



Calmet TS33

Three-phase Fully Automatic
Test System

with Reference Standard and

Integrated Current and Voltage Source



Calmet Sp. z o.o.

- ❑ Calmet = **CAL**ibrators + **MET**rology
- ❑ founded in **1989**, roots come from LUMEL, big factory of measurement equipment in Poland, Zielona Gora
- ❑ designing, production, selling and servicing new kind of calibrators and electric equipment testers
- ❑ employs over 25 engineers, including 3 with Ph.D.
- ❑ cooperates with University of Zielona Gora; common projects and lectures
- ❑ since **1996** – electricity meters testing and power network parameters analysing
- ❑ since **2002** – generating and measuring network quality parameters
- ❑ since **2006** – automation of electro-utility automatic protective equipment testing
- ❑ since **2011** – automatic Test Benches for energy meter testing
- ❑ since **2019** – new group of Automatic Test Systems

Measurement Equipment since 1989

Customer Support in problems solving

Energy meter testers, Current Transformers testers, Power quality analysers

AC/DC Voltage, Current & Power Calibrators, Test Benches



1 phase, 0,2%



3 phase, 0.05%



3 phase, 120A, 0.02%



3 phase U,I,φ,P,Q,S,E



1 phase U,I,φ,P,Q,S,E

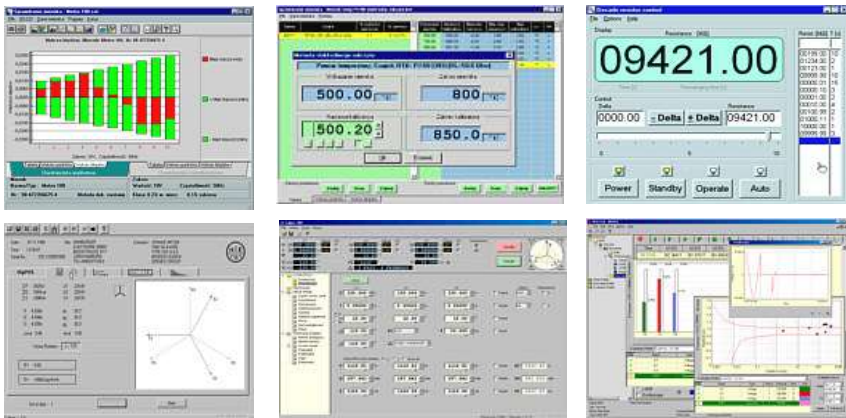


3 phase Test Bench



Multifunctions DC/AC

Control Software for measurement equipment



Current and Voltage Source with Integrated Reference Standard



Testing the entire energy measurement system!

Accuracy of all kinds of meters ϵ [%]

Electromechanical (Ferraris)



Electronic (static)



4 - Quadrants
Smart Meters



Max. demand



CT/PT burden, ratio, phase shift error



Wiring errors



TS33

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



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

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



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

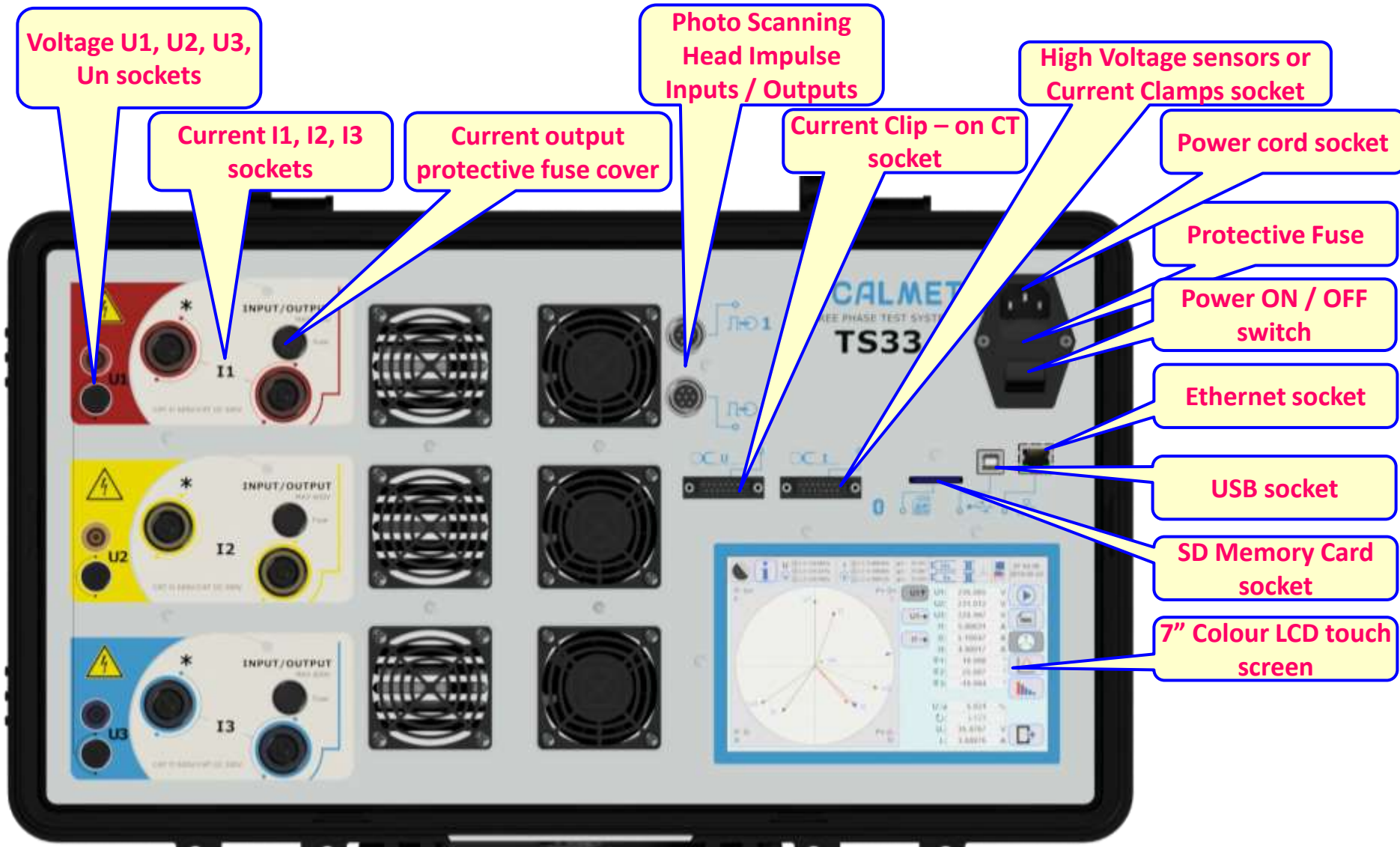
Testing without meter disconnecting!

- ▶ Easy verification of meters under precise load conditions, using integrated current and voltage source in class **0.02, 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 TS PC Soft
- ▶ Reading data and remote controlled via **USB, Ethernet, Bluetooth**
- ▶ Recording data on flash memory **SD card** up to **32GB**
- ▶ Calibration Certificate



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

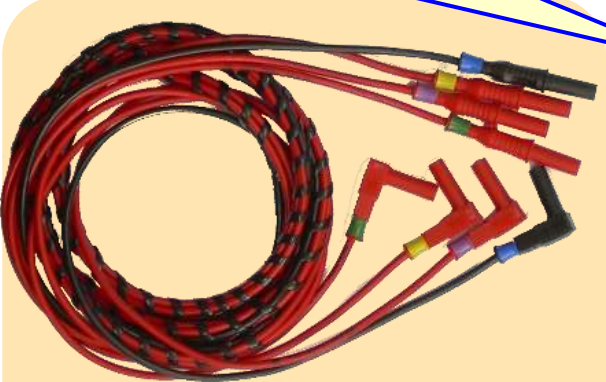
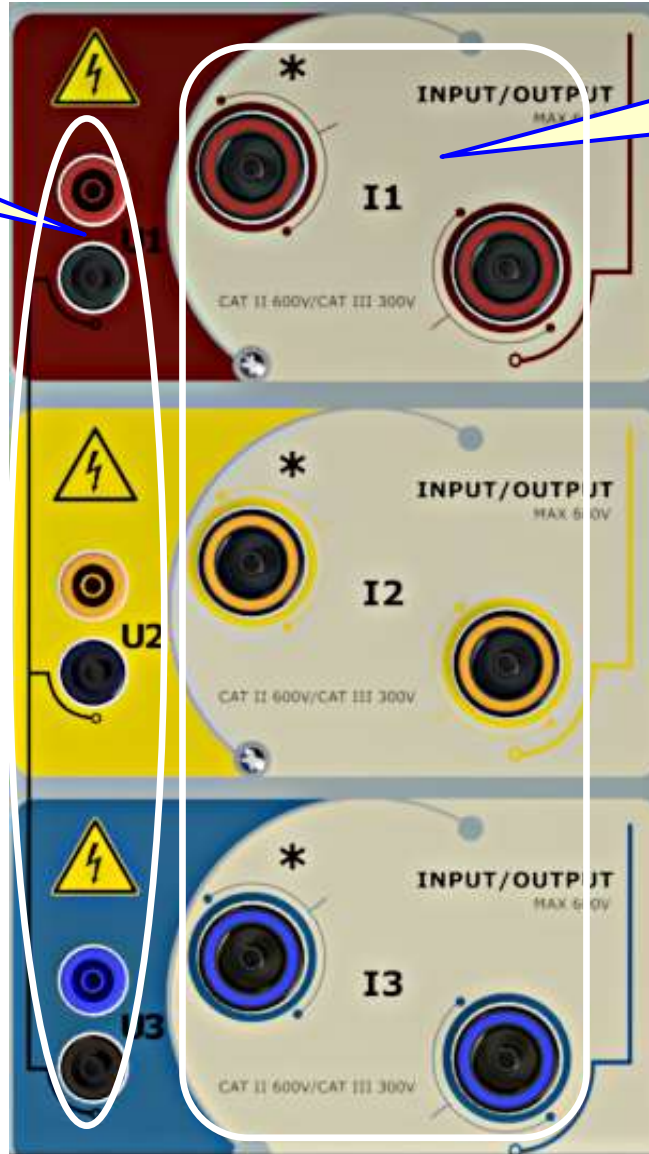
TS33 Inputs, Outputs and Connectors:



TS33 Voltage and Current Inputs:

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

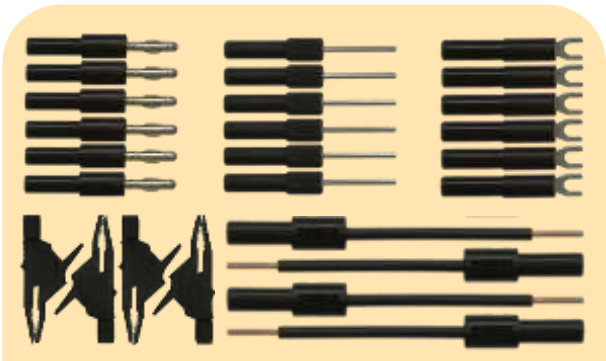
Current I1, I2, I3, Un Input / Output sockets
0.001...120A



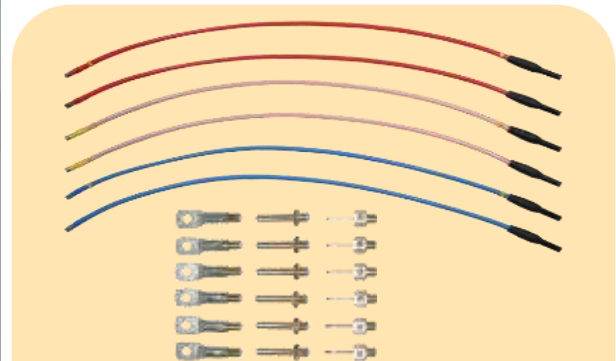
4mm Voltage Safety Cables
Length=2m



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



Easy connection due to rich set of accessories for safety cables




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

TS33 Pulse Input / Output;

can test all kinds of Electricity Meters

Electronic energy meter

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




0.0001Hz...200kHz

1. Pulse Input / Output socket

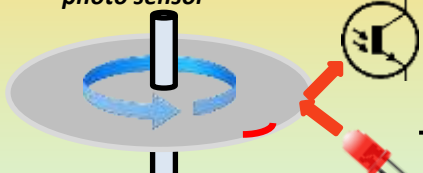
Electronic and Inductive energy meter

manual push – button and pulse generation



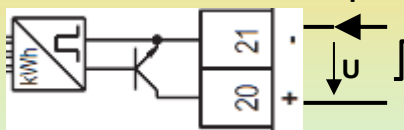
Inductive energy meter

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



Electronic and Inductive energy meter

50 standard electric pulse




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

Additional, external very, high accuracy Reference Meter

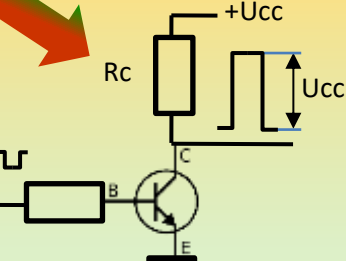


2. Pulse Input for external Reference Meter socket

Open collector pulse output + external Rc

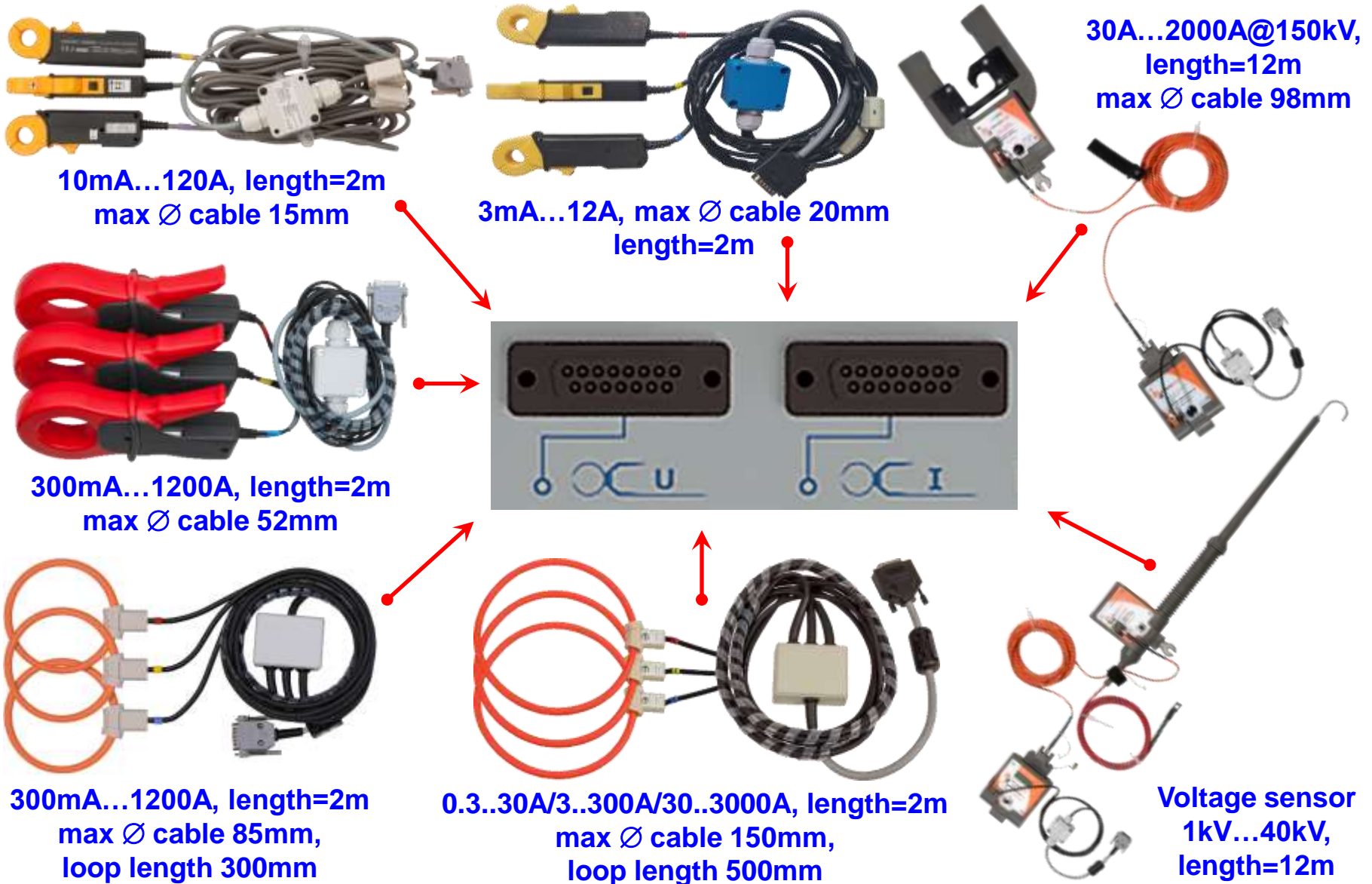
$U_{cc} \max \leq 27V$
 $I_c \max \leq 100mA$

0.0001Hz...200kHz



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

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



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

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

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

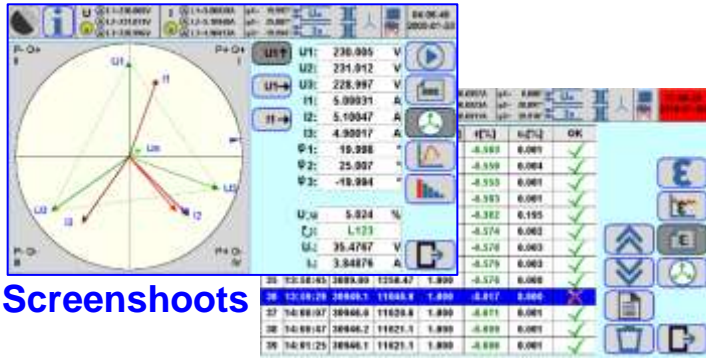
**300mA...1200A, length=2m
max Ø cable 52mm**

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

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

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

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



Results



CalproTS33 PC Soft



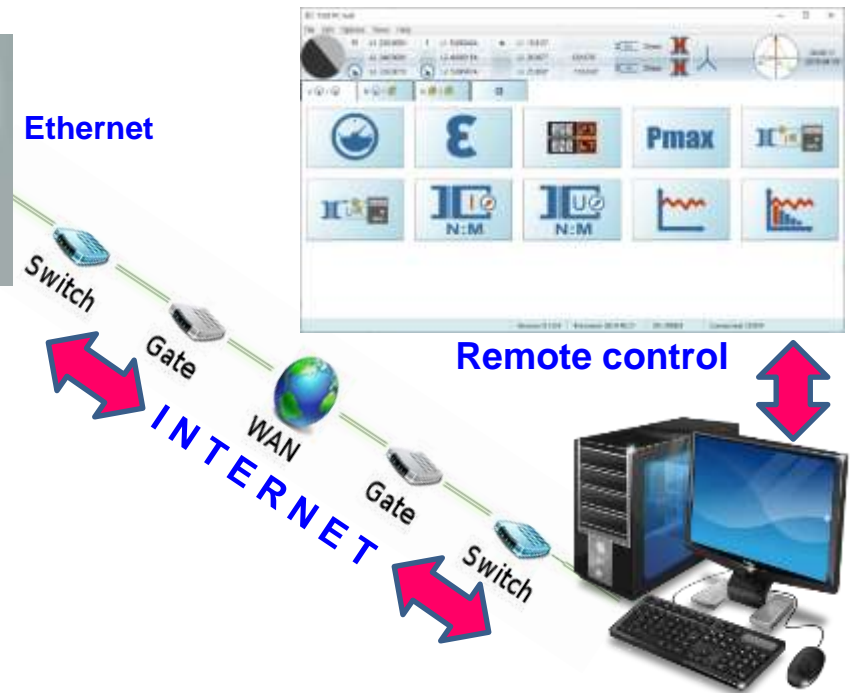
Removable SD cards 2..32GB



Ethernet

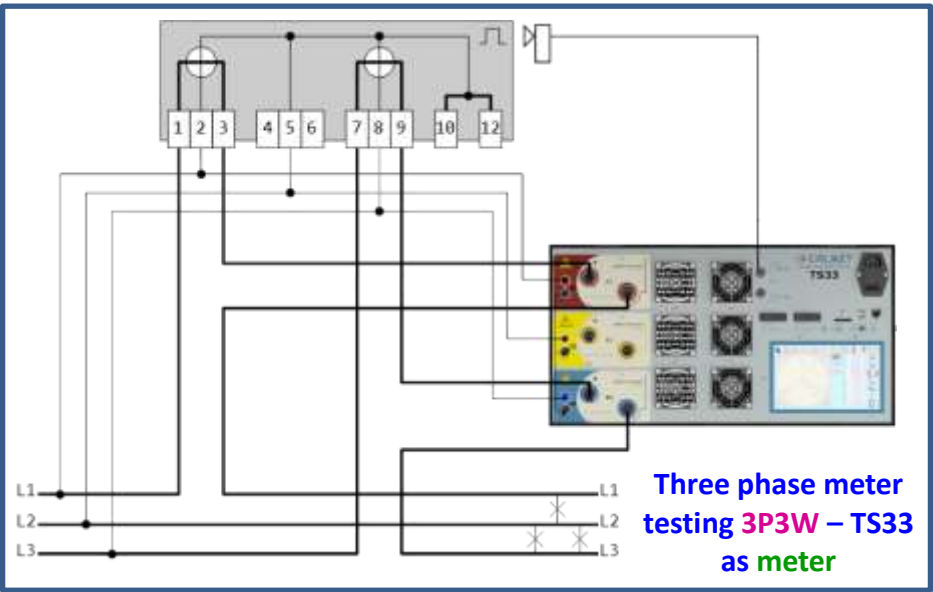
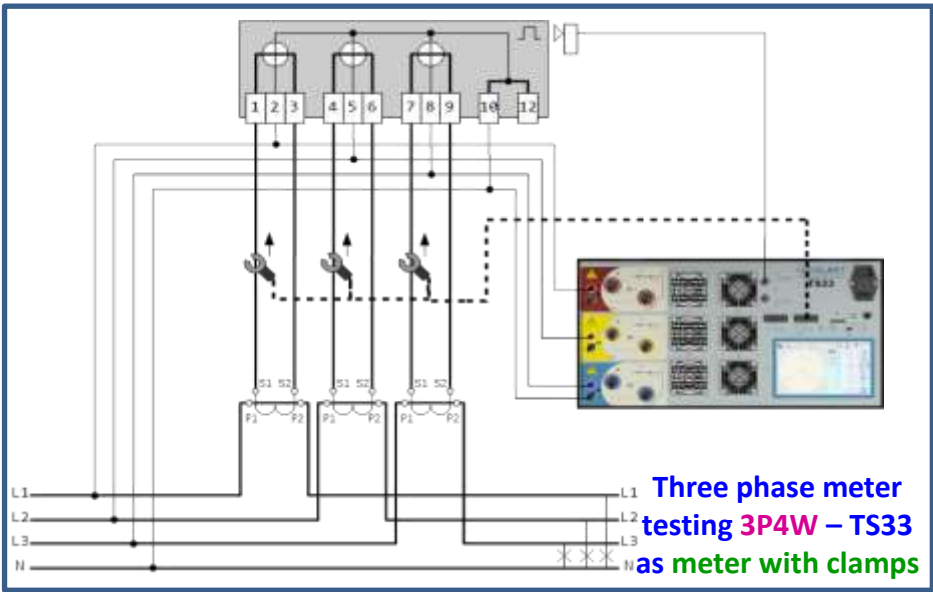
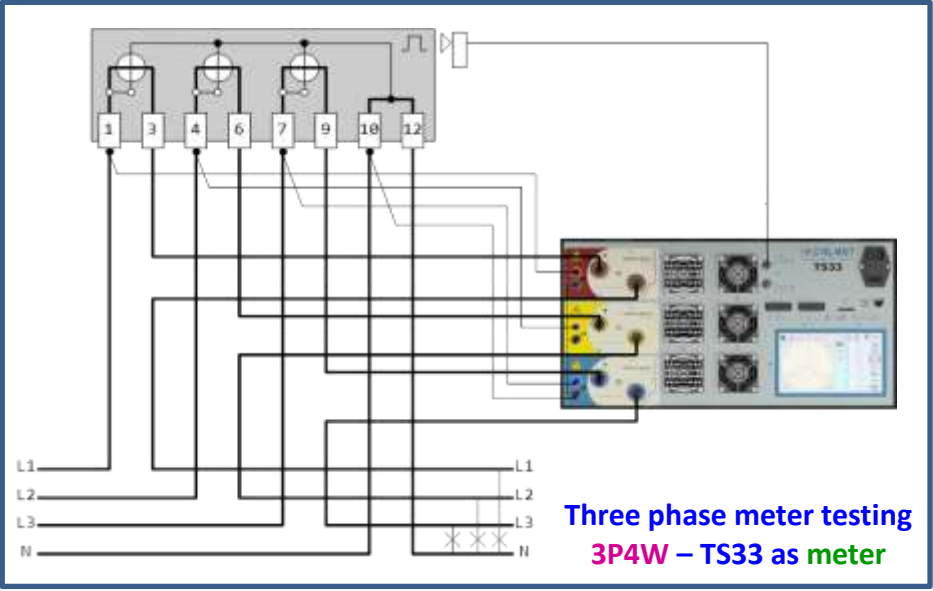
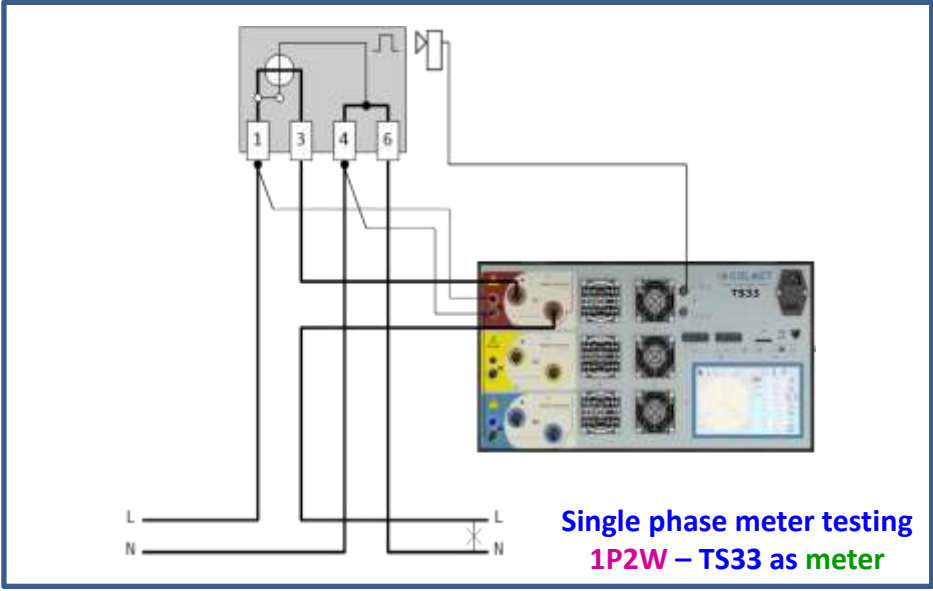


Bluetooth, wireless printer & laptop

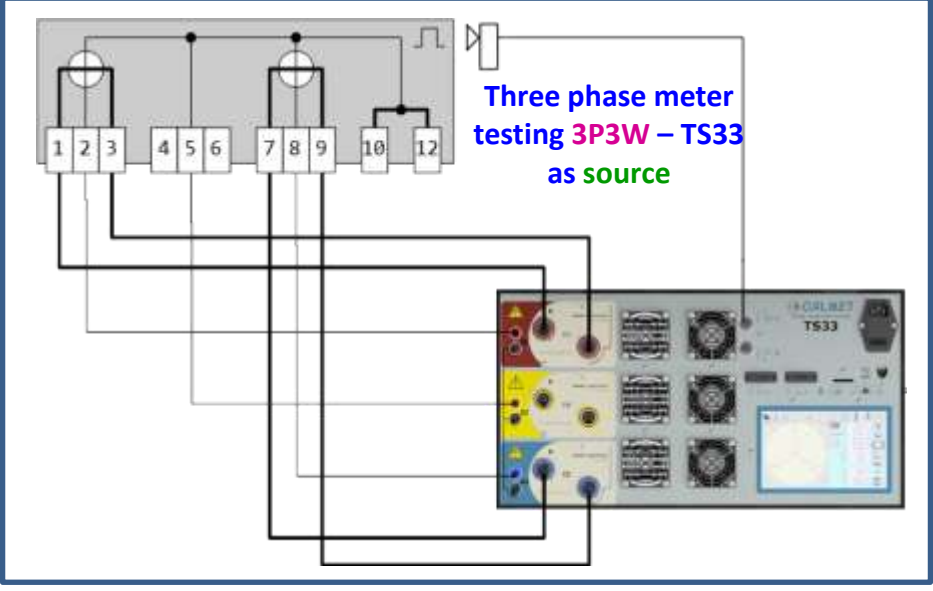
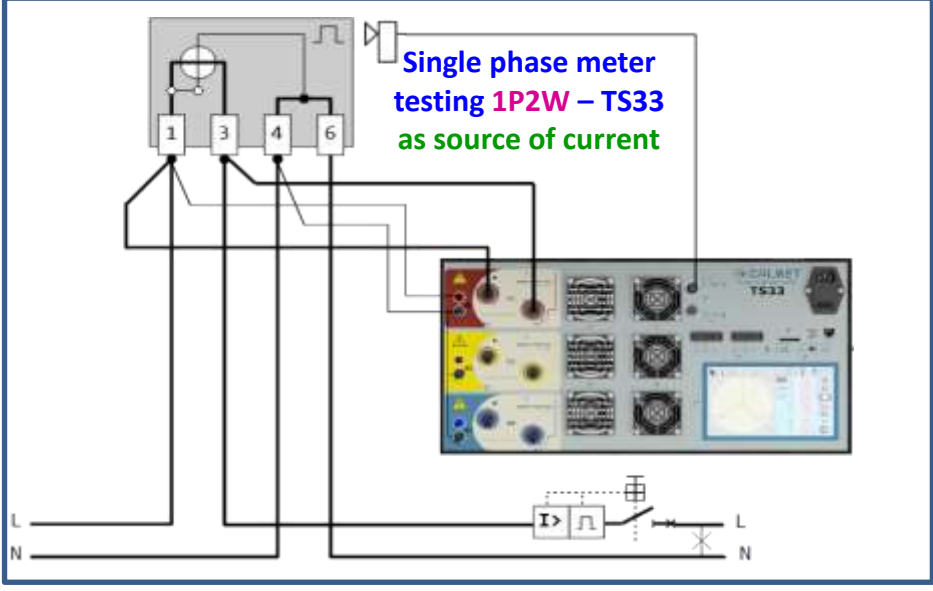
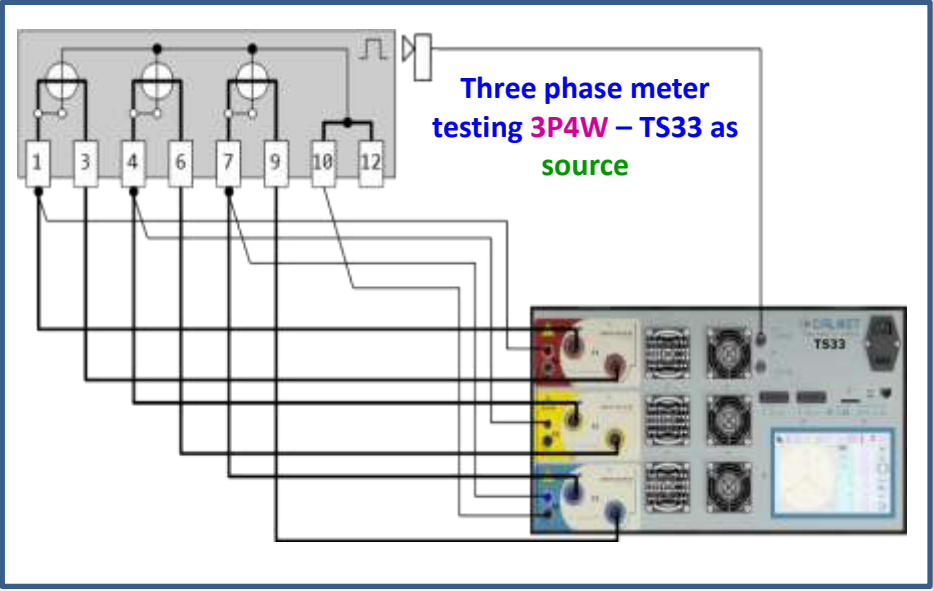
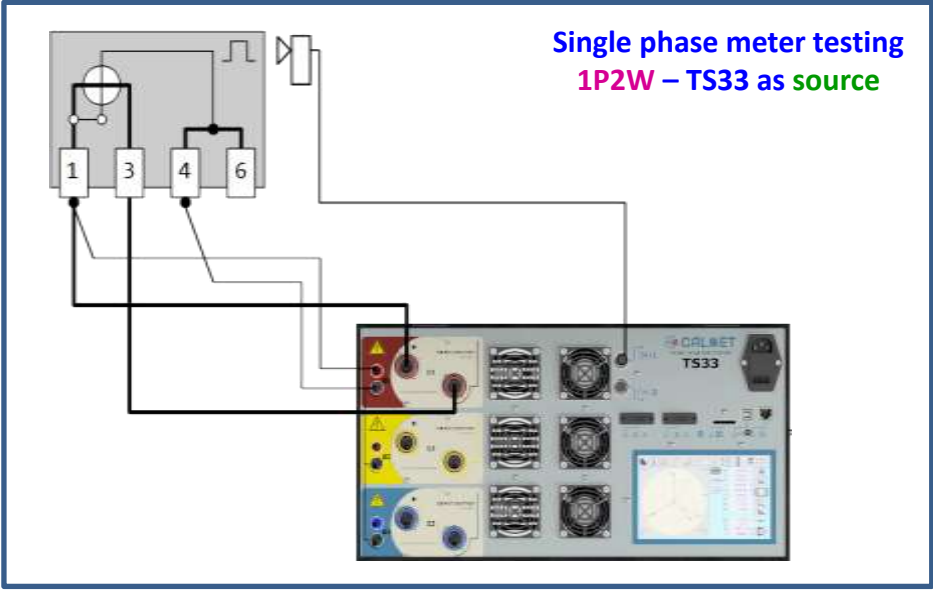


Remote control

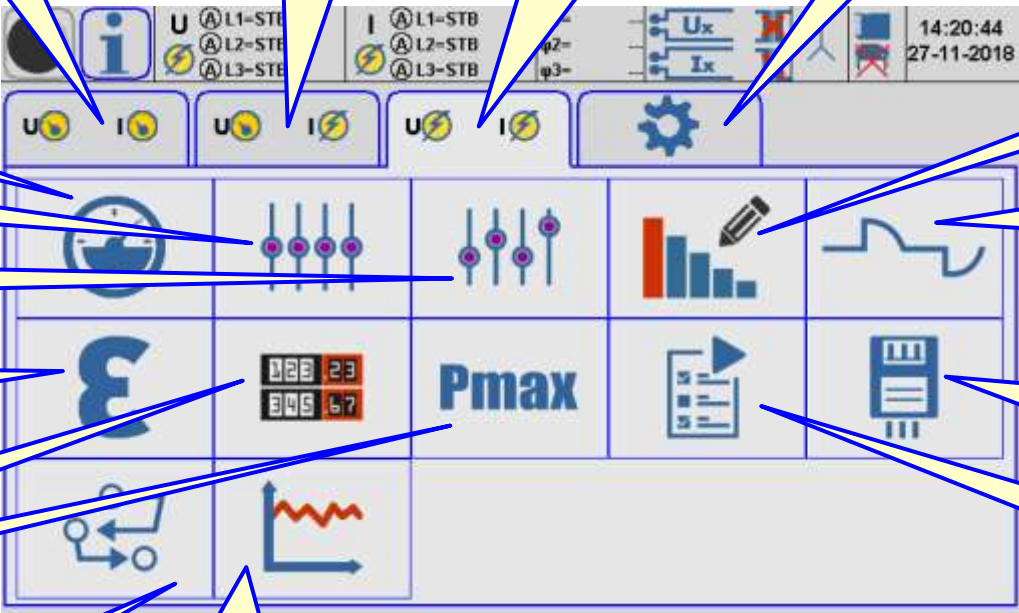
All possible types of connection: **1P2W**, **3P4W**, **3P3W**, ... , direct or with clamps



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



The screenshot shows a software interface with a top status bar, a grid of control buttons, and a bottom section with data displays. Callouts point to various features:

- Reference meter mode** (points to the 'U' button)
- Reference meter with current injection mode** (points to the 'I' button)
- Voltage and current source with built in reference meter mode** (points to the 'Ux' and 'Ix' buttons)
- TS33 General Settings** (points to the gear icon)
- Status line** (points to the top bar)
- RMS values at TS33 terminals** (points to the 'U' and 'I' buttons)
- Setting U, I, ϕ , F ... in symmetric output** (points to the first control panel)
- Setting U, I, ϕ , F ... in asymmetric output** (points to the second control panel)
- Meter error testing** (points to the 'E' button)
- Register (counter) testing** (points to the '23' and '67' displays)
- Maximum demand meter testing** (points to the 'Pmax' display)
- Load points setting for procedures in automatic testing** (points to the circuit diagram icon)
- All quantities trend (versus time) observation** (points to the graph icon)
- Setting harmonics in output signal** (points to the bar chart icon)
- Setting special shapes of the output signal** (points to the waveform icon)
- Meter under test parameters settings for automatic testing** (points to the document icon)
- Automatic test execution** (points to the play button icon)

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

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

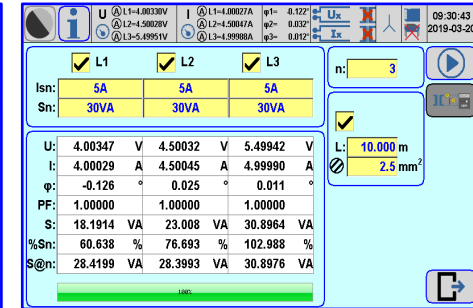
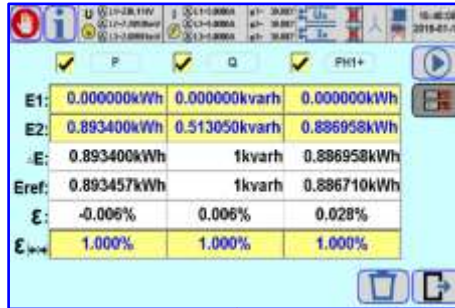
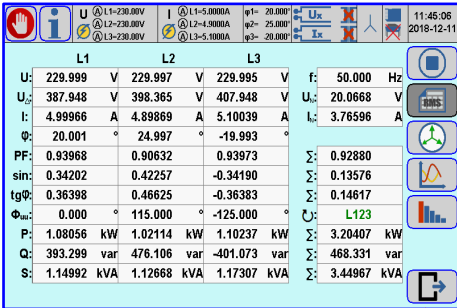


RMS values of U,I,φ,F,P,Q,S

Counter (register) test

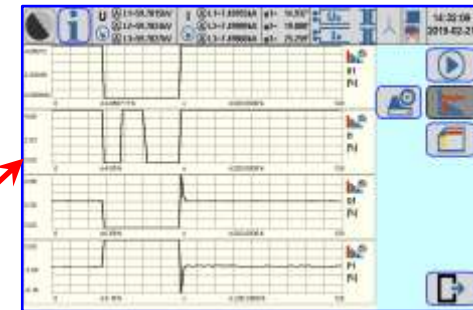
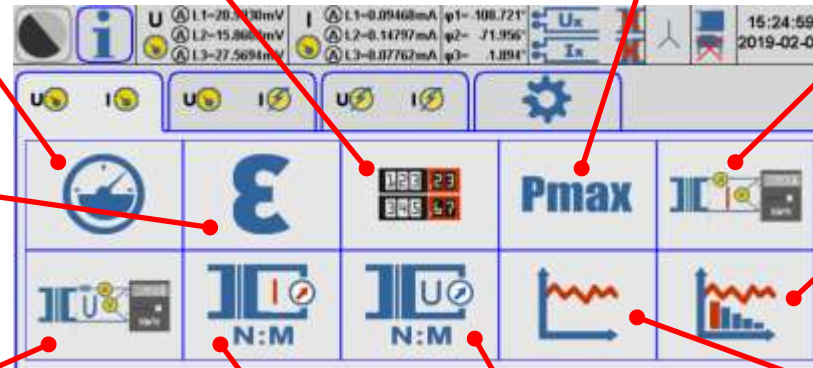
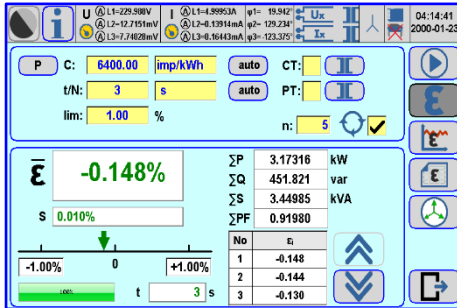
Maximum demand meter test

CT burden test



Meter error test in [%]

Harmonics trend test

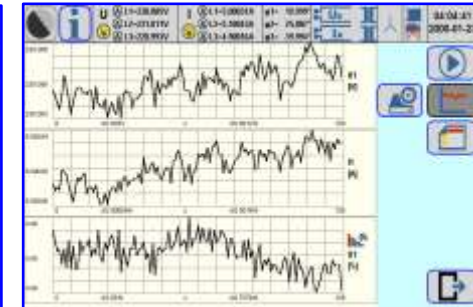


PT burden test

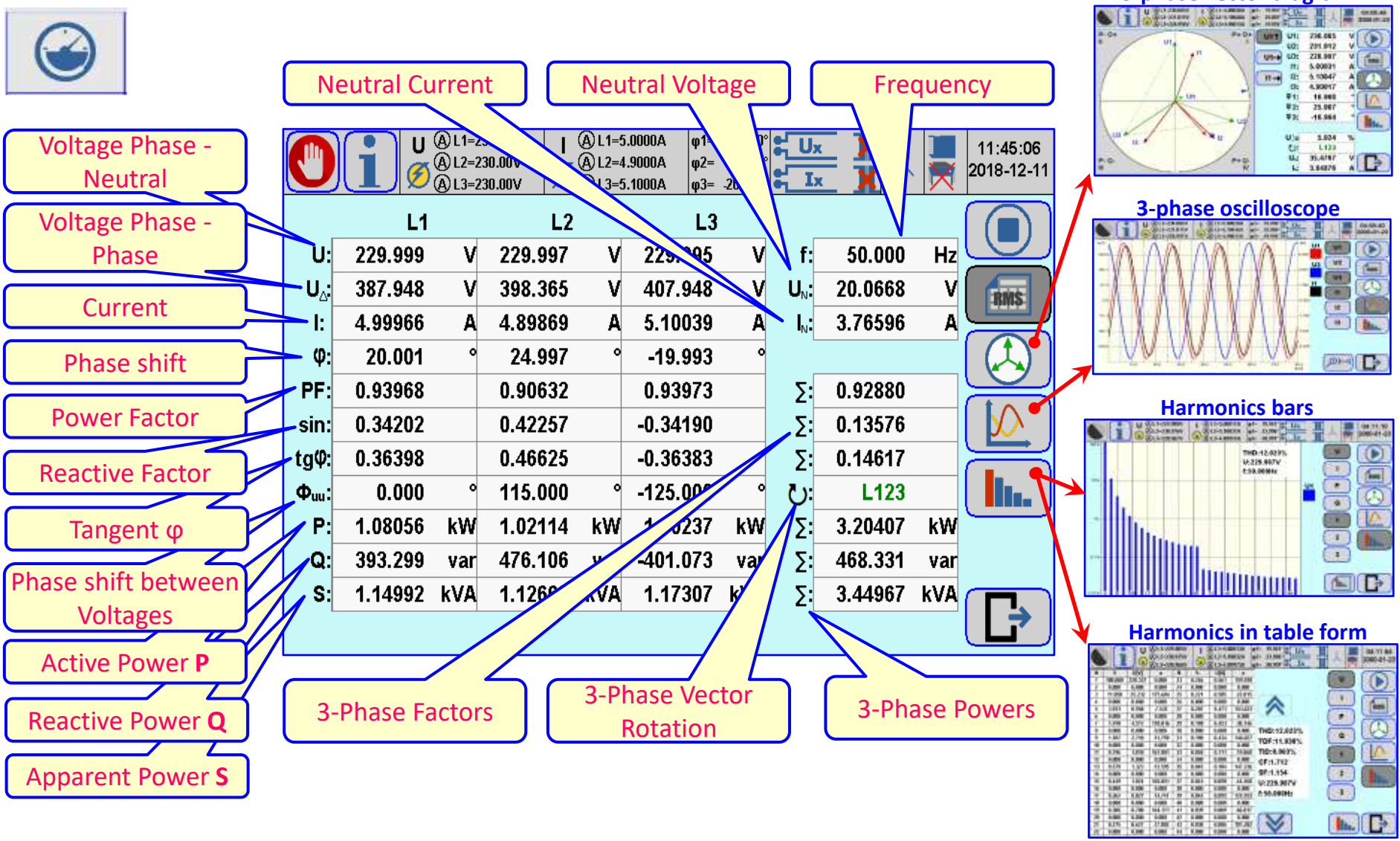
CT ratio test

PT ratio test

U,I,φ,F,P,Q,S trend test



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



Neutral Current

Neutral Voltage

Frequency

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

3-Phase Factors

3-Phase Vector Rotation

3-Phase Powers

3-phase vector diagram

3-phase oscilloscope

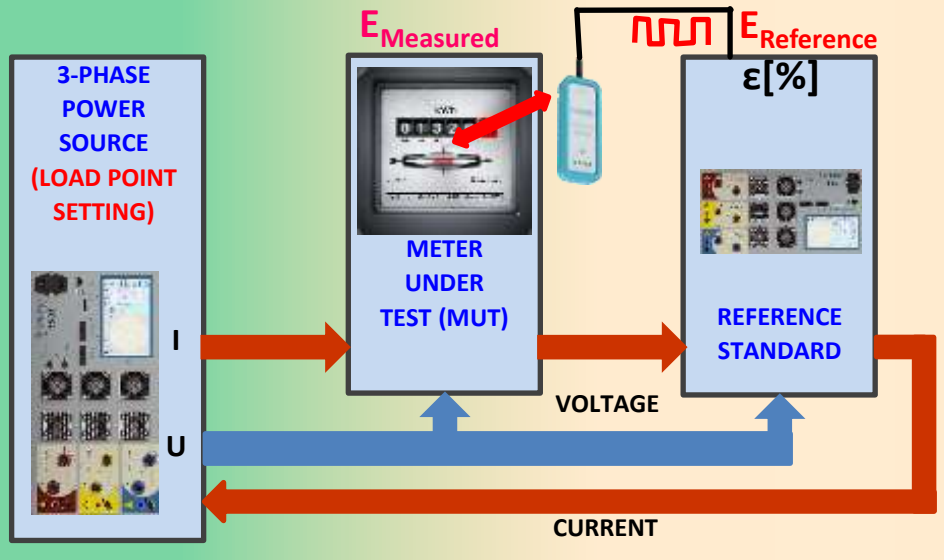
Harmonics bars

Harmonics in table form

	L1	L2	L3		
U:	229.999 V	229.997 V	229.995 V	f:	50.000 Hz
U _Δ :	387.948 V	398.365 V	407.948 V	U _N :	20.0668 V
I:	4.99966 A	4.89869 A	5.10039 A	I _N :	3.76596 A
φ:	20.001 °	24.997 °	-19.993 °	Σ:	0.92880
PF:	0.93968	0.90632	0.93973	Σ:	0.13576
sin:	0.34202	0.42257	-0.34190	Σ:	0.14617
tgφ:	0.36398	0.46625	-0.36383	Σ:	3.20407 kW
φ _{uu} :	0.000 °	115.000 °	-125.000 °	Σ:	468.331 var
P:	1.08056 kW	1.02114 kW	1.0237 kW	Σ:	3.44967 kVA
Q:	393.299 var	476.106 var	-401.073 var		
S:	1.14992 kVA	1.1260 kVA	1.17307 kVA		


TS33 functionality: energy meter error testing idea
Principle of electricity meter testing

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


TS33 works both:

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



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

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

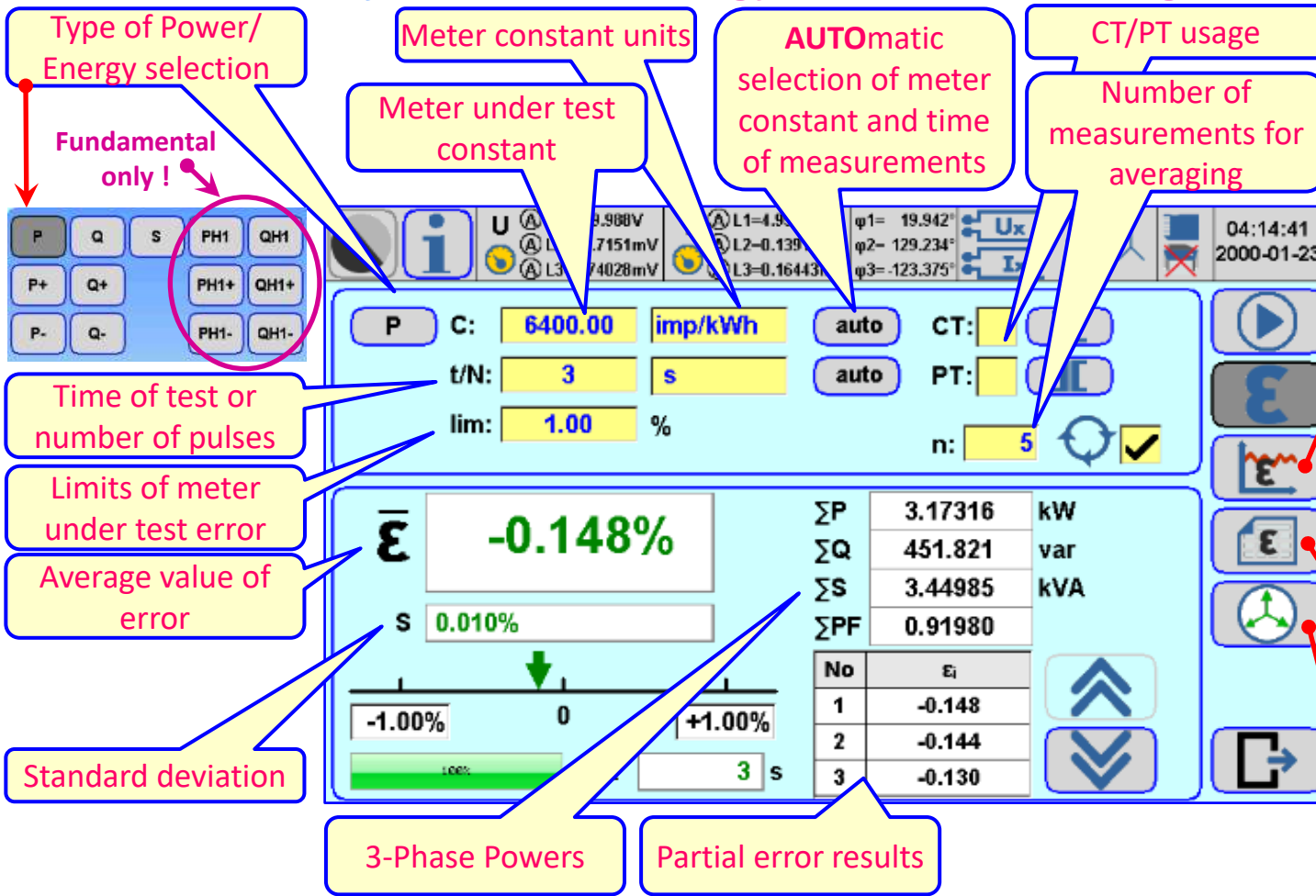
and then compare it with, reference value measured by special, at least 5 times more accurate standard meter ($E_{reference}$).

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

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



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

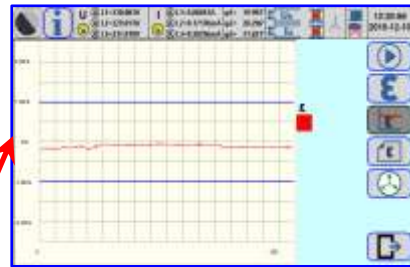
Settings: P, C: 6400.00 imp/kWh, t/N: 3 s, lim: 1.00 %, n: 5

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

Error diagram $\epsilon=f(t)$



Error table

No	PPV	QVAV	Lim[%]	ϵ_i [%]	ϵ [%]	OK
27	10.5518	3333.00	0.91.987	1.000	-0.393	0.001
28	10.52538	3333.00	0.91.976	1.000	-0.338	0.004
29	10.54534	3333.00	0.91.988	1.000	-0.533	0.001
30	10.56118	3333.00	0.91.988	1.000	-0.603	0.001
31	10.55516	3089.00	1259.48	1.000	-0.352	0.100
32	10.56541	3089.00	1259.48	1.000	-0.574	0.002
33	10.57122	3089.00	1259.48	1.000	-0.619	0.002
34	10.58206	3089.00	1259.48	1.000	-0.619	0.002
35	10.58540	3089.00	1259.47	1.000	-0.619	0.000
36	10.5518	30946.0	11406.8	1.000	-0.217	0.000
37	10.56507	30946.8	11426.8	1.000	-0.411	0.001
38	10.58047	30946.2	11421.5	1.000	-0.699	0.001
39	10.59125	30946.5	11421.5	1.000	-0.699	0.001

Vector diagram

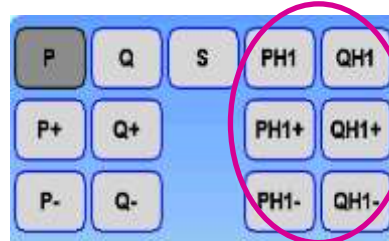


- ▶ function of computing meter error (partial errors, average error, standard deviation) directly in percentages [%] with method of setting time of measurement or number of impulses,
- ▶ function of automatic identification energy meter constant,
- ▶ function of automatic determining measurement time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

TS33 functionality: register (counter) test



The type of power setting for selected register



Fundamental only !

Up to 3 registers testing at time

U (A) L1=228.810V (A) L1=4.99986A $\phi 1= 29.750^\circ$ Ux Ix
 (A) L2=0.25538mV (A) L2=STB $\phi 2= -0.018^\circ$
 (A) L3=0.19500mV (A) L3=STB $\phi 3= -0.002^\circ$

13:36:17
2019-01-15

Test START / STOP

Register value before starting test

Register value after stopping test

Difference between E2-E1

Reference value of Energy flow

Value of error

Limits of error

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

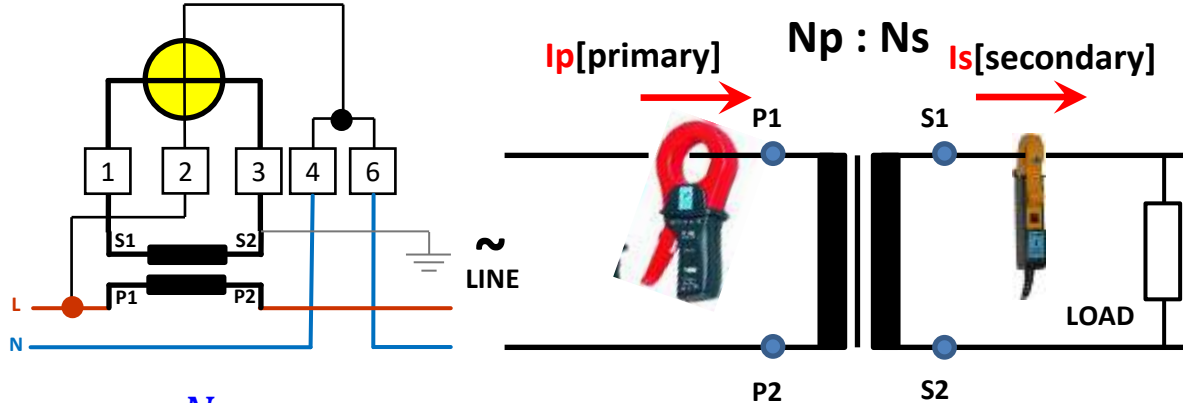
Value of active energy with all harmonics

Value of first harmonic only in active energy

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



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



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

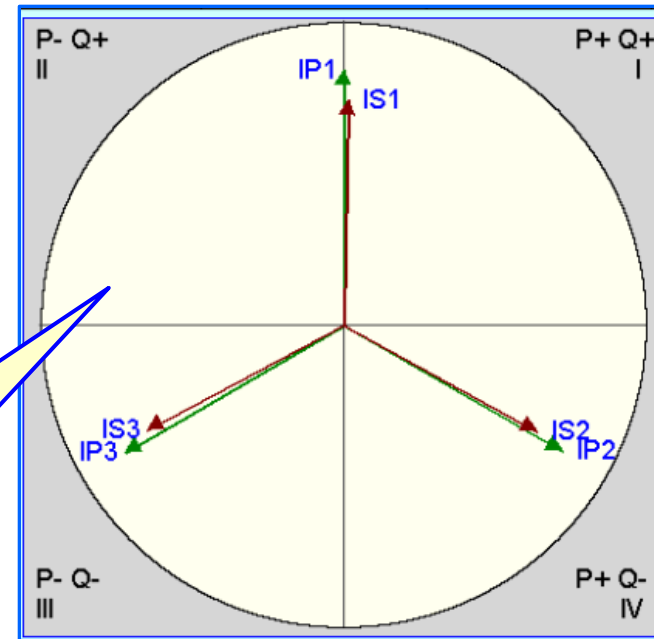
$$\delta I = \frac{N_P}{N_S} \cdot I_S - I_P$$

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

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 $\delta I=0\%$ and phase shift error $\varphi=0^\circ$

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

Individual phase



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

lp:	100.006 A	99.0032 A	99.5007 A
ls:	5.00011 A	4.90018 A	4.95051 A
φ :	0.988 °	-1.001 °	1.980 °
lp/ls:	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

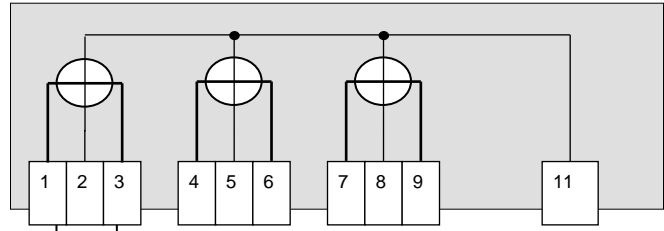
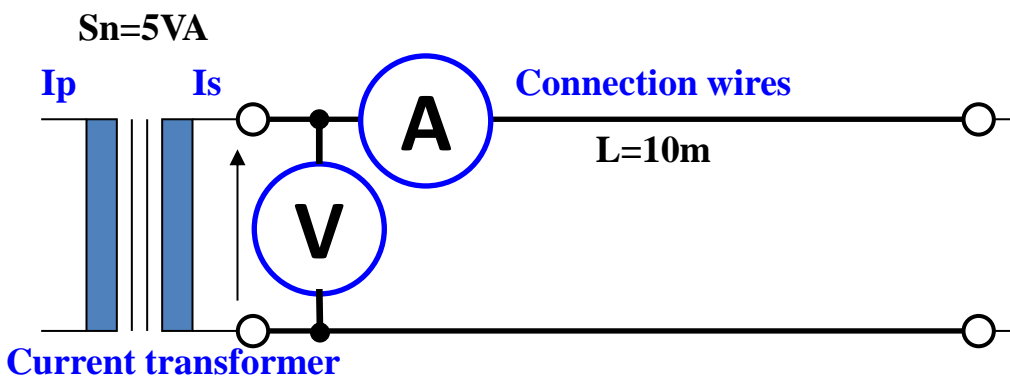
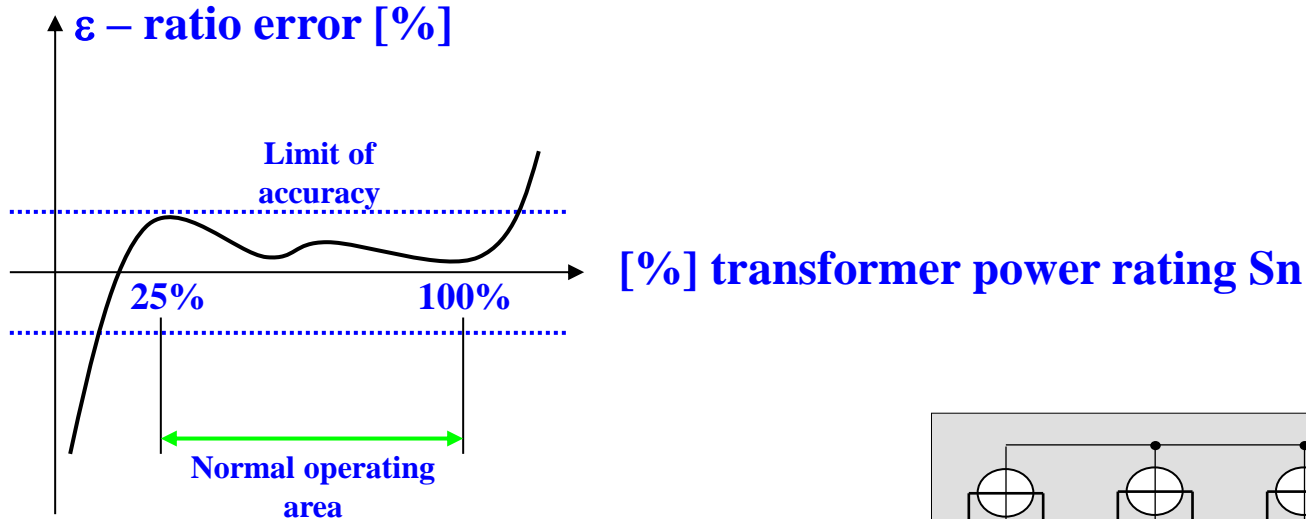
Vector diagram of primary and secondary side allows for easy connection testing

- ▶ 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



- 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

U (V) L1=330V L2=330V L3=330V
 I (A) L1=4.00027A L2=4.50047A L3=4.99988A
 φ1= -0.122° φ2= 0.032° φ3= 0.012°

Number of measurements for averaging

n: 3

Test START / STOP

L1 L2 L3

Isn:	5A	5A	5A
Sn:	30VA	30VA	30VA

Distance between CT/PT and meter [m]

L: 10.000 m

Cross section of connection wires

2.5 mm²

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

100%

- 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

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

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



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

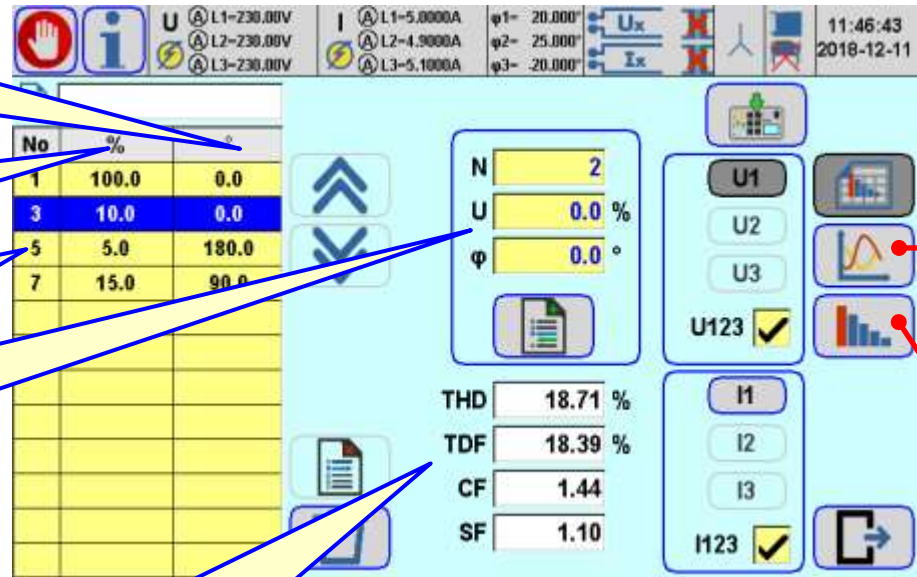
The screenshot shows the main control interface of the TS33 system. At the top, there are status indicators for voltage (U) and current (I) across three phases (L1, L2, L3). Below this, there are control buttons for switching channels on/off and setting ranges (auto or constant). The central part of the interface displays real-time data for voltage (U) and current (I) in each phase, along with phase angles (φ) and frequency (f). The bottom section contains a table of phase shift settings between voltages.

	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	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

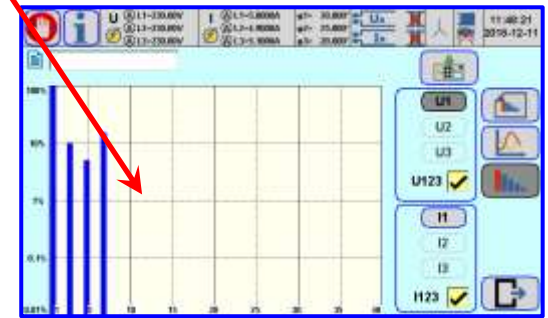
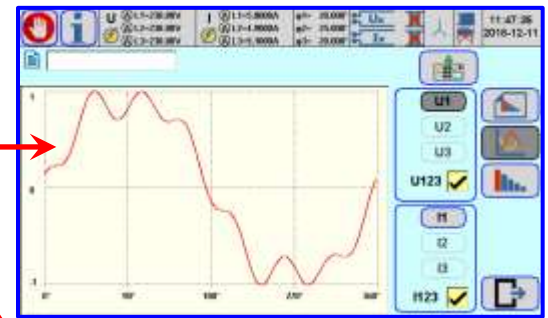
TS33 functionality: Voltage and current source – harmonic generation

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



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

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



Real signal measured at TS33 output

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



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

METER TYPE



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

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



TEST PROCEDURE

Type of test:

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

Load points:

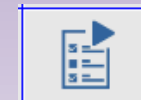
- value of current
- value of voltage
- power factor
- frequency
- harmonics



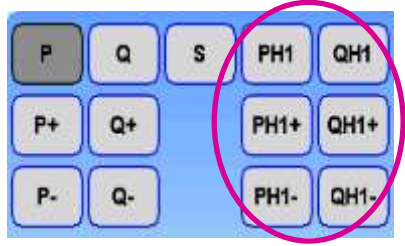
TEST EXECUTION

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

No	🕒	P[W]	Q[VAR]	lim[%]	ε[%]	sc[%]	OK
1	11:43:27	172.502	-0.008651	1.000	0.660	0.022	✓
2	11:44:50	344.987	-0.013448	1.000	0.638	0.010	✓
3	11:45:35	689.912	-0.049329	1.000	0.505	0.107	✓
4	11:46:57	1725.03	-1.00910	1.000	0.628	0.003	✓
5	11:48:16	2760.15	-0.290766	1.000	0.616	0.006	✓
6	11:49:37	3450.06	-0.479581	1.000	0.600	0.004	✓
7	11:50:56	4139.97	-0.75082	1.000	0.589	0.001	✓



TS33 functionality: Automatic energy meter test – Meter Type



Fundamental only!

Power type measured by meter

Type of meter in Data Base or new meter

Comment to the meter

Meter connection type: STAR / DELTA / SINGLE PHASE

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

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

U (A) L1=STB (A) L2=STB (A) L3=STB
I (A) L1=STB (A) L2=STB (A) L3=STB
 φ1= φ2= φ3=
 U_x I_x
 15:21:02 2019-01-02
PAFAL12E
PAFAL12EA5gw
 P
 U_b 230 V U_{max} 300
 I_b 5 A I_{max} 60 A
 C 6400 imp/kWh
 0 s
 PT CT
 U_{pn} 30000 V I_{pn} 800 A
 U_{sn} 57.7 V I_{sn} 5 A

Base voltage of meter under test

Maximum voltage to protect meter

Base (nominal) current

Maximum current






Current transformer if used and its primary and secondary nominal current

Potential transformer if used and its primary and secondary nominal voltage

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

TS33 functionality: Automatic energy meter test – Procedure



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

Type of test

Error limit

Time of test

Number of measurements for averaging

Name of load point

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

Phase shift or power factor

Symmetry of voltages and rotation direction

Harmonics in signal

Synchronization with network frequency

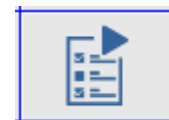
	L1	L2	L3	L123
U	100.000 %	100.000 %	100.000 %	<input checked="" type="checkbox"/>
I	5.000 %	STB %	STB %	<input type="checkbox"/>
ϕ	10.00 °	10.00 °	10.00 °	<input checked="" type="checkbox"/>
L123	0.00 °	120.00 °	-120.00 °	<input type="checkbox"/>
f	50.000 Hz			<input type="checkbox"/>

Table with load points

Load Point	U	I	ϕ	L123	f
L1	100.000	5.000	10.00	0.00	50.000
L2	100.000	STB	10.00	120.00	50.000
L3	100.000	STB	10.00	-120.00	50.000
L4	100.000	5.000	10.00	0.00	50.000
L5	100.000	5.000	10.00	0.00	50.000

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

Load point execution and error results

Results in table format

Results as diagram

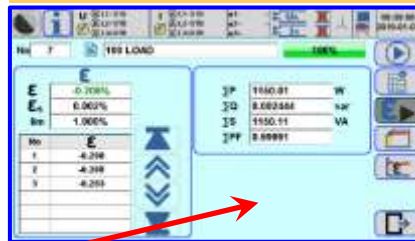
L1=STB L1=STB φ1=
 L2=STB L2=STB φ2=
 L3=STB L3=STB φ3=

PAPAL12E BASICSTST

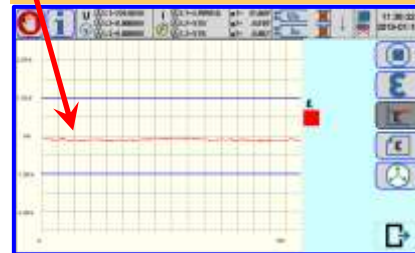
S0 test C test

Ok	No		L1	L2	L3
	1	U: 500V 50Hz	230.000V	230.000V	230.000V
	2	U: 230V 50Hz	10.0000A	10.0000A	10.0000A
	3	U: 110V 50Hz	0.00°	0.00°	0.00°
	4	U: 57V 50Hz	50.000Hz		
	5	I: 120A 50Hz	L123		
	6	I: 12A 50Hz	6900.00W		
	7	I: 1A 50Hz			
	8	I: 0.12A 50Hz	0%		
	9	I: 0.02A 50Hz	0%		
	10	F: 230V 50Hz	0%		

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 L123
 6900.00W
 0%
 0%
 0%



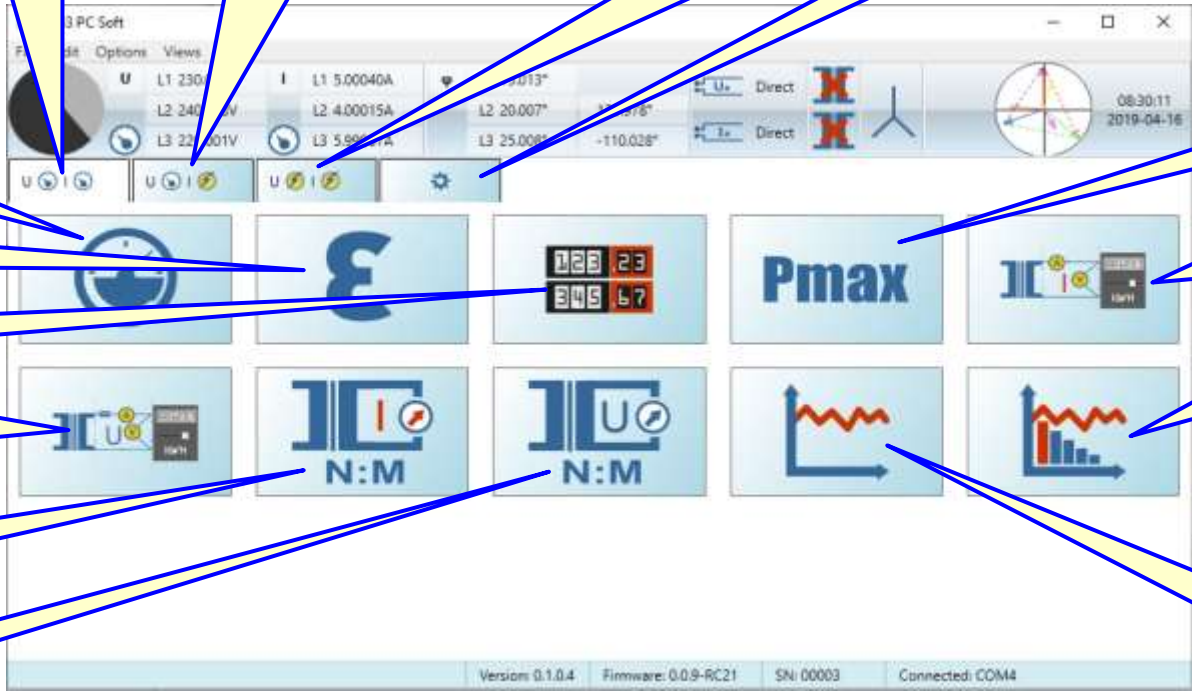
№	U	I	φ	P	W	VA	OK
1	230.00	10.00	0.00	6900.00	1150.11	8.00991	✓
2	230.00	10.00	0.00	6900.00	1150.11	8.00991	✓
3	230.00	10.00	0.00	6900.00	1150.11	8.00991	✓
4	230.00	10.00	0.00	6900.00	1150.11	8.00991	✓
5	230.00	10.00	0.00	6900.00	1150.11	8.00991	✓
6	230.00	10.00	0.00	6900.00	1150.11	8.00991	✓
7	230.00	10.00	0.00	6900.00	1150.11	8.00991	✓



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 point in the procedure

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



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

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

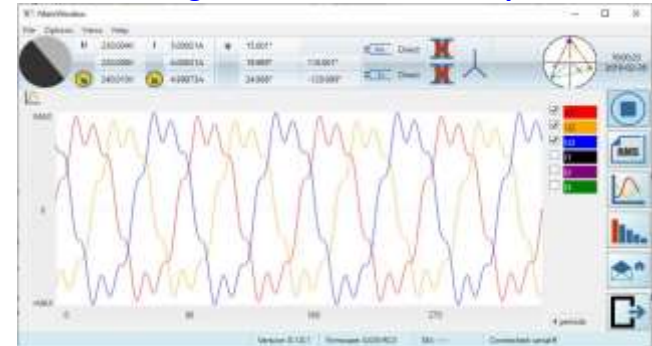
Conclusion: All functionality of the TS33 is available through **USB, Bluetooth and Ethernet** connection (including **Internet** remote control). TS33 PC Soft enables to download real time results of measurement made by TS33, download stored in memory results, readout the SD card memory and remote control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

TS33 PC Soft functionality: example screenshots

RMS values of U,I, ϕ ,F,P,Q,S



Voltage U1, U2, U3 oscilloscope



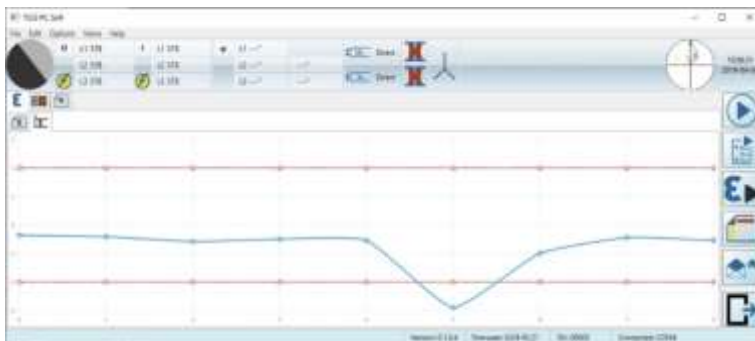
Voltage, current and THD trend



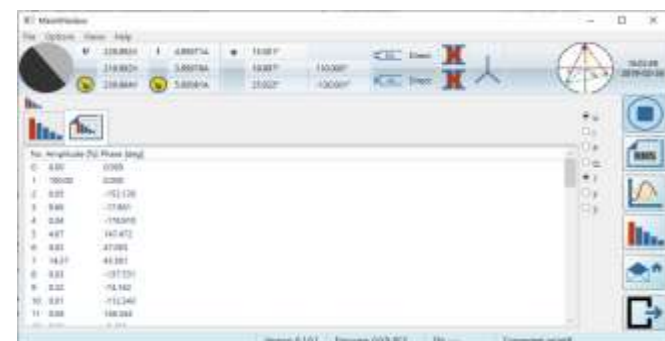
Harmonics in voltage U1



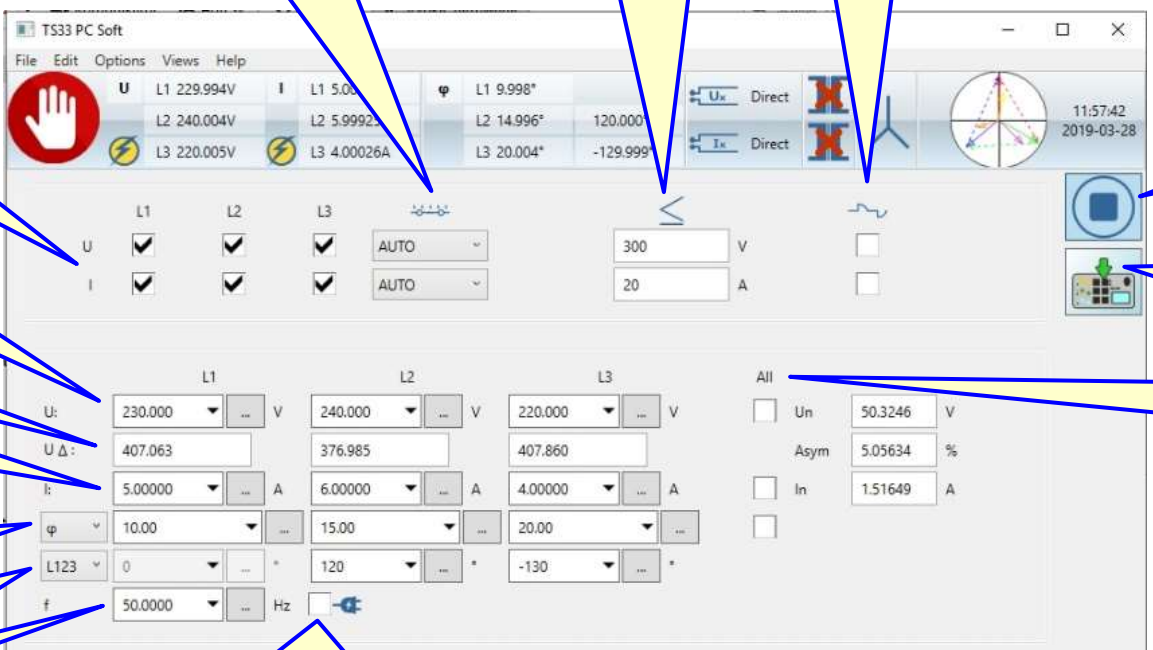
Meter error versus I load $\epsilon=f(I)$



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 for voltage and current.
- Setting maximum value of Voltage or Current**: Points to the numerical input fields for maximum voltage (300 V) and current (20 A).
- Switching harmonics ON / OFF**: Points to the harmonic control buttons.
- Switching ON / OFF of individual U & I channels**: Points to the channel selection checkboxes.
- Voltage in phase L1 L2 L3**: Points to the phase voltage input fields.
- Voltage between phases**: Points to the phase-to-phase voltage input fields.
- Current in phase L1 L2 L3**: Points to the phase current input fields.
- Phase shift U&I**: Points to the phase shift input fields for voltage and current.
- Phase shift between Voltages**: Points to the phase shift input fields between phases.
- Frequency setting**: Points to the frequency input field (50.0000 Hz).
- Frequency synchronised with power frequency**: Points to the synchronization checkbox.
- START / STOP generation**: Points to the start/stop buttons.
- 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 input 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 three phase electronic (static) Energy Meter example (1)

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

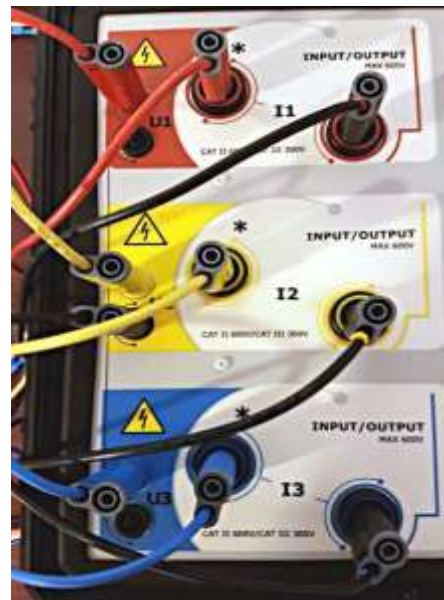
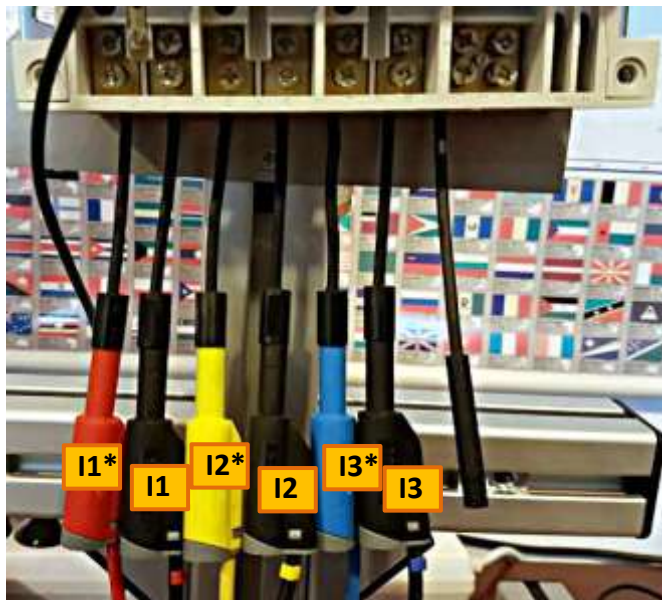
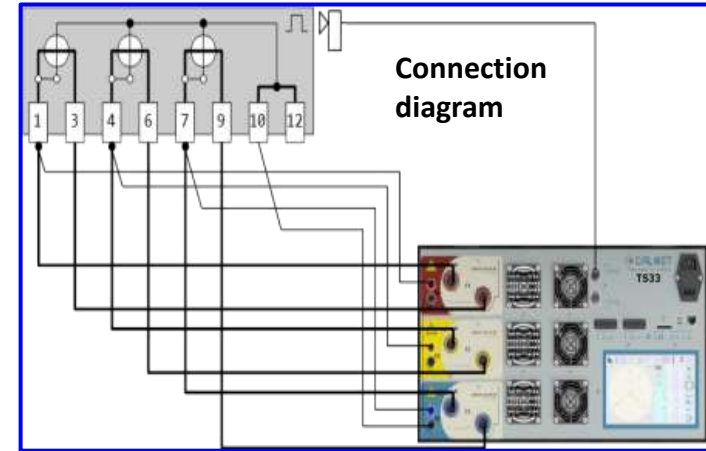


Meter parameters:
 Base voltage: 230V
 Base current: 5A
 Max. current: 100A
 Meter constant:
 1000 imp/kWh

Typical three phase electronic meter with LED and its parameters

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

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



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

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



Connected meter ready for testing

Setting the output values (load point)

Three phase operation; individual outputs switch ON/OFF

Limit of maximum voltage & current

Send to the output

Generate signal

Set harmonics

Set value of Voltage

Set value of current

Set value of frequency

Set phase shift between U1&U2

Set phase shift between U2&U3

Set value of phase shift U&I

Set synchronization with network frequency

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

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

U I U I U I

ε

23 67

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

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

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

Load point parameters

This mode requires meter disconnection!

	L1	L2	L3
U _L	229.999 V	240.002 V	220.001 V
U _φ	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
sinφ	0.25878	0.34213	0.42272
gφ	0.26791	0.36411	0.46646
φ _u	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	1.31967 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	13:51:53	3209.16	1184.07	2.000	0.059	0.045	✓
2	13:52:10	3209.21	1184.18	2.000	0.038	0.048	✓
3	13:52:28	3208.99	1184.08	2.000	0.008	0.022	✓
4	13:52:48	3209.13	1183.98	2.000	0.117	0.010	✓
5	13:53:06	3209.15	1184.15	2.000	-0.011	0.023	✓
6	13:53:24	3209.19	1184.04	2.000	0.079	0.037	✓
7	13:53:39	3209.06	1184.14	2.000	0.047	0.037	✓
8	13:53:57	3209.23	1183.99	2.000	0.077	0.011	✓
9	13:54:17	3209.03	1184.04	2.000	0.050	0.040	✓
10	13:54:32	3209.03	1184.03	2.000	0.037	0.009	✓
11	13:54:50	3209.18	1184.06	2.000	0.052	0.010	✓
12	13:55:09	3209.20	1184.20	2.000	0.015	0.025	✓
13	13:55:26	3209.15	1184.13	2.000	0.006	0.008	✓

Meter constant

Time of test

Class of Meter under test

Table with recorded results versus time

C: 1000.00 imp/kWh

t/N: 10

lim: 2.00 %

n: 3

ΣP: 3.20925 kW

ΣQ: 1.18401 kvar

ΣS: 3.43013 kVA

ΣPF: 0.93561

ε: 0.005%

s: 0.007%

Averaged error result

Standard deviation

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

TS33: testing three phase electronic (static) Energy Meter example (4)
 TS33 as **Voltage and Current Source** and Reference Meter and meter under test connected **directly**

Automatic Procedure for whole load characteristics

Meter Type Definition

Meter name: AP20EC3G
 Connection type: Pafal Apator
 Power type: P+
 Comment: [empty]
 Base voltage: Ub 230 V Umax 250 V
 Max. voltage: [empty]
 Max. current: Ib 5 A Imax 100 A
 Base current: [empty]
 Meter constant: C 1000 imp/kWh
 Delay time: 5 s
 PT primary & secondary voltage: Upn 57.7 V Ipn 57.7 A
 CT primary & secondary current: Usn 2.5 V Isn 2.5 A

Test Point and Procedure Definition

Load point name: 100pr
 Time of measurement: lim 2.000 t 20 s n 3
 Meter Class: E
 Add load point to list: [button]
 Number of measurements per result: n 3

	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			

Meter error test: U, I, φ, L123, f
 Voltage in [%]: U
 Current in [%]: I
 Phase shift U&I: φ, L123
 Vector rotation: L123, f

List of load points:

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

List edition: insert, move up/down, remove

List of load points

Frequency: f 50.000 Hz
 Harmonics: [empty]
 Phase shift U&U: L123

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

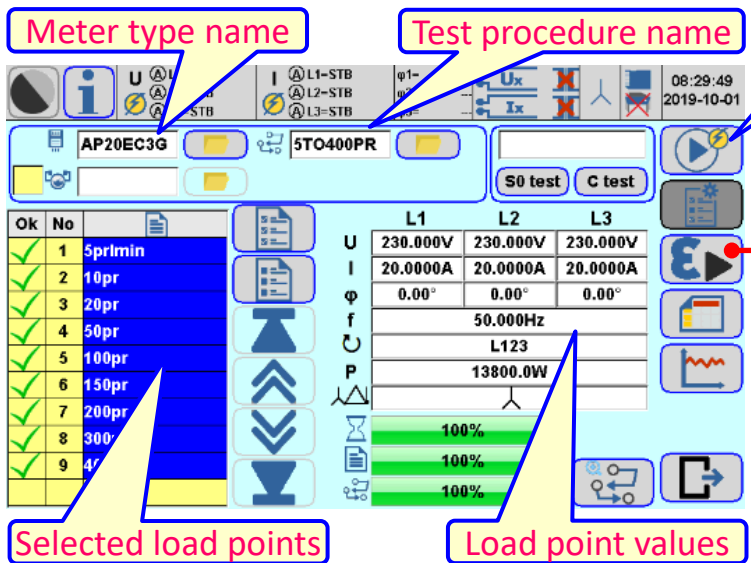
Meter or Procedure name field: 00000008

Automatic Procedure for whole load characteristics

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

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

Meter Test Execution



Meter type name: AP20EC3G

Test procedure name: 5TO400PR

Test starting: [Start button]

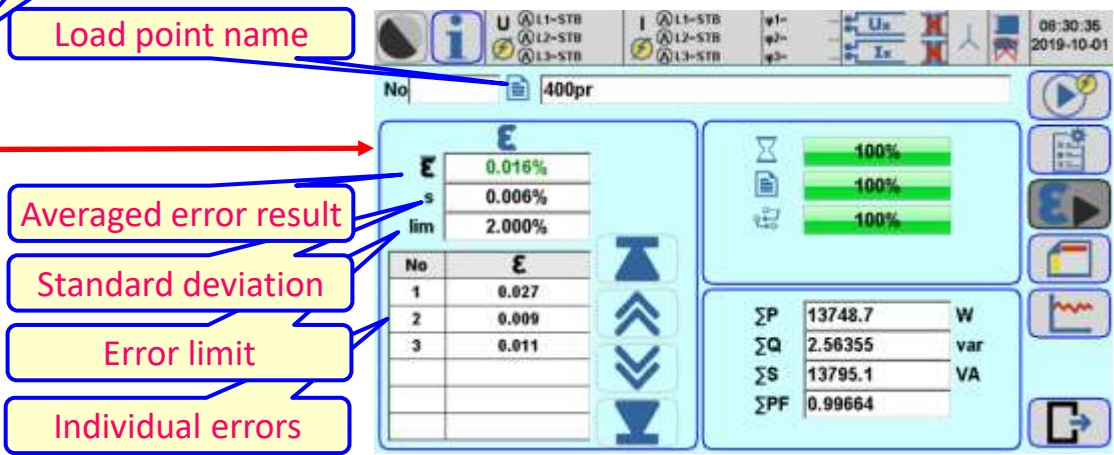
Load point name: S0 test, C test

Ok	No	U	I	ϕ	f	P
		L1	L2	L3		
		230.000V	230.000V	230.000V		
		20.0000A	20.0000A	20.0000A		
		0.00°	0.00°	0.00°		
					50.000Hz	
					L123	
					13800.0W	
					100%	
					100%	
					100%	

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

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

Individual load point test



Averaged error result: 0.016%

Standard deviation: 0.006%

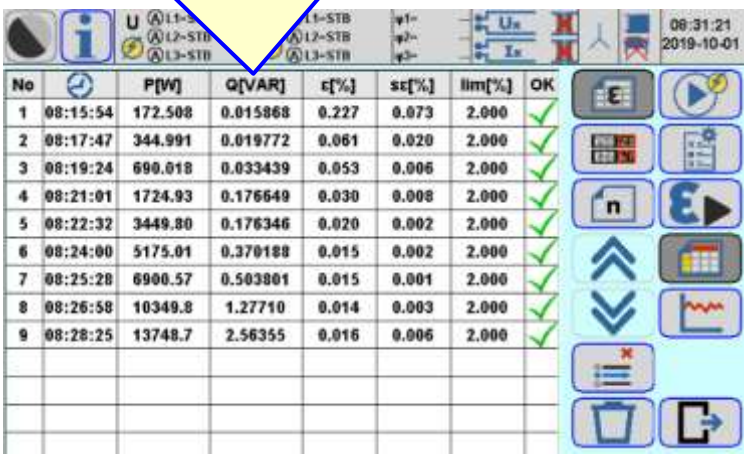
Error limit: 2.000%

Individual errors: 0.027, 0.009, 0.011

No	ϵ
1	0.027
2	0.009
3	0.011

ΣP	13748.7	W
ΣQ	2.56355	var
ΣS	13795.1	VA
ΣPF	0.99664	

Table with results for each load point



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

Results transferred to the PC Soft as diagram



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

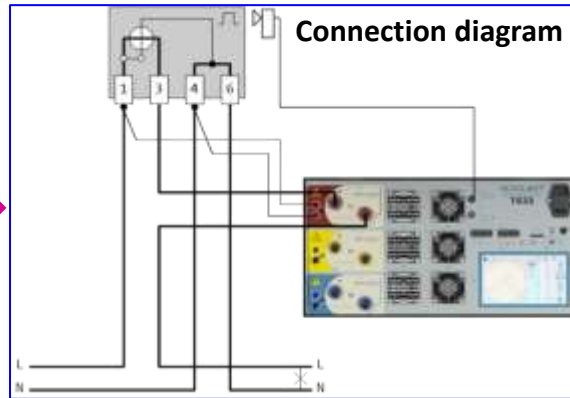
TS33 as Reference Meter and meter under test directly connected



Meter parameters:

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

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



Wiring to meter terminals



Disconnect phase wire connected to load



Magnets

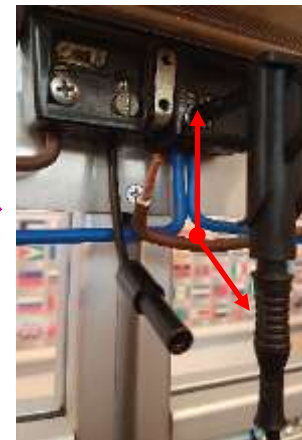
Magnetic plugs for safety cables



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



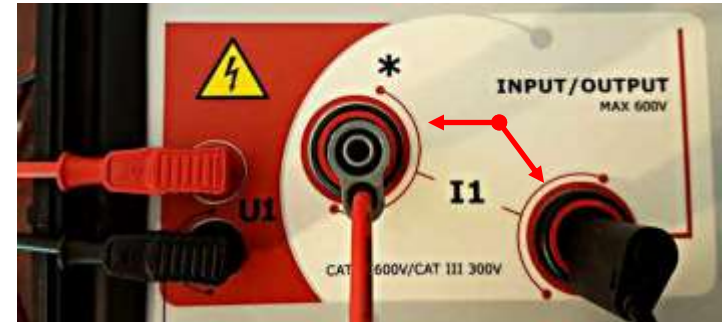
Connect cables from meter to voltage inputs of TS33



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

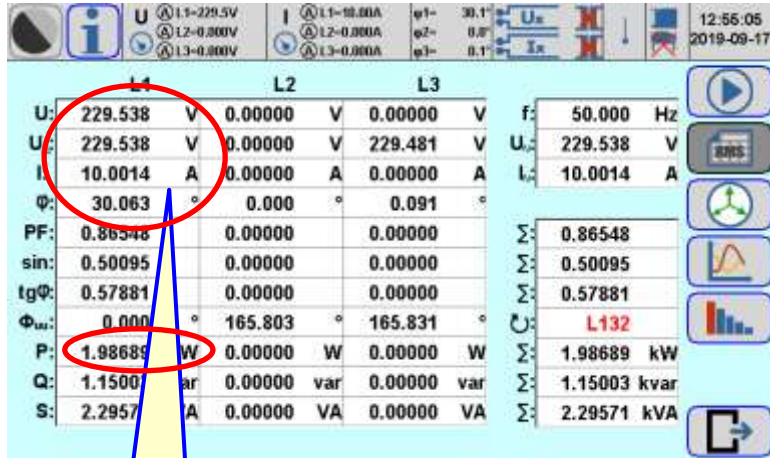
Now the measurement system is ready to test meter error and register test

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

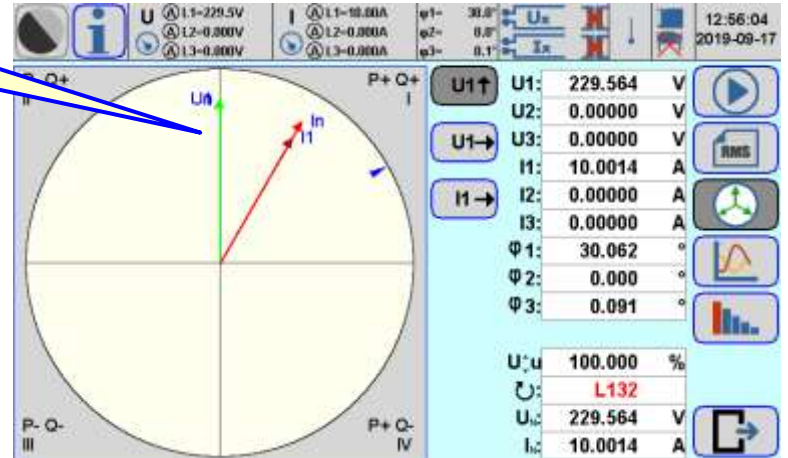


TS33 : testing single phase electromechanical Energy Meter example (3)

TS33 as Reference Meter and meter under test directly connected



Vector diagram



Testing schedule:

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

Load point parameters

Meter constant

Class of Meter under test

TS33 enables fast end efficient way of testing

Type of power measured by meter

Time of test

Number of results for averaging

Table with recorded results versus time



Averaged error result

Standard deviation

Partial error results

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

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

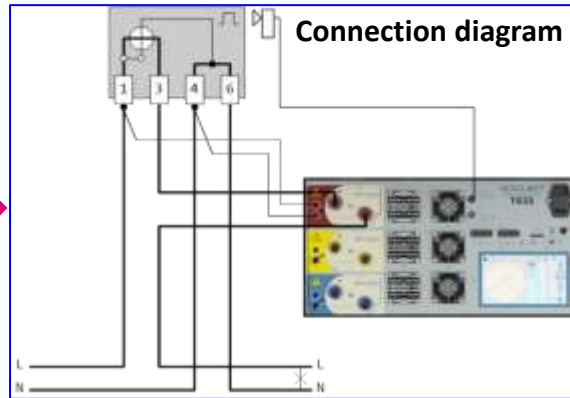
TS33 as Reference Meter and meter under test directly connected



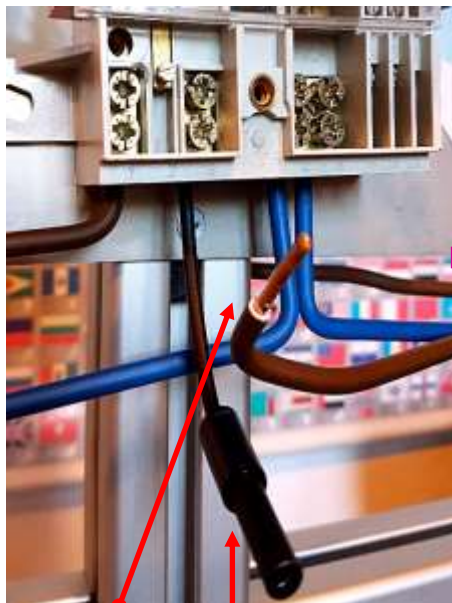
Meter parameters:

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

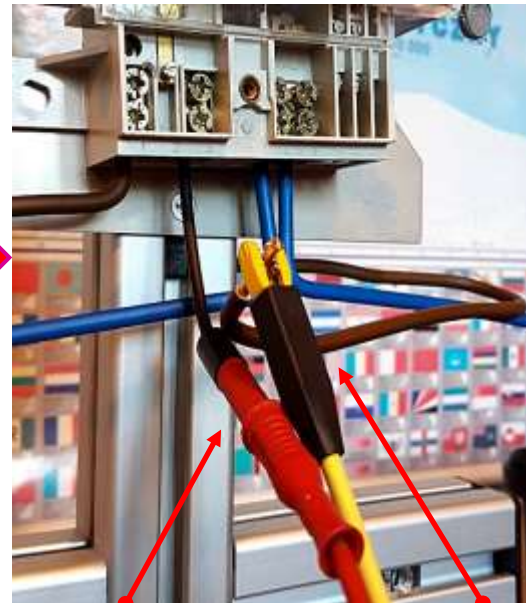
Typical single phase electronic meter with LED and its parameters



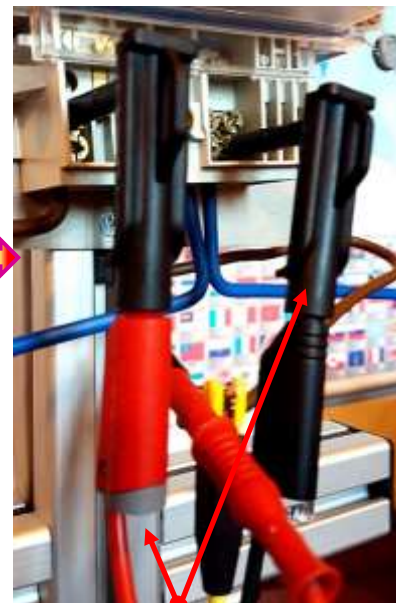
Wiring to meter terminals



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



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



Connect voltage by safety magnetic plugs



Connect voltage and current to TS33 inputs

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

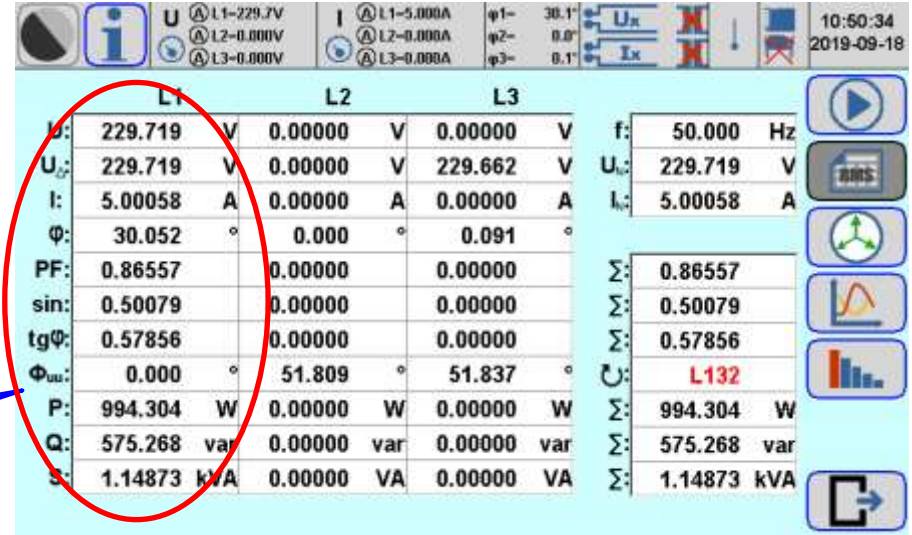
TS33 as Reference Meter and meter under test directly connected



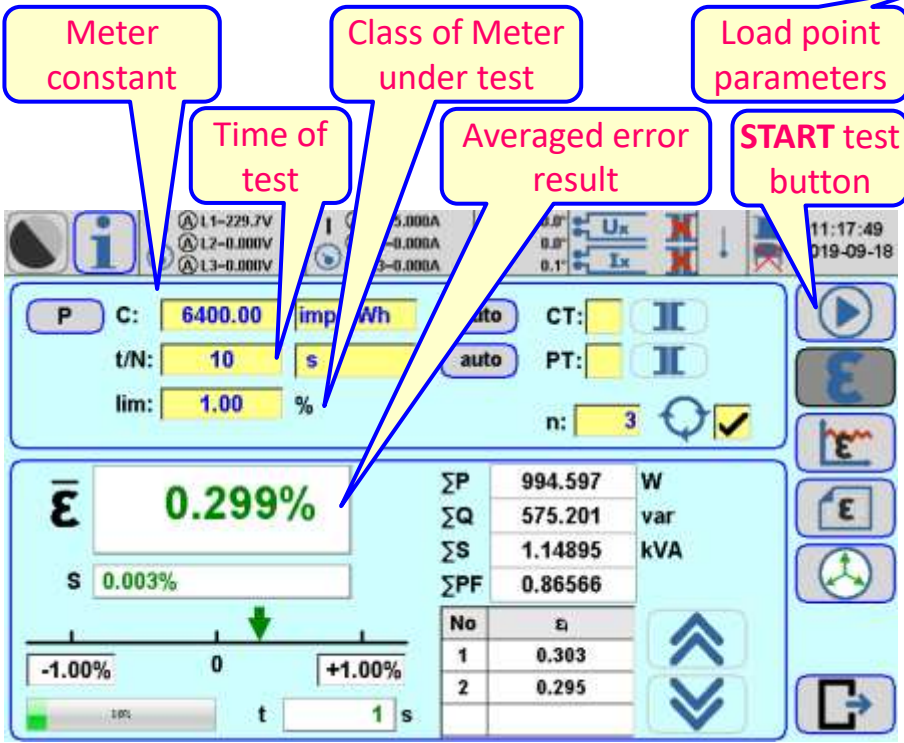
Assembly scanning head fix to see LED in hole



„Click” scanning head and set LED sensing option



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



Meter constant: 6400.00 imp/Wh

Class of Meter under test: CT: I, PT: I, n: 3

Time of test: t/N: 10 s

Averaged error result: 0.299%

START test button: [Play]

Other parameters: lim: 1.00%, S: 0.003%

No	ε _i
1	0.303
2	0.295

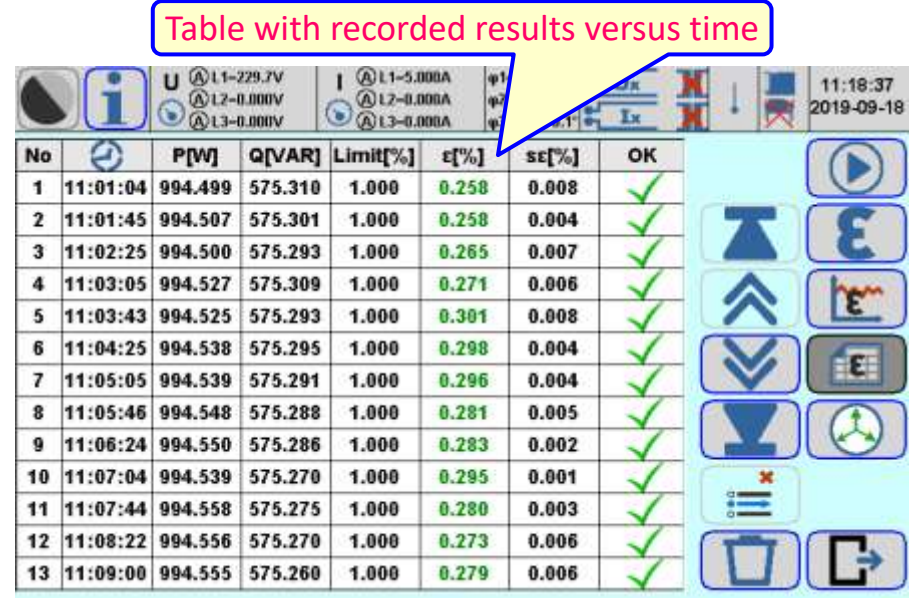


Table with recorded results versus time

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

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

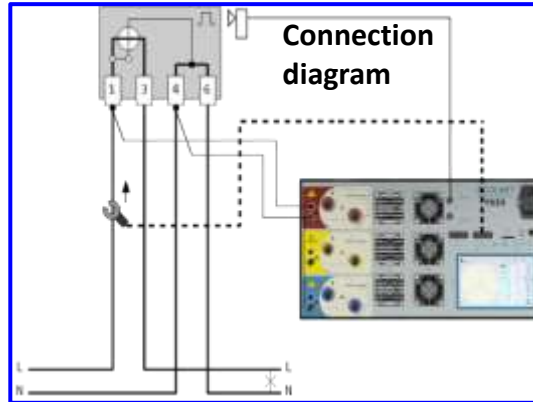
TS33 as Reference Meter and meter under test connected by current clamps CT100AC



Meter parameters:

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

Typical single phase electronic meter with LED and its parameters



Wiring to meter terminals



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



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



Connect voltage magnetic plugs and assembly the scanning head

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

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



Connect voltage cables to TS33

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

Current clamps connected

Load point parameters

START test button

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

Meter constant

Class of Meter under test

Time of test

Averaged error result

Table with recorded results versus time

P C: 6400.00 imp/kWh
 t/N: 10 s
 lim: 1.00 %
 auto CT: II
 auto PT: II
 n: 3

ε 0.350%
 S 0.004%

ΣP 994.193 W
 ΣQ 574.663 var
 ΣS 1.14833 kVA
 ΣPF 0.86577

No	ε
1	0.345
2	0.355

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

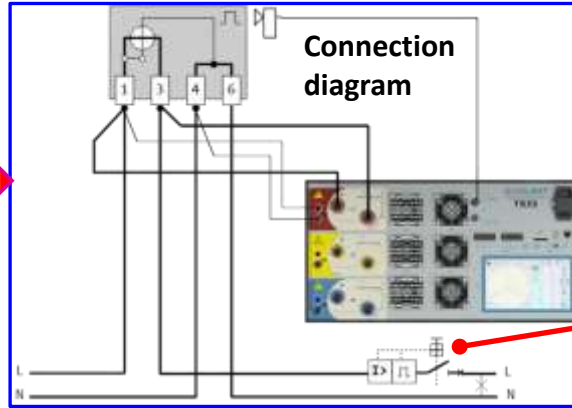
TS33 : testing single phase electronic (static) Energy Meter example (1)

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



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

Typical single phase electronic meter with LED and its parameters



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



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



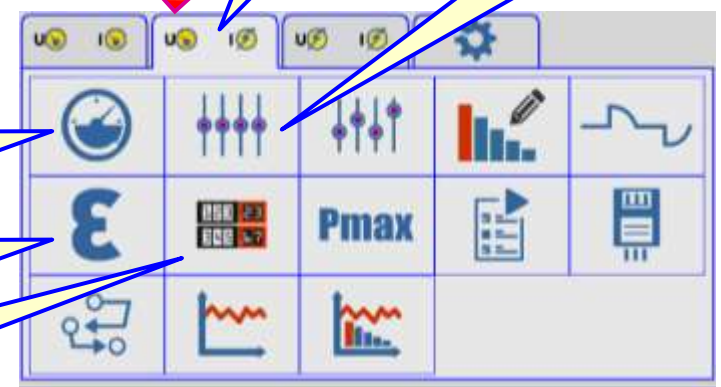
In the TS33 LCD select U measurement and I generation mode

Setting value of current and phase shift

RMS measured values

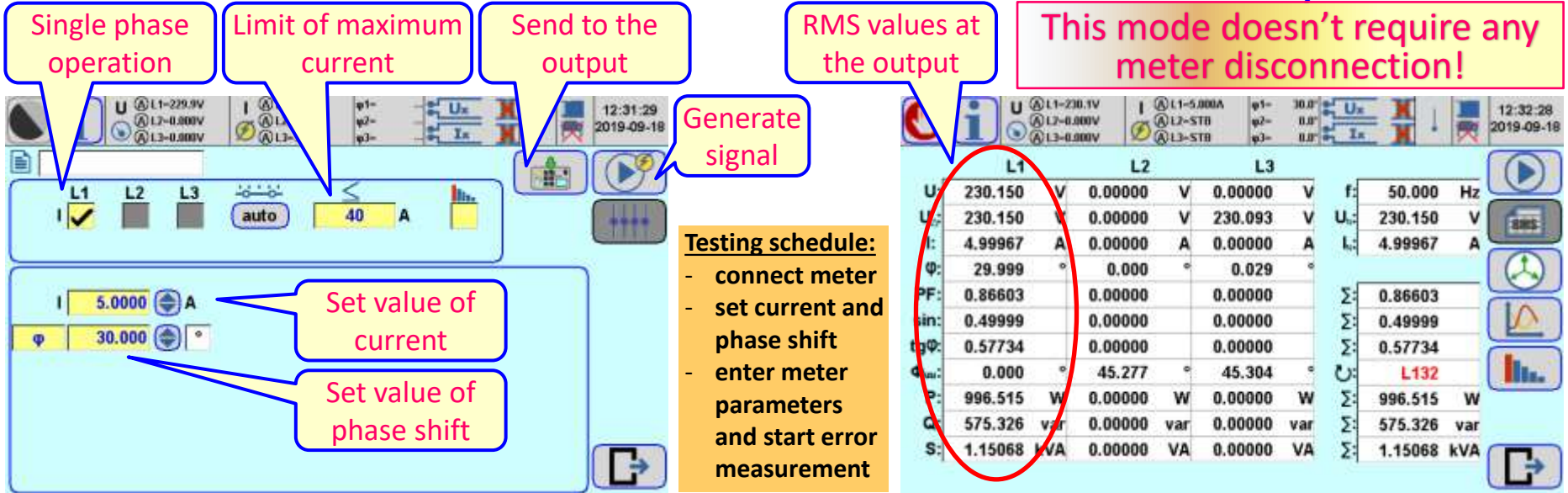
Meter error test

Meter register test



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

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



Single phase operation

Limit of maximum current

Send to the output

RMS values at the output

This mode doesn't require any meter disconnection!

Generate signal

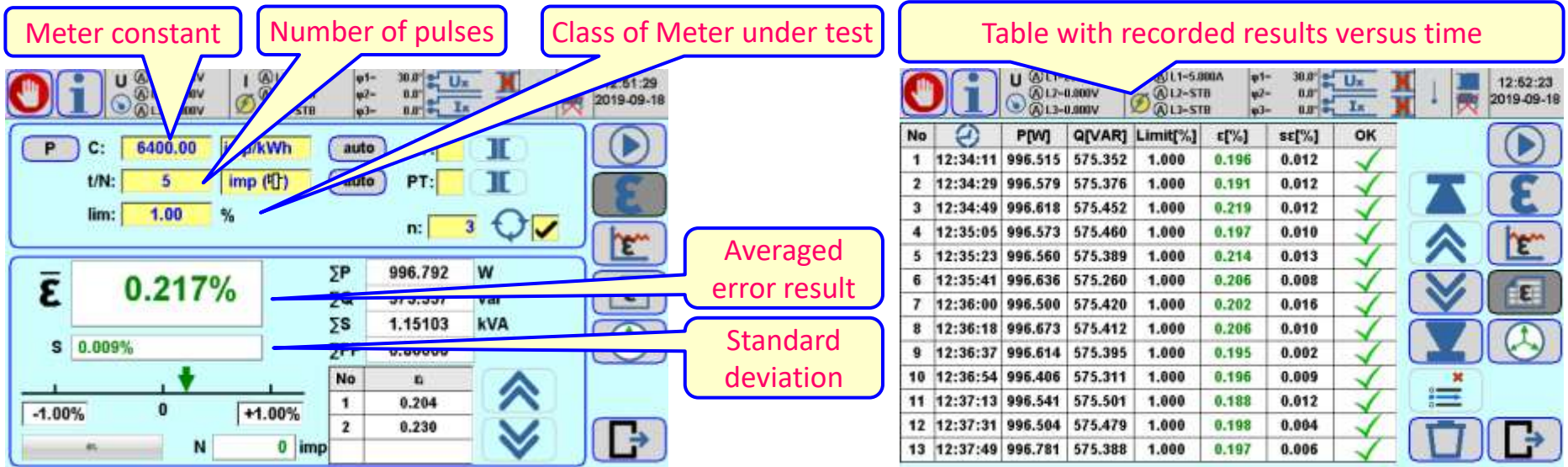
Testing schedule:

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

Set value of current

Set value of phase shift

	L1	L2	L3	
U ₁	230.150 V	0.00000 V	0.00000 V	f: 50.000 Hz
U ₂	230.150 V	0.00000 V	230.093 V	U ₃ : 230.150 V
I ₁	4.99967 A	0.00000 A	0.00000 A	I ₂ : 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
tgφ:	0.57734	0.00000	0.00000	Σ: 0.57734
Q _{act} :	0.000 °	45.277 °	45.304 °	Σ: L132
P:	996.515 W	0.00000 W	0.00000 W	Σ: 996.515 W
Q:	575.326 var	0.00000 var	0.00000 var	Σ: 575.326 var
S:	1.15068 kVA	0.00000 VA	0.00000 VA	Σ: 1.15068 kVA



Meter constant

Number of pulses

Class of Meter under test

Averaged error result

Standard deviation

Table with recorded results versus time

No		P[W]	Q[VAR]	Limit[%]	ε[%]	σε[%]	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 three phase electronic (static) Energy Meter example (1)

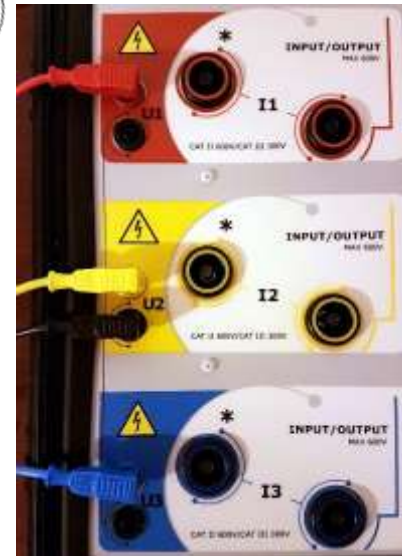
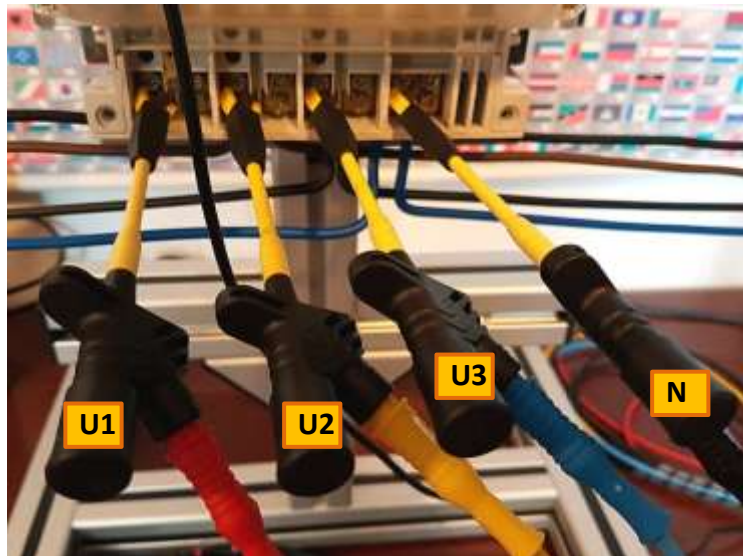
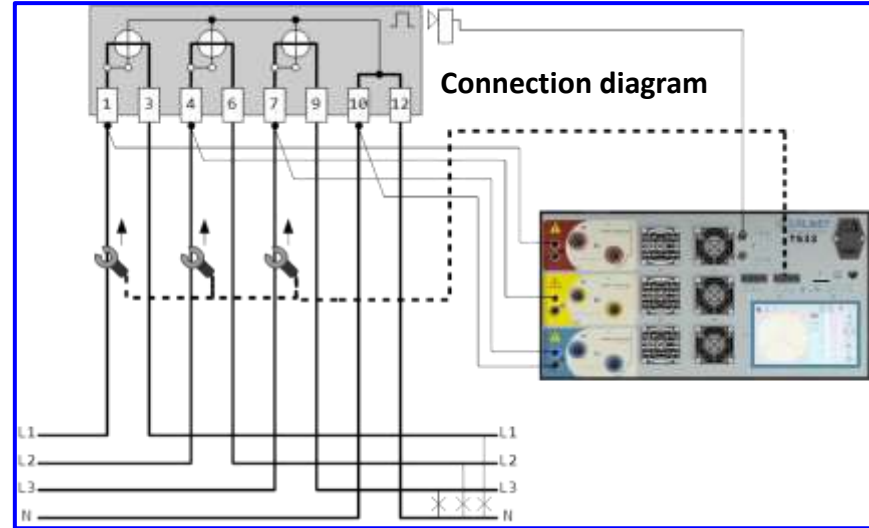
TS33 as Reference Meter and meter under test connected by means of current clamps



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

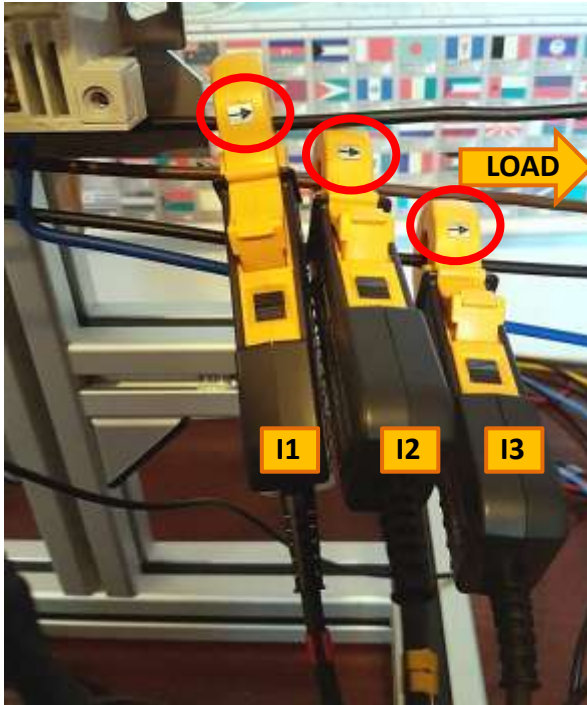
Connect voltage U1, U2, U3 and neutral N by means of crocodile clips



Connect voltage U1, U2, U2 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 (⇒)!



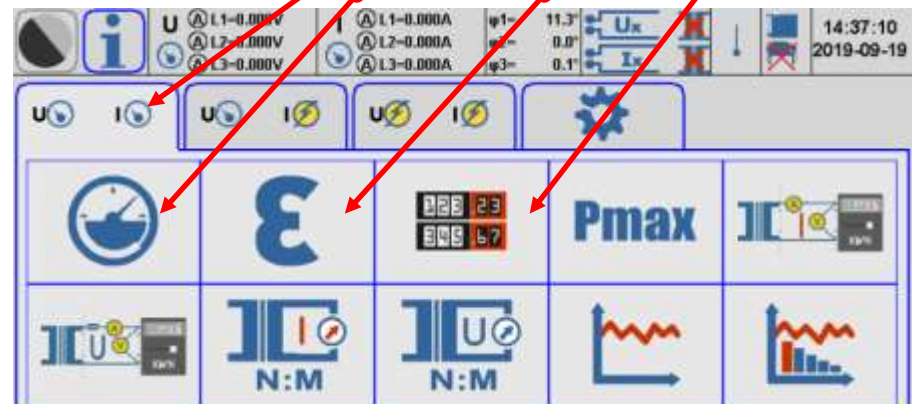
Close clamp jaws and lock them. Direction (⇒)!



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 ₁	229.658 V	239.747 V	219.654 V
U ₂	406.523 V	397.916 V	389.304 V
I ₁	4.99845 A	4.00007 A	5.99794 A
Φ	14.993 °	19.999 °	24.983 °
PF	0.96596	0.93970	0.90643
sin	0.25870	0.34200	0.42235
tgΦ	0.26781	0.36395	0.46595
Q _{act}	0.000	119.994	-120.038
P	1.10885 kW	901.173 W	1.19420 kW
Q	296.967 var	327.984 var	556.436 var
S	1.14793 kVA	959.005 VA	1.31747 kVA

Vector diagram

Testing schedule:

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

No	Time	P[W]	Q[VAR]	Limit[%]	e[%]	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

C: 1000.00 p/kWh

t/N: 5 s

lim: 2.00 %

0.062%

0.062

Table with recorded results versus time

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

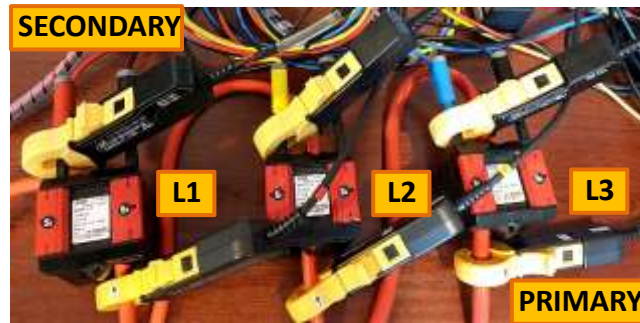
TS33 as Reference Meter and CT primary and secondary current measured by current clamps



CT parameters:

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

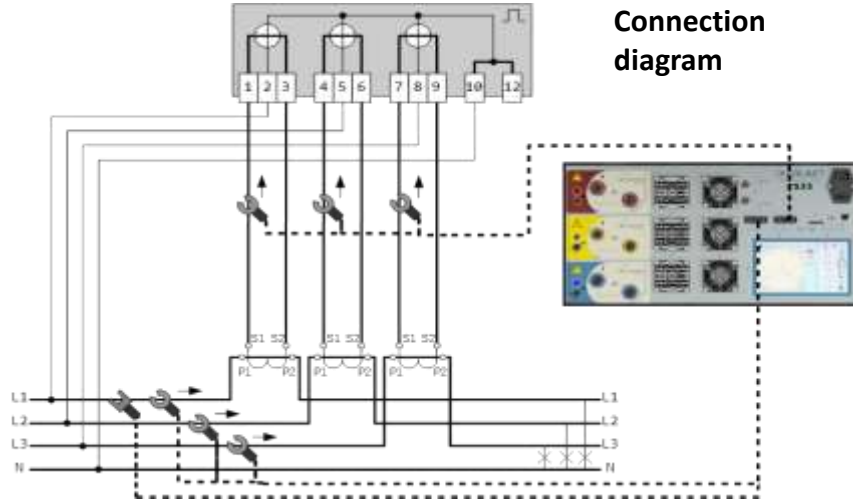
Typical current transformer CT in metering installation



TS33 side clamps connection



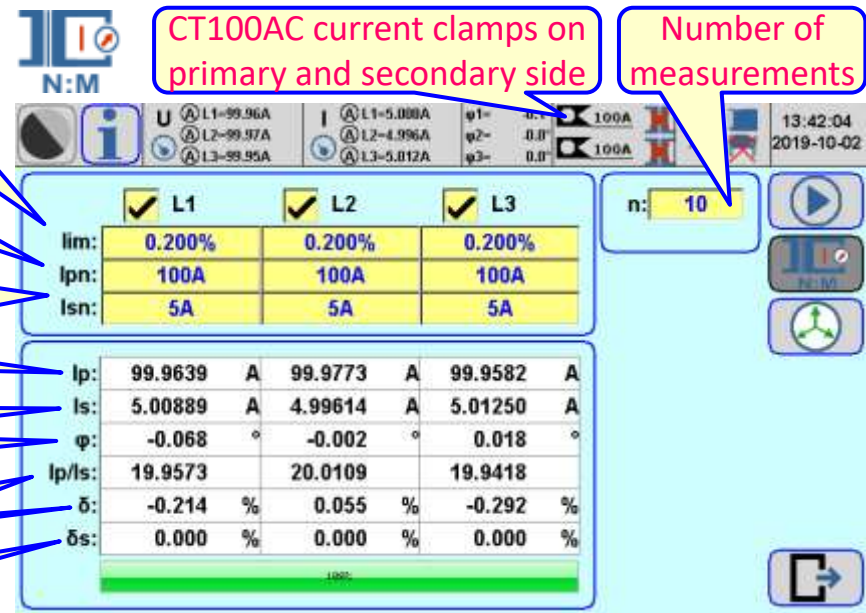
Primary clamps
Secondary clamps



Connection diagram

TS33 can test automatically up to 3 different CTs at time

- Accuracy class of current transformer
- Nominal primary current
- Nominal secondary current
- Primary current
- Secondary current
- Phase error
- Actual ratio
- Ratio error
- Standard deviation



CT100AC current clamps on primary and secondary side

Number of measurements: 10

	L1	L2	L3
lim:	0.200%	0.200%	0.200%
l _{pn} :	100A	100A	100A
l _{sn} :	5A	5A	5A
l _p :	99.9639 A	99.9773 A	99.9582 A
l _s :	5.00889 A	4.99614 A	5.01250 A
φ:	-0.068 °	-0.002 °	0.018 °
l _p /l _s :	19.9573	20.0109	19.9418
δ:	-0.214 %	0.055 %	-0.292 %
δ _s :	0.000 %	0.000 %	0.000 %

TS33: testing current transformers CT burden example (1)

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



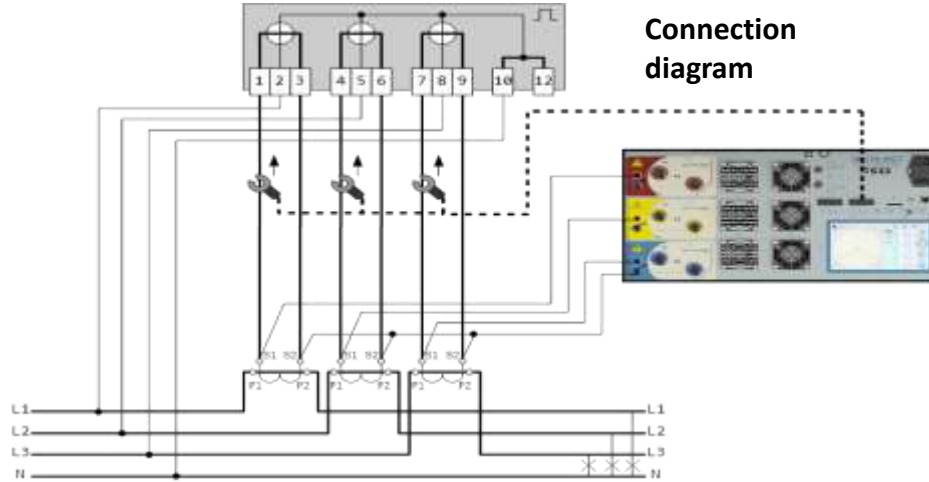
CT parameters:
Ratio: 100/5A
Power: 2.5VA
Class: 0.2

Typical current transformer CT in metering installation



TS33 side voltage connection

Voltage and clamps connection to the CT



Connection diagram

TS33 can test automatically up to 3 different CTs at time

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

	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

n: 3
 L: 4.000 m
 2.5 mm²

Length and cross section of CT connection cables

TS33: how to order – versions, options, accessories

TS33 versions: accuracy class 0.02%, 0.04% or accuracy class 0.1%

Standard scope of delivery



TS33 Automatic Test System



Power cord



Fuses



C091 Amphenol connector

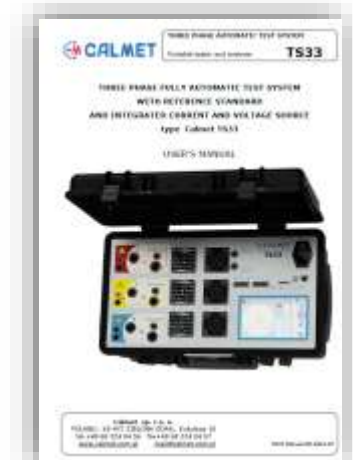


EA36

Voltage and 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



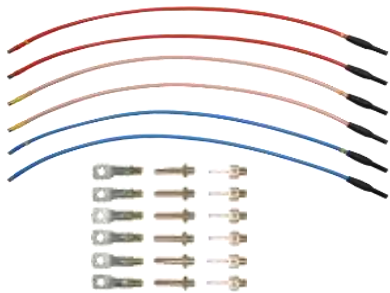
FCT3000AC.B flexible clamps



AmpLiteWire 2000AC
(@150kV)



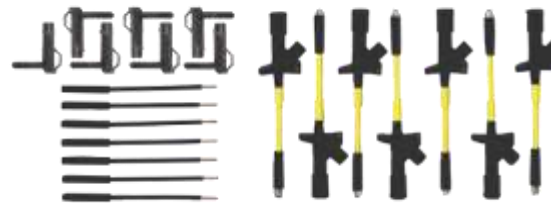
VoltLiteWire 40kVC



EA30 120A cable set



DR200D thermal printer



EA20 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



ET31 case for additional accessories

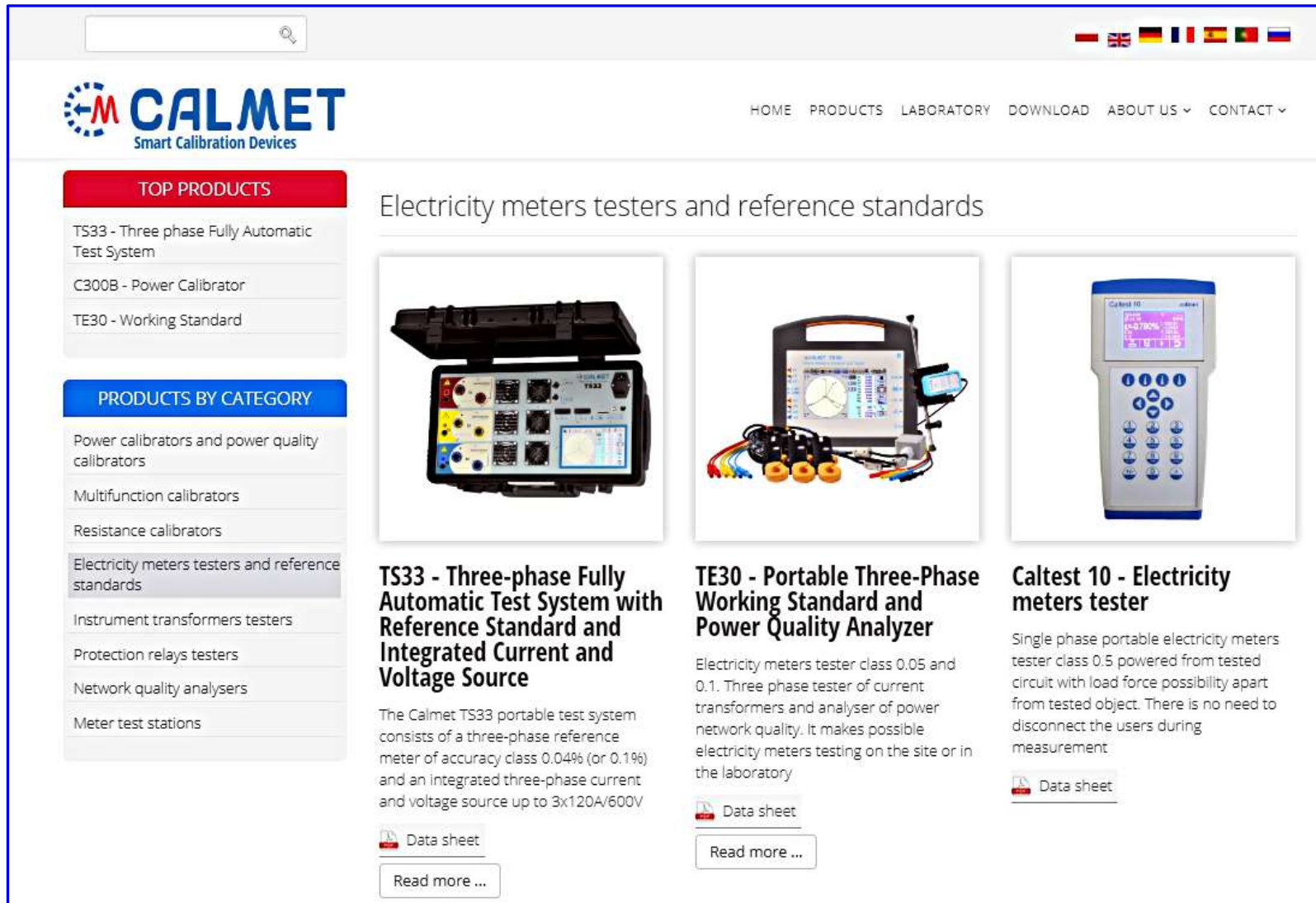


Calibration Certificate from ISO17025 accredited lab



Certificate of Origin from Customs and Chamber of Commerce

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



The screenshot shows the CALMET website interface. At the top, there is a search bar and a navigation menu with links for HOME, PRODUCTS, LABORATORY, DOWNLOAD, ABOUT US, and CONTACT. The main content area is titled "Electricity meters testers and reference standards" and features three product cards. The left sidebar contains a "TOP PRODUCTS" section with links to TS33, C300B, and TE30, and a "PRODUCTS BY CATEGORY" section with various calibration and testing categories. Each product card includes an image, a title, a 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