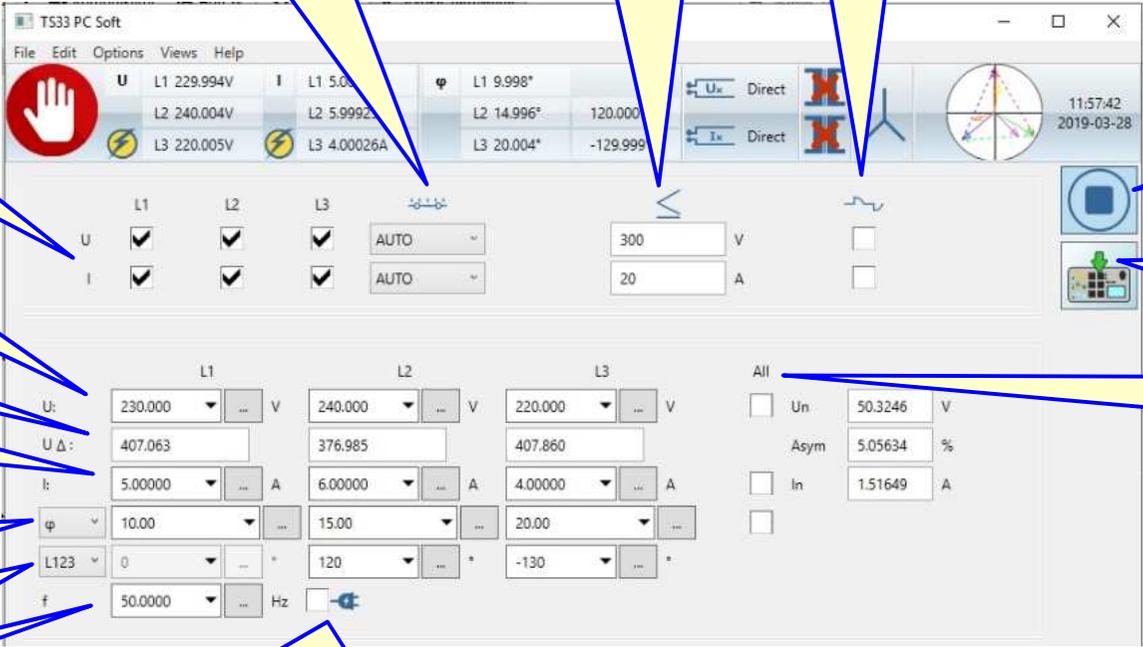
Meter error versus I load $\epsilon=f(I)$



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
- Setting maximum value of Voltage or Current
- Switching harmonics ON / OFF
- Switching ON / OFF of individual U & I channels
- Voltage in phase L1 L2 L3
- Voltage between phases
- Current in phase L1 L2 L3
- Phase shift U&I
- Phase shift between Voltages
- Frequency setting
- Frequency synchronised with power frequency
- START / STOP generation
- Set data acceptance
- Setting the same value for all three phases

- ▶ 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

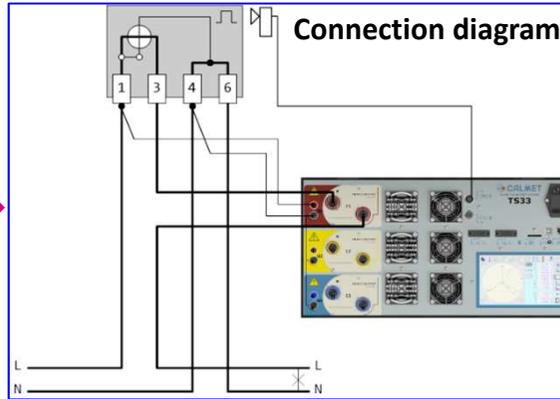
TS33: testing single phase electromechanical Energy Meter example (1)

TS33 as Reference Meter and meter under test directly connected

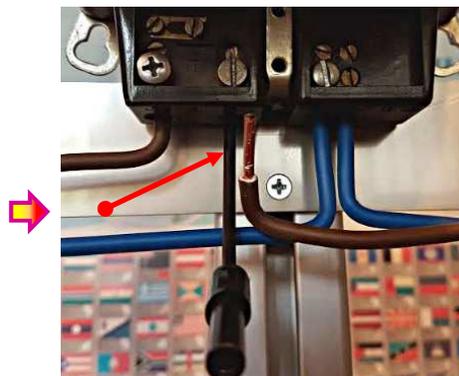


Meter parameters:
Base voltage: 230V
Base current: 5A
Max. current: 40A
Meter constant:
375 turns/kWh

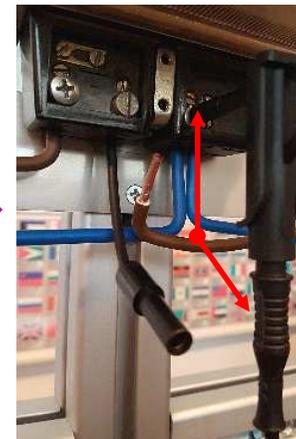
Typical, „old fashioned”, electromechanical meter and its parameters



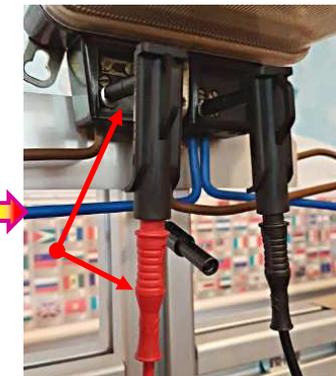
Disconnect phase wire connected to load



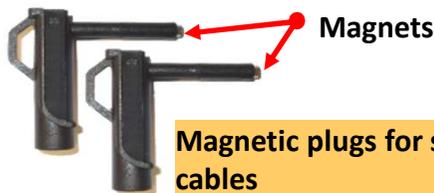
Connect instead „Cu” pin for safety cables



Connect „Neutral” meter terminal to neutral safety cable by means of magnetic plug



Connect „Phase” meter terminal to phase safety cable by means of magnetic plug



Magnetic plugs for safety cables



„Cu” pin for safety cables

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

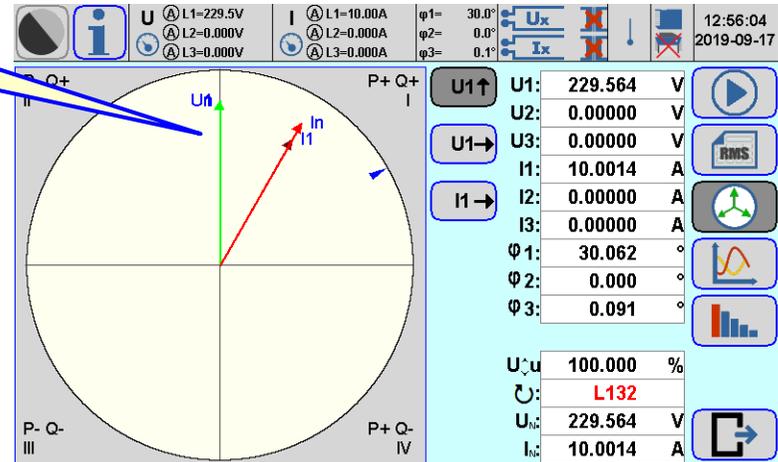
TS33 as Reference Meter and meter under test directly connected

	L1	L2	L3
U ₁ :	229.538 V	0.00000 V	0.00000 V
U ₂ :	229.538 V	0.00000 V	229.481 V
I ₁ :	10.0014 A	0.00000 A	0.00000 A
φ:	30.063 °	0.000 °	0.091 °
PF:	0.86548	0.00000	0.00000
sin:	0.50095	0.00000	0.00000
tgφ:	0.57881	0.00000	0.00000
Φ _{uu} :	0.000 °	165.803 °	165.831 °
P:	1.98689 W	0.00000 W	0.00000 W
Q:	1.15003 var	0.00000 var	0.00000 var
S:	2.29571 kVA	0.00000 VA	0.00000 VA

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

Averaged error result

Standard deviation

Partial error results

ε **0.716%**

s **0.009%**

No	ε _i
1	0.719
2	0.727
3	0.725

Table with recorded results versus time

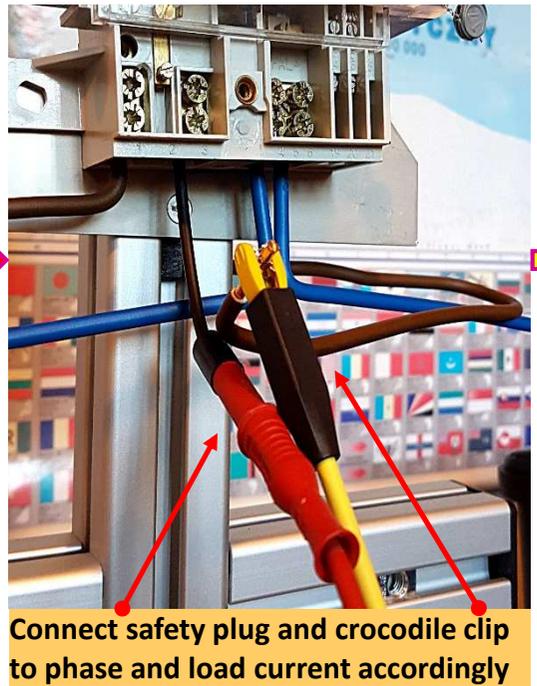
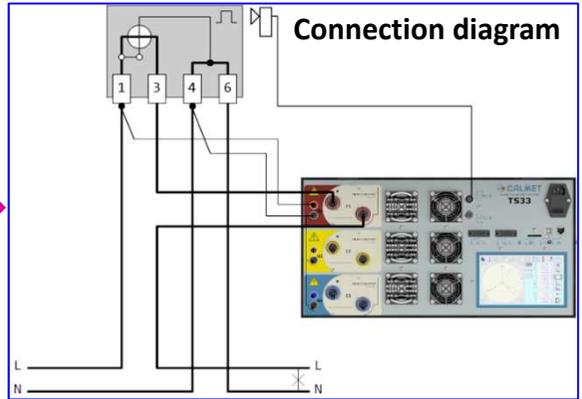
No	Time	P[W]	Q[VAR]	Lim [W]	ε[%]	se[%]	OK
1	13:05:14	1987.55	1149.65	2.000	0.716	0.009	✓
2	13:09:23	1987.42	1149.91	2.000	0.634	0.014	✓
3	13:10:50	1987.43	1149.89	2.000	0.706	0.004	✓
4	13:12:16	1987.42	1149.79	2.000	0.674	0.018	✓
5	13:13:43	1987.40	1149.88	2.000	0.705	0.003	✓
6	13:15:09	1987.43	1149.90	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



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° Ux Ix

	L1	L2	L3	
U:	229.719 V	0.0000 V	0.0000 V	f: 50.000 Hz
U _Δ :	229.719 V	0.0000 V	229.662 V	U _N : 229.719 V
I:	5.00058 A	0.0000 A	0.0000 A	I _N : 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: 0.299%

Load point parameters: P=994.597 W, Q=575.201 var, S=1.14895 kVA, PF=0.86566

Time of test: 10 s

Averaged error result: 0.299%

START test button

lim: 1.00 %

n: 3

ΣP 994.597 W
ΣQ 575.201 var
ΣS 1.14895 kVA
ΣPF 0.86566

No 1 ε_i 0.303
No 2 ε_i 0.295

-1.00% 0 +1.00%

10% t 1 s

Table with recorded results versus time

No	Time	P[W]	Q[VAR]	Limit[%]	ε[%]	σε[%]	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	✓

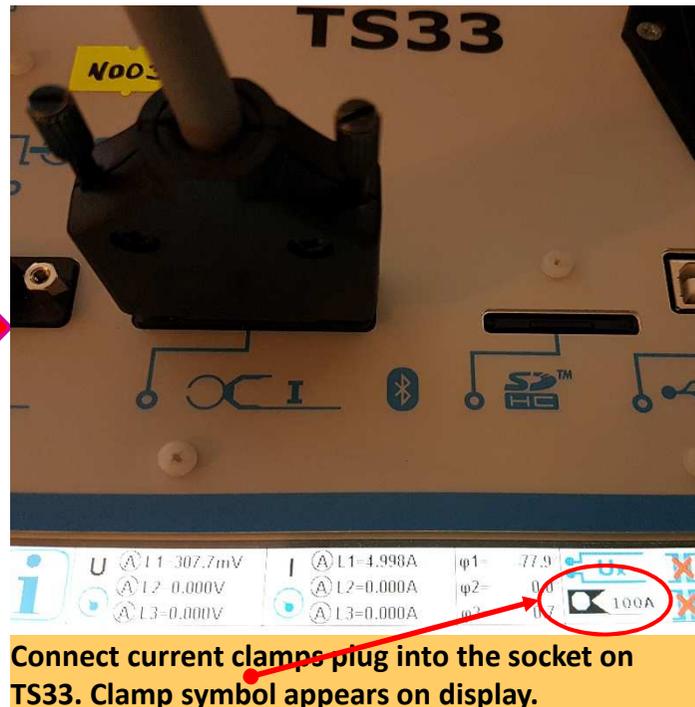
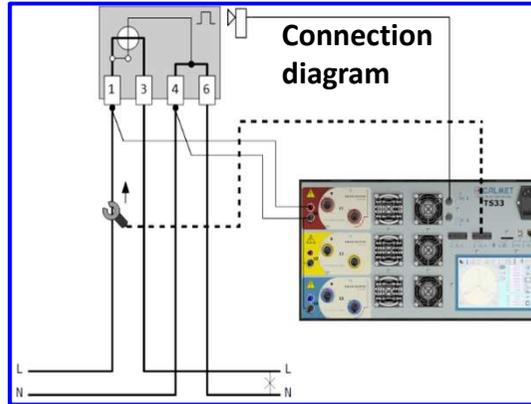
TS33 : testing single phase electronic (static) Energy Meter example (1)

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



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

Current clamps connected

Load point parameters

	L2	L3	
U _{L1}	229.736 V	0.00000 V	0.00000 V
U _{L2}	229.736 V	0.00000 V	229.679 V
I _{L1}	4.99855 A	0.00000 A	0.00000 A
φ _{L1}	30.030 °	0.000 °	0.729 °
PF	0.86576	0.00000	0.00000
sinφ	0.50046	0.00000	0.00000
tgφ	0.57806	0.00000	0.00000
φ _{uu}	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

START test button

Meter constant

Class of Meter under test

Time of test

Averaged error result

Table with recorded results versus time

0.350%

0.004%

6400.00 imp/kWh

t/N: 10 s

lim: 1.00 %

CT: I

PT: I

n: 3

ΣP	ΣQ	ΣS	ΣPF
994.193 W	574.663 var	1.14833 kVA	0.86577

No	ε
1	0.345
2	0.355

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

No	P[W]	Q[VAR]	Limit[%]	ε[%]	se[%]	OK
1	994.163	574.684	1.000	0.353	0.005	✓
2	994.177	574.689	1.000	0.350	0.001	✓
3	994.173	574.689	1.000	0.355	0.003	✓
4	994.164	574.686	1.000	0.356	0.003	✓
5	994.172	574.688	1.000	0.345	0.004	✓
6	994.173	574.686	1.000	0.356	0.004	✓
7	994.161	574.674	1.000	0.367	0.004	✓
8	994.165	574.675	1.000	0.374	0.006	✓
9	994.165	574.676	1.000	0.382	0.005	✓
10	994.167	574.677	1.000	0.378	0.006	✓
11	994.174	574.681	1.000	0.369	0.005	✓
12	994.161	574.669	1.000	0.381	0.006	✓
13	994.175	574.673	1.000	0.371	0.005	✓

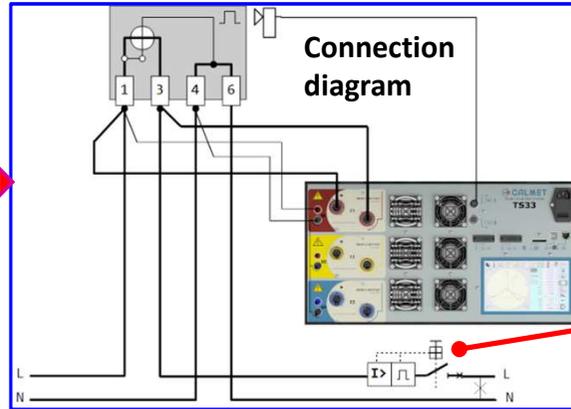
TS33 : testing single phase electronic (static) Energy Meter example (1)

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 (*).



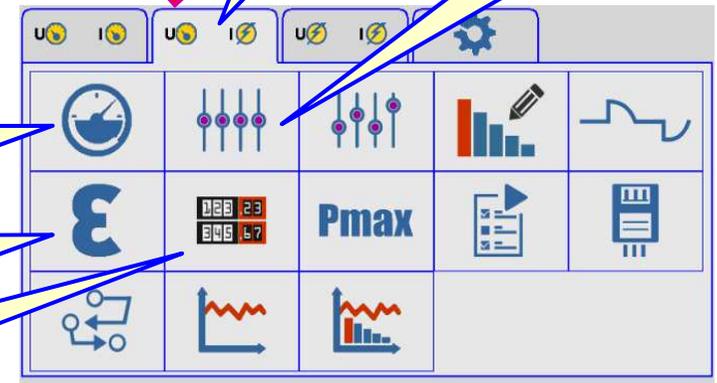
In the TS33 LCD select U measurement and I generation mode

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 _n : 230.150 V
I:	4.99967 A	0.00000 A	0.00000 A	I _n : 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 _{uu} :	0.000 °	45.277 °	45.304 °	Σ: 996.515 W
P:	996.515 W	0.00000 W	0.00000 W	Σ: 575.326 var
Q:	575.326 var	0.00000 var	0.00000 var	Σ: 1.15068 kVA
S:	1.15068 kVA	0.00000 VA	0.00000 VA	

Meter constant
Number of pulses
Class of Meter under test
Table with recorded results versus time

Averaged error result
Standard deviation

0.217%
0.009%

No		P[W]	Q[VAR]	Limit[%]	ε[%]	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	✓

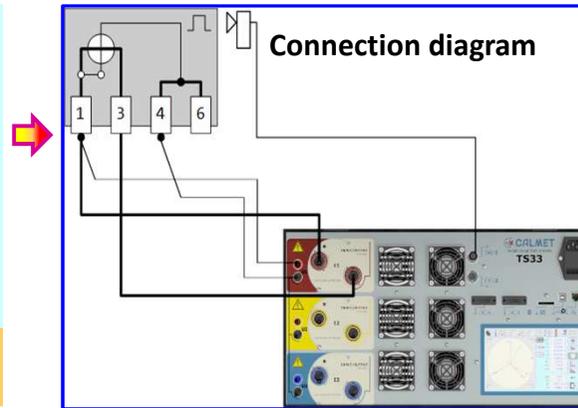
TS33 : testing single phase electronic (static) Energy Meter example (1)

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



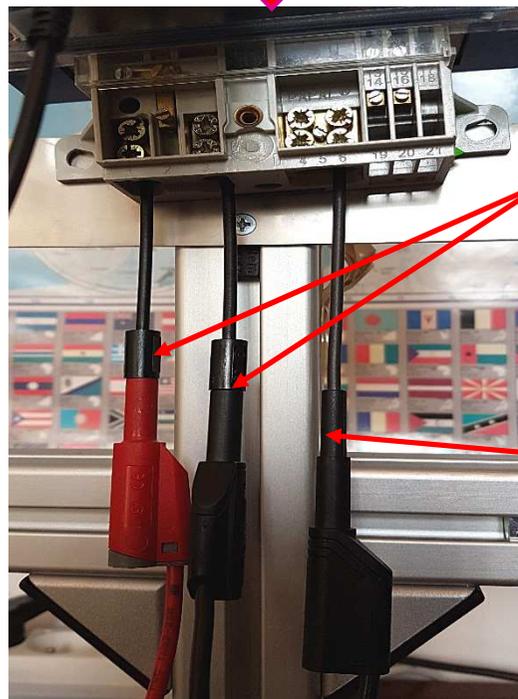
Meter parameters:
Base voltage: 230V
Base current: 5A
Max. current: 60A
Meter constant: 6400 imp/kWh

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



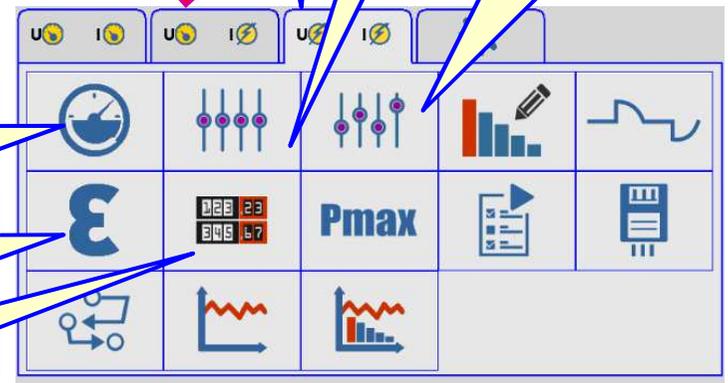
connect current input and output of the meter (eg. by „Cu” pins) by means of safety cables to TS33 current inputs; connect neutral meter terminal to the neutral voltage input of TS33; Shunt TS33 voltage input and current output (*).



Setting value of voltage, current and phase shift

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

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!

Testing schedule:

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

	L1	L2	L3	
U _{L1}	229.998 V	0.00000 V	0.00000 V	f: 50.000 Hz
U _{L2}	230.000 V	0.00000 V	230.083 V	U _N : 229.998 V
I _{L1}	5.00002 A	0.00000 A	0.00000 A	I _N : 5.00002 A
φ	30.001 °	0.000 °	0.011 °	
PF:	0.86601	0.00000	0.00000	Σ: 0.86601
sin:	0.50001	0.00000	0.00000	Σ: 0.50001
gφ:	0.57738	0.00000	0.00000	Σ: 0.57738
φ _{uu} :	0.000 °	-89.992 °	-89.993 °	Σ: 995.903 W
P:	995.903 W	0.00000 W	0.00000 W	Σ: 575.014 var
Q:	575.014 var	0.00000 var	0.00000 var	Σ: 1.15000 kVA
S:	1.15000 kVA	0.00000 VA	0.00000 VA	

Meter constant

Number of pulses

Class of Meter under test

Table with recorded results versus time

Averaged error result

Standard deviation

No	Time	P[W]	Q[VAR]	Limit[%]	ε[%]	σε[%]	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

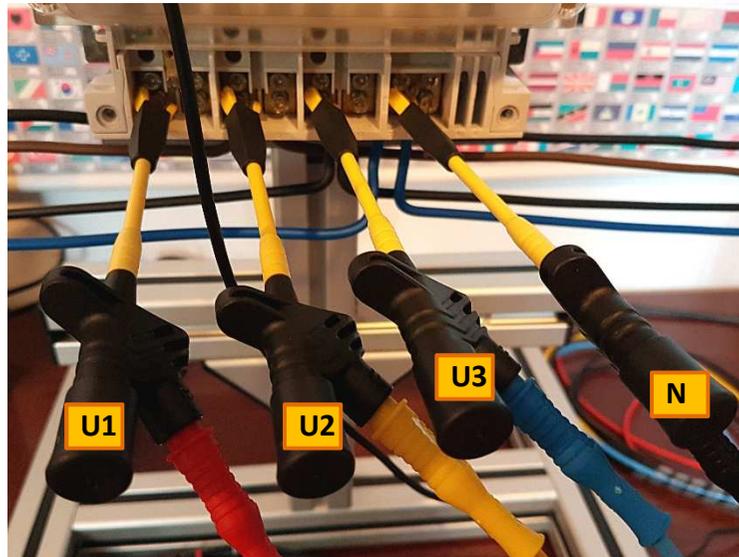
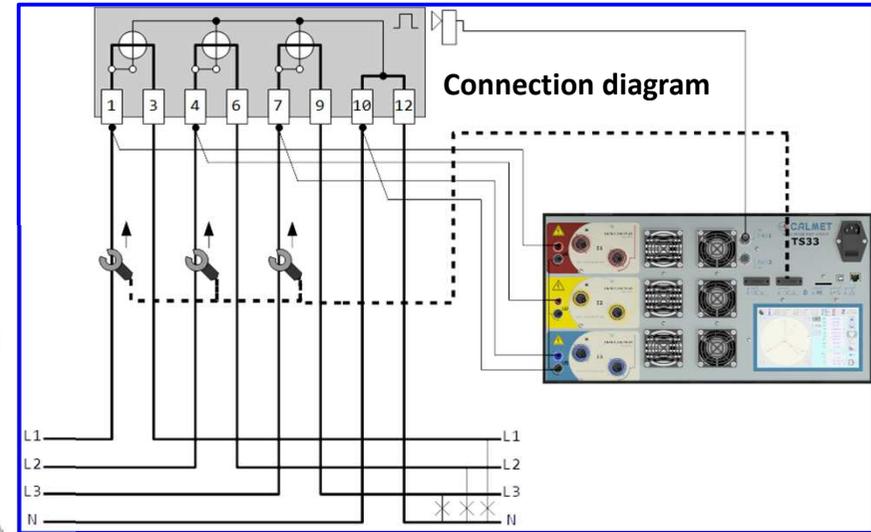


Meter parameters:

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

Typical three phase electronic meter with LED and its parameters

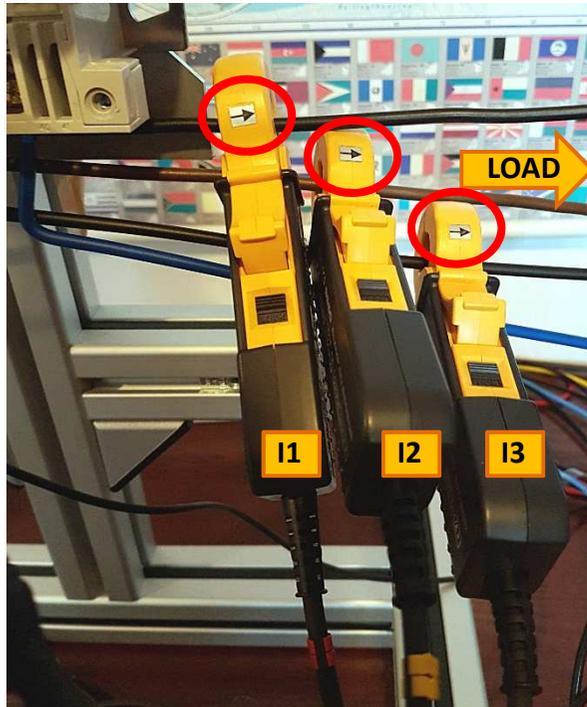
Connect voltage U1, U2, U3 and neutral N by means of crocodile clips



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

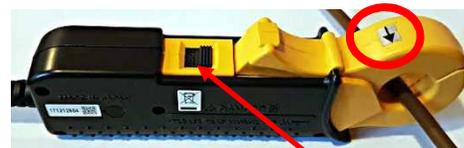


Close current clamps on load cables, respectively I1, I2, I3. Take care about clamps direction (⇒)

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



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



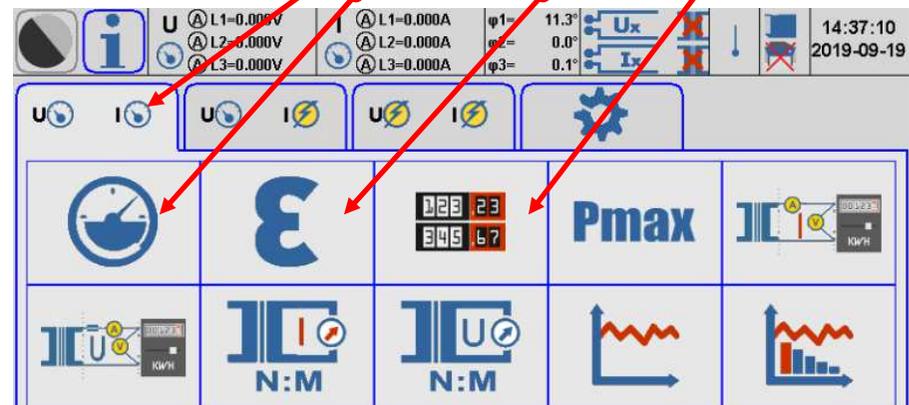
Close clamp jaws and lock them. Direction (⇒)!



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



Connect common current clamps output to the TS33 input



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 _L	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 _{uu}	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

No	Time	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	✓

Meter constant Time of test Class of Meter under test

Averaged error result

Standard deviation

No	ε _i
1	0.062

Table with recorded results versus time

No	Time	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**

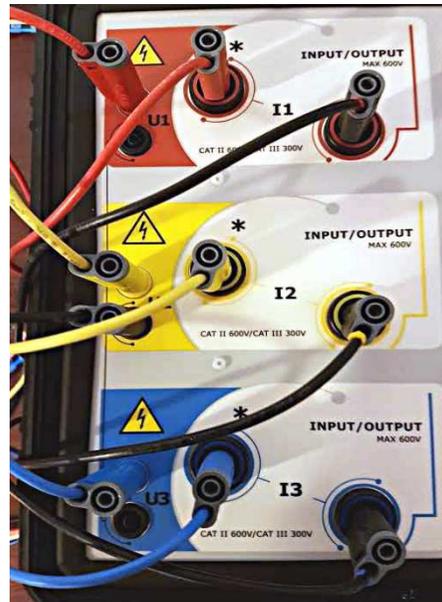
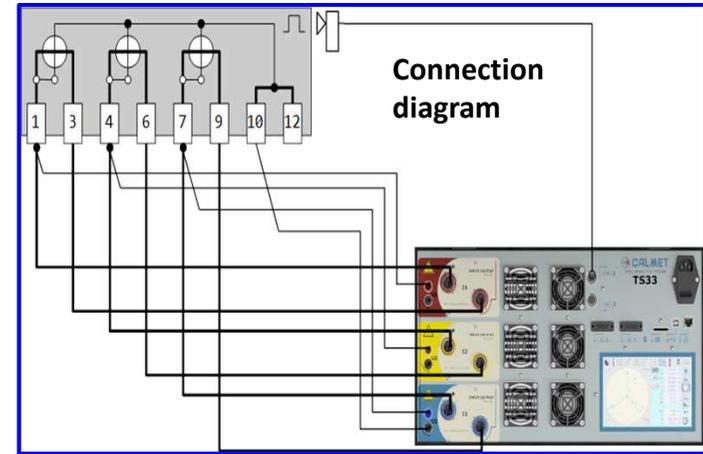


Meter parameters:
Base voltage: 230V
Base current: 5A
Max. current: 100A
Meter constant:
1000 imp/kWh

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

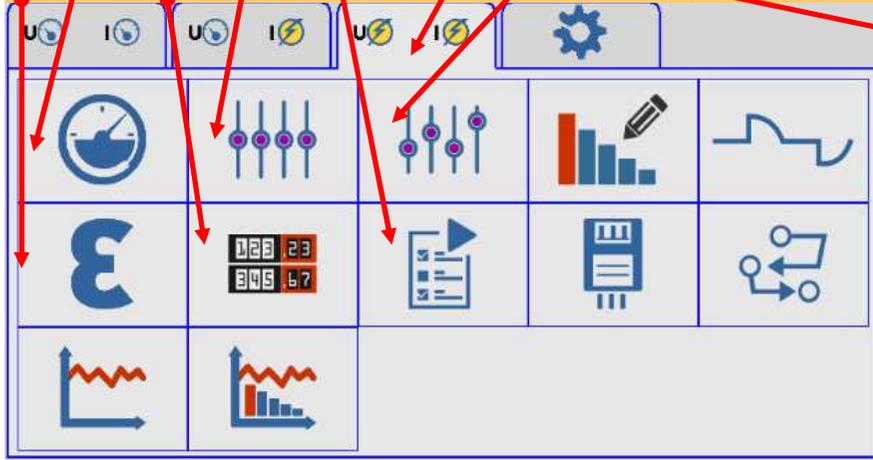
Set phase shift between U2&U3

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



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

This mode requires meter disconnection!

	L1	L2	L3	
U _L :	229.999 V	240.002 V	220.001 V	f: 50.000 Hz
U _Σ :	407.050 V	398.497 V	389.825 V	U _Σ : 17.3203 V
I:	5.00005 A	4.00016 A	5.99939 A	I _Σ : 2.45044 A
φ:	14.998 °	20.007 °	25.007 °	
PF:	0.96592	0.93964	0.90624	
sin:	0.25878	0.34213	0.42272	
tgφ:	0.26791	0.36411	0.46646	
Q _Σ :	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	1.31987 kVA	Σ: 3.42993 kVA

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

Averaged error result

Standard deviation

Table with recorded results versus time

No	P[W]	Q[VAR]	Limit[%]	ε[%]	se[%]	OK
1	3209.16	1184.07	2.000	0.059	0.045	✓
2	3209.21	1184.18	2.000	0.038	0.048	✓
3	3208.99	1184.08	2.000	0.008	0.022	✓
4	3209.13	1183.98	2.000	0.117	0.010	✓
5	3209.15	1184.15	2.000	-0.011	0.023	✓
6	3209.19	1184.04	2.000	0.079	0.037	✓
7	3209.06	1184.14	2.000	0.047	0.037	✓
8	3209.23	1183.99	2.000	0.077	0.011	✓
9	3209.03	1184.04	2.000	0.050	0.040	✓
10	3209.03	1184.03	2.000	0.037	0.009	✓
11	3209.18	1184.06	2.000	0.052	0.010	✓
12	3209.20	1184.20	2.000	0.015	0.025	✓
13	3209.15	1184.13	2.000	0.086	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

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

Load point name | **Meter Class** | **Time of measurement** | **Add load point to list** | **Number of measurements per result**

Meter error test | **Voltage in [%]** | **Current in [%]** | **Phase shift U&I** | **Vector rotation** | **Frequency** | **Harmonics** | **Phase shift U&U**

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

Meter or Procedure name field

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

List of load points

List edition insert, move up/down remove

	L1	L2	L3	L123
U	100.000 %	100.000 %	100.000 %	
I	100.000 %	100.000 %	100.000 %	
φ	0.00 °	0.00 °	0.00 °	
L123	0.00 °	120.00 °	-120.00 °	
f	50.000 Hz			

Phase shift U&I

Frequency

Harmonics

Phase shift U&U

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**

Automatic Procedure for whole load characteristics

Meter Test Execution

Meter type name: AP20EC3G
Test procedure name: 5TO400PR
Test starting: [Start]

Individual load point test

Load point name: 400pr

Averaged error result: 0.016%
Standard deviation: 0.006%
Error limit: 2.000%
Individual errors: 0.027, 0.009, 0.011

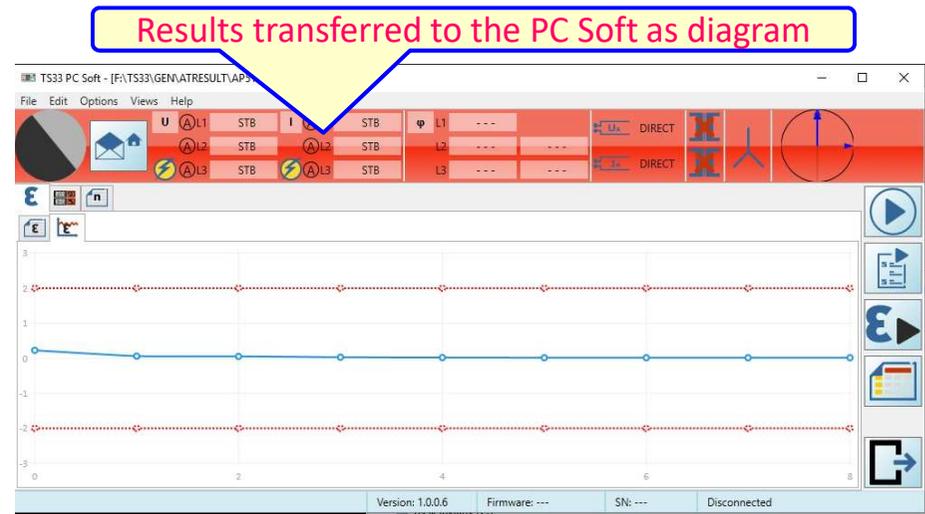
Selected load points: 1-9
Load point values: 230.000V, 20.0000A, 50.000Hz, 13800.0W

100% 100% 100%

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[%]	σε[%]	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	✓



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

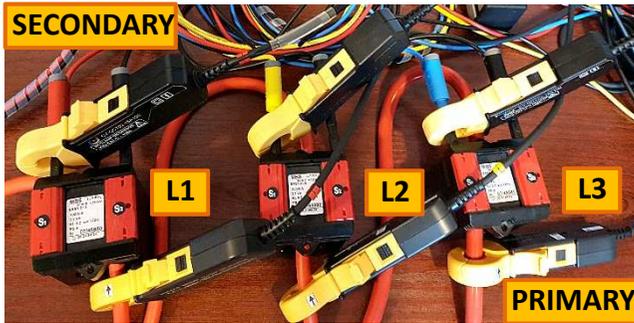
TS33 as Reference Meter and CT primary and secondary current measured by current clamps



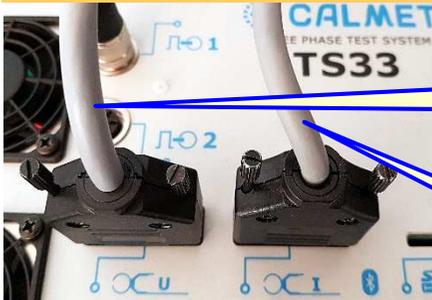
CT parameters:

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

Typical current transformer CT in metering installation

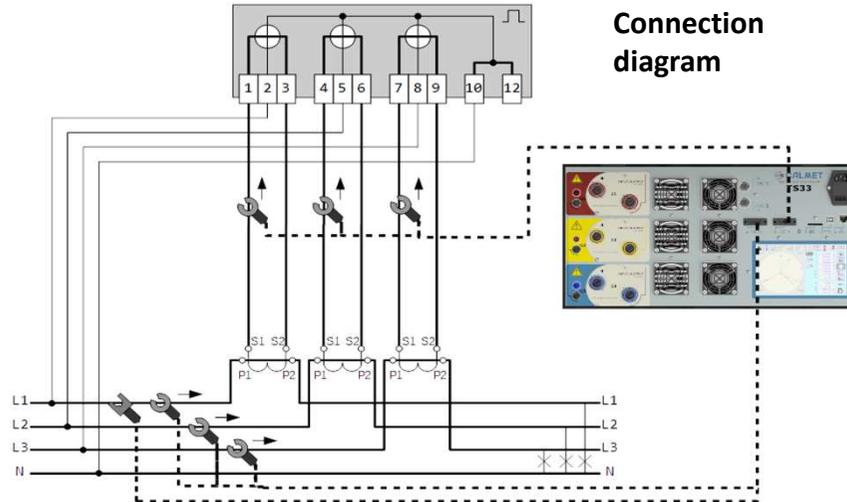


TS33 side clamps connection



Primary clamps

Secondary clamps



Connection diagram

TS33 can test automatically up to 3 different CTs at time

Accuracy class of current clamps

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
U	L1=99.96A	L2=99.97A	L3=99.95A
I	L1=5.0088A	L2=4.9961A	L3=5.0125A
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 %

lim: 0.200% 0.200% 0.200%

lpn: 100A 100A 100A

lsn: 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 %

n: 10

13:42:04
2019-10-02

TS33 : testing current transformers CT burden example (1)

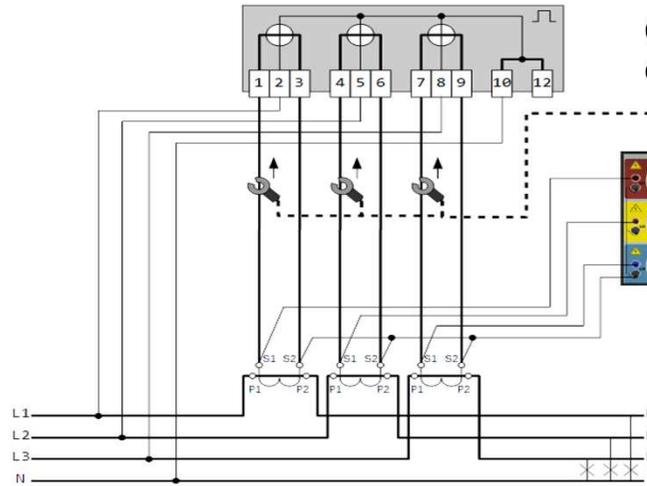
TS33 as Reference Meter and CT secondary current measured by current clamps and voltage directly



CT parameters:

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

Typical current transformer CT in metering installation

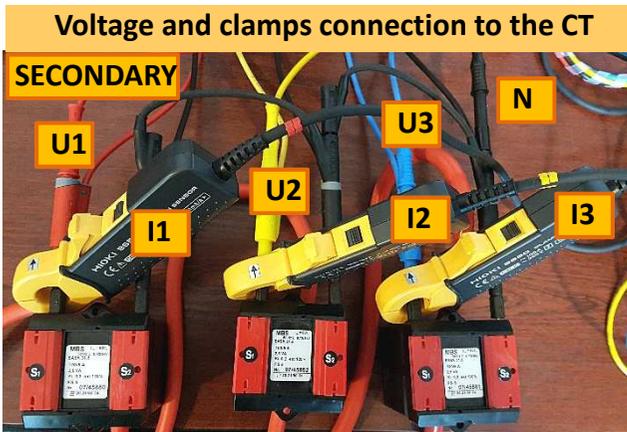


Connection diagram

TS33 can test automatically up to 3 different CTs at time



TS33 side voltage connection



Voltage and clamps connection to the CT

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

	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

Ux: 100A

φ2= 5.4°

φ3= 5.4°

n: 3

L: 4.000 m

2.5 mm²

14:30:24
2019-10-02

Length and cross section of CT connection cables

TS33 : how to order – versions, options, accessories

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

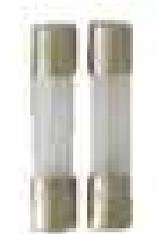
Standard scope of delivery



TS33 Automatic Test System



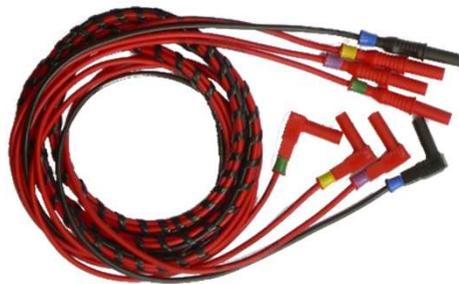
Power cord



Fuses



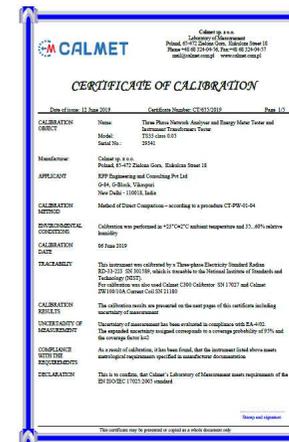
C091 Amphenol connector



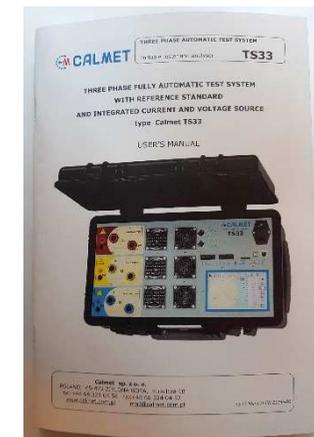
Voltage connection cables



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



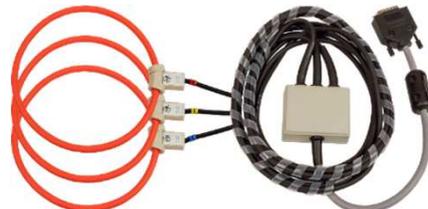
CT10AC current clamps



CT100AC current clamps



CT1000AC current clamps



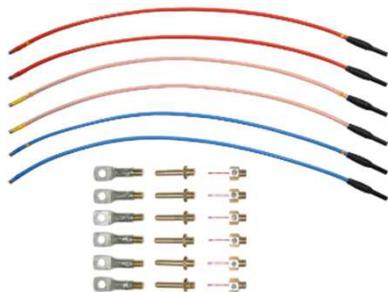
FCT3000AC flexible clamps



AmpLiteWire 2000AC (@150kV)



VoltLiteWire 40kVC



AKD300 120A cable set



DR200 thermal printer

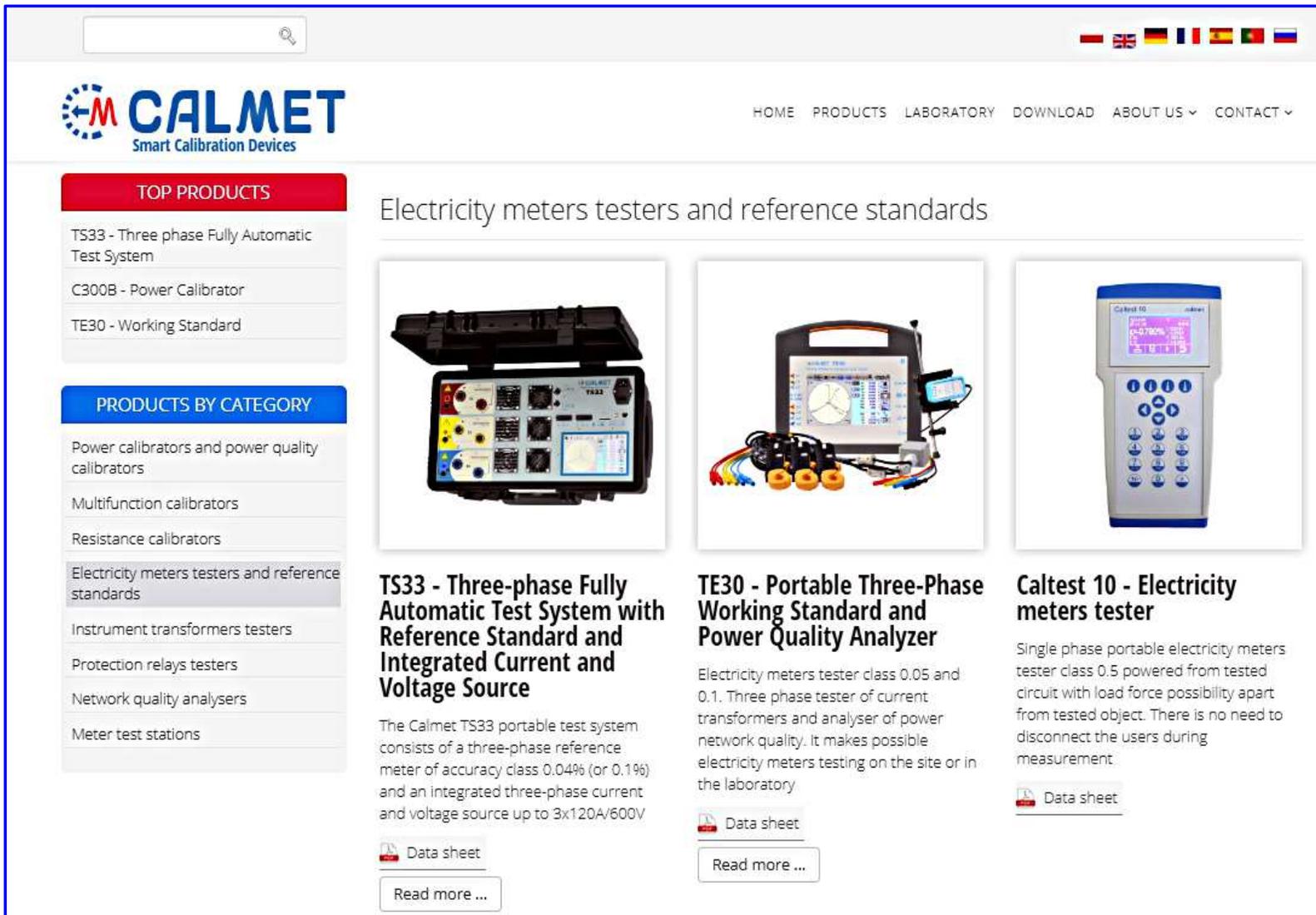


AKD100 accessories for safety cables



CF106H photo head for LED & mechanical meters

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 row of flags representing different languages. The main navigation menu includes HOME, PRODUCTS, LABORATORY, DOWNLOAD, ABOUT US, and CONTACT. The left sidebar features a 'TOP PRODUCTS' section with links to 'TS33 - Three phase Fully Automatic Test System', 'C300B - Power Calibrator', and 'TE30 - Working Standard'. Below this is a 'PRODUCTS BY CATEGORY' section with various categories like 'Power calibrators and power quality calibrators', 'Multifunction calibrators', 'Resistance calibrators', 'Electricity meters testers and reference standards', 'Instrument transformers testers', 'Protection relays testers', 'Network quality analysers', and 'Meter test stations'. The main content area is titled 'Electricity meters testers and reference standards' and displays three product cards. Each card includes an image of the device, a title, a brief description, a 'Data sheet' link, and a 'Read more ...' button.

TOP PRODUCTS

- TS33 - Three phase Fully Automatic Test System
- C300B - Power Calibrator
- TE30 - Working Standard

PRODUCTS BY CATEGORY

- Power calibrators and power quality calibrators
- Multifunction calibrators
- Resistance calibrators
- Electricity meters testers and reference standards
- Instrument transformers testers
- Protection relays testers
- Network quality analysers
- Meter test stations

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