Testing energy cost meters using the TS33 automatic testing system

Application note No46

In view of the growing demands for measurement precision, the need to verify large volumes and optimise control processes, the **TS33 Automatic Testing System from Calmet Sp. z o.o.** sets a new standard in the field of energy cost meter testing. This application note aims to present in detail how this innovative system **guarantees reliable and repeatable verification** — regardless of the type and sophistication of the meter being tested — enabling effective response to the challenges of modern energy distribution and trading.

Calmet TS33: Redefining Precision in the Field and Laboratory

The TS33 Automatic Test System is a portable, three-phase device that redefines the approach to energy meter verification and measurement system analysis. It is a comprehensive combination of a precision reference meter integrated with a current and voltage source, offering a versatile tool for both on-site and laboratory work.

Key Technical and Functional Features:

- **Unrivalled Accuracy:** The TS33 operates as a reference meter in the 0.02%, 0.04% or 0.1% accuracy class, guaranteeing minimal measurement error, which is critical for accurate energy billing.
- **Built-in Power Source:** Thanks to its integrated current and voltage source (3×120A/600V), the TS33 enables easy and precise setting of load conditions (so-called 'meter removal from the network'), which is necessary for full, automatic verification.
- **Full Test Automation:** The system allows for automatic operation with predefined load points, eliminating the need for continuous use of an external PC. It is possible to automatically test meters in accordance with standards (e.g. EN 50470, IEC 62052) and measure meter error, counter error and maximum power error.
- **Comprehensive Installation Diagnostics:** TS33 is not just a meter tester. The device allows for comprehensive analysis of measurement installations and local network operating conditions. It enables verification of connection correctness, measurement of power quality parameters, and visualisation of results in the form of vector, oscilloscope, and harmonic graphs.
- **Data Management and Reporting:** All results are stored on an SD memory card with a capacity of up to 32 GB. With **TS33 PC Soft software**, you can easily manage data, create print reports, and export measurement results directly to MS Excel.

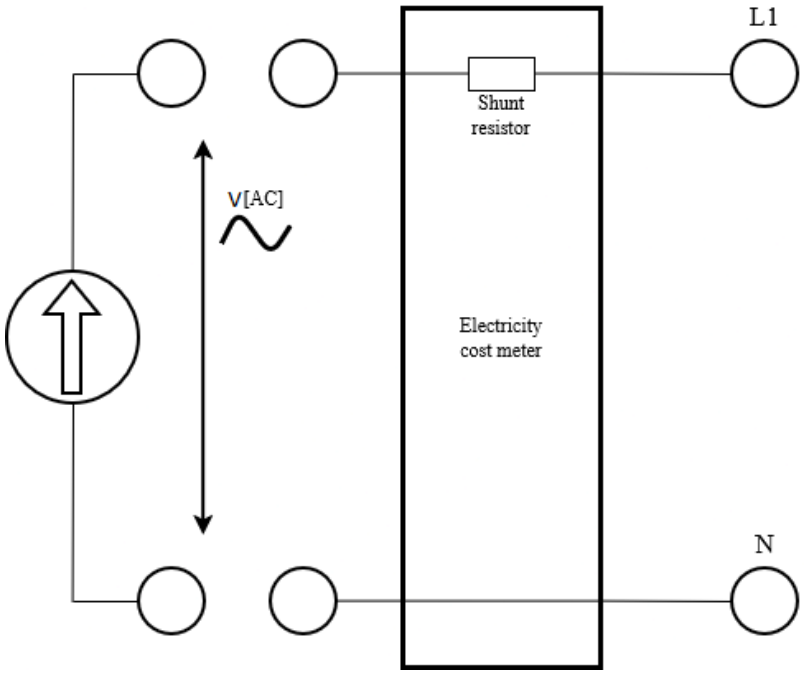
TS33 is an investment in precision, mobility and automation, reducing testing time and increasing measurement reliability at every stage of meter operation.

Most electricity meters currently in use, regardless of their class (from basic to advanced), are based on two key measurement elements: voltage measurement and current measurement.

While voltage measurement is achieved by direct connection to the circuit, current measurement remains a key challenge. In the vast majority of modern meters, current is measured using a **shunt resistor**.

Shunt Location and Impact on Testing:

- **Standard Location (Phase):** Most often, the shunt is located on the L1 phase current track. Its task is to generate a small voltage drop proportional to the current, which is then converted by the meter's analogue-to-digital converters to calculate power and energy.
- **Neutral variant:** In simpler or cheaper designs, the shunt can alternatively be placed on the neutral (N) current path. Although theoretically these currents should be identical (in an ideal symmetrical system), this solution is sometimes used to simplify the design and reduce costs.



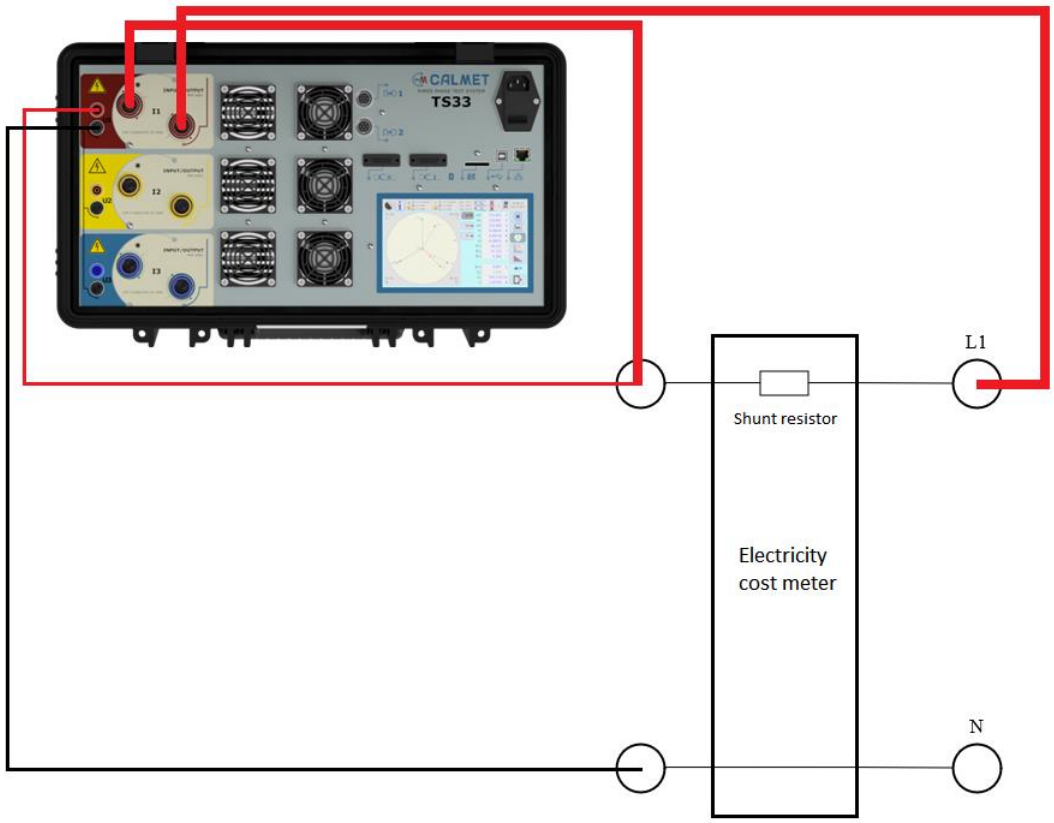
Verification Challenges:

Regardless of its location – whether on the phase or neutral wire – the shunt is a passive component and crucial for accuracy. Even a slight change in its resistance (caused, for example, by temperature or poor workmanship) or an error in the signal processing itself leads to an incorrect result.

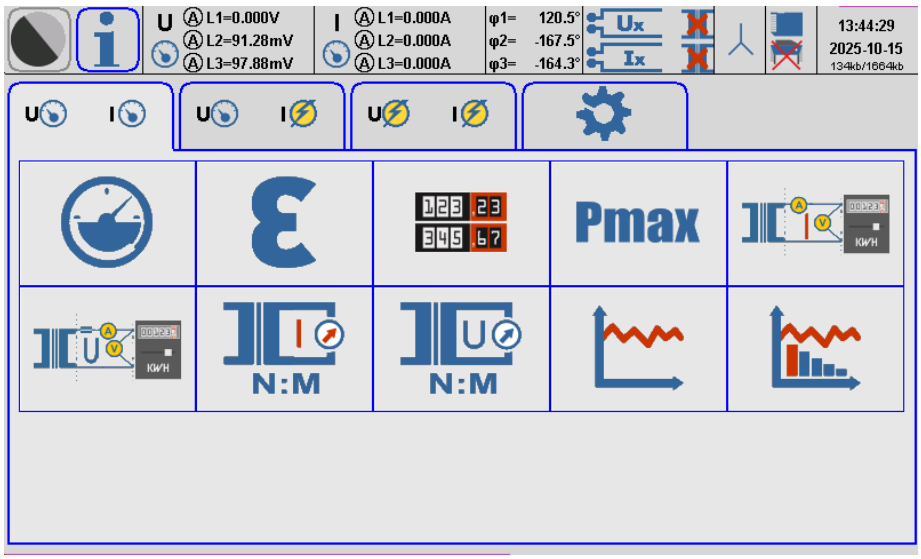
For this reason, **repeatable and precise meter verification** requires a system that is capable of simulating and measuring real operating conditions with an accuracy that far exceeds that of the meter being tested. The **TS33 system,** with its accuracy class of up to 0.02% and its ability to generate stable loads, is ideally suited for the reliable evaluation of critical measuring elements such as shunts in any type of energy cost meter.

The TS33 Automatic Test System for energy meter testing has been designed for maximum efficiency and simplicity, minimising preparation time in the field or in the laboratory.

Connection (according to the schematic diagram): Connect the meter under test to the TS33 current and voltage outputs, as shown in the diagram below. The TS33 will operate in generator mode and simulate the conditions prevailing in the network. Only after correct connection in this mode can you proceed to configure the **Test Procedure** in order to perform fast and repeatable measurements.



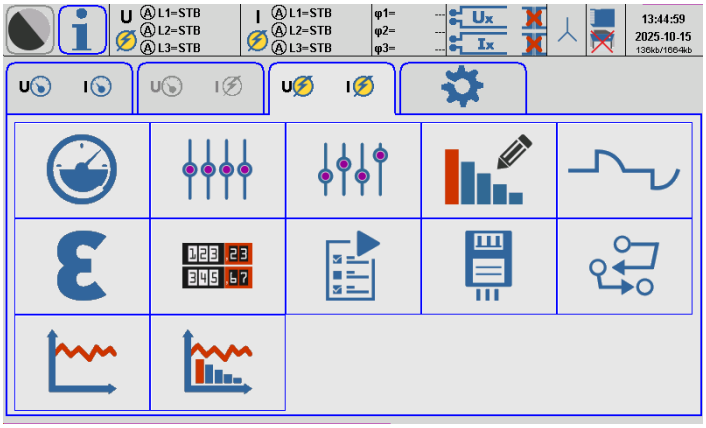
After correctly and safely connecting all current and voltage circuits of the tested meter to the TS33 System, in accordance with the selected operating mode, start the device. After turning on the power, the **Main Menu Screen** will appear on the large colour LCD touch screen. It is an intuitive control centre and provides access to all TS33 measurement and generation functions, allowing quick selection of the operating mode: **meter**, **mixed**, **generator** and **options**. Additionally, at the top there is an information bar where basic network parameters are displayed, such as current voltage, current and the angle of displacement between current and voltage, the system in which the user is operating (star - delta), information on whether measuring clamps are connected to the device, and the date and time.



To test such a counter in full simulation mode, go to the module responsible for generating and configuring output signals from the Main Menu Screen.

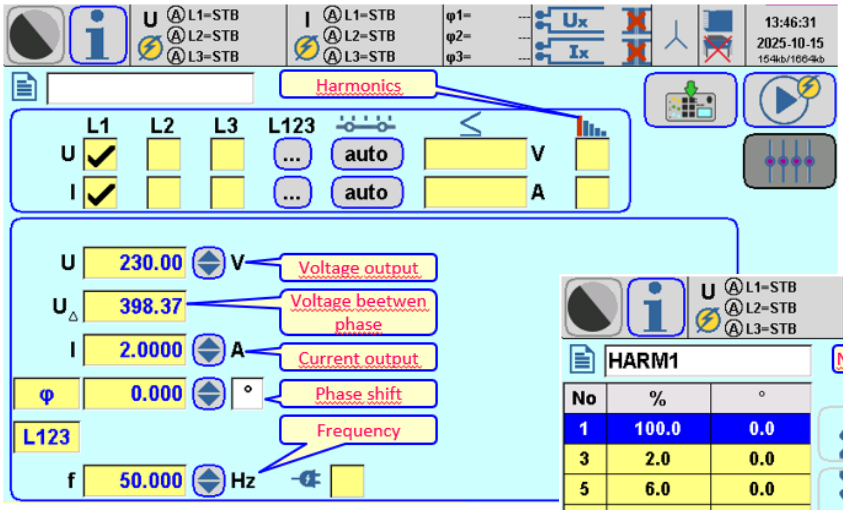
To do this, select the **Power and Voltage Sources** (Generator) icon.

This module is the central point where the TS33 system ceases to function solely as a meter and begins to operate as a **precise three-phase power calibrator**. At this stage, you will define the exact power supply conditions that will simulate the actual network load and allow you to verify the meter under test. You will be able to precisely set:

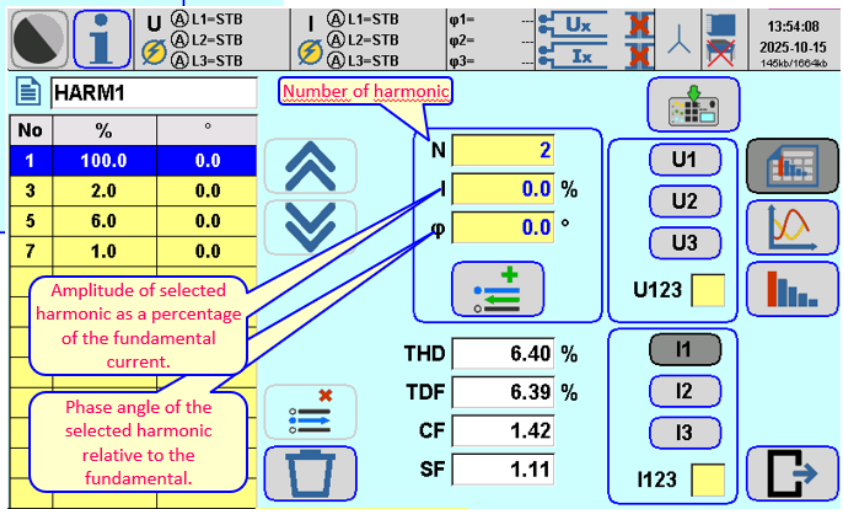


- Voltage values (V_1, V_2, V_3) and current (I_1, I_2, I_3).
- Frequency (f).
- Phase shifts (φ_1, φ_2, φ_3) and power factors (PF_1, PF_2, PF_3).
- Output signal shapes, using harmonics or predefined special shapes.

Once the desired load point has been set, the generator is ready to supply the meter with a stable and repeatable signal.



The TS33 menu, where the above-described parameters can be set, is clear and transparent for the user, which facilitates working with the device and allows for quick and efficient testing. This ensures that the entire process runs smoothly, which translates into work efficiency.



Once you have mastered the use of the Generator module and precisely set the individual electrical parameters, you can proceed to systematically verify the tested energy cost meter. In order to obtain a complete and reliable assessment of its accuracy, it is necessary to check it at the most important load points, resulting from technical specifications and metrological standards.

The TS33 Automatic Testing System allows you to quickly go through the following test points, minimising the time required to obtain a full report.

The table below shows a set of typical load points that are necessary to check the key parameters of the meter.

Table with suggested measurement points:

The test was performed for the energy cost meter: JGQ02S-01,

- 230 [V] ~ 50Hz 3680W max,
- 16 [A] max
- Klasa dokładności: ±2,0 %
- **Basic test:**

Points	I[A]	cos φ	V[V]	Frequency[Hz]	Range
1	0.8	1.00	230	50	Auto
2	1.6	1.00	230	50	Auto
3	3.2	1.00	230	50	Auto
4	8.0	1.00	230	50	Auto
5	16.0	1.00	230	50	Auto

- **Test for different cos φ**

Points	I[A]	cos φ	V[V]	Frequency[Hz]	Range
1	0.8	0.5L	230	50	Auto
2	3.2	0.8C	230	50	Auto
3	16.0	0.5L	230	50	Auto

- **Harmonics:**

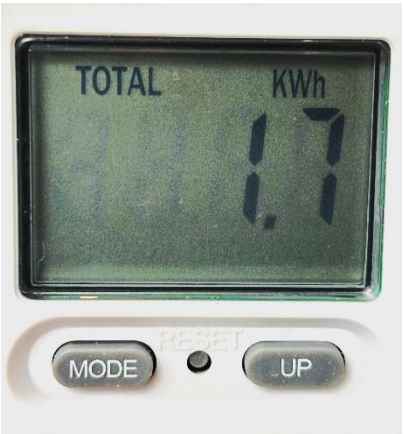
Points	I[A]	cos φ	V[V]	Frequency[Hz]	Range	[%]Harmonic current 3/5/7
1	0.8	0.5L	230	50	Auto	5% 3.h + 3% 5.h
2	3.2	0.8C	230	50	Auto	10% 3.h + 5% 5.h
3	16.0	0.5L	230	50	Auto	15% 3.h + 10% 5.h + 5% 7.h

The key to verifying the accuracy of the meter lies in a precise comparison of two values: the reference signal generated by the TS33 and the measurement response of the meter under test.

The test is performed by following this sequence of steps:

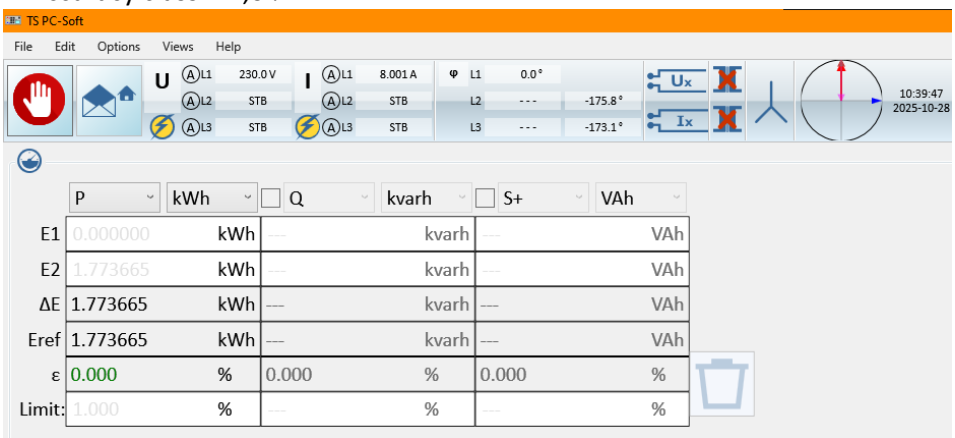
1. **Setting Reference Values:** In the TS33 System **Generator** module, the operator sets the desired voltage, current, and phase angle values that correspond to the selected test point from the verification procedure. This value is generated with the highest accuracy at which the TS33's built-in source operates.
2. **Reference Reading:** At the same time, the Reference Meter section of the TS33 System precisely measures the power and energy of the signal that is supplied to the electricity meter under test. This value is treated as a reference, ideal measurement.
3. **Operator's work:** The operator reads the power value supplied by the TS33 device on the electricity meter and compares it with the value displayed by the tested device. On this basis, the measurement error of such a device can be easily calculated.

Additional procedure – Register Test



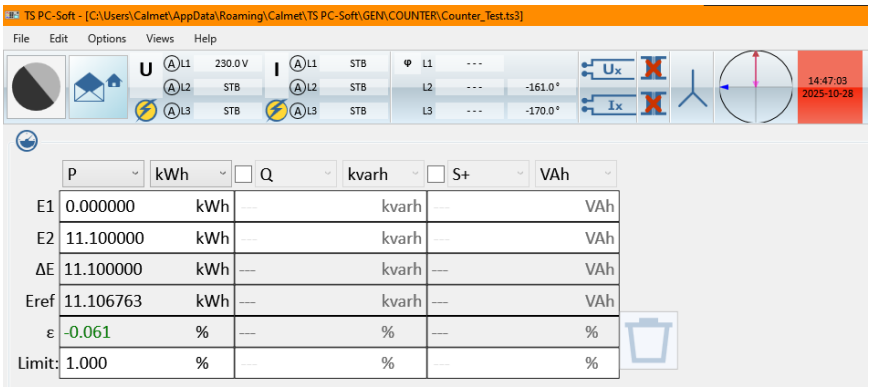
The test was performed for the energy cost meter: **JGQ02S-01**,

- 230 [V] ~ 50Hz 3680W max,
- 16 [A] max,
- Accuracy class: ±2,0 %



The TS33 Automatic Testing System enables the performance of a Register Test, which is used to verify the correctness of energy summation by the meter. During the measurement, the TS33 compares the reference energy (*E_ref*) with the energy recorded by the meter (*E_meter*), automatically calculating the relative error. This test allows you to confirm the correct operation of the energy register over a longer period and detect any accumulation errors.

Results can be saved and reported in **TS33 PC-Soft** software, providing full verification documentation.



To obtain reliable results, it is recommended to set the generator to **230V** and **8A**, and then record data for at least **24–48 hours**. Such a long test period is necessary because energy cost meters have limited resolution — a shorter measurement could result in an apparently large error due to an insufficient number of energy units counted. The test results can be saved and reported in the **TS33 PC-Soft** software, providing full documentation of the long-term verification.

After completing a full measurement cycle, we obtain a reliable verification report.
Although this mode requires operator intervention at each test point, the **TS33 system consistently ensures the highest precision** of generated signals and reference measurements. This eliminates errors resulting from network instability and manual calculations, which is crucial for ensuring confidence in the results.
Correct interpretation of the recorded data is crucial. After correctly performed measurements at the required test points, the obtained picture of the behaviour of the energy cost meter — and in **particular the error curve as a function of load** — allows for an unambiguous conclusion as to whether the device meets the requirements of its accuracy class.

The graph shows the **measurement error characteristics** of the tested JGQ02S-01 energy meter as a function of measurement points (measurement indices). The **X-axis** corresponds to successive measurement points (different values of current, power factor and harmonics), while the **Y-axis** shows the measurement **error in [%]**, calculated as the difference between the reference value (*P_Ref*) and the value indicated by the meter (*P_Meter*).
The graph shows:

- **white line** – measured relative error of the meter at individual points,
- **dashed black line** – device **accuracy class** limits (±2.0%), defining the permissible error range.

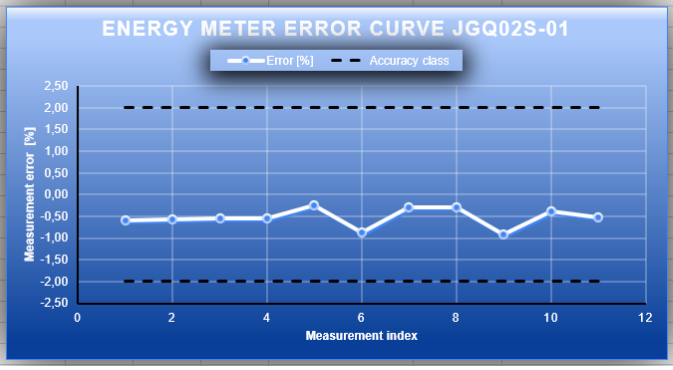
Analysis of the graph indicates that:

- all measurement points are within the permissible accuracy class,
- The largest negative error (approx. –0.9%) occurs at low loads and in the presence of higher harmonics,
- The average measurement error remains at approximately –0.5%, which confirms the stability of the meter readings within the tested load range.

Points	I [A]	Cos φ	V [V]	Frequency [Hz]	Range	P_Ref [W]	P_Meter [W]	Error [%]
1	0.8	1.0	230	50	Auto	184,0	182,9	-0,60
2	1.6	1.0	230	50	Auto	367,9	365,8	-0,57
3	3.2	1.0	230	50	Auto	735,9	731,8	-0,56
4	8.0	1.0	230	50	Auto	1839	1829	-0,54
5	16.0	1.0	230	50	Auto	3680	3671	-0,24

Points	I [A]	Cos φ	V [V]	Frequency [Hz]	Range	P_Ref [W]	P_Meter [W]	Error [%]
1	0.8	0.5L	230	50	Auto	92,00	91,20	-0,87
2	3.2	0.8C	230	50	Auto	588,9	587,1	-0,30
3	16.0	0.5L	230	50	Auto	3680	3669	-0,30

Points	I [A]	Cos φ	V [V]	Frequency [Hz]	Range	[%] Current harmonic 3/5/7	P_Ref [W]	P_Meter [W]	Error [%]
1	0.8	0.5L	230	50	Auto	5% 3.h + 3% 5.h	91,85	91,00	-0,92
2	3.2	0.8C	230	50	Auto	10% 3.h + 5% 5.h	585,2	582,9	-0,40
3	16.0	0.5L	230	50	Auto	15% 3.h + 10% 5.h + 5% 7.h	1809	1799	-0,53



The error curve presented is direct evidence that even in manual adjustment mode, the **TS33 Automatic Testing System** is an indispensable tool that provides accurate and documented data for evaluating each energy meter. The speed of reading and calculating errors by the TS33 after each load change significantly improves the verification process and guarantees metrological certainty. This application note fully demonstrates why the **TS33 Automatic Testing System** from Calmet Sp. z o.o. is not only a tool, but a **strategic asset** in the management of an energy cost meter fleet. Regardless of the simplicity of the tested devices (shunt verification, start or maximum current check), the key to the **reliability and security of billing is the quality** of the control tool. TS33 fully ensures this by offering:

- **Unquestionable Accuracy:** With a reference class of up to 0.02%, the TS33 eliminates any doubts about the precision of reference measurements, effectively exposing even the smallest errors in the meters being tested.
- **Full Control over the Test:** An integrated, three-phase current and voltage source allows for **complete isolation of the test from grid instability**. The operator has absolute control over the simulated conditions (voltage, current, phase angle), which is impossible when testing a meter that is 'connected to the grid'.
- **Work Efficiency:** While the operator controls the load points, the **TS33 instantly performs power calculations** and data logging, drastically reducing the time spent at each measurement point and allowing for a quick transition through the full current characteristics.
- **Reliable Documentation:** The measurement result is not just a number — it is a professional, digitally recorded protocol that becomes irrefutable metrological evidence.

By choosing Calmet TS33, you are investing in the highest quality, which guarantees peace of mind, optimisation of operating costs and the certainty that every meter — from the simplest to the most advanced — has been verified in accordance with the highest standards.