# AN43 EN Testing the TS23 three-phase reference meter with the C300B three-phase calibrator

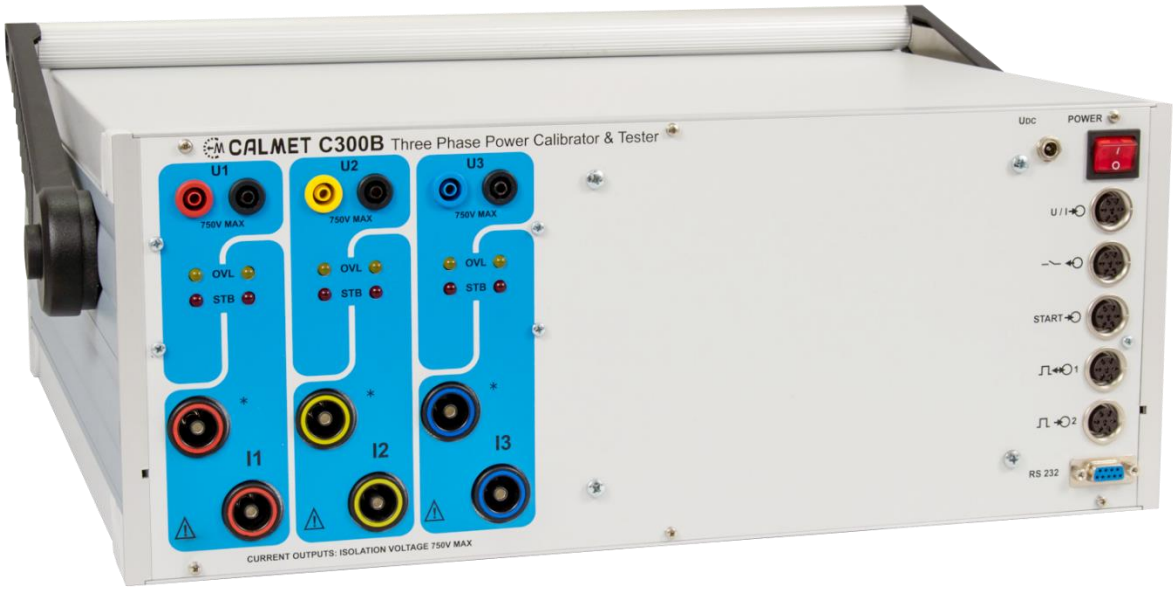
**Application note** No43

The purpose of this application note is to present a method for testing the TS23 three-phase energy meter using the C300B three-phase calibrator. This document guides the user through the process of verifying the TS23 meter's accuracy by analyzing the number of pulses generated by the meter and received by the calibrator.

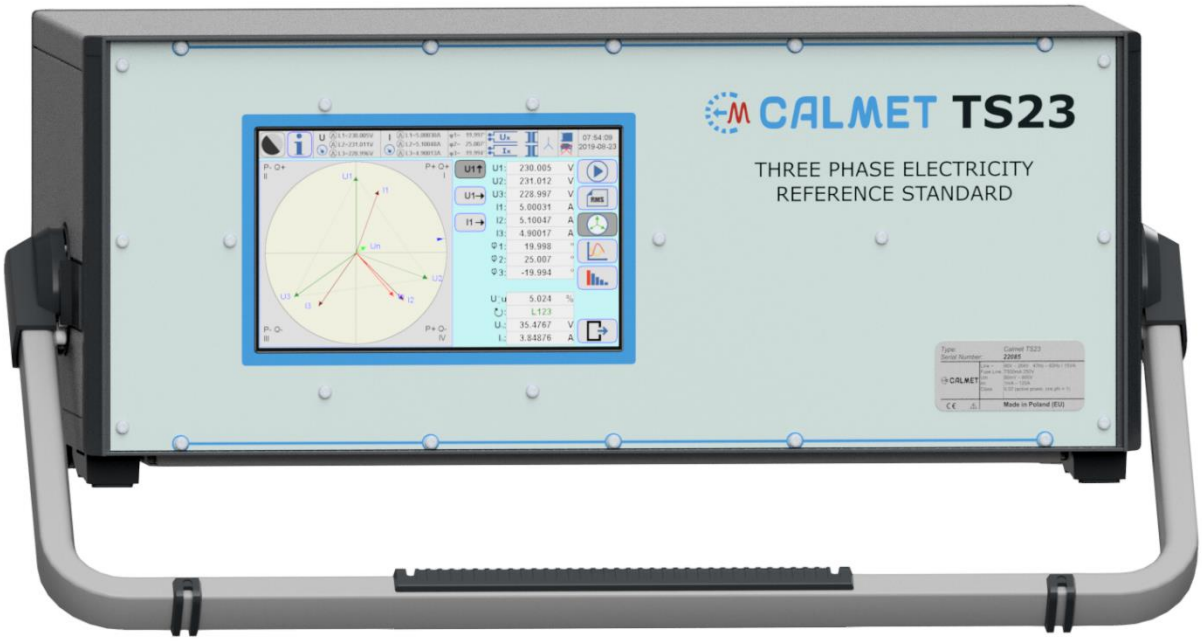
In addition, the note includes a detailed description of the test procedure, which can serve as a template for conducting such tests in the future. Also discussed will be the proper connection of the TS23 meter to the C300B calibrator, which is a key element in ensuring correct and repeatable measurements.

It's worth noting that during testing—especially for power factors of cos 0.5L and cos 0.5C—the results may be slightly less precise. This is because we're testing a meter that has the same or even higher accuracy class than the reference calibrator. That's why it's important to take the calibrator's measurement uncertainty into account when evaluating the results. This uncertainty plays a key role in analyzing the overall measurement accuracy and interpreting the data.

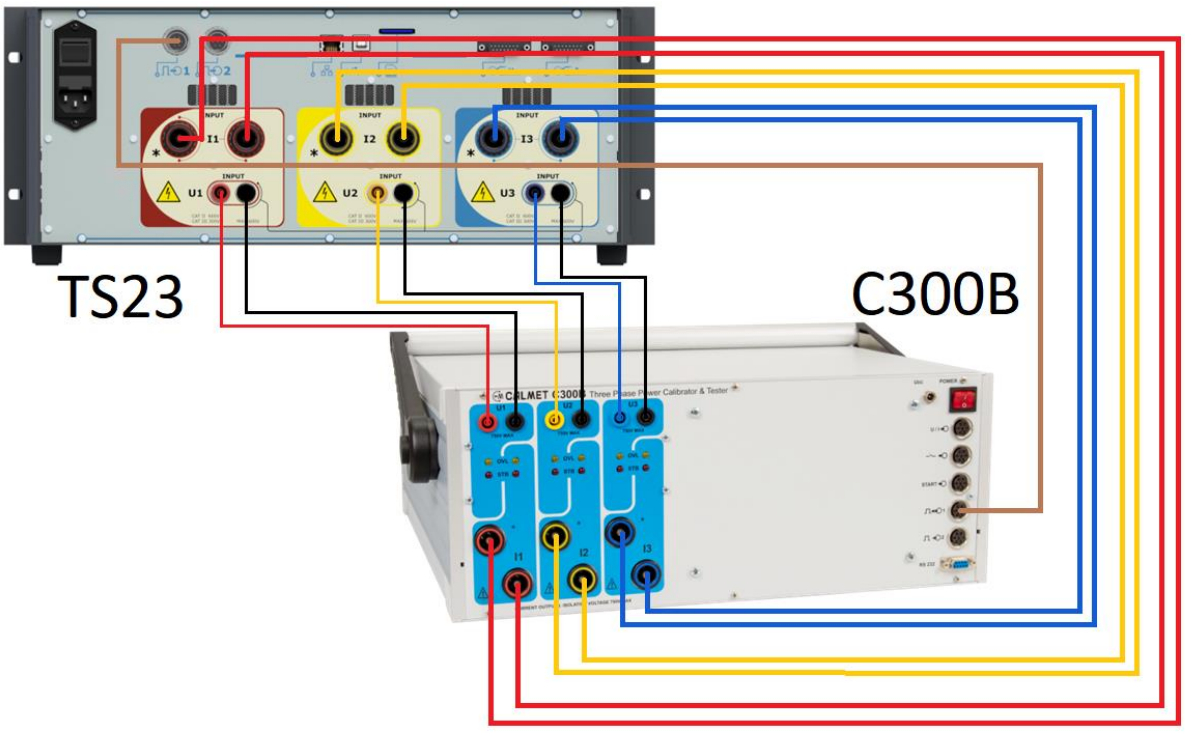
The C300B calibrator is a versatile device designed to simulate electrical network parameters in three-phase systems. It can generate voltages of 70 V, 140 V, 280 V, and 560 V, as well as currents of 0.5 A, 6 A, 20 A, and up to 120 A. With its built-in pulse input, the C300B is capable of testing energy meters by comparing the number of pulses received. In addition, it supports harmonic generation up to the 63rd order, making it a powerful tool for simulating complex network conditions.



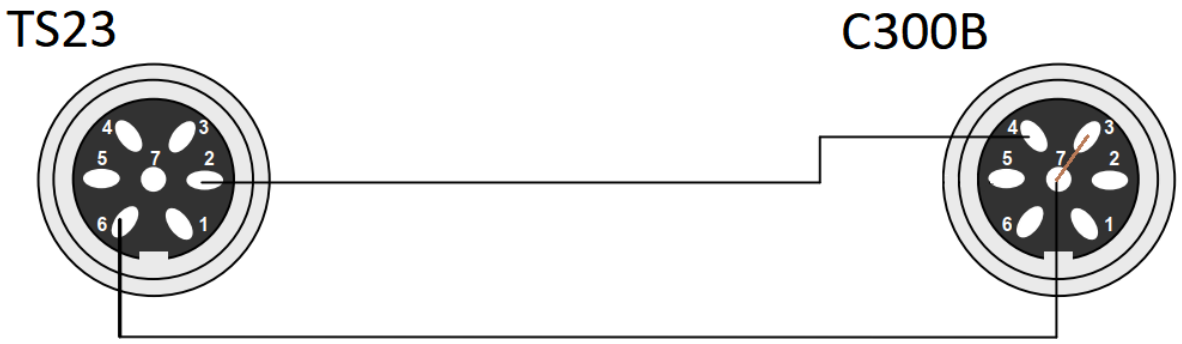
The TS23 is a three-phase power meter designed for accurate measurement of voltage, current, and power quality. It allows direct voltage measurements up to 600 V and current measurements up to 120 A. Additionally, thanks to its clamp inputs, current transformers (measurement clamps) can be connected, enabling indirect measurement of higher currents. The TS23 can be used both for testing energy meters at individual load points and as a reference device—comparing actual electrical parameters with the readings from a tested meter. The device is also equipped with a pulse input for counting pulses from the tested meter, as well as a pulse output, which can be used to verify the TS23's own accuracy against a higher-precision reference meter.




To properly carry out a test of the TS23 meter using the C300B calibrator, both devices must be connected correctly. The C300B acts as a source of test signals—it generates three-phase voltages and currents that simulate real operating conditions in an electrical power network. Voltage and current cables from the calibrator's outputs should be connected directly to the corresponding measurement inputs on the TS23 meter.
For tests involving higher currents—up to 120 A—it is recommended to use cables rated for such loads, as the TS23 meter supports direct current measurements in this range without the need for current transformers.



Additionally, to enable pulse counting from the TS23 meter, its pulse output should be connected to the pulse input of the C300B calibrator. This allows the calibrator to register the number of pulses in response to the applied voltage and current conditions, forming the basis for evaluating the meter's performance.
Depending on the pulse frequency used during testing, the way the TS23 meter's pulse output is connected to the C300B calibrator's pulse input may vary.
When working with a pulse frequency below 100 kHz, it is sufficient to connect the TS23's pulse output directly to the C300B's pulse input, following the wiring diagram shown in the first figure (jumper between pin 7 and pin 3).



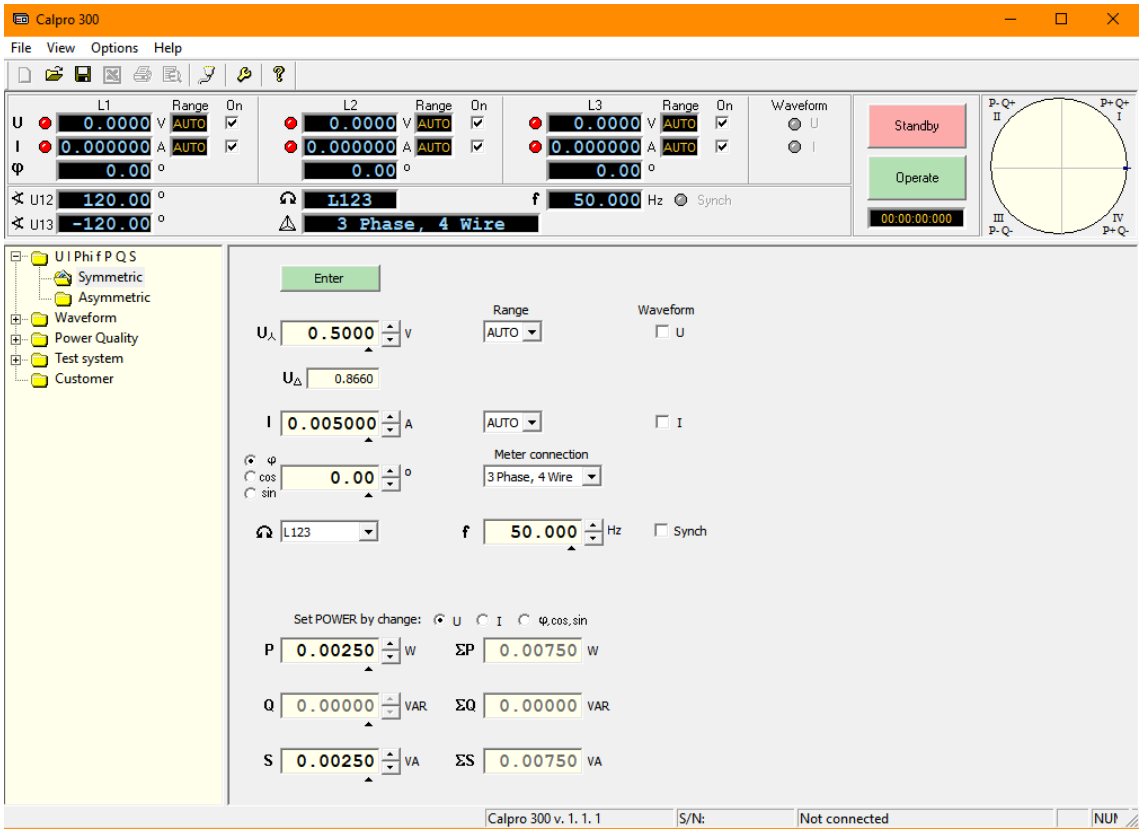

For tests involving high pulse frequencies (above 100 kHz), it is recommended to use the alternative wiring method shown in the second diagram. This configuration ensures proper operation and greater signal stability during high-frequency pulse transmission.

- Metal film resistor 470Ω ±5%, 1W, THT

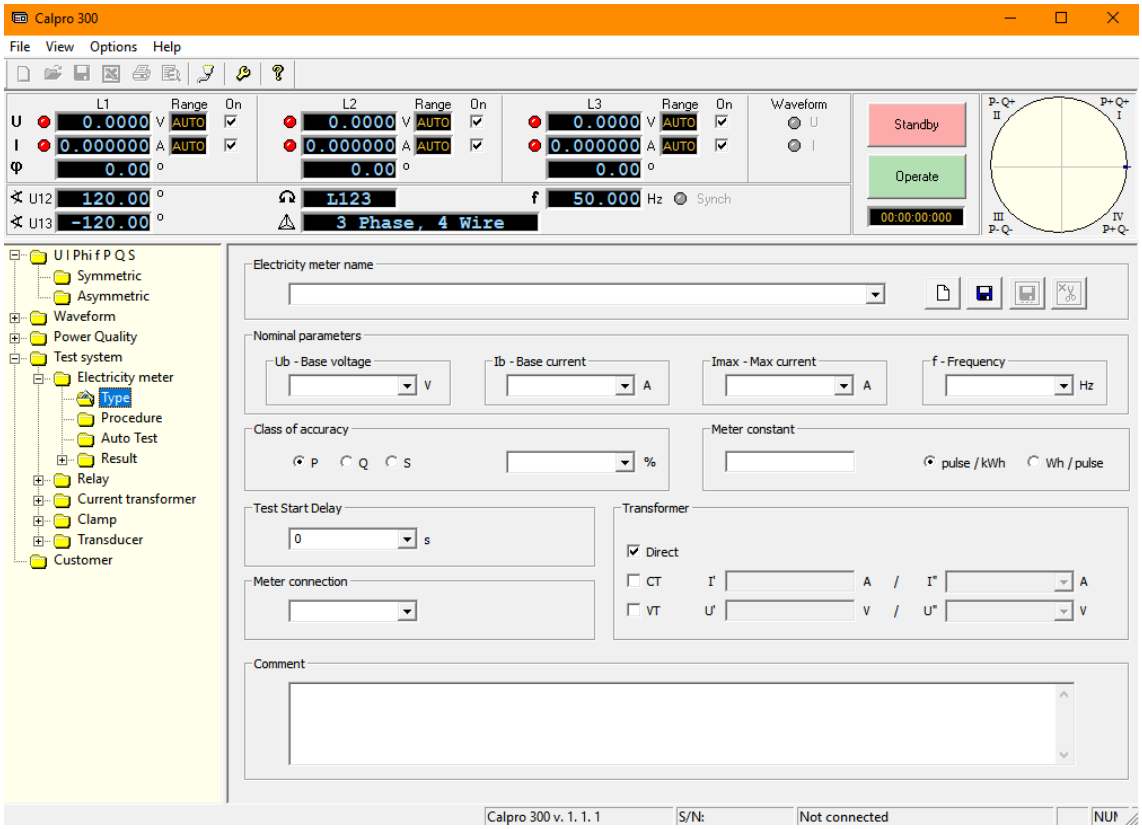
***Note:*** Correctly wiring the connections according to the provided diagram is essential to ensure the accuracy and repeatability of the tests.
**Calmet offers a dedicated PC21 cable designed for reliable connection between the pulse output of the meter and the pulse input of the calibrator. This ensures correct signal transmission during testing procedures.**

Once all the connections have been made according to the diagram, the next step is to launch the Calpro300 software. This application is used to control the C300B calibrator and create customized test procedures.
At this stage, you'll prepare a procedure that enables the automatic testing of the TS23 meter—including the definition of voltage and current parameters, test duration, and pulse counting conditions. Calpro300 also allows real-time monitoring of results and saving of measurement data for further analysis.

After launching the Calpro300 software, the main dashboard will appear on the screen, as shown in the screenshot below. This start panel provides quick access to the core features of the program, including test procedure setup, device configuration, and real-time test monitoring.

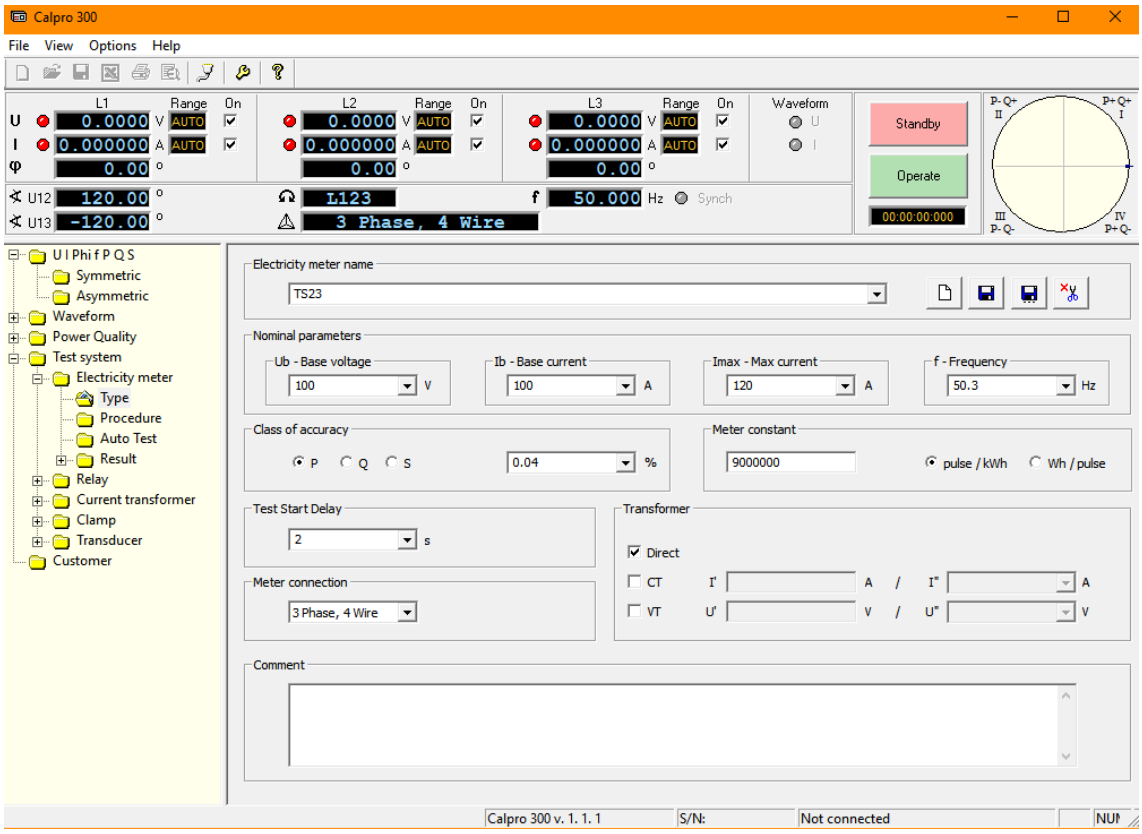



To begin creating a test procedure for the TS23 meter, go to the Test System tab and select Electricity Meter. Then, click on the Type tab, which allows you to define the key parameters of the meter under test—such as the model type, nominal voltage and current values, and the meter constant (impulse constant).



After selecting the Type option, the next step is to fill in the meter parameters in the form that appears on the screen—as shown in the screenshot below. This section is where all the key data needed for the test are defined:

- **Electricity meter name** - Name of the type of device / meter
- **Nominal parameters**:
    - **Ub (Base voltage)** - Base voltage is a reference value defined when setting up the meter type. Later, in the test procedure, we choose what percentage of that voltage we want to apply to the device. Example: if the base voltage is 230 V and in procedure we set 50% in a test point, the calibrator will output 115 V. This makes it easy to control test conditions without typing in each value manually.
    - **Ib (Base current)** - Base current is a reference value set when defining the meter type. Later, in the test procedure, we decide what percentage of that current we want to send to the device. Example: if the base current is 5 A and we set 20% in a test point, the calibrator will generate 1 A. This way, we control the test load in a simple and consistent way.
    - **Imax (Max current)** - Maximum current per phase is the highest current value that the meter can handle on a single phase, based on its technical specification.
    - **f (Frequency)** - In the frequency field, set the frequency at which you want to perform the tests. It's recommended to choose a value slightly different from the standard mains frequency (for example, 50.3 Hz instead of 50 Hz) to avoid interference and achieve more stable and reliable measurement results.

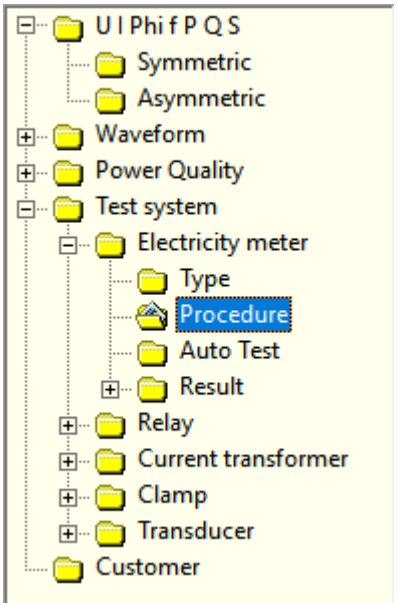



- **Class of accuracy** - In this section, you select the type of power to test (P – active, Q – reactive, S – apparent) and assign the appropriate accuracy class according to the test requirements.
- **Meter constant** - Enter the pulse constant value. In this case, 9 000 000 pulses per kWh have been set, and the unit pulse/kWh is selected.
- **Test start delay** - Specifies the delay time before the test starts, allowing the measurement system to stabilize.

- **Meter connection** - Select the meter connection type. In this case, it's "3 Phase and 4 Wire", as this configuration was used during the test.
- **Transformer** - In this option, we can include a transformer (current or voltage transformer) if available. However, in this test, it is not taken into account.
- **Comment** - The comment field can be filled in, for example, as: Testing TS23 by C300B – to easily identify the type in the documentation.

After entering all the required data, save the created device type by clicking the floppy disk icon. This saves the configured TS23 meter profile, allowing you to use it later in the test procedure and avoid having to re-enter the same information.

Next, we move on to creating the actual test procedure. To do this, open the Procedure tab, where you can define individual test points.

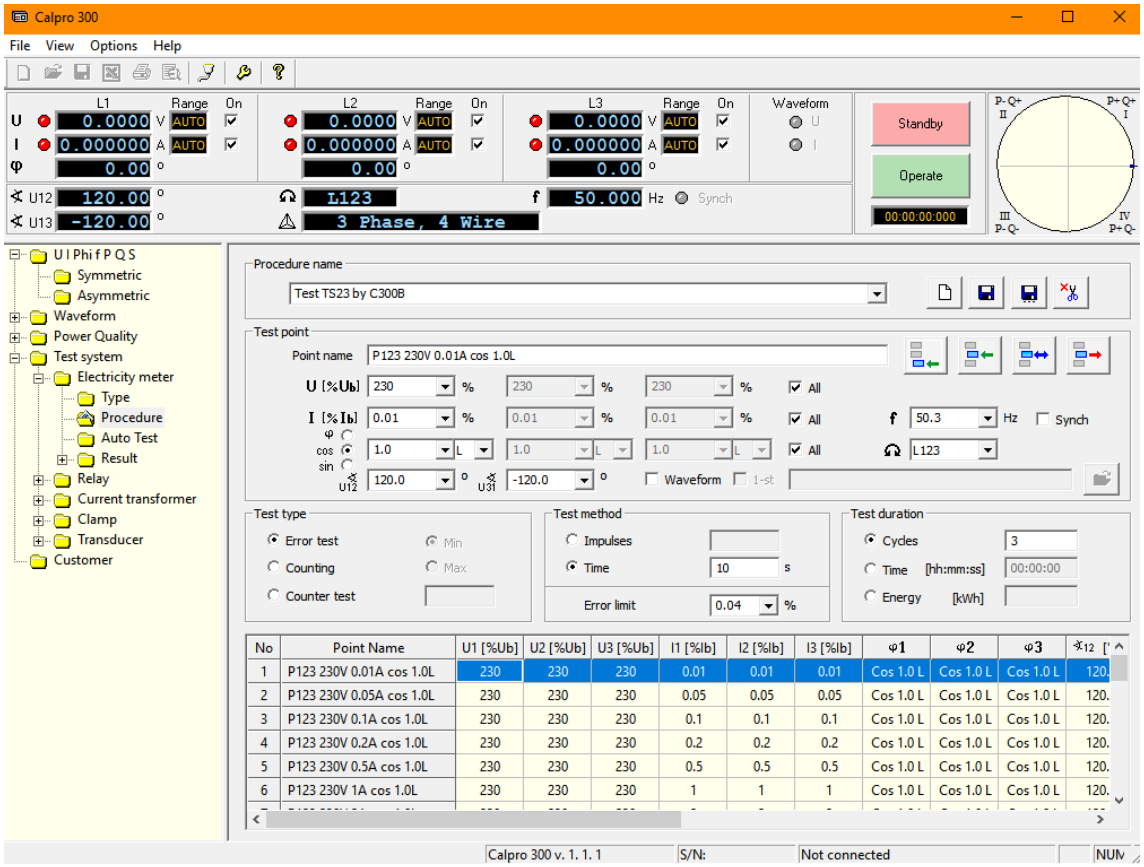



Here we set the voltage, current, power factor and duration of each test, according to the previously planned test range for the TS23 meter.After entering the Procedure tab, we can start creating the actual test procedure for the TS23 meter. Here, we define individual test points, setting the appropriate parameters for each one. The editable fields and options allow precise configuration of the measurement conditions. Below is a description of the available settings:

- **Procedure name** - In this field, enter the name of the entire test procedure, for example, "TS23 – Voltage characteristic cos(ϕ)=1."
- **Point name** - Name of the individual test point. For clarity, it is recommended to use simple names like P1, P2, and so on.
- **U [%Ub]** - Percentage of the base voltage (defined earlier in the "Type" section, e.g., 100 V). You can check the "All" box to apply the same value simultaneously to all three phases.
- **I [%Ib]** - Percentage of the base current (e.g., 100 A) that we want to set for a given test point.

- **Phase shift angle / power factor:**

    - In this section, we can choose one of three methods to define the phase shift between voltage and current:
        - **fi (°)** - We enter the phase shift angle in degrees, and the program automatically calculates cos(ϕ) and sin(ϕ).
        - **cos(ϕ)** - We enter the power factor, and the rest of the parameters are calculated automatically.
        - **sin(ϕ)** - We can enter the sine value of the phase shift (e.g., 1 for cos(ϕ)=0), and the angle ϕ and cosine values will be calculated automatically.




- **Phase voltage shifts (U12 / U31)** - We set the phase-to-phase shifts. For a classic symmetrical three-phase system, the recommended values are:

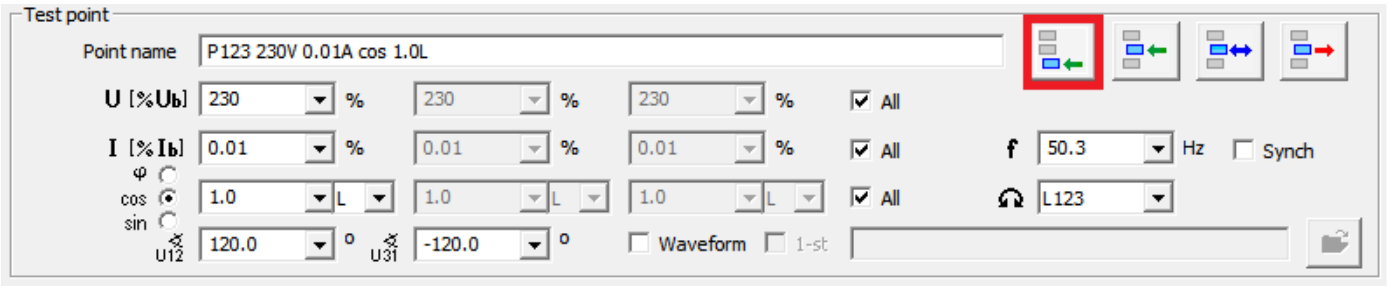
    - **U12 = 120°**

    - **U31 = -120°**

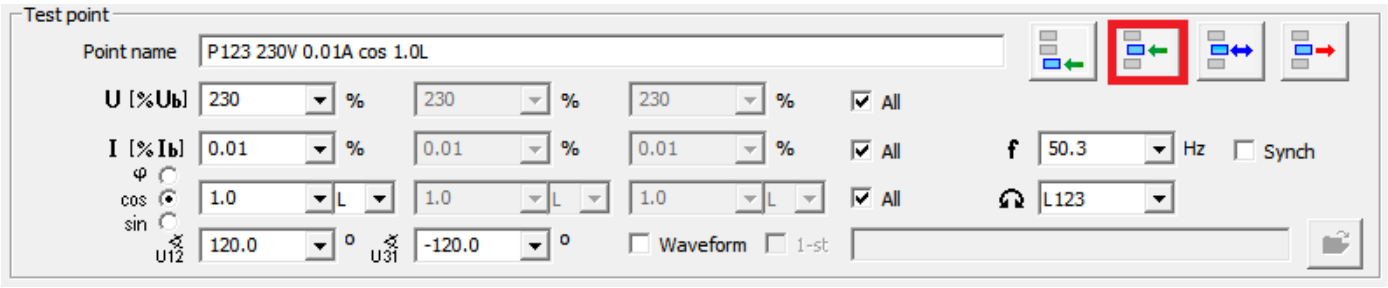
- **Waveform (harmonics)** - Selecting this checkbox allows you to add harmonics to the voltage and current waveforms. This enables testing the meter's performance under distorted signal conditions.
- **Test type** - The program offers three test modes: Error test, Counting, and Counter test. In our case, we choose the Error test mode, as we want to evaluate the measurement error of the TS23 meter – that is, to compare the number of pulses the meter should generate under specific conditions with the actual number recorded by the calibrator.

- **Test method** - There are two methods to choose from:
    - **Impulses** - The calibrator counts the pulses sent by the meter and calculates the measurement error based on this data.
    - **Time** - The test lasts for a specified period of time, and the error is determined by the number of pulses counted during this time. In our case, we chose the timed method because it provides more control over the stability of the test conditions.
- **Error limit** - Here, we enter the acceptable measurement error, e.g. ±1%. The software will compare the test result with this limit and automatically determine whether the test point meets the criteria.
- **Test duration** - We specify how long the test point is to be executed. There are three modes to choose from:
    - **Cycles** - The point will be repeated a certain number of times (e.g., 3 cycles).
    - **Time** - The test lasts for a certain amount of time (e.g., 30 seconds).
    - **Energy** - The test will be conducted until a preset amount of energy (e.g., 1 kWh) is counted.

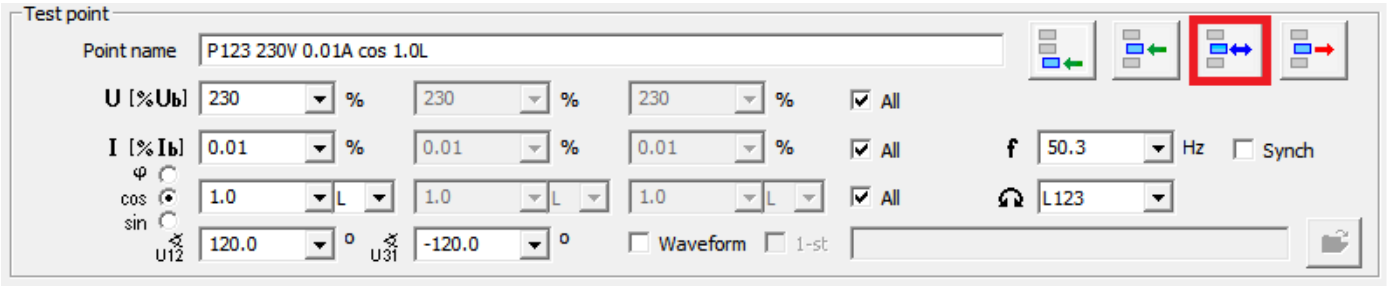
After completing all fields, we click Add point to add the point to the procedure list. In this way, we create more points - according to the previously adopted scope of research for TS23.



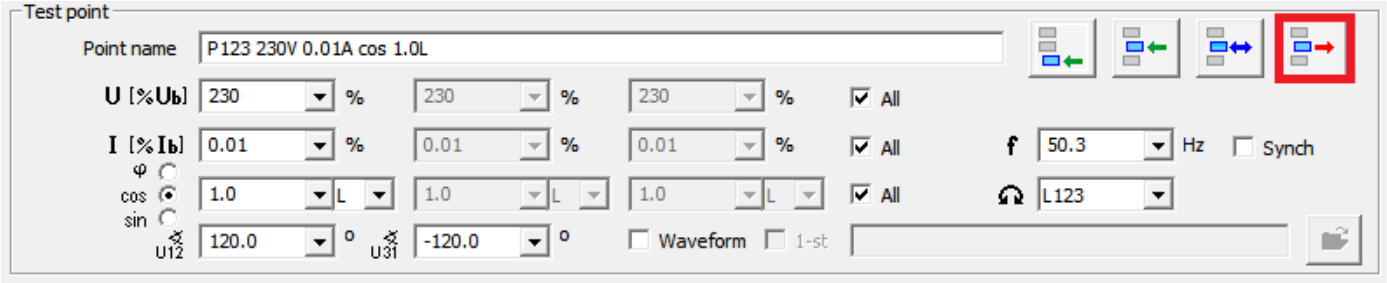

- To add a point but out of sequence, click **Insert Point.**




- To edit a point, click on the point you want to edit, change its parameters, the ones you need to change and then it is necessary to click on the Replace Point button.



- To delete a point, click the Delete point button.




After adding all the test points to the list, the final step is to save the created procedure. To do this, click the floppy disk icon to store the entire set of settings under the previously chosen name. This way, the procedure will be available for future use and can be launched at any time.

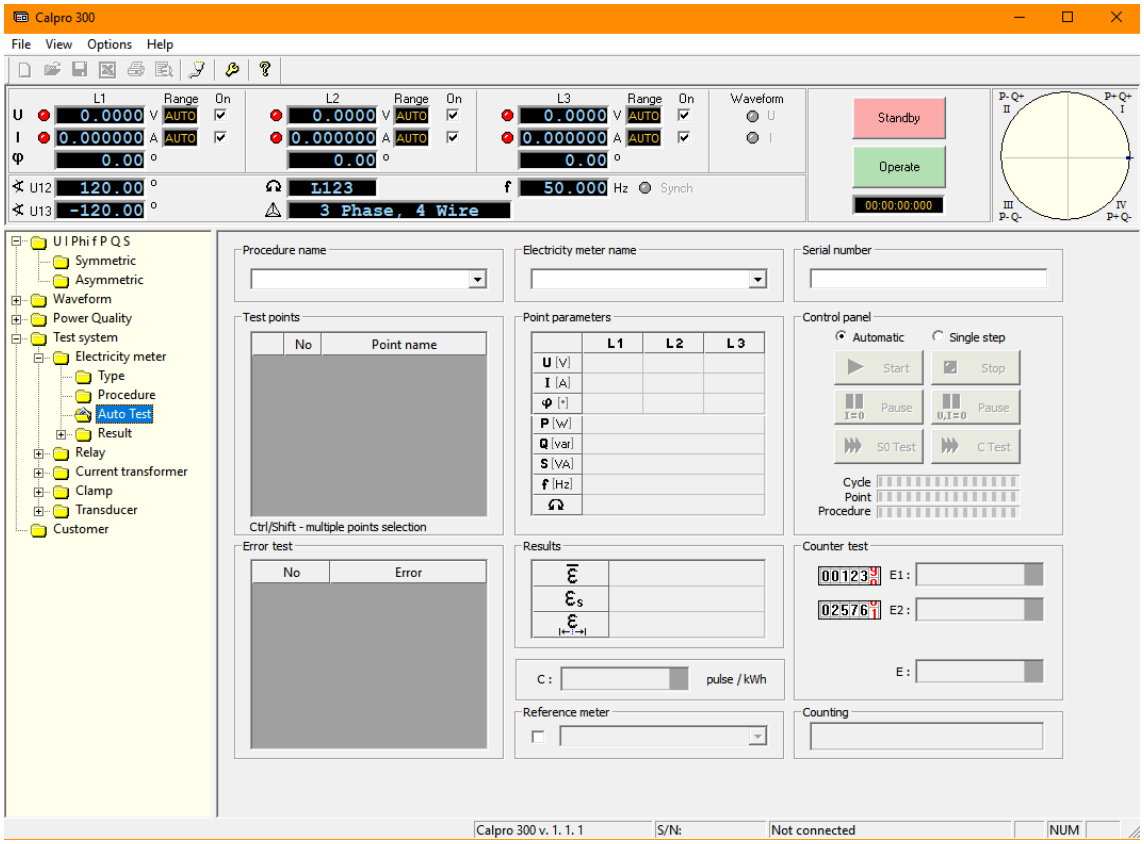
Below is an example set of test points defined as part of this procedure. The points are divided into two main cases: one for power factor cos(ϕ) = 1 and the other for cos(ϕ) = 0.5. For each point, voltage and current are set as a percentage of their respective base values, along with the appropriate phase shift mode.

| No | P.Name | U123[%] | I123[%] | Φ123 | U12[°] | U13[°] | F [Hz] | Limit[%] |
|---|---|---|---|---|---|---|---|---|
| 1. | 230V 0,01A cos 1.0L | 230 | 0,01 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 2. | 230V 0,05A cos 1.0L | 230 | 0,05 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 3. | 230V 0,1A cos 1.0L | 230 | 0,1 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 4. | 230V 0,2A cos 1.0L | 230 | 0,2 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 5. | 230V 0,5A cos 1.0L | 230 | 0,5 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 6. | 230V 1A cos 1.0L | 230 | 1 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 7. | 230V 2A cos 1.0L | 230 | 2 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 8. | 230V 5A cos 1.0L | 230 | 5 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 9. | 230V 10A cos 1.0L | 230 | 10 | cos 0.5 L | 120 | -120 | 50,3 | 0,04 |
| 10. | 230V 20A cos 1.0L | 230 | 20 | cos 0.5 L | 120 | -120 | 50,3 | 0,04 |
| 11. | 230V 50A cos 1.0L | 230 | 50 | cos 0.5 L | 120 | -120 | 50,3 | 0,04 |
| 12. | 230V 100A cos 1.0L | 230 | 100 | cos 1.0 L | 120 | -120 | 50,3 | 0,04 |
| 13. | 230V 0,05A cos 0.5L | 230 | 0,05 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 14. | 230V 0,1A cos 0.5L | 230 | 0,1 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 15. | 230V 0,2A cos 0.5L | 230 | 0,2 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 16. | 230V 0,5A cos 0.5L | 230 | 0,5 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 17. | 230V 1A cos 0.5L | 230 | 1 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 18. | 230V 2A cos 0.5L | 230 | 2 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 19. | 230V 5A cos 0.5L | 230 | 5 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 20. | 230V 10A cos 0.5L | 230 | 10 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 21. | 230V 20A cos 0.5L | 230 | 20 | cos 0.05 L | 120 | -120 | 50,3 | 0,08 |
| 22. | 230V 50A cos 0.5L | 230 | 50 | cos 0.05 L | 120 | -120 | 50,3 | 0,2 |
| 23. | 230V 100A cos 0.5L | 230 | 100 | cos 0.05 L | 120 | -120 | 50,3 | 0,2 |
| 24 | 230V 0,05A cos 0.5C | 230 | 0,05 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 25 | 230V 0,1A cos 0.5C | 230 | 0,1 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 26 | 230V 0,2A cos 0.5C | 230 | 0,2 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 27 | 230V 0,5A cos 0.5C | 230 | 0,5 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 28 | 230V 1A cos 0.5C | 230 | 1 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 29 | 230V 2A cos 0.5C | 230 | 2 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 30 | 230V 5A cos 0.5C | 230 | 5 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 31 | 230V 10A cos 0.5C | 230 | 10 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 32 | 230V 20A cos 0.5C | 230 | 20 | cos 0.05 C | 120 | -120 | 50,3 | 0,08 |
| 33 | 230V 50A cos 0.5C | 230 | 50 | cos 0.05 C | 120 | -120 | 50,3 | 0,2 |
| 34 | 230V 100A cos 0.5C | 230 | 100 | cos 0.05 C | 120 | -120 | 50,3 | 0,2 |

***Note:*** All points have been configured with phase shifts of U12 = 120° and U31 = -120°, and the test is performed using the Cycles method with 3 partial results. In this case, harmonics were not enabled. Additionally, for the points 230 V 50 A and 230 V 100 A at cos ϕ = 0.5L and cos ϕ = 0.5C, an adjusted error limit was applied due to the reference uncertainty.

After saving the complete test procedure and configuring the device type, the next step is to perform the actual test. To do this, go to the AutoTest tab, which is used to automatically execute the entire previously defined measurement sequence.




This is where you select the previously prepared test procedure along with the corresponding meter type (e.g., TS23). Once loaded, the program will automatically execute each test point in sequence, following the defined parameters—voltage, current, power factor, test duration, and measurement method.

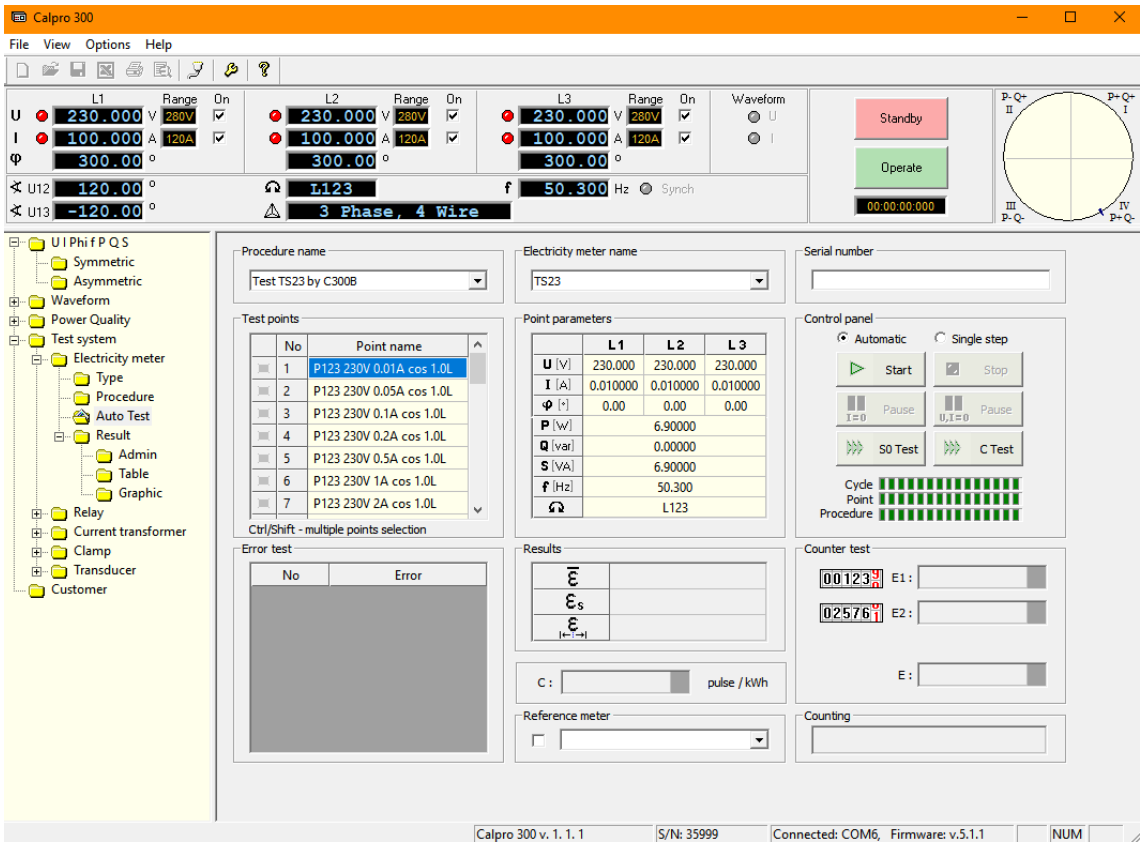
After entering the AutoTest tab, the first step is to establish a connection with the C300B calibrator. To do this, click the plug/cable icon located at the top of the program window. Once the connection is successfully established, the serial number of the calibrator will appear in Calpro300, and the status will change to "connected", indicating that the program has detected the calibrator and is ready to begin the test.

***Note:*** If the connection fails, make sure that the C300B is properly connected to the computer and that the correct communication port (COM) has been selected.

After establishing a connection with the C300B calibrator, the next step is to select the appropriate test settings. In the central part of the AutoTest tab, you need to choose the previously saved data:

- **Procedure name** – select from the list the name of the test procedure that was created earlier in the Procedure tab. This is the exact procedure that will be executed step by step by the program.
- **Electricity meter name** – select the name of the meter type, in our case TS23, which was previously defined in the Type.

Correctly assigning the procedure to a specific meter type is crucial, as all test parameters (such as base voltage, base current, or accuracy class) must match the characteristics of the device.

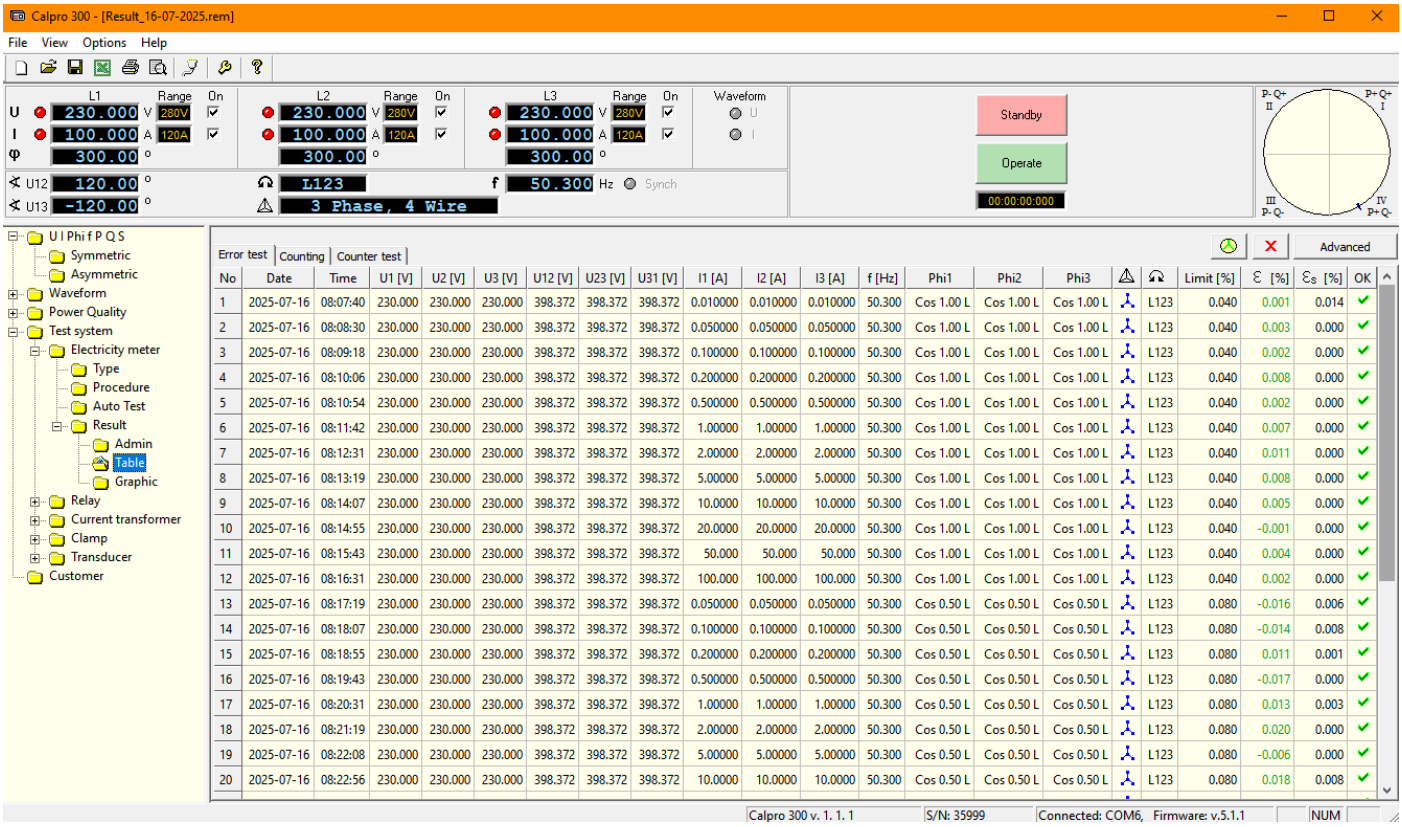



Once we have selected the appropriate procedure (Procedure name) and assigned the corresponding meter type (Electricity meter name), we can proceed to start the actual test.

To do this, click the Start button located at the bottom of the AutoTest tab. The program will begin automatically executing the defined sequence of test points according to the parameters specified earlier in the procedure.

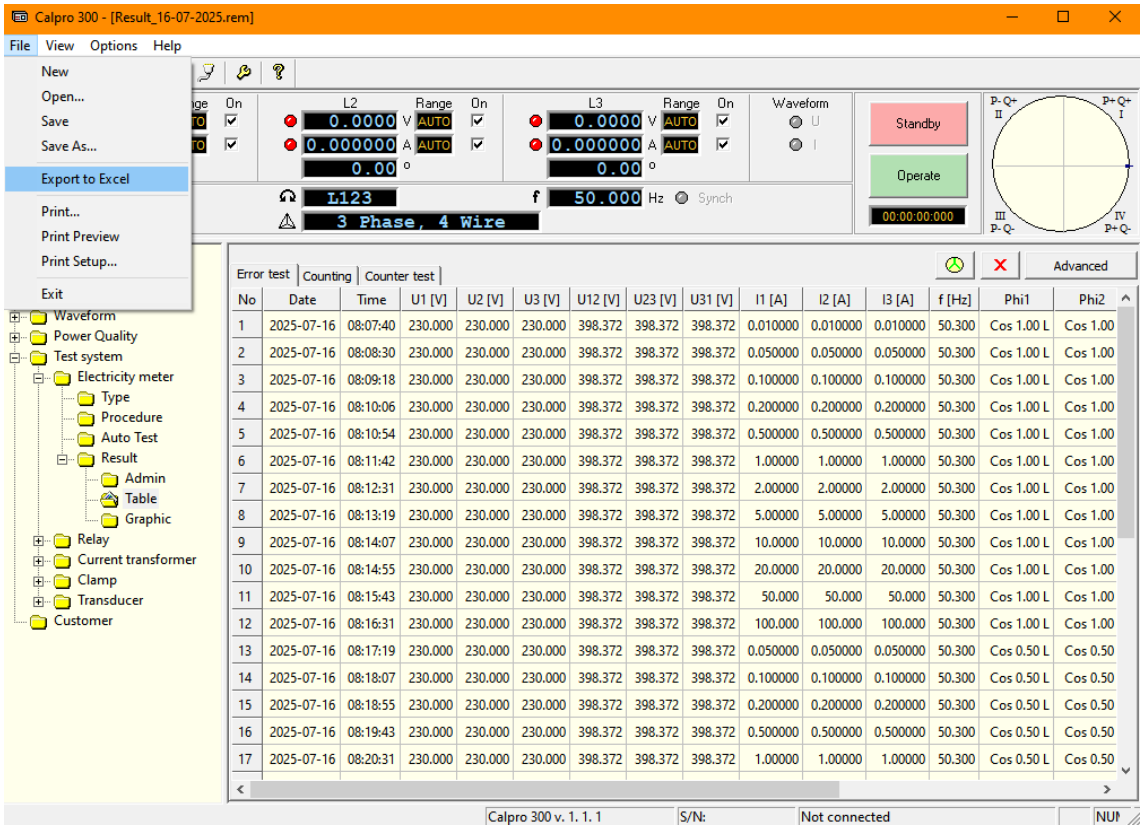
During the test, information about the current test point, duration, results, and any errors will be displayed in real time. After the test is completed, detailed results for each point will be available for analysis or saving.

After completing all the planned test points, the next step is to go to the Results section and then to the Table tab. Here, we can thoroughly review the measurement results recorded during the test. The table allows convenient comparison of the measured values with the reference values and assessment of the TS23 meter's compliance with the established accuracy criteria.



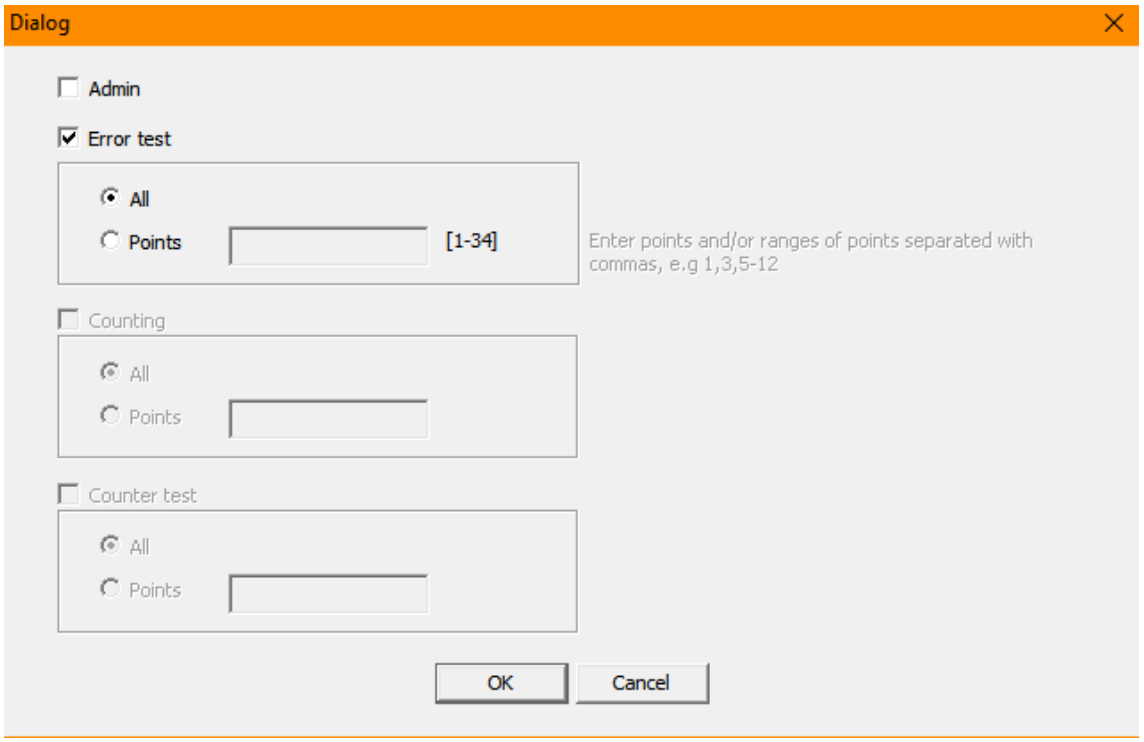

This stage provides a comprehensive overview of the tested device's performance and precision, which is crucial for a reliable analysis and potential further refinement of the testing procedure.

After reviewing the results in the Table tab, you have the option to export the data to an Excel file. To do this, click on the File tab in the upper left corner of the program window, then select Export to Excel from the dropdown menu. This allows you to easily save and further analyze the test results outside of the Calpro300 environment.




| No | Date | Time | U1 [V] | U2 [V] | U3 [V] | U12 [V] | U23 [V] | U31 [V] | I1 [A] | I2 [A] | I3 [A] | f [Hz] | Phi1 | Phi2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2025-07-16 | 08:07:40 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.010000 | 0.010000 | 0.010000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 2 | 2025-07-16 | 08:08:30 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.050000 | 0.050000 | 0.050000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 3 | 2025-07-16 | 08:09:18 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.100000 | 0.100000 | 0.100000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 4 | 2025-07-16 | 08:10:06 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.200000 | 0.200000 | 0.200000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 5 | 2025-07-16 | 08:10:54 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.500000 | 0.500000 | 0.500000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 6 | 2025-07-16 | 08:11:42 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 1.00000 | 1.00000 | 1.00000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 7 | 2025-07-16 | 08:12:31 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 2.00000 | 2.00000 | 2.00000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 8 | 2025-07-16 | 08:13:19 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 5.00000 | 5.00000 | 5.00000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 9 | 2025-07-16 | 08:14:07 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 10.0000 | 10.0000 | 10.0000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 10 | 2025-07-16 | 08:14:55 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 20.0000 | 20.0000 | 20.0000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 11 | 2025-07-16 | 08:15:43 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 50.000 | 50.000 | 50.000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 12 | 2025-07-16 | 08:16:31 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 100.000 | 100.000 | 100.000 | 50.300 | Cos 1.00 L | Cos 1.00 |
| 13 | 2025-07-16 | 08:17:19 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.050000 | 0.050000 | 0.050000 | 50.300 | Cos 0.50 L | Cos 0.50 |
| 14 | 2025-07-16 | 08:18:07 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.100000 | 0.100000 | 0.100000 | 50.300 | Cos 0.50 L | Cos 0.50 |
| 15 | 2025-07-16 | 08:18:55 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.200000 | 0.200000 | 0.200000 | 50.300 | Cos 0.50 L | Cos 0.50 |
| 16 | 2025-07-16 | 08:19:43 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 0.500000 | 0.500000 | 0.500000 | 50.300 | Cos 0.50 L | Cos 0.50 |
| 17 | 2025-07-16 | 08:20:31 | 230.000 | 230.000 | 230.000 | 398.372 | 398.372 | 398.372 | 1.00000 | 1.00000 | 1.00000 | 50.300 | Cos 0.50 L | Cos 0.50 |

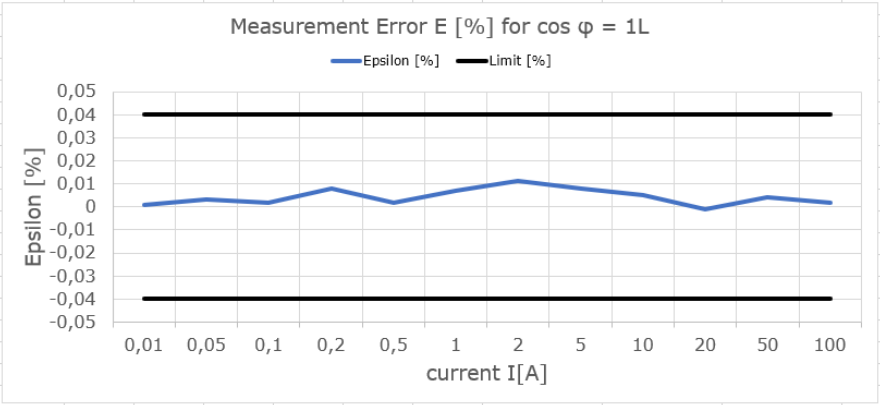
After clicking the Export to Excel option, a window will appear allowing you to select the data to export. If client data or administrative information has been entered in the Admin tab, you can check the Admin checkbox to include this information in the export file.



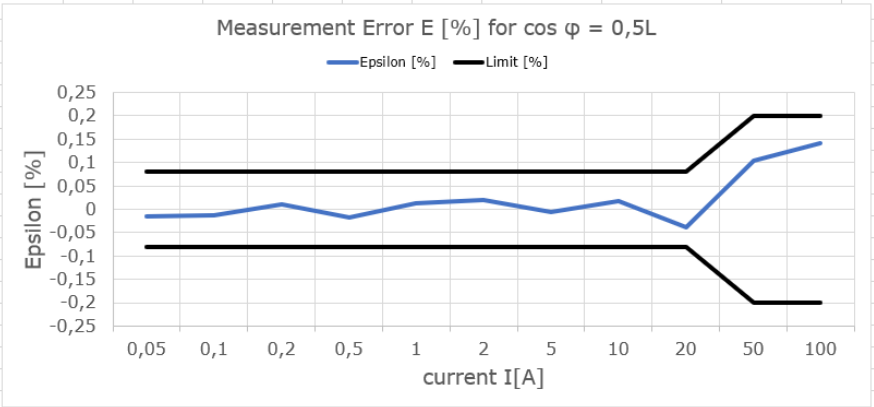
Additionally, you can choose specific test points to export. To do this, uncheck the All box and manually select the desired points in the Points section. If you want to export results from all points, simply check the All option. This way, you can customize the scope of exported data according to your needs and conveniently prepare your report.

After exporting the results to an Excel file, it is possible to further analyze and present them in a form tailored to the user's needs. An example of data processing can look like this - measurement data can be sorted, grouped according to selected criteria, and graphically presented in the form of charts or comparison tables.

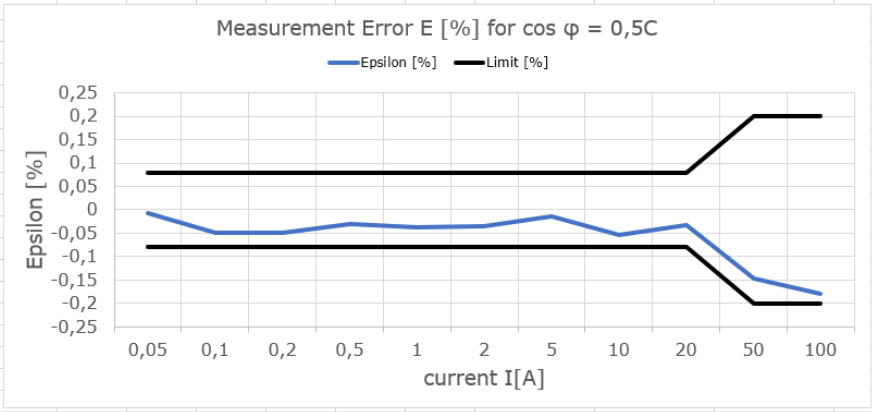
| U1 [V] | U2 [V] | U3 [V] | I1 [A] | I2 [A] | I3 [A] | f [Hz] | Phi1 | Phi2 | Phi3 | Limit [%] | Epsilon [%] | EpsilonS [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 230 | 230 | 0,01 | 0,01 | 0,01 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,001 | 0,014 |
| 230 | 230 | 230 | 0,05 | 0,05 | 0,05 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,003 | 0 |
| 230 | 230 | 230 | 0,1 | 0,1 | 0,1 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,002 | 0 |
| 230 | 230 | 230 | 0,2 | 0,2 | 0,2 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,008 | 0 |
| 230 | 230 | 230 | 0,5 | 0,5 | 0,5 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,002 | 0 |
| 230 | 230 | 230 | 1 | 1 | 1 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,007 | 0 |
| 230 | 230 | 230 | 2 | 2 | 2 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,011 | 0 |
| 230 | 230 | 230 | 5 | 5 | 5 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,008 | 0 |
| 230 | 230 | 230 | 10 | 10 | 10 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,005 | 0 |
| 230 | 230 | 230 | 20 | 20 | 20 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | -0,001 | 0 |
| 230 | 230 | 230 | 50 | 50 | 50 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,004 | 0 |
| 230 | 230 | 230 | 100 | 100 | 100 | 50,3 | Cos 1.00 L | Cos 1.00 L | Cos 1.00 L | 0,04 | 0,002 | 0 |




| U1 [V] | U2 [V] | U3 [V] | I1 [A] | I2 [A] | I3 [A] | f [Hz] | Phi1 | Phi2 | Phi3 | Limit [%] | Epsilon [%] | EpsilonS [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 230 | 230 | 0,05 | 0,05 | 0,05 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | -0,016 | 0,006 |
| 230 | 230 | 230 | 0,1 | 0,1 | 0,1 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | -0,014 | 0,008 |
| 230 | 230 | 230 | 0,2 | 0,2 | 0,2 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | 0,011 | 0,001 |
| 230 | 230 | 230 | 0,5 | 0,5 | 0,5 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | -0,017 | 0 |
| 230 | 230 | 230 | 1 | 1 | 1 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | 0,013 | 0,003 |
| 230 | 230 | 230 | 2 | 2 | 2 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | 0,02 | 0 |
| 230 | 230 | 230 | 5 | 5 | 5 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | -0,006 | 0 |
| 230 | 230 | 230 | 10 | 10 | 10 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | 0,018 | 0,008 |
| 230 | 230 | 230 | 20 | 20 | 20 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,08 | -0,039 | 0,006 |
| 230 | 230 | 230 | 50 | 50 | 50 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,2 | 0,105 | 0,001 |
| 230 | 230 | 230 | 100 | 100 | 100 | 50,3 | Cos 0.50 L | Cos 0.50 L | Cos 0.50 L | 0,2 | 0,141 | 0,004 |



| U1 [V] | U2 [V] | U3 [V] | I1 [A] | I2 [A] | I3 [A] | f [Hz] | Phi1 | Phi2 | Phi3 | Limit [%] | Epsilon [%] | EpsilonS [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 230 | 230 | 0,05 | 0,05 | 0,05 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,007 | 0,008 |
| 230 | 230 | 230 | 0,1 | 0,1 | 0,1 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,048 | 0,003 |
| 230 | 230 | 230 | 0,2 | 0,2 | 0,2 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,048 | 0 |
| 230 | 230 | 230 | 0,5 | 0,5 | 0,5 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,03 | 0 |
| 230 | 230 | 230 | 1 | 1 | 1 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,038 | 0,008 |
| 230 | 230 | 230 | 2 | 2 | 2 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,036 | 0,004 |
| 230 | 230 | 230 | 5 | 5 | 5 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,014 | 0 |
| 230 | 230 | 230 | 10 | 10 | 10 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,054 | 0,001 |
| 230 | 230 | 230 | 20 | 20 | 20 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,08 | -0,032 | 0,001 |
| 230 | 230 | 230 | 50 | 50 | 50 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,2 | -0,147 | 0,004 |
| 230 | 230 | 230 | 100 | 100 | 100 | 50,3 | Cos 0.50 C | Cos 0.50 C | Cos 0.50 C | 0,2 | -0,18 | 0,002 |




This form of elaboration of the results allows better interpretation of the test results and quicker catching of possible irregularities or trends in the behavior of the measured device.

**Conclusion:** presented application note provides a comprehensive overview of the testing process for the TS23 three-phase energy meter using the C300B calibrator. It covers both the technical aspects related to hardware and software configuration, as well as the preparation of the test procedure and the interpretation of the results. This approach enables reliable and repeatable testing, allowing for an accurate assessment of the meter's performance under various load conditions. Particular attention is also given to metrological considerations, such as reference uncertainty and limitations when testing devices with similar accuracy classes. The methodology and tools used can serve as a basis for further improvement of measurement procedures and implementation in laboratory and field practice.