



## Testing the entire energy measurement system!

Accuracy of all kinds of meters  $\epsilon$ [%]

Electromechanical (Ferraris)



Electronic (static)



4 – Quadrants  
Smart Meters



Max. demand



CT/PT burden, ratio, phase shift error



Wiring errors



# TS33

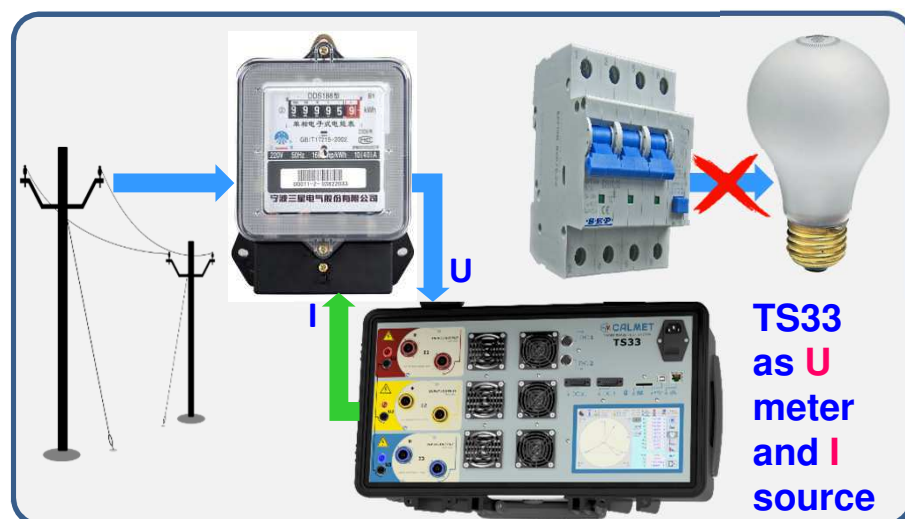


## Reference Meter & 3-phase U&I Source in one case! Modes of testing



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

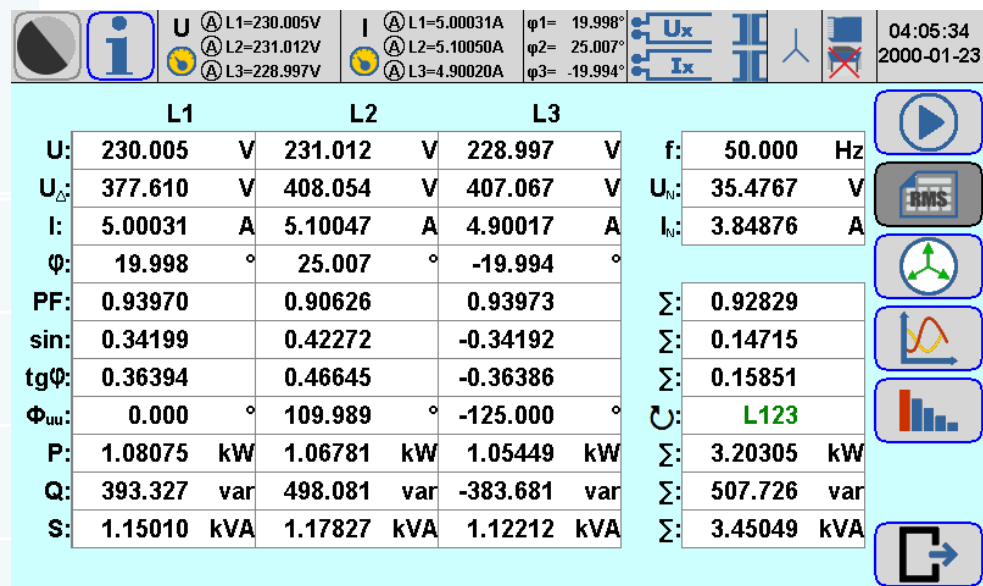
Testing **OFF LINE** – meter & load are not connected to the network; metering point can be set in whole range of load; TS33 works as source of U&I and reference meter



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

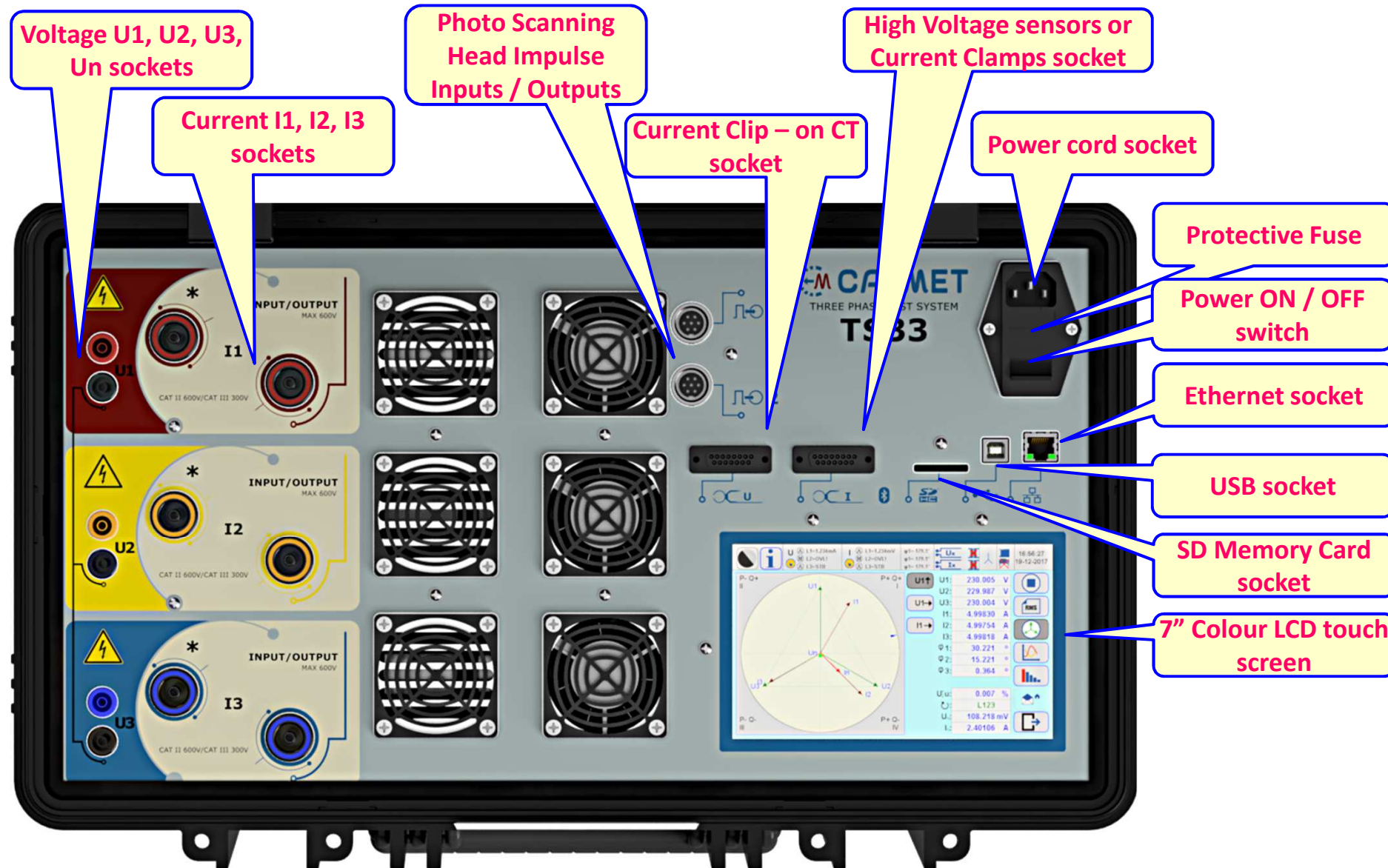
Testing without meter disconnecting!

- ▶ 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



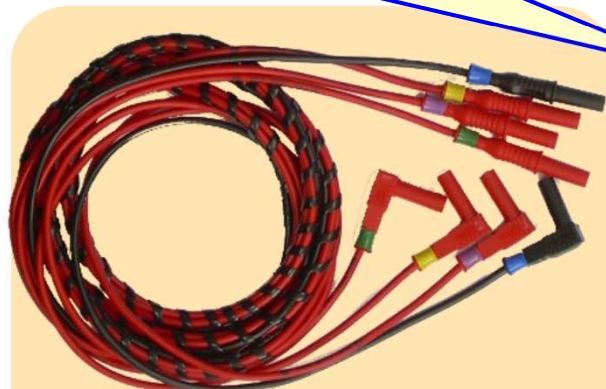


## TS33 Inputs, Outputs and Connectors:

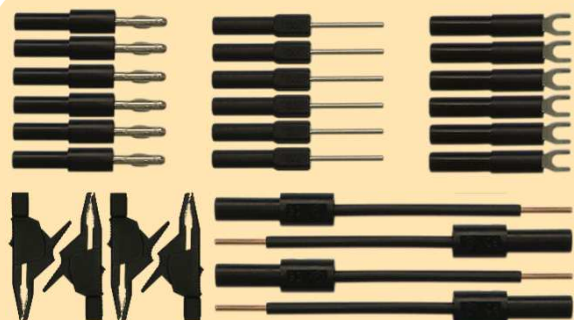


## TS33 Voltage and Current Inputs:

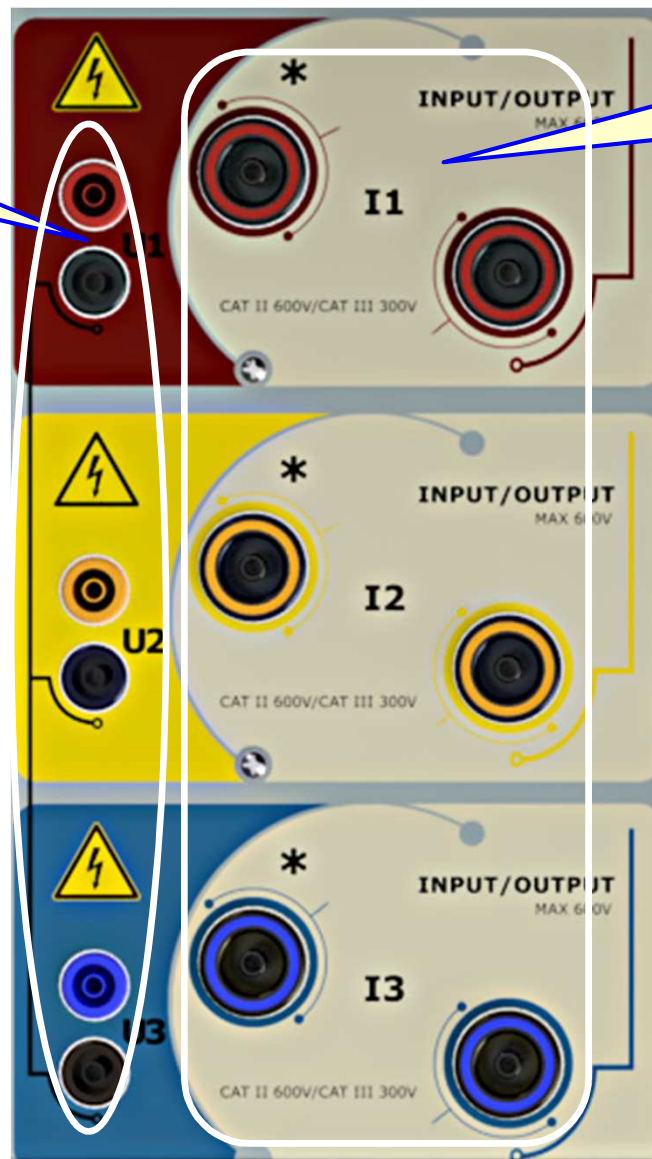
Voltage U1, U2, U3, Un Input /  
Output sockets  
0.05...600V



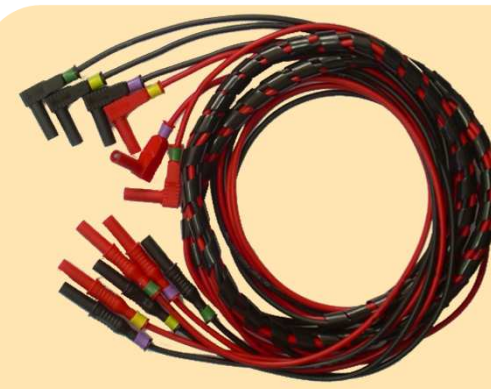
4mm Voltage Safety Cables  
Length=2m



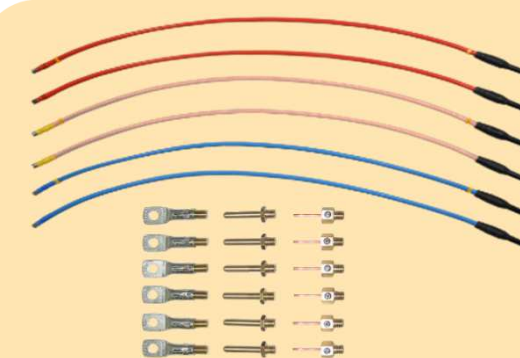
Easy connection due to rich set  
of accessories for safety cables



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



4mm Current Safety Cables  
Length=2m,  $I \leq 30A$



25mm<sup>2</sup> High Current Cables  
Length=1m,  $I \leq 120A$



## TS33 Pulse Input / Output;

## can test all kinds of Electricity Meters

**Electronic energy meter**

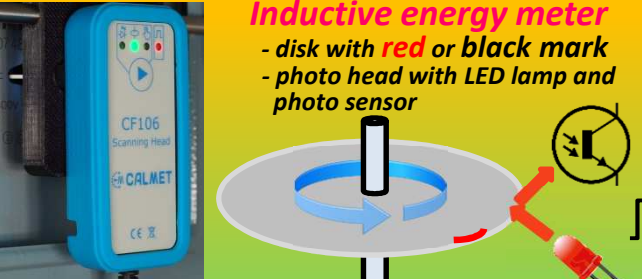
- red, green or infrared LED blinking or LCD segment flashing
- photo head with photo sensor

0.0001Hz...200kHz



**Inductive energy meter**

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

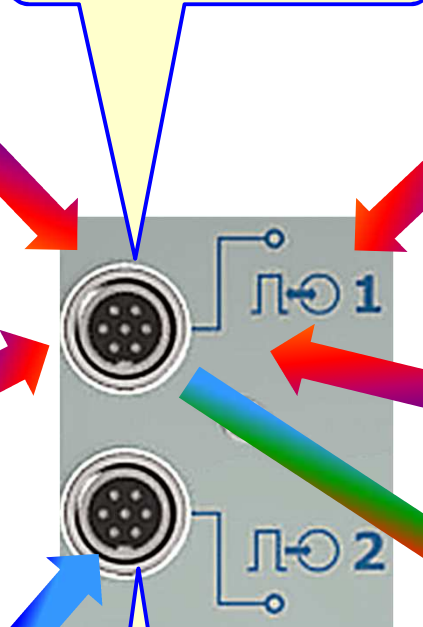


In case, that we need higher than offered by TS33 accuracy 0.04 or 0.1, we can use external reference easy way

**Additional, external very, high accuracy Reference Meter**



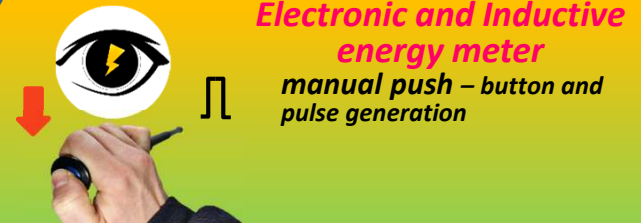
1. Pulse Input / Output socket



2. Pulse Input for external Reference Meter socket

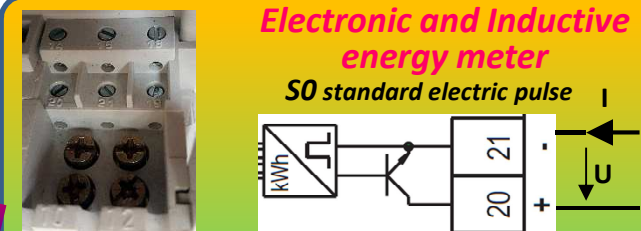
**Electronic and Inductive energy meter**

manual push – button and pulse generation



**Electronic and Inductive energy meter**

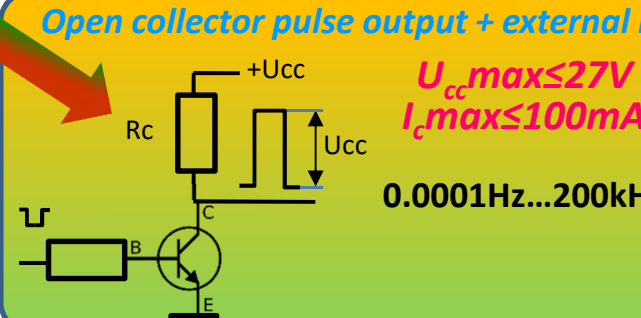
50 standard electric pulse



**Open collector pulse output + external Rc**

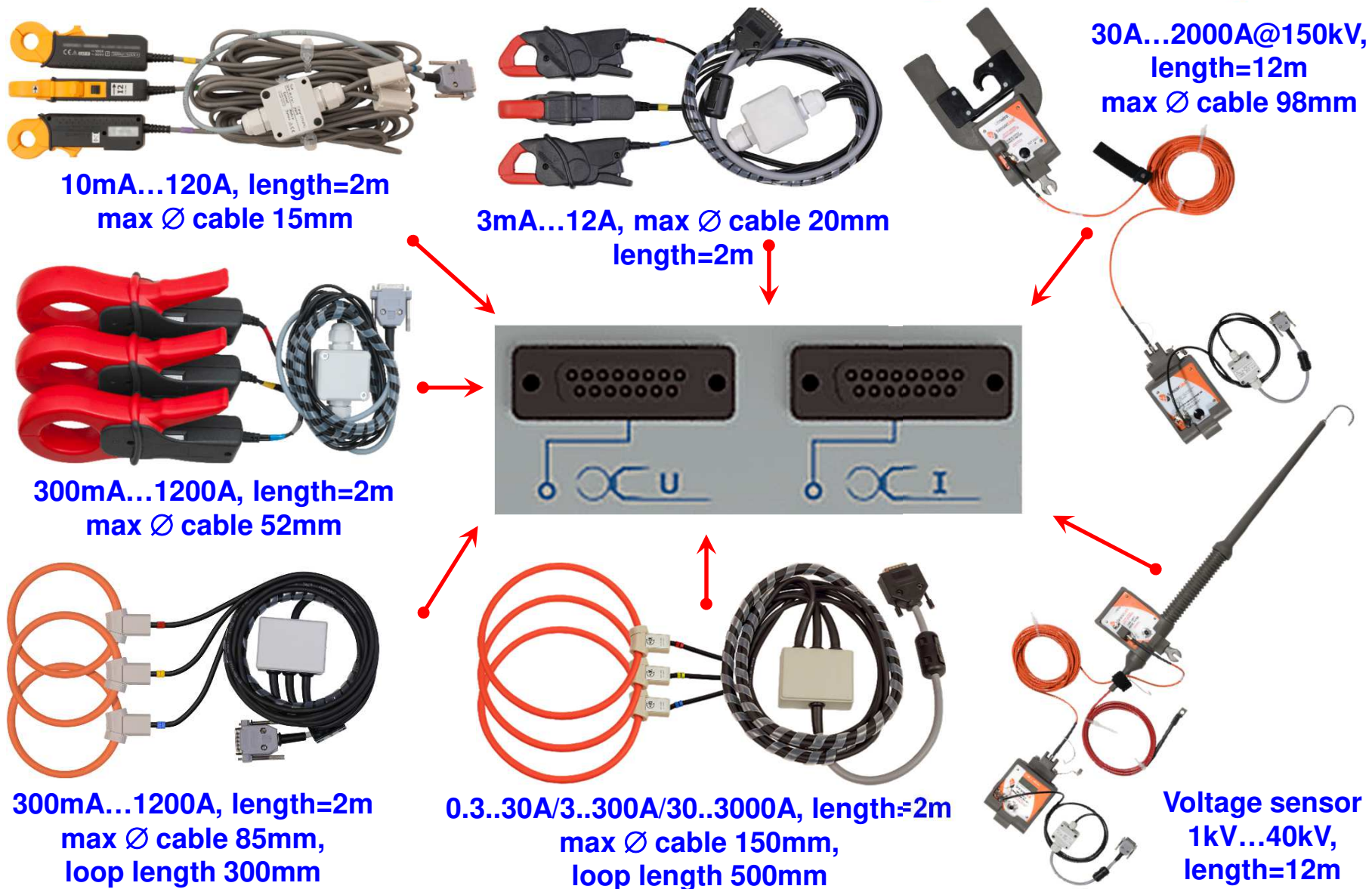
$U_{cc} \max \leq 27V$   
 $I_c \max \leq 100mA$

0.0001Hz...200kHz



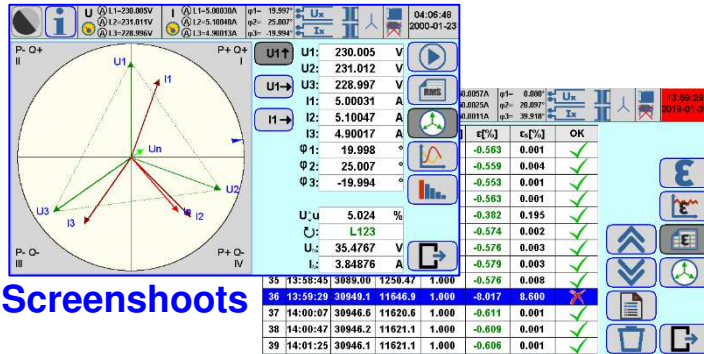
TS33 has pulse output with frequency proportional to the power, with freely programmable constant imp/kWh

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





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

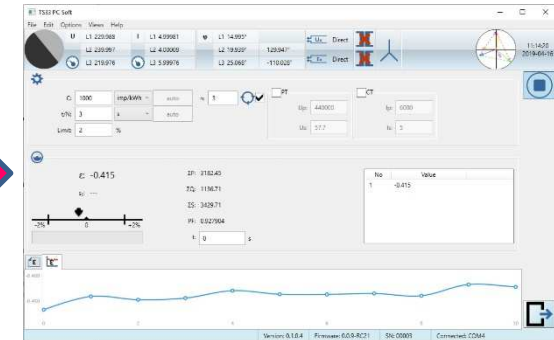


Screenshots

Results



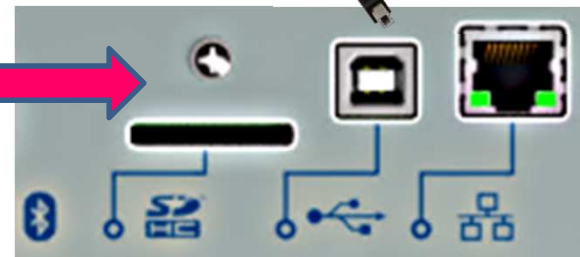
USB



CalproTS33 PC Soft



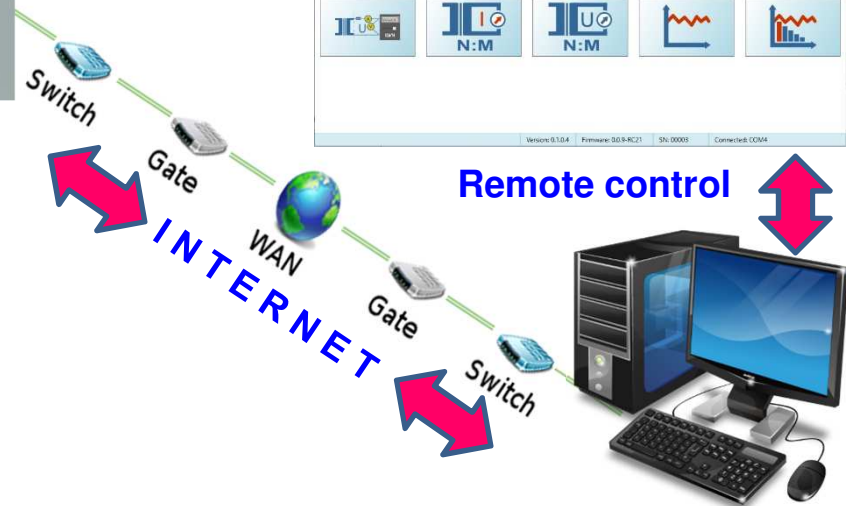
Removable SD cards 2..32GB



Ethernet

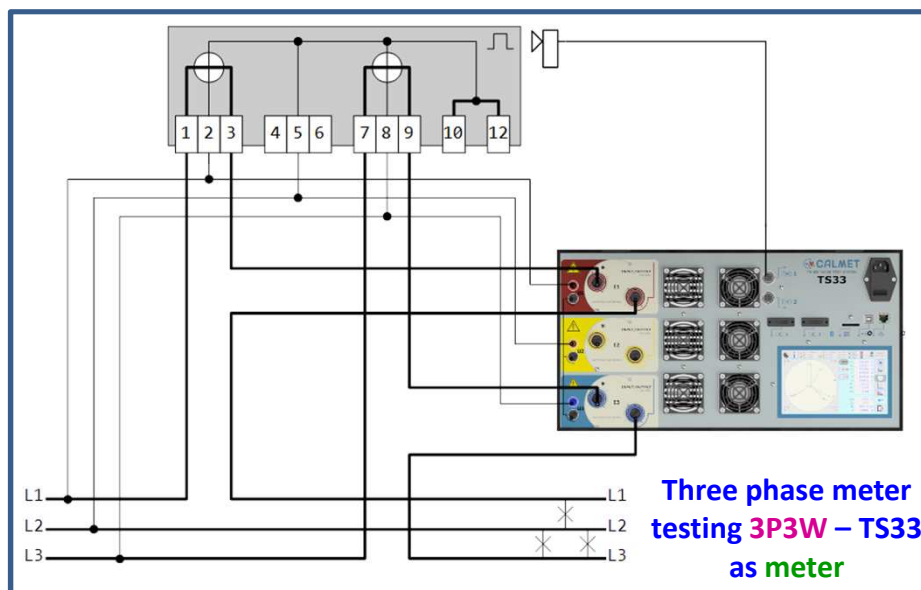
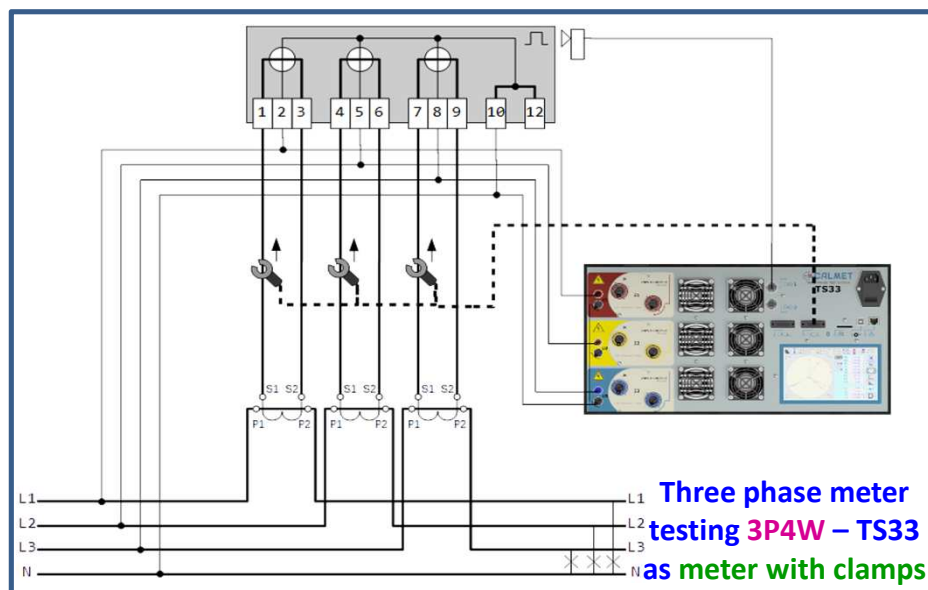
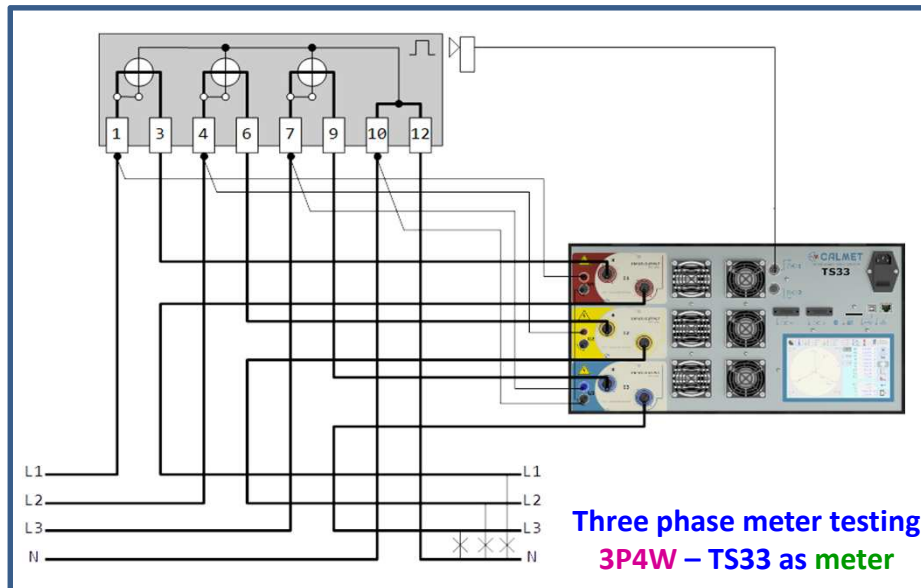
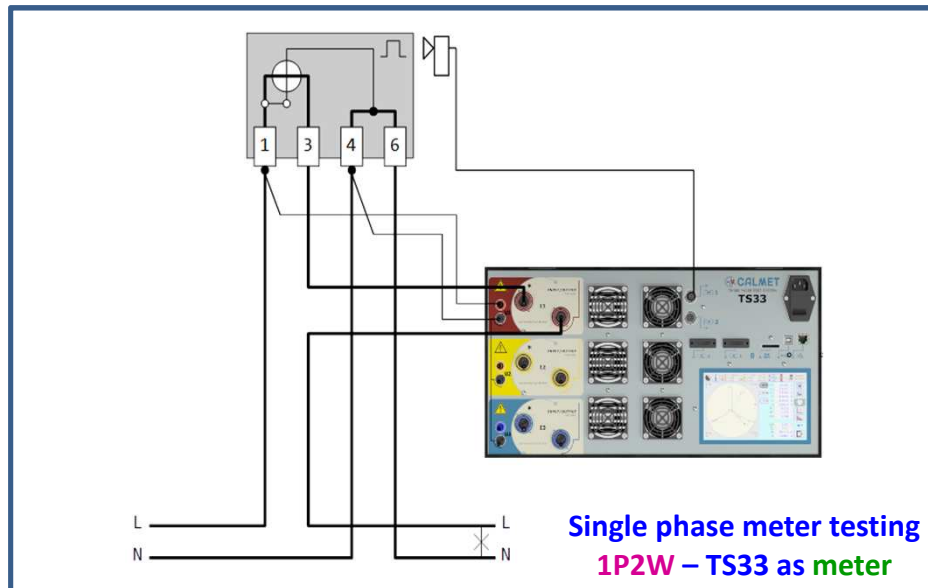


Bluetooth, wireless printer & laptop



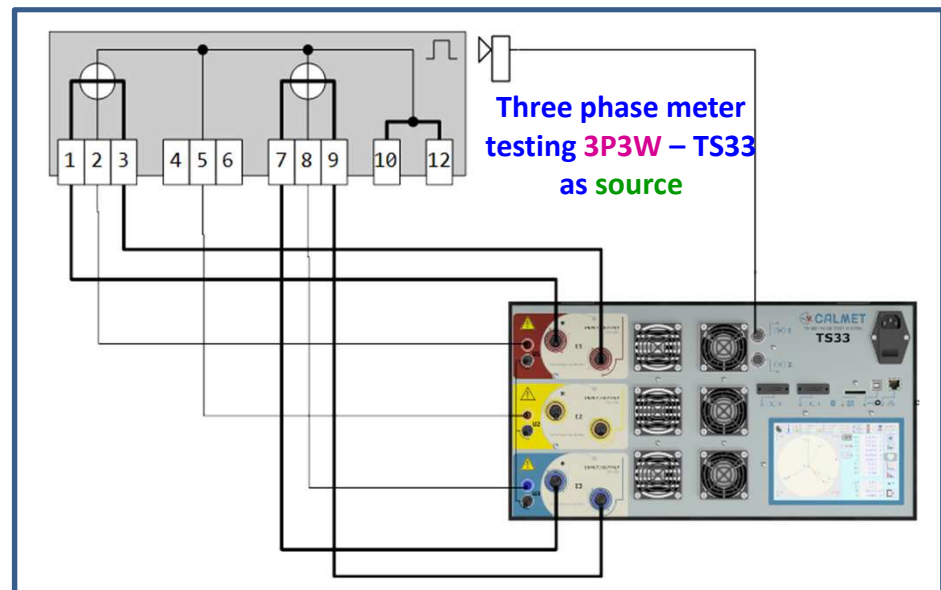
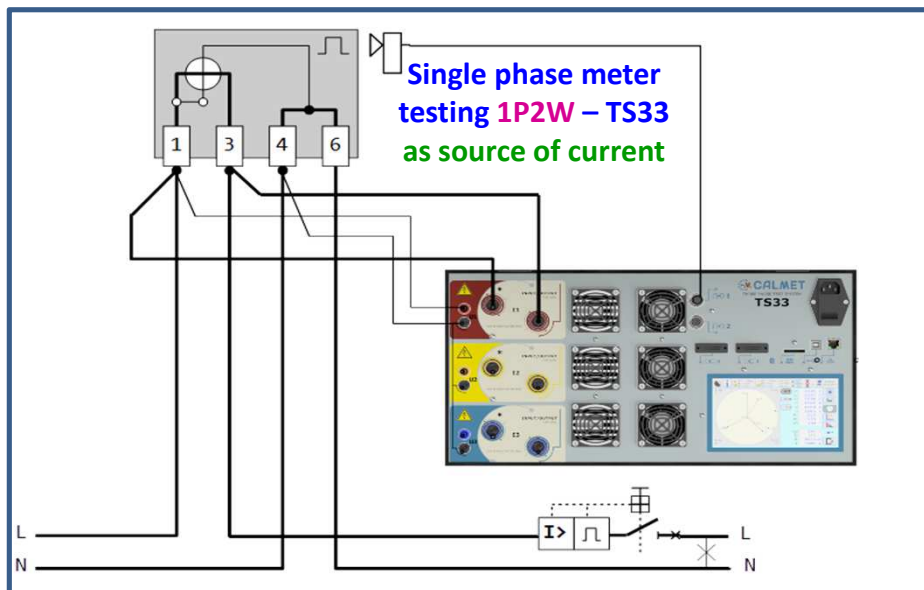
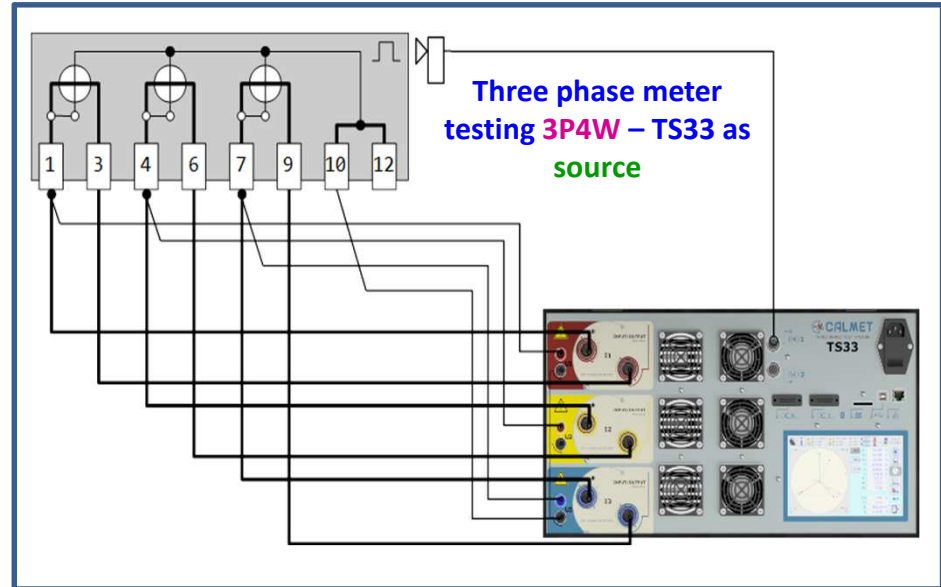
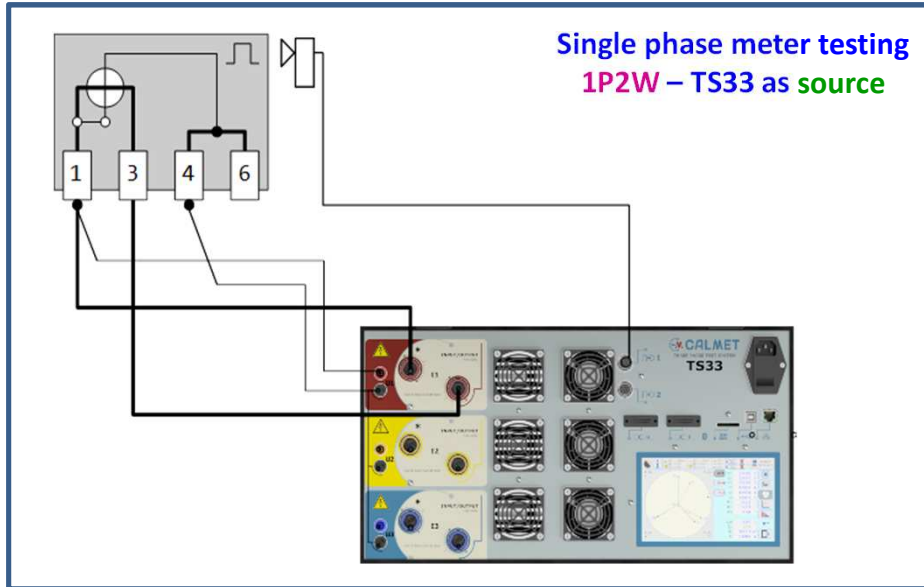
Remote control

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

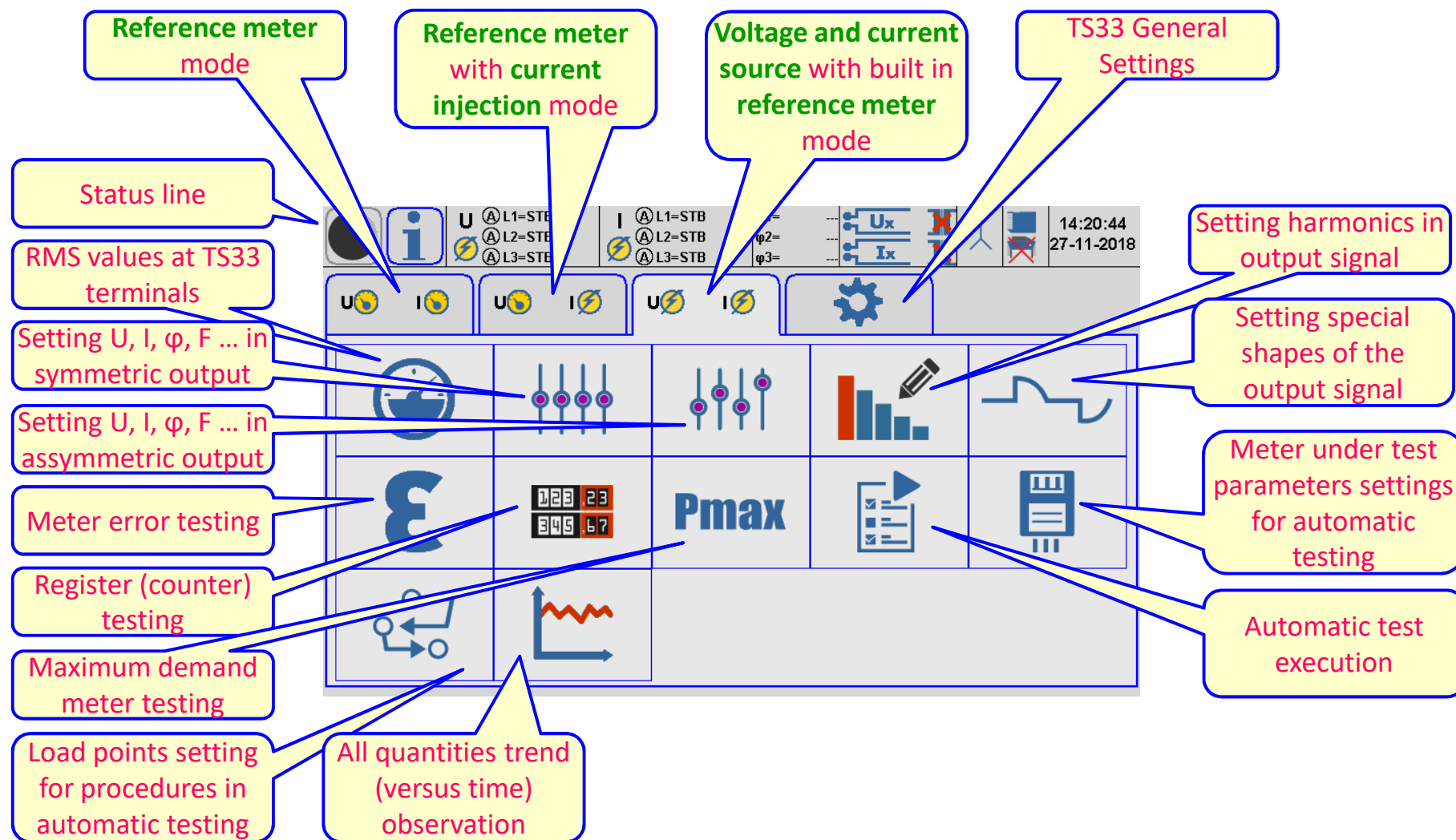




**All possible types of meters: 1P2W, 3P4W, 3P3W. TS33 as source and reference**



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



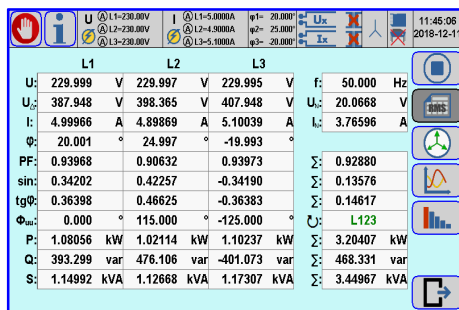
**Easy, icon driven, operation on big 7" touch screen**



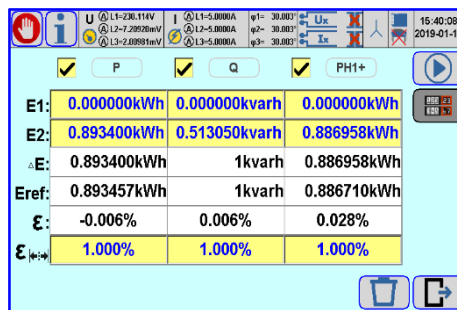
## TS33 reference meter mode: whole installation measurement „as it is”



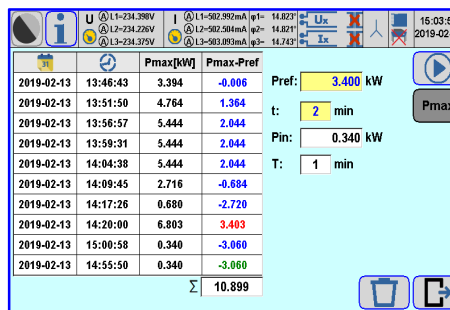
RMS values of U,I,φ,F,P,Q,S



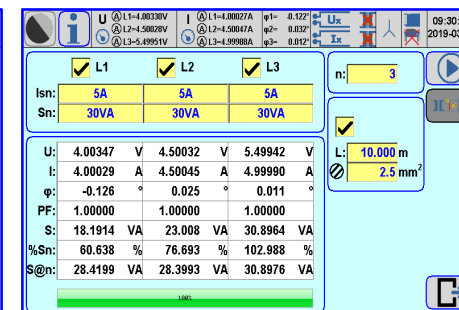
Counter (register) test



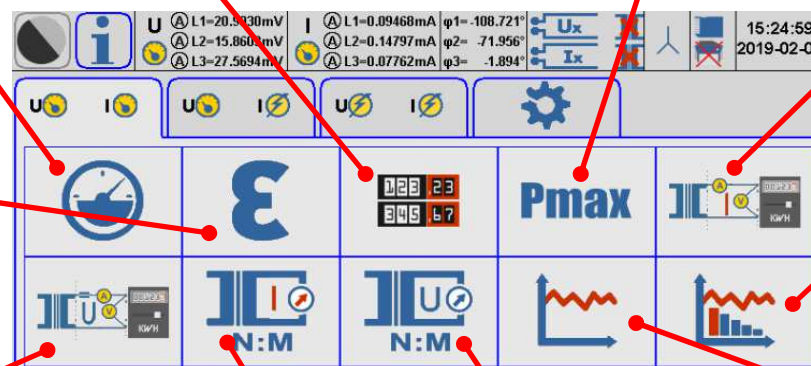
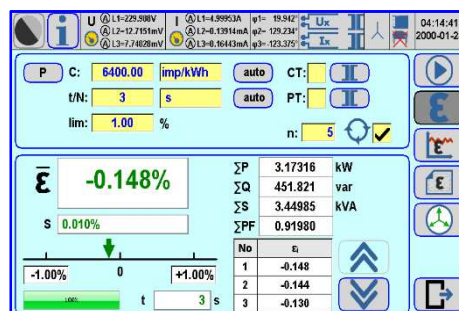
Maximum demand meter test



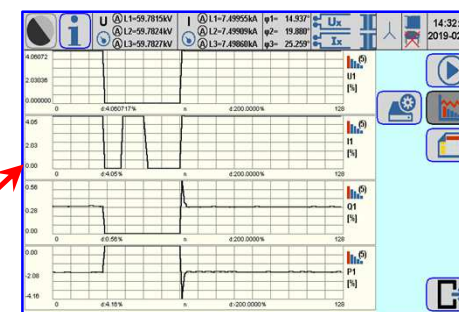
CT burden test



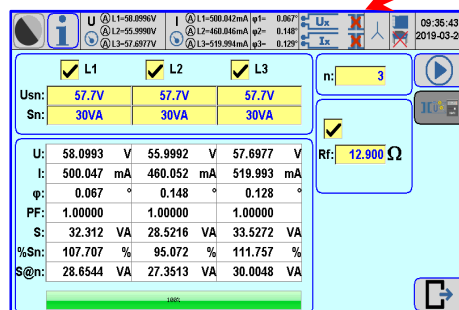
Meter error test in [%]



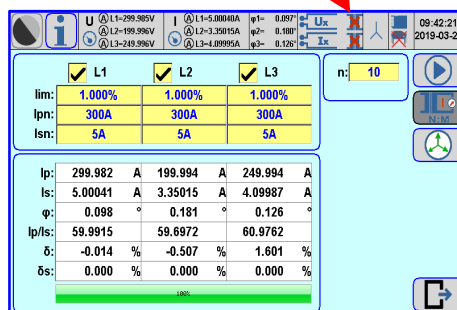
Harmonics trend test



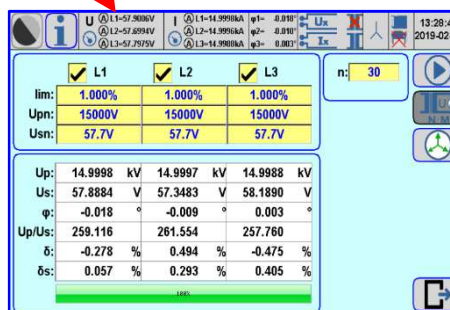
PT burden test



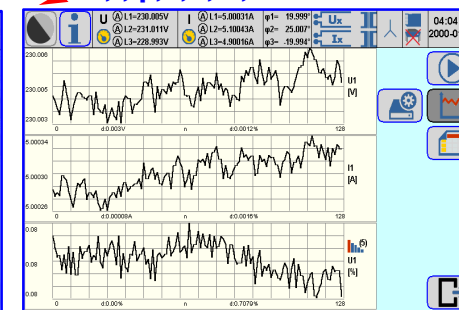
CT ratio test



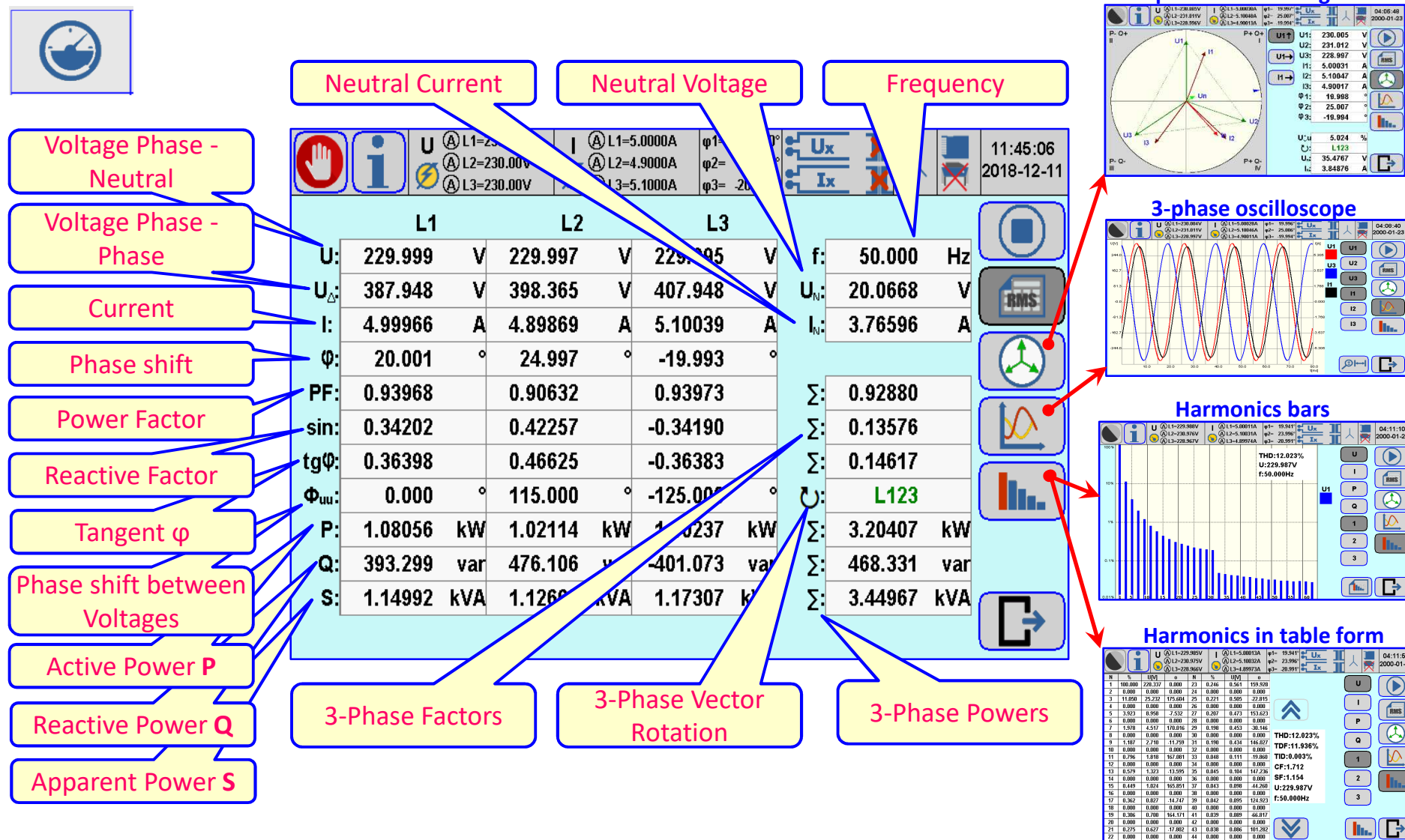
PT ratio test



U,I,φ,F,P,Q,S trend test



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



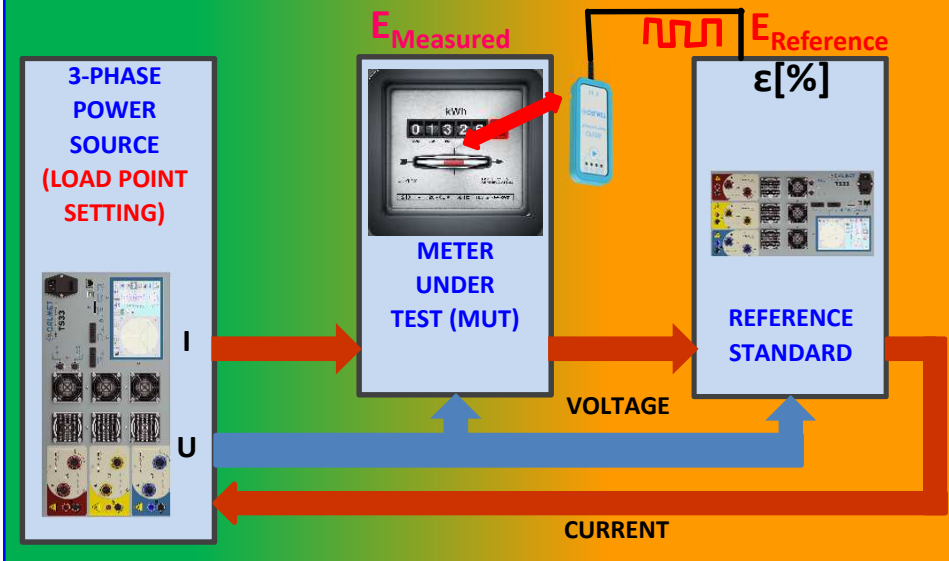


**TS33 functionality: energy meter error testing idea**



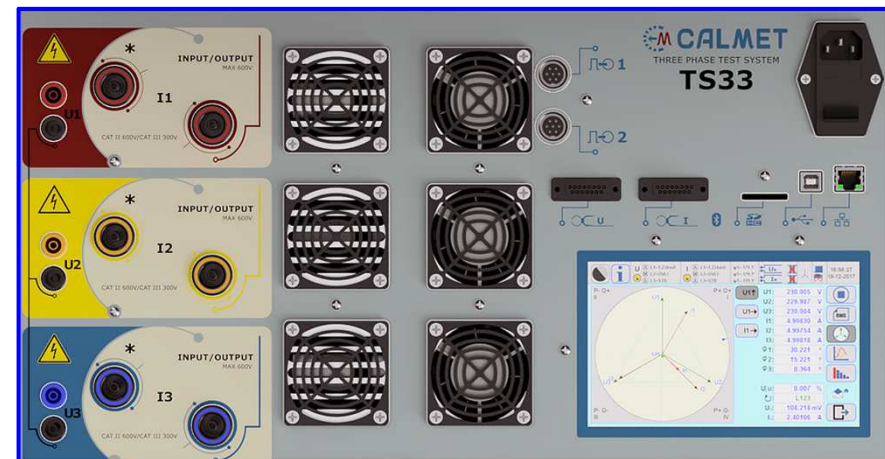
**Principle of electricity meter testing**

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



**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:

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

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**

**Summary Data:**  
 P: 6400.00 imp/kWh  
 t/N: 3 s  
 lim: 1.00 %  
 n: 5  
 Average error:  $\bar{\epsilon} = -0.148\%$   
 Standard deviation:  $S = 0.010\%$

**3-Phase Powers Summary:**

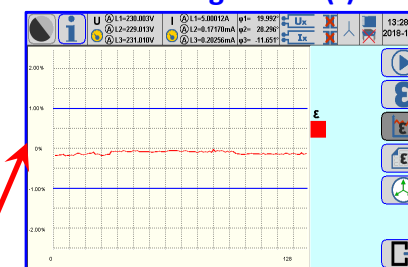
	$\Sigma P$	$\Sigma Q$	$\Sigma S$	$\Sigma PF$
	3.17316 kW	451.821 var	3.44985 kVA	0.91980

**Partial error results table:**

No	$\epsilon_i$
1	-0.148
2	-0.144
3	-0.130



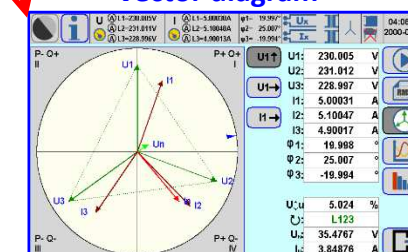
Error diagram  $\epsilon=f(t)$



Error table

Error Data							
No	PPM	QVARI	Limit[%]	$\epsilon_i$ [%]	$\epsilon_a$ [%]	OK	
27	13:52:10	3333.00	891.167	1.000	-0.583	0.001	✓
28	13:53:53	3333.02	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	3333.02	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	11646.8	1.000	-8.017	8.800	✗
37	14:00:07	30946.5	11620.6	1.000	-6.611	0.001	✓
38	14:00:47	30946.2	11621.1	1.000	-6.609	0.001	✓
39	14:01:25	30946.1	11621.1	1.000	-6.606	0.001	✓

Vector diagram



- ▶ 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

Up to 3 registers testing at time

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

Fundamental only !

Test START / STOP

Value of active energy with all harmonics

Value of first harmonic only in active energy

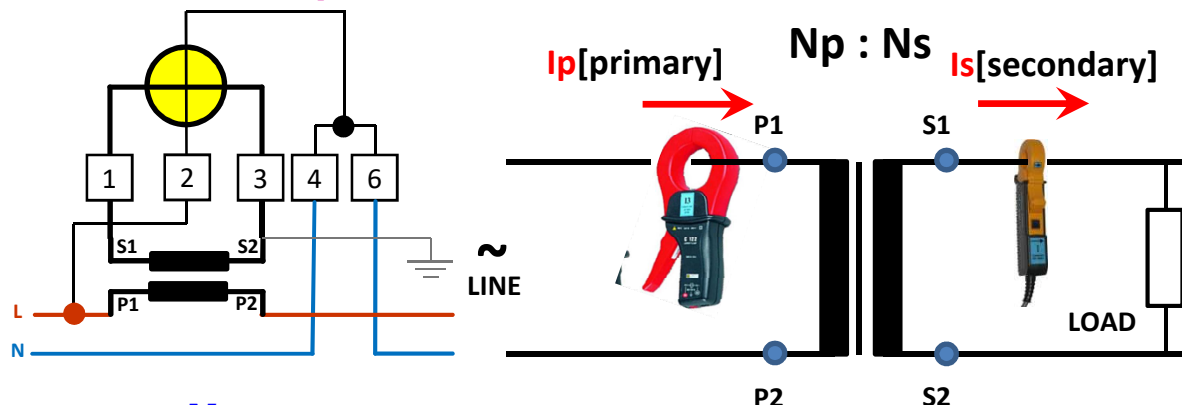
	P	Q	PH1+
E1:	0.000000kWh	0.000000kvarh	0.000000kWh
E2:	1.019123kWh	0.588698kvarh	1.019680kWh
$\Delta E$ :	1.019123kWh	0.588698kvarh	1.019680kWh
Eref:	1.019277kWh	0.588480kvarh	1.018611kWh
$\epsilon$ :	-0.015%	0.037%	0.105%
$\epsilon_{lim}$ :	1.000%	1.000%	1.000%

- ▶ 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:

$\delta I$  – current transformer error [%]

$N_P$  - number of primary turns

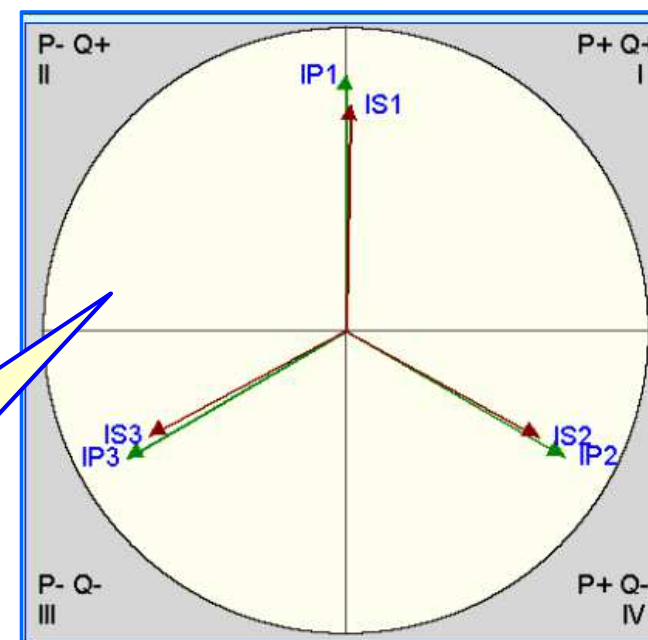
$N_S$  - number of secondary turns

$N_P / N_S$  – nominal CT ratio

$I_P$  - primary current

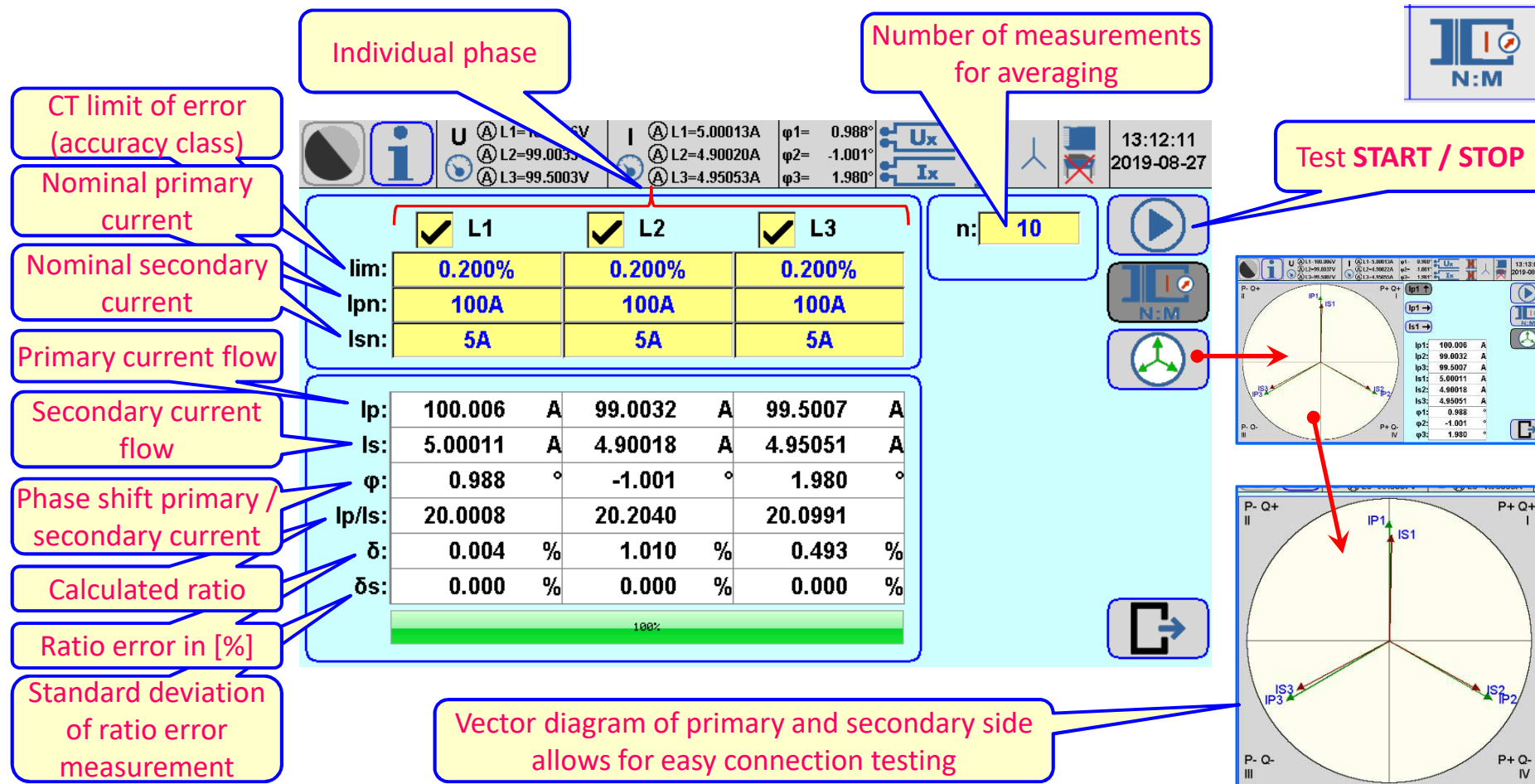
$I_S$  - secondary current

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  $\varphi=0^\circ$

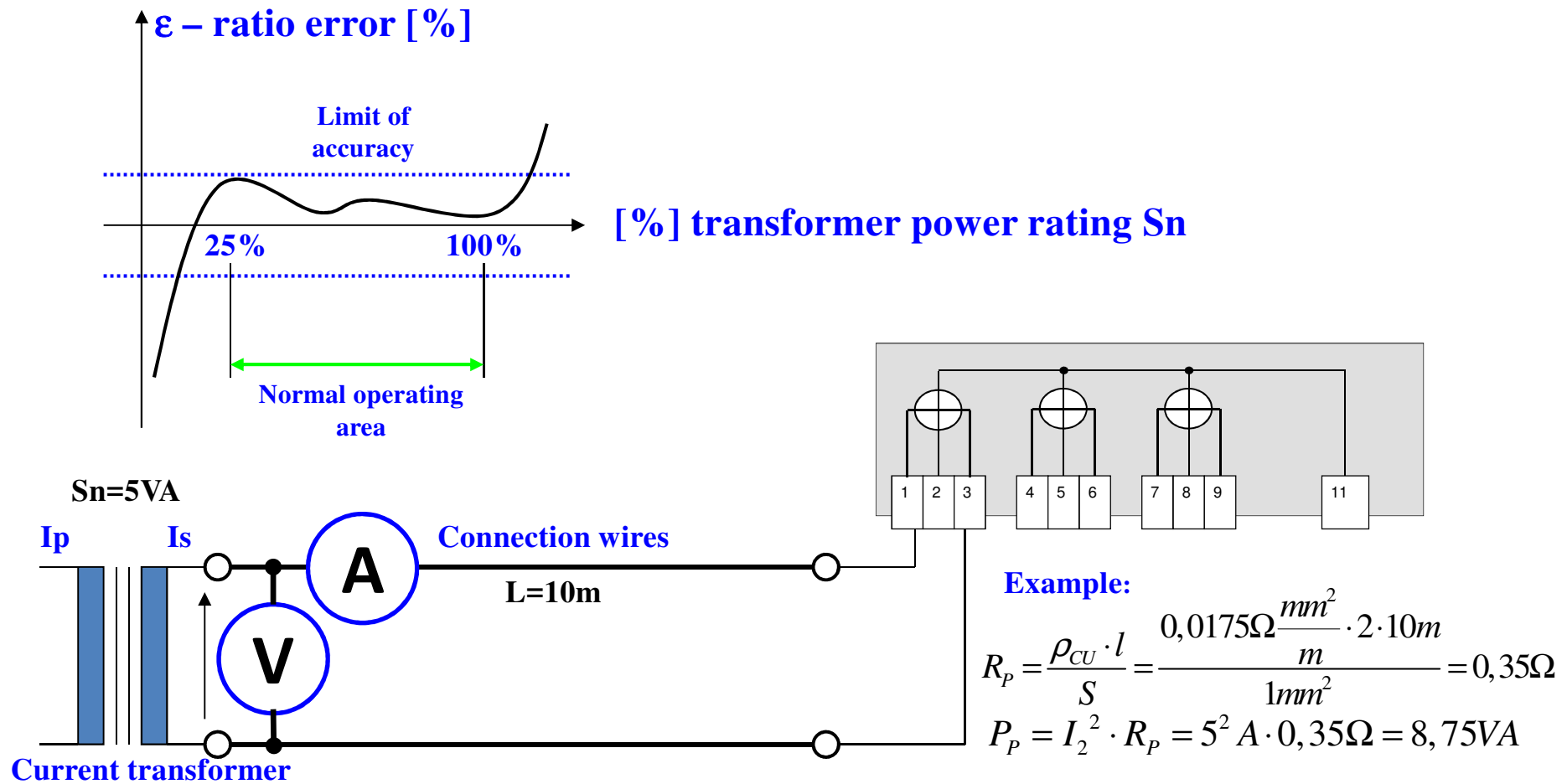
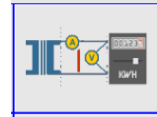
**TS33 functionality: CT/PT ratio test; vector diagram with primary and secondary side**



- ▶ 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

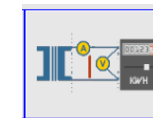
CT/PT – current / voltage transformer can operate with stated accuracy only between 25% - 100% of burden (load). In case of **too long** length, or **too thin** wire dimension or **too small load**, the result, secondary current / voltage can be **out of accuracy** limits



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



## TS33 functionality: CT/PT burden test



**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**

**Individual phase**

**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
$\phi$ :	-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

100%

- ▶ 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 TS33 Automatic Test System interface. It features a top status bar with icons for file management, information, and safety. Below this is a main control area with buttons for switching individual channels (U, I) for L1, L2, and L3 phases. A central display shows the current settings for voltage (300 V) and current (15 A) in auto range. To the right, there are controls for switching harmonics ON/OFF and a 'START / STOP generation' button. The bottom section displays a detailed table of phase settings for L1, L2, and L3, including voltage, current, phase shift, and frequency. Callouts provide detailed explanations for these various functions.

**Callouts:**

- File name of stored settings
- 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
- Set data acceptance
- START / STOP generation
- 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
- Setting the same value for all three phases

	L1	L2	L3	L123
U	230.00 V	240.00 V	220.00 V	
U <sub>Δ</sub>	407.06	398.50	389.74	
I	5.0000 A	5.0000 A	5.0000 A	
φ	0.000 °	0.000 °	0.000 °	
L123	0.000 °	120.000 °	-120.000 °	
f	50.000 Hz			

- ▶ 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

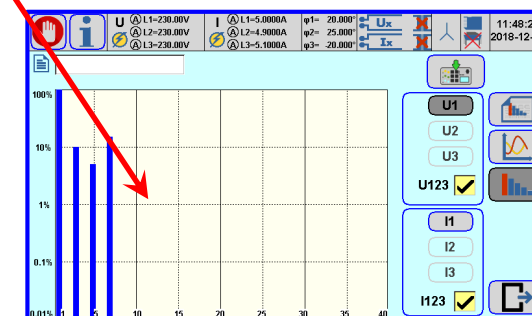
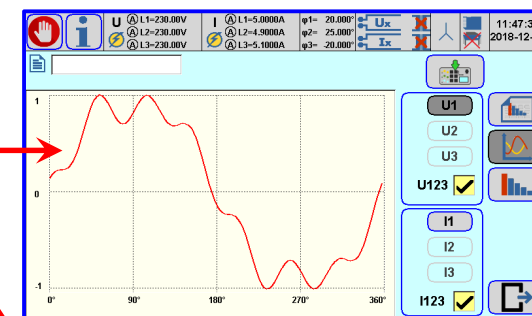
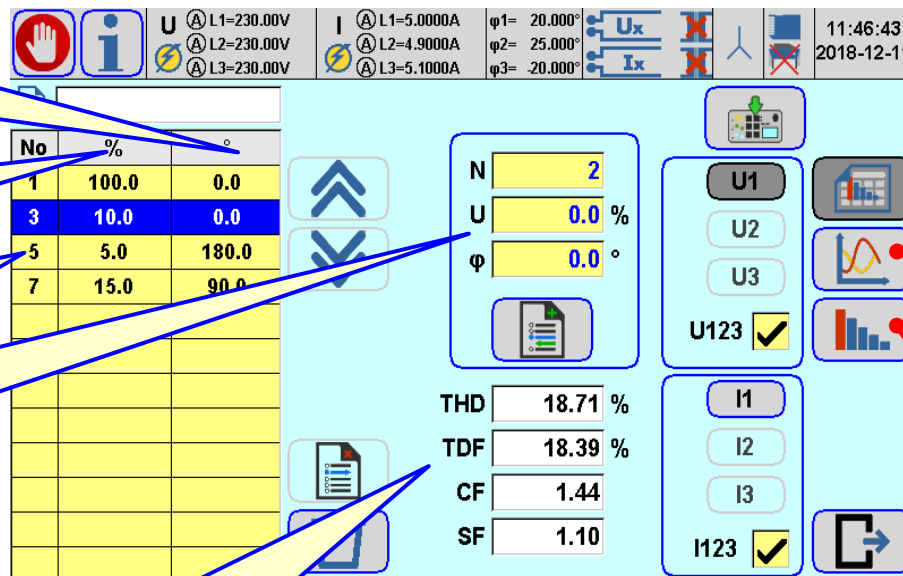
## TS33 functionality: Voltage and current source – harmonic generation

Phase shift with reference to fundamental

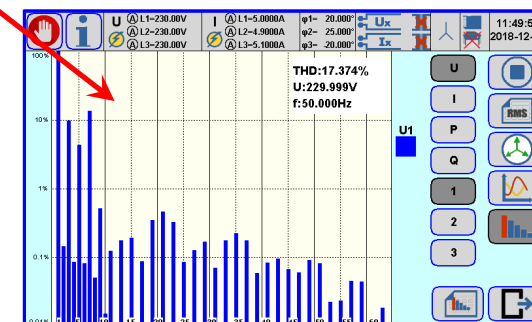
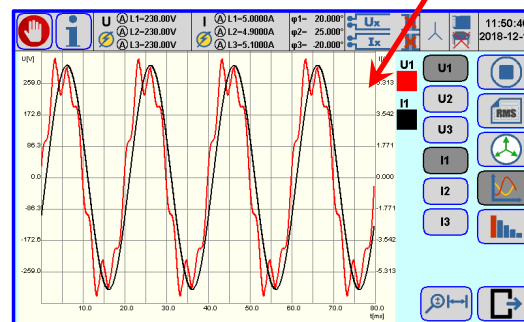
Amplitude in % of fundamental

Number of harmonic

Setting number of harmonic, its amplitude and phase shift



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

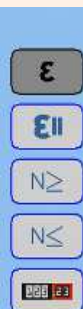
U:230V  
I:0.25-5(60)A  
f:50Hz  
C:6400imp/kWh  
Cl: A



**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



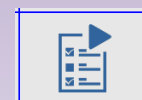
**Data  
base**



## TEST EXECUTION

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

No		P[W]	Q[VAR]	lim[%]	ε[%]	se[%]	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	-1.00918	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	-0.479581	1.000	0.600	0.004	✓
7	11:50:56	4139.97	-0.758822	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)**

**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**

**Parameters shown in the interface:**

- U: L1=STB, L2=STB, L3=STB
- φ1=, φ2=, φ3=
- Ux, Ix
- 15:21:02, 2019-01-02
- PAFAL12E
- PAFAL12EA5gw
- Ub: 230 V, Umax: 300 V
- Ib: 5 A, Imax: 60 A
- C: 6400 imp/kWh
- PT, CT
- Upn: 30000 V, Ipn: 800 A
- Usn: 57.7 V, Isn: 5 A
- 0 s

## TS33 functionality: Automatic energy meter test – Procedure

$\epsilon$   
 $\epsilon II$   
 $N \geq$   
 $N \leq$

✖ - 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

U (A) L1=STB  
I (A) L2=STB  
φ1=

φ2=

φ3=

15:21:14  
2018-12-18

005 LOAD

$\epsilon$

lim 1.000

t 10 s

n 3

	L1	L2	L3	L123
U	100.000 %	100.000 %	100.000 %	✓
I	5.000 %	STB %	STB %	
φ	10.00 °	10.00 °	10.00 °	✓
L123	0.00 °	120.00 °	-120.00 °	
f	50.000 Hz			

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

**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**

10:02:23  
2019-08-23

PAPAL12E BASICSTST

S0 test C test

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

$\phi$  0.00° 0.00° 0.00°

f 50.000Hz

L123

P 6900.00W

0% 0% 0%

**Load point execution and error results**

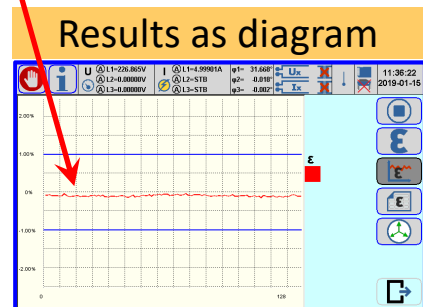
No 7 100 LOAD 100%

$\epsilon$  -0.205%  
 $\epsilon_s$  0.002%  
lim 1.000%

$\Sigma P$  1150.01 W  
 $\Sigma Q$  0.002444 var  
 $\Sigma S$  1150.11 VA  
 $\Sigma PF$  0.99991

**Results in table format**

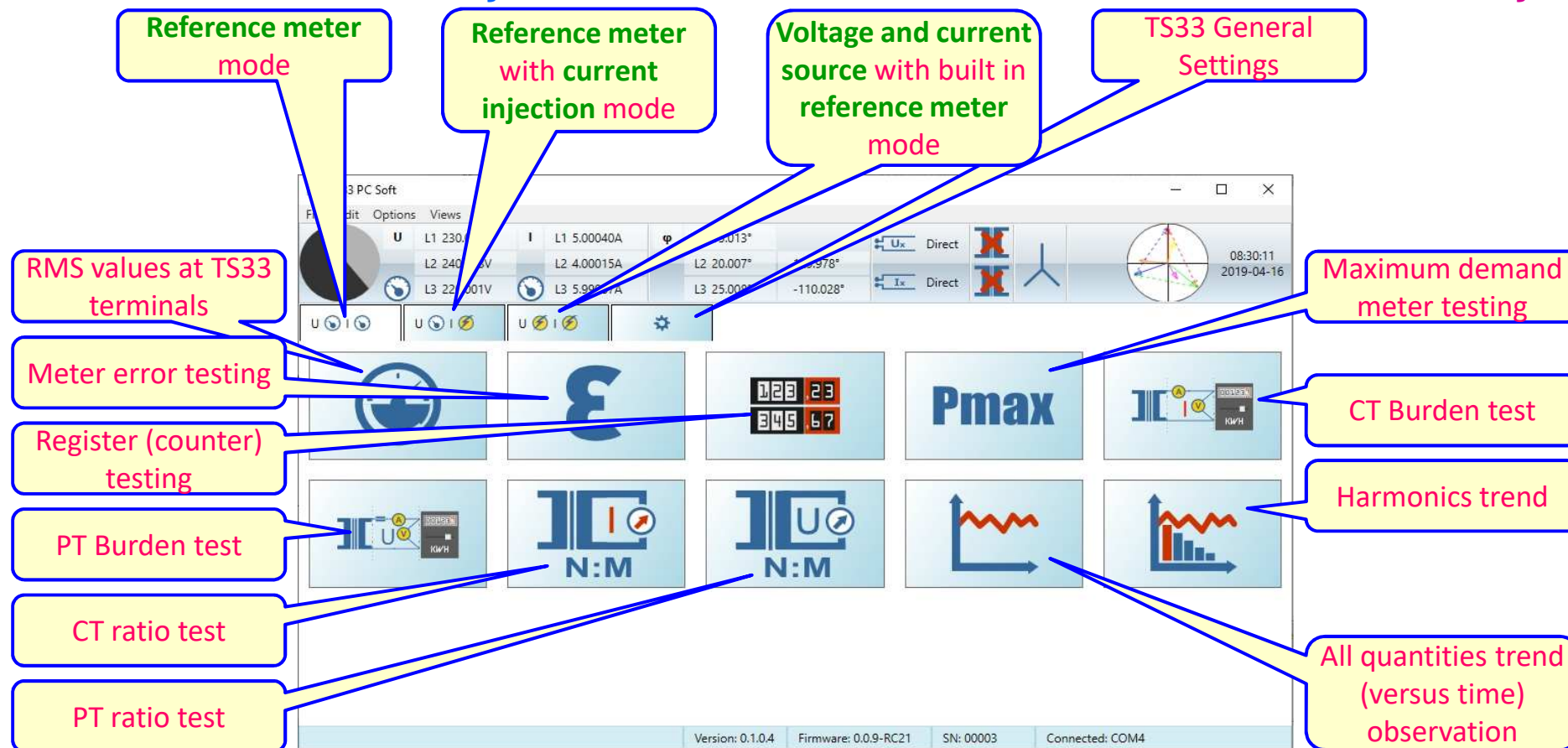
No	U	I	P	Q	S	PF	OK
1	11:44:50	172.562	-0.00851	1.000	0.680	0.022	
2	11:44:50	344.887	-0.013448	1.000	0.638	0.010	
3	11:45:35	689.912	-0.049329	1.000	0.505	0.107	
4	11:48:57	1725.03	-1.00918	1.000	0.628	0.003	
5	11:48:16	2760.15	-0.290768	1.000	0.610	0.006	
6	11:48:37	3450.06	-0.479581	1.000	0.600	0.004	
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

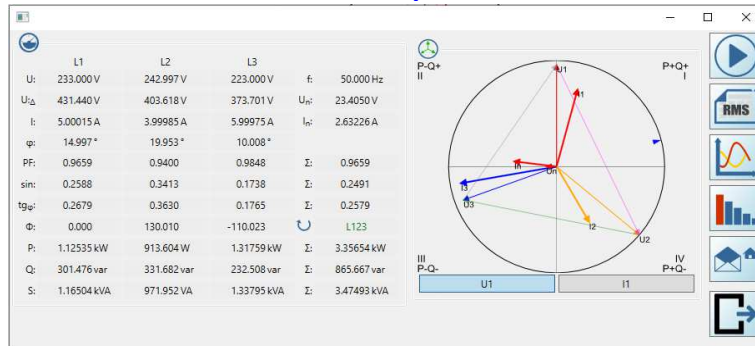
**TS33 PC Soft functionality: all of TS33 functions can be accessed in remote way**



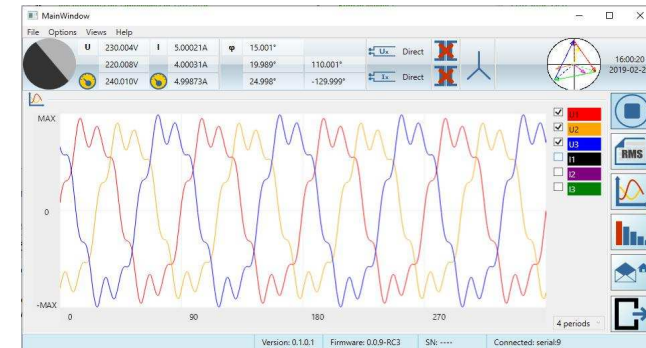
**Conclusion:** All functionality of the TS33 is available through **USB, Bluetooth and Ethernet** connection (including **Internet** remote control). TS33 PC Soft enables to download real time results of measurement made by TS33, download stored in memory results, readout the SD card memory and remote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



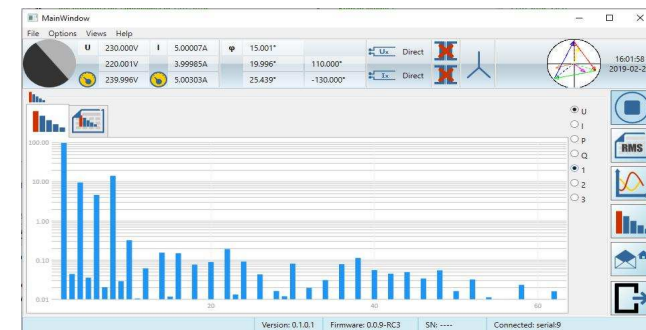
Voltage U1, U2, U3 oscilloscope



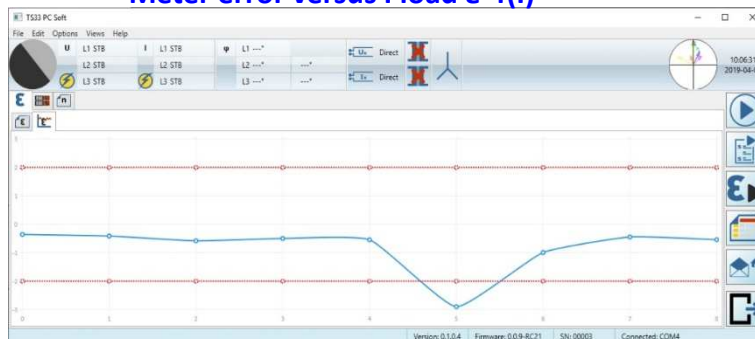
Voltage, current and THD trend



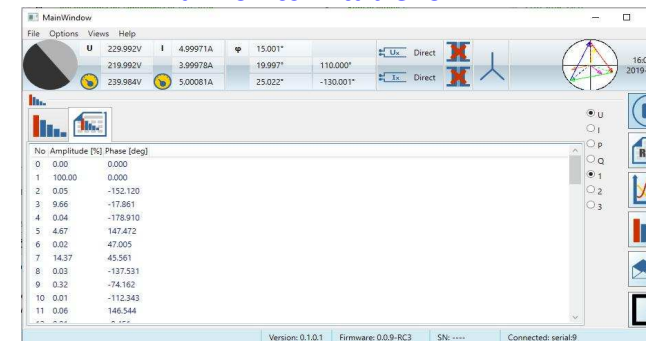
Harmonics in voltage U1



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:** Points to the range selection dropdowns (AUTO) for voltage and current.
- Setting maximum value of Voltage or Current:** Points to the input fields for maximum voltage (300 V) and current (20 A).
- Switching harmonics ON / OFF:** Points to the harmonic switching checkboxes.
- Switching ON / OFF of individual U & I channels:** Points to the channel selection checkboxes for voltage (U) and current (I) in phases L1, L2, and L3.
- Voltage in phase L1 L2 L3:** Points to the individual voltage setting fields for each phase.
- Voltage between phases:** Points to the phase-to-phase voltage setting fields.
- Current in phase L1 L2 L3:** Points to the individual current setting fields for each phase.
- Phase shift U&I:** Points to the phase shift setting fields for voltage and current.
- Phase shift between Voltages:** Points to the phase shift setting fields between voltages.
- Frequency setting:** Points to the frequency setting field (50.0000 Hz).
- Frequency synchronised with power frequency:** Points to the synchronization checkbox.
- START / STOP generation:** Points to the start/stop 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 common value fields.

- ▶ 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

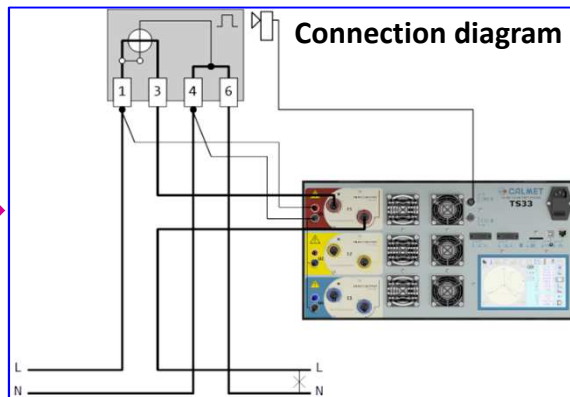
Base current: 5A

Max. current: 40A

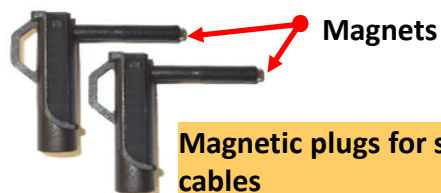
Meter constant:

375 turns/kWh

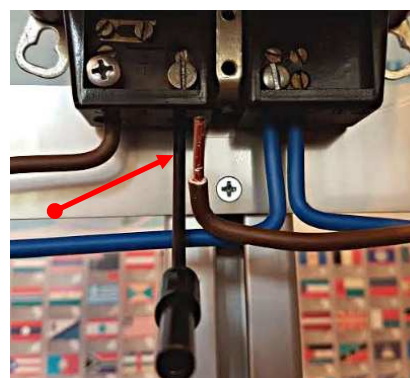
Typical, „old fashioned”, electromechanical meter and its parameters



Disconnect phase wire connected to load



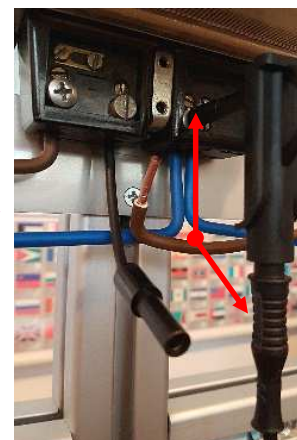
Magnetic plugs for safety cables



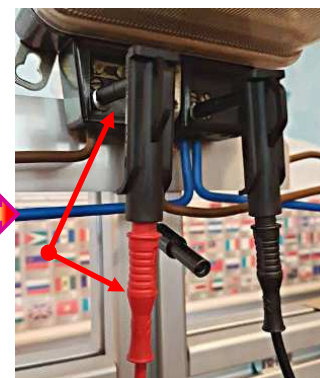
Connect instead „Cu” pin for safety cables



„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



## 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

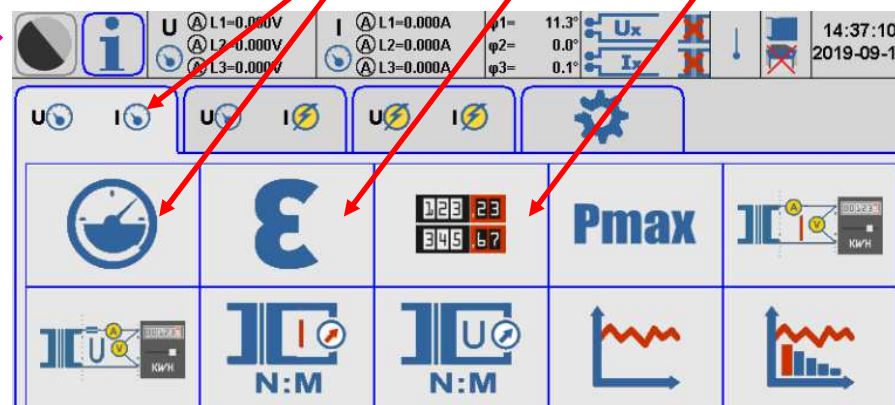


Scanning head assembly:

- 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)

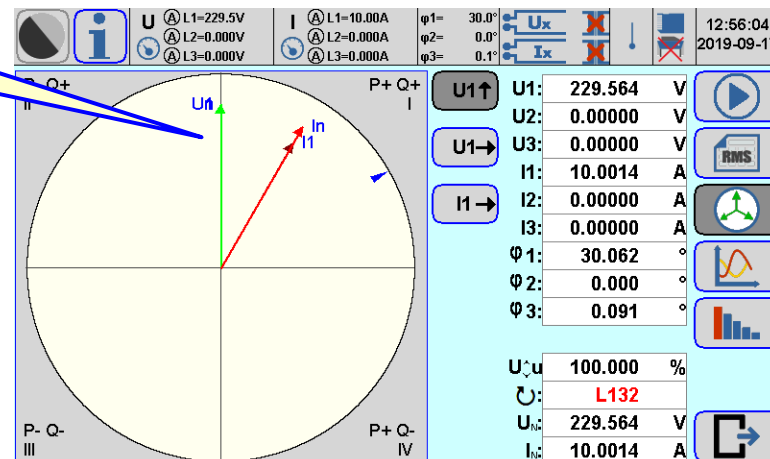
TS33 as Reference Meter and meter under test directly connected

L1	L2	L3	
U: 229.538 V	0.00000 V	0.00000 V	f: 50.000 Hz
U: 229.538 V	0.00000 V	229.481 V	U <sub>N</sub> : 229.538 V
I: 10.0014 A	0.00000 A	0.00000 A	I <sub>N</sub> : 10.0014 A
φ: 30.063 °	0.000 °	0.091 °	Σ: 0.86548
PF: 0.86548	0.00000	0.00000	Σ: 0.50095
sin: 0.50095	0.00000	0.00000	Σ: 0.57881
tgφ: 0.57881	0.00000	0.00000	Σ: 1.98689 kW
Φ <sub>uu</sub> : 0.000 °	165.803 °	165.831 °	Σ: 1.15003 kvar
P: 1.98689 W	0.00000 W	0.00000 W	Σ: 2.29571 kVA
Q: 1.15000 var	0.00000 var	0.00000 var	
S: 2.29571 VA	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 and efficient way of testing

Type of power measured by meter

Time of test

Number of results for averaging

Table with recorded results versus time

P	C: 375.000	lim: 2.00 %	auto	CT:	PT:	n: 10
t/N:	10					
lim:	2.00	%				
ΣP	1.98755	kW				
ΣQ	1.14965	kvar				
ΣS	2.29610	kVA				
ΣPF	0.86562					
No	εi					
1	0.719					
2	0.727					
3	0.725					

Averaged error result

Standard deviation

Partial error results

No		P[W]	Q[VAR]	Lim [%]	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

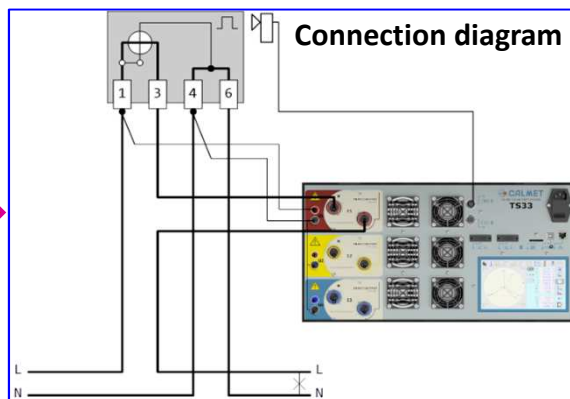
Base current: 5A

Max. current: 60A

Meter constant:

6400 imp/kWh

Typical single phase electronic meter with LED and its parameters



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

A

L1=229.7V

A

L2=0.000V

A

L3=0.000V

I

A

L1=5.000A

A

L2=0.000A

A

L3=0.000A

φ1=

30.1°

φ2=

0.0°

φ3=

0.1°

10:50:34

2019-09-18

L1

L2

L3

U:

229.719

V

0.00000

V

0.00000

V

U<sub>Δ</sub>:

229.719

V

0.00000

V

229.662

V

I:

5.00058

A

0.00000

A

0.00000

A

φ:

30.052

°

0.000

°

0.091

°

PF:

0.86557

0.00000

0.00000

sin:

0.50079

0.00000

0.00000

tgφ:

0.57856

0.00000

0.00000

Φ<sub>uu</sub>:

0.000

°

51.809

°

51.837

°

P:

994.304

W

0.00000

W

0.00000

W

Q:

575.268

var

0.00000

var

0.00000

var

S:

1.14873

kVA

0.00000

VA

0.00000

VA

f:

50.000

Hz

U<sub>N</sub>:

229.719

V

I<sub>N</sub>:

5.00058

A

Σ:

0.86557

Σ:

0.50079

Σ:

0.57856

U:

L132

Σ:

994.304

W

Σ:

575.268

var

Σ:

1.14873

kVA

**Meter constant**  
C: 6400.00 imp/Wh

**Time of test**  
t/N: 10 s

**Class of Meter under test**  
lim: 1.00 %

**Averaged error result**  
ΣP: 994.597 W  
ΣQ: 575.201 var  
ΣS: 1.14895 kVA  
ΣPF: 0.86566

**START test button**  
n: 3

**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)

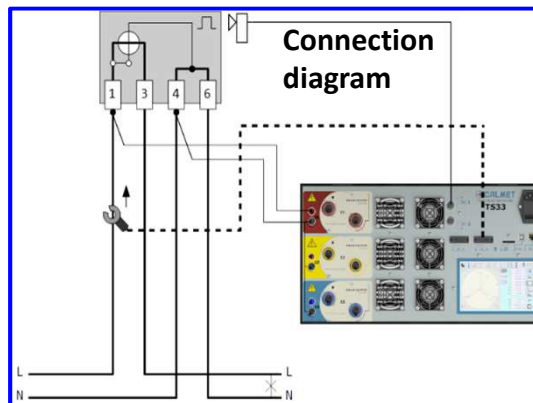
TS33 as Reference Meter and meter under test connected by current clamps CT100AC



### Meter parameters:

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

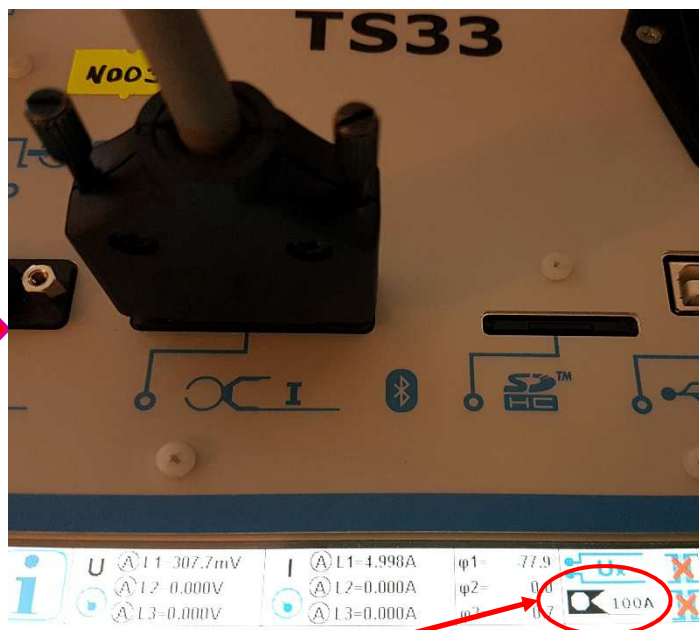
Typical single phase electronic meter with LED and its parameters



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

Current clamps connected

Load point parameters

START test button

Meter constant

Class of Meter under test

Time of test

Averaged error result

Table with recorded results versus time

U	L1=229.7V	I	L1=4.998A	φ1=	30.0°	Ux		11:37:36
L2=0.000V	L2=0.000A	φ2=	0.0°					2019-09-18
L3=0.000V	L3=0.000A	φ3=	0.7°					
U <sub>1</sub>	229.736 V	L2	0.00000 V	L3	0.00000 V	f	50.000 Hz	
U <sub>2</sub>	229.736 V	L2	0.00000 V	L3	229.679 V	U <sub>1</sub>	229.736 V	
I <sub>1</sub>	4.99855 A	L2	0.00000 A	L3	0.00000 A	I <sub>1</sub>	4.99855 A	
φ	30.030 °	L2	0.000 °	L3	0.729 °	Σ	0.86576	
PF	0.86576	L2	0.00000	L3	0.00000	Σ	0.50046	
sin	0.50046	L2	0.00000	L3	0.00000	Σ	0.57806	
gφ	0.57806	L2	0.00000	L3	0.00000	Σ	0.86576	
φ <sub>uu</sub>	0.000 °	L2	-2.673 °	L3	-2.645 °	Σ	0.50046	
P	994.190 W	L2	0.00000 W	L3	0.00000 W	Σ	0.57806	
Q	574.702 var	L2	0.00000 var	L3	0.00000 var	Σ	994.190 W	
S	1.14835 kVA	L2	0.00000 VA	L3	0.00000 VA	Σ	574.702 var	
		L2		L3		Σ	1.14835 kVA	

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

P	C:	6400.00	imp/kWh	auto	CT:	I	11:39:29
t/N:	10	s	auto	PT:	I		2019-09-18
lim:	1.00	%	n:	3			
ΣP	994.193	W					
ΣQ	574.663	var					
ΣS	1.14833	kVA					
ΣPF	0.86577						
No	ε <sub>i</sub>						
1	0.345						
2	0.355						

No	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	11:45:00	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)

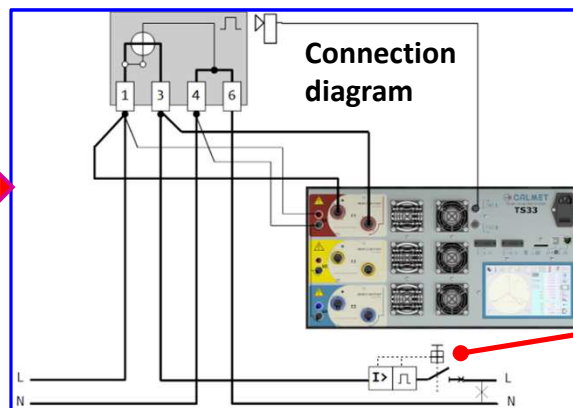
TS33 as **Current Source** and Reference Meter and meter under test connected **directly**



### 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**

**Meter constant**

**Number of pulses**

**Class of Meter under test**

**Averaged error result**

**Standard deviation**

**Table with recorded results versus time**

No	Time	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)

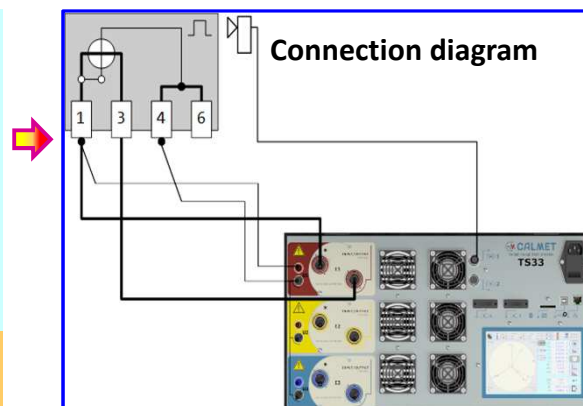
TS33 as **Voltage and Current Source** and Reference Meter and meter under test connected **directly**



### 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

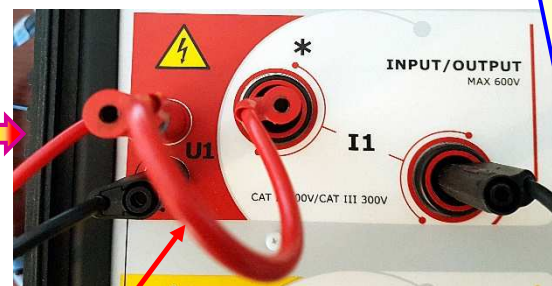


**CAUTION!!!** Unconnect meter from network before connection to TS33 (voltage and current is delivered by TS33)

In the TS33 LCD select U and I generation mode



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 (\*).



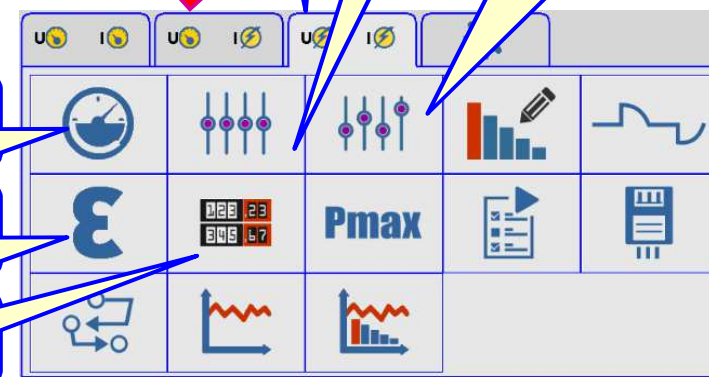
Setting value of voltage, current and phase shift

Setting value of U, I,  $\phi$ , 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!**

**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**

The screenshot displays the TS33 software interface for testing a single-phase electronic energy meter. The interface is divided into several sections:

- Top Section:** Shows the test configuration for a single-phase operation. Parameters include voltage (230.00 V), current (5.0000 A), phase shift (30.000°), and frequency (50.000 Hz). The meter constant is set to 6400.00 imp/kWh, and the number of pulses is 10. The class of the meter under test is 1.00.
- Left Panel:** Displays the test results for the meter under test. The averaged error result is 0.299%, and the standard deviation is 0.016%.
- Right Panel:** Shows a table with recorded results versus time. The table has columns for No, Time, P[W], Q[VAR], Limit[%], ε[%], se[%], and OK. The results show a consistent error rate of approximately 0.22% to 0.27% across 13 measurements.



## 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

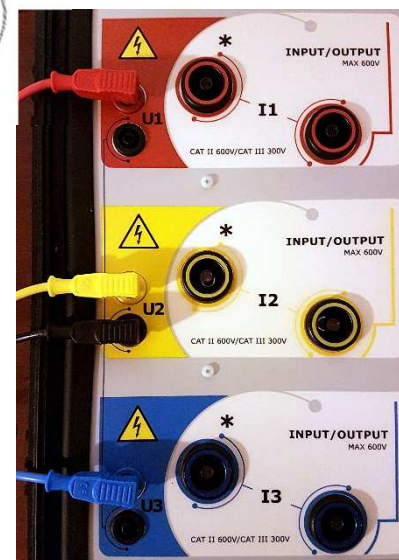
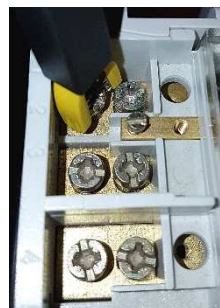
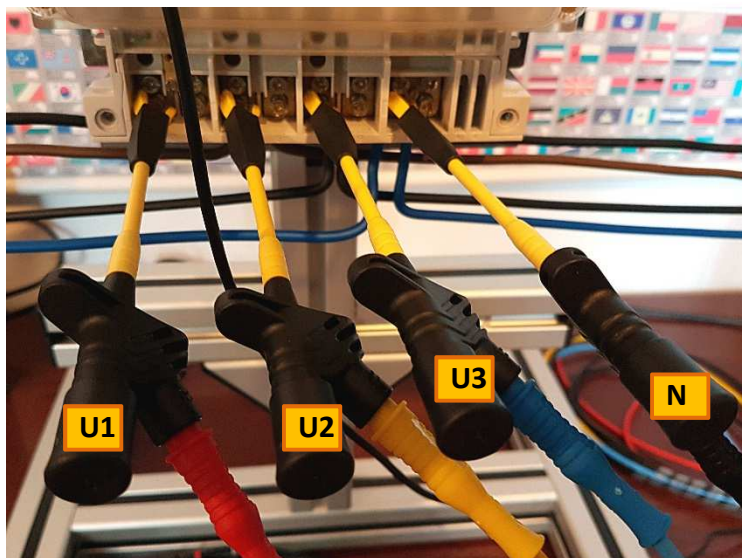
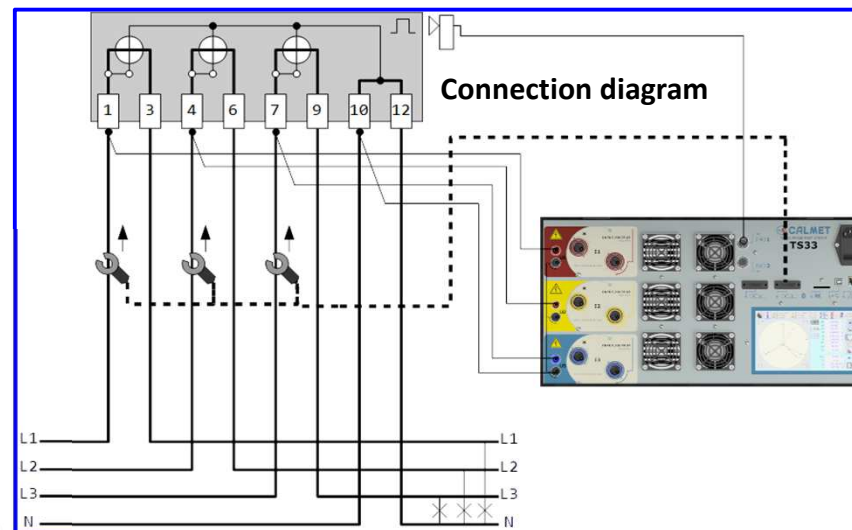
Base current: 5A

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

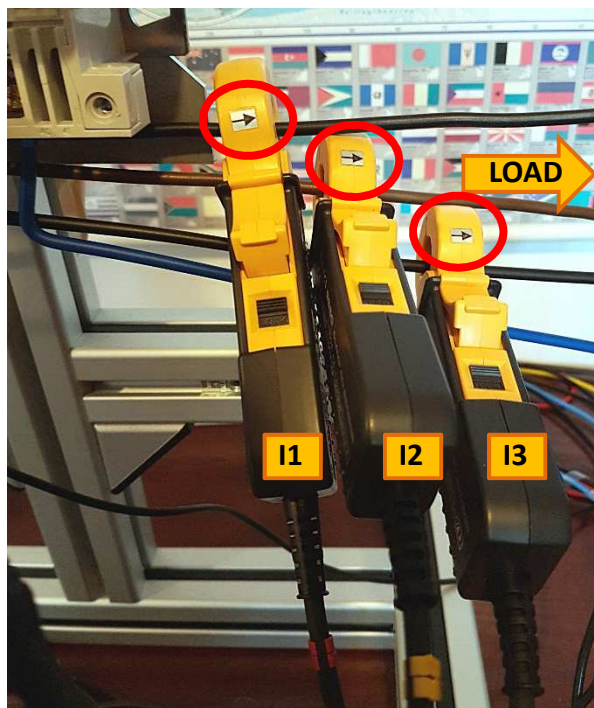


Connect voltage U1, U2, U3 and neutral N to voltage inputs of TS33.

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

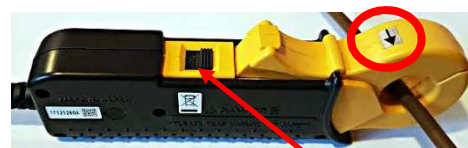


Close current clamps on load cables, respectively I1, I2, I3. Take care about clamps direction (⇒)

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



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

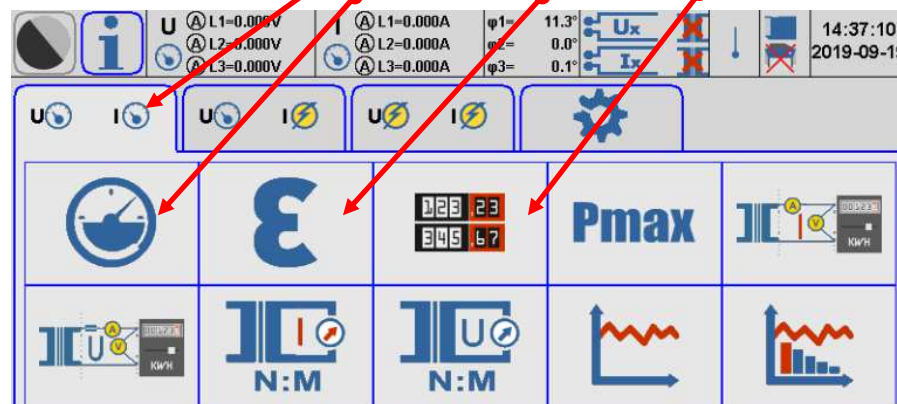


Close clamp jaws and lock them. Direction (⇒)!



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!**

**Load point parameters table:**

	L1	L2	L3
U <sub>L</sub>	229.658 V	239.747 V	219.654 V
U <sub>LL</sub>	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 <sub>uu</sub>	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:** A circular diagram showing three voltage vectors (U<sub>1</sub>, U<sub>2</sub>, U<sub>3</sub>) and three current vectors (I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>) originating from a central point. The diagram is labeled with 'P- Q+' and 'P+ Q-' at different quadrants.

**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**

**Meter constant settings:**

C: 1000.00 p/kWh

t/N: 5 s

lim: 2.00 %

**Averaged error result:** 0.062%

**Standard deviation:** 0.062

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**



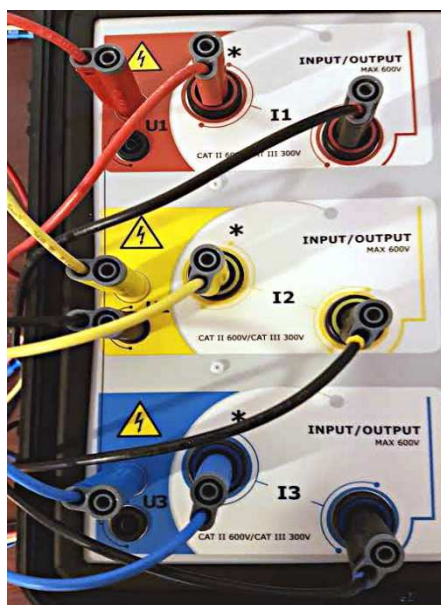
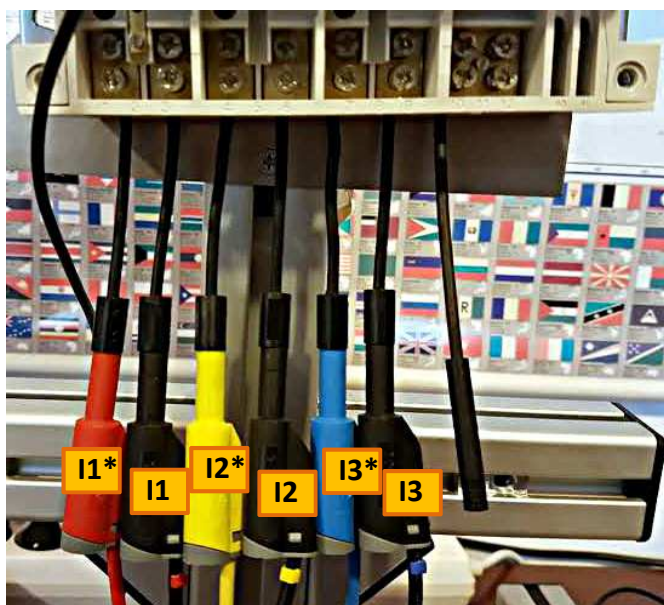
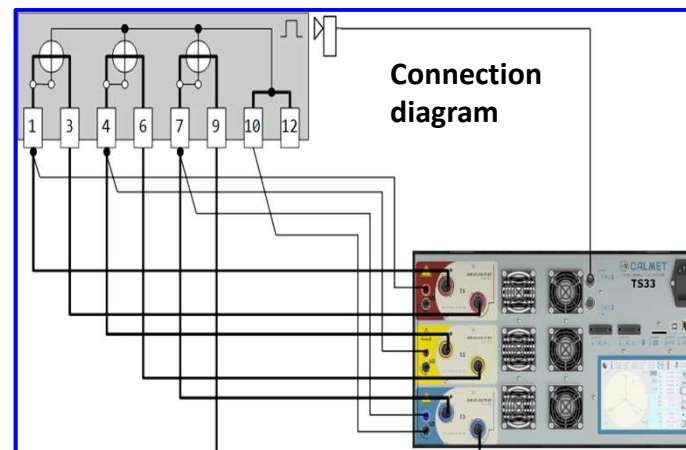
### Meter parameters:

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 TS33  
inputs U and I.



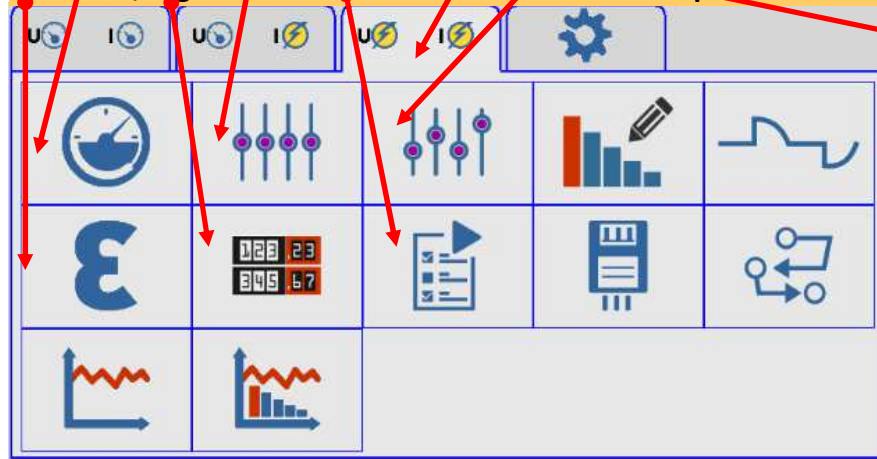
## TS33 : testing three phase electronic (static) Energy Meter example (2)

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



Connected meter ready for testing

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



### 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 synchronization with network frequency

Set value of phase shift U&I

U (A) L1=STB		I (A) L1=STB		φ1=	
A L2=STB		A L2=STB		φ2=	
A L3=STB		A L3=STB		φ3=	
L1	U	L2	U	L3	U
U	250 V	U	250 V	U	250 V
I	30 A	I	30 A	I	30 A
L1	U	L2	U	L3	U
U	230.00 V	U	240.00 V	U	220.00 V
U <sub>Δ</sub>	407.06	U <sub>Δ</sub>	398.50	U <sub>Δ</sub>	389.74
I	5.0000 A	I	4.0000 A	I	6.0000 A
φ	15.000 °	φ	20.000 °	φ	25.000 °
L23	0.000 °	L23	120.000 °	L23	-120.000 °
f	50.000 Hz	f	50.000 Hz	f	50.000 Hz



## 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 <sub>L</sub>	229.999 V	240.002 V	220.001 V
U <sub>φ</sub>	407.050 V	398.497 V	389.825 V
I	5.00005 A	4.00016 A	5.99939 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 <sub>qu</sub>	0.000	120.000	-120.000
P	1.11082 kW	902.094 W	1.19613 kW
Q	297.604 var	328.460 var	557.939 var
S	1.15001 kVA	960.046 VA	1.31987 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**

**Averaged error result**

**Standard deviation**

**ε = 0.005%**

**s = 0.007%**

**ΣP = 3.20925 kW**

**ΣQ = 1.18401 kvar**

**ΣS = 3.43013 kVA**

**ΣPF = 0.93561**

**No**

**εi**

**1 0.007**

**2 -0.008**

**3 0.015**

**Table with recorded results versus time**

No		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	0.086	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**: AP20EC3G  
**Connection type**: Pafal Apator  
**Power type**: P+  
**Base voltage**: Ub 230 V  
**Max. voltage**: Umax 250 V  
**Base current**: Ib 5 A  
**Max. current**: Imax 100 A  
**Meter constant**: C 1000 imp/kWh  
**Delay time**: 5 s  
**PT primary & secondary voltage**: U<sub>pn</sub> 57.7 V, U<sub>sn</sub> 2.5 V  
**CT primary & secondary current**: I<sub>pn</sub> 57.7 A, I<sub>sn</sub> 2.5 A

### Test Point and Procedure Definition

**Load point name**: 100pr  
**Meter Class**: ε  
**Time of measurement**: t 20 s  
**Number of measurements per result**: n 3  
**Meter error test**: lim 2.000  
**Voltage in [%]**: U 100.000 %  
**Current in [%]**: I 100.000 %  
**Phase shift U&I**: φ 0.00 °  
**Vector rotation**: L123 0.00 °  
**Frequency**: f 50.000 Hz  
**Harmonics**: L1 100.000 %, L2 100.000 %, L3 100.000 %  
**Phase shift U&U**: L123 120.00 °

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

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

**Meter or Procedure name field**: 00000008

## 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: 08:29:49 2019-10-01

**Individual load point test**

Load point name: 400pr

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

Selected load points:

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

Load point values:

	L1	L2	L3
U	230.000V	230.000V	230.000V
I	20.0000A	20.0000A	20.0000A
φ	0.00°	0.00°	0.00°
f	50.000Hz		
P	13800.0W		
W	100%	100%	100%
var	100%	100%	100%
VA	100%	100%	100%

**Table with results for each load point**

No	Time	P[W]	Q[VAR]	ε[%]	se[%]	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 PC Soft - [F:\TS33\GEN\ATRESULT\AP20EC3G\5TO400PR\400pr]

Graph showing error results for load point 400pr. The y-axis represents error (ε) from -3 to 3, and the x-axis represents load points from 0 to 8. The data points are clustered around 0, indicating high accuracy.

Version: 1.0.0.6 | Firmware: --- | SN: --- | Disconnected

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



Secondary clamps





## 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

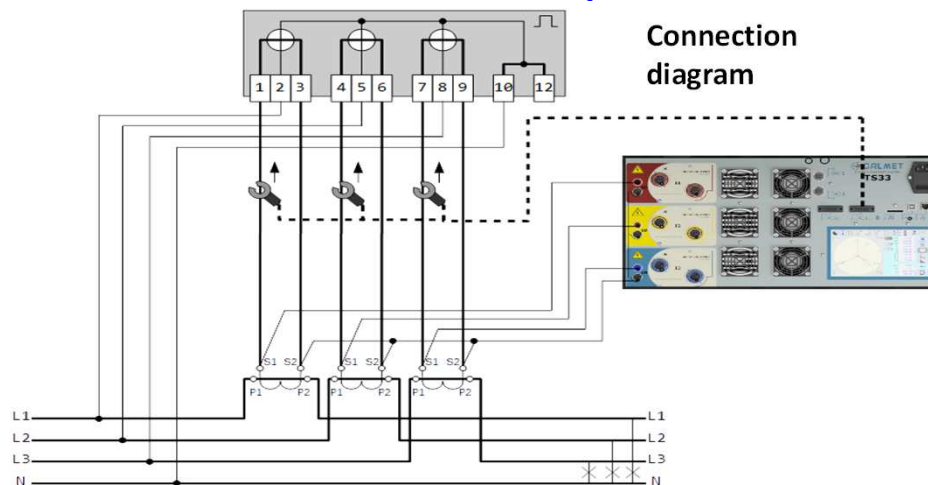
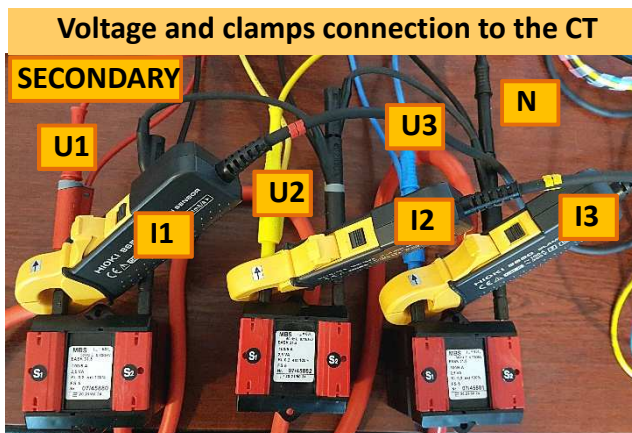
Power: 2.5VA

Class: 0.2

Typical current transformer CT in metering installation



TS33 side voltage connection



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

U	L1=149.7mV	L2=156.6mV	L3=151.9mV	I	L1=5.001A	L2=4.999A	L3=5.019A	φ	φ2=5.4°	φ3=5.4°	Ux	100A	14:30:24	2019-10-02
✓	L1	✓	L2	✓	L3						n:	3		
Isn:	5A	5A	5A	Sn:	2.5VA	2.5VA	2.5VA				✓	L:	4.000 m	
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 °	2.5 mm <sup>2</sup>		
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

## 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



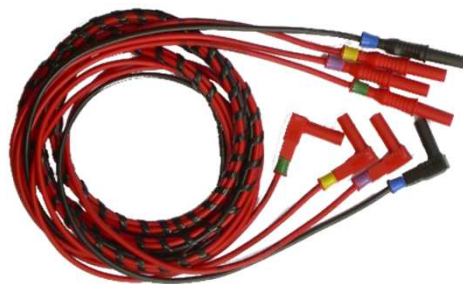
Power cord



Fuses



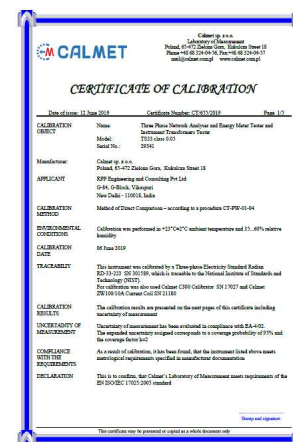
C091 Amphenol connector



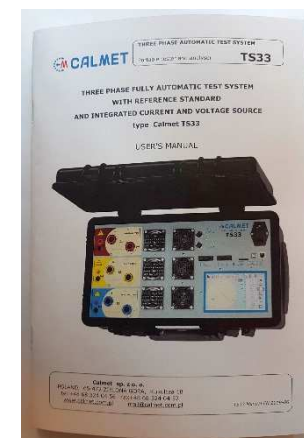
Voltage connection cables



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



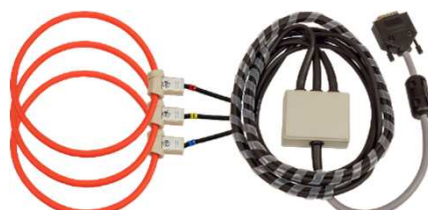
CT10AC current clamps



CT100AC current clamps



CT1000AC current clamps



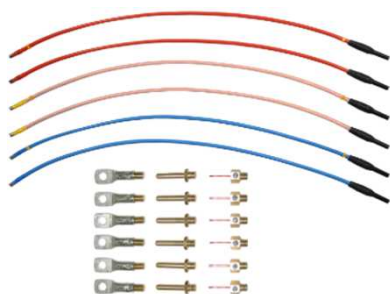
FCT3000AC flexible clamps



AmpLiteWire 2000AC  
(@150kV)



VoltLiteWire 40kVC



AKD300 120A cable set



DR200 thermal printer



AKD100 accessories for  
safety cables



CF106H photo head for LED  
& mechanical meters



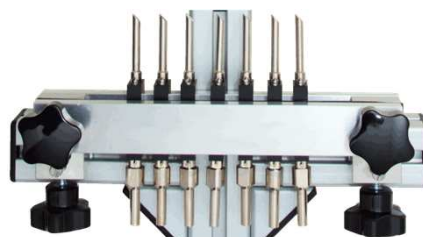
## TS33 : how to order – versions, options, accessories

### TS33 optional accessories:

### Optional scope of delivery 2



**ER10 single position rack  
for hanging meter**



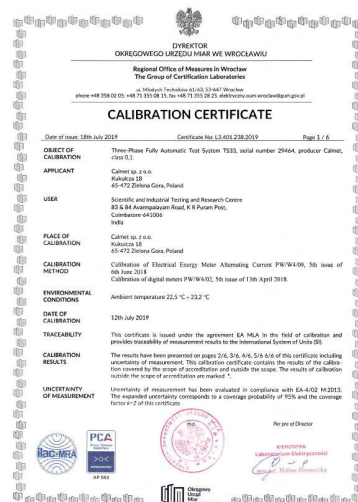
**EH10.3 Quick  
Connector for meters**



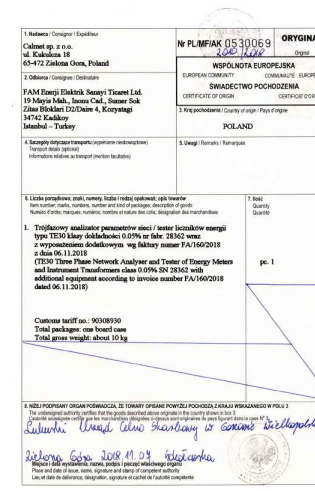
**ER10H.3 single position rack  
with quick connector**



**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](http://www.calmet.com.pl)



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**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](mailto:mail@calmet.com.pl)