# Testing DIN rail energy meters using the C300B three-phase power calibrator.

CALMET
Smart Calibration Devices

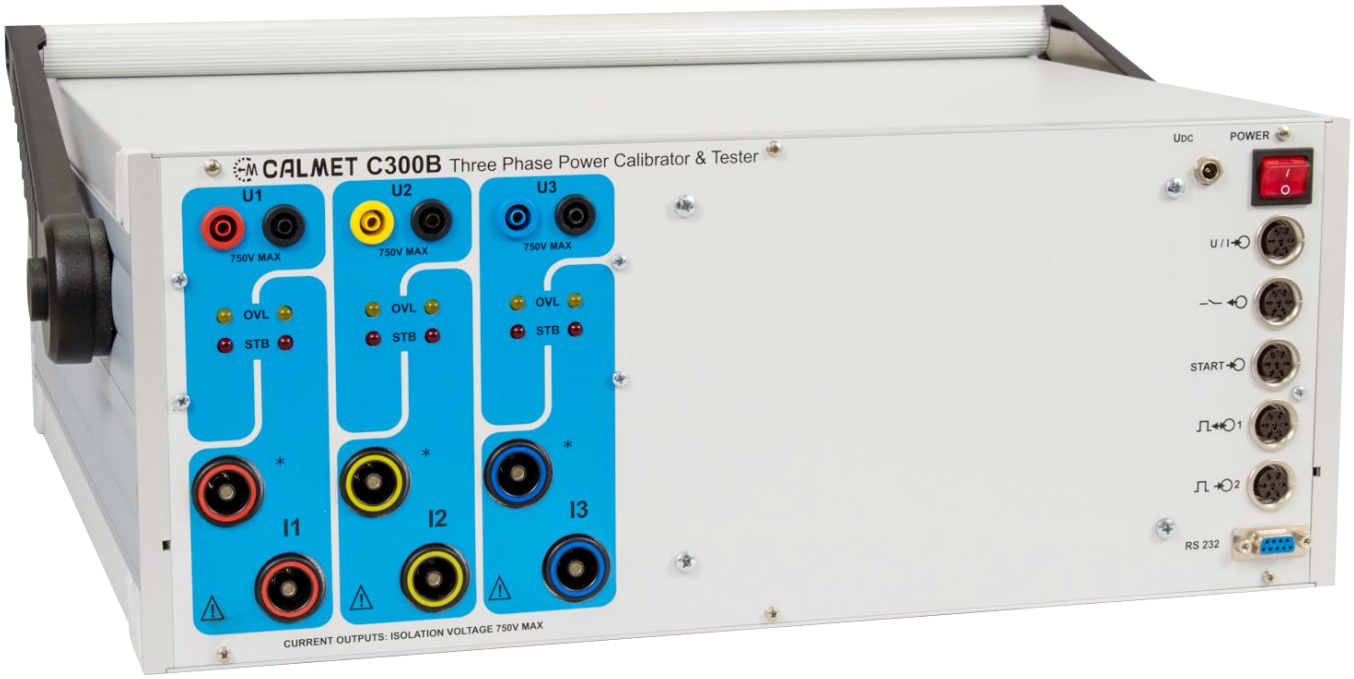
**Application note** No47

In an era of growing energy efficiency requirements and increasingly higher standards of energy supply quality, ensuring the highest measurement precision is becoming a key challenge for laboratories and energy services. The answer to these needs is the Calmet C300B – an advanced three-phase power calibrator and energy equipment tester that combines the function of a precise signal source with an automatic testing system.

What distinguishes the C300B from competing solutions is primarily:

- **Uncompromising precision and versatility:** The device offers an accuracy class of 0.02% or 0.05%, allowing calibration of even the most demanding digital instruments and energy meters compliant with EN 50470.
- **Impressive power in a compact form:** The C300B is a complete all-in-one solution. It houses a three-phase voltage source up to 560V and currents up to 120A (with the possibility of generating up to 360A in a single-phase system) in a single enclosure, eliminating the need for external amplifiers.
- **High output load capacity:** Thanks to its high current and voltage output, the calibrator can easily control older analogue instruments with high power consumption, ensuring stable settings in all conditions.
- **Advanced Power Quality Features:** The C300B offers more than just stable sine wave signals. The device enables the generation of harmonics (up to the 64th), interharmonics, and the simulation of phenomena such as dips, surges, and flicker in accordance with the IEC 61000-4 series of standards.
- **Full process automation:** Working with dedicated Calpro 300 software allows you to create your own measurement procedures and fully automate meter testing, including calculation of basic error, frequency impact and starting current.

The Calmet C300B is synonymous with reliability and modernity in energy metrology. Implementing this solution allows for a significant acceleration of testing processes while maintaining the highest reliability of results. It is the foundation on which modern, precise equipment control in the modern energy industry is based.



Energy meters mounted on a DIN rail (TS-35) have become an indispensable element of almost every modern electrical installation. Due to their low price, compact dimensions and ease of installation, they are widely used wherever there is a need to monitor energy consumption without the need to build complex measuring systems. They can be found in domestic sub-distribution boards, stairwells, lighting control systems and for monitoring individual machines in workshops.

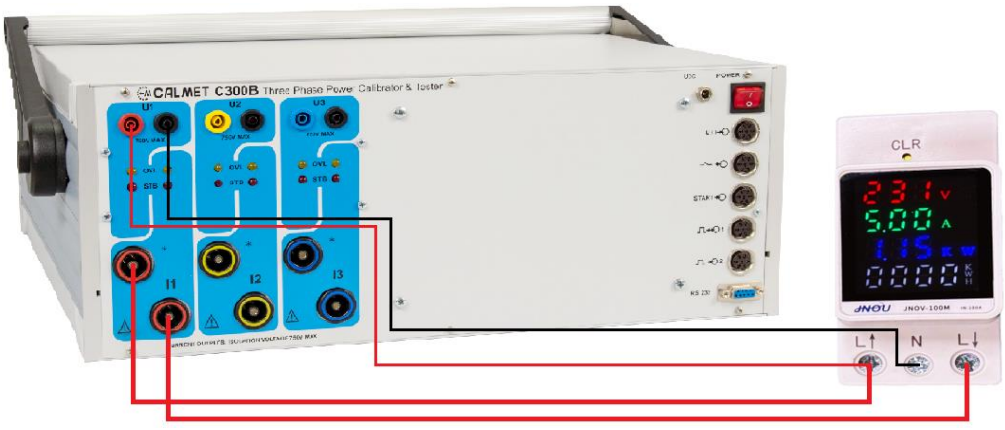
Although these are often budget devices, their role in internal settlements or verification of energy consumption of devices is crucial. Due to their popularity and the varying quality of models available on the market, their control becomes an important issue. Even in the case of simple meters costing a few money, the end user or facility manager must be sure that the device does not exhibit errors beyond acceptable limits and that its response to load is predictable.

Testing such meters requires a tool that is as practical as the meters themselves. The Calmet C300B calibrator perfectly meets these needs, offering the ability to quickly and repeatedly check the accuracy of energy metering under controlled conditions. This allows for instant selection of devices and rejection of those units that could overstate or understate bills.

Thanks to the use of **individual sockets for each current output** and clear marking of voltage and current sections, connecting a three-phase meter (or several single-phase meters) takes only a few moments. Robust current terminals allow for secure cable installation, which is extremely important when generating higher current settings, where contact stability determines measurement accuracy.

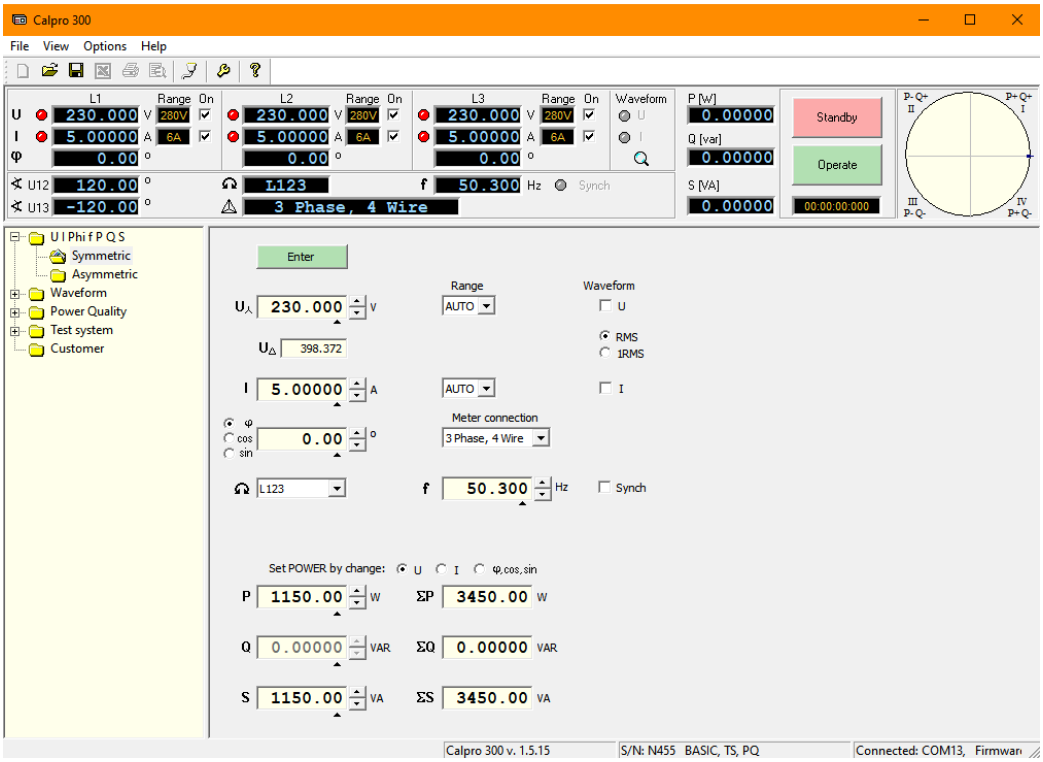
**Integration of voltage and current circuits**

The connection diagram is based on a classic layout, in which the C300B acts as a precise excitation source:




- **Voltage circuit:** Supplies the meter with reference voltage (e.g. 230V).
- **Current circuit:** Forces current flow at a specified value and power factor, simulating actual load from receivers.

Once the meter is physically connected to the calibrator, **Calpro 300** software becomes the command centre. This is where the intuitive user interface meets metrological capabilities, allowing you to fully exploit the potential of the **Calmet C300B**.

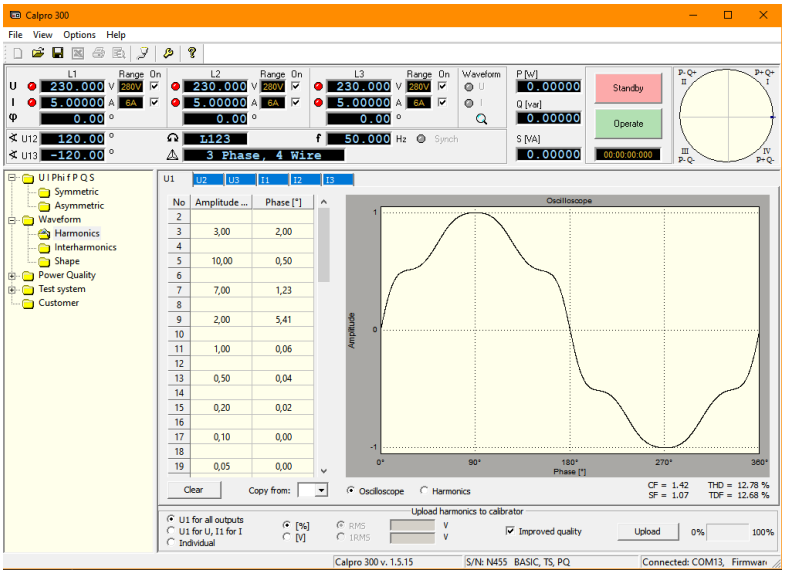



## Precision at your fingertips

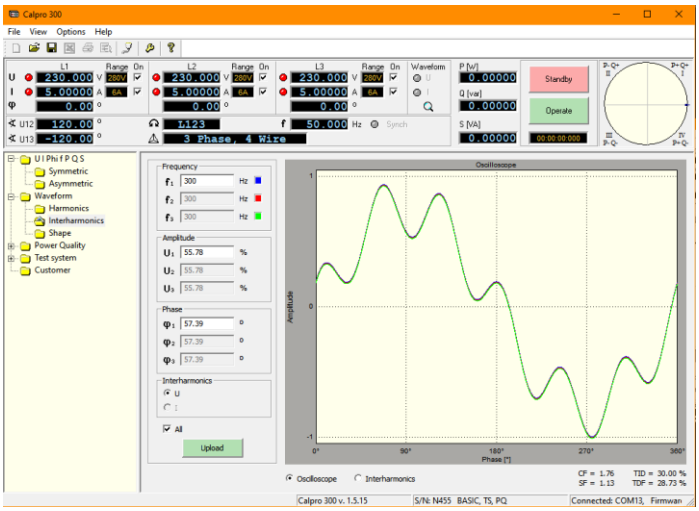
The programme allows for instant setting of measurement points. The user can define voltage, current and angle values with the highest resolution. Thanks to the clear layout of windows, monitoring the status of the calibrator outputs and the currently calculated counter error is extremely simple and clear, even during quick comparative tests.

## Not just sine waves – advanced technical features

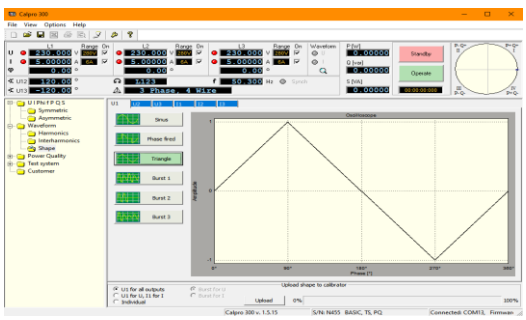
Contemporary loads in low-voltage networks are rarely perfectly sinusoidal. Calpro300 allows you to go beyond standard schemes and check how a cheap DIN rail meter performs in more difficult conditions:



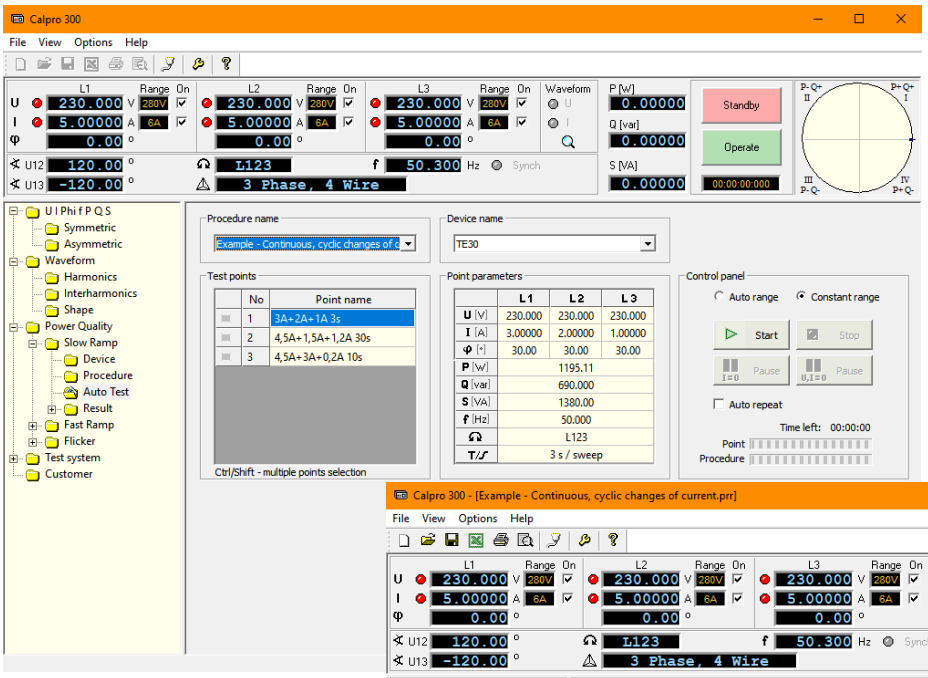

- **Harmonic implementation:** The programme allows higher harmonics (up to the 64th) to be superimposed on the fundamental signal, simulating the operation of the meter in an environment with a large number of switching power supplies or inverters.
- **Distortion response analysis:** We can easily check whether a budget measuring device maintains its declared accuracy class with a distorted current waveform.



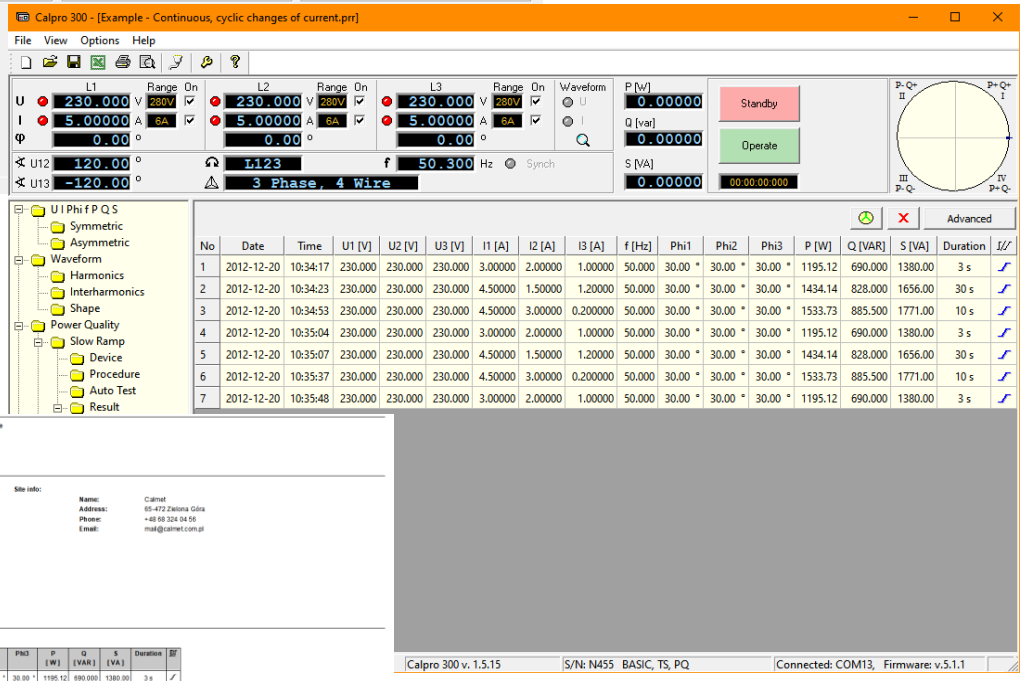

**Defining Power Quality Parameters:** The software provides access to the generation of interharmonics, dips and surges, making the C300B + Calpro 300 set a complete test station.



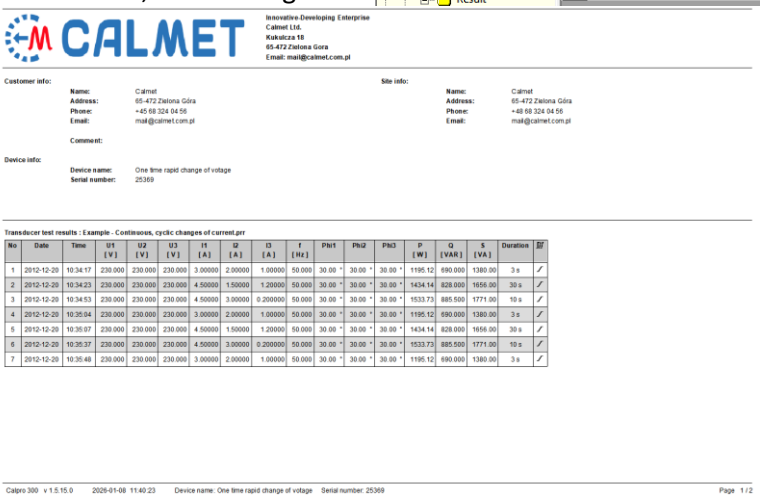
## Automation and reporting




The greatest advantage of using Calpro 300 is the ability to create **automatic test procedures**. Instead of manually changing the parameters for each point, the user can run a ready-made scenario. After the test is completed, the programme automatically generates a professional report, which is ready-made evidence of the load points at which a specific meter was tested.




It is worth noting that the intuitive Calpro300 interface makes preparing a new test procedure a breeze literally a few minutes, even taking into account the specific technical requirements of the device under test. Once configured, the scenario can be reused many times in the future, which saves a lot of time when performing regular measurements.




Once the **Calpro 300** interface has been mastered, moving on to the crucial phase – testing the basic error of the meter – becomes an extremely intuitive process.

### Why are we moving away from automatic testing via pulse output for modular meters?

Although the Calmet C300B calibrator has advanced automatic pulse counting functions (S0 standard or photometric LED reading), in practice, this method is sometimes impossible to use when testing the simplest DIN rail meters. This is due to the fact that many budget models available on the market are as simple as possible in design and do not have an S0 standard pulse output, and often do not even have a signal LED. In such situations, the only reliable method of verification is the direct reading from the device display described above and comparing it with the reference values generated by the C300B.

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: JN0V-100M,

- 80 - 270[V], 50 / 60Hz,
- 16 (100)[A],
- Accuracy class: ±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 various 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 | [%]Current Harmonics 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 C300B and the measurement response of the meter under test.

The verification process for DIN rail meters has been designed to minimise the risk of errors and ensure full repeatability of measurements. It boils down to three specific steps carried out in the software:

1. **Preparing the scenario in the 'Slow Ramp' tab:** In the first step, the user configures the measurement points in the **Slow Ramp** tab. Here, in accordance with the guidelines contained in the standards or internal company procedures, the desired values of voltages, currents and power factors are defined. This function allows for precise 'designing' of the forces that the C300B calibrator will apply to the meter terminals, thus creating a ready-made verification procedure.
2. **Performing measurements in 'Autotest' mode:** After preparing the scenario, the user goes to the **Autotest** tab, where they run the previously created procedure. The programme automatically enforces the settings from the C300B calibrator step by step. The operator's task in this phase is to read the energy or power values directly from the display of the tested meter for each of the set points and enter them into the system.
3. **Verification and error determination:** In the final stage, the results recorded from the meter are compared with the reference values continuously generated by the C300B calibrator. Based on this difference, the deviation of the tested meter can be determined.

## Additional procedure – Register Test

The test was performed for the energy cost meter: JN0V-100M,

- 80 - 270[V], 50 / 60Hz,
- 16 (100)[A],
- Accuracy class: ±2.0%

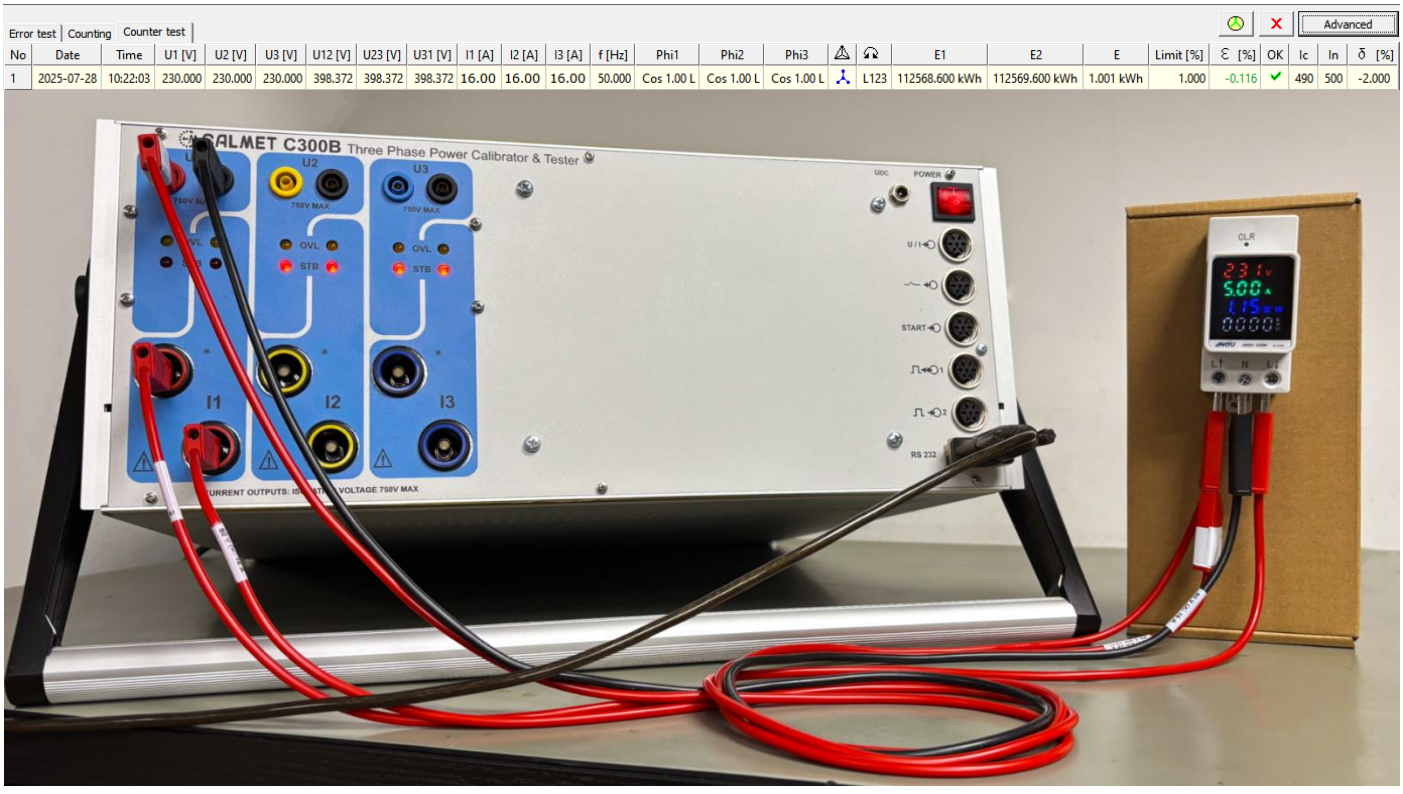
After checking for transient errors, the next step is the **Register Test**, i.e. testing the counting mechanism (counter). While the basic error tells us about the measurement precision at a given moment, the counter test confirms that the energy measured by the electronic system is correctly counted over time.

**Why is the duration of the test crucial?**

In the case of budget meters mounted on a DIN rail, the display resolution is often limited (e.g. to one or two decimal places). This results in the so-called quantisation error – in a short test, a difference of one 'point' on the last digit of the counter can generate a huge percentage error.

This is why, in professional metrology practice, this test is performed based on the following principles:

- **More energy:** The longer the test lasts and the more energy we 'run through' the meter, the less impact the low resolution of the display has on the result.
- **Increased accuracy:** Extending the test time allows rounding errors to be eliminated. With each additional kilowatt recorded by the meter, the calculated error becomes more representative of the actual class of the device.
- **Stability verification:** A longer test also ensures that the meter operates stably under constant load and does not exhibit errors during prolonged operation.

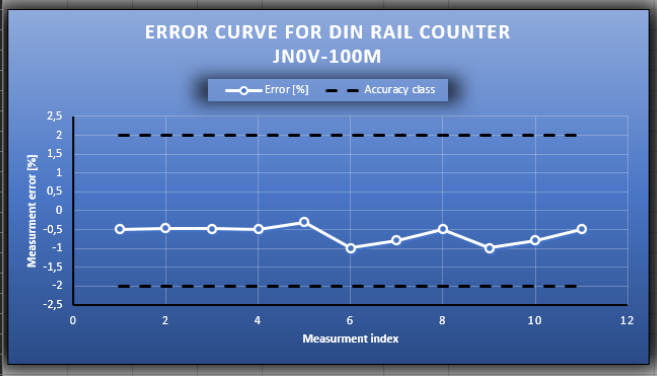



Using the **Calmet C300B** calibrator, performing a Register Test is extremely simple. The device allows for precise measurement of a specified amount of energy (e.g. 1 kWh or more), which, combined with the appropriate test duration, ensures that the meter readings used for billing are fully reliable.

| 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 | 183,1 | -0,49 |
| 2 | 1.6 | 1.0 | 230 | 50 | Auto | 368,0 | 366,3 | -0,46 |
| 3 | 3.2 | 1.0 | 230 | 50 | Auto | 736,0 | 732,5 | -0,48 |
| 4 | 8.0 | 1.0 | 230 | 50 | Auto | 1840 | 1831 | -0,49 |
| 5 | 16.0 | 1.0 | 230 | 50 | Auto | 3680 | 3669 | -0,30 |

| 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 | 91,10 | -0,99 |
| 2 | 1.6 | 0.8C | 230 | 50 | Auto | 588,8 | 584,2 | -0,79 |
| 3 | 3.2 | 0.5C | 230 | 50 | Auto | 1840 | 1831 | -0,49 |

| Points | I [A] | Cos φ | V [V] | Frequency [Hz] | Range | [%] Current harmonics 3/5/7 | P_Ref [W] | P_Meter [W] | Error [%] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.5L | 230 | 50 | Auto | 5% 3. h + 3% 5. h | 92,00 | 91,10 | -0,99 |
| 2 | 1.6 | 0.8C | 230 | 50 | Auto | 10% 3. h + 5% 5. h | 588,8 | 584,2 | -0,79 |
| 3 | 3.2 | 0.5C | 230 | 50 | Auto | 15% 3. h + 10% 5. h + 5% 7. h | 1840 | 1831 | -0,49 |




The graph shows the relationship between the percentage error and the load current (I) at a constant voltage. This is a key characteristic that allows the linearity of the measuring system of the tested meter to be assessed.

**Comments on the results:**

- **Stability in terms of rated currents:** The graph shows that the meter error remains at a constant, low level across a wide range of loads. This demonstrates the high quality of the device's measuring components.
- **Low current range:** A slight deviation in characteristics at very low currents (close to the start-up threshold) is typical for simple energy meters. Thanks to the precision of the C300B calibrator, we can accurately determine this point and check whether the device falls within the acceptable accuracy class even under such unfavourable conditions.
- **Measurement repeatability:** The very small spread of measurement points on the curve confirms the excellent stability of the signal generated by the C300B calibrator. This eliminates measurement uncertainty resulting from source fluctuations and allows you to focus solely on the parameters of the object under test.

Choosing the **Calmet C300B** calibrator is an investment in the highest metrological standard, combining uncompromising precision with exceptional signal stability. By choosing this solution, you gain measurement accuracy of 0.02%, which, combined with the **full automation** of the Calpro 300 software, significantly speeds up the meter verification process and eliminates the risk of human error. This versatile all-in-one tool allows you to perform advanced tests, such as energy meter deviation tests or other measuring devices, without the need for additional amplifiers or meters. By choosing the C300B, you are choosing reliability and professionalism that build a technological advantage in any modern energy laboratory. The Calmet C300B is simply a guarantee of quality where precision does not compromise.