TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One
Testing the entire energy measurement system!

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

Electromechanical (Ferraris)

Electronic (static)

4 – Quadrants Smart Meters

Max. demand

CT/PT burden, ratio, phase shift error

Wiring errors

TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One
TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One

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:

- Voltage U1, U2, U3, Un sockets
- Current I1, I2, I3 sockets
- Photo Scanning Head Impulse Inputs / Outputs
- Current Clip – on CT socket
- High Voltage sensors or Current Clamps socket
- Power cord socket
- Protective Fuse
- Power ON / OFF switch
- Ethernet socket
- USB socket
- SD Memory Card socket
- 7” Colour LCD touch screen
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
- Easy connection due to rich set of accessories for safety cables

4mm **Current Safety Cables**
- Length=2m, I ≤ 30A
- 25mm² **High Current Cables**
- Length=1m, I ≤ 120A
TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One

**TS33 Pulse Input / Output:**

1. **Electronic energy meter**
   - red, green or infrared LED blinking or LCD segment flashing
   - photo head with photo sensor
   - 0.0001Hz…200kHz

2. **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**

Can test all kinds of Electricity Meters

1. **Pulse Input / Output socket**

2. **Pulse Input for external Reference Meter socket**

**Open collector pulse output + external Rc**

- $U_{cc} \leq 27V$
- $I_{cc} \leq 100mA$

- 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 ∅ cable 15mm

30mA…1200A, length=2m, max ∅ cable 52mm

300mA…1200A, length=2m, max ∅ cable 85mm, loop length 300mm

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

3mA…12A, max ∅ cable 20mm, length=2m

30A…2000A@150kV, length=12m, max ∅ cable 98mm

Voltage sensor 1kV…40kV, length=12m
TS33 Communication; many ways of printer, PC connection and data storage

- Bluetooth, wireless printer & laptop
- Screenshots
- Results
- Removable SD cards 2..32GB
- Ethernet
- USB
- Remote control
- CalproTS33 PC Soft
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

- Single phase meter testing 1P2W – TS33 as source
- Three phase meter testing 3P4W – TS33 as source
- Single phase meter testing 1P2W – TS33 as source of current
- Three phase meter testing 3P3W – TS33 as source
Functionality of TS33: as reference meter, as source of U&I, as U meter & I source

- Reference meter mode
- Reference meter with current injection mode
- Voltage and current source with built in reference meter mode
- TS33 General Settings
  - Setting harmonics in output signal
  - Setting special shapes of the output signal
  - Meter under test parameters settings for automatic testing
  - Automatic test execution

Status line
RMS values at TS33 terminals
Setting U, I, \( \varphi \), F ... in symmetric output
Setting U, I, \( \varphi \), F ... in asymmetric output
Meter error testing
Register (counter) testing
Maximum demand meter testing
Load points setting for procedures in automatic testing
All quantities trend (versus time) observation

Easy, icon driven, operation on big 7” touch screen
TS33 reference meter mode: whole installation measurement „as it is”

- RMS values of $U, I, \varphi, F, P, Q, S$
- 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
- $U, I, \varphi, F, P, Q, S$ trend test
TS33 functionality: RMS values of U, I, ϕ, F, P, Q, S measurement results

- 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 Vector Diagram
3-Phase Oscilloscope
3-Phase Powers
3-Phase Factors
3-Phase Vector Rotation
Harmonics in Table Form
Harmonics Bars
TS33 functionality: energy meter error testing idea

Principle of electricity meter testing

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

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:

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

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

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

\[ E_{\text{Measured}} = \frac{500}{375} \text{kWh} = 1.333\text{kWh} \]
TS33 functionality: automatic energy meter error testing in [%]

- **Type of Power/ Energy selection**
- **Fundamental only!**
- **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**

### Key Features:

- **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
- 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

<table>
<thead>
<tr>
<th>E1:</th>
<th>0.0000000kWh</th>
<th>0.0000000kvarh</th>
<th>0.0000000kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2:</td>
<td>1.019123kWh</td>
<td>0.588698kvarh</td>
<td>1.019680kWh</td>
</tr>
<tr>
<td>ΔE:</td>
<td>1.019123kWh</td>
<td>0.588698kvarh</td>
<td>1.019680kWh</td>
</tr>
<tr>
<td>Eref:</td>
<td>1.019277kWh</td>
<td>0.588480kvarh</td>
<td>1.018611kWh</td>
</tr>
<tr>
<td>ε:</td>
<td>-0.015%</td>
<td>0.037%</td>
<td>0.105%</td>
</tr>
<tr>
<td>ε:</td>
<td>1.000%</td>
<td>1.000%</td>
<td>1.000%</td>
</tr>
</tbody>
</table>

- Value of active energy with all harmonics
- Value of first harmonic only in active energy

Test START / STOP
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.

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

\[
\delta I = \frac{N_P \cdot I_S - I_P}{I_P} \cdot 100\%
\]

Expected value of ratio error is \( \delta I = 0\% \) and phase shift error \( \phi = 0^\circ \).
TS33 functionality: CT/PT ratio test; vector diagram with primary and secondary side

- CT limit of error (accuracy class)
- Nominal primary current
- Nominal secondary current
- Primary current flow
- Secondary current flow
- Phase shift primary / secondary current
- Calculated ratio
- Ratio error in [%]
- Standard deviation of ratio error measurement
- Vector diagram of primary and secondary side allows for easy connection testing

- testing CT / PT ratio and phase shift error simultaneously in three phases,
- ratio error measured directly in [%],
- vector diagram allows easy check of proper installation connections and error removing
TS33 functionality: CT/PT burden test idea

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

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**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Current</th>
<th>Voltage</th>
<th>Power Factor</th>
<th>Power Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>4.0029</td>
<td>30V</td>
<td>0.126</td>
<td>1.0000</td>
</tr>
<tr>
<td>L2</td>
<td>4.0024</td>
<td>30V</td>
<td>0.025</td>
<td>1.0000</td>
</tr>
<tr>
<td>L3</td>
<td>4.0029</td>
<td>30V</td>
<td>0.011</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

- 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

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.638%</td>
<td>76.693%</td>
<td>102.988%</td>
</tr>
<tr>
<td>28.4199 VA</td>
<td>28.3993 VA</td>
<td>30.8976 VA</td>
</tr>
</tbody>
</table>
### 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**

**Toggling ON / OFF of individual U & I channels**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Voltage Setting</th>
<th>Current Setting</th>
<th>Phase Shift Setting</th>
<th>Frequency Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>230.00 V</td>
<td>5.0000 A</td>
<td>0.0000 °</td>
<td>50.0000 Hz</td>
</tr>
<tr>
<td>L2</td>
<td>240.00 V</td>
<td>5.0000 A</td>
<td>0.0000 °</td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td>220.00 V</td>
<td>5.0000 A</td>
<td>0.0000 °</td>
<td></td>
</tr>
</tbody>
</table>

- **Frequency synchronized with power frequency**
- **Individual setting in each phase value of voltage, current, power factor, and phase shift between voltages**
- **Independent switching ON / OFF of each current and voltage in phase L1, L2, L3**
- **Automatic or manual range selection**
- **Protection against overvoltage or overcurrent**
- **Pure sinusoidal or harmonic distorted signal generation**
TS33 functionality: Voltage and current source – harmonic generation

<table>
<thead>
<tr>
<th>No</th>
<th>N</th>
<th>U (%)</th>
<th>Φ (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
<td>10.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>5</td>
<td>5.0</td>
<td>180.0</td>
<td>0.0</td>
</tr>
<tr>
<td>7</td>
<td>15.0</td>
<td>90.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Phase shift with reference to fundamental**

**Amplitude in % of fundamental**

**Number of harmonic**

**Setting number of harmonic, its amplitude and phase shift**

**Signal parameters:**

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

**Real signal measured at TS33 output**
TS33 functionality: Automatic energy meter test in whole range of loads idea

**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

Data base

<table>
<thead>
<tr>
<th>No</th>
<th>T1 [s]</th>
<th>P[V]</th>
<th>Q[VAR]</th>
<th>% [%]</th>
<th>e [%]</th>
<th>e [%]</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11:43:27</td>
<td>172.562</td>
<td>-0.008551</td>
<td>1.000</td>
<td>0.660</td>
<td>0.022</td>
<td>✔</td>
</tr>
<tr>
<td>2</td>
<td>11:44:50</td>
<td>344.987</td>
<td>-0.013448</td>
<td>1.000</td>
<td>0.638</td>
<td>0.010</td>
<td>✔</td>
</tr>
<tr>
<td>3</td>
<td>11:45:35</td>
<td>689.912</td>
<td>-0.049329</td>
<td>1.000</td>
<td>0.565</td>
<td>0.167</td>
<td>✔</td>
</tr>
<tr>
<td>4</td>
<td>11:46:57</td>
<td>1725.03</td>
<td>-1.80918</td>
<td>1.000</td>
<td>0.828</td>
<td>0.003</td>
<td>✔</td>
</tr>
<tr>
<td>5</td>
<td>11:48:16</td>
<td>2760.15</td>
<td>-0.290766</td>
<td>1.000</td>
<td>0.610</td>
<td>0.006</td>
<td>✔</td>
</tr>
<tr>
<td>6</td>
<td>11:49:37</td>
<td>3450.06</td>
<td>-0.479534</td>
<td>1.000</td>
<td>0.600</td>
<td>0.004</td>
<td>✔</td>
</tr>
<tr>
<td>7</td>
<td>11:50:56</td>
<td>4139.97</td>
<td>-0.758822</td>
<td>1.000</td>
<td>0.589</td>
<td>0.001</td>
<td>✔</td>
</tr>
</tbody>
</table>
TS33 functionality: Automatic energy meter test – Meter Type

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)

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

Table with load points

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

<table>
<thead>
<tr>
<th>No</th>
<th>Meter Type</th>
<th>List of load points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U: 500V 50Hz</td>
<td>[Marked load point values]</td>
</tr>
<tr>
<td>2</td>
<td>U: 230V 50Hz</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>U: 110V 50Hz</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>U: 57V 50Hz</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I: 120A 50Hz</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I: 12A 50Hz</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I: 1A 50Hz</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I: 0.12A 50Hz</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I: 0.02A 50Hz</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>F: 230V 50Hz</td>
<td></td>
</tr>
</tbody>
</table>

### 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

- 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, \( \varphi \), F, P, Q, S
- Voltage, current and THD trend
- Meter error versus I load \( \varepsilon = f(I) \)

TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One

Voltage U1, U2, U3 oscilloscope

Harmonics in voltage U1

Harmonics in table form
TS33 PC Soft functionality: remote control of TS33 source

- Operation with auto range or constant range
- Setting maximum value of Voltage or Current
- Switching harmonics ON / OFF
- Switching ON / OFF of individual U & I channels
- Voltage in phase L1 L2 L3
- Voltage between phases
- Current in phase L1 L2 L3
- Phase shift U&I
- Phase shift between Voltages
- Frequency setting
- Frequency synchronised with power frequency

- 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)

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

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

TS33 as Reference Meter and meter under test directly connected

- Disconnect phase wire connected to load
- Connect instead „Cu” pin for safety cables
- Connect „Neutral” meter terminal to neutral safety cable by means of magnetic plug
- Magnetic plugs for safety cables

Connection diagram

Wiring to meter terminals

**Example:**

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

**Example:**

- “Cu” pin for safety cables
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

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

TS33 enables fast and efficient way of testing

Load point parameters
Meter constant
Class of Meter under test

Vector diagram

Type of power measured by meter
Time of test
Number of results for averaging

Averaged error result
Standard deviation
Partial error results

Table with recorded results versus time

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

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

**Connection diagram**

**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

Meter constant
Class of Meter under test
Load point parameters
Time of test
Averaged error result
START test button

Table with recorded results versus time

<table>
<thead>
<tr>
<th>No</th>
<th>P [W]</th>
<th>Q [VAR]</th>
<th>Limit [%]</th>
<th>ε [%]</th>
<th>σ [%]</th>
<th>ok</th>
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</table>
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

Connection diagram

- Connect voltage magnetic plugs and assembly the scanning head

Wiring to meter terminals

Connection diagram

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

Current clamp closed on phase to load cable. Note direction ⇆!
TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One

**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**
- **Table with recorded results versus time**

**Current clamps do not require any break or modification of metering installation**
TS33: testing single phase electronic (static) Energy Meter example (1)

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

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

**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**

Connect current input and output of the meter (e.g., 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 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One**

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

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
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<tbody>
<tr>
<td>Single phase operation</td>
<td>Limit of maximum current</td>
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<tr>
<td>Send to the output</td>
<td>RMS values at the output</td>
</tr>
<tr>
<td>This mode doesn’t require any</td>
<td>Steady state operation</td>
</tr>
<tr>
<td>meter disconnection!</td>
<td></td>
</tr>
</tbody>
</table>

**Testing schedule:**
- Connect meter
- Set current and phase shift
- Enter meter parameters and start error measurement

**This mode doesn’t require any meter disconnection!**

**Table with recorded results versus time**

<table>
<thead>
<tr>
<th>No</th>
<th>Date</th>
<th>P [W]</th>
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<th>[%]</th>
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**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**

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

**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**

**Connection diagram**
- 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 (*).

**In the TS33 LCD select U and I generation mode**

- Setting value of voltage, current and phase shift
- Setting value of U, I, \( \varphi \), f in asymmetrical circuit
- RMS measured values
- Meter error test
- Meter register test
TS33 as Voltage and Current Source and Reference Meter and meter under test connected directly

Single phase operation
Set value of Voltage
Limit of maximum current
Set value of Current
Send to the output
Set value of phase shift
RMS values at the output
Vector rotation
Generate signal

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

This mode doesn’t require any meter disconnection!

Table with recorded results versus time

Averaged error result
Standard deviation

Example (2)
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

**Connection diagram**
- Connect voltage U1, U2, U3 and neutral N by means of crocodile clips.
- Connect voltage U1, U2, U3 and neutral N to voltage inputs of TS33. Neutral inputs in the TS33 are internally connected between them.
**TS33 : testing three phase electronic (static) Energy Meter example (2)**

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

- Close current clamps on load cables, respectively I1, I2, I3. Take care about clamps direction (➡️)
- Assembly to the meter and connect to the TS33 photo scanning head
- Open clamp jaws and place them on wire. Direction (➡️)!
- Close clamp jaws and lock them. Direction (➡️)!

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

- Connect common current clamps output to the TS33 input
TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One

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!

Vector diagram

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

Table with recorded results versus time

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</table>

Averaged error result

Standard deviation

Meter constant
Time of test
Class of Meter under test
**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**

**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.

**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](image)

![Connection diagram](image)
In the TS33 LCD select U&I generation mode and then RMS values at the output, setting symmetric U&I, setting asymmetric U&I, error test, register test or whole characteristics test procedure.
TS33 : testing three phase electronic (static) Energy Meter example (3)

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

This mode requires meter disconnection!

Load point parameters

Meter constant

Time of test

Class of Meter under test

Averaged error result

Standard deviation

Vector diagram

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

Table with recorded results versus time
**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**

<table>
<thead>
<tr>
<th>Meter name</th>
<th>Connection type</th>
<th>Power type</th>
<th>Comment</th>
<th>Base voltage</th>
<th>Max. voltage</th>
<th>Max. current</th>
<th>Base current</th>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test Point and Procedure Definition**

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

**List of load points**

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

**Meter error test**

- **Voltage in [%]**
- **Current in [%]**
- **Phase shift U&I**
- **Vector rotation**

**Frequency**

**Harmonics**

**Phase shift U&U**

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

**List of load points**

- **Meter or Procedure name field**
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

Table with results for each load point

Results transferred to the PC Soft as diagram
**TS33 : testing current transformers CT ratio and phase shift error example (1)**

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

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

Typical current transformer CT in metering installation

**TS33 side clamps connection**

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

TS33 can test automatically up to 3 different CTs at time.

**CT100AC current clamps on primary and secondary side**

L1 L2 L3

Nominal primary current

Nominal secondary current

Primary current

Secondary current

Phase error

Actual ratio

Ratio error

Standard deviation

Number of measurements

<table>
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<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
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<td>100A</td>
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<td>5A</td>
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<th>ls</th>
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<td>5.00889 A</td>
<td>-0.068 °</td>
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<td>99.9773 A</td>
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<td>99.9582 A</td>
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</table>

δ:
- 0.214 %
- 0.055 %
- 0.292 %

δs:
- 0.000 %
- 0.000 %
- 0.000 %
**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**

**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**

**Length and cross section of CT connection cables**

**TS33 can test automatically up to 3 different CTs at time**

**Connection diagram**
TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One

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:

- 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:

- 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
TS33 Automatic Test System for Electricity Meters Testing on Site and Lab: All-in-One

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

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.

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.

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.

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